# Detailed Project Report for Information Communication and Technology (ICT) Components

Adaptive Traffic Control System (ATCS)
Intelligent Traffic Management System (ITMS)
City Wide CCTV Surveillance System
ICT Enabled Solid Waste Management (SWM)
Smart Public Transport System
Enterprise and City GIS Solution
Environment Sensors
Data Centre and Disaster Recovery (DC-DR)
Integrated Command and Control Centre (ICCC)

Submitted By
**Project Management Consultants (PMC)**
**of**
**Agra Smart City Limited (ASCL)**

## Contents

1. **Executive Summary** ---- 11
1.1. About Agra ---- 11
1.2. About Agra Municipal Corporation ---- 11
1.3. About Agra Smart City Limited ---- 12
1.4. Key Project Stakeholders ---- 12
1.5. Population ---- 12
1.6. Economy ---- 13
1.7. Climate ---- 13
1.8. Smart City Solutions ---- 13
1.9. Project Objective ---- 14
1.10. Scope of Study ---- 14
1.11. Methodology ---- 15
2. **Design Principles** ---- 15
2.1. Business Principles ---- 16
2.1.1. Principle 1: Primacy of Principles ---- 16
2.1.2. Principle 2: Management of System and its Operations is Everybody's Business ---- 16
2.1.3. Principle 3: Business Continuity ---- 16
2.1.4. Principle 4: Service Orientation ---- 16
2.1.5. Principle 5: Compliance with Law ---- 16
2.1.6. Principle 6: Business Process Reengineering and Capacity Building ---- 17
2.2. Data Principles ---- 17
2.2.1. Principle 6: Data is an Asset ---- 17
2.2.2. Principle 7: Data is Shared ---- 17
2.2.3. Principle 8: Data is Accessible ---- 18
2.2.4. Principle 9: Data Trustee ---- 18
2.2.5. Principle 10: Common Vocabulary and Data Definitions ---- 18
2.2.6. Principle 11: Data Security ---- 18
2.3. Application Principles ---- 19
2.3.1. Principle 12: Technology Independence ---- 19
2.3.2. Principle 13: Ease-of-Use ---- 19
2.4. Technology Principles ---- 19
2.4.1. Principle 14: Requirements-Based Change ---- 19
2.4.2. Principle 15: Responsive Change Management ---- 19
2.4.3. Principle 16: Control Technical Diversity ---- 20
2.4.4. Principle 17: Interoperability ---- 20
3. **Primary and Secondary Data Collection** ---- 20

3.1. Traffic Data Analysis ---- 20
3.2. Accidents and Casualties Analysis ---- 30
3.3. Google Maps Based Traffic Analysis ---- 31
3.4. Junction Survey Analysis ---- 47
3.5. City Surveillance Analysis ---- 61
3.6. ICT Enablement in Solid Waste Management Study ---- 70
3.7. Smart Transportation Analysis ---- 84
3.8. Smart Parking Solution Analysis ---- 90
3.9. City Pollution Analysis ---- 91
3.10. Integrated Command and Control Centre Requirement ---- 93

4. **Purpose of ICT Components** ---- 96
4.1. Adaptive Traffic Control System (ATCS) ---- 96
4.2. Intelligent Traffic Management System (ITMS) ---- 96
4.3. City-wide CCTV Surveillance System ---- 97
4.4. ICT Enabled Solid Waste Management System ---- 97
4.5. Environment Sensors ---- 97
4.6. City and Enterprise GIS Solution ---- 98
4.7. Smart Public Transport System ---- 98
4.8. Data Centre and Disaster Recovery ---- 98
4.9. Integrated Command and Control Centre ---- 99

5. **Proposed Solution and Conceptualization** ---- 99
5.1. Agra City Complete Architecture ---- 99
5.1.1. Requirement of Network backbone ---- 99
5.1.2. Overview of Proposed Solution ---- 99
5.1.3. Volumetric Analysis ---- 100
5.1.4. Design Considerations ---- 100
5.1.5. Technical Requirement Specifications ---- 101
5.1.6. Network Topology ---- 103
5.1.7. Network Architecture Design ---- 105
5.1.8. Proposed Deployment Architecture ---- 106
5.1.9. Data Center and Disaster Recovery ---- 108
5.1.9.1. Solution Overview ---- 108
5.1.9.2. Data Center Design ---- 108
5.1.9.3. Disaster Recovery Design ---- 109
5.1.9.4. Infrastructure at DC/DR ---- 109
5.1.9.5. Data Center and Disaster Recovery – Deployment Architecture ---- 110
5.1.9.6. Storage Strategy – Deployment Architecture ---- 112
5.2. City Command and Operation Center ---- 112

5.2.1. Integrated Command and Control Centre ---- 112
5.2.2. Control Center for Police ---- 113
5.2.3. Network Operations Center ---- 113
5.2.4. Deployment Architecture ---- 114
5.3. Intelligent Traffic Management and City Surveillance System ---- 115
5.3.1. ICT Blueprint ---- 115
5.3.2. Proposed Components ---- 116
5.3.2.1. CCTV System ---- 116
5.3.2.1.1. Types of Cameras ---- 116
5.3.2.1.2. Factors considered for selecting CCTV Camera ---- 117
5.3.2.1.2.1. Resolution ---- 117
5.3.2.1.2.2. Image Quality ---- 117
5.3.2.1.2.3. Video Compression ---- 117
5.3.2.1.2.4. Network Connectivity ---- 118
5.3.2.2. Surveillance Applications ---- 119
5.3.2.3. Video Management System ---- 119
5.3.2.4. Video Analytics ---- 120
5.3.3. Deployment Architecture ---- 121
5.4. Adaptive Traffic Control System ---- 122
5.4.1. Structure of Adaptive Controlling ---- 122
5.4.2. Static Techniques ---- 123
5.4.3. Mobile Sensing Techniques ---- 124
5.4.4. Hybrid Sensing Techniques ---- 125
5.4.5. Prediction ---- 125
5.4.6. Optimization ---- 125
5.4.7. Differences between fixed-time planning traffic control system and ATCS ---- 126
5.4.8. Deployment Architecture with Network Connectivity ---- 127
5.5. ICT Enabled Solid Waste Management System ---- 128
5.5.1. Mandatory H/W for Real time monitoring of Solid Waste Collection Process ---- 129
5.5.2. Proposed Solution and Deployment Architecture ---- 129
5.5.2.1. Door to Door Collection ---- 130
5.5.2.2. Storage Bin Collection ---- 131
5.5.2.3. Fleet Status Monitoring ---- 132
5.5.2.4. Integration with Weighbridge Application ---- 133
5.5.2.5. Real Time Community bin level monitoring ---- 134
5.5.2.6. Biometric Attendance System ---- 135
5.5.2.7. Asset Lifecycle Monitoring ---- 136
5.5.2.8. Recycler and Rag picker's Registration System ---- 137
5.5.2.9. Central Control Center ---- 137
5.5.2.10. Integration with Smart City Platform ---- 138

6. **Detailed Scope and Functional Requirement** ---- 138

6.1. Overall Project Scope ---- 138
6.1.1. Finalization and Submission of a Detailed Technical Architecture ---- 139
6.2. Adaptive Traffic Control System (ATCS) ---- 142
6.2.1. Brief Scope ---- 142
6.2.2. Design, Integration and Maintenance of ATMS ---- 142
6.2.3. Functional Specification ---- 143
6.3. Intelligent Traffic Management System (ITMS) and City-wide CCTV Surveillance Solution ---- 147
6.3.1. Solution Requirements ---- 147
6.3.2. Public Address system ---- 147
6.3.3. Variable Message Signboards ---- 147
6.3.4. Emergency Call Box System or Panic Box ---- 148
6.3.5. On site Local Processing Unit with Communication and Electrical Interface ---- 148
6.3.6. Automatic Number Plate Recognition ---- 148
6.3.7. Red Light Violation Detection (RLVD) system ---- 149
6.3.8. E Challan System ---- 149
6.3.8.1. Functional Requirements of E Challan System ---- 150
6.3.8.2. Handheld Devices ---- 151
6.3.9. Face Recognition System ---- 152
6.3.10. No Helmet Detection System ---- 154
6.3.11. Operating Conditions ---- 154
6.3.12. Mobile Enforcement Solution for Police ---- 155
6.3.12.1. Police Vehicles ---- 155
6.3.12.2. Temporary Monitoring ---- 156
6.3.12.3. Wearable Monitoring ---- 156
6.3.12.4. Modern Infra and Peripherals ---- 156
6.3.13. CCTV Surveillance Cameras – Functional Specification ---- 157
6.3.13.1. Surveillance System Infrastructure at Field Locations ---- 157
6.3.13.2. Networking and Power Cables and Other Related Infrastructure ---- 158
6.3.13.3. Supply and Installation of CCTV Surveillance Infrastructure ---- 158
6.3.13.4. Installation of Poles/Cantilevers/Gantry ---- 158
6.3.13.5. UPS for Field Locations ---- 159
*6.3.13.6.* Outdoor Cabinets/Junction Boxes ---- 159
6.3.13.7. Civil and Electrical Works ---- 160
6.3.13.8. Earthing and Lightning Proof Measures ---- 160
6.3.13.9. Miscellaneous ---- 161
6.3.13.10. Mounting Structure ---- 161
6.4. ICT Enabled Solid Waste Management Solution ---- 162
6.4.1. Scope of Work ---- 162
6.4.2. Mandatory H/W for Real-time Monitoring of Solid Waste Collection Process ---- 163
6.4.3. Functional Specifications ---- 163
6.4.3.1. Automated Vehicle Tracking Management System ---- 164
6.4.3.2. Mobile GPS Based Staff Attendance Management System ---- 164
6.4.3.3. Mobile Application for Customers ---- 164
6.4.3.4. Unified Dashboard View for Solid Waste Management ---- 164
6.4.3.5. Infrastructure Solution – Field Devices ---- 165

6.5. City and Enterprise GIS Solution ---- 167
6.5.1. Scope of Work ---- 167
6.5.1.1. Geospatial Data Creation and Updating Base Map for PAN Area ---- 167
6.5.1.2. Data Collection ---- 167
6.5.1.3. Data Validation and Gap Analysis ---- 167
6.5.1.4. Positional Accuracy ---- 167
6.5.1.5. Procurement of High Resolution Satellite Imagery – Pan Area ---- 168
6.5.1.6. Geo Referencing and Post Processing of Satellite Imagery – PAN area ---- 168
6.5.1.7. Data Modelling Pan Area ---- 169
6.5.1.8. Digitization of Satellite Imagery, Updating and Capturing of Various Layers ---- 169
6.5.1.9. Property Survey and Property Tagging – ABD Area ---- 169
6.5.1.10. Final Base Map Preparation – PAN Area ---- 170
6.5.1.11. Tentative GIS Data Layers Required for Geospatial Smart City Project ---- 170
6.5.2. Data Migration ---- 174
6.5.3. Design and Development of Enterprise Web GIS Smart City Department Application ---- 174
6.5.3.1. Modules and Sub Modules of Land and Estate Management System ---- 175
6.5.3.2. Estate Management ---- 176
6.5.3.3. Disaster Fire and Emergency Services Management ---- 176
6.5.3.4. Park and Gardens Management System ---- 177
6.5.3.5. Water Management System ---- 177
6.5.3.6. Sewerage Operation ---- 178
6.5.3.7. Road and Traffic Management ---- 179
6.5.3.8. Strom Water Drainage Management System ---- 179
6.5.3.9. Street Light Management System ---- 179
6.5.3.10. Capital Project Monitoring and Control ---- 180
6.5.4. Integration GIS with Existing and Proposed/Future Smart Systems ---- 180
6.6. Smart Public Transport System ---- 181
6.6.1. Scope of Work ---- 181
6.6.2. Functional Specifications – Vehicle Location System and Passenger Information System ---- 181
6.6.3. Functional Specifications – Mobile Application ---- 182
6.6.4. Module: Multi Fleet System ---- 182
6.6.5. Module: Live Vehicle/Real Time Tracking ---- 182
6.6.6. Module: Reports and MIS ---- 183
6.6.7. General Requirement of the Application Software ---- 183
6.7. Environmental Sensors ---- 185
6.7.1. Scope of Work ---- 186
6.7.2. Functional Specifications ---- 186
6.8. Data Centre (DC) and Disaster Recovery (DR) Centre ---- 186
6.8.1. Scope of Work ---- 186
6.8.2. Design, Configuration, Installation and Commissioning of DC and DR ---- 187
6.8.3. DR Plan and Implementation ---- 189
6.8.4. Testing and Validation ---- 191
6.8.5. Post Implementation Maintenance and Support ---- 192
6.8.6. Security Audit ---- 192

6.8.7. Managed Hosting DataCentre Specification ---- 192
6.8.8. IT Infrastructure at Data Centre/ Disaster Recovery Centre ---- 193
6.8.10. Enterprise Management System (EMS) ---- 197
6.8.10.1. Network Management System ---- 197
6.8.10.2. Server Performance Monitoring System ---- 197
6.8.10.3. Centralized Help Desk System ---- 198
6.8.11. Reporting ---- 199
6.8.12. Centralised Anti-virus Solution ---- 199
6.8.13. Central Identity Management Service ---- 200
6.8.14. Authorization ---- 200
6.8.15. Unified Collaboration Solution ---- 200
6.9. City Communication and Network Infrastructure ---- 201
6.9.1. Scope of Work ---- 201
6.9.2. Security Requirements for Network as a Service ---- 202
6.9.3. Network Operations Centre ---- 202
6.10. Integrated Centralized Command and Control Centre (CCC) ---- 203
6.10.1. Scope of Work ---- 203
6.10.2. Design and Implementation of ICCC Control Room ---- 205
6.10.3. Indicative Representations of Command and Control Centre ---- 207
6.10.4. UP Dial 100 Control Room ---- 209
6.10.5. City Operations Platform ---- 211
6.10.6. Forensic Investigation Room ---- 212
6.10.7. Integrated Operation Platform (IOP) ---- 214
6.10.7.1. Data Aggregation, Normalization and Access ---- 215
6.10.7.2. GIS Map Support ---- 215
6.10.7.3. IOT platform Shall Enable Online Developer Program Tools ---- 217
6.10.7.4. Authentication ---- 217
6.10.7.5. Resiliency ---- 217
6.10.7.6. API Repository/API Guide ---- 217
6.10.7.7. Platform Upgrade and Maintenance ---- 218
6.10.7.8. Platform Functionality API Management and Gateway ---- 218
6.10.7.9. SDK/API Based Open Platform ---- 218
6.10.7.10. Trending Service ---- 218
6.10.7.11. Policies and Events ---- 218
6.10.8. Visualization Layer ---- 218
6.10.8.1. ICCC Operations ---- 218
6.10.8.2. Integration Capabilities ---- 220
6.10.8.3. Notifications, Alerts and Alarms ---- 220
6.10.8.4. Users and Roles ---- 220
6.10.8.5. Reports ---- 220
6.10.8.6. Standard Operating Procedure ---- 221
6.10.8.7. Collaboration among Stakeholders ---- 221
6.10.8.8. Analytics Engine ---- 222
6.10.8.9. API and Interface Security ---- 222
6.10.8.10. Business Operations Audit and Logging ---- 223
6.10.8.11. Field Responder Mobile ---- 223

6.10.9. Video Management System ---- 223
6.10.9.1. VMS Core Components ---- 225
6.10.9.2. VMS General ---- 226
6.10.9.3. VMS GUI Capabilities ---- 227
6.10.9.4. VMS Map Functionality ---- 228
6.10.9.5. VMS Configuration ---- 228
6.10.9.6. VMS User Hierarchy ---- 229
6.10.9.7. VMS Recording Requirements ---- 229
6.10.9.8. Manual or On-demand Recording ---- 231
6.10.9.9. VMS Review System ---- 231
6.10.9.10. VMS Alarm Handling ---- 232
6.10.9.11. VMS Integration Requirements ---- 233
6.10.9.12. VMS System Size ---- 233
6.10.10. Video Analytics ---- 233
6.10.11. Access Control System – Functional Specifications ---- 234
6.10.12. Edge Analytics and Artificial Intelligence with Continuous Learning ---- 234
7. **Minimum Technical Requirement** ---- 236
7.1. Adaptive Traffic Control System (ATCS) ---- 236
7.2. Intelligent Traffic Management System and City Wide CCTV Surveillance Solution ---- 238
7.3. ICT Enabled Solid Waste Management ---- 257
7.4. City and Enterprise GIS Solution ---- 265
7.5. Smart Public Transport System ---- 277
7.6. Environmental Sensors ---- 283
7.7. Data Centre (DC) and Disaster Recovery (DR) Centre ---- 285
7.8. Integrated Centralized Command and Control Centre (CCC) ---- 332
8. **Testing and Acceptance Procedures** ---- 346
8.1. Test Plan ---- 347
8.2. Test scenarios ---- 347
8.3. Test Execution ---- 348
8.3.1. Unit Testing ---- 348
8.3.2. Integration Testing ---- 348
8.3.3. Incremental Integration Testing ---- 348
8.3.4. System Testing ---- 348
8.3.5. Pre-Production Testing ---- 349
8.3.6. Regression Testing ---- 349
8.3.7. Performance Testing ---- 349
8.3.8. Load Testing ---- 349
8.3.9. Installation Testing ---- 349
8.3.10. Security/Penetration Testing ---- 349

8.3.11. Recovery/Error Testing ---- 350
8.3.12. Acceptance Testing ---- 350
8.3.13. Performance Testing ---- 350
8.3.14. Field Acceptance Testing ---- 350
8.4. Testing, Commissioning and Successful Operation ---- 351

9. **Training and Capacity Building** ---- 351
9.1. Types of Trainings ---- 352
9.1.1. Basic IT Training ---- 352
9.1.2. Functional Training ---- 352
9.1.3. Administrative Training ---- 353
9.1.4. Senior Management Training ---- 353
9.2. Post-Implementation Training ---- 353
9.3. Capacity Building ---- 353

10. **Project Implementation** ---- 353

11. **Project Timelines** ---- 356
11.1. Phase I – T + 2 months (T is the date of signing of the contract with MSI) ---- 356
11.2. Phase II – T + 6 months ---- 356
11.3. Phase III – T + 9 months ---- 357
11.4. Phase IV – T1 + 60 months (T1 is the date of Go Live of all application) ---- 357

12. **Project Risk and Mitigation** ---- 357

13. **Project Controls, Measurement and Targets** ---- 357
13.1. Implementation phase related performance levels ---- 357
13.2. Data Centre (DC) / Disaster Recovery (DR) Centre ---- 358
13.3. Network related performance levels ---- 359
13.4. Service Level for ICT Solutions ---- 360
13.5. Help Desk / Extension of UP Dial 100 ---- 365
13.6. Camera Feed and Quality ---- 366

14. **Project Governance Committee** ---- 367

15. **Indicative Bill of Material for City Requirement** ---- 369

16. **Proposed Financial Estimates** ---- 373

17. **Annexures** ---- 373
17.1. Annexure 1: Junctions for Intelligent and Adaptive Traffic Signals ---- 373
17.2. Annexure 2: Intelligent Traffic Management System with General Surveillance ---- 375
17.3. Annexure 3: CCTV for City Surveillance System ---- 379
17.4. Annexure 4: Emergency Panic Button with Public Addressing System ---- 388

17.5. Annexure 5: Environment Sensors---------- 389
17.6. Annexure 7: List of Location for Variable Message System ---------- 390
17.7. Annexure 6: OFC Network Availability---------- 391
17.8. Annexure 7: List of Police Stations and Chowkis---------- 392

# 1. Executive Summary

## 1.1. About Agra

Agra, the city of Taj Mahal, is the third most populous city in Uttar Pradesh and is the administrative headquarters of the Agra district. The city is a major tourist hub with a number of monuments like Agra Fort and Fatehpur Sikri Fort, other than the Taj Mahal, which are listed as UNESCO World Heritage sites.

In the past few decades, Agra Development Authority (ADA) Area has experienced unprecedented spatial expansion from 61.80 sq km in 1971 to 520.20 sq km in 2008, and a steep rise in population. The city's population grew from just 5.91 lakhs in 1971 to more than 9.78 lakhs in 1991, and in the census of 2001 the city's population was found to be 12.75 lakhs. It is now a million plus city.

The administrative limits of the Agra Nagar Nigam (ANN) encompass an area of 141.0 sq. km with a population density of about 9,043 persons per sq. km. The highest density is in the old city areas where the settlements started flourishing in the Mughal period like Loha Mandi, Shahganj, and lowest in colonial Agra.

Although the spatial growth has been considerable, disproportionate spatial development has led to pockets of high density in terms of employment and population, putting pressure on the infrastructure of the city. A phenomenal increase in commercial activities were witnessed during the post-independence period with the associated industrial development and establishment of industrial estate, which resulted in the increase of city population.

1n 1998 Ministry of Environment and Forests, Government of India notified an area of 10400 sq. km as Taj Trapezium Zone (TTZ). The CPCB delineated the Taj Trapezium Zone on the basis of the weighted mean wind speed in twelve directions from Agra to Mathura and Bharatpur. The boundaries of the zone were made keeping in mind the possible effect of pollution sources in this zone on the critical receptor – the Taj Mahal. It banned the use of coal/coke in industries located in the TTZ with a mandate for switching over from coal/coke to natural gas, and relocating them outside the TTZ or shutting down. Promoting bicycling shall thereby support this objective by adding a green, non-polluting mode of transportation.

## 1.2. About Agra Municipal Corporation

The Agra Nagar Nigam (ANN) is among the largest municipal bodies in the state of Uttar Pradesh providing civic services to the estimated population of 1,686,976 (as per 2010 est.) Within its jurisdiction are some of the most attractive tourist spots of the world including Taj Mahal and Sikandra. ANN came into existence under the Nagar Mahapalika Adhiniyam, 1959 of UP. Since then, the municipal body has always been responsive in its constitution and functioning to the growing needs of citizens. Agra Nagar Nigam (ANN) is a local government body committed to providing basic infrastructure facilities, including entertainment facilities, to the people of the city. ANN is well known for managing the city by using private sector participation as well as introducing innovative managemnt mechanisms to serve people efficiently. The city has prepared different plans for improving services and to nullify the gap between services and demand. The Health Department of ANN takes up the responsibility of health and sanitation management with the Chief Health Officer heading the department, whereas the Engineering Department assists in the procurement of vehicles, equipment, and developing the landfill site, etc. The Health Department has a total employee strength of 2299,of which 2090

(90.9%) are sanitation workers. Agra Nagar Nigam is committed to clean and green Agra and promotes any cause that helps reduce pollution such as bicycling. Agra Nagar Nigam also participated in the Swachh Sarveshan 2018 held post January 4, 2018.

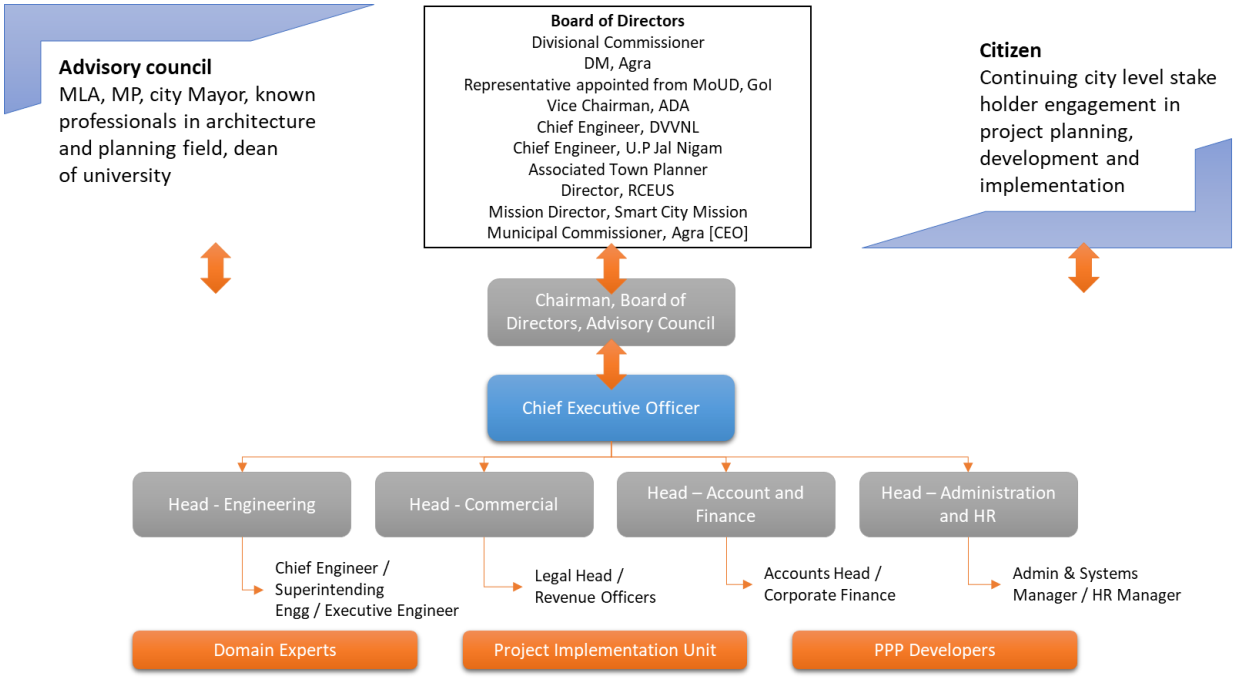
Urban local bodies in the state of Uttar Pradesh are governed by two important legislations — UP Municipal Corporations Adhiniyam, 1959, and UP Municipalities Act, 1916. These two acts specify the governance framework, spatial jurisdiction, and the functional domain of the urban local bodies. The corporation has a democratically elected leadership from the constituencies within the geographic jurisdiction of the corporation boundaries.

### 1.3. About Agra Smart City Limited

Agra Smart City Limited (ASCL) is a Special Purpose Vehicle (SPV) created with representation from all major stakeholders from the city of Agra, as per the Government of India's Smart City guidelines. This SPV is responsible for the implementation of projects under the Smart City Mission. This SPV shall carry out end-to-end responsibility for vendor selection, implementation, and operationalization of various smart city projects.

### 1.4. Key Project Stakeholders

The project envisages involvement of multiple stakeholders that would be a part of the project. There are a set of stakeholders that would be common for all the smart city solutions, while some of them would be solution-specific. The list of all key stakeholders is as follows:




### 1.5. Population

As of 2011 India census, Agra city has a population of 1,585,704, while the population of Agra Cantonment is 53,053. The urban agglomeration of Agra has a population of 1,760,285. Males constitute 53% of the population and females 47%. Agra city has an average literacy rate of 75.11%, (above the national average of

74%). The ;iteracy rate of males is considerably higher than that of females. The sex ratio in the city was 875 females per thousand males while child sex ratio stood at 857. Agra district literacy rate is 62.56%. According to the 2011 census, Agra district has a population of 4,380,793, roughly equal to the nation of Moldova or the US state of Kentucky. This gives it a ranking of 41st in India (out of a total of 640). The district has a population density of 1,084 inhabitants per sq. km (2,810/sq mi) and 52.5% of Agra's population is in the 15–59 years age category. Around 11% of the population is under 6 years of age.

### 1.6. Economy

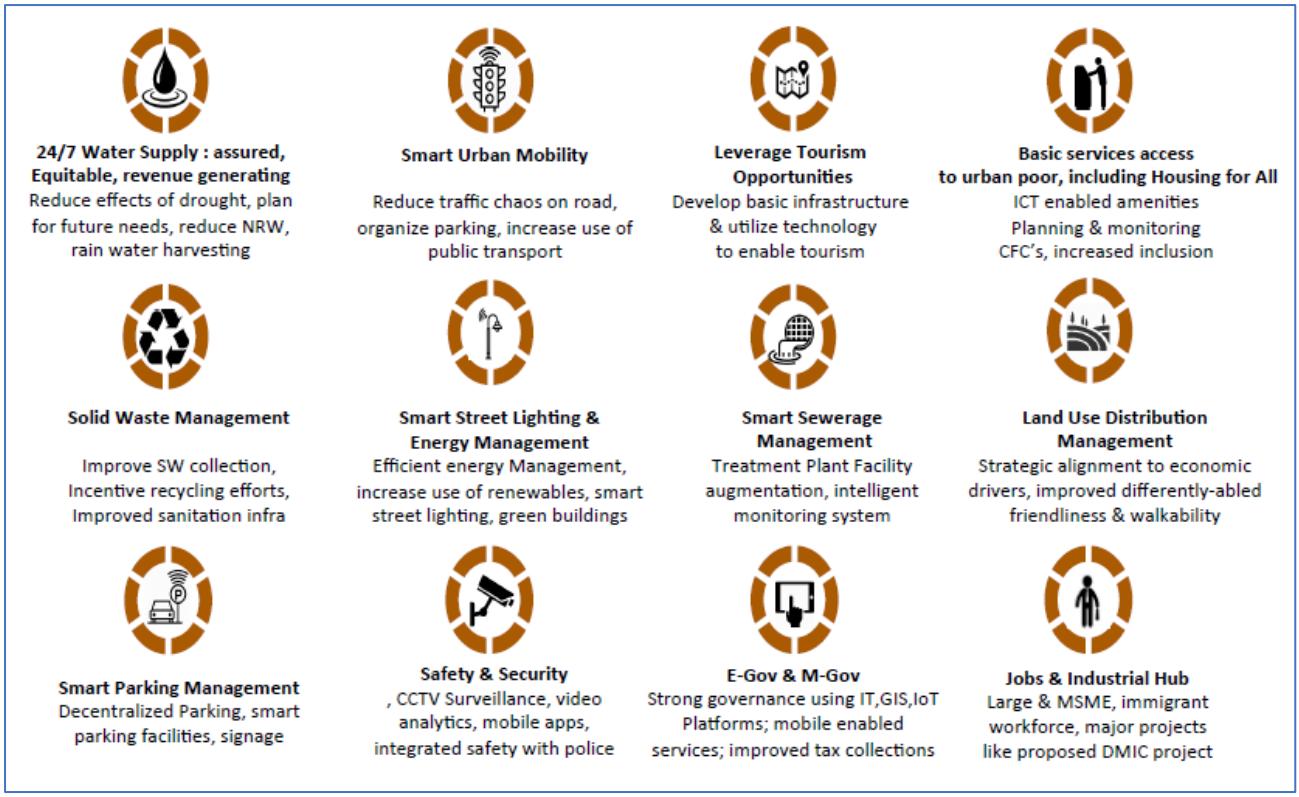
Although tourism contributes to a large extent in the economy of Agra, the city has a substantial industrial base. A lot of manufacturing plants and industry-related wholesale markets are prominent in Agra. Agra industries are doing a fine job in various fields. Producers and dealers of Agra deal in different products and have a vast market to support them. The economy of Agra is also dependent on industrial production. But the cities industrial base also produces automobiles, leather goods, handicrafts, and stone carving.

### 1.7. Climate

Agra, located on the Indo-genetic plain has a continental sub-tropical climate, with long, hot summers from April to September when temperatures can reach as high as 45°C (113°F). During summers, dry winds blow in this region. The monsoon months from July to September see about 67 cm (27 inches) of rainfall annually.
Area: 120.57 sq. km
Altitude: 169 m above sea level
Location: Uttar Pradesh, India
Languages: Hindi and Urdu

### 1.8. Smart City Solutions

Of the exhaustive list of smart city solutions, the following ICT-based smart components have been shortlisted for implementation for Agra Smart City. These would be implemented within the city in a phased manner, either through PAN City or Area Based Development. The below presented diagram provides a big picture of identified solutions:




## 1.9. Project Objective

One of the primary objectives of Agra under its smart city mission is to enhance the safety and security for citizens of Agra and worldwide tourists visiting Agra to see the beauty, affection, and love symbol, its Heritage Monument, the TAJ MAHAL.

Other objective caters to bring law enforcement and public awareness among citizens of Agra on various horizons of Traffic Rules, Safe Driving, Solid Waste, and Improved Sanitation, which will promote a better quality of life for residents and also enhance and improve the efficiency of municipal services.

In order to achieve these objectives, Agra Municipal Corporation desires to foster the development of a robust ICT infrastructure that supports digital applications and ensures seamless steady state operations, transport and traffic management, emergency response mechanisms, and real time tracking of services and vital city metrics throughout the city and in government departments.

## 1.10. Scope of Study

Considering the objective the city is looking to attain, with an overall perspective to have smart components and enablers that bring Public Awareness and Law Enforcement on several scales, the scope of the study is majorly on the analysis of detailed study conducted by various departments like Agra Development Authority on Comprehensive Mobility Plan for City, Detailed Project Report on Solid Waste Management. The plan is and proposed for the next 25-30 years with inputs received from the officials/board member and inputs from local citizens and their engagement etc. Based on the junctions/locations, a detailed scope of work for each horizon

in ICT components is noted and its functional and technical requirements are defined whose capabilities and compatibilities shall be available in MSI RFP for compliances.

A. Requirement of Traffic Signals and ITMS Components at the junctions was studied and identified by following reports:
   - The junctions which were identified critical in Comprehensive Mobility Plan shared by ADA
   - Traffic Study of Live and Typical Traffic through GIS Maps
   - Understanding of Critical Junctions from SP Traffic and pain points on each of these junctions
   - Report submitted by PwC during preparation of Smart City Plan
   - Traffic Count conducted on few of the junctions which are intermediaries point on critical roads
   - Physical Site Survey conducted on critical junctions

B. List of Surveillance Points for monitoring and law enforcement was solely on the input of City Police due to threats like snatching, theft, accidents, and causalities etc., followed by physical site surveys to understand the count of cameras and their placement with desired power and network requirement

C. Identification of important routes, busy roads and critical infrastructure like buses, bus shelters etc., to understand the need and upgradation for better transport facilities in the city

D. Identification of parking locations in the city and checking the number of cars being catered to at various times/durations in a day to accumulate maximum number of vehicles through smart parking solutions

E. Detailed scope where ICT Components need to act as an enabler to Solid Waste Management. A detailed study was conducted by RCUES and a Detailed Project Report is submitted which contains details in brief on actual number of wards, waste collection in each ward, types of waste collection from households/commercial establishments etc.

F. Environment monitoring of Agra city through current available sensors and its authenticity of data resembling the actual pollution level of city

G. Need of Centralized GIS with complete layer creation for ICT Components with existing layer and available data

H. Identification and Analysis of Existing Control Centre with the horizon it monitors and captures the data. Consolidate the current need and consider expansion of ICT Components in the city, identify the actual requirements of the Integrated Command and Control Centree where all the critical data is being captured, maintained, monitored and analyzed to provide the evidence, and even forecast the need for future for betterment of the city

### 1.11. Methodology

The project preparation has been broadly classified into following stages:

1. Identifying the Need of the city
2. Analysis on Survey conducted and Data received from Primary and Secondary Collection
3. Identification of Issues and Gaps
4. Purpose of ICT Components
5. Setting up the Objectives in each of the Horizons
6. Identifying and Detailing Functional and Technical Specifications
7. Budgetary Cost

## 2. Design Principles

## 2.1. Business Principles

### 2.1.1. **Principle 1: Primacy of Principles**

**Statement:** All principles of information management set out shall apply to all organizations/stakeholders within the city.

**Rationale:** The only way proposed Smart City for Agra can provide a consistent and measurable level of quality information to decision-makers is if all organizations/stakeholders abide by the principles.

### 2.1.2. **Principle 2: Management of System and its Operations is Everybody's Business**

**Statement:** All stakeholders of the proposed Smart City for Agra including participating Government Departments and agencies other than Agra Nagar Nigam (ANN), and private stakeholders shall participate in management activities for system and operations needed to accomplish objectives set for Agra Smart City.

**Rationale:** All users of the proposed Agra Smart City are stakeholders in the application of technology to address a business need. In order to ensure the management of system and operations is aligned with the objectives set, all organizations/stakeholder must be involved in all aspects.

### 2.1.3. **Principle 3: Business Continuity**

**Statement:** System operations shall be maintained in spite of any interruptions.

**Rationale:** As operations of the proposed Agra Smart City become more pervasive, all stakeholders will become more dependent on them; therefore, reliability of the System must not just be considered as fundamental during its design phase but must also be considered as essential during its operations. Business premises throughout the universe of participating Government Departments and agencies, and private stakeholders must be provided with the capability to continue their business functions regardless of external events. Hardware failure, natural disasters, and data corruption should not be allowed to disrupt or stop enterprise activities. Functionality of proposed Agra Smart City must be capable of operating on alternative information delivery mechanisms.

### 2.1.4. **Principle 4: Service Orientation**

**Statement:** Architecture of the proposed Agra Smart City shall be based on a design of services that mirror real-world business activities within the participating Government Departments and agencies, and private stakeholders.

**Rationale:** Service orientation delivers agility and Boundary-less Information Flow across participating Government Departments and agencies. Service orientation will allow users to access and transact the same functionality through various methods – like by accessing applications through web or mobile apps.

### 2.1.5. **Principle 5: Compliance with Law**

**Statement:** System and information management processes shall comply with all relevant laws, policies, and regulations.

**Rationale:** System and information management policy drives operations to abide by laws, policies, and regulations. But this will not preclude business process improvements that lead to changes in policies and regulations. Hence, a tight control on adherence to laws, policies and regulations shall be maintained through monitoring and course correction whenever non-compliance is observed.

#### 2.1.6. **Principle 6: Business Process Reengineering and Capacity Building**

**Statement:** Business process flows and how each stakeholder and business actor interacts with the system and the overall process will require change.

**Rationale:** As new systems are put in place, older business and people processes get redefined. Different steps of the overall processes get streamlined, changed, deleted, and augmented. This requires a people change management to ensure people understand the new processes so that they can comply with them, as per the principles of Business Continuity and Service Orientation. This will require mapping of the old and new processes, identifying key changes, and thus creating detailed process documents and capacity building manuals.

The change management process will include workshops with stakeholders at all levels, including 'train the trainer' workshops to ensure that process changes cascade through the organization down to the last mile. This will need newer methods of monitoring compliance and performance.

### 2.2. Data Principles

#### 2.2.1. **Principle 6: Data is an Asset**

**Statement:** Data is an asset that has value to the stakeholders and ought to be managed accordingly.

**Rationale:** Data is a valuable organizational resource; it has real, measurable value. In simple terms, the purpose of data is to aid decision-making. Accurate, timely data is critical to accurate, timely decisions. All organizational assets ought to be carefully managed, and data is no exception. Data is the foundation of any decision-making decision, and so it must also be carefully managed to ensure that stakeholders know where it is, can rely upon its accuracy, and can obtain it when and where we need it.

#### 2.2.2. **Principle 7: Data is Shared**

**Statement:** Users have access to the data necessary to perform their duties; therefore, data ought to be shared across organizational functions and organizations themselves.

**Rationale:** Timely access to accurate data is essential to improving the quality and efficiency of decision-making. It is less costly to maintain timely, accurate data in a single application, and then share it, than it is to maintain duplicative data in multiple applications. An organization may typically hold a wealth of data, but it may be stored in hundreds of incompatible stovepipe databases. The speed of data collection, creation,

transfer, and assimilation is driven by the ability of the organization to efficiently share these islands of data across the organization/organizations.

Shared data will result in improved decisions since the need for relying on fewer (ultimately one virtual) sources of more accurate and timely managed data for all decision-making. Electronically shared data will result in increased efficiency when data entities can be used, without re-keying, to create other entities.

#### 2.2.3.**Principle 8: Data is Accessible**

**Statement:** Data is accessible for users to perform their functions.

**Rationale:** Wide access to data leads to efficiency and effectiveness in decision-making, and affords timely response to information requests and service delivery. Using information must be considered from an organizational perspective to allow access by a wide variety of users. Staff time is saved and consistency of data is improved.

#### 2.2.4.**Principle 9: Data Trustee**

**Statement:** Each data element has a trustee accountable for data quality.

**Rationale:** One of the benefits of an architected environment is the ability to share data (e.g., text, video, sound, etc.) across participating Government Departments and agencies, and private organizations. As the degree of data sharing grows and organizations rely upon common information, it becomes essential that only the data trustee makes decisions about the content of data. Since data can lose its integrity when it is entered multiple times, the data trustee will have sole responsibility for data entry, which eliminates redundant human effort and data storage resources.

#### 2.2.5.**Principle 10: Common Vocabulary and Data Definitions**

**Statement:** Data will be defined consistently throughout system, and the definitions shall be understandable and available to all users.

**Rationale:** The data that will be used in the development of applications must have a common definition throughout to enable sharing of data. A common vocabulary will facilitate communication and enable dialog to be effective. In addition, it is required to interface systems and exchange data.

#### 2.2.6.**Principle 11: Data Security**

**Statement:** Data shall be protected from unauthorized use and disclosure. In addition to the traditional aspects of national security classification, this shall include, but will not be limited to, protection of pre-decisional, sensitive, source selection-sensitive, and proprietary information.

**Rationale:** Open sharing of information and the release of information via relevant legislation must be balanced against the need to restrict the availability of classified, proprietary, and sensitive information.

Existing laws and regulations require the safeguarding of the State's security and the privacy of data, while permitting free and open access. Pre-decisional (work-in-progress, not yet authorized for release) information must be protected to avoid unwarranted speculation, misinterpretation, and inappropriate use.

## 2.3. Application Principles

### 2.3.1. **Principle 12: Technology Independence**

**Statement:** Applications shall be independent of specific technology choices and therefore can operate on a variety of technology platforms.

**Rationale:** Independence of applications from the underlying technology allows applications to be developed, upgraded, and operated in the most cost-effective and timely way. Otherwise technology, which is subject to continual obsolescence and vendor dependence, becomes the driver rather than the user requirements themselves.

Realizing that every decision made with respect to IT makes Agra city dependent on that technology, the intent of this principle is to ensure that Application Software is not dependent on specific hardware and operating systems software.

### 2.3.2. **Principle 13: Ease-of-Use**

**Statement:** Applications shall be easy to use. The underlying technology shall be transparent to users, so they can concentrate on tasks at hand.

**Rationale:** The more a user has to understand the underlying technology, the less productive that user will be. Ease-of-use is a positive incentive for use of applications. It will encourage users to work within the integrated information environment instead of developing isolated systems to accomplish the task outside of the proposed eProcurement Systems integrated information environment. Most of the knowledge required to operate one system will be similar to others. Training can be kept to a minimum, and the risk of using a system improperly will be low.

## 2.4. Technology Principles

### 2.4.1. **Principle 14: Requirements-Based Change**

**Statement:** Changes to applications and technology shall be made only in response to user needs.

**Rationale:** This principle will foster an atmosphere where the information environment changes in response to the needs specified by users, rather than having the operational processes change in response to IT changes. This will ensure that the purpose of the information support – any transaction – is the basis for any proposed change. Unintended effects on the System due to IT changes will be minimized. A change in technology may provide an opportunity to improve the business process and, hence, change business needs.

### 2.4.2. **Principle 15: Responsive Change Management**

**Statement:** Changes to the proposed Agra Smart City information environment shall be implemented in a timely manner.

**Rationale:** If people are to be expected to work within the proposed information environment, that information environment must be responsive to their needs.

#### 2.4.3. **Principle 16: Control Technical Diversity**

**Statement:** Technological diversity shall be controlled to minimize the non-trivial cost of maintaining expertise in and connectivity between multiple processing environments.

**Rationale:** There is a real, non-trivial cost of infrastructure required to support alternative technologies for processing environments. There are further infrastructure costs incurred to keep multiple processor constructs interconnected and maintained.

Limiting the number of supported components will simplify maintainability and reduce costs. The operational advantages of minimum technical diversity include standard packaging of components; predictable implementation impact; predictable valuations and returns; redefined testing; utility status; and increased flexibility to accommodate technological advancements. Common technology across the enterprise will bring the benefits of economies of scale to the State. Technical administration and support costs will be better controlled when limited resources can focus on this shared set of technology.

#### 2.4.4. **Principle 17: Interoperability**

**Statement:** Software and hardware shall conform to defined standards that promote interoperability for data, applications, and technology.

**Rationale:** Standards help ensure consistency, thus improving the ability to manage systems and improve user satisfaction, and protect existing IT investments, thus maximizing return on investment and reducing costs. Standards for interoperability additionally help ensure support from multiple vendors for their products, and facilitate supply chain integration.

## 3. Primary and Secondary Data Collection

### 3.1. Traffic Data Analysis

Urban Mass Transit Company Limited (UMTCL) has done a rigorous survey for Agra City in coordination with Agra Development Authority (ADA) and have shared a draft copy of Comprehensive Mobility Plan, December 2017.

The following table represents the surveys conducted during Primary Data Collection. The survey location, duration, and sample quantity have been indicated.

| S.No. | Survey Type | Coverage |
|---|---|---|

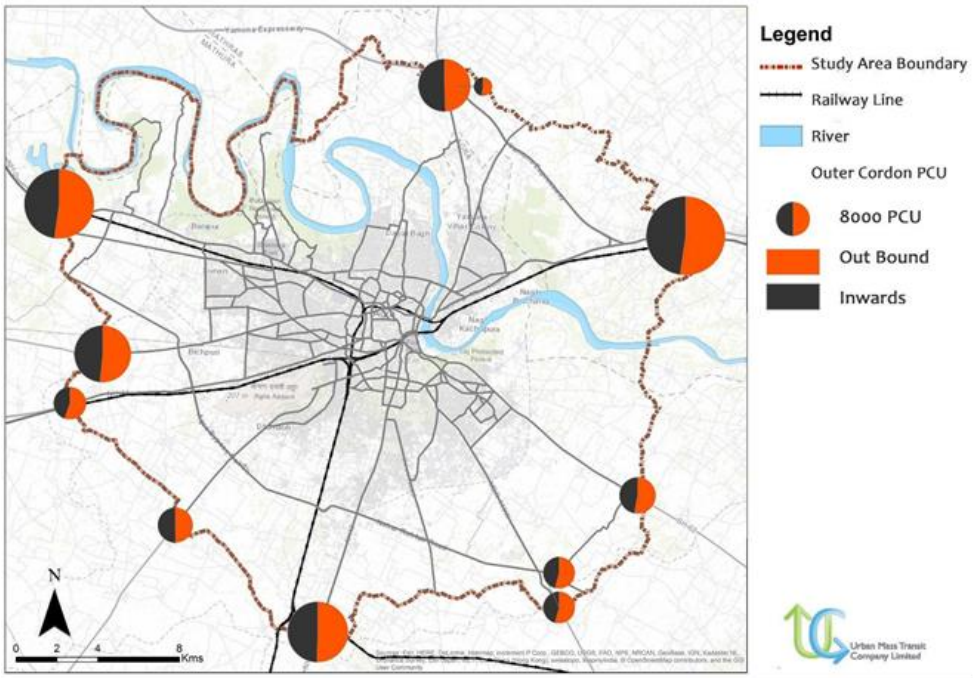
| | | |
|---|---|---|
| **1** | Directional Classified Traffic Volume Counts and Vehicle Occupancy Surveys | |
| | a. Mid-Blocks/Screen Line | 31 Locations |
| | b. Junctions | 50 Locations |
| | c. Outer Cordons | 10 Locations |
| **2** | Pedestrian Volume Counts | 60 Locations |
| **3** | Speed and Delay Surveys | Along all arterial and major roads in the study area for 414.4 km length |
| **4** | Road Network Inventory | Along all arterial and major roads in the study area for 414.4 km length |

### A. Classified Traffic Volume Count Surveys on Outer Cordon Locations (16 hours)

The main objective of the survey was to estimate the classified vehicular volumes crossing the screen lines and along the cordon points to be used for validation of the transport model. Traffic counts on Screen lines and cordon counts were conducted for 16 hours a day, covering both peak and off-peak periods. A total of 10 outer cordon points are:

1) Yamuna Expressway (towards Delhi)
2) NH-2 (towards Kanpur)
3) SH-62 (towards Fatehabad)
4) Shamshabad Road
5) NH-3 (towards Gwalior)
6) SH-39 (towards Jagner)
7) NH-11 (towards Jaipur)
8) Bharatpur Road
9) NH-2 (towards Mathura)
10) Aligarh Road

Outer cordon surveys were conducted at 10 locations to understand the characteristics of outbound and inbound traffic of Agra. Following is a summary of the analysis of the survey.



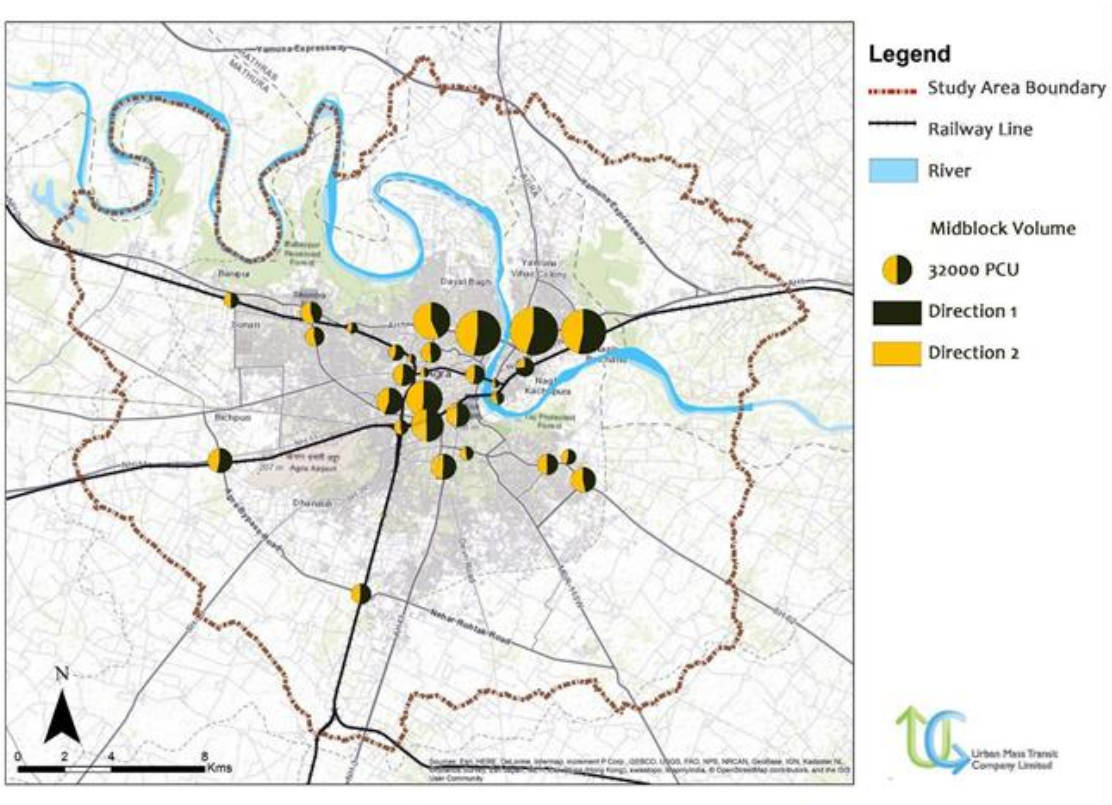

- Daily Traffic Flow – Roads towards Kanpur, Mathura and Gwalior showed highest volume of traffic at outer cordon survey locations, whereas, the Yamuna Express Highway towards Delhi witnessed the least traffic.
- Peak Hour Traffic – Morning peak constituted 8% of the total traffic whereas, the evening peak constituted to 7%. During morning and evening peak hours, 78% of the vehicles passed through were passenger vehicles, out of which 40% were two wheelers and 20% were cars.
- Traffic Composition – Out of the total vehicle flow in outer cordons, 75% of the traffic were passenger vehicles, out of which nearly 47% of vehicles were two wheelers. Goods vehicles constituted 25% of the whole traffic.
- Occupancy – Average occupancy of the different categories of vehicles at outer cordon are as follows:
    - Car – 2.38
    - SUV/Van – 3.81
    - Two Wheeler – 1.23
    - Auto Rickshaw – 2.11
    - Shared Auto – 3.58
    - Bus – 32.15
    - Mini Bus – 17.21
    - School Bus – 24.74
- Daily Passenger Trips – Bus, car and two wheelers have constituted nearly 20% individually to the total daily passenger trips. Maximum daily trips where observed at the location towards Kanpur, followed by Gwalior and Mathura.
- Travel Frequency – Daily trips were at 39%, followed by weekly trips at 20.9% and monthly trips at 20.4%.
- Trip Lengths – Majority of the trips are made to a destination farther than 30 kms; 8.5% of the trips performed are to a distance less than 10 km; 12.3% of the trips were in range of 10-20 kms, and 14.1% of the trips were in the range of 20-30 kms.

- Average Trips of the goods vehicles were observed as, Multi Axle Vehicle – 480 kms and Trucks – 458 kms

**B. Classified Traffic Volume Count Surveys on Mid Blocks (16 hours)**

The quantum and temporal variation of total and daily vehicles and trips moving in the study area within the sub areas is carried out in the following sections. The locations are as follows:

1) NH-2, Near Trans Yamuna Colony – Phase 1
2) NH-2, Near Trans Yamuna Colony – Phase 2
3) Near GIC Ground (M.G. Road-2)
4) Near Idgah Railway Station
5) Dhakran (M.G. Road)
6) ROB at NH-39 (near Overhead Water Tank)
7) Near Bilochpura Railway Station
8) Near Bijli Ghar Crossing
9) Near Yamuna Bridge Railway Station
10) General Cariappa Road (near B.D.Jain Girls College)
11) Bichpuri Fatak
12) Agra College (near S.N.Medical College)
13) Kinari Bazaar Chowk towards Raja Ki Mandi
14) Institute of Mental Health (near entry gate)
15) UPSIIDC (ROB near Sikandara)
16) Hans Chowk towards Bodla
17) Hilton Chowk (Staggered – Fatehabad Road)
18) Hyundai Factory Chowk – Fatehabad Road
19) Tora Police Chowki (near Jaypee Palace Hotel – Fatehabad Road)
20) Runkata (Near ROB)
21) Loha Mandi Pul (between Raja Ki Mandi and St. John's College Chowk)
22) Kamla Nagar (T-Point along NH-2)
23) Naulakha
24) Rail Bridge (Itimad-Ud-Daulah to NH-3)
25) Moti Mahal
26) Near Corporation Bank, Belanganj
27) Naal Band Choraha – M.G. Road
28) Diwani Chowk – M.G. Road
29) Khandori Mod (near Shri Ram Hospital – M.G. Road)
30) Nagla Kachhan Railway Fatak
31) Ramratan Road




- Daily Traffic Flow – Varies from 1,977 vehicles 1,546 PCUs to 80,994 PCUs throughout a normal working day. Maximum traffic volume is observed at Yamuna Colony – Phase 1, followed by Yamuna Colony – Phase 2, Kamala Nagar.
- Peak Hour Traffic – The morning peak hour volume varies from 246 PCUs (294 vehicles) on Nagla Kachhan Railway Fatak to 8,323 PCUs (8,377 vehicles) along NH-2 near Trans Yamuna Colony Phase – 2 and evening peak hour volume varies from 114 PCUs (133 vehicels) on Nagla Kachhan Railway Fatak to 10,517 PCUs (11,010 vehicles) along NH-2 near Trans Yamuna Colony Phase –2.
- Traffic Composition – On an average, about 82% of traffic consists of light, fast-moving passenger vehicles. The share of slow-moving average vehicles is about 14%. The share of buses are 2%, whereas the maximum share of bus traffic near GIC College Ground is 10.5%. Similarly, goods traffic average share is 3.4%, where as it is 34% at Bichpuri Fatak.
- Occupancy – Average occupancy of the different categories of vehicles at outer cordon are as follows:
    - Bus – 35.2
    - Mini Bus – 30.4
    - School Bus – 31.2
    - Pvt./Shared Auto – 5.7
    - Two Wheeler – 6.2
    - Car – 3.1
    - Sumo – 5.4

### C. Classified Turning Moment Volume Counts at Junctions

Turning volume counts of classified vehicles was made separately for direction-wise movements including left-turning and right-turning traffic at all the major intersections. The assessment was done for 16 hours a day for 1 day covering both peak and off peak hours of a day. The data generated on turning movements will be in

respect of stream composition, direction wise, and category wise vehicle volumes. The locations are as follows:

1) Sikandara
2) Guru Ka Taal
3) Guru Agrasen Chowk (near Raja Ki Mandi Railway Station)
4) TDI Mall Chowk (near Hotel Trident – Fatehabad Road)
5) Bhagwan Talkies
6) Sultan Ganj Ki Puliya (Vijay Nagar crossing on NH-2)
7) Water Works Junction – NH-2
8) Ram Bagh Choraha – NH-2
9) Fuwara Chowk (Kinari Bazaar Road)
10) Ghatia Azam Khan Chowk (near Agra City Railway Station - Kinari Bazaar Chowk)
11) 100 Feet Rd Junction – NH-2
12) Pratapura Chowk – M.G. Road
13) Chhipitola Chowk – M.G. Road
14) Kargil Choraha (Staggered) (on Bodla Road)
15) Bodla Choraha
16) Maruti Estate Choraha (M.G. Road -2)
17) Bhogipura Choraha
18) Sector-12C Chowk
19) Sector 4 – T Junction (near Hanuman Mandir)
20) Khatipara (Amba Prasad Road)
21) RBS College Chowk
22) Soor Sadan Chowk (Sanjay Place) – M.G. Road
23) Hari Parvat Chowk – M.G. Road
24) St. John's College Chowk – M.G. Road
25) Subhash Park – M.G. Road
26) Paliwal Chowk (near Paliwal Park)
27) Jeoni Mandi Chowk
28) New Yamuna Park Chowk
29) Haathi Ghat Chowk
30) Itimad-Ud-Daulah Chowk
31) Idgah Chowk
32) Sai Ki Takia Chowk – M.G. Road
33) Avanti Bai Chowk – M.G. Road
34) Sadar Bazaar Chowk – M.G. Road
35) Solanki Market Chowk
36) Agra Fort
37) Collectorate Chowk – M.G. Road
38) Agra Cantt. Railway Station Chowk
39) Phool Sayyed Ka Choraha
40) Purani Mandi Chowk (Taj Mahal West Gate Entry)
41) Dikshit Chowk (near Hotel Gateway)
42) Sabha Kalyan Chowk (Fatehabad Road)

43) Poorvi Gate Chowk (Taj Mahal East Gate Entry Road near Hotel Trident)
44) Shamsabad Chowk (Mall Road – Minto Road Crossing near Hotel Amar Inn)
45) Commissioner Agra Mandal Residence Choraha (Mall Road)
46) Mahal Talkies Chowk (Mall Road)
47) After Kargil Chowk (near Eat Mandi)
48) Nand Chowk
49) Victoria Chowk
50) Ram Nagar Puliya

Classified traffic volume count surveys were conducted at 50 selected intersections locations. Direction-wise classified traffic volume surveys were carried out to quantify the mode-wise volume and intensity of traffic flow throughout the day, which is used in a later stage to assess the existing traffic problems and to validate the transport demand models.

Summary of Turning Movement Count are as follows.

- Average Daily Traffic – Highest average daily traffic was observed at Bhagwan Talkies (130,479 PCU), followed by Ram Bagh Choraha (124,837 PCU) and Water Works Junction (109,105 PCU). wheelers have the maximum share in terms of traffic vehicles composition.
- Morning Peak Hour – Highest morning peak PCU count was observed at Bhagwan Takies with 15,927 which constitutes of 12% of the daily traffic through the junction. Out of the whole traffic 37% were two wheelers, 19% were cars and 10% were shared autos. High morning peak PCU counts are followed by Soor Sadan Chowk with 13,515 PCU (13.4% of daily traffic) and at St. Johns College Chowk with 11,561 PCU (13.5% of daily traffic).
- Evening Peak – Highest evening peak PCU count was observed again at Bhagwan Takies with 17,443 (between 17:45-18:45) which constitutes of 13.4% of the daily traffic through the junction. Share of cars in the evening peak increased to 22.7% from 19% in the morning peak. However, two wheelers constituted the maximum share to traffic composition with 34%. Water Works Junction with 16,262 PCU (14.9% of daily traffic) and Hari Parvat Chowk with 14,075 PCU (15.8% of daily traffic) follows Bhagwan Chowk in the PCU counts in Agra.

**D. Road Side Interview at Outer Cordon Locations (16 hours)**

The main objective of the survey was to derive the passenger and freight travel pattern by road. This survey was aimed at analyzing the movement between the study area and other parts of the country. The scope of the survey included conducting interviews at identified outer cordon locations in the study area. The survey was carried out on a sample basis for 16 hours on a typical working day by stopping the vehicles with the help of police. The objective was to achieve minimum sample coverage of 10% spread across the time of the day and type of vehicles proportionately. Classified volume counts were carried out along with the interviews in order to calculate expansion factors. The information collected will include origin and destination of trip, occupancy, trip purpose, and in the case of goods vehicles their type and tonnage. The locations are as follows:

1) Yamuna Expressway (towards Delhi)
2) NH-2 (towards Kanpur)
3) SH-62 (towards Fatehabad)

4) Shamshabad Road
5) NH-3 (towards Gwalior)
6) SH-39 (towards Jagner)
7) NH-11 (towards Jaipur)
8) Bharatpur Road
9) NH-2 (towards Mathura)
10) Aligarh Road

**E. Pedestrian Volume Counts at Critical Junctions (16 hours)**

Pedestrian count data is used frequently in planning applications. The data collected shall be used to evaluate sidewalk and crosswalk needs, to justify pedestrian signals, and to time traffic signals. Pedestrian counts were carried out for a period of 16 hours in critical locations of Agra city. Data from the pedestrian traffic counts conducted at several locations on the selected stretches in the study area where pedestrians are exposed to risk of accidents will be determined. This will enable in identification of the High Risk Pedestrian Zones in the study area and will enable in improvement options for pedestrian facilities in the study area. The locations are as follows:

1) Sikandra
2) Guru Ka Taal
3) Guru Agrasen Chowk
4) TDI Mall
5) Bhagwan Talkies
6) Sultan Ganj Ki Puliya on NH-2
7) Water Works Junction
8) Rambaug Chauraha
9) Kinnari Bazaar Road
10) Ghatia Azam Khan Chowk
11) 100 Ft Road NH2
12) Pratapura Chowk
13) Chippitola Chowk
14) Kargil Chauraha
15) Bodla Chauraha
16) Maruti Estate Chauraha
17) Bhogipura
18) Sec-12 C Chowk
19) Sec-4 T-Junction
20) Khatipara
21) RBS College Chowk
22) Soor Sadan Chauraha
23) Hariparwat Chauraha
24) St. John College Chauraha
25) Subhash Park Chauraha
26) Paliwal Chowk
27) Jeoni Mandi

28) New Yamuna Park Chowk
29) Haathi Ghaat Chowk
30) Itmad-Ud-Daulah Chowk
31) Idgah Chowk
32) Sai Ka Takya Chauraha
33) Avanti Bai Chauraha
34) Sadar Bazaar
35) Solanki Market Chowk
36) Agra Fort Chauraha
37) Collectorate Chauraha
38) Agra Cantt. Railway Station Chauraha
39) Phool Sayyad Ka Chauraha
40) Purani Mandi Chauraha
41) Dikshit Chauraha
42) Sabha Kalyan Chauraha
43) Poorvi Gate Chauraha
44) Shamshadabad Chauraha
45) Mall Road (Commissioner Agra Mandal Residence)
46) Mahal Talkies
47) Kargil Chauraha
48) Nand Chowk
49) Victoria Chauraha
50) Ramnagar Ki Pulia
51) Diwani Chauraha
52) Nalband Chauraha
53) Near Idgah Railway Station
54) Dhakran Chauraha
55) Cariappa Road
56) Agra College
57) Institute of Mental Health
58) Kamlanagar
59) Bijli Ghar Crossing

### F. Speed and Delay Study at Peak and Off Peak Hours

Speed on a road section is governed by volume of traffic, its composition, roadway features, and environment. In order to estimate the speeds, a relationship of speed and factors governing the speed is required. The principle objective of the study is to find out the journey speed, running speed, and types of delay such as stopped delay and operational delay to evaluate the level of service or quality of traffic flow of a road or entire road network system. The purpose of this survey is dual – journey speeds are used for validation and delay at junctions for developing delay study area. Any additional links, which UMTC felt necessary to be included in the survey, would be taken after a detailed Network Inventory. This data shall be used to evaluate congestion levels in the influence area with and without the improvement measures. The data will be used in developing the speed flow relationships, which will be used in building the Transport Model and to validate journey speeds predicted by the transport model.

The speed and delay surveys was carried out for different modes of transport like buses, autos, taxis, cars, two-wheelers, school buses etc.

Speed and delay survey was conducted along a length of 414 kilometers. It was conducted using the running car method during peak and off-peak periods.

Following is the summary of the speed and delay survey:

- Journey Speed – Like any other Indian city, Agra also has slow network speed in its core area. More than 42% of the surveyed road network has the journey speed range of 21-30 km/hr and nearly 20% of the road network has journey speed less than 20 km/hr. Average Journey Speed during peak period for a city as a whole is observed to be 25.3 km/hr. The figure depicting the speed of the network in the peak hour and off peak hour are shown as Figure 3-3 and Figure 3-4 respectively.
- Running Speed – Nearly 45% of the road network has the running speed of 21-20 km/hr.
- Delays – In peak hours, nearly 65% of the delay in the Agra streets were caused by the traffic signals, and traffic signal along with congestion caused 10% of delay. Whereas in off peak hours, nearly 68% delays were caused by the traffic signals and railway crossing, traffic and congestion, and traffic congestion causing 10% each.

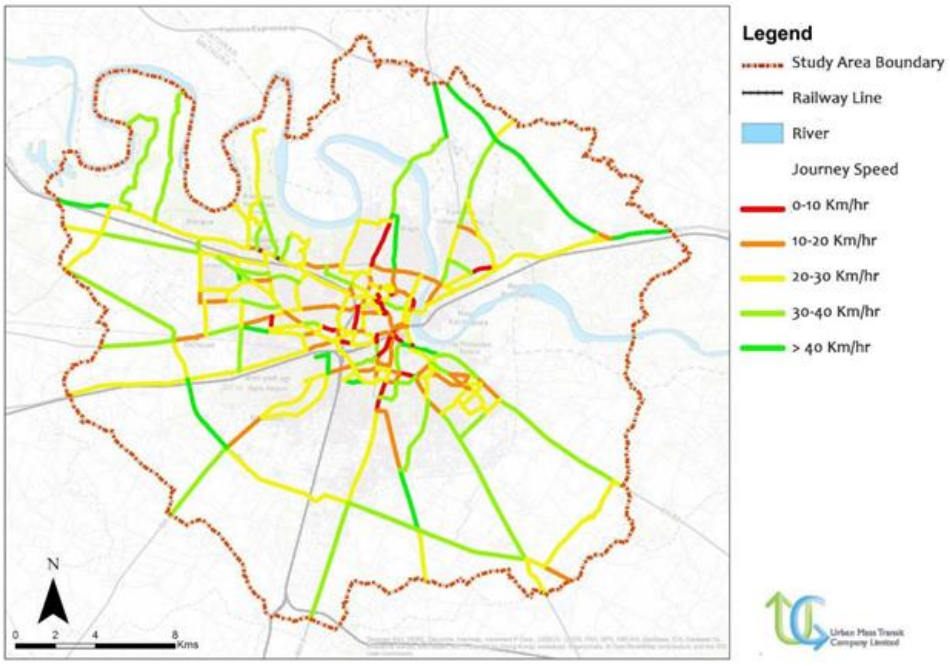



Figure 1: Journey Speed (Peak Hour)

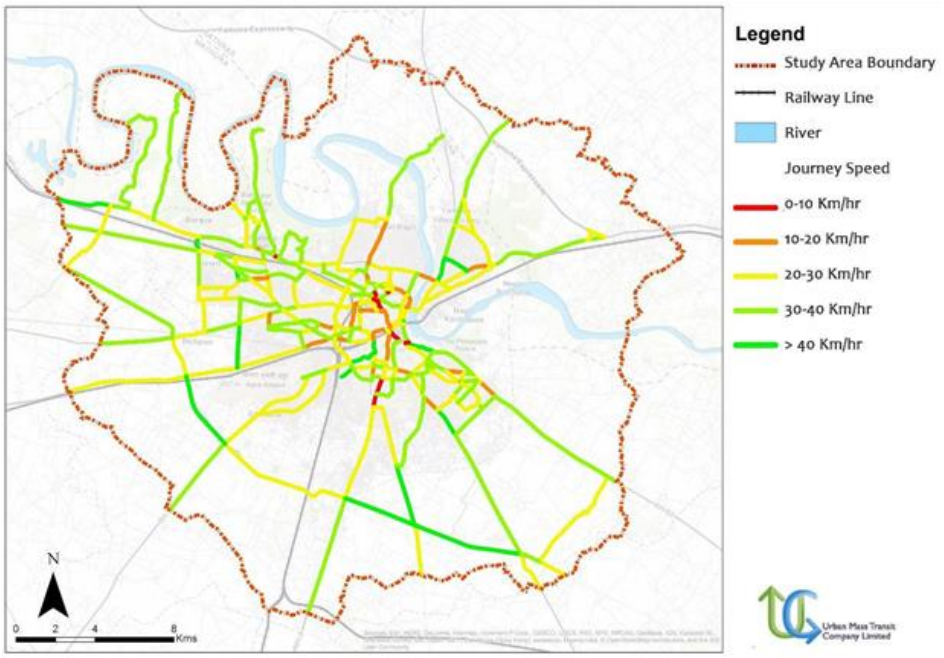



Figure 2: Journey Speed (Off Peak Hours)

### 3.2. Accidents and Casualties Analysis

Agra has witnessed a steady rise in number of people injured in road accidents over the past three years. (Source: Road accidents data compiled by the Ministry of Road Transport and Highways, Nov 2017). In fact in 2016, Agra reported more than 15% increase in the number of people sustaining injuries due to road accidents as against 2015. Agra recorded 811 injured persons in 2016 whereas there were 687 in 2015 and 803 in 2014. It is also revealed that there was a 5.17 % increase in road accidents. In 2016, 1,062 road accidents were reported in Agra in comparison to 1,007 in 2015 and 971 in 2014.

However, the number of casualties dropped by nearly 2% in 2016. As many as 522 deaths due to road accidents were reported in 2016, which was 532 in 2015 and 492 in 2014. Agra was ranked eighth in number of fatalities in the country but was ranked third in the state in 2016. Kanpur Nagar reported 684 deaths in 1,451 accidents in which 911 people were injured, while state capital Lucknow recorded 631 casualties in 1,639 accidents, which also resulted in injuries to 990 people.

| Year | Total Accidents | Serious / Minor Injuries | Fatality / Deaths |
|---|---|---|---|
| **2010** | 1120 | 818 | 559 |
| **2011** | 1207 | 967 | 607 |
| **2012** | 951 | 649 | 426 |
| **2013** | 1021 | 698 | 500 |
| **2014** | 971 | 811 | 492 |
| **2015** | 1007 | 687 | 532 |
| **2016** | 1062 | 803 | 522 |

Source: Traffic Police, Agra

Roads in Agra have been ranked sixth in terms of severity of accidents in India with 522 deaths in 1,062 road mishaps during 2016, reveals data from the Ministry of Road Transport and Highways. Accident severity is measured by the number of people killed per 100 accidents. The 522 deaths in year 2016 reveals that there are 22.96 fatality per lakh of population in Agra, which is among the highest fatality rate in country.

As discussed with authorities, few of the black spots for road accidents in Agra are:

- NH 509 and Yamuna Expressway Junction at Khandoli
- NH 19 and Yamuna expressway Junction at Kuberpur
- Foundry Nagar Crossing
- Shahadra Crossing
- Rambagh Crossing
- Water Works Chauraha
- Sultan Ganj Chauraha
- Bhagwan Talkies Chauraha
- Guru Ka Taal T-junction
- Sikandra Chauraha
- Ring Road and Agra-Lucknow Expressway Junction at Hingot Kheria
- Mayapura Etava Road
- Deewani Crossing
- Nagar Nigam Crossing
- Hari Parbat Crossing
- St. Johns Crossing
- Raja Mandi Crossing
- Collector Office Crossing
- Sai Ki Takiya Crossing
- Mall Road Crossing
- Malpura Crossing NH-21
- Rohta NH-21 and 44 Crossing

It is observed that the majority of the accidents occurred when those riding two wheelers did not wear a helmet. Speeding on national highways and Yamuna expressway caused four wheelers to meet with accidents. The rise in casualties in Agra city is also a result of poor conditions of national highways especially NH-2, which connects eastern part of the city, Rambagh, to the western part, Sikandra. There are four national highways (NH-2, 3, 11 and 93) which pass through Agra city. Similarly, the poor construction of dividers, speed breakers, and illegal cuts between lanes on cities roads also contributed to the rise in accidents. The road accidents data create an urgent need of providing better, designed, and safe road infrastructure, better enforcement of traffic rules, reduction in traffic speeds, and wearing of helmets.

### 3.3. Google Maps Based Traffic Analysis

Google Traffic is a feature on Google Maps that displays traffic conditions in real-time on major roads and highways. Google Traffic can be viewed on the Google Maps website, or by using the Google Maps application on a handheld device.

Google Traffic works by analyzing the GPS-determined locations transmitted to Google by a large number of mobile phone users. By calculating the speed of users along a length of road, Google is able to generate a live traffic map. Google processes the incoming raw data about mobile phone device locations, and then excludes anomalies such as a postal vehicle that makes frequent stops. When a threshold of users in a particular area is noted, the overlay along roads and highways on the Google map changes color.

Crowdsourced Traffic Data – Cellular telephone companies constantly monitor the locations of user devices. One tracking method is trilateration, whereby the distance (time delay) to three or more surrounding cell phone towers is measured. Another tracking method monitors the exact user coordinates determined by a GPS receiver inside the phone. GPS-equipped cellphones began appearing in 2004 and by 2011, the US Federal Communications Commission required that all new cellular phones be able to pinpoint location to within 50 feet.

Soliciting electronic information from a large group of people this way is referred to as crowd-sourcing.

Google stated: "When we combine your speed with the speed of other phones on the road, across thousands of phones moving around a city at any given time, we can get a pretty good picture of live traffic conditions."

Earlier, Google provided traffic data based on running algorithm on historical data, which doesn't comes out to be so accurate. After that Google uses third-party data and tools and now with the help of crowd-sourcing, Google makes a very fine judgment of traffic.

Google gathers live data from the crowd. All those people who are currently using Google Maps or using Android devices with location tracking or GPS enabling, are eventually providing anonymous data to Google with speed and location information. This allows Google to track live data, process the data with an algorithm to determine congestion considering all important factors and limitations and ultimately used to render the traffic layer on Google Maps for free to all users.

Mostly Google covers highways and arterials roads to predict the traffic, when data is available. This data is stored on Google database servers. Ultimately Google applies mining process on this data and runs prediction algorithm to provide "Typical Traffic" or "Future Traffic" behavior.

**Google Maps Traffic Color Shows Speed of Rraffic on Road**

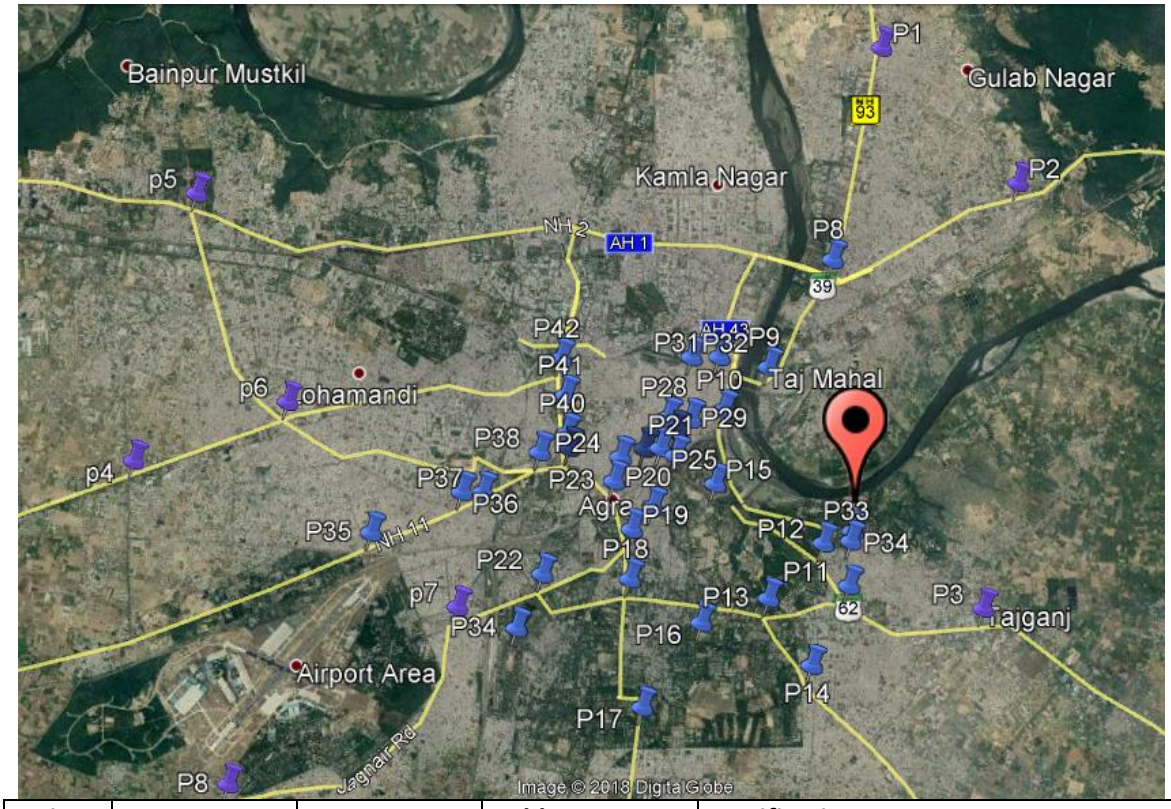
Speed of traffic is shown in **four different** colors:

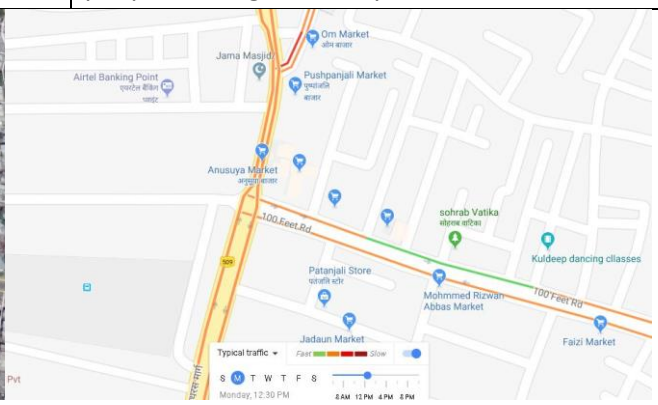
- **Green:** Means no traffic.
- **Yellow:** Means there is some traffic, while it is tolerable and you could drive easily.
- **Orange:** Means there is a medium amount of traffic and you may be delayed with this.
- **Dark Red:** Heavy traffic, means there are traffic delays.

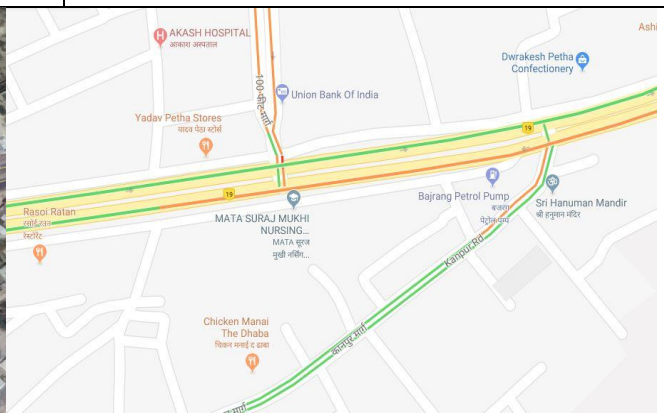
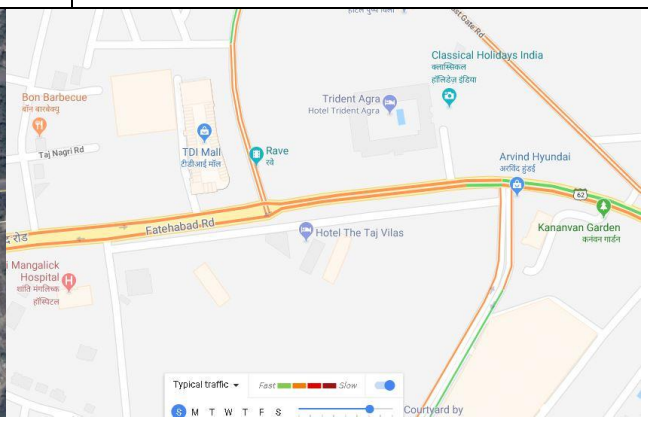
Two other colors indicate:

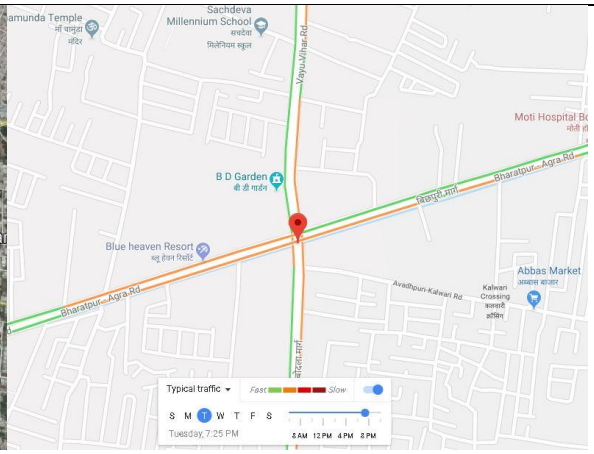
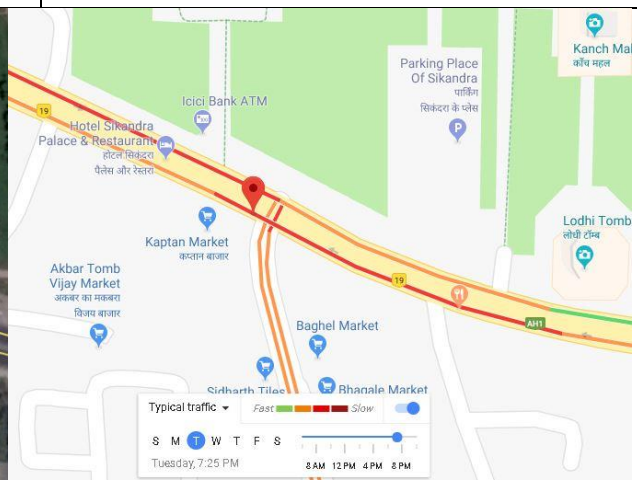
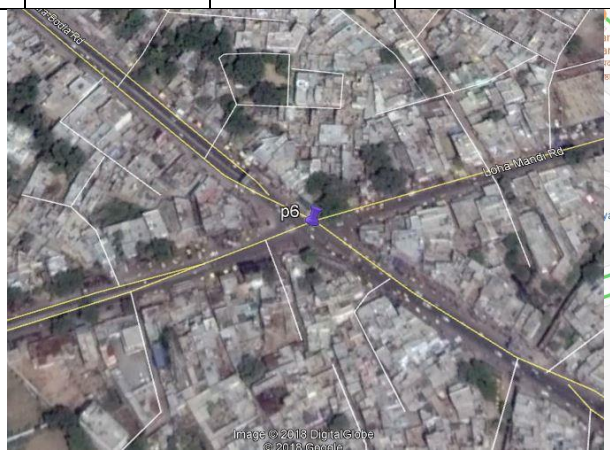
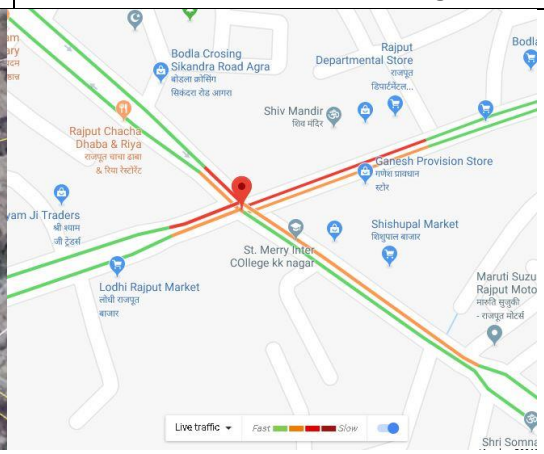
- **Blue:** This line indicates your direction route on Google Maps.
- **Gray:** Indicates there is no data.

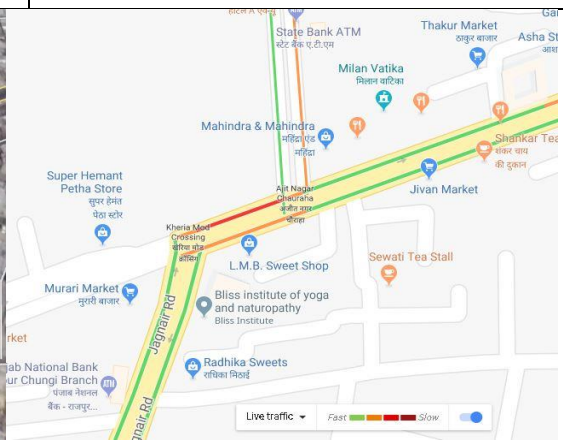
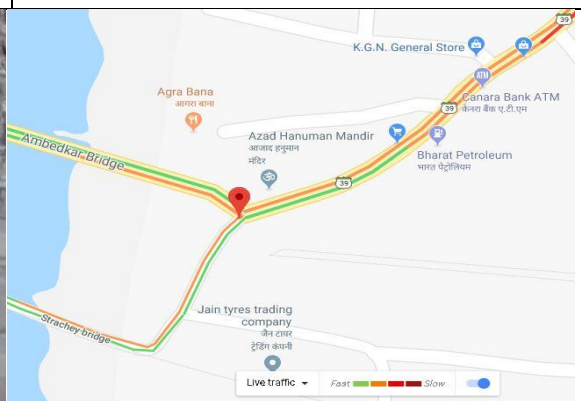
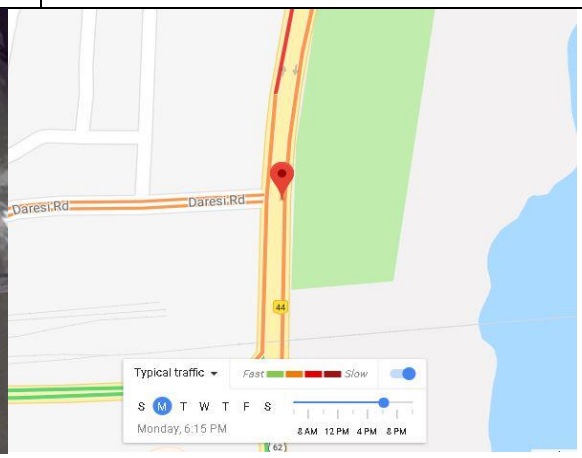
Looking at the feature provided by Google Traffic, a survey was done for complete Agra city for real-time traffic as well as typical traffic at various periods and several such points were identified where a moving to heavy traffic was observed. Latitude and longitude are captured with some justification and understanding of moving traffic. The details are as follows:

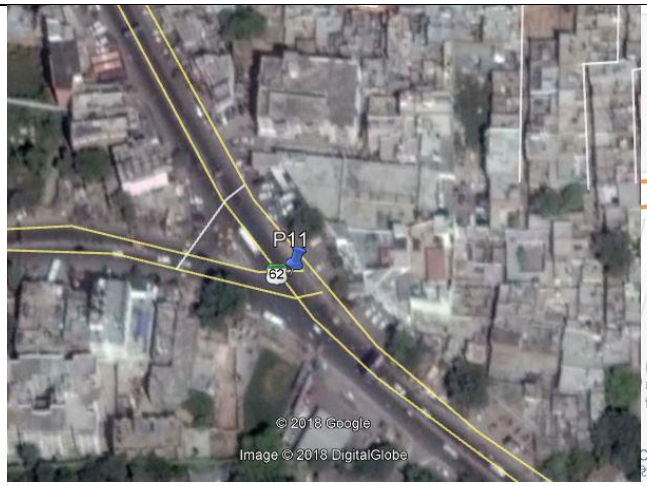
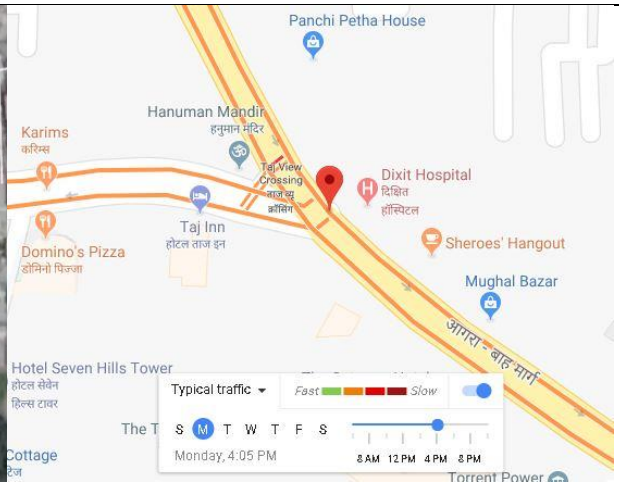
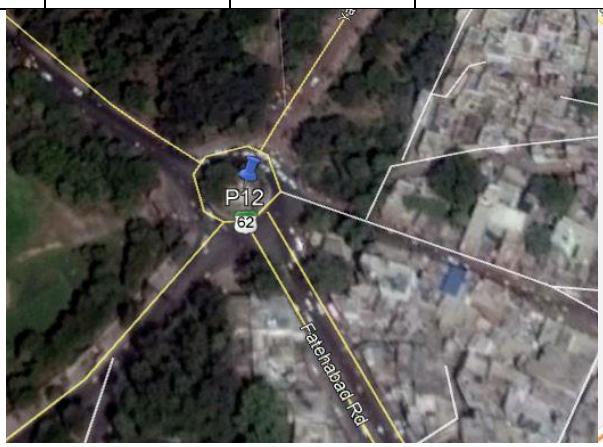
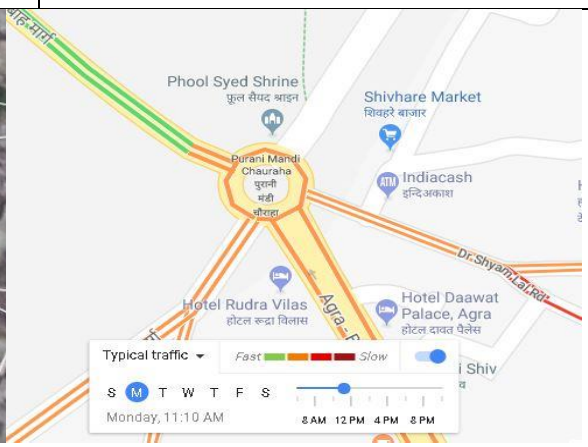
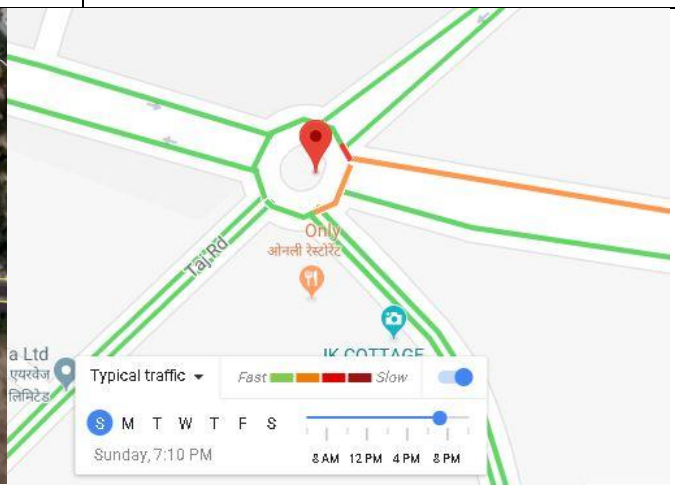


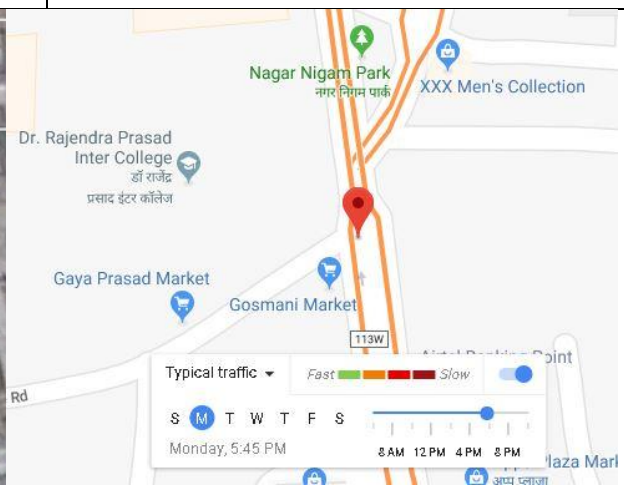
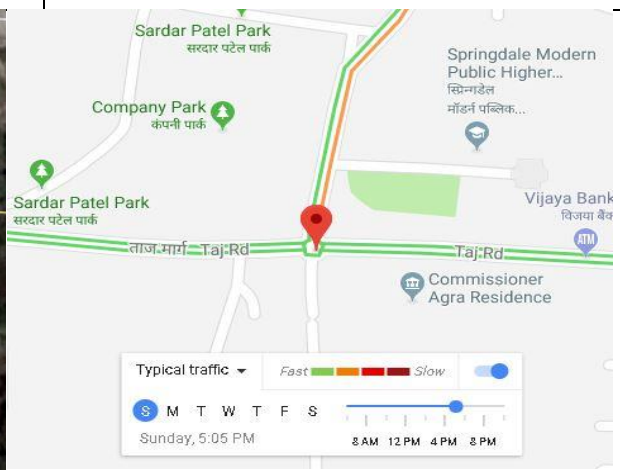

| Point | Lat | Long | Address | Justification |
|---|---|---|---|---|
| 1 | 27.229553 | 78.048538 | Foundary Nagar, Kuberpur | Main inbound and outbound road, tourists traveling to Agra normally takes this route to enter Agra. Smart Signal Network is designed to create easy traffic movement. This point is having heavy traffic as seen which needs to be directed for better and smooth movement for people coming in the city. |
| | | | |  |
| 2 | 27.211681 | 78.066787 | Tedi Bagiya Road | Connecting to Inter City, Tri Junction, it is important to keep it clear for entire supply line. |

| | | | | |
|---|---|---|---|---|
| | | | | This junction shows peak traffic and traffic jams during morning hours. |
| | | |  | |
| 3 | 27.15833708 | 78.05837729 | TDI Mall | Fatehabad Road is one of the busiest and most important roads for movement of tourists due to its direct path towards Taj Mahal. TDI mall is important junction, which connects Agra Inter City through Purani Mandi and Mall Road going forward. It is an important junction to have direct way towards the west gate of the Taj Mahal. It shows peak traffic across all day due to heavy movement of tourist vehicles and also local citizen vehicles especially in evening hours. |
| | | |  | |
| 4 | 27.18233022 | 77.93995758 | Bichpuri Road, Mata Mandir | Tourists and citizens visiting the city normally cross this junction, BD Garden and Mata Mandir make this junction very busy and hence to keep entire supply line effective this junction need to be smartly managed. |

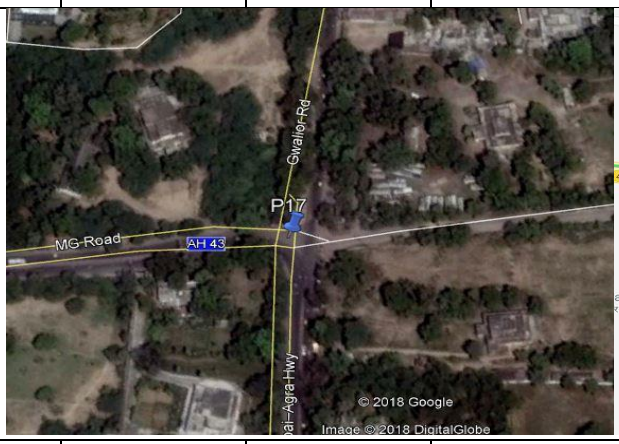
| | | | | |
|---|---|---|---|---|
|  | | | | |
| 5 | 27.21556738 | 77.95042937 | Sikandra Chauraha | Very Important Tri Junction as it is near Akbar's Tomb and major tourists and travelers pass through this junction, also this junction shows all time chaos of traffic on all days. |
|  | | | | |
| 6 | 27.18872656 | 77.96202507 | Bharatpur Agra Road | Live traffic data captured by Google Traffic shows that Bharatpur Agra Road Junction has heavy traffic jams across all days; hence needs to be addressed with Smart Traffic Signals. |
|   | | | | |
| 7 | 27.16172437 | 77.98403937 | Ajit Nagar Chauraha | Ajit Nagar Chauraha is most important crossing as it connects the airport, Agra Cantt. Station and major tourist places. Traffic jams on Khera |

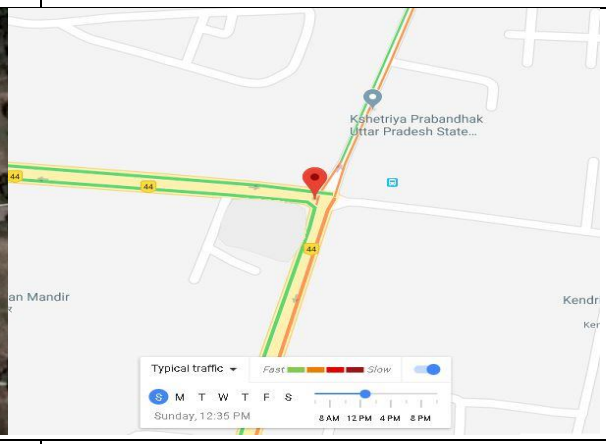
| | | | | |
|---|---|---|---|---|
| | | | | Mod occur quite often and need to be addressed. |
| | | | |  |
| 9 | 27.18994139 | 78.03005849 | Ambedkar Bridge | Ambedakr Bridge Corner Flyover Crossing is very important as major traffic coming from the Expressway enters or meets and crosses from here. Study shows that this junction has heavy traffic jams. |
| | | | |  |
| 10 | 27.18485017 | 78.023431 | Daresi Road | Daresi Road Tri Junction shows regular traffic jams and can be considered. |
| | | | |  |
| 11 | 27.16206527 | 78.03968536 | Taj View Crossing | Being a major junction to reach the Taj Mahal, this junction shows major traffic jams especially in the evenings which cause chaos in tourist movements. |

| | | | | |
|---|---|---|---|---|
|   | | | |
| 12 | 27.16756062 | 78.03639858 | Purani Mandi Chauraha | Purani Mandi Chaurha is a major connecting place for traffic coming from all directions like Taj, Agra Fort, and Railway Station. Major tourist and citizen crossings here and hence it has heavy traffic flow and shows traffic chaos. |
|   | | | |
| 13 | 27.16101266 | 78.02828259 | Taj Road | Important place for tourist traffic, doesn't have major issue but can be considered to keep entire traffic supply chain smooth. |
|  | | | |
| 14 | 27.15239914 | 78.03383489 | Grand Parade Road | Grand Parade Road Junction is important as education, tourism and market meet at same |

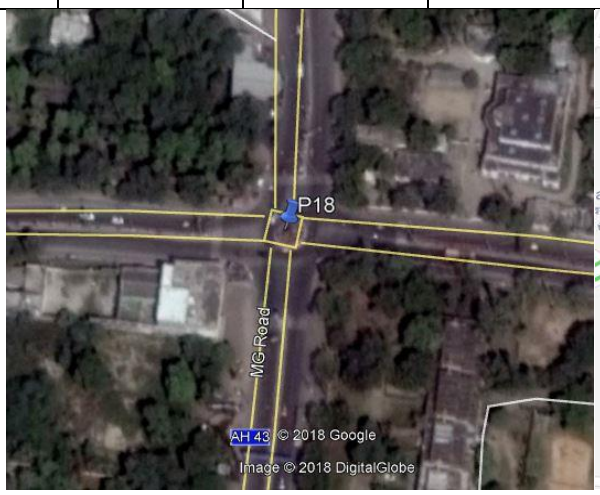
| | | | | |
|---|---|---|---|---|
| | | | | place and shows heavy traffic chaos. |
| | | |  | |
| 15 | 27.17567896 | 78.02164186 | Red Fort Road | Red Fort is the heart of Agra and all buses and auto move across this area. This place is an open area but traffic flow is high and shows traffic chaos. Tourist faces lots of delay here as the buses get jammed and thus give negative impression about the city. |
| | | | | |
| 16 | 27.1584178 | 78.0186509 | Taj Marg | This junctions is okay as far as traffic jams are concerned, but to keep entire traffic supply line Smart Traffic Diversion can be considered. |
| | | |  | |

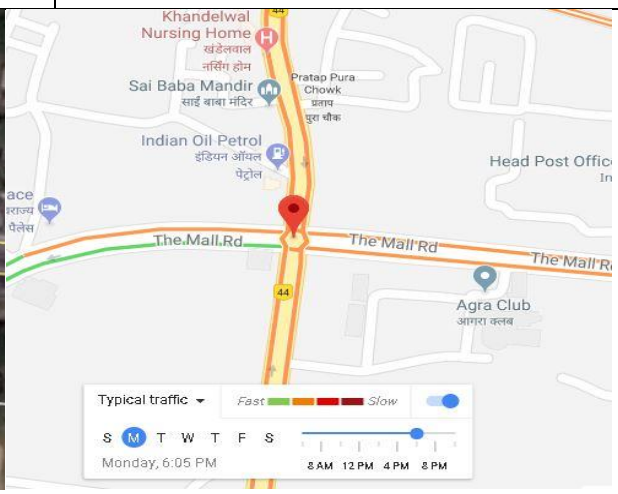
| | | | | |
|---|---|---|---|---|
| 17 | 27.151566 | 78.010589 | Gwalior Road | Traffic coming from the southern side gets jammed here and that makes the entire supply line chaotic; hence can be considered. |



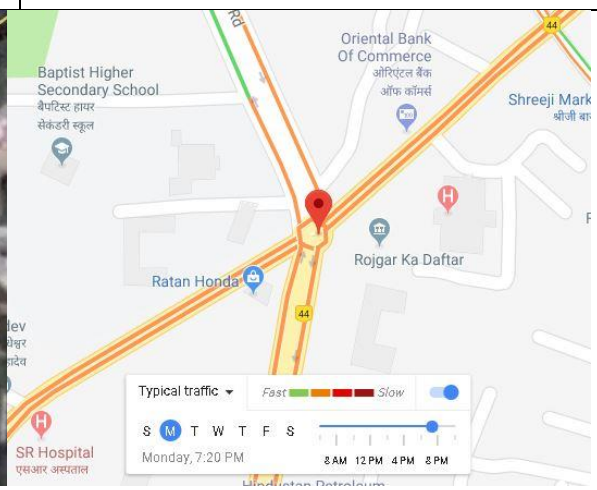



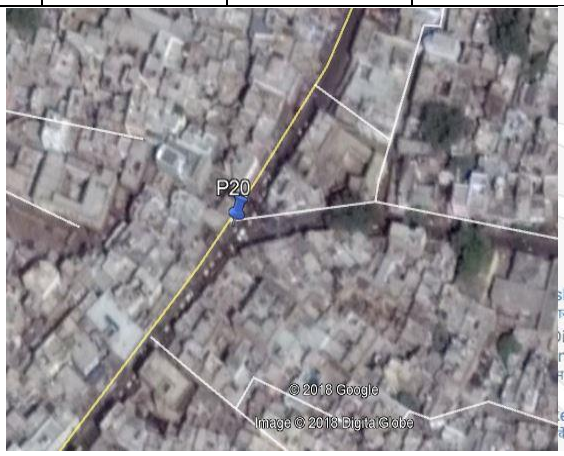
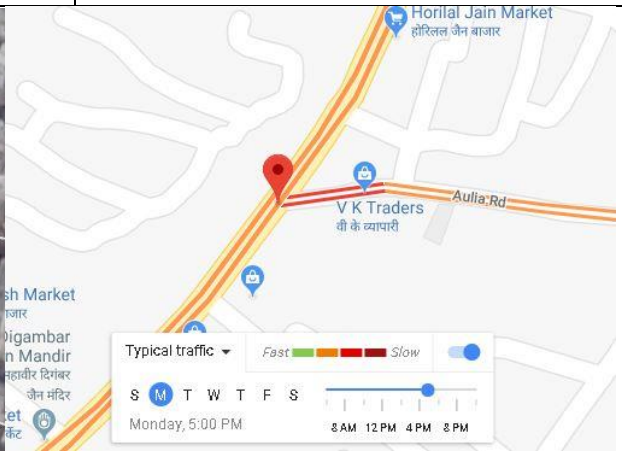
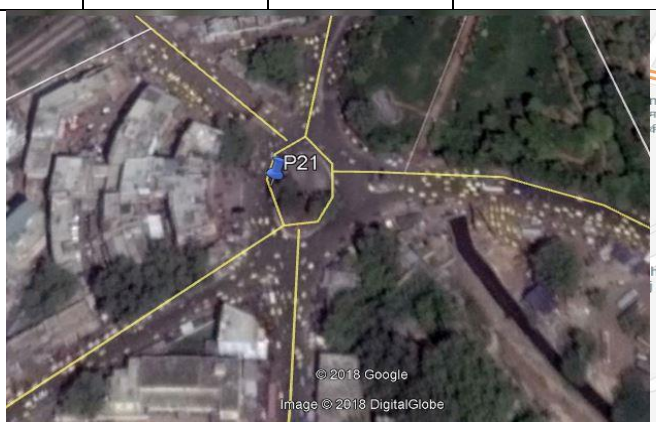
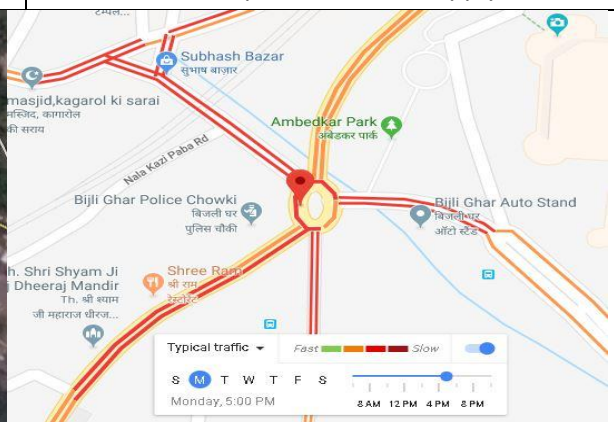
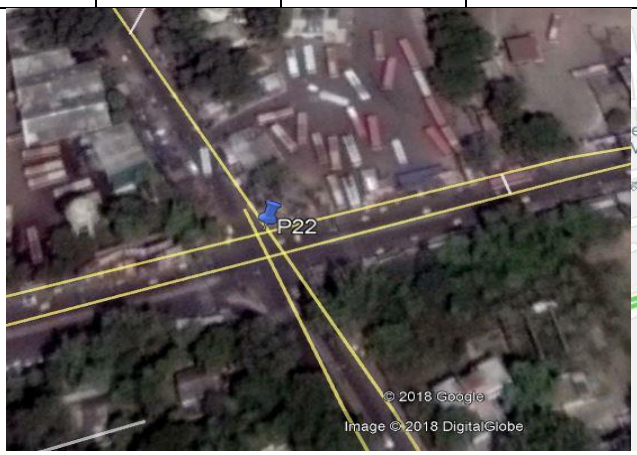
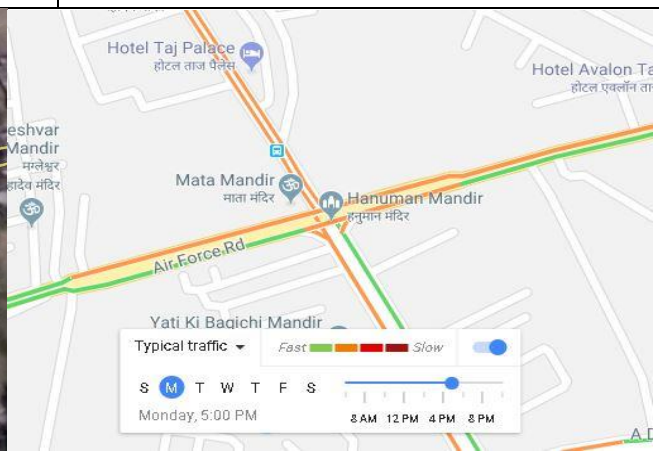

| | | | | |
|---|---|---|---|---|
| 18 | 27.16432532 | 78.00894718 | Mall Road | Sai Baba Mandir, hotels, malls, GPO etc. make this junction vulnerable to traffic jams, which affect traffic at other ends of the road. It can also be used for Smart Diversions. |

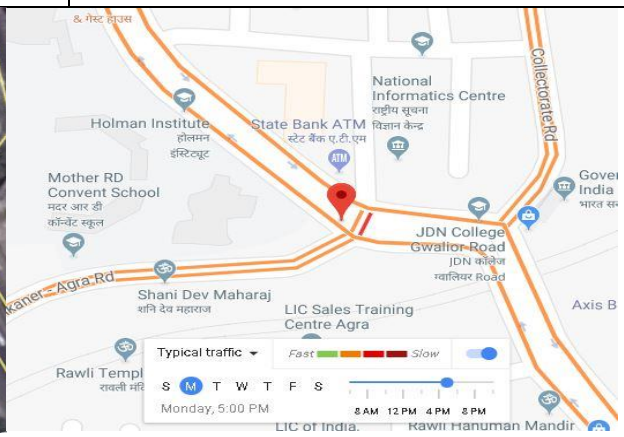
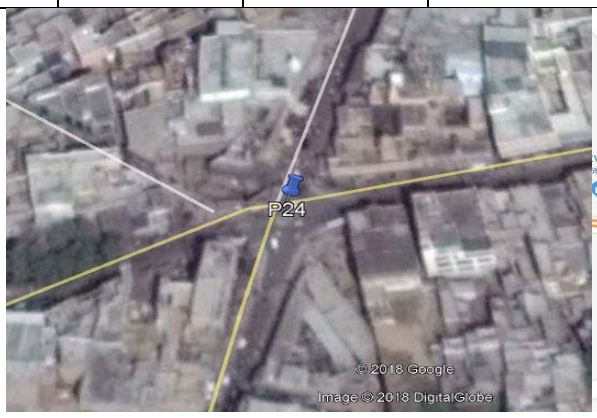
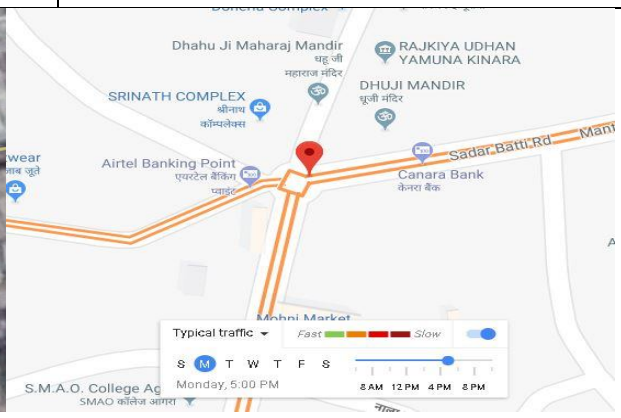
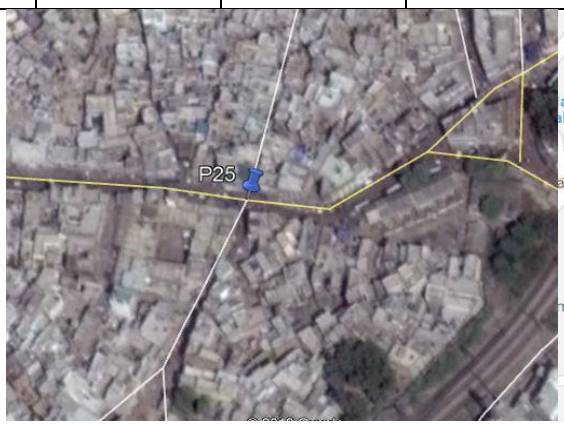
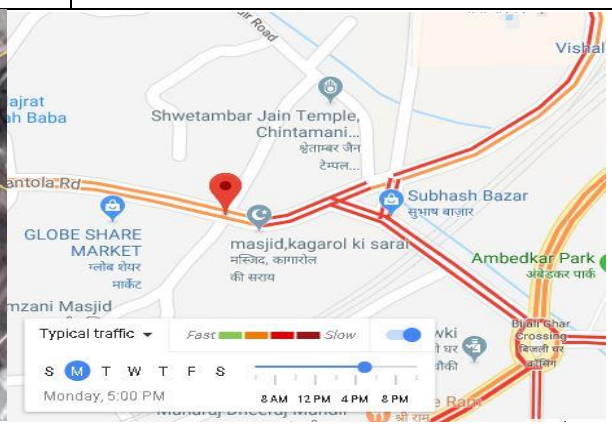


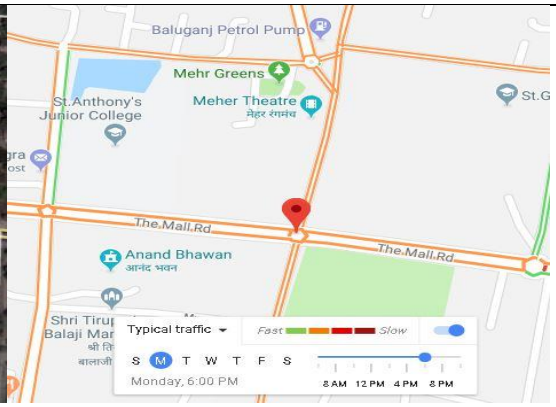
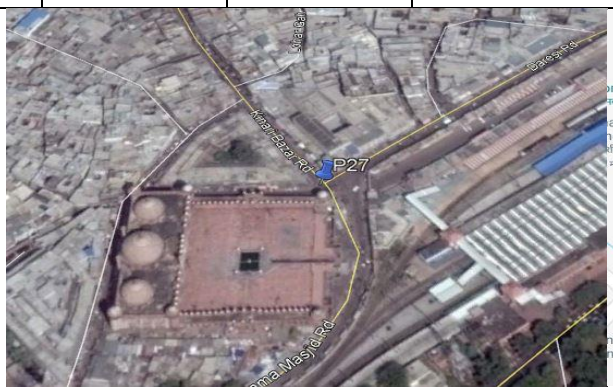
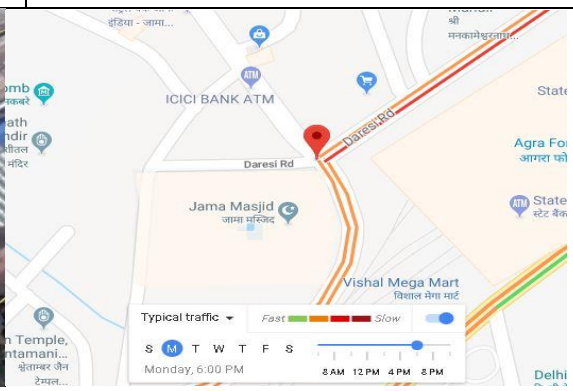
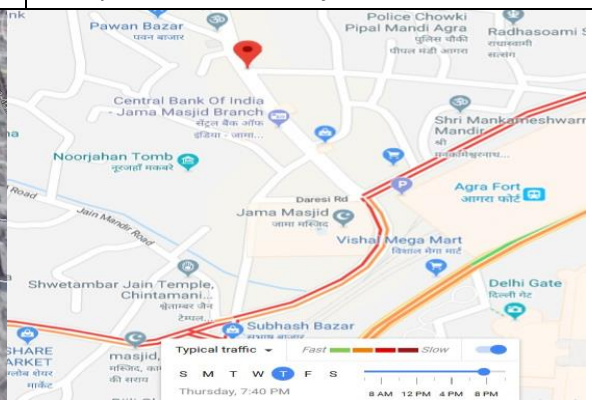



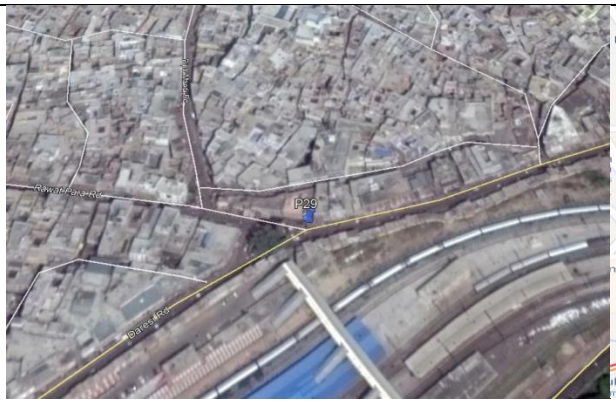
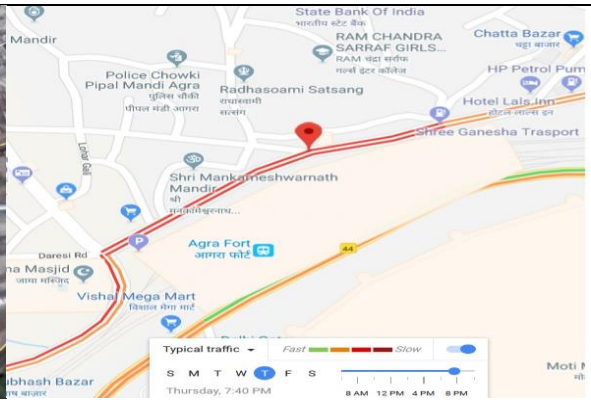
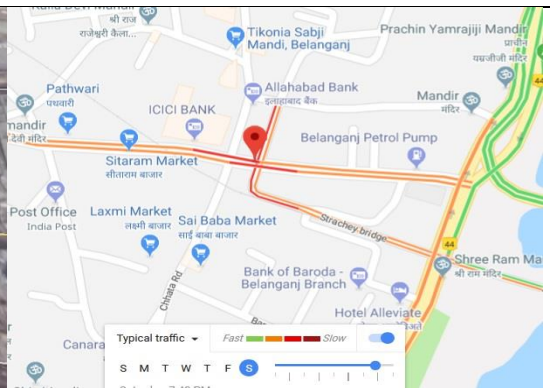
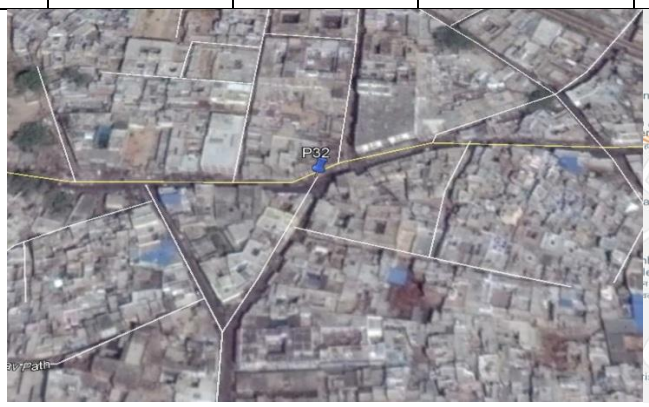
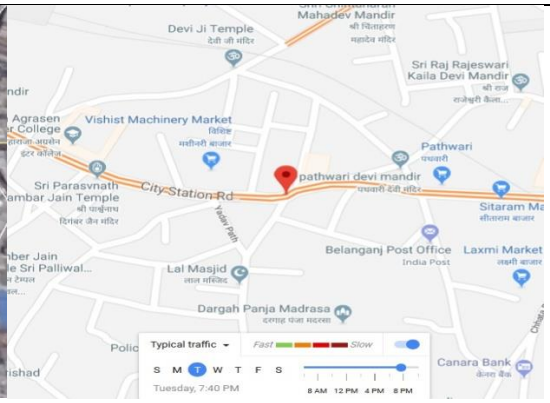

| | | | | |
|---|---|---|---|---|
| 19 | 27.1705189 | 78.00955476 | Mahatma Gandhi Road | Very important junction and its heavy traffic movement all day and every day needs to be addressed. |

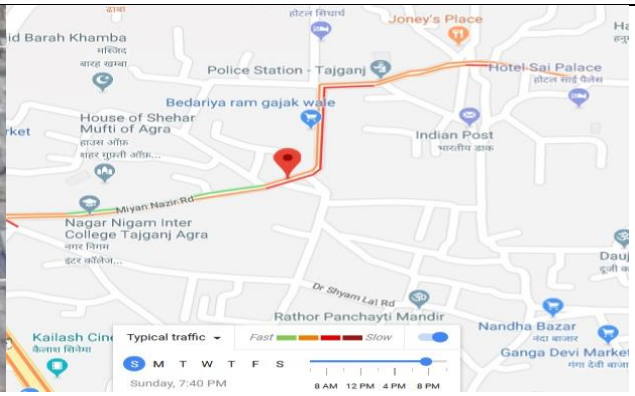
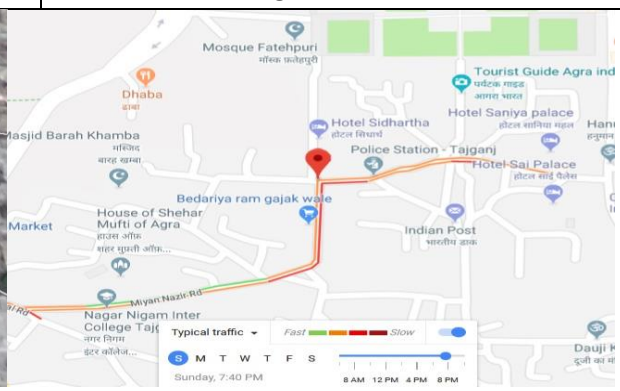
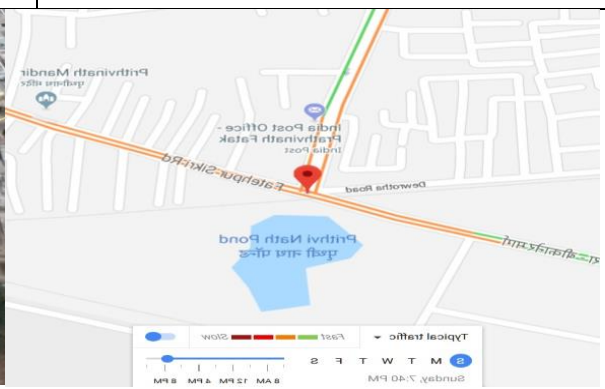


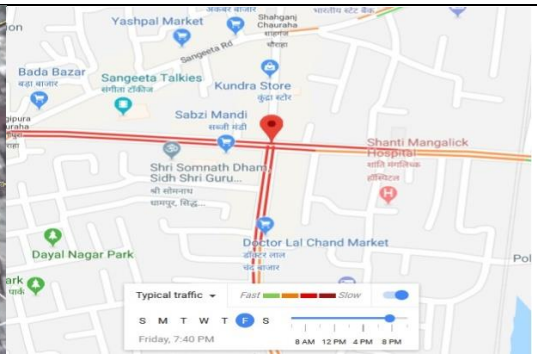
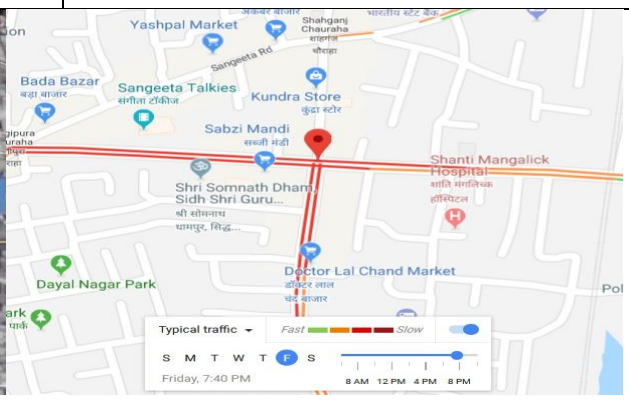
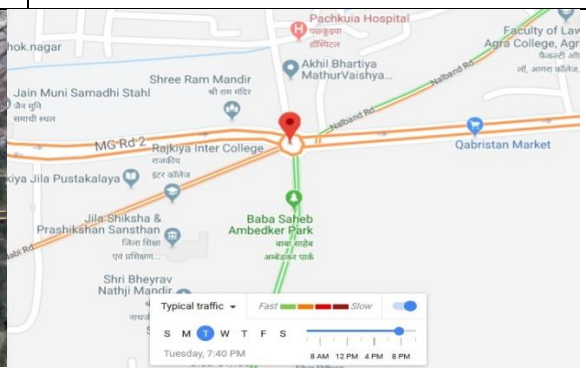
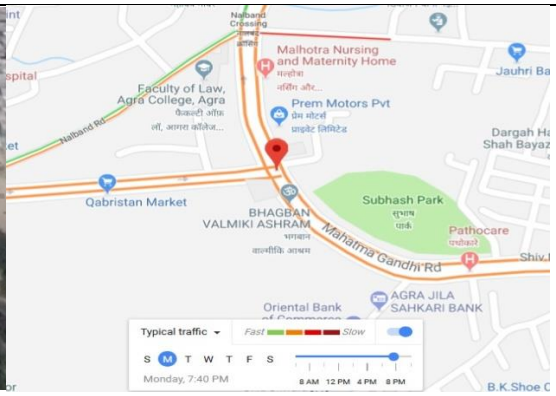
| | | | | |
|---|---|---|---|---|
| 20 | 27.17316991 | 78.01266933 | Aulia Road | Aulia Road Tri Junction is an important inter-connecting junction and has quite dense population and traffic which affects entire city movement. |
|  | | |  | |
| 21 | 27.17949745 | 78.01629629 | Bijali Ghar Crossing | Bijali Ghar crossing is an important junction and has heavy traffic chaos, and needs to be smartly addressed to keep entire traffic supply smooth. |
|  | | |  | |
| 22 | 27.16552811 | 77.99665191 | Hanuman Mandir, Air Force Road | Hanuman Mandir and Air Force Road get traffic jams and are amajor tourists crossings for hotels etc. Faces lots of problems; hence need to be smartly addressed. |
|  | | |  | |
| 23 | 27.17667266 | 78.00743388 | Collectorate Cross | Important junction as all major Govt. offices are located around here and thus has lots of traffic |

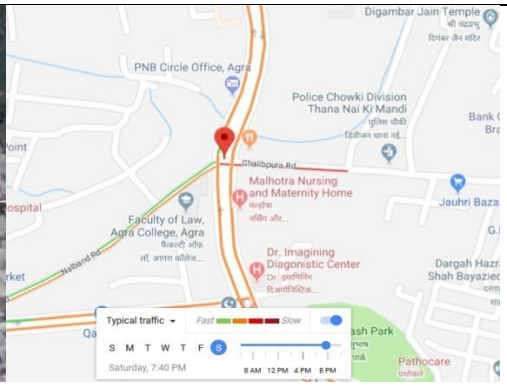
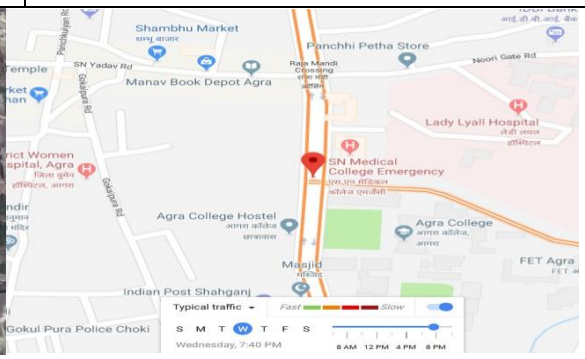
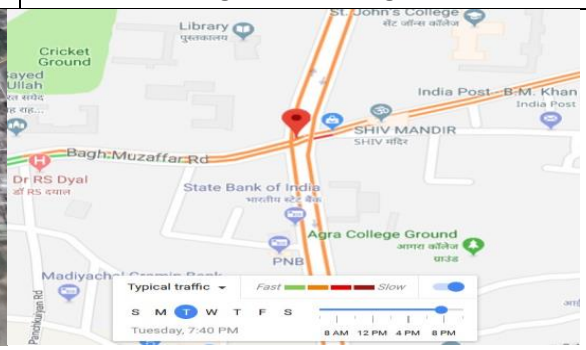
| | | | | |
|---|---|---|---|---|
| | | | | movement, also this is inter-connecting major tourist monuments and hotels. |
| | | | |  |
| 24 | 27.17964996 | 78.00850477 | Sardar Bhatti Crossing | Heavy dense population and traffic show quite heavy traffic chaos and jams. |
|  | | | |  |
| 25 | 27.18050216 | 78.01423518 | Mantola Road | Important to keep traffic supply chain smooth and can be effective for Smart Diversions. |
|  | | | |  |
| 26 | 27.163715 | 78.014776 | Mall Road | Important to keep traffic supply chain smooth and can be effective for Smart Diversions. |

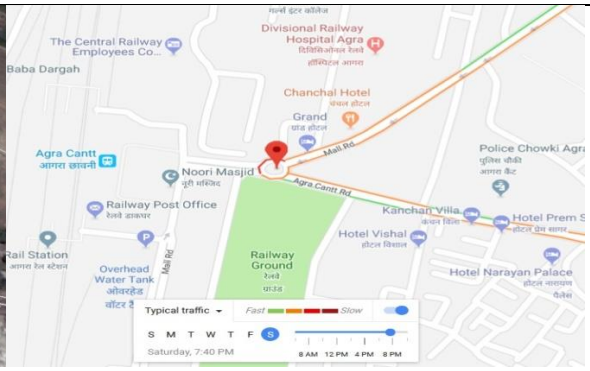
| | | | | |
|---|---|---|---|---|
|  | | | | |
| 27 | 27.182501 | 78.016604 | Dareshi Road | Being near Jama Masjid and connecting all important monuments, this becomes a major connecting signal. This signal shows heavy traffic chaos during peak hours specially on Friday and druing Namaz times. It needs to be addressed smartly to keep entire supply smooth with effective diversions during peak hours. |
|   | | | | |
| 28 | 27.1843 | 78.01552028 | Ravatpara Road | Heavy dense population and traffic show quite heavy traffic chaos and jams. |
|  | | | | |
| 29 | 27.1839 | 78.01867703 | Dareshi Cross Road | Heavy dense population near Agra Fort creates quite heavy traffic chaos and jams. |

| | | | | |
|---|---|---|---|---|
|     | | | | |
| 31 | 27.1916 | 78.02319019 | City Station Road | Heavy dense population and traffic create quite heavy traffic chaos and jams. It can be used for Smart Diversion for effective traffic movement. |
|   | | | | |
| 32 | 27.1917 | 78.01926021 | Kala Mahal Road/ KM Medical Hall | Heavy dense population and traffic creates quite heavy traffic chaos and jams especially during peak market hours. This junction also affects entire traffic movement in the area. |
|     | | | | |
| 33 | 27.1676 | 78.04029981 | Miyan Nazir Road | Sometimes there are traffic jams which eafect other connecting areas. Hence, it can be used for smoothing traffic and Smart Diversion. |

| | | | | |
|---|---|---|---|---|
|   | | | | |
| 34 | 27.1689 | 78.04062622 | Jag Prem Restaurant | Heavy dense area shows traffic jams which affect other connecting areas. Hence, it can be used for smoothing traffic and Smart Diversion. |
|   | | | | |
| 35 | 27.1718 | 77.97287716 | Fatehpur Sikari Road | This is an inter-connecting junction and traffic movement, both incoming or outgoing, needs to be regulated. This junction can be used for effective movement. |
|  | | | | |
| 36 | 27.1763 | 77.98593854 | Bhogipura Chauraha | Very important city junction, as it is inter-connecting roads from all directions and is in the most important market place where heavy traffic is always an issue. |

| | | | | |
|---|---|---|---|---|
|  | | | | |
| 37 | 27.1761 | 77.98886459 | Bikaner Agra Road | Important intercity connecting junction. |
|  | | | | |
| 38 | 27.1808 | 77.99717747 | Pachkuian Chauraha | Important intercity connecting junction, shows heavy traffic movement. |
|  | | | | |
| 39 | 27.1812 | 78.00140085 | MG Road 2 | Important Intercity connecting junction, it ialso shows heavy traffic movement and can be used for smoothening traffic through Smart Diversion. |
|  | | | | |

| | | | | |
|---|---|---|---|---|
| 40 | 27.1829 | 78.00107445 | Nalbandh Crossing | Important junction as per Intercity traffic movement, and shows heavy traffic jams during evenings. |
|   | | | | |
| 41 | 27.1877 | 78.00119261 | SN Medical College | Important Intercity connecting junction, it also shows heavy traffic movement and can be used for smoothening traffic through Smart Diversion. |
|   | | | | |
| 42 | 27.1924 | 78.00081287 | St. Johns Crossing | Important inter-city connecting junction, it also shows heavy traffic movement and can be used for smoothening traffic through Smart Diversion. |
|   | | | | |
| 43 | 27.1589 | 77.99264623 | Mall Road | Important inter-city connecting junction, near Agra Cant, Noori Majid and Mall Road. It also shows heavy traffic movement and can be used for smoothening traffic through Smart Diversion. |




### 3.4. Junction Survey Analysis

Insights from key stakeholders i.e., IG Police, SP Traffic, and SP City, who are directly impacted by irregular or unavailable traffic signals, have provided the complete list of intersections (including those mentioned in comprehensive mobility plan) in order of criticality and needs for availability of Intelligent Traffic Management System in a phased manner considering the issue faced by them to manage traffic and pedestrian crossings.

The list of 122 Junctions were provided in 3 phases considering the urgency and availability of ITMS solution: Phase 1 has a list of 28 Junctions, Phase 2 has 62 Junctions and Phase 3 has remaining 32 Junctions.

The list of junctions, with their current status, is as follows:

| S. No. | Junction Name | Phases | Signals | CCTV | Digital Signage |
|---|---|---|---|---|---|
| **1** | Bijli Ghar Chauraha | Phase 1 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **2** | Hari Parvat Chauraha | Phase 1 | Available and Working | Available and Managed by Local Station | No Digital Signage available |
| **3** | Collectorate Tiraha, SSP office, Agra | Phase 1 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **4** | Sikandara Chauraha | Phase 1 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **5** | Soor Sadan Tiraha | Phase 1 | Available but not working | Not Available | No Digital Signage available |
| **6** | Bhagwan Talkies Chauraha | Phase 1 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **7** | Water Works Chauraha | Phase 1 | Available but not working | Available and Managed by | No Digital Signage |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Local Station | available |
| **8** | Rambagh Chauraha | Phase 1 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **9** | Gurudwara Cut | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **10** | Khandhari Chauraha | Phase 1 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **11** | Nalband Chauraha | Phase 1 | Available but not working | Not Available | No Digital Signage available |
| **12** | Sai Ka Takiya Chauraha | Phase 1 | Available but not working | Not Available | No Digital Signage available |
| **13** | St Johns Chauraha | Phase 1 | Available but not working | Not Available | No Digital Signage available |
| **14** | Subhash Park Tiraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **15** | Itimad-Ud-Daulah Tiraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **16** | Taj View Tiraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **17** | TDI Mall | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **18** | Purani Mandi Chauraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **19** | Phool Sayyed Chauraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **20** | Railway Station, Cantt | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **21** | Bodhla Chauraha | Phase 1 | Not Available at Junction | Available and Managed by Local Station | No Digital Signage available |
| **22** | Shahdra Chauraha, Bajrang | Phase 1 | Not Available | Not Available | No Digital |

| | | | | | |
|---|---|---|---|---|---|
| | Petrol Pump, Entry Point | | at Junction | | Signage available |
| **23** | PWD Club Chauraha | Phase 1 | Available but not working | Not Available | No Digital Signage available |
| **24** | Shamshan Ghat ChaurahaChauraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **25** | Amar Singh Gate (Red Fort) | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **26** | Red Fort Railway Station | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **27** | Bhogi Pura Chauraha | Phase 1 | Not Available at Junction | Available and Managed by Local Station | No Digital Signage available |
| **28** | Victoria Park Tiraha | Phase 1 | Not Available at Junction | Not Available | No Digital Signage available |
| **29** | Kariappa Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **30** | Pachkuia Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **31** | Kalakriti Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **32** | Entry point Inner Ring Road Fatehabad Road | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **33** | M.G. Road-2 | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **34** | Targhar Chauraha | Phase 2 | Available but not working | Not Available | No Digital Signage available |
| **35** | Subhash Murti Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **36** | Madiya Katra Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |

| | | | | | |
|---|---|---|---|---|---|
| **37** | State Bank Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **38** | Agrsen Murti Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **39** | Loha Mandi Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **40** | Raja Mandi Chauraha | Phase 2 | Available but not working | Not Available | No Digital Signage available |
| **41** | Agra College Tiraha | Phase 2 | Available but not working | Not Available | No Digital Signage available |
| **42** | Kargil Petrol Pump Chauraha | Phase 2 | Not Available at Junction | Available and Managed by Local Station | No Digital Signage available |
| **43** | RBS Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **44** | Pratap Pura Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **45** | Rooi Ki Mandi Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **46** | Wazir Pura Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **47** | Deewani Tiraha, New Agra | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **48** | New Nyayalaya Deewani, New Agra | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **49** | Nyayala Gate, Cemetary | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **50** | ISBT | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **51** | Delhi Gate | Phase 2 | Not Available at Junction | Not Available | No Digital Signage |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | available |
| **52** | Bhawna Tower | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **53** | SN Medical College, SBI Gate | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **54** | Barrier Gate SN Medical College | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **55** | Entance Gate Taj Nature Walk | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **56** | Amar Hotel Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **57** | Main Market Sadar Bazaar | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **58** | 100 Ft Tiraha PS Shah Ganj, Fatehpur Sikri Rd, Entry Point | Phase 2 | Not Available at Junction | Available and Managed by Local Station | No Digital Signage available |
| **59** | 100 Ft Road, Kalindi Vihar | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **60** | City Railway Station | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **61** | Belanganj Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **62** | Chimman Puri Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **63** | Kerawali Tiraha, Runakta, Entry Point | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **64** | Rohta Neher Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **65** | Tedhi Baghiya, Entry Point | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **66** | Keriya More, Sarai Khawaja, | Phase 2 | Not Available | Not Available | No Digital |

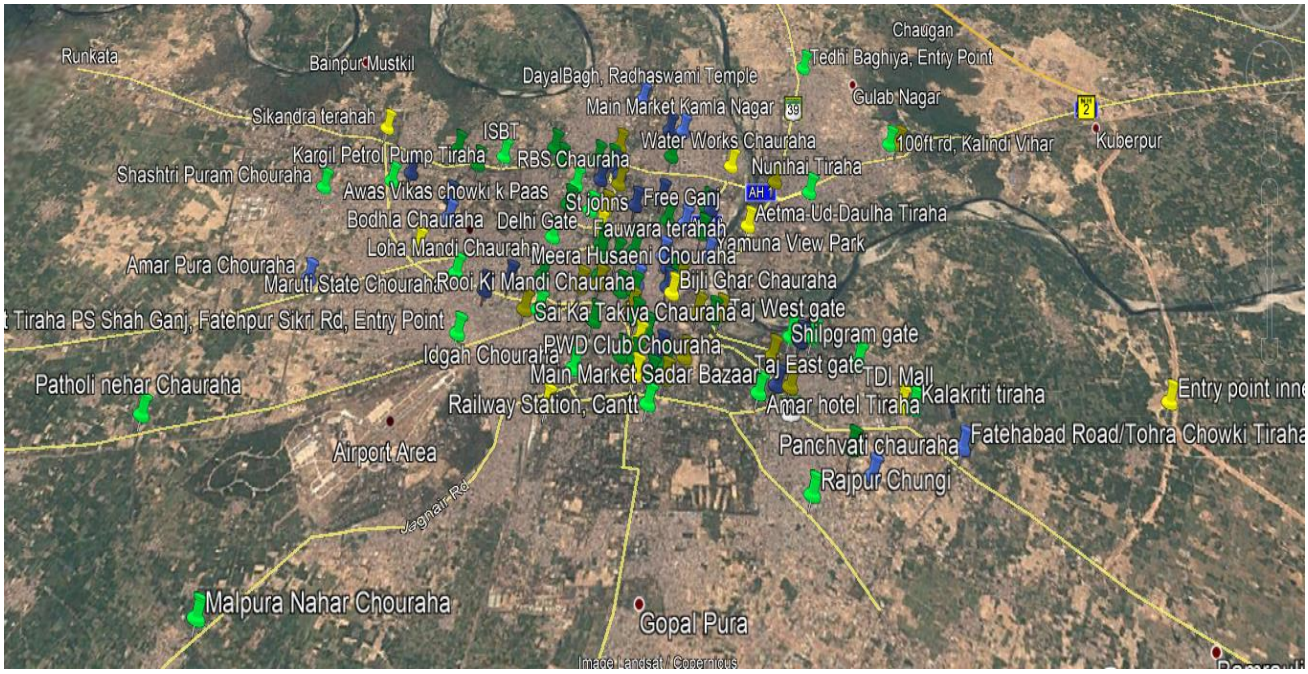
| | | | | | |
|---|---|---|---|---|---|
| | Entry Point (Traffic) | | at Junction | | Signage available |
| **67** | Sultan Ganj ki Puliya | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **68** | Sadar Bhatti | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **69** | Dhakran Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **70** | Nammer Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **71** | Rajpur Chungi | Phase 2 | Available but not working | Not Available | No Digital Signage available |
| **72** | Nunihai Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **73** | Shastri Puram ROB Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **74** | Malpura Nahar Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **75** | Idgah Chauraha | Phase 2 | Available but not working | Available and Managed by Local Station | No Digital Signage available |
| **76** | Maruti State Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **77** | Chhipitola Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **78** | Baluganj Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **79** | Shashtri Puram Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **80** | University Gate Khandari Campus | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |

| | | | | | |
|---|---|---|---|---|---|
| **81** | Idgah Railway Station | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **82** | Jivani Mandi | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **83** | Kothi Meena Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **84** | Basai Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **85** | Shilpgram Gate | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **86** | Taj East Gate | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **87** | Taj West Gate | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **88** | Patholi Nehar Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **89** | G.P.O Chauraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **90** | Tridet Tiraha | Phase 2 | Not Available at Junction | Not Available | No Digital Signage available |
| **91** | Mankameshwar Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **92** | Pani Ki Tanki, Ghatia Azam Khan, Sanjay Palace | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **93** | Shah Market , Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **94** | Shah Market, Nehru Nagar Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **95** | Dayal Bagh, Radhaswami Temple | Phase 3 | Not Available at Junction | Not Available | No Digital Signage |

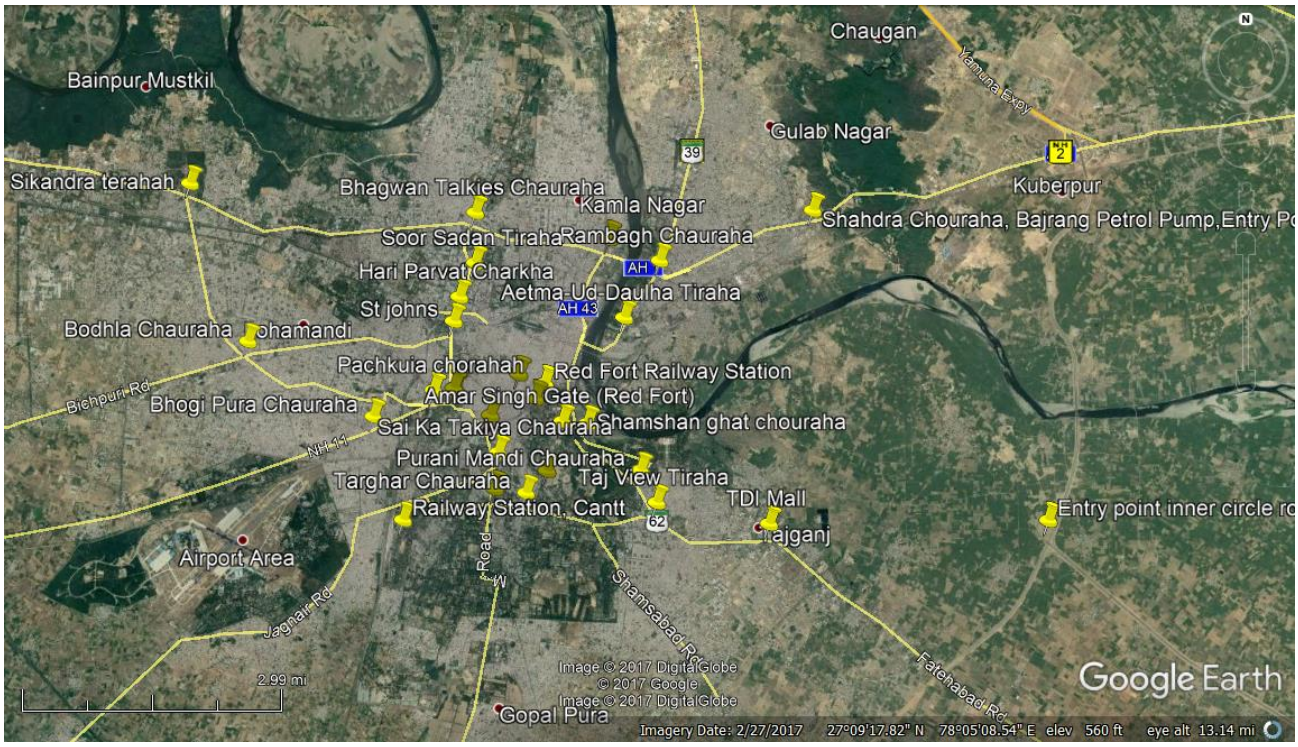
| | | | | | |
|---|---|---|---|---|---|
| | | | | | available |
| **96** | Main Market Kamla Nagar | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **97** | Dhulia Ganj Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **98** | 100 Ft, Shamshabad Rd, Entry Point | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **99** | SSP Residence Office | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **100** | Fauwara Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **101** | Madina Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **102** | Meera Husaeni Chauraha | Phase 3 | Available but not working | Not Available | No Digital Signage available |
| **103** | Amar Pura Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **104** | Ram Nagar Ki Puliya Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **105** | Shankar Gargh Puliya Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **106** | Karbala/Motilal Nehru Road Chauraha Near University | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **107** | Fatehabad Road/Tohra Chowki Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **108** | Awas Vikas Chowki Ke Paas | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **109** | Awas Vikas Sector 8 | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **110** | Karkunj Chauraha | Phase 3 | Not Available | Not Available | No Digital |

| | | | | | |
|---|---|---|---|---|---|
| | | | at Junction | | Signage available |
| **111** | Kamla Nagar Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **112** | Gadha Pada Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **113** | Kinari Bazar Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **114** | Taj South Gate | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **115** | Panchvati Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **116** | Retreat Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **117** | Bagh Farjana Chauraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **118** | Hanuman Mandir Chauraha | Phase 3 | Available but not working | Not Available | No Digital Signage available |
| **119** | St. Poal Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **120** | Saket Tiraha | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **121** | Free Ganj | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |
| **122** | Yamuna View Park | Phase 3 | Not Available at Junction | Not Available | No Digital Signage available |

The 122 Junctions cover the complete city inclusive of the entry and exit of Agra City. The coverage is mapped on to Google Earth as follows:



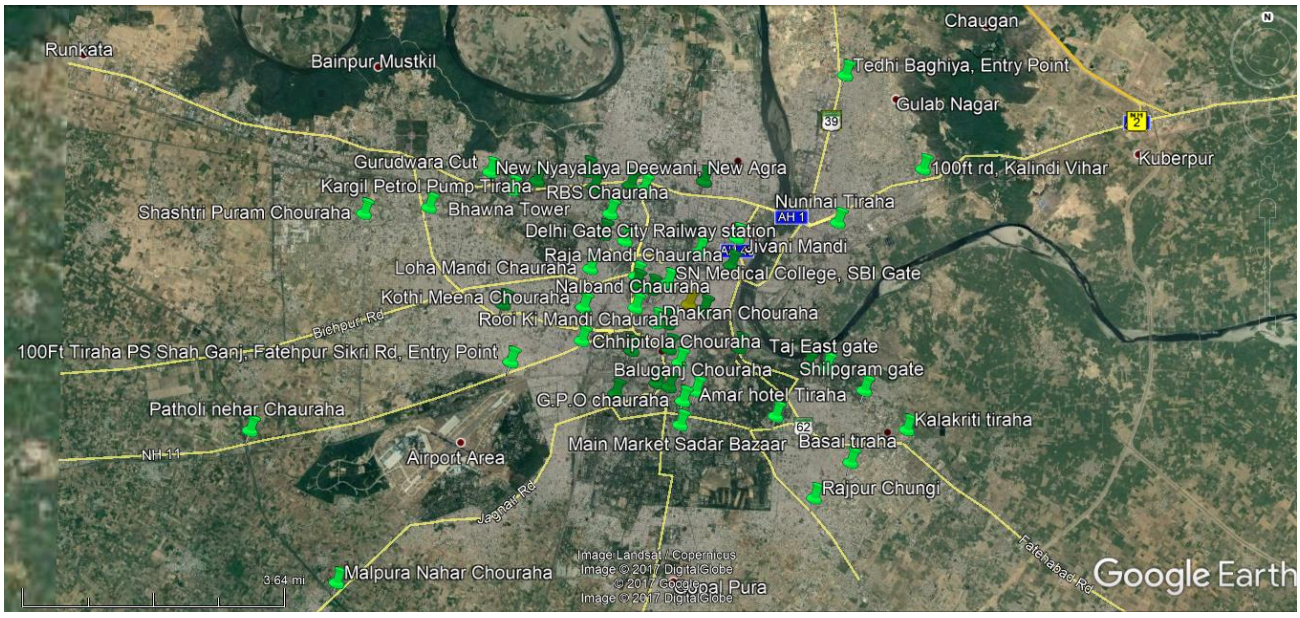

List of 28 critical junctions as part of Phase 1, which covers major entry and exit points to Agra along with the busiest roads as identified by SP Traffic and conveyed through detailed report on mobility plan are captured as follows:




**List of Junctions - 28 in Phase 1**

| | | | |
|---|---|---|---|
| **Bijli Ghar Chauraha** | Gurudwara Cut | Rambagh Chauraha | Shahdra Chauraha, Bajrang Petrol Pump, Entry Point |
| **Hari Parvat Chauraha** | Khandhari Chauraha | Taj View Tiraha | PWD Club Chauraha |
| **Collectorate Tiraha, SSP office, Agra** | Nalband Chauraha | TDI Mall | Shamshan Ghat ChaurahaChaurahaChauraha |
| **Sikandara Chauraha** | Sai Ka Takiya Chauraha | Purani Mandi Chauraha | Amar Singh Gate (Red Fort) |
| **Soor Sadan Tiraha** | St. Johns Chauraha | Phool Sayyed Chauraha | Red Fort Railway Station |
| **Bhagwan Talkies Chauraha** | Subhash Park Tiraha | Railway Station, Cantt | Bhogi Pura Chauraha |
| **Water Works Chauraha** | Itimad-Ud-Daulha Tiraha | Bodhla Chauraha | Victoria Park Tiraha |

List of 62 junctions captured as part of Phase 2 majorly covers the intermediate junctions and locations between two critical junctions on busies roads along with roads going towards the markets areas. The coverage of phase 2 is larger and mapped as follows:

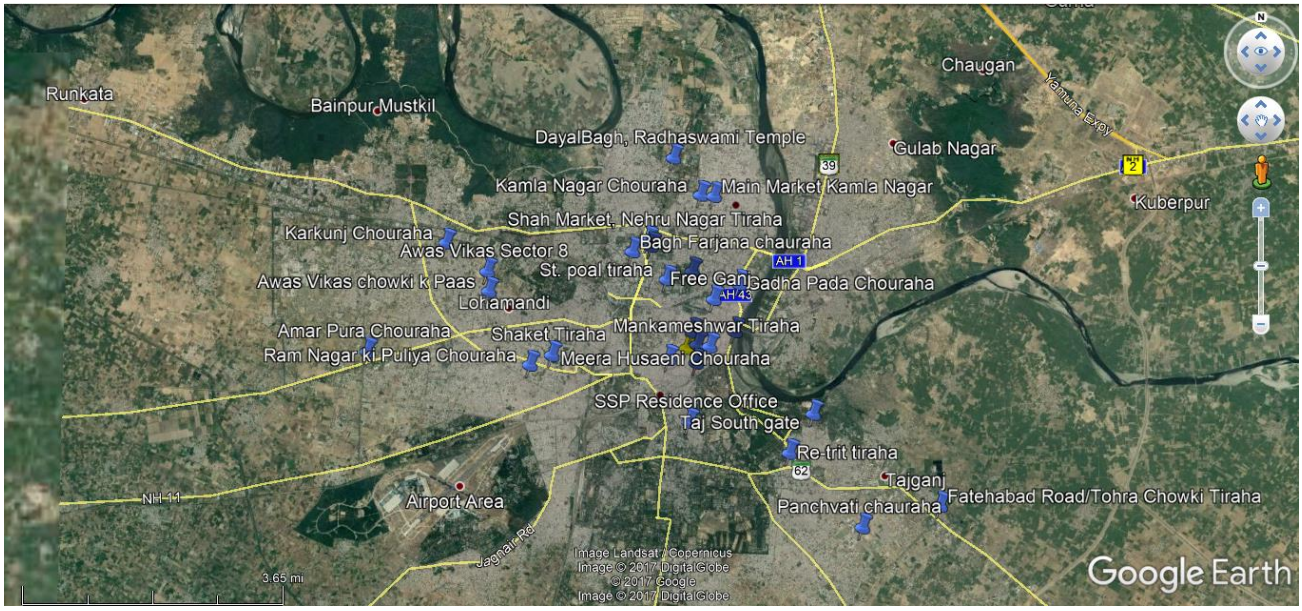



| List of Junctions - 62 in Phase 2 | | | | |
|---|---|---|---|---|
| **Kargil Petrol Pump Chauraha** | Kariappa Chauraha | Entance Gate Taj Nature Walk | Sadar Bhatti | Idgah Railway Station |
| **RBS Chauraha** | Pachkuia Chauraha | Amar Hotel Tiraha | Dhakran Chauraha | Jivani Mandi |
| **Pratap pura** | Kalakriti Tiraha | Main Market | Nammer Chauraha | Kothi Meena |

| | | | | |
|---|---|---|---|---|
| **Chauraha** | | Sadar Bazaar | | Chauraha |
| **Rooi Ki Mandi Chauraha** | Entry point Inner Ring Road Fatehabad Road | 100 Ft Tiraha PS Shah Ganj, Fatehpur Sikri Rd, Entry Point | Rajpur Chungi | Basai Tiraha |
| **Wazir Pura Tiraha** | M.G. Road -2 | 100 Ft Road, Kalindi Vihar | Nunihai Tiraha | Shilpgram Gate |
| **Deewani Tiraha, New Agra** | Targhar Chauraha | City Railway Station | Shastri Puram ROB Chauraha | Taj East Gate |
| **New Nyayalaya Deewani, New Agra** | Subhash Murti Chauraha | Belanganj Chauraha | Malpura Nahar Chauraha | Taj West Gate |
| **Nyayala Gate, Cemetary** | Madiya Katra Tiraha | Chimman Puri Chauraha | Idgah Chauraha | Patholi Nehar Chauraha |
| **ISBT** | State Bank Tiraha | Kerawali Tiraha, Runakta, Entry Point | Maruti State Chauraha | G.P.O Chauraha |
| **Delhi Gate** | Agrsen Murti Tiraha | Rohta Neher Chauraha | Chhipitola Chauraha | Trident Tiraha |
| **Bhawna Tower** | Loha Mandi Chauraha | Tedhi Baghiya, Entry Point | Baluganj Chauraha | |
| **SN Medical College, SBI Gate** | Raja Mandi Chauraha | Keriya More, Sarai Khawaja, Entry Point (Traffic) | Shashtri Puram Chauraha | |

| | | | | |
|---|---|---|---|---|
| **Barrier Gate SN Medical College** | Agra College Tiraha | Sultan Ganj Ki Puliya | University Gate Khandari Campus | |

List of 32 junctions are part of Phase 3 which cover minor internal roads between critical junctions and major roads and captured on map as follows:




| List of Junctions - 32 in Phase 3 | | | |
|---|---|---|---|
| **SSP Residence Office** | Mankameshwar Tiraha | Fatehabad Road/Tohra Chowki Tiraha | Panchvati Chauraha |
| **Fauwara Chauraha** | Pani Ki Tanki, Ghatia Azam Khan, Sanjay Palace | Awas Vikas Chowki Ke Paas | Retreat Tiraha |
| **Madina Tiraha** | Shah Market, Tiraha | Awas Vikas Sector 8 | Bagh Farjana Chauraha |
| **Meera Husaeni Chauraha** | Shah Market, Nehru Nagar Tiraha | Karkunj Chauraha | Hanuman Mandir Chauraha |
| **Amar Pura Chauraha** | Dayal Bagh, Radhaswami Temple | Kamla Nagar Chauraha | St. Poal Tiraha |
| **Ram Nagar ki Puliya Chauraha** | Main Market Kamla Nagar | Gadha Pada Chauraha | Shaket Tiraha |
| **Shankar Gargh Puliya Tiraha** | Dhulia Ganj Chauraha | Kinari Bazar Tiraha | Free Ganj |
| **Karbala/Motilal Nehru Road Chauraha Near University** | 100 Ft, Shamshabad Road, Entry Point | Taj South Gate | Yamuna View Park |

During first hand survey of phase 1 location, we observed several key flaws that need to be considered during implementation phase, details are as follows:

*a.* Except for Hariparvat Chauraha and Sai Ka Takia, no traffic signals are working at any intersections even though traffic signals are installed. *(Citizens and pedestrians were found abiding to the traffic signal rules when traffic signal was working.)*

b. Advertisement Hoardings are directly hung on to traffic signal, which defeats the purpose of traffic signal and have significant impact on citizens, causing them to misjudge the traffic lights notations.

c. Each of the Intersections (Chauraha/Tiraha), currently have no Digital Signage/Hoardings which shows the direction and movement of traffic. This breaches the traffic rules at each of the intersections, which results in accidents and causalities.

d. There are no digital signage and hoardings which displays the traffic rules and law regulations.

e. Every intersection is currently manually managed and monitored by traffic police, which is a cumbersome task. It is practically impossible to have complete coverage of intersections due to traffic and pedestrian crossing on road, giving significant challenges to Traffic Team to manage the number of officials on the field.

f. There is no Right of Way given to pedestrians, even when they are accessing the Zebra Crossing and even public and private transport vehicles violate the zebra crossing and bypass the zone in presence of traffic police.

g. Citizens lack awareness on Rules and Regulations to be followed while driving, which hampers safety and security of pedestrians.

h. Four wheeler vehicles are seen driving without wearing seat belts and two wheeler vehicles without helmets. This law needs to be enforced for safety of citizens.

i. No signals or indicators are provided by two or four wheelers (public/private) while taking a turn or changing directions. This sudden change in directions has direct impact on accidents and proportional increase in usage of horn, creating noise pollution.

Sample Images Captured during Survey are as follows:

Figure 3: Soor Sadan Chauraha

Figure 4: St. Johns Chauraha

Figure 5: Subhash Park Chauraha

### 3.5. City Surveillance Analysis

Discussion with SSP and city police officials highlighted the areas and locations that are more prone to accidents like theft, chain snatching, weak accident prone due to traffic etc. and incidents being reported.

Further understanding and surveys, with local citizens and officials, indicated areas of significant footfalls of local citizen for grocery and other related shopping, most visited tourist places (especially monuments), and several entry and exit cordons to Agra.

This led to the identification of a list of total 347 locations which need to be under 100% CCTV Surveillance. Although 122 Junctions are covered as part of Intelligent Traffic Management system, these junctions will need additional equipment for surveillance other that smart traffic components. There was an additional list of 225 junctions/locations/places that will need the surveillance equipment. Together, these junctions will cover the entire city and help police in maintaining command and control of the complete CCTV and Surveillance systems by keeping a closer look on the activities being conducted at these locations.

| Sr No | Junction Name | Area/Thana | | Sr No | Junction Name | Area/Thana |
|---|---|---|---|---|---|---|
| **1** | Hing Ki Mandi Tiraha | Kotwali | | 113 | Madhunagar | Sadar Bazaar |
| **2** | Rawatpada Tiraha | Kotwali | | 114 | BD Jain Inter College Campus | Sadar Bazaar |
| **3** | Roxy Cinema Tiraha | Kotwali | | 115 | Nand Tackies Chairah | Sadar Bazaar |
| **4** | Fubbara Tiraha Kotwali | Kotwali | | 116 | R. M. O Chauraha | Sadar Bazaar |
| **5** | Seth Gali Tiraha | Kotwali | | 117 | Allabakh Chauraha | Sadar Bazaar |
| **6** | Kashmiri Bazaar Tiraha | Kotwali | | 118 | Kotli Bagchi Semari Taj Chauraha | Sadar Bazaar |
| **7** | Sindhi Bazar Tiraha | Kotwali | | 119 | Rajeshwar Temple | Sadar Bazaar |
| **8** | City Station Tiraha | Kotwali | | 120 | Eklavya Stadium | Sadar Bazaar |
| **9** | Tilak Bazar Chauraha | Kotwali | | 121 | Cariappa Chauraha | Sadar Bazaar |
| **10** | Roshan Mohalla Chauraha | Kotwali | | 122 | Veeragana Jhalkarvi Chauraha | Taj Ganj |
| **11** | Nalla Mahavir Pulia Tiraha | Kotwali | | 123 | Basai Chauraha | Taj Ganj |
| **12** | Subhash Bazar Tiraha | Kotwali | | 124 | Double Tree Y Hilton Chauraha | Taj Ganj |
| **13** | Lohargali Tiraha | Kotwali | | 125 | Vibhav Nagar Chauraha | Taj Ganj |
| **14** | Fubbara Tiraha Kinari Bazaar | Kotwali | | 126 | ADA Heights | Taj Ganj |
| **15** | Chaubey Ji Ki Fatak | Kotwali | | 127 | Todra Chowki Tiraha | Taj Ganj |

| | | | | | | |
|---|---|---|---|---|---|---|
| **16** | Seb Ka Bazaar Tiraha | Kotwali | | 128 | Canara Bank Crossroads Idgah | Rakab Ganj |
| **17** | Johari Bazaar Tiraha | Kotwali | | 129 | Mayur Talkies Railway Colony Thiraha Idgah | Rakab Ganj |
| **18** | Emergency Tiraha | MM Gate | | 130 | Railway Station Idgah Colony | Rakab Ganj |
| **19** | Purani Emergency Tiraha | MM Gate | | 131 | Gostwali Gali | - |
| **20** | Kaliwadi Chauraha | MM Gate | | 132 | Idgah Katgarh Terraha | - |
| **21** | Collectorate Gate | Nai Ki Mandi | | 133 | Mohanpura Turn Corp Compound | - |
| **22** | Vishwa Vidyalay Main Gate | Hariparvat | | 134 | Ravli Mandir Terrah | - |
| **23** | Paliwal Main Gate | Hariparvat | | 135 | Ghoulpur House | - |
| **24** | Sahyog Vatika Main Gate | Hariparvat | | 136 | Petrol Pump Intersection Baluganj | - |
| **25** | Vishwa Vidyalay Main Gate (Chauraha) | Hariparvat | | 137 | Chauki Baluganj Chauraha | - |
| **26** | Wazirpura | Hariparvat | | 138 | Targhar Chauraha Baluganj | - |
| **27** | Big Bazaar | Hariparvat | | 139 | Chilagarh Chauraha Baluganj | - |
| **28** | GG Nursing Home | Hariparvat | | 140 | Auliya Tiraha | - |
| **29** | Sanjay Talkies | Hariparvat | | 141 | Sai Ki Takiya Chauraha | - |
| **30** | LIC Building | Hariparvat | | 142 | Dhaulpur | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | House Raipur Terraha | |
| **31** | Vikash Bhawan | Hariparvat | | 143 | Red Fort Terah Man Gate | - |
| **32** | Kapda Market | Hariparvat | | 144 | Victoria Park Tiraha | - |
| **33** | Max Mall | Hariparvat | | 145 | Chhalkara Devi Cremation Ground Crossing | - |
| **34** | SBI Zonal Karyalay | Hariparvat | | 146 | Yamuna Kinara Road | - |
| **35** | Shoe Market | Nai Ki Mandi | | 147 | Fort Railway Station | - |
| **36** | Guffa Baar Parking | Hariparvat | | 148 | Bhairo Temple Chandappan Alleyaha Biography Mani Mandi | - |
| **37** | ICICI Bank Parking | Hariparvat | | 149 | Garib Nagar Tiraha | - |
| **38** | Pratik Centre Parking | Hariparvat | | 150 | Patel Nagar Kali Mata Temple Krishna Kaloni Thiraha Biography Mandi | - |
| **39** | Delhigate Chauraha | Hariparvat | | 151 | Motiganj Market Division | - |
| **40** | Hanuman Chauraha | Hariparvat | | 152 | Kala Mahal Peepal Mandi | - |
| **41** | Diwani Chauraha | New Agra | | 153 | Mutwir Masjid Terah Pipal Mandi | - |
| **42** | Radhakrishn a Choraha | Hariparvat | | 154 | Stretchy Bridge | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| **43** | Abhinandana Tiraha | Hariparvat | | 155 | Ambedkar Pool (Below) | - |
| **44** | Vijaynagar Chowki | Hariparvat | | 156 | Bijlighar Dhuliaganj | - |
| **45** | Shah Market | Hariparvat | | 157 | Gudgi Chauraha (Mansoor Khan) | - |
| **46** | Anjaana Market | Hariparvat | | 158 | BP Oil Mill | - |
| **47** | Opposite Thirrah Khandari Chemps in front of University Gate | Hariparvat | | 159 | Naya Pool Tiraha | - |
| **48** | Langde Ki Chowki Chauraha | Hariparvat | | 160 | Royal Cut Tiraha | - |
| **49** | Char Khamba Chauraha | Hariparvat | | 161 | Niraich near Bhatia Petrol Pump | - |
| **50** | Ratanpura Chauraha | Hariparvat | | 162 | Nunihai in front of the Dauji Misthan | - |
| **51** | Chauraha Ganda Nala (near Bijar Nagla) | Hariparvat | | 163 | Saufhuta Road in front of RB Degree College | - |
| **52** | Masta Ki Bagichi Chauraha | Hariparvat | | 164 | Roshan Mohalla Tiraha | - |
| **53** | Sanjay Palace | Hariparvat | | 165 | Subhash Bazar | - |
| **54** | DhuliaGanj Chauraha | Hariparvat | | 166 | Peepalwala Tiraha | - |
| **55** | Hanuman Temple Chauraha | Hariparvat | | 167 | Hotel Lalas | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| **56** | Church Road Suresh Chandra Chandra Dinesh Chandi in front of the showroom | Hariparvat | | 168 | Haathi Gate Tiraha | - |
| **57** | Bhagwaan Talkies Chauraha | New Agra | | 169 | Mahaveer Nala Mode Meera Hussaini | - |
| **58** | Shakya Market | New Agra | | 170 | Near Mahavir Nalla Temple | - |
| **59** | Tejnagar mode | New Agra | | 171 | Mantola Terahaha | - |
| **60** | Hydel Chauraha | New Agra | | 172 | Barfwali Lane | - |
| **61** | Central Bank Cut | New Agra | | 173 | Gostwali Gali | - |
| **62** | Shriram Check | New Agra | | 174 | Naubasta Chairah | Loha Mandi |
| **63** | Shreeji Guest House Cut | New Agra | | 175 | Besan Basti Chauraha | Loha Mandi |
| **64** | Agarwal Hospital Cut | New Agra | | 176 | Telipada Terahaha | Loha Mandi |
| **65** | Janak Park Chauraha | New Agra | | 177 | Pirabahabud din Chauraha | Loha Mandi |
| **66** | Aadarsh Nagar Mode | New Agra | | 178 | Madia Katra Chauraha | Loha Mandi |
| **67** | Agarwal Seva Sadar Tiraha | New Agra | | 179 | Kidwai Park Chauraha | Loha Mandi |
| **68** | Hiralal Halwai Tiraha | New Agra | | 180 | Rajamandi Chauraha | Loha Mandi |
| **69** | Waterworks from Chairla to the guest house on the road to | New Agra | | 181 | St. Johns Chauraha | Loha Mandi |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Bulkeshwar | | | | | |
| **70** | Chandi Chowki Chauraha | New Agra | | 182 | Panchkuya Chirahah | Loha Mandi |
| **71** | Shakti Market Chauraha | New Agra | | 183 | Jaipur House | Loha Mandi |
| **72** | Shalimar Extenson Chairah | New Agra | | 184 | Baldevganj Sarafa Bazar | Loha Mandi |
| **73** | Subhash Nagar Chairah | New Agra | | 185 | Lohamandi Main Market | Loha Mandi |
| **74** | Dayalbauh Road (Nagla Padi Road) | New Agra | | 186 | Arya Samaj Temple Chirah Jaipur House | Loha Mandi |
| **75** | Chitalamata Temple Garden JP Nagar Mode | New Agra | | 187 | Tota Ka Taal Tiraha | Loha Mandi |
| **76** | Mau Road Nirbhaya Nagar Terraha Mode | New Agra | | 188 | Syedpada Tiraha | Loha Mandi |
| **77** | Lions Colony Mode Madhusuda n Motors | New Agra | | 189 | Alamganj police check post | Loha Mandi |
| **78** | Near NH-2 Gupta Overseas | New Agra | | 190 | Alamgunj Police Check Old | Loha Mandi |
| **79** | Dayalbagh Road Sabzi Mandi Choraha | New Agra | | 191 | Avadhpuri Terrah | Jagdispura |
| **80** | Dayalbagh Road Post Office (Tiraha) | New Agra | | 192 | Jeevan Jyoti Tiraha | Jagdispura |
| **81** | Abulula | New Agra | | 193 | Pratap | Jagdispura |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Tiraha | | | | Nagar Chauraha | |
| **82** | Abulula's Pulia | New Agra | | 194 | Tempo Station Sector 7 Tiraha Housing Developmen t Colony | Jagdispura |
| **83** | HI-2 slope before Dia Komplex | New Agra | | 195 | Bichpuri Naharpur | Jagdispura |
| **84** | Bhagwan Talkies Flyover (Parking Stand) | New Agra | | 196 | Jeevan Jyoti Hospital Housing Developmen t | Jagdispura |
| **85** | Sultanganj's Puliyya Flyover Mughal Road | New Agra | | 197 | Vinayak Hospital Housing Developmen t | Jagdispura |
| **86** | Manoj Dhaba Tiraha Dayalbagh Road | New Agra | | 198 | Moti Hospital Bidla Bychpuri Road | Jagdispura |
| **87** | Near Mughal Road Chor Road | New Agra | | 199 | Sadar Tehsil Tiraha | Shahganj |
| **88** | Union Bank Dayal Bagh Road | New Agra | | 200 | Shahganj Chauraha | Shahganj |
| **89** | Nagla Budi Chauraha | New Agra | | 201 | Speed Color Lab Chauraha | Shahganj |
| **90** | Kalyani Height Ke Samne | New Agra | | 202 | Panchkuya near GIC School Gate | Shahganj |
| **91** | Sanjivani Tiraha 100 Ft Road | New Agra | | 203 | C News Terra | Shahganj |
| **92** | BOI Cut 100 Ft Road | New Agra | | 204 | Shivaji Nagar | Shahganj |

| | | | | | | |
|---|---|---|---|---|---|---|
| **93** | Service road cut near Omex Mal | New Agra | | 205 | Alok Nagar Chauraha | Shahganj |
| **94** | Diwani Chauraha (Mandir Ke Paas) | New Agra | | 206 | Saket Chairah | Shahganj |
| **95** | Badawar House | New Agra | | 207 | COD Terra | Shahganj |
| **96** | Kendriya Hindi Sasthan | Hariparvat | | 208 | Shakargadh Ki Pulia | Shahganj |
| **97** | Charchit Chauraha Shastripuram | Sikandra | | 209 | Pruthvinath Fatak Police Chowki | Shahganj |
| **98** | Kailash Mode Guru | Sikandra | | 210 | Rajiv Talkies Tiraha | Shahganj |
| **99** | Kailas Mandir | Sikandra | | 211 | 12 Khamba Double Fatak | Shahganj |
| **100** | Bhavna State Mode | Sikandra | | 212 | 12 Khamba Single Fatak | Shahganj |
| **101** | Gurdwara Cut | Sikandra | | 213 | Arjun Nagar Tiraha | Shahganj |
| **102** | Kirawali Tiraha | Sikandra | | 214 | Arjun Nagar near Shishu Bharti School Mode | Shahganj |
| **103** | Sikandra Sabzi Mandi | Sadar Bazaar | | 215 | Ayodhayakunj Tiraha | Shahganj |
| **104** | Sultanpura Chauraha | Sadar Bazaar | | 216 | Ajit Nagar Tiraha | Shahganj |
| **105** | Mustafa Quarter (Bhappa Chawlai Tiraha) | Sadar Bazaar | | 217 | Malpura Terrah | Shahganj |
| **106** | Shahid nagar Tiraha | Sadar Bazaar | | 218 | Kamalakhah Dargah Gate | Shahganj |
| **107** | Bhagat Murthy Chauraha | Sadar Bazaar | | 219 | Niripura Tiraha Jaganar Road | Shahganj |

| | | | | | | |
|---|---|---|---|---|---|---|
| **108** | Safoota Chauraha | Sadar Bazaar | | 220 | CNG Petrol Pump Sarai Khwaja | Shahganj |
| **109** | Outside Railway Cantt. Station | Sadar Bazaar | | 221 | Idgah Chauraha | Shahganj |
| **110** | Rajpur Chugi | Sadar Bazaar | | 222 | Dayalu Porshad Mode Nagla Chauya | Shahganj |
| **111** | Takkar Road Tiraha | Sadar Bazaar | | 223 | Vayubihar Tiraha | Shahganj |
| **112** | Ukhra Pulia | Sadar Bazaar | | 224 | Shah Market Tiraha | Hariparvat |
| | | | | 225 | Shah Market Nehru Nagar Tiraha | Hariparvat |

Given its importance as a National Heritage Monument and one of the Seven Wonders of World, it is of utmost importance that Taj Mahal should have 24x7 Security and Surveillance along with CISF Force. A detailed survey was conducted of entry and exit points of the three gates of Taj Mahal i.e., East, West and South, along with assessment of the monitoring done through internal CISF force. The paths leading towards entry and exit gates are monitored and controlled by SP Police through placement of 140 CCTVs, which are centrally monitored through Command and Control Centre at Shilpgram. This deployment was done as part of tendering done by Tourism Department and Nirman Nigam in 2016, which included the complete rejuvenation, façade, lightning and development done at East Gate and was awarded to RCL Limited, which, in turn, intends to provide the contract of CCTV and Surveillance to Spectrum Company.

### 3.6. ICT Enablement in Solid Waste Management Study

In Agra city, 9 wards were selected for ABD under Smart Cities Mission. These wards were located around Taj Mahal and were selected to improve the existing quality at International Standard in order to attract pleasant tourism. The list of wards under ABD are:

| S. No | Ward Number |
|---|---|
| **1** | 07 |
| **2** | 71 |
| **3** | 72 |
| **4** | 74 |
| **5** | 80 |
| **6** | 81 |
| **7** | 85 |

| | |
|---|---|
| **8** | 86 |
| **9** | Kalal Kheria and Mayapura (Village) |

A major issue in Agra is the floating population. Tourists and short-term migrants come and stay in Agra for varying periods of time. These pose challenges to the city administration with respect to sanitary facilities, toilets, solid waste management, sewage, water supply, transport etc. Furthermore, Agra attracts about 19-22% of total population per day from nearby villages and urban area for employment and other official/business/personal purposes. The floating population is reported as 0.3 million per day (AJS, 2015).

| S. No | Ward Number | Total Ward Area (Ha.) | Project Coverage Area (Ha.) | % of Coverage | Total no of House-holds as per 2011 Census | No of House-holds in ABD | Total Ward Population in 2017 | Project Converge Area Population | Population Density in Project Area (nos/ha) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | Ward-7 | 353 | 161 | 46 | 2466 | 1134 | 19397 | 8923 | 55 |
| **2** | Ward-71 | 200 | 120 | 60 | 2989 | 1793 | 17695 | 10617 | 88 |
| **3** | Ward-72 | 796 | 183 | 23 | 1307 | 300 | 8684 | 1997 | 11 |
| **4** | Ward-74 | 30 | 30 | 100 | 3557 | 3557 | 25530 | 25530 | 851 |
| **5** | Ward– 80 | 66 | 66 | 100 | 3471 | 3471 | 22570 | 22570 | 342 |
| **6** | Ward– 81 | 17 | 9 | 50 | 1606 | 803 | 5948 | 2974 | 330 |
| **7** | Ward– 85 | 21 | 4 | 20 | 2576 | 515 | 14741 | 2948 | 737 |
| **8** | Ward– 86 | 25 | 3 | 12 | 2189 | 263 | 12271 | 1473 | 491 |
| **9** | Kalal Kheria and Mayapura (Village) | 319 | 319 | 100 | 1088 | 1088 | 5442 | 5442 | 17 |
| | | | | | 2466 | 1134 | | | |
| | Total / Average | 1827 | 895 | 23 to 100% | 21249 | 12924 | 13228 | 82474 | 325 |

*Details of area, population, no. of households, density in the ABD area*

| S. No. | Ward No | House holds | Restaurant, Dhaba Hotel | Whole sale, Retailer Shop | Vegetable, Fruit Shop | Meat, Fish shop | Institutions |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | Ward-7 | 1134 | 132 | 678 | 78 | 1 | 53 |
| **2** | Ward-71 | 1793 | 246 | 1527 | 90 | 60 | 51 |
| **3** | Ward-72 | 300 | 73 | 376 | 80 | 0 | 43 |
| **4** | Ward-74 | 3557 | 77 | 318 | 21 | 0 | 8 |
| **5** | Ward- 80 | 3471 | 41 | 623 | 15 | 0 | 21 |
| **6** | Ward- 81 | 803 | 59 | 583 | 75 | 0 | 18 |
| **7** | Ward- 85 | 515 | 26 | 375 | 23 | 0 | 10 |
| **8** | Ward- 86 | 263 | 26 | 942 | 39 | 0 | 17 |
| **9** | Kalal Kheria and Mayapura (Village) | 1088 | 12 | 28 | 25 | 0 | 2 |
| | **Total (MT/day)** | **12924** | **692** | **5450** | **446** | **66** | **223** |

*No. of waste generation sources in ABD area*

| Waste Category | Year | | |
|---|---|---|---|
| | **2017** | **2027** | **2037** |
| **Domestic** | 40.91 | 48.92 | 58.41 |
| **Commercial** | 30.28 | 36.04 | 42.90 |
| **C&D Waste** | 13.59 | 16.22 | 19.33 |
| **Road Sweeping** | 8.23 | 9.82 | 11.71 |
| **Total Tonnes/Day** | **93** | **111** | **132** |

*Projected decadal increase in MSW generation in ABD area, Agra*

### A. CURRENT MANAGEMENT OF MSW IN ABD AREA

The present practices followed for the MSW manage net are categorized as follows:

1. Collection from domestic and other establishments
2. Collection in small dustbins
3. Transfer to big size dustbins
4. Transportation from big size dustbins to dump site through trucks

| S. No | Waste Category | % of composition |
|---|---|---|
| **1** | Biodegradable Matter | 50% |
| **2** | Glass | 4% |
| **3** | Plastics | 3% |
| **4** | Paper | 5% |
| **5** | Metals | 1% |

| | | |
|---|---|---|
| **6** | Leather and Rubber | 1% |
| **7** | Rags | 5% |
| **8** | Household Hazardous | 1% |
| **9** | Inert Materials | 30% |
| | **Total** | **100%** |

*Typical characteristics of MSW at Agra*

Now considering the implementation of ICT Components for PAN City, following is the current understanding and data availability.

Agra is divided into 4 zones. The details about each zone are presented below:

a. Zone 1: There are 19 census wards in Zone 1 covering an area of 27.73 sp. km out of 126.15 sq. km (12478Ha) of Agra Nagar Nigam.
b. Zone 2: There are 15 census wards in Zone 2 covering an area of 23.28 sp. km out of 126.15 sq. kms (12478Ha) of Agra Nagar Nigam
c. Zone 3: There are 28 census ward in Zone 3 covering an area of 31.14 sq. km out of 126.15 sq. km (12478Ha) of Agra Nagar Nigam
d. Zone 4: There are 28 census wards in Zone 4 covering an area of 44.004 sq. km out of 126.15 sq. km (12478Ha) of Agra Nagar Nigam

A detailed survey was conducted by RCUES by collecting domestic waste from households, specific waste streams, and commercial establishments like hotels, fast food joints and institutional areas from all the zones. The detailed ward wise population, ward map household, waste generated from residential, commercial settlement, total waste, length of major roads, minor road, dual carriage and highway, number of establishments were also compiled in order to have a clear cut glance of the existing situation in wards.

Based on population projection and current waste generation of MSW from the jurisdiction of Agra Nagar Nigam, the same waste generation has been projected up to 2037. The proposed infrastructure, machinery and other equipment will be planned accordingly. The same is presented below:

| Year | Zone 1 | | | Zone 2 | | | Zone 3 | | | Zone 4 | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MSW | Road Sweeping | C&D Waste | MSW | Road Sweeping | C&D Waste | MSW | Road Sweeping | C&D Waste | MSW | Road Sweeping | C&D Waste | MSW | Road Sweeping | C&D Waste |
| **2017** | 138.08 | 16.57 | 27.62 | 124.96 | 15 | 24.99 | 230.06 | 27.61 | 46.01 | 207 | 24.84 | 41.4 | 700.1 | 84 | 140 |
| **2021** | 148.81 | 17.86 | 29.76 | 134.64 | 16.16 | 26.93 | 247.44 | 29.69 | 49.49 | 223.09 | 26.77 | 44.62 | 754 | 90.5 | 150.8 |
| **2022** | 151.49 | 18.18 | 30.3 | 137.05 | 16.45 | 27.41 | 251.79 | 30.22 | 50.36 | 227.12 | 27.25 | 45.42 | 767.5 | 92.1 | 153.5 |
| **2027** | 164.89 | 19.79 | 32.98 | 149.15 | 17.9 | 29.83 | 273.52 | 32.82 | 54.7 | 247.23 | 29.67 | 49.45 | 834.8 | 100.2 | 167 |
| **2031** | 177.6 | 21.31 | 35.52 | 160.62 | 19.27 | 32.12 | 293.56 | 35.23 | 58.71 | 266.3 | 31.96 | 53.26 | 898.1 | 107.8 | 179.6 |
| **2032** | 180.78 | 21.69 | 36.16 | 163.49 | 19.62 | 32.7 | 298.57 | 35.83 | 59.71 | 271.07 | 32.53 | 54.21 | 913.9 | 109.7 | 182.8 |
| **2037** | 196.67 | 23.6 | 39.33 | 177.84 | 21.34 | 35.57 | 323.62 | 38.84 | 64.73 | 294.9 | 35.39 | 58.98 | 993 | 119.2 | 198.6 |

*Waste projection for Agra Nagar Nigam (in MT/day)*

The entire Agra Nagar Nigam has 90 wards divided into 4 zones and waste is collected by Nagar Nigam from dustbins. Sweepers are deployed by the Nagar Nigam for road sweeping, drain cleaning. There workers are handling the waste in Agra Nagar Nigam. Door-to-door waste is not being collected.

Single bin system, without segregation is prevalent and the use of polythene for waste disposal has been also found to be in vogue.

Moreover, major portion of residents belonging to the residential establishments create littering on road or they throw some packaged material of waste in dustbin (if available), or on the streets (unidentified secondary point), or in the drains running in front of the house. The karamcharis/operators collect waste from all such sources and dispose them unscientifically without any processing and treatment. Overall, the existing scenario of SWM practices in Agra Nagar Nigam is not satisfactory. Some observations during visit of project area are as below:

- In Agra the waste is littered on the roadsides or near the residential buildings by the people.
- Current bin locations have become an open dumpsite for the people residing in the immediate proximity.
- Community bins are overflowing as the bins are transported regularly for disposal. Waste is being disposed unscientifically.
- There is a plan for 100% door-to-door waste collection from entire jurisdiction of Agra Nagar Nigam so as to avoid littering on the roadside. This component shall receive help from GAIL (Gas Authority of India Limited) under CSR (Corporate Social Responsibility) scheme.
- The existing Dhalao Ghar have become an open dumping site.

Overall, the existing scenario of MSW management in Agra reflects the need for strengthening in all areas for their effective management.

The gap between generation and collection of waste is showing the need to increase collection efficiency which may be carried out through primary collection by door and door or by providing adequate number of collection bins. There are large numbers of vehicles, but there is lack of synchronization.

**Following were the Overall Compliances in SWM Rules:**

**Step 1: Waste Generation**

**Prohibit littering of waste on the streets and storage of waste at source**: 100% littering has not been prohibited by municipal authority, nor is there door-to-door coverage of waste in all the wards. Door-to-door collection of waste has recently been initiated in 15 wards through a private operator. There is no segregation of waste at source and only few people store their waste at household level to put the waste in the nearby bin. The majority of the population throws the waste on the streets, open spaces etc. Further, due to awareness and initiative taken at ULB level through providing adequate number of secondary storage bins, the collection efficiency from primary sources is increasing.

**Segregation of Recyclable Wastes:** There is no segregation of waste at household level and the system is not organized. Traditionally, segregation of recyclable waste is partially practiced by households/commercial establishments for sale to kabadiwalas (waste purchasers). Rest of the recyclable material is disposed off by residents along with domestic waste in a mixed form. This waste finds its way on the streets, in the drains, dumping grounds, etc., from where rag pickers collect the waste to earn their livelihood. Recyclable waste is generally found mixed with domestic waste.

**STEP 2: Primary Collections**

System of primary collection of waste from the doorstep has been recently introduced in the city. Door-to-door waste is being collected from 15 wards. The waste is being thrown anywhere, giving a filthy look to overall locality and the city in whole.

**STEP 3: Street Sweeping**

The work of cleaning of streets is not being done regularly in the city on account of inadequacy of sanitary workers and supervisors. As per beat analysis, the requirement of sweepers for year 2017 is as calculated below:

Street Sweeping and Drain Cleaning:
Sweeping Staff - 1402 Nos.
(Agra Municipal Corporation annexure-5 cost of labor and road sweeping and drain cleaning)

**STEP 4: Secondary Storage Waste Storage Depots**

Presently bins of 1 cu m , 1.1 cu m, 1.2 cu m 4.5 cu m and 8 cu m capacity are provided in different places in the city. The waste is thrown haphazardly in the dustbin. However, it is noticed that bins in some areas get filled in one day or more, whereas bins in other areas gets filled within 10 to 12 hours time period, mostly in high-density commercial places. Due to inadequate capacity and placement of metallic bins in areas of high-density waste generation such problem arises. The details of the bins available with Agra Nagar Nigam are mentioned below.

| Purchase | 1.0 Cum | 1.1 Cum | 1.2 Cum | 4.5 Cum | 8.0 Cum | Total |
|---|---|---|---|---|---|---|
| **Non Utilizable Bins (based on life expectancy of material)** | | | | | | |
| 2012 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 200 | 0 | 0 | 182 | 175 | 557 |
| **Utilizable Bins** | | | | | | |
| 2015 | 0 | 200 | 231 | 0 | 25 | 456 |
| 2016 | 228 | 0 | 0 | 40 | 33 | 301 |
| **Total** | **428** | **200** | **231** | **222** | **233** | **1314** |

*List of available vehicles and their capacity*
*Source: Agra Nagar Nigam*

**STEP 5: Transportation of Waste**

The transportation of waste from secondary storage bins is being practiced by vehicles, whose selection is based on topography and quantification of waste generation from that particular area. During consultation with sanitary official of ULBs it was noticed that small dumper placer and tractors are used for transportation of waste.

**STEP 6: Waste Processing and Treatment**

The existing processing plant is not in functional condition and occupies an area of about 5 acres at Kuberpur. This waste processing plant has the capacity of 250 TPD. It was inaugurated in 2011, but as per present scenario it is not in working condition.

**STEP 7: Disposal of Waste**

There was one scientific disposal site in Agra. It exists for disposal of inert/composting residue/non-biodegradable/non-recyclable material. Scientific Landfill Site is totally closed. Presently waste is being thrown in Kuberpur, near Yamuna Express. The total area is 71.7 acres

**Proposed Plan for Effective Implementation as Proposed in Detailed Project Report which seems to be the Way Forward for Nagar Nigam is as Follows:**

**Segregation and Storage of Waste**

- Promotion of the practice of segregation and storage of waste at source in three separate streams- First (1) stream of biodegradable waste, and second (2) for recyclable waste, and third (3) stream shall be for domestic hazardous waste. First two streams to be stored in bins for daily lifting and third one will be stored as per guidelines of State Pollution Control Board and shall be deposited to PCB authorized centre only.
- Large hotels/restaurants/commercial complexes, residential societies, vegetable markets to follow segregation at source.
- Containerized and segregated storage at source by all waste generators.
- Immediate ban upon open storage sites and roadside waste dumping.
- Avoid littering on road and nallahs.
- Awareness creation for segregation and storage at source.

1. **Primary Collection of Waste**

- Organization of door-to-door collection in all wards of city with community participation on cost recovery basis. Minimization of the multiple handling of waste and improvement in the productivity of labor and equipment.

- 100% door-to-door collection through rickshaw trolleys and covered Light Commercial Vehicles of 1.0, 1.1 and 1.8 cu m capacity.

2. **Secondary Collection of Waste**

- Street sweepings including solid waste and silt from the drains to be collected by containerized handcarts and to be transported separately through existing tractors.
- Containers to be lifted by RCV directly and DP vehicles.
- Phasing out of containerized secondary storage facilities in time bound manner to make city bins free.

**3. Transportation of Waste**

- Daily transportation of segregated waste to the transfer station/treatment site.
- Separate transportation of domestic waste, commercial and institutional waste, C&D waste and sweeping silt through the fleet dedicated for particular waste stream.
- RFID technology shall be adopted for effective management of waste lifting from household/secondary storage of each zone.

Collection and transportation system proposed for Agra Nagar Nigam is basically on the concept of bin-less city as defined. However, it is also kept in mind that 100% people's participation for door-to-door collection cannot be ensured right from beginning of project

**4. Processing and Disposal of Waste**

- Centralized waste processing unit for conversion waste to biomethanation, waste to energy and C&D Waste processing system.
- Disposal of residual inert/processing rejects into eco-friendly designed sanitary landfill.
- Monitoring system to increase the productivity and complaint resolution system.
- Door-todoor collection and assure 100% collection from each ward of ANN.
- Generation of domestic and non-domestic waste in each ward of Agra.
- Available road width and transportation arteries.
- Optimization of transportation vehicle.
- Availability of land parcel available for SWM.
- Quantification and characterization of waste generation.
- Geographical needs of city.
- Gaps in existing system.
- Views of officials, city managers and community leaders.
- Assure each house garbage collection by state-of-the-art technology.

The above literature illustrates on the actual conditions of Solid Waste Management for Agra city and post detailed survey, the proposals and recommendations submitted which ASCL is looking forward to implementation for which desired tenders have been issued and awarded to 4 independent vendors to take care of collection mechanism. Now there is a highlight on supporting software components that are currently available to compliment the proposals.

The Agra Municipal Corporation is looking after the Municipal Waste Collection and Sanitation, besides delivering many other functions to serve better for its people living within its limits. AMC developed a state-

of-the-art system to keep a full track on daily routine waste collection and sanitation work along with vehicles movement and public grievance redressal system.

The system is divided in four parts i.e.,

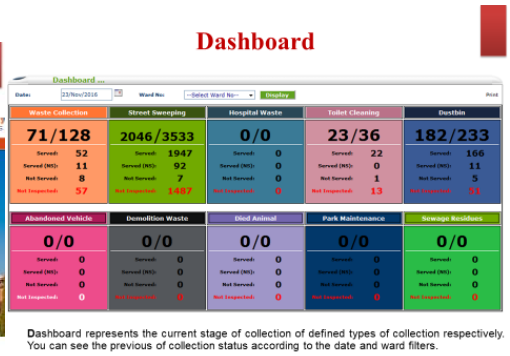
1. Mobile Application for Online Complaint with Geo Location and Pictorial Evidence for Public Use
2. Mobile Application for Supervisors and Inspectors for Inspection of Waste Collection and Sanitation Work with Time Stamp, Geo Location and Pictorial Evidence for Daily Routine Work

   Residents of Agra Municipality may download the Android/iOS mobile app from Google Play store or App Store and they will have a set of options in the app like Waste Collection, Street Light Issue, Illegal Issue and Other Municipality Related Issue through which they can take the photo as evidence. The app will automatically take the time stamp with geo location of the place where the photo is captured. All the information will be sent and uploaded on a cloud server.

   Based on the geo location captured, an alert will pop up on tge respective Supervisor and Inspector's mobile app (Sanitation Mobile App) according to the roster and accordingly they have to resolve the complaint. Supervisors have to take a photo as evidence post resolution so that management can see the time of complaint resolution and compare photographs and variations in location. There is no option in the app to upload photos from the gallery. On resolution of the complaint, complainant can also see the pictorial evidence of the complaint raised.
3. GPS Tracking of Vehicles, used for Waste Collection and Transportation
4. Cloud based Web Application (Management Tool) for Centralized Monitoring – Live feeds of data collected from the field inspected by supervisors will be displayed in control room in Nagar Nigam Campus, Agra. All the inspection and complaint related data will be routed through the cloud from the control room. After making sure the waste is collected, the operator in the control room will monitor the vehicles movement, which are collecting the waste and transporting to dumping yard or any designated place. Route summary, deviation from route, running km on daily basis, idle status and fuel filling and consumption status will also be monitored in control room only.

   Visual displays of the Web Based Application for Monitoring and Tracking along with Mobile Applications for Internal and Workforce Management, Citizen for Grievance Redressal and Dashboard for Monitoring Purpose are as follows:

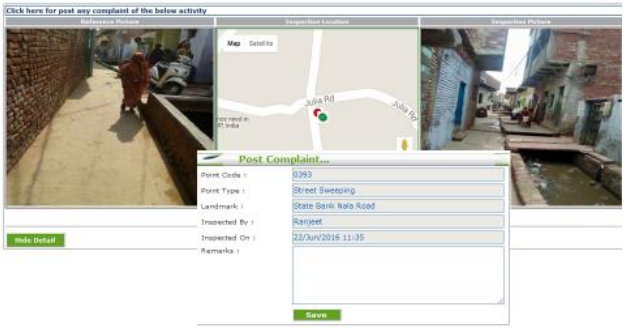
Home screen of Waste Collection System



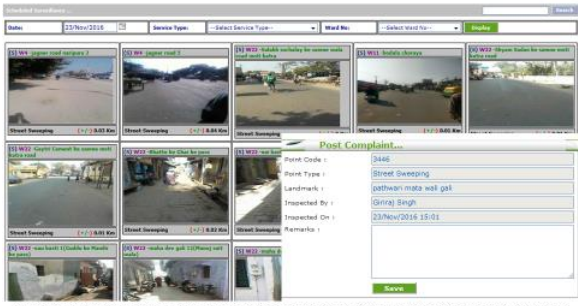

Dashboard represents the current stage of collection of defined types of collection respectively. You can see the previous of collection status according to the date and ward filters.

## Scheduled Inspection - I

## Scheduled Inspection - II




## Scheduled Surveillance




Scheduled Surveillance is displaying the evidence of the points which is been served by the supervisors. This can see only photographs regarding to the points. Inspector can post complaint the respective point by clicking on "**Status**" if he /she is not satisfied.

## Daily Inspection Summary Report

Daily Inspection summary report display the date wise points status. If you will click on the any number this will show the detailed report for the same as you selected.

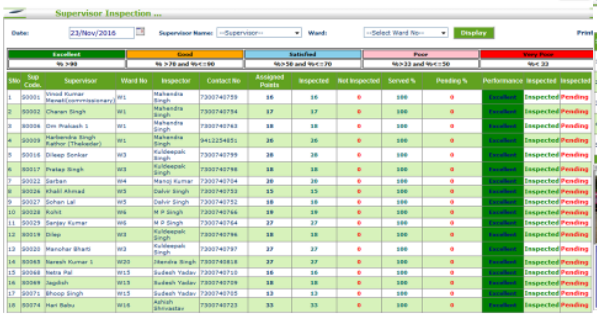
## Geographical Points Location

All points will be display in geographically on map. Images will be changes as per the points status. If point is served the icon will be green and not served then it will be black. You can see the status according to the ward.

## Supervisor Monthly Summary

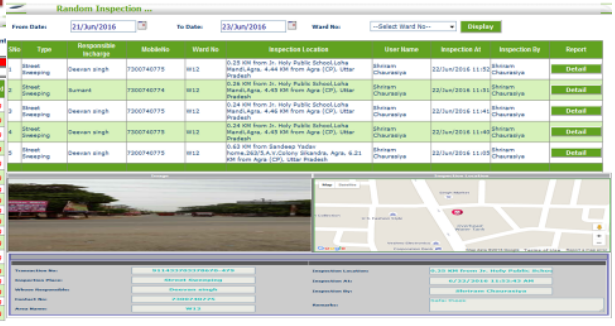
With the help of monthly summary of supervisor we can see the status of points which is being served by him as the defined by the Nagar Nigam. This report will display the total points assigned and inspected points by the supervisor.

## Supervisor Inspection



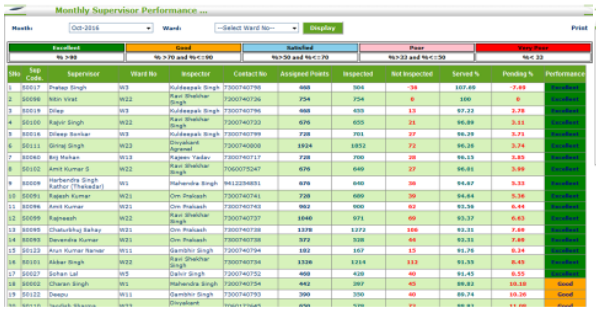

Daily basis supervisor with his performance and Inspected or Pending points. Percentage calculated as per the points assigned and performance will be displaying according to percentage wise like **Excellent**, **Good**, **Satisfied**, **Poor**, **Very Poor**.

## Random Inspection



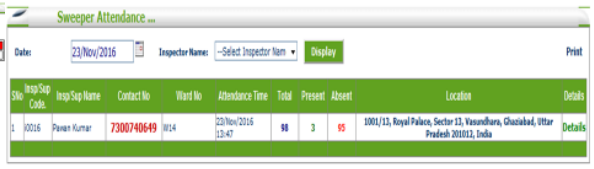

Inspector can do the random inspection of any point and he will check the supervisor done the points yes or no. If any he found bug related to the inspected point then he can do the any action for the same.

## Monthly Supervisor Performance




Monthly basis supervisor with his performance and Inspected or Pending points. Percentage calculated as per the points assigned and performance will be displaying according to percentage wise like **Excellent**, **Good**, **Satisfied**, **Poor**, **Very Poor**.

## Attendance of Staff - I



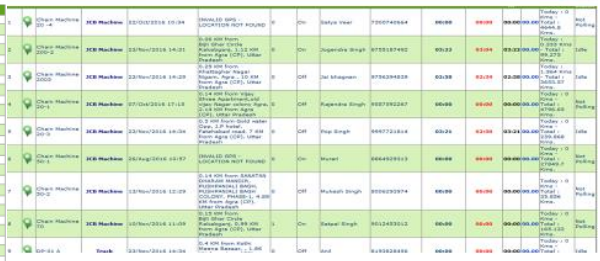

Supervisor or Inspection will take the attendance of sweepers on daily basis. They will select the Daily Attendance from the mobile application. Assigned sweepers list will be visible on the app and they can mark absent and present as per the status. After clicking on the detail option all sweepers will be display on the application with their attendance.

**Benefits of Attendance:** Before this feature we cannot identified how many sweepers are working in a day. With the online attendance we can check the live attendance monitoring of the sweepers as well as there leaves status.

## Attendance of Staff - II

After taken the attendance by supervisor or Inspector, report will be generated in system with evidence of image and location. As well as this will displaying the entered record in below of evidence.

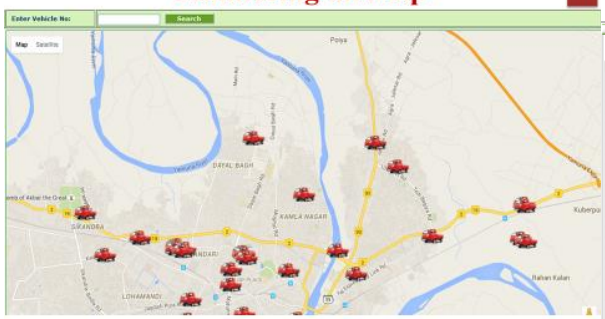
## Vehicle Status



Above screen will displaying the vehicle list of Nagar Nigam which is running for taking the waste collection. Its displaying the current location, total working hours, current kilometer as well as current vehicle engine status either its ON or OFF. All vehicle has installed the GPS devices.

**Benefits of Vehicle Tracking:** With the help of GPS we can track the current location of the vehicles with the actual working hours in a day.

## Monitoring on Map

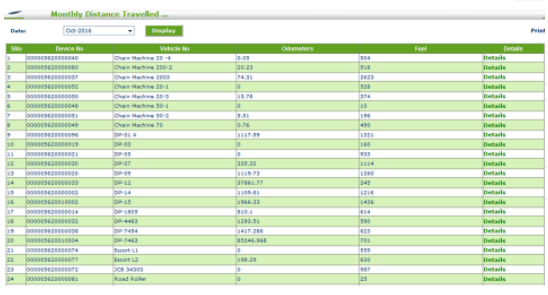



All GPS installed vehicles will be displaying on map with actual location. We can see the exact location of a particular vehicle with this screen.

## Distance Travelled Report

We can see the total distance travelled of the vehicle which is running. We can also see the distance travelled report for previous days.

## Monthly Distance Travelled Report




We can see monthly distance travelled of the vehicle which is running. We can also see the distance travelled report for previous months.

## Fuel Saving Report

**Fuel Saving Report from April to September 2016**

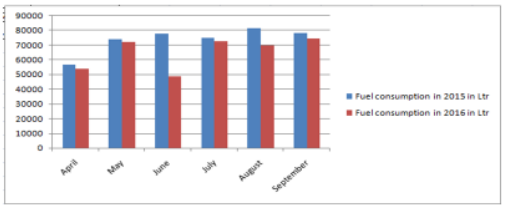
| Month | Number of Vehicles in 2015 | New Vehiles in 2016 | Total Vehicles in 2016 | Fuel consumption in 2015 in Ltr | Fuel consumption in 2016 in Ltr | Fuel Saving in Ltr |
|---|---|---|---|---|---|---|
| April | 63 | 29 | 92 | 56554 | 62442 | -5888 |
| May | 81 | 11 | 92 | 73968 | 72139 | 1829 |
| June | 83 | 9 | 92 | 77803 | 48923 | 28880 |
| July | 85 | 7 | 92 | 75112 | 72754 | 2358 |
| August | 85 | 7 | 92 | 81552 | 69665 | 11887 |
| September | 86 | 6 | 92 | 78081 | 74321 | 3760 |
| | | | Total | 443070 | 400244 | 42826 |

Fuel Saving in Ltr

We can see monthly fuel balance of the vehicle which is running. We can see the fuel balance report for previous months.

**Fuel Monitoring:** As per the above details, fuel consumption is reducing month by month as per the previous months. We are getting very benefit with the GPS Technologies in order to fuel consumption.

## Fuel Saving Graphical Report




**Fuel Monitoring**: As per the above details, fuel consumption is reducing month by month as per the previous months. We are getting very benefit with the GPS Technologies in order to fuel consumption. As per the details we save the Apprx **51398** Ltrs fuel in last some months.

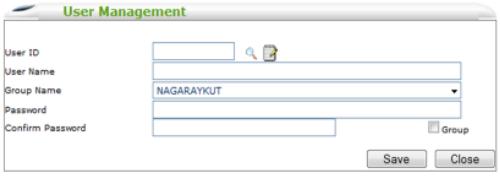
## Online Complaint - I

All online complaints will be displaying in this screen. We can set the status of complaint "close, forwarded or In Progress" with this screen. And check the evidence of Geo location of the complaint point.

## Online Complaint Status

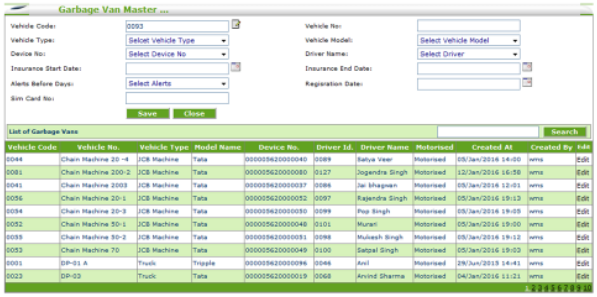
We can check the complaints with status wise and also check the duration which is spent for a complaint and also we can check the images complaint posting and after resolving.

## User Management



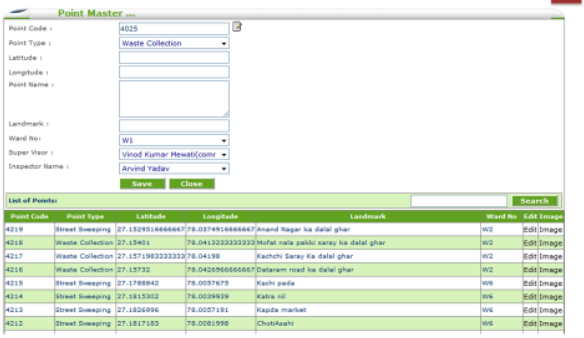

With the help of above screen, we can create the user's of Waste Collection System. According to the level of users we can assign the group for them.

## Master Data Entry



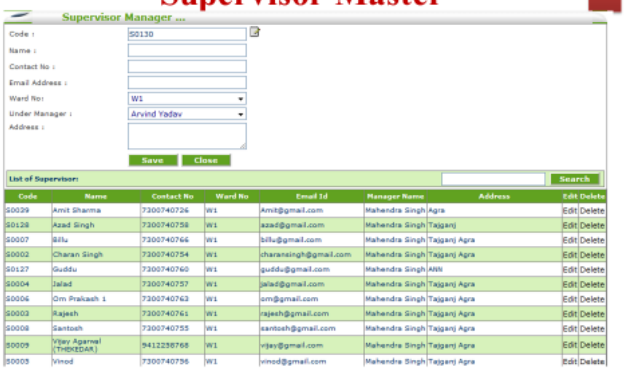

We will add a new Garbage van (Vehicle) with the help of above screen. Enter the all details regarding the vehicle.

## Point Master



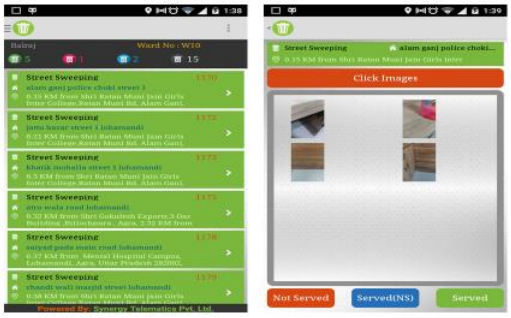

We will add a new point for supervisor. Select Supervisor, Inspector and ward for the particular point.

## Supervisor Master




We will add a new Supervisor. Select the manager name to assignment this supervisor.

## Point List

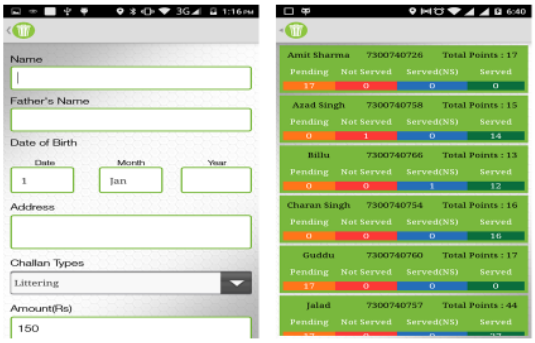



After login the application supervisor found the listed point for supervision and will start the routine activity.

## Online Compliant

Supervisor can see the online complaint request for assigned to him from the menu list.

## Online Challan and Served Points




Supervisor can cut the online challan in a district and see the his served point status.

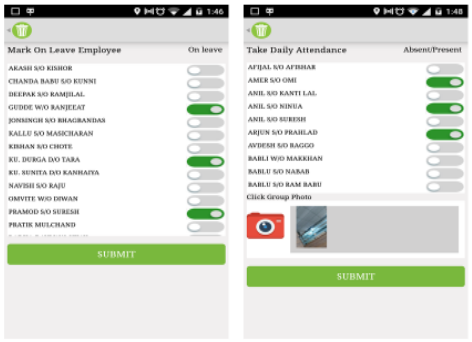
## Daily Inspection Report

Inspector can see the daily Inspection report of any supervisor. He can select the any supervisor name and get the report like above.

## Random Inspection

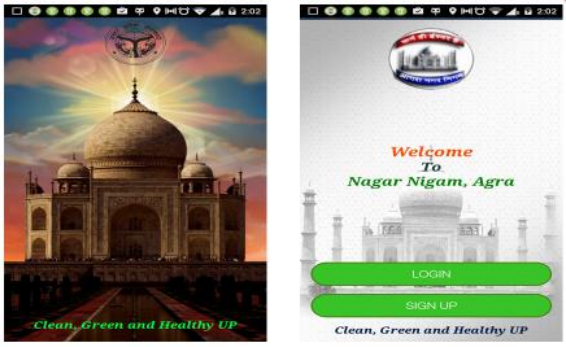
Inspector can do the random inspection of any points as well as complaint which is assigned to supervisors. They can mark or send the complaint if the things was not completed by the supervisors.

## Leave and Attendance



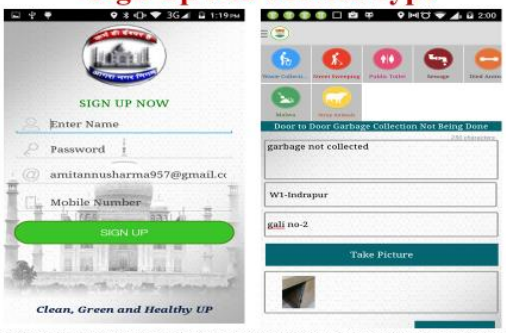

Inspector/Supervisor will take the attendance of sweepers after marking the leave status. This process will be done by the Inspector/Supervisor on daily basis.

**User Application Home Page**




Home Screen of User Application

**Sign Up and Service Type**




After sing up and login into the application, they can send any request as per the listed types of home screen with evidence of pictures.

**Checking Complaint Status**

User can send the complaint and check the status immediately about his/her complaint. And they will receive notification for the submitted complaint for an acknowledgment.

The operationalization of this system will have a severe impact in overall horizon due to following highlights of the applications:

- Constant surveillance and monitoring of waste collection activities based on a huge database of reference points.
- Image of the served sites can be taken and registered.
- Online inspection can be carried out by comparing reference image with image of served location.
- Free user app for citizens through which they can register their complaints.
- Users can give their valuable feedback about the action taken against their complaints.
- Daily monitoring of activities in all the wards can be done.
- Effective management of the fleet of vehicles involved in waste collection and disposal task.
- With the help of GPS devices fitted in vehicles, real-time position and status of a vehicle can be adjudged and fuel calculation could be performed.
- Performance of personnel assigned on the task can be evaluated.
- Total distance travelled report for vehicles can be generated.
- Work hour report can be made available which would give clear information about the number of hours a vehicle has worked.
- Fuel consumption of the vehicles can be calculated for a desired duration of time.
- Enable administrators in decision-making and formulating policies for effective management.
- Graphical reports for various services can be taken out for a ward.
- Graphical reports regarding the performance of the supervisors and inspectors can be generated.

- Various services like street sweeping, waste collection, street light, hospital waste, abandoned vehicles, construction waste and dead animals etc. are available in a ward.
- Complaint regarding these mentioned services will be answered in a time-bound manner and that too with transparency.

The total budget allotted to E-Solid waste management has been calculated based survey done by Crisil. Since the Detailed Project Report (DPR) is now available, there are variations in few numbers and financials may vary from the actual quoted number and BoM is considered as follows, based on our understanding, numbers received from ANN, and DPR report analyzed:

| Solid Waste Management System | | | |
|---|---|---|---|
| **1** | Number of Households | Nos. | 3,50,000 |
| **2** | Number of Wards | Nos. | 100 |
| **3** | Number of Community Bins | Nos. | 444 |
| **4** | Vehicle Tracking System (VTS) GPS device | Nos. | 100 |
| **5** | RFID Reader Devices | Nos. | 1968 |
| **6** | RFID Tags for Bins/Collection Containers | Nos. | As per Bins and Per Vehicles |
| **7** | RFID Tags for Street Sweepers | Nos. | 1600 |
| **8** | Bin Volume Sensors | Nos. | Per Bin |
| **9** | GPS and Biometric Based Handheld Device with Attendance Management System Application | Nos. | As Per Requirement |
| **10** | GPRS/GSM Connectivity – SIM Card and Service Plan | Nos. | As per Requirement |
| **11** | Micro Controller + GSM Based Weigh Bridge (If weigh bridge not available at treatment site)/Micro controller + GSM Device to Send Real-time Data from Rreatment Site to ICCC | Nos. | 1 |

### 3.7. Smart Transportation Analysis

Public Transport in the study area is mainly a road-based system. Presently, public transport services are rather limited and bus is the only mass transport system in the Agra. Agra Mathura City Transport Services Limited (AMCTSL) operates the city bus services consisting of mainly normal buses, few low floor buses, and mini buses.

The city bus services only has fleet size of about 170 buses currently, which is a visible factor indicating the poor supply of public transport. The present supply of buses is far below the benchmark of 60 to 70 buses per lakh population for city like size of Agra.

On few peripheral routes, private city bus (mini and midi) services also ply to cater sub-urban and peripheral riders. The length of the routes for AMCTSL city bus services is approx. 215 km in the urban area. On an average 80 to 85% of fleet is available for operation and rest of the fleet is under repair or idle due to maintenance issue. During the month of November 2017, City Bus Service (CBS) made 8975 trips to cater to the commuters. Actual operated kilometers were 514,715. The total ridership for all city bus routes, in the month of November was 490,650. The income per km for the system is Rs 17.81. The conditions of the city

buses is not good as the fleet is getting older and the maintenance facilities are not adequate. For 170 buses there is only one depot, which is on Gwalior road. The depot also lacks adequate facilities and manpower to maintain and operate these 170 buses.

Intermediate Para-Transit System (IPT) system comprising of private auto, shared auto, cycle rickshaw and e-rickshaws form the spine of the mobility system of the city. Recently, e-rickshaws in the city have seen tremendous increase in their numbers. E-rickshaws, which were introduced essentially to combat pollution in Agra, may have instead contributed to increasing traffic congestion in the city. Due to overcrowding and rash driving, these battery-run vehicles have been involved in innumerable accidents and many e-rickshaws are unauthorized.

Instead of complementing the main public transport system like buses by feeding passengers, the IPT system in Agra competes with bus services by offering services in the same route causing the reduction in the ridership to city bus system.

The public transport system is Agra has not been able to catch up with the increase in the travel demand. Reliance on IPT for the main mobility needs and increasing number of private vehicles has resulted in chaotic situation of mobility in the city. Around on 15 routes, the IPT operates to cater to city commuters and connect all major nodes of the city. The total route length of the system is more than 150 km. The IPT vehicle types in the city include Ape CNG Auto, Bajaj CNG Auto, Tata Magic, battery operated rickshaw, 6-seater battery operated golf cart also operate as a shuttle between Taj Mahal and Red Fort.

As part of the fare structure, the minimum fare of IPT services is Rs 5.00 and maximum fare is Rs 20.00 for urban area.

Agra district has witnessed a rise in its share of private vehicles registered. Two wheelers constitute nearly 81% of all vehicles registered in the Agra (RTO), followed by four wheelers at 12%. The table shows the number of vehicles registered in the Agra RTO.

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scooter/Motor Cycle/Moped** | 31858 | 31615 | 38673 | 42290 | 52261 | 57115 | 62824 | 75652 | 76171 | 74873 | 73026 |
| **Car/Van/Jeep** | 4912 | 4272 | 5706 | 6406 | 7799 | 8795 | 8985 | 10837 | 12020 | 11761 | 11817 |
| **Taxi (Car/Jeep/Van)** | 131 | 166 | 276 | 425 | 400 | 448 | 435 | 361 | 547 | 630 | 682 |
| **Auto - Rickshaw (Passenger)** | 3431 | 379 | 570 | 431 | 565 | 748 | 449 | 504 | 297 | 3698 | 1144 |
| **E-Rickshaw** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 167 | 364 |
| **Buses (All Types)** | 151 | 122 | 132 | 194 | 62 | 63 | 34 | 19 | 18 | 22 | 37 |
| **School Bus** | 13 | 9 | 12 | 30 | 38 | 30 | 58 | 50 | 53 | 61 | 129 |

| Goods Vehicles | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Light/Medium** | 686 | 1020 | 1082 | 1319 | 1984 | 1806 | 1684 | 1451 | 859 | 1165 | 927 |
| **Heavy** | 151 | 121 | 131 | 99 | 217 | 212 | 148 | 131 | 162 | 150 | 248 |
| **Other Vehicles** | 978 | 588 | 1227 | 1098 | 2368 | 2066 | 1934 | 2803 | 1726 | 1575 | 1612 |
| | **42311** | **38292** | **47809** | **52292** | **65694** | **71283** | **76551** | **91808** | **91854** | **94102** | **89986** |

*Numbers of 2017 are till the end of November only. Source: Agra RTO – Vehicle Registration Data*

The analysis of the data shows that the gap between the number of private vehicles registered and public/passenger vehicles are widening. The huge rise in the private vehicular share in registration is an indicator of the increasing dependence on private vehicles.

As per the report received from UPSRTC, the number of vehicles in Agra has grown by 45% from 4.25 lakhs in 2003-04 to 6.15 lakhs in 2010, of which 76% are two wheelers. This has had an impact on the average journey speed, which is less than 15 kmph on nearly 65% of the network.

Heavy congestion is witnessed in the city during peak hours, however, it is more pronounced during the morning peak when nearly 65% of the major road network comprising of MG road, NH-2 and other arterials has an average journey speed of less than even 10 kmph. The increased vehicle ownership has also affected the trip rates for the city.

Detailing of routes, frequency, demand estimates, and calculations of bus requirements as per UPSRTC are as follows:

Agra, Mathura City Transport Service Ltd. have total 230 buses in Agra viz 10 AC, 10 Non AC Low Floor Marco pPolo Buses, 75 Tata Buses, 75 Swaraj Mazda Buses, and in Mathura 60 Swaraj Mazda Buses. It covers the entire city and is used by daily commuters like office goers, students, senior citizens, and ladies.

The buses majorly operates on two routes i.e., urban (within city) and nearby Agra. There are 3 entry points to the Agra city and majority of buses in urban area ply on 4 routes.

Other details available from Departments: Traffic Directorate, RM Roadways and UPSRTC are as follows:

| S.No. | Description | 2012-2013 | 2013-2014 | 2014-2015 | 2015-2016 |
|---|---|---|---|---|---|
| **1** | No. of FOB (Foot Over Bridges) | 1 | 1 | 1 | 1 |
| **2** | Total Number of Bus Stops | 104 | 104 | 104 | 104 |
| **3** | Ridership in Public Transport | 32984 | 34552 | 32904 | 32835 |
| **4** | Total Number of Vehicles Registered in the City | 752194 | 825131 | 905023 | 922701 |
| **5** | Number of Public Parking Facilities | 30 | 30 | 30 | 30 |
| **6** | Total Capacity of Public Parking (ECS) | 28000 | 29000 | 31000 | 33000 |
| **7** | Total Number of Signalized Junctions in the City | 17 | 17 | 17 | 17 |
| **8** | Average Travel Speed in the City | 30 | 30 | 40 | 40 |
| **9** | Number of Road Accidents Recorded | 891 | 925 | 952 | 1021 |

| | | | | | |
|---|---|---|---|---|---|
| **10** | Fatality Rate in Road Accidents | 415 | 449 | 475 | 541 |
| **11** | Total Number of Traffic Police Persons | 249 | 249 | 249 | 249 |

Details of Green Transportation, if any. (CNG Buses/CNG Tata Magics/NMT/E-Rickshaws)/Women-only public transportation

- CNG Buses – 292
- Four Wheelers – 5902
- Three Wheelers – 12052
- E-Rickshaws – 5000

The existing public transport system available for performing inter-city trips mainly consists of buses operated by UPSRTC and private operators. The intra-city travel within the city is primarily through buses, tempos, auto rickshaws, and cycle rickshaws. The city bus service in Agra city operates through private operators. As on date buses are operational on 8 circular routes and 6 direct routes in Agra City. Average length of the said routes is 21 km. A total of 293 buses are operational on these routes. However, it has been observed that a large number of buses are operating on profitable routes rather than prescriber routes. Considering the connectivity requirement of Agra city and need in nearby areas, following type of routes network are proposed in the city for sub-urban and urban areas. The details are as follows:

| Sr No | Route Details | Route Length (in Km.) | Frequency in Minutes | Running Time (Min) | Stand Time (Min) | No.of Buses Required on route) |
|---|---|---|---|---|---|---|
| 1 | Agra Fort Bus-Baluganj-Agra-Cantt-PWD Inspection House-Idgah Bus Station Pratapura-Collectorate-Kothi Meena Bazaar-Jaipur House-Saket Colony-Bodala Marg-Shashtripuram | 16 | 20 | 64 | 15 | 8 |
| 2 | Agra Cantt-PWD Inspection House-Hotel Agra Ashok Commissioner Office-Hotel Haward-Taj View-TDI Mall-Shilpgram | 10 | 20 | 40 | 15 | 6 |
| 3 | Agra Fort-Olia Road-Baluganj Police Chauki-Commissioner Chauraha-CTO Head PO Sardar Bazar, Collectorate-Hariparwat-Soorsadan-Bhagwan Talkies-Sultanganj Pulia-Kamala Nagar | 20 | 20 | 80 | 15 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | ISBT-Bhagwan Talkies-Sultanganj Pulia-Jal Sansthan-Jeevani Mandi-Agra Fort Bus Station-Baluganj-Agra Ashok Cantt Railway Station-Pratapurra-Collectorate-Panchkuia-Kothi Meena Bazaar-Saket Colony-Shahganj-Bodala Road-Ramnagar Pulia-Bodala Chauraha-Shashtripuram-Sikandra-ISBT | 30 | 20 | 120 | 15 | 14 |
| 5 | Agra Fort-Agra Ashok Cantt-Railway Station-Pratapurra-Collectorate-Subhas Park-Raja Mandi-Hariparvat-Soorsadan-Bhagwan Talkies-Sultanganj Pulia-Kamala Nagar-Balkeshwar Temple | 19 | 20 | 76 | 15 | 9 |
| 6 | Agra Fort-Olia Road-Agra Kila-Jamuna Kinara-Jeevani Mandi-Waterworks-Kamalanagar-Sultanganj Pulia-Bhagwan Talkies-Dayal Bagh and Back | 16 | 20 | 64 | 15 | 8 |
| 7 | ISBT-Bhagwan Talkies-Sultanganj Pulia-Jal Sansthan-Ramnagar Junctions-Agra Fort-Balunganj-Pratapurra-Namner-Idgah Bus Stand-Arjun Nagar Tiraha-Nowamail | 17 | 20 | 68 | 15 | 8 |
| 8 | Agra Fort-Olia Road-Kila-Jamuna Kinara-Jeevani Mandi-Waterworks-Rambagh Chauraha-Trans Yamuna Colony-Kalindi Vihar-Sofuta Road-Foundry Road-Rambagh Chauraha-Water Works-Jamuna Kinara-Agra Fort-Agra Fort Bus Station | 21 | 20 | 84 | 15 | 5 |
| 9 | Agra Fort-Olia Road-Kila Shahjhan Garden-Purani Mandi-Taj View-Amar Hotel-Vibhav Nagar-Shamshanbad Road-Radio Station | 12 | 20 | 48 | 15 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Transport Nagar-Bhagwan Talkies-Nai Ki Mandi-Collectorate-Agra Cantt-Idgah Bus Stand-Rui Ki Mandi-Alamganj-Transport Nagar | 20 | 20 | 80 | 15 | 10 |
| 11 | Cantt Railway Station PWD inspection House, Idgha Bus station, Collectorate, Agra College, S N Hospital (Shahid Bhagat Singh Road), Hospital Road, Akbari Maszid, Phawara Bazar, Jankai Das Sava Sadan, Gariha Azam Khan, Agra University, Sultani Ganj and Works Crossing | 11 | 20 | 44 | 15 | 6 |
| 12 | Nunhai to Nagla Prithvinath via Industrial Estate, Nagla Balchand, Nawal Gunj, Idmad-Ud-Daulah, Yamuna Bridge (Moti Bagh), Chatta Bazar, Vaikunthi Devi Degree College, Agra Fort, Mantola, Nai Ki Mandi, Panckkuia, Shahganj, Dhoripura, Gyaspura, Nagla Prithvinath | 10 | 20 | 40 | 15 | 6 |
| 13 | Shastripuram to Bijlighar Bus Station via Vodla Marg, Krishna Nagar, Ramnagar, Lohamandi, Hanuman Nagar, Naubasta, Rajamandi Chauraha, Bageshwarnath Temple, Gharia Azamkhan, Agra Railway Station, Belanganj, Kachahari Ghat, Pipal Mandi, Agra Fort, Subhash Nagar, Mantola, Bijli Ghar | 11 | 20 | 44 | 15 | 6 |

| Sr No | Route Details | Route Length (in Km.) | Frequency in Minutes | Running Time (Min) | Stand Time (Min) | No. of Buses Required on route) |
|---|---|---|---|---|---|---|
| 1 | Agra (Idgah Bus Station)-Fatehpur Sikri | 27 | 30 | 74 | 45 | 8 |
| 2 | Agra Fort-Saiyaan–Khaigarh | 39 | 45 | 106 | 45 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Agra (Fort)–Shamshanbad | 23 | 30 | 63 | 45 | 7 |
| 4 | Agra (Fort) – Fatehabad | 23 | 30 | 63 | 45 | 7 |
| 5 | Agra (Fort)-Ferozabad | 44 | 45 | 120 | 45 | 7 |
| 6 | Agra-Sadabad | 34 | 45 | 93 | 45 | 6 |
| 7 | Agra Fort Bus Station-Tundla Railway Station | 27 | 30 | 74 | 45 | 8 |
| 8 | Agra Fort Bus Station-Devri-Naglapatam-Iradatnagar | 27 | 45 | 74 | 45 | 5 |
| 9 | Agra Fort Bus Station-Vichpuri-Achnera | 40 | 45 | 109 | 45 | 7 |
| 10 | Agra Fort Bus Station–Farehae | 34 | 45 | 93 | 45 | 6 |
| 11 | Agra-Mathura | 58 | 30 | 158 | 45 | 14 |
| 12 | Agra-Khandoli-Maie-Bisawar | 40 | 45 | 109 | 45 | 7 |
| 13 | Agra-Etamadpura-Barhaan | 22 | 30 | 60 | 45 | 7 |

Of the total 230 buses, around 100 buses are not operational and only 130 buses are currently serving the urban and sub-urban areas and this itself is creating a major gap between supply and demand.

Hence, Agra Smart City Limited proposes to induct 50 smart electric buses in their fleet. Smart electric buses offers connectivity, AC, and comfort. This, along with clean transportation, will attract passengers to use more and more public transportation.

Considering the need of the Agra city in terms of pollution level and dependency of citizens on public transport (urban and suburban) areas, Agra PMC team responded to the Expression of Interest floated by Ministry of Heavy Industry (HNI) under FAME scheme to avail the incentives for procurement of Electric Vehicle buses. Agra Smart City limited have submitted the proposed for 100 Electric Buses and 120 charging stations to fill the current gap and enhance the need of the city, which was not awarded in phase 1 allotment and shall have to wait for phase 2 allotment. Once the desired transportation is available, which is capable of complementing the smart components, a separate RFP shall be worked on and will be floated separately which shall even consider the modernization of existing Bus Shelters with desired technology.

### 3.8. Smart Parking Solution Analysis

To ease traffic congestion and for the ease of tourists and local residents, it was proposed to establish 9 multi-level car parking facilities with 2700 car parking facility in the entire city in Pan City proposals. PMC team in consultation with stakeholders had thought of identifying exact land for these parking locations. The road stretches where the facilities were planned to proposed are:

- NH-2: Sikandara Road
- NH-93: Hathras Road

- NH-93: Firozabad Road
- SH-62: Fathehabad Road
- SH-62: Shamshabad Road
- NH-3: Gwalior Road
- SH-39: Jagnair Road
- NH-11: Fathepur Sikri Road
- Bharatpur Road

Out of nine, one was proposed to develop smart multi-level car parking facility in Jalkal campus on Fatehabad Road with a parking capacity of 300 cars which comes under Area Based Development Area.

The proposed site at Jalkal campus for the multi-level car parking is presently used as a water supply pumping station and underground storage, which acts as a feeder for the whole Tajgang area.

Since no multi-level parking is currently available, which can be taken up for implementing Smart Components for Parking Solution, the ICT solutions and its placements shall be worked upon once available.

Hence, the MSI RFP document shall not propose smart parking locations and will be taken up separately once a suitable location is available.

### 3.9. City Pollution Analysis

"Agra is facing severe air pollution especially during a quarter of a year. According to the reports of WHO, the average PM 2.5 level was 125.66 µg/$m^3$ which was very poor for the year 2016 which got a rating of severe during the month of January (247.99 µg/$m^3$), November (234.61 µg/$m^3$) and December (245.85 µg/$m^3$).

As per the guidelines of CPCB, the concentration level of PM 2.5 should be less than 60 µg/$m^3$ to have a satisfactory atmosphere, whereas the average PM 2.5 for the year 2016 was 125.66 µg/$m^3$ which is five times that of the permissible limit, and is exceeding the limit 120 µg/$m^3$ which is very poor as per the AQI standards and dangerous for human health.

As per the survey of MOI, Agra is among the top 10 polluted cities in India, which makes the situation worse for the people of Agra. Severe level of PM 2.5 increases health issues for the citizens of Agra as it causes respiratory and cardiovascular morbidity.

As per the reports of SCROLL, “The pollution levels in a few Indian cities have the embarrassing distinction of having exceeded the toxic levels of Beijing and other Chinese cities, demonstrating levels at least ten times higher than the WHO standards, making air pollution truly a national emergency.” The pollution level in Agra, as per the data from government’s monitors, the problem isn’t likely to go away anytime soon if strong measures won’t be taken."

Based on the information available, there are probably 4-6 Environment Sensors which are installed across the Agra City, off which 1 at Sanjay Palace is operational and monitored whose feed is taken to calculate the PM Level of entire city, which is not a true representation.

The pollution levels in Agra city as on 29.12.2017 are appended below:

- Sulpher di Oxide (So2) = 2.0
- Oxides of Nitrogen = 61.0
- Suspended Particulate Matter (SPM) = 351
- Respirable Suspended Particulate Matter (RSPM) (Size less than 10 microns)

| Level of Service | Oxides of Sulphur | Oxides of Nitrogen | SPM | RSPM (size less than 10 microns) |
|---|---|---|---|---|
| 1 | 0-40 | 0-40 | 0-180 | 0-40 |
| 2 | 40-80 | 40-80 | 180-360 | 40-80 |
| 3 | 80-120 | 80-120 | 360-540 | 80-120 |
| 4 | >120 | >120 | >540 | >120 |

Source: http://aqicn.org/city/india/agra/sanjay-palace/

Hence, considering the current scenario and looking at US-EPA standards, any environmental monitoring point describes the environmental condition of 1 sp. km area. As per the total area of Agra (220 sq. km), ideally 220 sensors are required to a create real-time pollution map of the city. But, it is not financially feasible and even ergonomically to have so many sensors monitoring the pollution level of city. It was decided to identify 39 strategic locations with a span of 5 km resolution to solve the purpose with least number of sensors.

Out of the 39 sensors, it is proposed to place 6 sensors with special parameters around the Taj Mahal to monitor the effect of pollution on the marble surface of Taj Mahal, and the rest across the city.

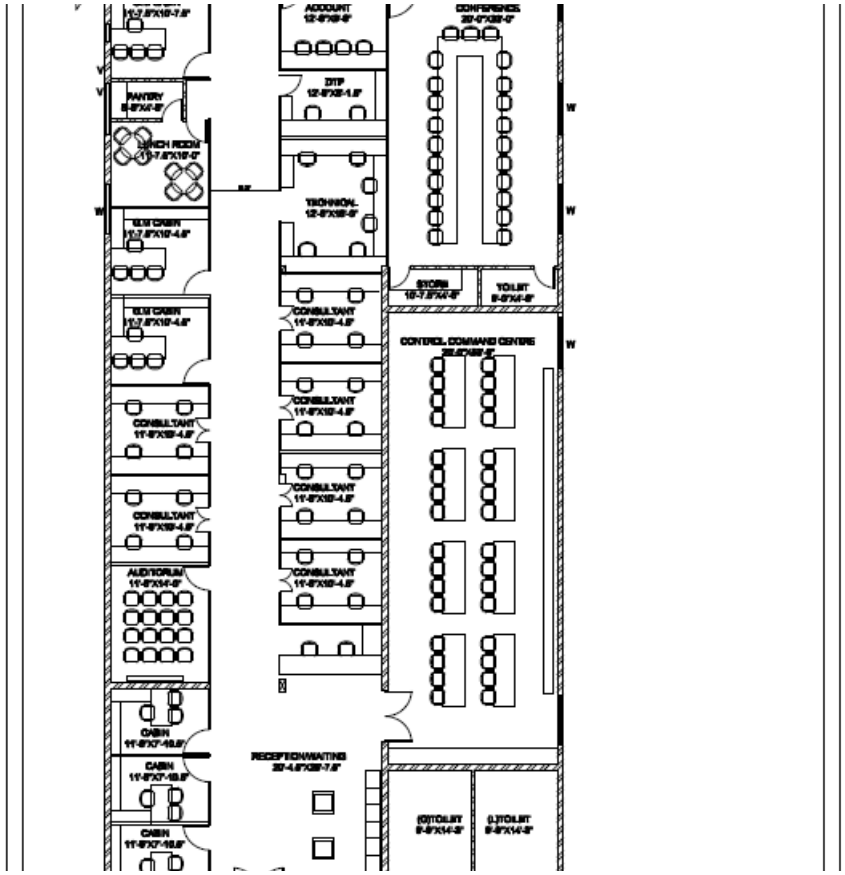
| S.no | Location | Type of Monitoring |
|---|---|---|
| **1** | Rajdeep Bhawan, NH-2, Transport Colony | Urban Monitoring |
| **2** | Sanjay Place, Civil Lines | Urban Monitoring |
| **3** | Rambagh, Ramnagar Colony, Civil Lines | Urban Monitoring |
| **4** | Shri Mahabaleshwar Mandir, Babu Gulab Rai Marg | Urban Monitoring |
| **5** | Moti Katra, Mantola | Urban Monitoring |
| **6** | Namner, Rakabganj | Urban Monitoring |
| **7** | Phulatti Bazar, Rawatpara | Urban Monitoring |
| **8** | Raja Mandi, Mantola | Urban Monitoring |
| **9** | Rajpur Chungi, Indrapuram | Urban Monitoring |
| **10** | Sadar Bazar, Agra Cantt., | Urban Monitoring |
| **11** | Shahganj | Urban Monitoring |
| **12** | Shiv Nagar, Naripura | Urban Monitoring |
| **13** | Nai ki Mandi, Mantola | Urban Monitoring |
| **14** | Tajganj | Urban Monitoring |
| **15** | Dalihai, Paktola, Tajganj | Urban Monitoring |
| **16** | Dhandhupura | Urban Monitoring |

| | | |
|---|---|---|
| **17** | Kaserat Bazar, Tajganj | Urban Monitoring |
| **18** | Vibhav Nagar | Urban Monitoring |
| **19** | Indrapuram, Tajgan | Urban Monitoring |
| **20** | Defence Estate | Urban Monitoring |
| **21** | Jodha Bai Ka Roza | Urban Monitoring |
| **22** | Shanti Nagar, Ashok Nagar | Urban Monitoring |
| **23** | Dhuliya Ganj, Mantola | Urban Monitoring |
| **25** | Mandi Said, Civil Lines | Urban Monitoring |
| **26** | Model Town, Idgah Colony | Urban Monitoring |
| **27** | Agra Fort, Rakabganj | Urban Monitoring |
| **28** | Agra Fort-1, Bhogipura | Urban Monitoring |
| **29** | Delhi Gate, SH-39, Agra Fort | Urban Monitoring |
| **30** | Chhipitola Road, Rakabganj | Urban Monitoring |
| **31** | Sadar Bhatti, Dhawlikar | Urban Monitoring |
| **32** | Ghatiya Chauraha, Chilli Int Rd, Mandi Said | Urban Monitoring |
| **33** | Lajpat Kunj, Civil Lines | Urban Monitoring |
| **34** | Dharmapuri, Forest Colony | Taj Mahal Monitoring |
| **35** | Taj Museum | Taj Mahal Monitoring |
| **36** | Maa Sarawali Mandir | Taj Mahal Monitoring |
| **37** | Great Gate | Taj Mahal Monitoring |
| **38** | The Garden, Taj Mahal | Taj Mahal Monitoring |
| **39** | The Mosque-Kau Ban | Taj Mahal Monitoring |

### 3.10. Integrated Command and Control Centre Requirement

A designated location within the Agra Smart City Limited office is defined for overall monitoring and controlling of Smart Component, which are planned to deploy as part of Smart City Mission. The ASCL office is now available having designated cabins for officials, working space, and workstations for designated employees, a conference room, and washroom facilities. ASCL has given a free hand to PMC team to design a working and world-class control room, which is captured in detail in functional requirement along with complete scope.

Current layout is as per following design:

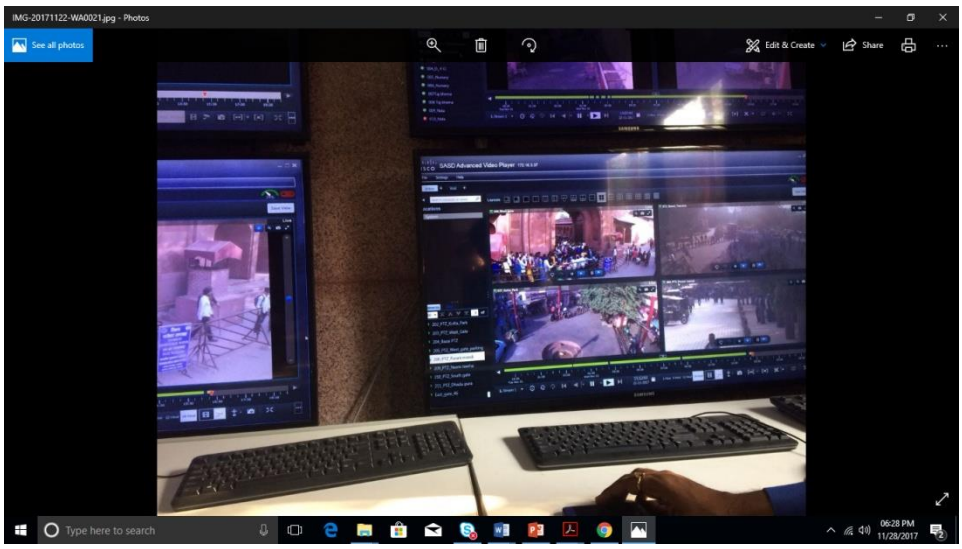



It was even identified there are several individual command centrecentres which are available and managed by independent authorities. For e.g.:

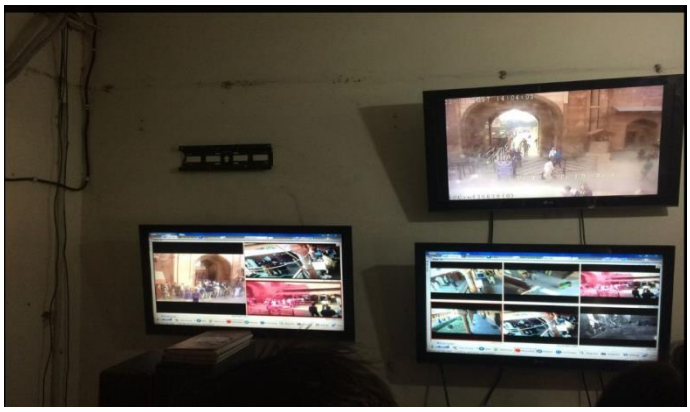
a) Agra Cantt. Station have their own Command and Control Centre managed by Railway Police Force (RPF) – They manage the complete surveillance and have extensive coverage through CCTV cameras (54 locations comprises of fixed and PTZ cameras) through 4 visual screens, a dedicated server room having storage of 31 days and under 24x7 monitoring by RPF officials with 3-4 seating capacity.

a. Monitoring of Taj Mahal (East Gate, West Gate, and South Gate) by SP Police from command centrecentre which have 140 Cameras (130 fixed and 10 PTZ) and monitored

from Command Centre at Shilpgram through 3 screens, a dedicated rack with UPS power backup and 2/3 operators monitoring 24x7.




b. Monitoring of Tah Mahal – Inside by CISF force who monitors 21 Cameras (16 operational) which was deployed independently by Shyam Vendor prescribed under Archaeological Survey of India (ASI) – This is currently monitored by 3 screens, no dedicated server room is provided and the actual server is not operational, hence it is operated through local PC which support 16 licenses and captures live data with backup of 31 days.



Currently all command centres are monitored and controlled by independent authorities and they are majorly concentrated on CCTV surveillance for a particular area allotted. Going forward if different officials intend to have a centralized viewing system, monitored by a dedicated authority, it shall be done through interoperability and integration.

In addition, although Agra city already lacks basic infrastructure like operational traffic signals, city-wide surveillance cameras, intelligent traffic management systems for law Enforcement, well designed buses for daily commute, dedicated spaces for bus stops and shelters, displays and signage to educate the citizens about rash driving, lane Cutting, absence of seat belt and helmet, over speeding, indications while turning etc.

Even though the IT infrastructure and application is in place for solid waste management and once the physical process of available for primary collection, there needs to be a significant intervention of ICT

components which track the movement of individual bins and confirmation of household pickup through RFID technology.

This complete integrated module needs to be monitored through a centralized monitoring system. So considering all the smart components like smart poles, smart bins,Smart traffic, smart signals, Smart sensors etc. this shall be centrally monitored and controlled through a Centralized Command and Control Centre.

Regarding Data Centre feasibility within given proposed building premise, an audit was conducted by Structural Experts, which provided following comments:

- The layout and design, including structure beams and walls, do not suit the standard guidelines for building a Tier 3 data centre.
- No confirmation was received whether the building is earthquake-resistant or not.
- There is no fire and safety mechanism found in the building.
- The floor level has to be raised to avoid flooding inside the building, which will make the building unsuitable for building the data centre.
- There was a request to ANN for conducting audits of building structural building safety.
- Requirement from a data centre perspective is for a pillar foundation building without any walls.

## 4. Purpose of ICT Components

### 4.1. Adaptive Traffic Control System (ATCS)

The Adaptive Traffic Management System will be installed on a specific stretch of road to make it a model smart road. On this stretch of road, the signals will be fully automated based on sensors technology.

As part of smart city project, major traffic junctions need to be identified. Currently, the city does not have basic infrastructure of traffic signals, which is used to control the traffic flow and avoid mishaps at the intersections. Due to lack of this, several problems are faced and they are as follows:

- Traffic congestion and huge waiting time.
- No dedicated lane reservation for emergency vehicles like ambulance, police, etc.
- No VIP movement clearance.
- Lack of information on prominent and frequent traffic congestions, both location wise and time wise.
- Absence of street level public information and communication channels.
- Absence of central control mechanism to monitor and regulate the city traffic flow.

### 4.2. Intelligent Traffic Management System (ITMS)

The city-wide surveillance CCTV cameras installed in the field across Agra city will help in monitoring and managing crime and enforce traffic. The CCTV cameras will include ANPR, RLVD, No Helmet Detection, PTZ, Fixed, FRS etc.

To implement holistic and integrated video surveillance system in Agra, the major stakeholders of CCTV surveillance system will be Agra Traffic and Agra City Police Department. The system will help:

- Support police to maintain law and order.
- Act as an aid to investigation.
- Improve traffic management.
- Help in deterring, detecting and thus dealing with criminal activities.
- Address threats from terrorist attacks.
- Attain faster turnaround time for crime resolution and proper investigation.
- Monitoring suspicious people, vehicles, objects etc. with respect to protecting life and property and maintaining law and order in the city.
- Continuous monitoring of some vital installations/public places in Agra area for keeping an eye on regular activities and for disaster management support.
- CCTV video surveillance system will enable the above by following:
    - Providing alerts/feedback to the police department about abnormal movements/suspicious objects etc.
    - Better management of security breaches based on alerts received from the system.
    - Improved turnaround time in responding to any investigation case, faster access to evidence in case of security breach, law violation in the prescribed areas.

### 4.3. City-wide CCTV Surveillance System

Protecting citizens and ensuring public safety is one of the topmost priorities for any Government. It requires advanced security solutions to effectively fight threats from activities of terrorism, organized crime, vandalism, burglary, acts of violence, and all other forms of crime. CCTV based video surveillance is a security enabler to ensure public safety.

### 4.4. ICT Enabled Solid Waste Management System

The ICT enabled solid management component will provide a comprehensive mechanism to monitor and manage the solid waste management process across all the wards in the city. Under this component, existing vehicles deployed for collection of solid waste will be fitted with GPS devices for vehicle tracking and RFID readers to read the RFID tagged community bins. RFID tags will be installed on community bins. RFID tags will be installed at each house in the city and all the field staff collecting the solid waste will be provided with RFID readers. Handheld devices will be deployed to manage the workforce deployed for solid waste collection.

### 4.5. Environment Sensors

Smart environment sensors will gather data about pollution, ambient conditions (light, noise, temperature, humidity, and barometric pressure), weather conditions (rain), levels of gases in the city (pollution) and any other events on an hourly and subsequently daily basis. It is for information of citizens and administration to further take appropriate actions during the daily course/cause of any event.

### 4.6. City and Enterprise GIS Solution

The broad objective of the work is to develop a comprehensive Instigated Enterprise GIS Application for corporation for planning, management, and governance in the context of the entire functioning of the organization. The major activities of the departments to be supported by the system shall be as follows:

a. Creation and Updating of Geospatial Data – ABD Area.
b. Supply of Enterprise GIS Platform Suit – Pan City.
c. Design Develop Enterprise Web GIS Municipal Application for all ASCL Departments – Pan City.
d. Design and Develop Geo-enabled Mobile Application for ASCL Pan City.

### 4.7. Smart Public Transport System

As part of Agra Smart City initiatives, the aim is to make transport efficient by introducing the following components.

- Smart Bus Stops with Various Functionalities such as VMS, CCTV Cameras for Surveillance, Passenger Information Systems, Emergency Panic Button etc.
- Fleet Management System for UPSRTC City Transport Vehicles.
- Geo Tagging of Bus Routes through RF Readers on Bus Stops and RF Tags / GPS Devices on Buses.
- Public Vehicle Tracking Application for Complete Monitoring at Integrated Command and Control Centre

The solution should give UPSRTC the ability to track, record, and analyse how vehicles are performing in real time. These features will lead to improvements in the public transit service through better on-time performance and quicker response time to emergencies. The location information along with other details such as the speed of bus, route followed, etc., will be used to provide the passengers waiting at the bus stops with expected arrival time of bus. The information will be displayed on boards installed at the bus stops, inside bus, mobile apps, etc. The system should also help in improving the efficiency of bus operation by generating various standard and exception reports.

### 4.8. Data Centre and Disaster Recovery

The Data Centre wherein all the ICT infrastructure along with the network infrastructure are installed. The data centre will host all the software applications for various smart city components. The data centre will provide private cloud-like functionalities which allows agility, seamless expansion which is non-disruptive, and help infuse the new technologies into the existing landscape as and when available. The data centre will have adequate provision for data security through implementation of firewalls, IPDS, anti-virus systems, etc. The physical access to the data centre shall be managed through a biometric access system.

The Disaster Recovery Centre is a mirror image of all the applications hosted at the data centre and will be 50% of the compute, however, the data of video feeds is to be 100% available in case of a disaster. In case of non-availability of Data Centre, the DR Centre should be able to operate all the applications for the smart city components. The DR Centre will have all the functionality and infrastructure similar to the Data Centre.

Disaster Recovery Centre will be 50% of Data Centre site, it is mandatory to have two separate physical location and distance itself through seismic zones.

### 4.9. Integrated Command and Control Centre

The Operation Control Centre shall be the nerve centre for monitoring and management of all smart city solutions and Traffic Control Centre shall be the nerve centre for monitoring and management of all surveillance cameras for crime management and traffic enforcement. The centres display the status of various ICT applications through visuals and graphical representations. The Command and Control Centre are well equipped with various analytics and Business intelligence tools that will ascertain the operators and officials to have proactive monitoring and also arrange emergency as a reactive mechanism.

The ICCC will be manned by operators and will be equipped with all office infrastructure such as cubicles, cabins, conference rooms, meeting rooms, etc. A common Data Centre and Disaster Recovery Centre for the ICCC will house the entire IT infrastructure.

## 5. Proposed Solution and Conceptualization

### 5.1. Agra City Complete Architecture

#### 5.1.1. **Requirement of Network backbone**

Smart cities seek to implement information and communication technologies (ICT) in order to improve the efficiency and sustainability of urban spaces while reducing costs and resource consumption. ICT enabled interventions run on the network backbone, which shall cater to all the solutions.

The authorities here intend to establish a network backbone through existing telecom service provider (TSP) or Internet Service Provider (ISP) or mix with various cable operators who have rich fiber spread in area of 300 km across the city. The network should support all the planned initiatives like Cameras through General Surveillance and Intelligent Traffic Management System, several sensors and controllers of Adaptive Traffic Control System, ICT enabled Solid Waste Management System, Environmental Sensors, Smart Public Transport System etc. and be scalable to accommodate future solutions (City Wi-Fi, SCADA System, Smart Meter Solution, Smart Street Lighting, Smart Parking etc.).

Considering critical network design parameters such as Secure, Reliable, Scalable, Manageable, Interoperable, Capable and Resiliency to have end-to-end service-oriented network delivery, it is proposed that a secure fiber network backbone based service delivery network shall be deployed for the proposed network backbone.

The proposed network backbone is expected to provide a converged network, bringing together different city management vertical solutions on a common network infrastructure for Agra City. The converged network shall facilitate information exchange between resources and applications across different domains. It will be an end-to-end open platform enabling services across the city.

#### 5.1.2. **Overview of Proposed Solution**

An overarching fiber network with three-tier architecture is being proposed here as part of the Agra Smart City initiative which forms the basis for all the envisaged applications. The network architecture being proposed will comply with the best practices and industry standards to ensure high availability, scalability, manageability, and security for the information, services and solutions being managed on the network.

The designed network shall provide uninterrupted services across the city connecting seamlessly with various stakeholders. With the capability to handle high bandwidth applications with low latency, the network forms the pivot for ICT based Smart City interventions in Agra City.

### 5.1.3.**Volumetric Analysis**

It is essential to reiterate that reaching the last objectives of implementation of Network backbone is to bring about enablement of the smart city interventions. Given the strong dependence on network backbone for rolling out smart city services, successful implementation of the city-wide network and deriving its benefits entails a significant change.

Key Points Considered while Liaison from Network Provider (ISP/TSP/Cable Operator):

- As and when the rollout of various smart city initiatives happens, a provision for the integration of third-party smart city solutions for each of the initiatives has been envisaged. It is well understood that the network backbone solution may not have all the required functionalities of handling all the smart city requirement aspects in preliminary stage, hence, the solution shall be designed to accommodate the future requirements of integration and customization with third-party smart city solutions.
- Capacity would need to be built up to manage ICT based components on a large scale Network backbone which shall be rollout as envisaged in Smart City Project. ASCL shall built competitive IT and Network Department would need to incorporate functional area experts, IT experts/managers and key decision makers in a project-oriented organization structure.
- For reaching the last mile connectivity for proposed ICT enabled components it is required to establish the network with high sustainability and for that we consider every length of major and minor road to make better and strong network.

### 5.1.4.**Design Considerations**

The city network backbone should be liaison such that it provide the secure, reliable, scalable, manageable, interoperable, capable, and resilient network connectivity for all the requirements of Agra Smart City initiative. The city-wide network has accordingly been designed considering these design considerations and as depicted below.

Design considerations applied for developing network backbone are:

- High Performance: Network should provide better user experience while connecting with Citizens, Government, Business, and Communities. The system should be up and running without any single point of failure as per the demands of various mission critical applications running on the network. Hence the uptime of 99.982% is required for the availability.

- Scalable: The network shall be scalable to future growth such as all smart city initiatives. The network infrastructure (routers, switches, servers, etc.) shall support these scalability requirements. Similarly, the last mile connectivity should also be upgradable to meet the future requirements.
- Secure: The network shall have built-in security features so that network access is controlled. Access control shall be implemented at all levels. Firewall, Intrusion Protection System and VPN solutions shall be employed to prevent attacks from hackers and secure the systems effectively.
- Manageable: The entire network shall be seamlessly managed with a centralized network management software. All the network components shall be manageable using open standard management protocols such as SNMP.
- Fault Tolerance and Resilient: The network should have built-in redundancy features to provide high availability. Redundant connectivity shall be proposed for all locations to ensure that single link failure does not affect the functionality. Similarly equipment level redundancy is mandatory at DC, DR and Aggregation Level.
- Intelligent: The network shall be configured with the required QoS features to prioritize traffic based on the application and handle the traffic accordingly.
- Interoperability: All products shall be open standards based and should be interoperable with different vendors' products following industry standards.

Based on the design objective, geographical spread and the expected usage, the following technical features are envisaged for network backbone:

- A protocol independent network and is designed to carry multi-protocol traffic.
- Capable of offering hierarchical Quality of Service (QoS) for real-time traffic (voice and video) and guaranteed bandwidth for business critical applications. City network backbonebackbone governance backs it up by Service Level Agreements (SLAs) from the service provider.
- Supports by design IPv6 transport, IPv6 networking and IPv6 MPLS VPN services in addition to the similar facilities based on traditional IPv4.

Design, implementation, management, and control is such that service provisioning is internal to the network even though leased from telecom service providers for "raw" bandwidth or fiber is likely to be leased.

- Supports by design Multicast enabled VPN for running Multicast applications, both in IPv4 and IPv6.
- Management is capable of handling provisioning for the central services.
- Will provide access to secure Integrated Command and Control Centre with Information Assurance.
- Will enable provisioning of innovative new services unavailable from services providers, should the user agencies demand.

In short, network backbone should be more like a Dedicated Owned IP-MPLS Network in the Core from Internet Service Provider.

The design, planning, implementation, operations, and management of city network backbone would require an institutional mechanism that is agile and responsive. The design principles enable seamless expansion of the network as well as topological alterations.

### 5.1.5.**Technical Requirement Specifications**

In line with the objectives, the solution is designed based upon state-of-the-art and cutting-edge technology which shall provide the city an edge for delivering the current and future services in the most efficient way.
The proposed design is aligned with the emerging service delivery models and is envisaged to be able to deliver all the smart city services as and when they evolve. The network shall be capable to provide different services like intranet, internet, sensors, Wi-Fi, surveillance, voice, video, multimedia, data applications, conferencing features for both voice and video, VOD, distant learning, e-medicine, IP-TV and any future applications that will be deployed by the city.

Following are the minimum technical requirements envisaged for the solution:

- The network will be an exclusive carrier class next generation IP based network engineered to interconnect end locations spread across the city.
- All the equipment's shall be carrier class and capable of providing 99.982% uptime.
- The network shall be implemented with standard protocols.
- The network equipment shall adhere to the performance parameters for IPv4 and IPv6.
- The equipment's deployed in the network shall have wire speed, non-blocking and line rate for all present and future interfaces.
- The solution shall be IPv6 compliant for all the network, captive and end-user services and should provide a smooth transition path for such services as and when they are rolled out.
- High availability features like node protection, path protection, link protection, for critical components should be in redundant mode.
- The proposed network shall provide flexibility with subsequent enhancement to traffic engineering, resource reservation, dynamic provisioning, differentiated services and network resiliency.
- The proposed network solution shall provide a very high degree of service scalability with millions of connections.
- Network should provide sub 50ms of recovery and re-convergence at all levels.
- Should able to support thousands of VPN's for different services with traffic engineering defined.
- Network is envisaged be able to define Layer-2, Layer-3 VPN's as per the requirements across the network.
- The network needs to support deep packet inspection capabilities to provide clean traffic to the core network.
- The network is envisaged to have capabilities to define ethernet services at the edge carried across the core network to other locations.
- The network shall have multicast capabilities with all the resiliency, traffic engineering parameters defined for the network.
- The network should have route reflectors to reflect the routes across the network.
- The network shall have flexibility to enable dynamic policies as per the user authentication mechanisms.
- It should be possible to configure point to point, point to multipoint and any to any connection configurations to cater for different user defined network deployment options that can be optimized for different services and application requirement.
- The proposed network shall support traffic engineering and bandwidth guarantee.
- The network should have hierarchical management capabilities.
- The network must be able to grow and scale 100% with respect to control-plane and forwarding plane capabilities.

- There needs to be adequate protection mechanisms like DoS protection, DDoS protection to be supported.
- The proposed network should be robust architecture designed with products complying with the IETF/IEEE/ITU standards out

### 5.1.6.**Network Topology**

Network components can be physically linked in a number of ways, called “topologies”. There are two basic categories of network topologies, physical topologies and logical topologies.

- The cabling layout used to link devices is the physical topology of the network, which refers to the layout of cabling, the locations of nodes, and the interconnections between the nodes, and the cabling. The physical topology of a network is determined by the capabilities of the network access devices and media, the level of control or fault tolerance desired, and the cost associated with cabling or telecommunications circuits.
- The logical topology in contrast, is the way that the signals act on the network media, or the way that the data passes through the network from one device to the next without regard to the physical interconnection of the devices. A network's logical topology is not necessarily the same as its physical topology.

The logical classification of network topologies generally follows the same classifications as those in the physical classifications of network topologies but describes the path that the data takes between links being used as opposed to the actual physical connections between links. The logical topologies are generally determined by network protocols as opposed to being determined by the physical layout of cables, wires, and network devices or by the flow of the electrical signals, although in many cases the paths that the electrical signals take between links may closely match the logical flow of data, hence the convention of using the terms logical topology and signal topology interchangeably.

Logical topologies are often closely associated with media access control methods and protocols. Logical topologies are able to be dynamically reconfigured by special types of equipment such as routers and switches.

The study of network topology recognizes eight basic topologies: point-to-point, bus, star, ring or circular, mesh, tree, hybrid, or daisy chain.

In the current context, overall functional design of network backbone is based on three-tier architecture. These three tiers and their designs have been detailed subsequently.

Topology is designed in such a way to provide resiliency, robust connectivity and ensure seamless service delivery. Ring topology would be an ideal solution in such a scenario where each node will have a redundant path. It is proposed to create a physical network between core with aggregation and connect them to their respective hierarchical parents. This will ensure that the required vertical connectivity is available even when the direct link between the topological parents is disrupted/broken due to any reasons whatsoever (like fiber cut, nature calamity, etc.)

The network shall have a three-layer logical architecture where all key services shall be hooked to the fiber as and when required. These are:

- **Core Layer:** The Core layer forms the backbone of the entire , which consists of compute, storage, application, links and connectivity to be established at the Data Center and Disaster Recovery site. This layer shall enable all applications hosted in Data Center to be accessed from the Integrated Command and Control Centre and Police Control Room over the backbone for consumers, users and city officials. Core layer shall form the point of aggregation for all the traffic coming from the aggregator level and beyond. Key solution features of proposed core network are:
    - It is proposed that there will be two PoPs created for the core network, which shall cater to the failover requirements in case of primary site fails.
    - It is envisaged that the new emerging technologies such as Software Defined Network (SDN) may be factored for the core network for better service delivery and management of the network.
    - It is also proposed that the core network should have SDN capabilities to support network function virtualization. This will provide benefits like reduced dependency on specific vendors for field equipment, simpler network management, and service delivery.
    - Integrated Command and Control Centre shall be established at Agra Nagar Nigam wherein they will be connected with the respective core switches and other infrastructure. This shall ensure seamless service delivery over the network backbone.

- **Aggregation Layer:** The aggregation layer shall be formed at the edge device level considering the cluster of nodes in each region/zones. All the traffic coming from the respective access layer shall get aggregated at this aggregation layer. A ring shall be formed between each of the region/zones to establish the required redundancy at the aggregation level. The aggregation layer will further connect to the core layer for forwarding the traffic to the core layer. The access layer shall be connected to the aggregation layer using multiple topologies such as mesh, ring, linear, etc. The aggregation points should be designed with optimum number of access layers to be connecting in each point, considering the distance, household covered, bandwidth, and the network equipment capacity. This shall ensure better manageability, reliability, and network load at each of the aggregation points.

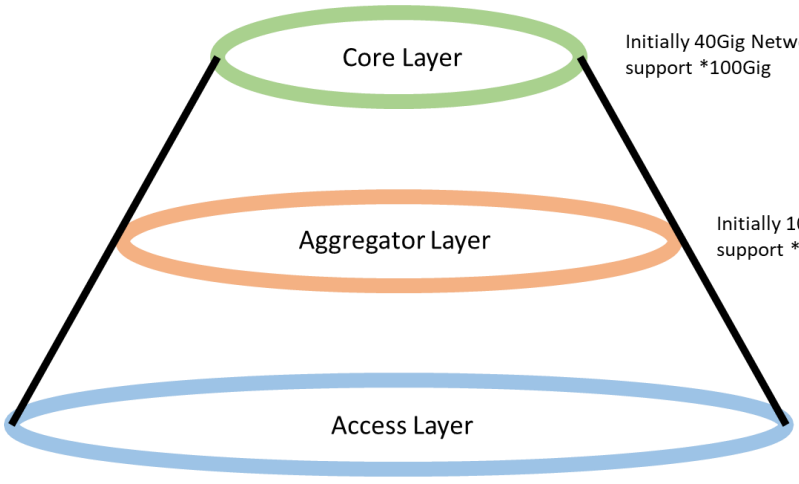
- **Access Layer:** It is proposed that the access layer shall be formed at each of the edge devices of same type. Access layer of the network is envisaged to be used to connect the respective smart city initiative as specified. The actual bandwidth requirement at the service layer will depend on multiple factors and the smart city services planned to be offered at each of the location. The detailed capacity planning shall be carried out by the implementation partner prior to designing of the access layer. Key solution features of proposed access network are:
    - It is proposed that depending on the network load, location, population, penetration, there will be various type of topology adopted ranging from linear, ring or mesh for establishing the connectivity.
    - Adequate level of redundancy shall be built which shall connect to multiple aggregation layer points.
    - The access layer is typically envisaged to handle approximately 10 GB of traffic within short distance and hence there is no requirement for transport infrastructure at the access network.

- The access network shall be used for delivering and integrating the smart city services and hence, the proposed technology should have adequate integration capability.
- The access layer shall enable the smart city solutions to connect to the network backbone. The aggregation switch of the individual smart city solution shall tap on the access layer switch.
- The network equipment shall provision various type of connectivity ports such as fiber and Copper so that the necessary solution level integration can be achieved.

- **Services Layer (Smart City Solution Level):** The service layer shall be formed at the street level and various locations covering across the city of Agra. The service layer shall enable the smart city solutions such as ATCS, ITMS Components, General Surveillance Cameras, SWM, VaMS, City Wi-FI, Citizen Kiosk, Street Lighting, Smart Parking, etc. to connect to the network backbone. The aggregation switch of the individual smart city solution shall tap on the access layer switch to connect to the network backbone. The actual bandwidth requirement at the service layer will depend on multiple factors and the smart city services planned to be offered at each of the locations. Each smart city initiative shall have varied requirement for the bandwidth and the capacity, hence, the detailed capacity planning shall be carried out by the implementation partner based on the smart city solution proposed. The components factored for the smart city solution should be having adequate interoperability to connect the same to the network backbone.

### 5.1.7. **Network Architecture Design**

Below diagram provides in brief the overall network requirements:




Initially 40Gig Network which will have to later support *100Gig

Initially 10Gig Network which will have to later support *40Gig depending on lower rings

Initially 1Gig Network which will have to later support *10Gig

Service layer where edge devices or components such as ATCS, ITMS, General Surveillance, Variable Message Signboard, ICT Enabled Solid Waste Management System, Environment Sensors etc. will be consolidated at Aggregator Layer. This connectivity from location to aggregation point is via access layer defined for similar types of devices/components. It is however expected from bidder to provision for sufficient capacity within network backbone to support these applications.

**The shift to a higher bandwidth is expected to happen during the course of this contract. Bidder is expected to factor this in design.*

Key services which shall be provisioned under various layers:

**Monitoring and Management** – The management and monitoring layer shall be provisioned centrally from core layer. Centralized management of infrastructure resources shall be implemented in core, aggregation layer, zonal layer, and ward layer. All key services that shall be provisioned for the users such as:

- Adaptive Traffic Control System
- Intelligent Traffic Management System
- CCTV Based General Surveillance
- ICT Enabled Solid Waste Management System
- Environment Sensors
- Public Addressing System and Variable Message Signboards
- Smart Public Transport System etc.

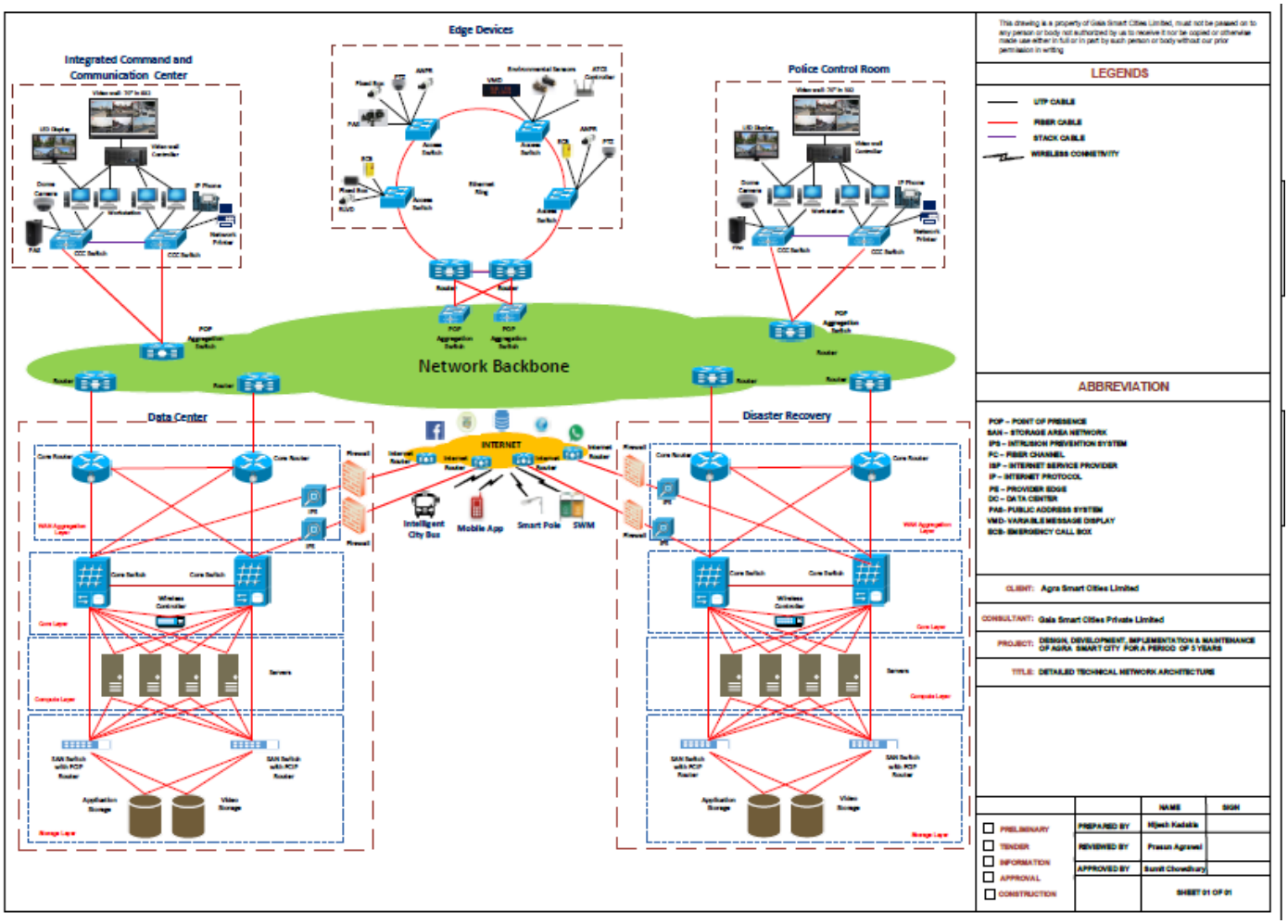
**Network Operation Centre (NOC):** The NOC shall consist of two layers:

- Core Layer: This shall monitor all the infrastructure devices (routers, switches, firewalls, bandwidth etc.) that are kept in core layer, aggregation layer along with key services that shall be provisioned in due course.
- Aggregation Layer: The aggregation layer shall help in monitoring the issues related to fiber, network, infrastructure implemented.

### 5.1.8.**Proposed Deployment Architecture**

The overall functional design of network backbone is indicative in nature and is envisaged to be implemented in a three-tier architecture as depicted below.

The three-tier architecture as below is indicative:




The envisaged layers of the city network backbone are:

- **Core Layer:** The core layer forms the backbone of the entire network which consists of compute, storage, application, links and connectivity to be established at the Data Centre and Disaster Recovery Site. This layer shall enable all applications hosted to be accessed over the backbone for consumers and users. Core layer shall form the point of aggregation for all the traffic coming from the aggregation layer and beyond.
- **Aggregation Layer:** The traffic coming from respective access layer shall get aggregated at the aggregation level. Ring architecture is proposed to be formed to establish the required redundancy. The aggregation layer shall further connect to the core layer for forwarding the traffic to the core layer.
- **Access Layer:** The Access layer shall be formed based on the similar types of devices gathered at Service layer. All the access layer in the respective region/location/junction shall form individual rings to establish redundancy. There can be multiple rings within the respective region/location/junction. The access layer shall enable the smart city solutions to connect to the network backbone. The aggregation switch of the respective smart city solution shall tap on the respective access layer devices.
- **Services Layer – Smart City Solution Level:** The service layer shall be formed at various locations. The service layer shall enable the smart city solutions such as City Surveillance, ICT Enabled Solid Waste Management, ATCS, and ITMS etc. to connect to the network backbone. The aggregation switch of the

respective smart city solution shall connect on the Access layer devices to connect to the network backbone.

### 5.1.9.Data Center and Disaster Recovery

#### 5.1.9.1. Solution Overview

The Data Centre wherein all the ICT infrastructure along with the network infrastructure are installed. The data center will host all the software applications for various smart city components. The Data Centre shall provide the private cloud like functionalities which allows agility, seamless expansion which is non-disruptive and help infuse the new technologies into the existing landscape as and when available. The data center to have adequate provision for data security through implementation of firewall, IPDS, antivirus system, etc. the Physical access to the data center shall be managed through a biometric access system.

The Disaster Recovery Centre is a mirror image of all the application hosted at the data center & will be 50% of the Compute however the data of video feeds is to be 100% available in case of Disaster. In case of non-availability of data center, the DR center should be able to operate all the applications for the smart city components. The DR center will have all the functionality and infrastructure similar to the data center.

Disaster Recovery Centre will be 50% of Data Centre Site, it is mandatory to have two separate physical location and distance itself through Seismic Zones.

#### 5.1.9.2. Data Center Design

The Data Center should conform to Tier III standard (preferably certified under TIA 942 or Uptime Institute certifications by a 3rd party) and implement tool-based processes based on ITIL standards.
The DC shall consist of two spaces:

- **Server Infrastructure Zone**: This zone shall host servers, server racks, storage racks and networking components like routers, switches to passive components. All the Data Centre LAN connections shall be provided through switches placed in this area. Access to this zone, where the surveillance project IT infrastructure is hosted, shall be demarcated and physical access to the place shall be given only to authorized personnel. Indoor CCTV Cameras shall be installed to monitor physical access of the system from remote location.
- **UPS and Electrical Zone:** This zone shall house all the Un-Interrupted Power Supply units, Main Power Distribution Units (PDUs) to feed the components such as PAC, UPS, lighting, fixtures etc. This shall also house all the batteries accompanying the UPS components. As these generate good amount of radiation, it is advised to house these components in a room separate from server infrastructure zone.

The DC should enable the city functions to run seamlessly, without loss of data for real time or historical analysis and incident reconstruction. The storage and service requirements of the DC should be:

- Storage of data
    - Video feeds should be stored for 30 days online/real-time and shall be securely archived for 1 year which is flagged or is registered in evidence. The transaction data for minimum 1 year shall also be stored within the Data Centre infrastructure.
    - DR should store video feeds for 30 days and transaction data for 1 year
    - Access logs must be stored for multiple years

- DC Service
    - Data Centre Availability must be guaranteed to 99.982% availability
    - Redundancy and concurrent maintainability.
    - N+1 fault tolerant providing at least 72-hour power outage protection
    - All IT equipment should be dual-powered and fully compatible within the topology of site architecture.

Although there is no separate Data Centre building currently available at Agra, it is proposed to build a local IT hub with all desired data center infrastructure within existing space of Integrated Command and Control Center.

#### 5.1.9.3. **Disaster Recovery Design**

Disaster Recovery Services should ensure continuity of operations in the event of failure of primary data center. RPO monitoring, Reporting and Events Analytics for the Disaster recovery solutions should be offered as part of the offering. Any lag in data replication should be clearly visible in dashboard and alerts of same should be sent to respective authorities. All server maintenance activities must be handled, including periodic health check, on-demand troubleshooting, etc. from certified vendors, and provisioning of requisite software licenses, Database licenses and other required monitoring software, tools for IT setup at DR site. It would ensure implementation of all applications at DR site.

The primary managed hosting datacenter location should not cause a latency of more than 15 millisecond (roundtrip) of access time from the ASCL ICC.

- It should provide RPO (Recovery Point Objective) in less than 1 hour
- It should provide RTO (Recovery Time Objective) in less than 4 hours
- It should support for synchronous and asynchronous data replication
- Automated site to site failover and failback
- Primary Managed hosted DC-DR should be in different seismic zones
- Website and live application (both external and internal) should be routed seamlessly from DC to DR

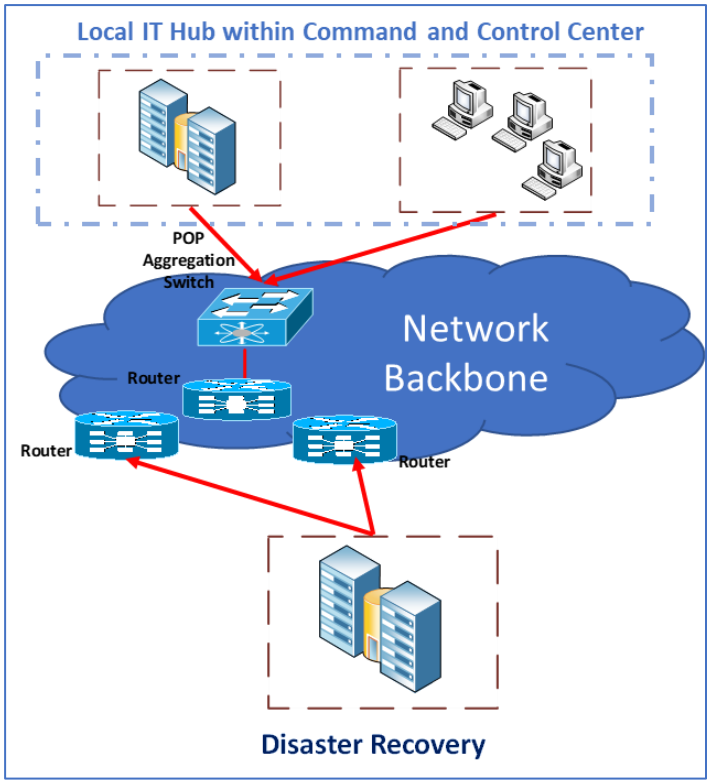
#### 5.1.9.4. **Infrastructure at DC/DR**

- Hardware and Network provisioning of servers/storage, network devices (like routers/switches, etc.), security equipment including firewalls, etc.

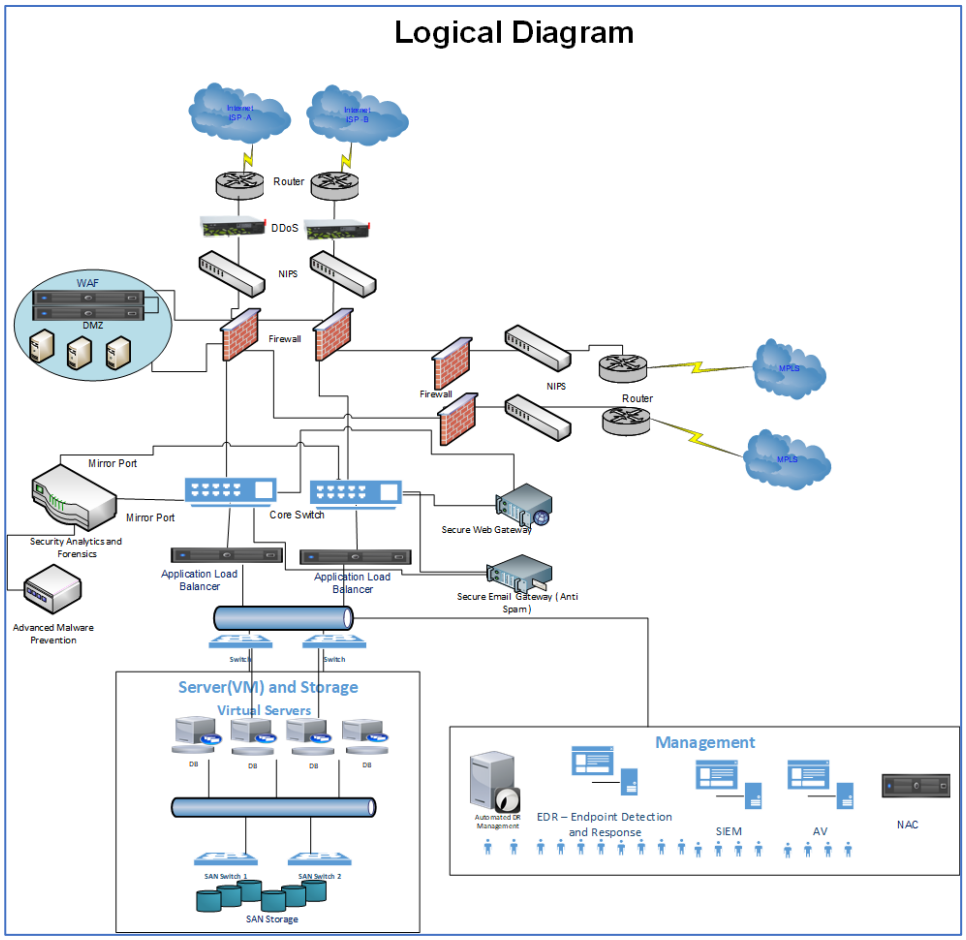
- Switches to connect DC and DR, with appropriate redundancy, and switches required for interconnecting various segments, operations centre, work area, etc.
- IP Address Schema for entire Local Area Network including DC & DR and interfaces to external systems/network
- Sub-Networks & Management of Network operation, with separation created using VLANs, switches and firewalls
- Storage with appropriate redundancy
- Network Equipment level redundancy with dual power option
- IT Security Equipment including firewalls, IDS/IPS for monitoring traffic of all VLANs, devices for log capture from servers, network equipment and other devices, DNS server
- Dedicated connectivity between DC & DR Site for replication & failover
- Backup solution with same GUI across heterogeneous platform to ensure easy administration and agentless backup for virtualization platform with non-staged granular recovery
- Enterprise Management System (EMS) for efficient management of the system, reporting, SLA monitoring and resolution of issues. Its components should be:
    - Network Monitoring System
    - Server Monitoring System
    - Helpdesk System
- Reporting, traffic analysis, bandwidth utilization, drill down capabilities, uptime
- Centralized Antivirus Solution
- Central Identity Management Service
- Authorization and Access controls
- Unified Collaboration Solution
    - Soft phones/ IP phones
    - Integrated HD Video Conferencing unit with built in HD display, Audio System and Microphone
    - Three Screen Telepresence System
    - IP PBX Solution
    - High Definition Multipoint Control Unit (MCU)

#### 5.1.9.5. Data Center and Disaster Recovery – Deployment Architecture

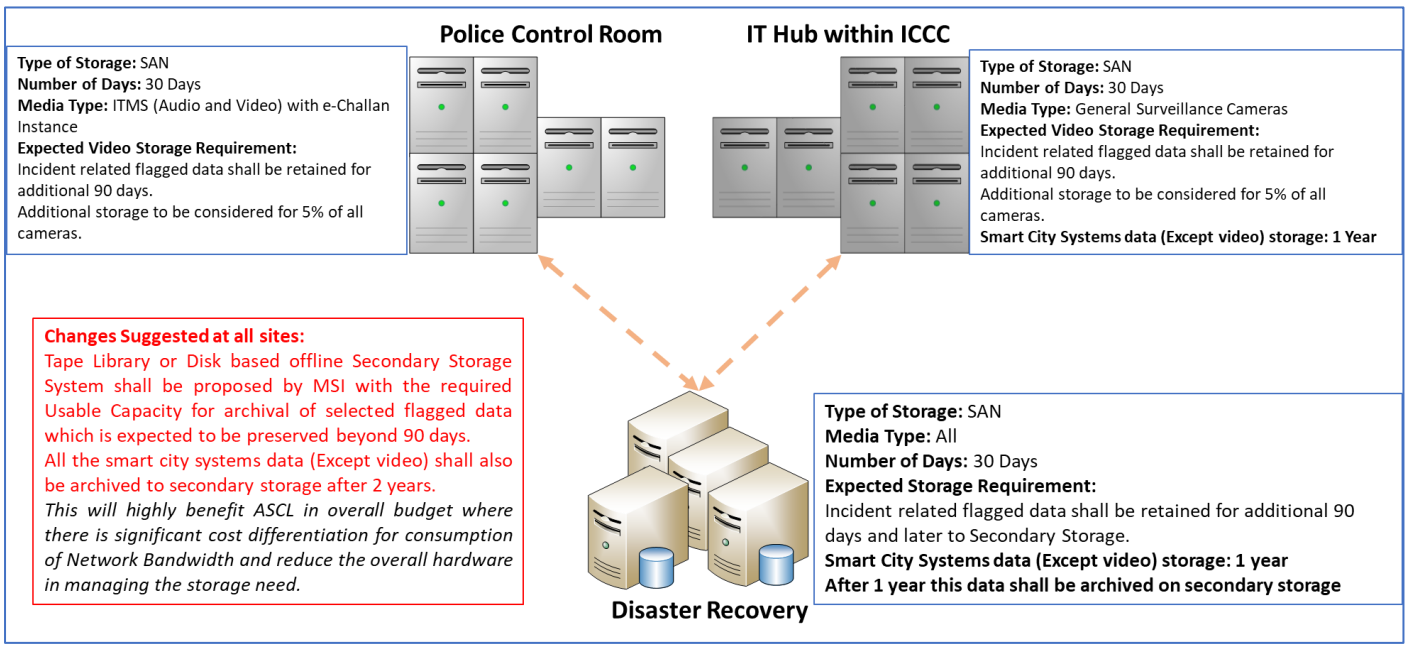
##### i. Logical Architecture of DC and DR




### ii. Component Architecture of Systems within DC / DR



#### 5.1.9.6. Storage Strategy – Deployment Architecture




## 5.2. City Command and Operation Center

With a view of enabling respective stakeholders to operate all the above-specified Smart City Components, following shall be different Operations Centres which are proposed:

1. Integrated Command and Control Centre will be known as City Operations Centre for managing all city Operations
2. Upgradation of UP Dial 100 Control Room for City monitoring and managing Intelligent Traffic Management System with respect to incident and events along with general surveillance
3. Network Operations Centre within ICCC for monitoring the Network consumed by Smart City Infrastructure

### 5.2.1. Integrated Command and Control Centre

City Operation Centre shall facilitate with a viewing and controlling mechanism for the field infrastructure of all Smart City interventions; current scope of work as well as future, in a fully automated environment for optimized monitoring, regulation and enforcement of services. City Operation Centre shall be accessible by the operators and concerned authorized entities with necessary authentication credentials. City Operation Centre shall be used and manned by the ASCL officers to keep surveillance on civil issues. City Operation Centre shall provide a comprehensive system for planning, optimizing resources and response pertaining to the standard functions of Agra Municipal Corporation.

City Operations Centre Platform enables diverse information sources to be shared and used for accurate and timely decision-making. It allows responding agencies to take advantage of detection and prediction technologies that can use all available and relevant data, and support decision-making the wider context of

the situation. It is a virtual environment that provides operational support for an organization during normal and emergency conditions and accomplishes the following:

- Access to date from external sources (sensors, video and other systems)
- Intelligent Organization and display of data
- Information Content
- Situational Awareness
- Execution and tracking of pre-planned response
- Decision making/support tools
- Command and Control of Assets

#### 5.2.2.Control Center for Police

Command Control Centre will be the central location operations centre to monitor all the camera feeds being received. It will also be the response mechanism centre for all the events triggered from various applications on the cameras along with the GIS map which shall provide the location co-ordinates for following the user defined SOP for events. The centre shall also facilitate integration of existing disparate systems like UP Dial 100 and other Data base applications as and when available. The entire process can be monitored using a application which can integrate with all the different applications.

City Operations Centre will primarily comprise of the following apart from the enabling backend IT infrastructure:

- Video Management Software
- Automatic Number Plate Recognition System
- Red Light Violation Detection System
- Face Recognition System
- Video Analytics and Dash-boarding System
- Video Wall

Functions of the Command Control Centre especially in UP Dial 100 include:

- Video Surveillance
- Video Investigation
- Emergency Response activities
- Video data storage & retrieval

Command Control Centre will comprise of a Video wall for viewing of the camera feeds supported by GIS map with all the relevant information layers and other integrated sensors which are visible on the screen, this gives a COP (Common Operating Picture) of the area. All these systems can be monitored and response action can be triggered from the CCC.

#### 5.2.3.Network Operations Center

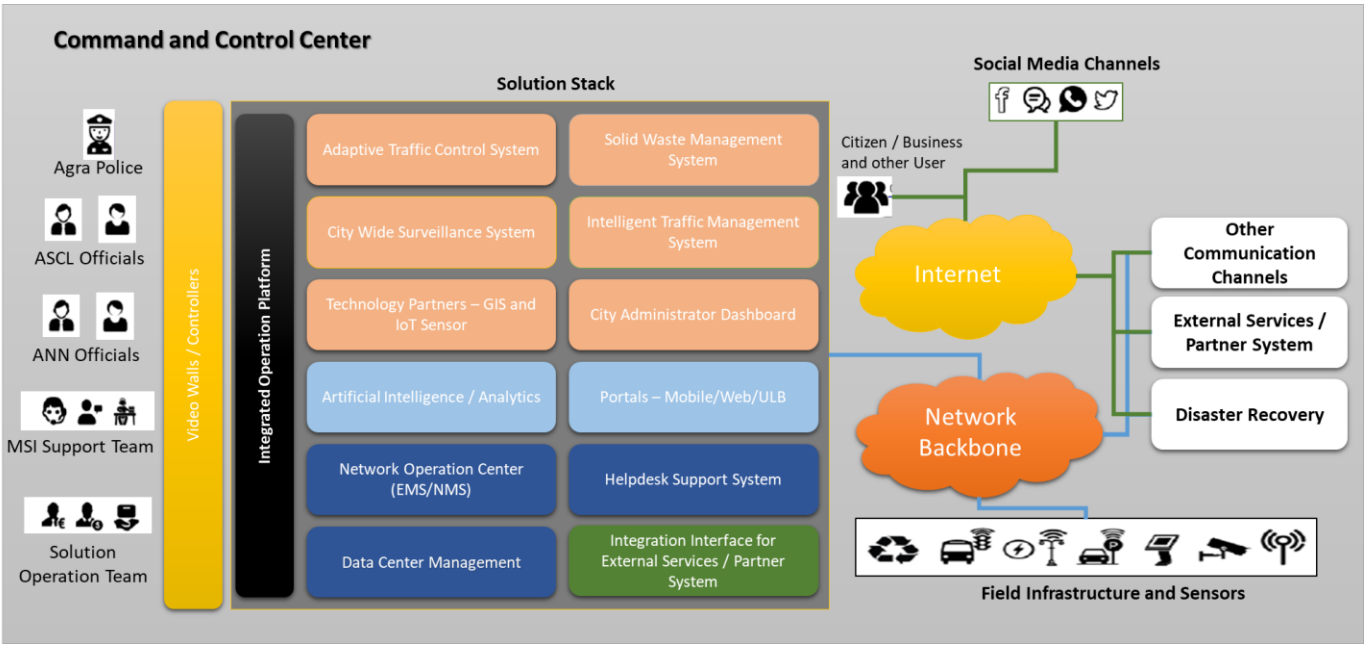
Network Operations Centre shall analyse network problems, perform troubleshooting, communicate with various ASCL officials / technicians and track problems through resolution. The key objective of the NOC is to ensure the health and availability of components. When necessary, NOC shall escalate problems to the appropriate stakeholders.

Following are the activities that will be undertake through the Network Operations Centre:

- Network Supervision and Monitoring
- Monitor the complete network 24/7, to keep network and systems functioning in a stable operation mode
- Configuration Management
- Ensure the proper configuration of network, systems and applications for the provision of reliable and high quality end-user services
- Change Management, Network Extension
- Ensure efficient day-to-day management of short-term network changes and optimization, including their implementation. This activity shall be synchronized with the maintenance scheduled activities
- Performance Management
- Provide efficient performance management procedures ensuring a reliable, high-quality network performance and service
- Service and Network Provisioning
- Define all necessary actions to be performed when a request for a new customer service is issued by customer care, and control the actions performed at NOC level or field level until completion
- Scheduled Activities Planning
- Provide regular plans for all scheduled activities, including preventive maintenance.
- Respect a schedule, and achievement of the plan. This is linked to the change management function which ensures overall synchronization of all network activities
- IT and DB Management
- Day-to-day management of all OSS systems, IT systems and databases (administration, backups)
- Security Management
- Define and implement security policies, guidelines, and best practices, and check for compliance with security regulations
- Quality Management
- Define quality management policies, and ensure implementation and usage for competitive quality of service
- Workforce Management
- Manage field personnel to ensure timely interventions and respect of the preventive maintenance plan
- Network Inventory Management
- Ensure consistent management of network equipment, and accurate, up-to-date documentation of it
- Spare Parts Management
- Manage spare part handling and logistics to minimize repair/swap turn-around times for defective items, and keep low CAPEX for spare parts and consumables
- Asset Inventory Management
- Ensure consistent inventory management for all assets including infrastructure, buildings, tools, spares, and equipment
- Repair and Return

### 5.2.4. Deployment Architecture

1. Integrated Operation Platform, Video Walls and all Smart City Solutions are part of Integrated Command and Control Centre.
2. Artificial Intelligence and Various types of Portals for Incidence and Event Management are monitored and controlled by City Police as part of upgradation of UP Dial 100
3. Help Desk and Support System for various Elements and Components deployed on-field and managing Data Centre are primary objective of Network Operation Centre




## 5.3. Intelligent Traffic Management and City Surveillance System

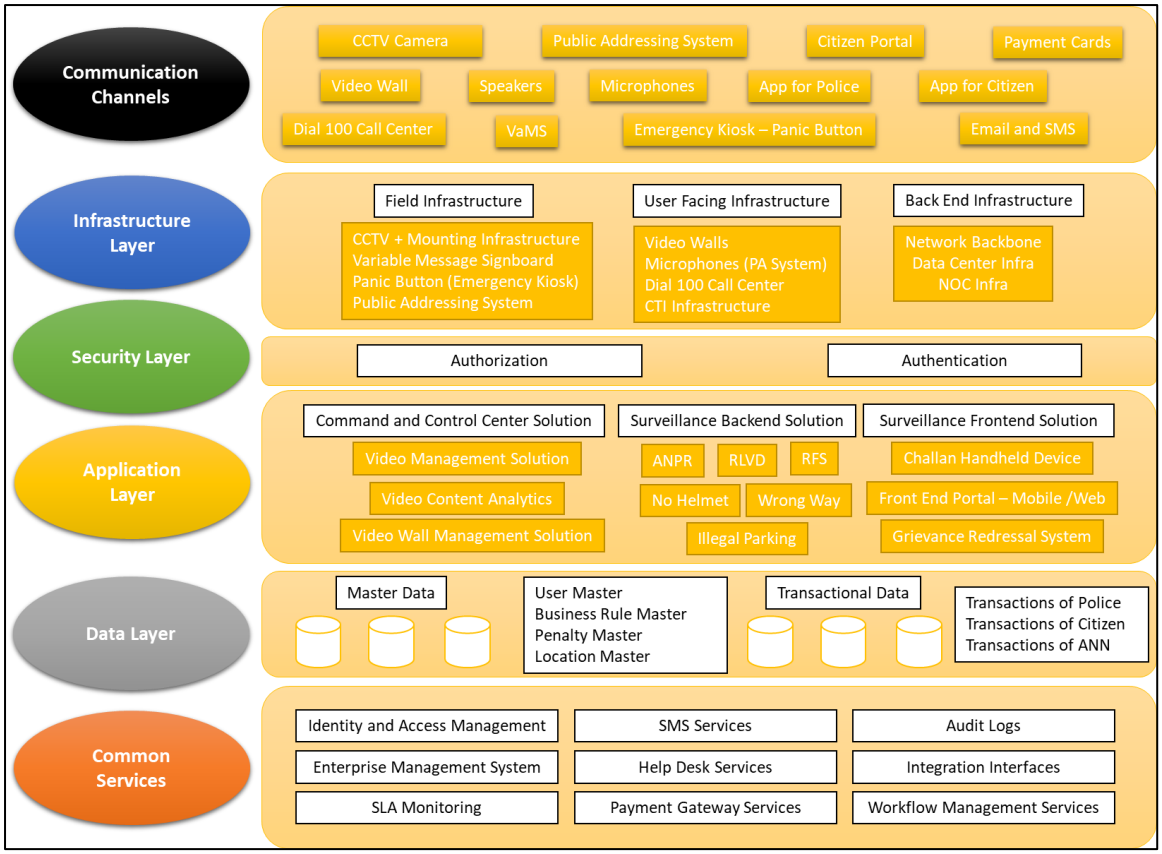
### 5.3.1. **ICT Blueprint**

The **Open Systems Interconnection model** (**OSI model**) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard protocols. The model partitions a communication system into abstraction layers. The original version of the model defined seven layers.

A layer serves the layer above it and is served by the layer below it. For example, a layer that provides error-free communications across a network provides the path needed by applications above it, while it calls the next lower layer to send and receive packets that comprise the contents of that path. Two instances at the same layer are visualized as connected by a horizontal connection in that layer.

The model is a product of the Open Systems Interconnection project at the International Organization for Standardization (ISO), maintained by the identification ISO/IEC 7498-1.

The below diagram shows similar different layer of ICT Components and various systems and their footprint in each of these areas:




### 5.3.2.**Proposed Components**

A holistic and robust surveillance system meeting the requirements set by Agra Police is to be proposed. The proposed solution shall comprise the following components:

- CCTV System
- Network Connectivity
- Command Control Centre
- Public Address System
- Variable Message System
- Mobile Surveillance System

#### 5.3.2.1. **CCTV System**

CCTV System is the street level system deployed for surveillance. The system shall be mounted on poles at selected locations like traffic junctions, critical/vital locations and other areas of interest which needs to be monitored for any untoward incidents / events.

##### **5.3.2.1.1. Types of Cameras**

An Internet protocol camera, or IP camera, is a type of digital video camera commonly employed for surveillance, and which can send and receive data via a computer network and the Internet.

**Closed-circuit television (CCTV),** is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though

it may employ point to point (P2P), point to multipoint, or mesh / wireless links. Though almost all video cameras fit this definition, the term is most often applied to those used for surveillance in areas that may need monitoring such as banks, casinos, airports, military installations and convenience stores.

**Surveillance cameras** are categorized into Fixed Cameras, PTZ Cameras and other function based cameras like Thermal Cameras. For a proper night vision using these cameras, IR Illuminator is used for the fixed cameras which provide illumination in the nights for a specific distance.

**Fixed cameras** are mounted in a stationary position and these cameras will view the same scene until physically relocated. The scene is typically recorded and, less often, the scene is also viewed simultaneously on a monitor by security personnel.

**Pan-Tilt-Zoom (PTZ)** cameras support a wide area coverage and typically have a zoom option which allows the operator at the control room to focus on parts of a scene for great detail. The other mode of operation is that allows camera to automatically scan back and forth in its range. In order to have a vision in low light conditions/ night vision, IR Illuminators provide the best solution. These are high power lamps that are covered by an infrared filter. It lets the infrared radiation pass and blocks the visible light component. LED illuminators utilize a group of standard infrared emitting LEDs.

**Panoramic** cameras support a 360 degree view of the area thus eliminating blind spots in the area of interest. This is of help in junctions where a 24x7 surveillance is required.

#### 5.3.2.1.2. Factors considered for selecting CCTV Camera

##### 5.3.2.1.2.1. Resolution

Resolution is important in selecting the right camera for the requirement. Considering various requirements of the agency, 2 MP HD (1920 x 1080) / 4K Vision cameras are being proposed for the current requirement. Given that traditional systems normally broadcasts in 704x576 or 704x480, the visual information on a High Definition system is two to five times larger.

##### 5.3.2.1.2.2. Image Quality

The image quality improvements now offer High resolutions, better color representation, 16:9 aspect ratio (wide screen) as compared to the 4:3 aspect ratio previously and frame rate that provide greater detail making them an appealing solution in surveillance situations that require high quality images.

##### 5.3.2.1.2.3. Video Compression

Image compression algorithms are divided in two groups namely:

- Lossless
- Lossy

Most CCTV compression algorithms used in CCTV are lossy compressions, because such algorithms offer higher compression ratio.

The compressions widely used in CCTV are:

- Motion JPEG
- MPEG-4
- H.265/ H.264 or Higher Profile
- JPEG2000

IP Video System Design Tool can help you to see how choosing of compression methods can affect required network bandwidth and CCTV storage space, so you can clearly see the difference in terms of compression ratio.

**Motion JPEG** is very popular compression format. MJPEG fits very well for video archives because of its frame based nature.

**MPEG4** can be 3 times more efficient in terms of compression ratio in compare with Motion JPEG. But MPEG4 is a bad choice for systems with frame rate less than 5-6 frames per second.

**H.265, H.264 and High Profile** can be 50-100% more efficient in compare with MPEG-4 and is ideal for CCTV systems with limited but stable bandwidth along with **MPEG4.**

#### 5.3.2.1.2.4. Network Connectivity

Network connectivity forms the backbone for Surveillance System on which the streams from cameras are sent to the Command Control Room where in the feeds are viewed, recorded and stored. The connectivity from field level includes various components such as Network Switch, Optic Fiber Connectivity and bandwidth utilization which ensure the feeds from each camera are received at the Command Control Centre. It is also important that the connectivity provides the data devoid of Latency, Jitter, Packet Loss and Performance and supports no single point of failure for all the locations covered. Some of the network solutions that can be considered for the project are:

**Fiber-optic network:** A fiber-optic network can be used if a wired network is considered for a city surveillance application. It is a technically good and robust solution with high capacity bandwidth. The project time for laying a fiber optic network is generally long because the fiber optic cable is usually laid underground. It may be time-consuming to get all the permissions from different city authorities. The ideal situation is if the network already exists. This solution may be used in mid- or large-sized city surveillance applications.

**Wireless solution:** It is easier to get permission to set up a wireless network solution and the installation work is minor. This means that it offers a way to cost-efficiently and quickly deploy cameras over a large area, especially in city surveillance applications. Another advantage of wireless networks is mobility. The benefit is particularly useful for camera installations in vehicles like buses or emergency vehicles.

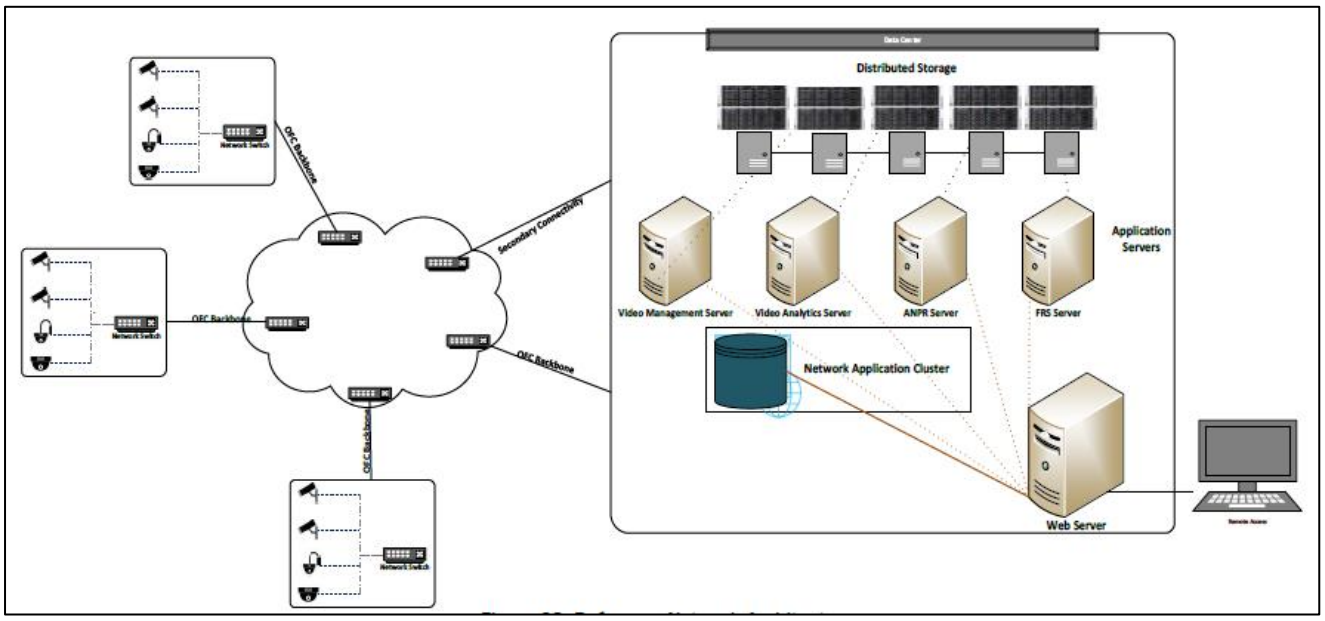
However, support from the wireless solution partner is crucial. Bandwidth could be an issue to the applications. In a city surveillance application with hundreds of cameras, a mesh or a point-to-multipoint wireless network can be the appropriate solution. This is recommended for small and midsize city surveillance applications.

**Fiber optic backbone + wireless mesh network:** The advantages with the combination is high capacity bandwidth with flexibility and scalability. This is recommended for mid- and large-sized city surveillance applications.

**GSM/GPRS/3G** based for mobile viewing of video images. This is regarded as an alternative and should not be used as the basic network.

The trend in system design is to decentralize. In a decentralized system, each camera has its own processor, storage, multiple routes in Network & Adaptive Policies. The advantage of this is that information is transmitted faster and provides additional redundancy, Scalability, Flexibility & Future ready. Considering the smart city initiatives for city of Agra and a dedicated network backbone is being planned, it will make an ideal solution for network catering to the City Surveillance Component.

**A typical network architecture covering the entire network is shared below:**



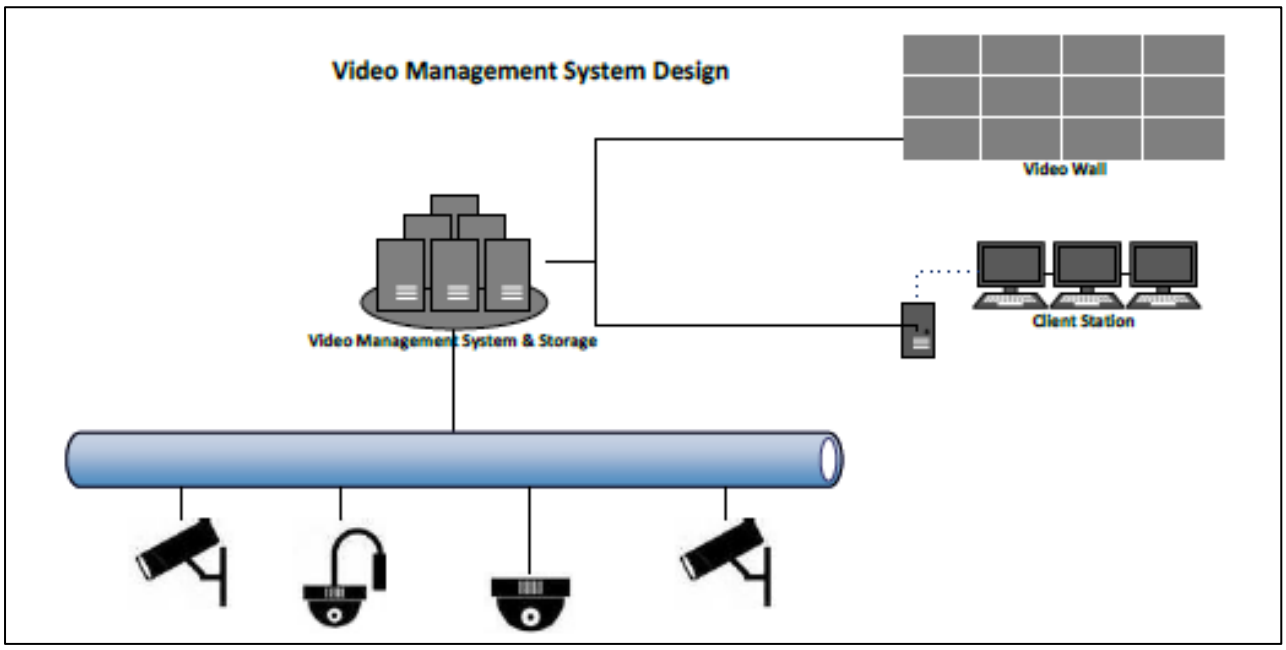

### 5.3.2.2. Surveillance Applications

Surveillance system comprising CCTV generates video feeds which are required to be received, monitored, and stored for various applications. Intelligence can be applied to run pre-defined rules and alerts can be generated from it. Specific applications like ANPR (Automatic Number Plate Recognition), FRS (Face Recognition System) and Red Light Violation Detection (RLVD) can also be implemented in defined conditions to help the Agra Police deter criminal offences and also safeguard public.

### 5.3.2.3. Video Management System

The Video Management System (VMS) will bring together physical security infrastructure and shall use the IP network as the platform for managing the entire surveillance system. An Open standard Video Management System is being suggested here which shall be highly scalable and can integrate Cameras from different manufacturers and provide the ease of integrating with other third party applications in the future. The

application works on a Server – Client architecture and provides multiple client viewing options using multicasting techniques based on the solution architecture of the manufacturer. The scalable system shall permit the retrieval of live or recorded video anywhere, anytime on a variety of clients and also through a web browser interface. The IP Cameras (Fixed & PTZ) installed in the identified locations are connected through network switches on the network backbone and the feeds are received at the control room.




#### 5.3.2.4. **Video Analytics**

Video content analysis (also Video content analytics, VCA) is the capability of automatically analyzing video to detect and determine pre-defined events. This technical capability is also used in home automation, safety and security. The algorithms can be implemented as software on general purpose machines, or as hardware in specialized video processing units.

Based on the internal representation that VCA generates in the machine, it is possible to build other functionalities, such as identification, behavior analysis or other forms of situation awareness. VCA relies on good input video.

Video Content Analysis is a very important tool for Police to analyze events of interest which can be predefined based on the requirement. Also the triggers generated can be sent to the responsible authorities for immediate response action.

The Analytics software shall bring significant benefit in both live video feeds and recorded footages to review the incidences and look for suspicious activity as defined in the customization.

Some of the video analytic applications include:

- Loitering
- Wrong direction
- Camera Tampering
- Unattended object

- Object Classification
- Tripwire/ Intrusion

### 5.3.3. **Deployment Architecture**

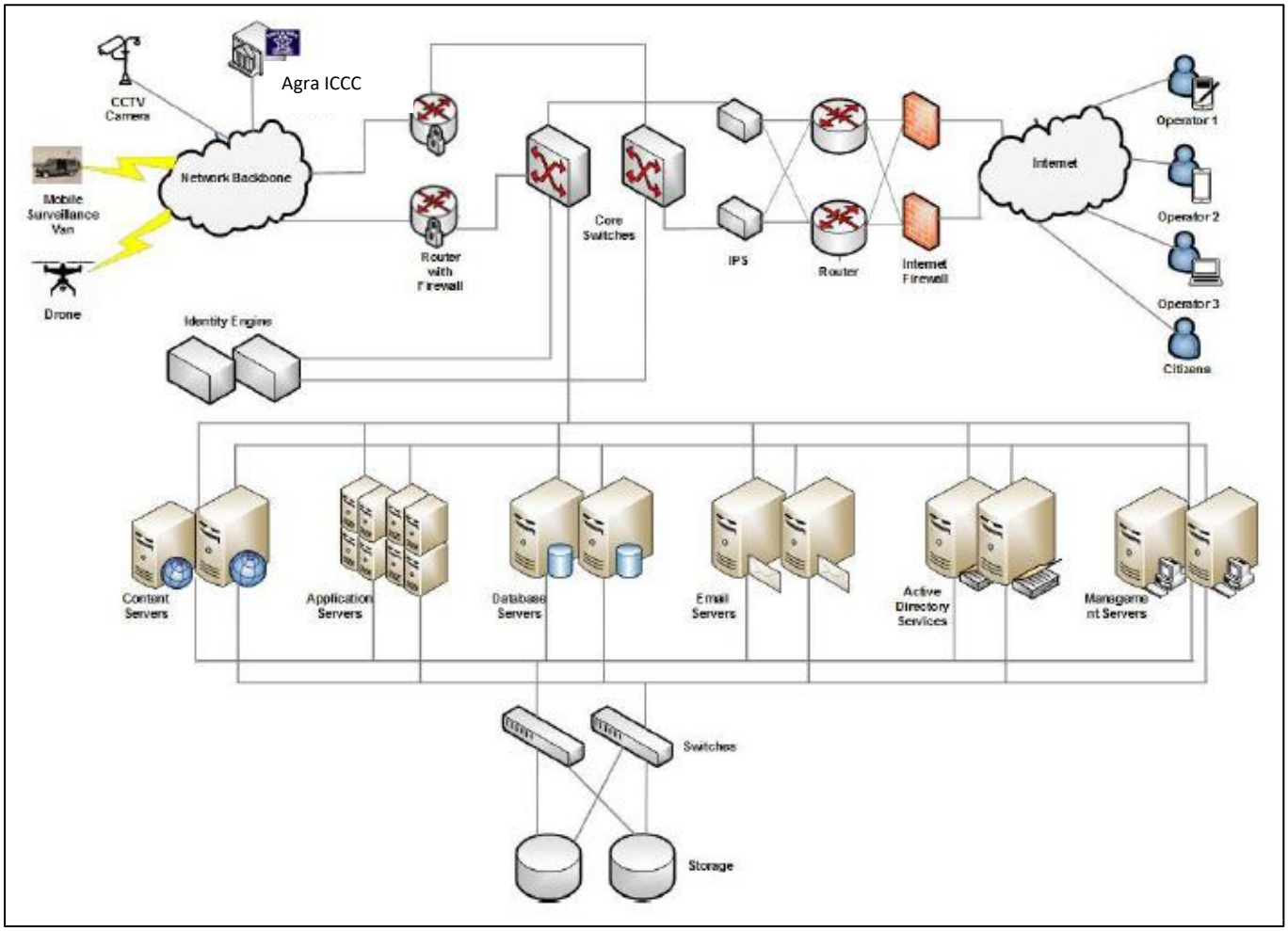



*Figure 6: This is an indicative diagram of Surveillance Systems Integration to ICCC*

At Police headquarter in UP Dial 100 Centre and in ICCC, a control room will be located with the help of network backbone. Existing ISP's ducts and complete Network Backbone will be utilized for connectivity for all ITMS components and CCTV Surveillance.

For Mobile surveillance Van (MSV), RF connectivity for synchronization with the ICCC and Police Control Room shall be used for storing the data. It has been proposed to implement using IP based mechanism for these Mobile Vans Surveillance System for connectivity. MSV have their internal storage devices for storing the captured data. Stored data can be transmitted once they get around to the network tapping point say last mile fiber tapping point. The feed will get transmitted to backend.

CCTV Cameras will have capability of wired or wireless connectivity for data transmission.

## 5.4. Adaptive Traffic Control System

Intelligent transportation System (ITS) is an integration of computer, electronics and communication technologies to improve safety and efficiency of transportation system through transmitting real time traveler information system. It also comprises of various wired and wireless technologies for better management of traffic. ITS enhance transportation safety and mobility by integrating various communication technologies into the Transportation Systems. Adaptive Traffic Signaling is a traffic management process in which traffic signal timing changes based on the demand of the traffic .It responds intelligently based on the traffic conditions, demand. The System requires the traffic surveillance, historically in form of pavement loop detectors and infrastructure that allows for communication with central servers. Adaptive Traffic Signaling is continuously adjusted based on the changing the arrival patterns of the traffic at the intersections

In India the growth of vehicles has increased substantially due to increase in population, increases in household income, and increases in commercial and industrial activities. The demand will further increase with India's population by 2035 and about 40% of those will be in the urban areas. This will lead to the increase in traffic congestion, pollution, and travel time and fuel consumption. Hence the demand for safe, reliable, environmental friendly, economical and efficient transport system, road infrastructure becomes crucial. Transport infrastructure is the backbone for an efficient, safe and reliable road transport system.

ATCS can be used as a method to reduce delays to the motoring public and extend the life of the current roadway systems by delaying the need to add capacity through additional travel lanes. The Lesser delays also result in improved fuel efficiency and lower vehicle emissions, which have a positive impact on the environment. Adaptive Traffic control system uses real time traffic information for optimizing the signal timing parameters such as cycle length, splits and offsets, so as to minimize traffic delays and stops .one of the most important difference between the traditional closed loop and ATCS is ATCS can adapts the current traffic and respond to real-time traffic flow changes thus are expected to be more effective and efficient for signaling. There are 3 different types of traffic signal operations

- **Fixed timed:-** Traffic Signals changes according to the pre-defined set of timings .The signals will be continued all the time even if there is no vehicle or pedestrian on the lane.
- **Actuated:-**Traffic Signals will change only whenever there is a vehicle or pedestrian on the lane and the green light timing of the program will be varied on basing of the traffic present in the lane.
- **Adaptive:-**Traffic Signals are programmed to change with a minimum and maximum green light timing basing on the demand of vehicles and pedestrians in all approaches where the Traffic Signals are changed based on the demand from each approach.

### 5.4.1.**Structure of Adaptive Controlling**

Adaptive Traffic Signaling System Contains the 3 basic Working Process:

a. Detection
b. Prediction
c. Optimization

Detection: Detection is the process of counting the number of vehicles that are present in the lane when the vehicle approaches the intersection placed on the roads which is used for adaptive control scheme. This Process of Detection includes the following.

- The types of Detection Devices Used: There are different ways to detect the Traffic on the lane. The different types of sensing are:

    a. **Static:** Static sensors and placed on the Road side.
    b. **Mobile:** Sensors which are in Mobility and placed on the Vehicles which allows to sense in the Motion.
    c. **Hybrid:** Detection requires both Static and Mobile Sensors where in vehicle or on board units and Road side units are units

5.4.2.**Static Techniques**

Various Static Sensing Techniques include the following:

- Induction Loop Traffic Sensors
- Wireless Sensor Networks
- Pneumatic Tubes
- Images and Videos
- Acoustic Sensors
- RF Sensors

a. **Induction Loop Traffic Sensors:** Inductive loop detectors (ILD) consist of one or more loops of wires placed inside the road and all these loops are connected to a control box, which is connected by a signal ranging in frequency from 10 KHz to 200 KHz. Whenever a vehicle moves over or stands on the loop, the inductance of the loop is reduced showing the presence of a vehicle. The data generated by detectors are vehicle passage, presence, count, and occupancy.

For incident detection, loop data is usually relayed to a centralized transportation management center for analysis with a computer based Automatic Incident Detection algorithm. These are capable of measuring flow and occupancy, and estimating vehicle speed. They can also be used to actuate traffic control devices and detect congestion and incidents. These detectors may suffer from poor reliability mostly due to improper installation and have high life-cycle costs.

In some locations they are not the most appropriate detectors, for example when pavement conditions are unfavorable, on structures or where detection is needed across railway tracks. It simply works on induction principle. Iron core (car) passing through a coil (simple wire) produces large inductance when compared to air.

The benefits of inductive loop detectors are:

- Inductive Loop Detectors continues to be the best in all weather, all light conditions of sensor for many applications.
- Inductive Loop Detectors works in similar manner both high and low volume traffic.

- ILDs meet even the most stringent vehicle flow error specifications required by some ITS application.

b. **Wireless vehicle detector sensor systems:** Detectors are positioned where they will detect queues that are in danger of blocking upstream junctions and causing congestion to spread through the network. Within SCOOT, the traffic manager is able to prioritize where such problems should be minimized and SCOOT then automatically adjusts timings to manage the congestion.

Why should people wait for a red signal if there is no traffic that is how it leads to rule breaking? Every time there is a jam at a particular crossing, someone goes and analyzes the pressure of vehicles and adjusts the signals times manually.

c. **Pneumatic Road Tubes**: Pneumatic road tube technology uses rubber tubes placed across traffic lanes in a specific configuration. When a pair of wheels (on one axle) hits the tube, air pressure in the compressed tube activates a recording device that notes the time of the event. Based on the pattern of these times (for instance, the length of the interval between the time that two axles of a typical vehicle activate the counter), the device will match each compression event to a particular vehicle according to a vehicle classification scheme. Two tubes attached to the same counter can be placed a set distance apart in order to determine speed by measuring the interval between the time an axle hits the first tube and the time it hits the second tube.

d. **Images and Videos:** Images and Videos are camera based detection which surveillance cameras monitor traffic states and detects the congestions other incidents that are occurring on the roads, based on various computer vision Techniques used for Traffic Controlling.

e. **Acoustic Sensors:** Acoustic Sensors now –a –days using in the lanes of developing countries for estimating the traffic in the lane where the traffic is busy and Noisy.

f. **RF sensors:** RF Sensors are Wireless Radios that are placed across the road have communication signals affected by vehicular movements in between which are used to monitor the status of the vehicles on the roads. E.g. Microwave Radar etc.

5.4.3.**Mobile Sensing Techniques**

a. **GPS on public transport or fleet vehicles:** Many public transport and fleet companies have GPS installed in their vehicles for real time tracking through which one can count the total number of vehicles in the lane.

b. **GPS on smart phones:** With the recent growth of Smart phones, the GPS in Smart Phones is using now a day to estimate travel time after handling noise in GPS readings.

c. **Using Ordinary Phones:** Ordinary phones are used for traffic sensing through sensing the localization of the current cellular tower and Wi-Fi information they are currently on their phone.

### 5.4.4.**Hybrid Sensing Techniques**

There are a set of techniques that use both static infrastructure and mobile sensors to gain traffic information.

a. **Tele density:** Tele density Refers to the density of mobile phones (nodes) that are connected to a network tower in that region through which the service provider can provide an approximate value of number of vehicles on the road.

b. **Bluetooth:** Bluetooth devices are placed on the road side which are able to detect and communicate with the Bluetooth devices that are present in the car On Board Units or the mobile phone user in the cars, the roadside units senses and gives travel times of the vehicles between the detectors and maintains a separate tables for every address that connects.

c. **RFID:** Vehicles are also can be detected by using RFID Tags placing on the vehicles and the RFID Tag Readers are placed on the intersection points for detections of vehicles and for counting the number of the vehicles.

d. Similar systems are being explored using RFID tags on vehicles and RFID readers on roads.

II. Types of data measured: These may include time of arrival, speed, and axle spacing (vehicle type).
III. The positioning of the devices used: This would involve investigating the distance for advance detection, number of detector to be used and use of detector arrays.

### 5.4.5.**Prediction**

Prediction is the process by which the data detected from the detector are used to determine the arrival pattern of the vehicles to be used by the adaptive control system. The system cannot process vehicles in reality it can make the determination for vehicles over a given time horizon. Prediction creates a pattern of vehicles over the time horizon in the control. The prediction includes the following issues:

1. **Length of time horizon to be used:** This may be as short as a minimum vehicle headway (e.g. 2 seconds) and may be considered as a given cycle length, a 15- minute interval, a peak periods, or may be left variable.
2. **Use of Multiple time horizons:** The Horizons may have different lengths, and may be used for different purposes, such as decision thresholds and detection intervals.
3. **Process by which pattern is generated:** This is a process replicating a old detected pattern, scaling a historical pattern, fitting a probability distribution, or using a time-series model.

### 5.4.6.**Optimization**

Optimization is the process by which the predicted vehicles arrivals are used to distribute green times to the various approaches of the intersection. It also optimizes a measure of effectiveness based on the vehicle arrivals.

Optimization includes the following:

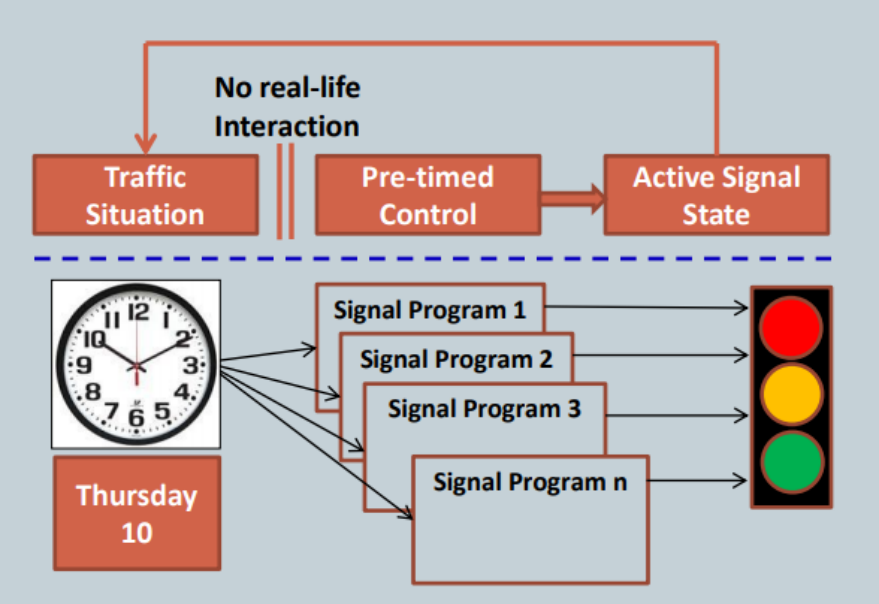
1. **Measure of Effectiveness to be used**: This is based on the number of vehicles and the type of user.
2. **Objective Function**: Objective Function is a mathematical Function that will determine the impact the vehicle arrival patterns have on the measure of effectiveness and the green time will be distributed

### 5.4.7.Differences between fixed-time planning traffic control system and ATCS

In India all most all Traffic Control Systems works on the fixed time basis, where a timing plans are predefined these fixed time systems having a problem that they cannot adopt the traffic conditions so that even a lane is filled with traffic and other lane is not filled with the traffic sometimes it may give the green even there is no traffic in the lane, this increases the waiting time and consumption of fuel is more. Whereas the adaptive traffic control systems will adapts the current traffic condition and it gives signals accordingly which improves economy of the country in terms of fuel and time.

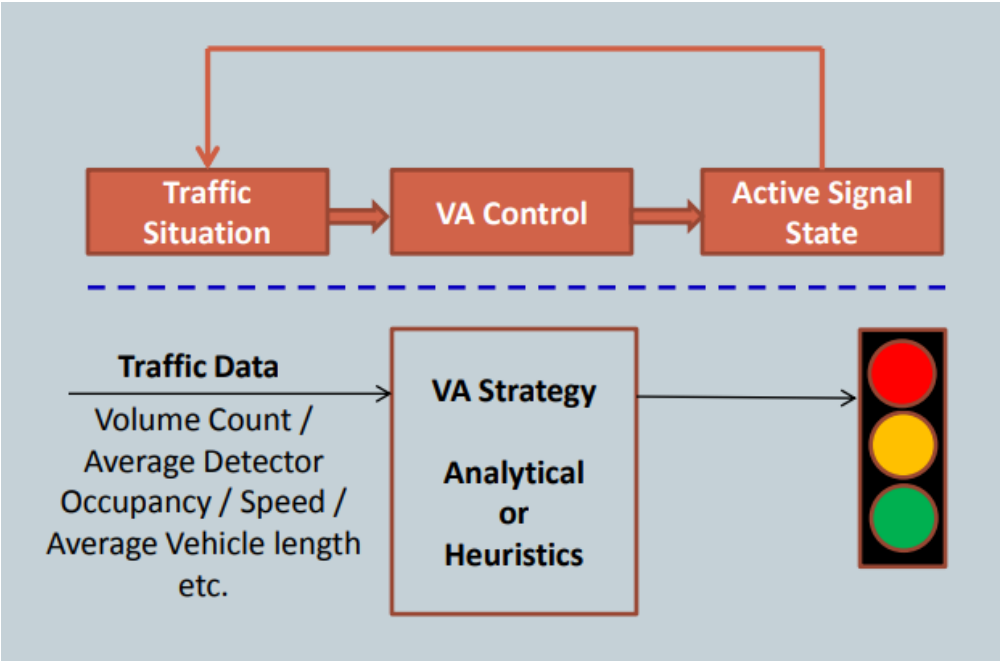
Most of them are Pre-timed

- Simple and inexpensive
- Signal timings derived from the statistical data
- Duration and order of all green phases are fixed
- Cannot respond to real-time demand



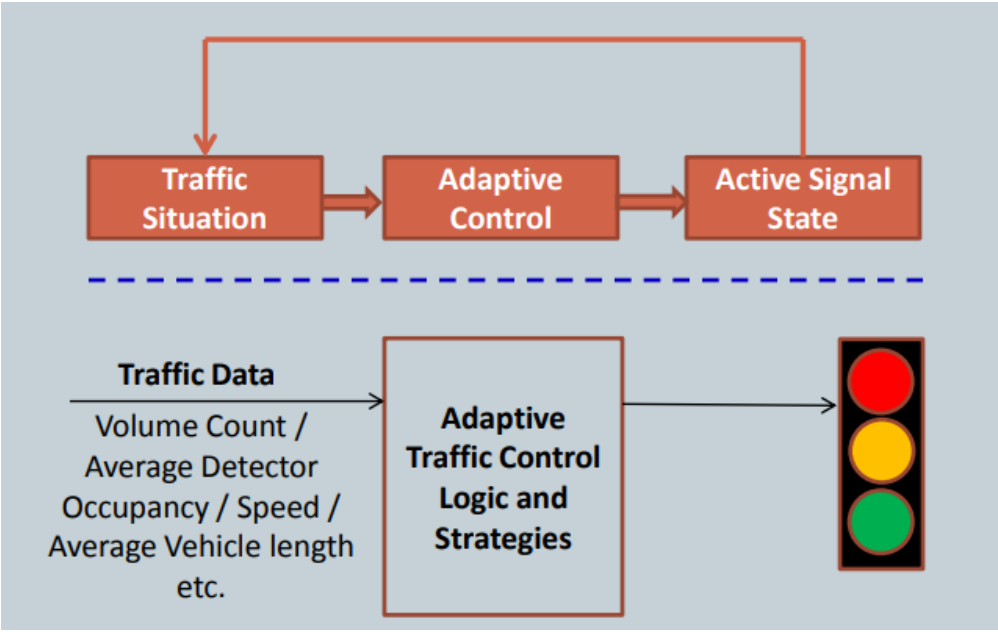

Few Vehicle Actuated Signal Controllers

- Signal timings based on real-time traffic demand




Very few Adaptive Traffic Control Systems

- Real-time signal control applied to a network of traffic junctions




### 5.4.8. **Deployment Architecture with Network Connectivity**

Network connectivity forms the backbone for Adaptive Traffic Control System along with Sensors and Controllers on which the streams and data from cameras and sensors are sent to the Command Control Room where it shall be viewed, recorded, stored, analysed and proactive/reactive measures are catered. The connectivity from field level includes various components such as Network Switch, Optic Fiber Connectivity and bandwidth utilization which ensure the feeds are received at the Command Control Centre. It is also important that the connectivity provides the

data devoid of Latency, Jitter, Packet Loss and Performance and supports no single point of failure for all the locations covered.

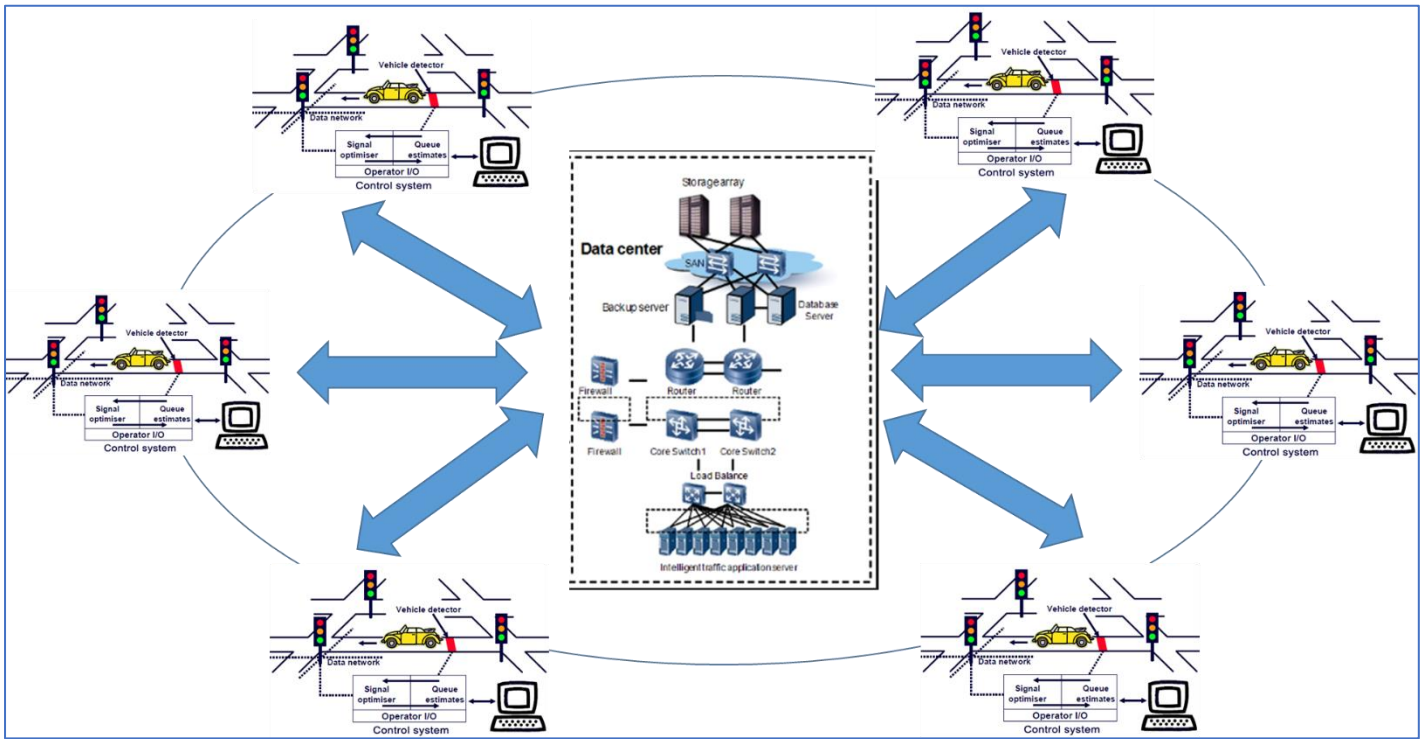



*Figure 7: This is an indicative diagram of ATCS system connectivity with ICCC*

At Integrated Command and Control Center, a traffic engineer will be assigned to monitor the data feeds received from the edge devices and controllers. Existing ISP's ducts and complete Network Backbone will be utilized for connectivity for all ATCS components.

### 5.5. ICT Enabled Solid Waste Management System

Any material which is discarded and not in liquid or gas form is known as solid waste. Solid waste management plays vital role in defining city's cleanliness status and in turn provides measures of lesser pollution and better health conditions of citizen. Residential area and homes where people live are major source of solid waste. Waste cycle starting from collection to recycling is monitored with the help of solid waste management software.

Objective of Solid Waste Management Application are as follows

- Real Time Fleet Operation Monitoring is possible for Solid waste collection vehicles (Door to door vehicles/ Bin Lifting Vehicles/ Hook Loader Vehicles/ Container Lifting Vehicles and other small electrical vehicles), Road Sweeping Vehicles, STP vehicles
- Reduction in complaint being registered through monitoring and managing overlooked garbage collection points, Road Sweeping and STP and Manhole related complains
- Increased Transparency in the process of providing the billing/credit of waste disposal or recycling
- Working hour and travelled distance based on GPS device to validate contractor payments.
- Reduction in intentional route duplication attempts.

- Real time garbage collection information for each route as well as each vehicle.
- Live Monitoring and control of Complaints being served.
- Fleet Service Management and Optimization of planning level
- Increase in Service Reliability, Accuracy and Safety.
- Higher visibility over garbage collection operations
- Increase in Citizen satisfaction by efficient garbage collection process
- Contractor Performance Evaluation can be done
- Elimination of contractor's fake billing payments issues / Billing verification has become possible
- Registration facility for recyclers and rag pickers.
- Biometric Attendance System for field workforce resulting better transparency in operation.

### 5.5.1.**Mandatory H/W for Real time monitoring of Solid Waste Collection Process**

- All garbage collecting & transferring vehicles need to be fitted with GPS devices and RFID Tags.
- Colored QR Code Tags on Door to Door Collection Points/Bins
- All Community Bins / Container Bins need to be fitted with plastic sticker RFID Tags.
- All Community Bins / Container Bins need to be fitted with Level Sensors and communication module for data transfer.
- RFID Readers at strategic location such as Key Entry/Exit Points, Parking Areas, Waste Transfer Stations, Regional/Zonal Offices, Weighbridges, Dump Site and Waste Recycling Plants
- Automated Weighing Scales needs to be fitted and integrated with RFID Readers
- Biometric attendance devices have to be given to supervisor staff.
- Premise biometric attendance devices needs to be fitted at office location.
- All STP and road sweeping vehicle should have GPS device fitted into it.
- Central control center should have facility of audio-video discussion and display unit.
- Weighbridge should have entry/exit boom barrier, IP Camera, Traffic light and pole mounted RFID reader fitted into it.
- Vehicle position sensor set, audio announcement system and visual weight indication system should be integrated with weighbridge solution.

### 5.5.2.**Proposed Solution and Deployment Architecture**

Over all integrated solutions' data level diagram will be as per the below mentioned diagram:

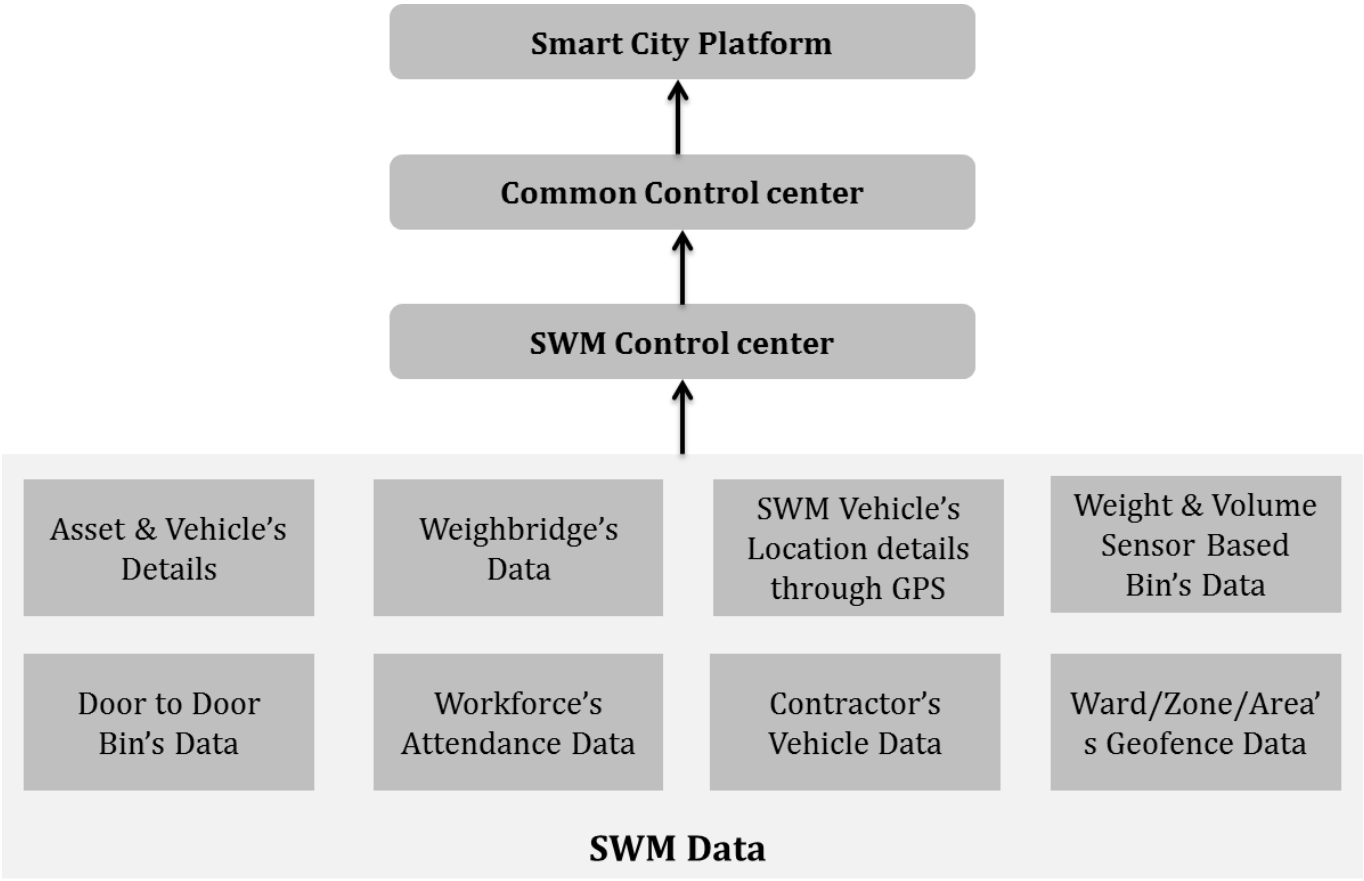



*Figure 8: Municipal Solid Waste Data Architecture Diagram*

SWM Data Centre will have following details as mentioned in the diagram:

- Vehicle's details with its registration number and type
- Vehicle's location details coming from GPS device
- Door to Door Bin's details coming through RFID reader
- Weight & Volume sensor based smart bin's data
- Asset and Inventory details
- Weighbridge's integration details
- Contractor's rental vehicle details
- Mobile & Office workforce's attendance details
- STP vehicle and city manhole's detail
- Sweeping vehicle's details
- Ward/Zone/Area's Geofence Details

Detailed Solution description will be as follows:

#### 5.5.2.1. Door to Door Collection

Door to Door bins play vital role in fulfilling goals of municipal solid waste. Door to door waste provides base for municipal solid waste and need to collect daily by municipal staff. Societies and house owner should be equipped with proper bin with RFID tag mounted over it. This will make it easier for municipality to track the waste collection of city.

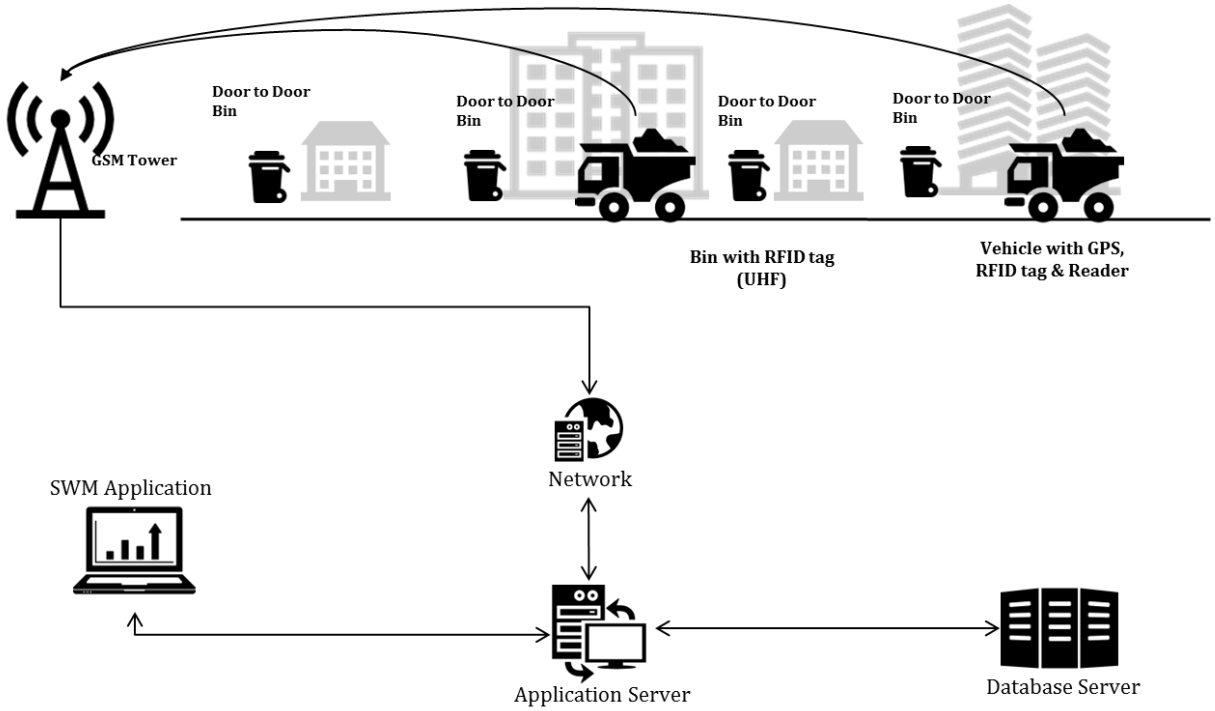



*Figure 9 : Door to Door Collection of Waste*

- Bins placed at door will have color QR code stickers mounted on it.
- Separate waste type will have separate color coded bins.
- Waste Collectors will have RFID reader with them to keep the track of waste collected from home or society.
- On collecting waste from home, RFID tags from bin get read by RFID reader.
- On collection of waste from RFID bin, data of served bin will be sent to application server with the help of GPRS/Wifi network.
- Missed bin will get notified in reports along with its area/zone/ward details at the end of day.

**Equipment Required:**

- Colored QR Code mounted on waste bins
- Handheld Unit for reading QR code as well as attendance management

#### 5.5.2.2. Storage Bin Collection

Various storage bins are placed thought the city with passive RFID tag mounted over it. Bins are integrated with level sensor in order to measure its level. All such bins should be segregated according to waste type like separate bin for dry waste or plastic waste etc. On collecting of waste from such bins, RFID tag of such bins will be read with the help of RFID reader and passes information to server.

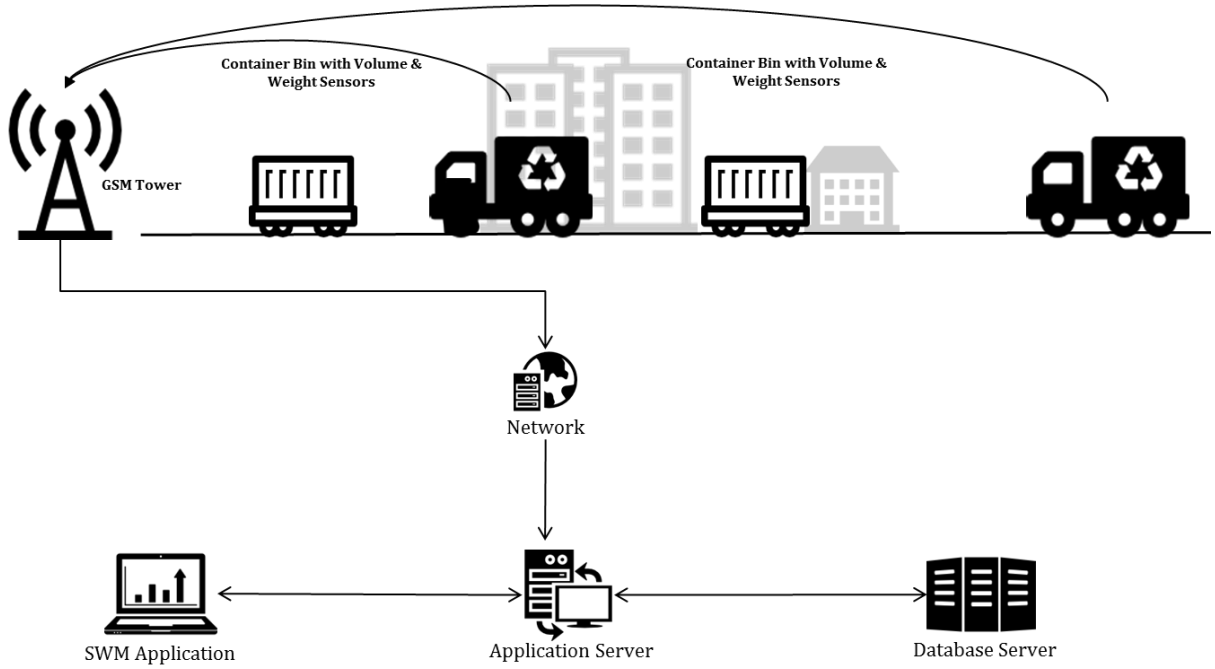



*Figure 10 : Storage Bin Collection*

- Storage bins should have plastic passive RFID tag mounted over it.
- Bins placed at various locations will have weight and volume sensor integrated with it.
- Real time status of bin level is monitored and data is sent to central server with the help of GPRS network.
- Bin collection vehicles should also have wireless bin level sensor mounted on it in order to measure the weight and level of lifted bins.
- After collecting garbage from storage bins, real time data will be sent to server with the help of RFID reader and RFID tag.
- Application server will use this data from database server to generate reports and alerts for missed storage bins.
- User at application level will be able to access such reports and alerts based on his/her access rights.

**Equipment Required:**

- Plastic Sticker RFID tag mounted on vehicle
- Wireless Bin Level Sensor Reader

#### 5.5.2.3. **Fleet Status Monitoring**

Both door to door and storage bin collecting vehicles are equipped with vehicle tracking unit as well as passive RFID Tag. Vehicle tracking unit will be GPS device mounted on vehicle for sending location details of vehicle at any time. Fleet status along with its routes, schedules and assigned driver details can be traced on real time basis on GIS map.

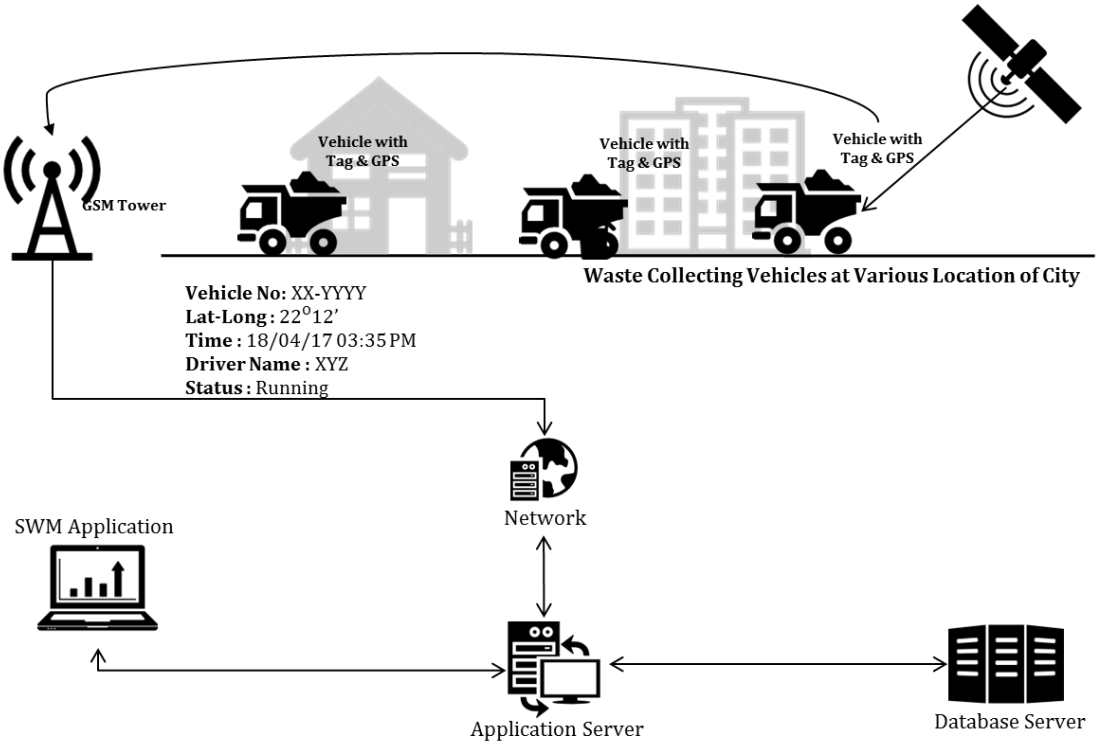



*Figure 11 : Fleet Status Monitoring*

- Fleet Status will be monitored with the help of GPS device mounted on vehicle.
- Satellite will send the data to GPS device mounted on vehicle which provides lat-long details, route details and driver details at particular time.
- Vehicle will send these lat-long details to application server with the help of GPRS network.
- Real time location of vehicle can be used for tracking vehicle at any point of time.
- Details about assigned route and actual route can be served with the help of fleet status monitoring.
- Vehicle status (i.e. running, idle, stand by, no communication) should be configured through application and similar data has to be shown in application.

**Equipment Required:**

- GPS unit mounted on vehicle
- Fixed RFID tag mounted on the windshield of vehicle

#### 5.5.2.4. Integration with Weighbridge Application

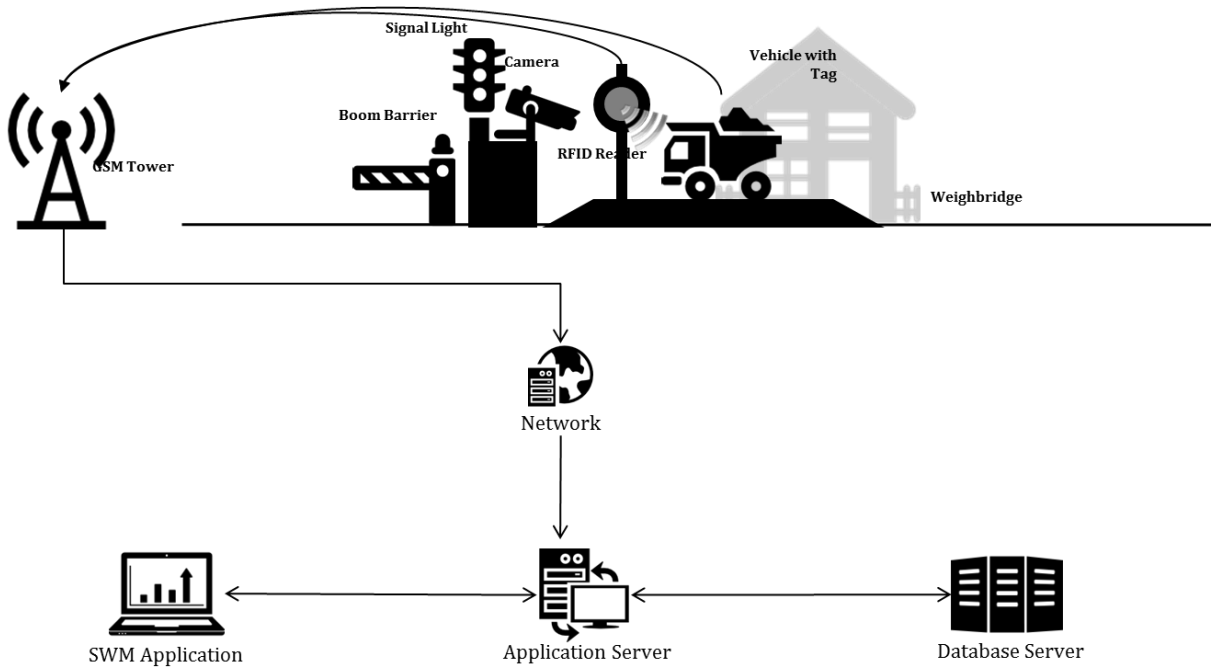



*Figure 12 : Weighbridge Integration*

- RFID reader should be installed at every weighbridge site.
- When vehicle arrives on weighbridge, RFID reader will identify the vehicle and sends information to Central server.
- Weighing information should also be capture from Weighbridge Application (if any available) and same data should be interfaced with Central Server through broadband connectivity.
- Weigh bridge solution needs to be integrated with GPS based fleet monitoring solution and relevant report needs to be generated from the application

**Equipment Required:**

- Pole mounted passive RFID reader
- Vehicle Position Sensor Set
- Traffic Signal Light
- Automated weighbridge controller
- Visual weight indication system
- Audio announcement system
- Panel computers and printers
- Fixed RFID tag mounted on the windshield of vehicle
- Boom Barrier at Entry/Exit point

#### 5.5.2.5. Real Time Community bin level monitoring

Level sensor which are mostly weight and volume based sensor serve the purpose of making a storage bin to "smart storage bin". It continuously monitors the level of storage bins and based upon pre-configuration passes regular alerts to application user.

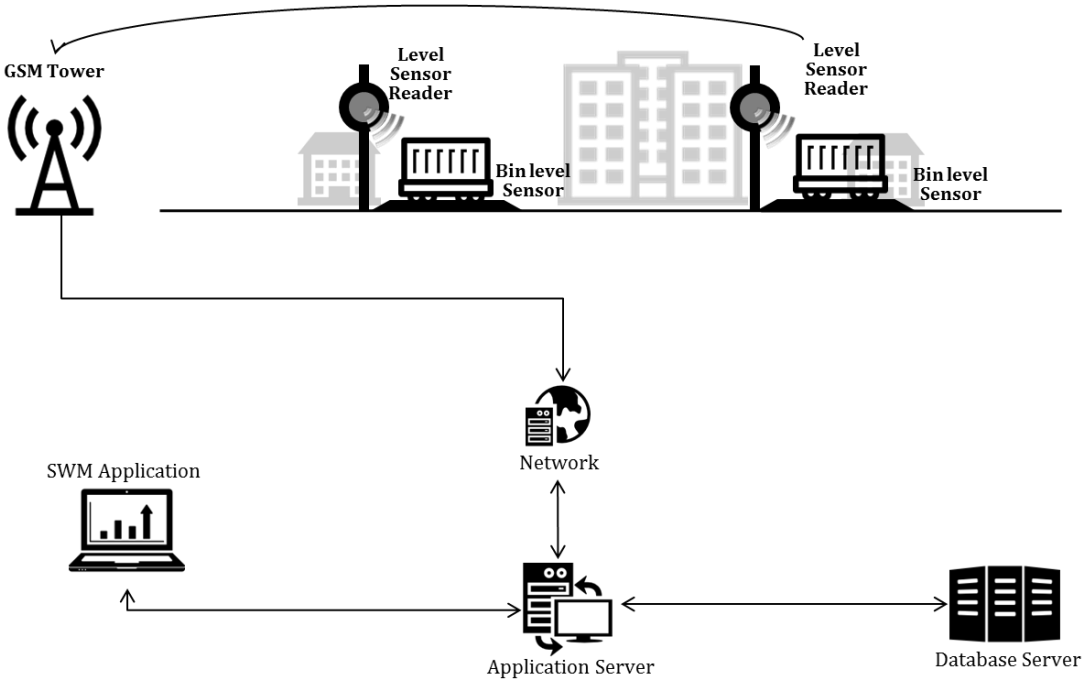



*Figure 13 : Weight and Volume Sensor Integration*

- Storage bins are equipped with weight and volume based sensor. Volume sensors are mounted on pole placed nearer to storage bin to monitor its level.
- Storage bin's level data calculated with the help of weight and volume sensor are sent to server with the help of GSM network.
- Automatic alerts should get generated on attaining pre-configured level of storage bins to user.
- Routes of storage bin container vehicle should be assigned on basis of level details of storage bins.

**Equipment Required:**

- Bin with bin level sensor
- Level sensor reader

#### 5.5.2.6. Biometric Attendance System

Integrated attendance system with the use of biometric would bring transparency in operation of collecting waste. Details of employee with its punch in and punch out time will be sent to application server for monitoring attendance.

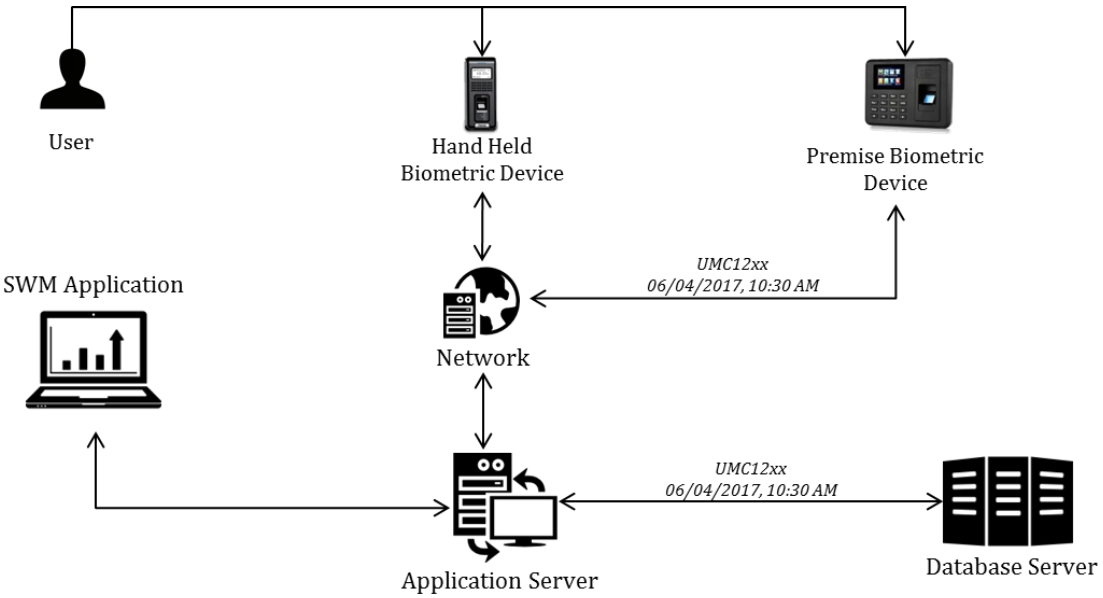



*Figure 14 : Biometric Attendance System*

- Hand-held biometric devices are used to take the biometric attendance of sweepers and workers working on streets.
- Premise biometric devices are stationary devices and can be used to take the attendance of workers at office premises.
- All such attendance details will be sent to application server on real time basis and appropriate reports can be viewed on application.

**Equipment Required:**

- Hand held biometric devices
- Premise biometric devices

### 5.5.2.7. Asset Lifecycle Monitoring

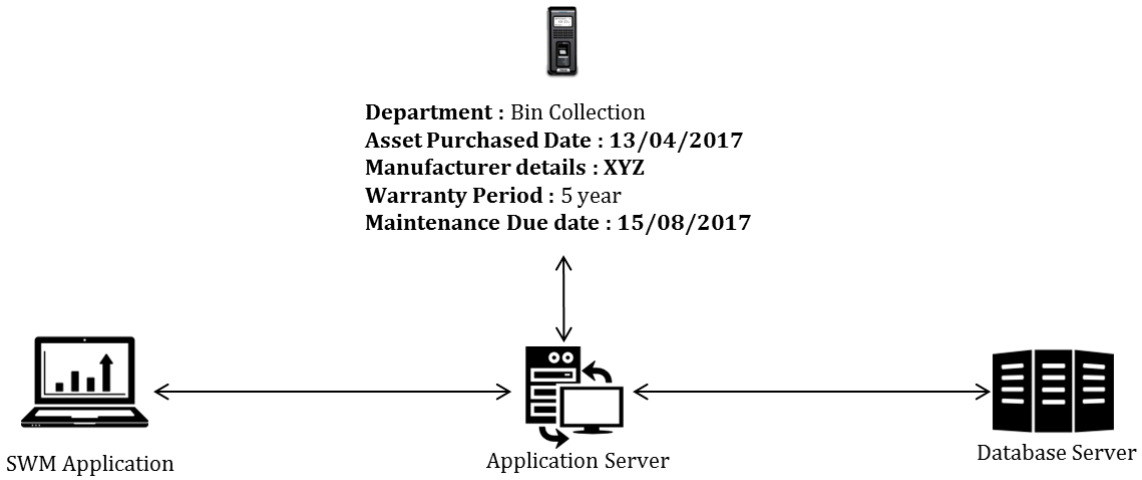



*Figure 15 : Asset lifecycle monitoring*

- Asset details should be stored in application database with all its details like department details, purchase date and warranty date.
- Asset maintenance details and due date should be calculated by system based upon preconfigured data and appropriate alerts has to be generated.
- Details of all purchased and rented assets are stored in data base and appropriate data can be generated at any time.
- Alerts should get generated by application in case of end of rental period of assets.

#### 5.5.2.8. Recycler and Rag picker's Registration System

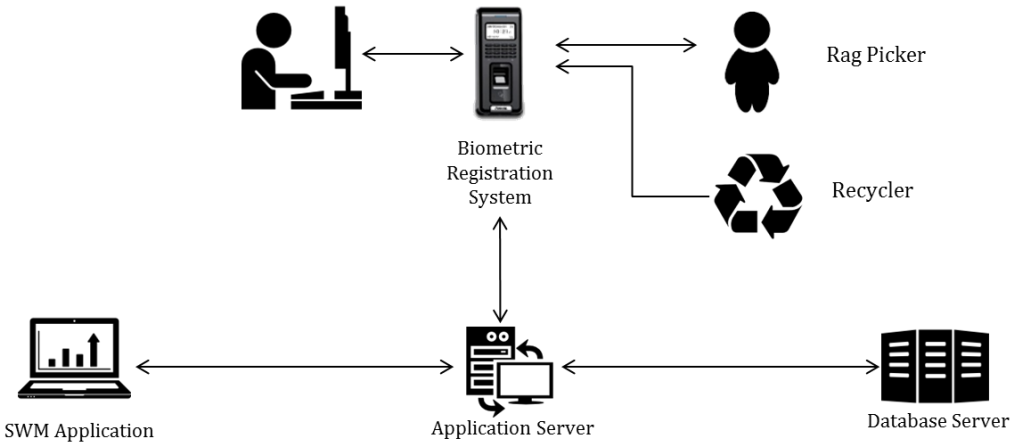



*Figure 16 : Recycler and Rag Picker's Registration*

- All the details of recyclers and rag picker of the city should be stored in system along with their biometric ID.
- Waste collected by/segregated by rag pickers and recycled by recyclers has to be monitored with the help of application.

#### 5.5.2.9. Central Control Center

*Figure 17 : Central Control Center*

- Central control center should have common monitoring system for all equipment and data like weighbridge details, storage bin details and vehicle's location details.

- Central control center should have audio video conferencing unit in order to directly communicating for complain monitoring.
- Management and scheduling of vehicle as well as storage bins and routes can be done at control center.
- Central control center shall be a point for monitoring all the details and data of solid waste management including complaint redressal system.
- It is single screen integrated equipment room with video devices and contact center for municipal solid waste.

#### 5.5.2.10. Integration with Smart City Platform

- All the required data should be sent to smart city server in the form of API.
- Data structure between solid waste management platform and smart city platform should be in coherence to generate city wide reports and analytics.

# 6. Detailed Scope and Functional Requirement

## 6.1. Overall Project Scope

Agra Smart City Company Ltd intends to on-board a Master System Integrator (MSI) for city of Agra by following competitive bidding process to design, develop, implement and maintain the Smart City System for a period of five years after Go Live date on turnkey basis. MSI will develop a Centralized Command and Control Centre which shall be managed by police for City Surveillance and Law Enforcement through CCTV Cameras, Public Awareness, Proactive Monitoring for Catastrophic Situation and Manage the VIP and Emergency Movement along (CCC) and City for managing various utilities like Automated Traffic Signal, Solid Waste Management, Public Transport Movement etc. as an Integrated Smart City System for Agra.

Main objective of the project is to create synergies within and across various departments of AMC for efficient city administration. To achieve this MSI shall also ensure appropriate check points are built-in the various smart city solutions. This will ensure optimum and efficient delivery of public services to the citizens and visitors of Agra city.

MSI shall be responsible to carry out detailed survey prior to submission of bid for the various components of smart city solution to finalize infrastructure requirement, network bandwidth requirement, operational and administrative challenges, etc.

The subsequent sections mention the detailed scope of work, functional requirement, and technical specifications for each component of smart city solution. MSI shall note that the activities defined in the scope of work mentioned in this RFP are indicative and may not be exhaustive. MSI is expected to perform independent analysis of any additional work that may be required to be carried out to fulfil the requirements as mentioned in this RFP and factor the same in its response.

More specifically, the following will be the activities to be carried out by MSI:

- Project planning, execution and management.
- Assessment and gap analysis of requirement for all smart city components under scope.

- Solution design, system customization and development for all components mentioned in the scope of work.
- Procurement, installation, deployment and commissioning of ICT and other equipment.
- Site preparation including required civil work, LAN/WAN Networking.
- Application and general awareness training.
- Business process reengineering for the selected applications/services, if required.
- STQC certification.
- UAT and Go Live.
- Training and capacity building support.
- Technical support.
- Operation and Maintenance (O & M) for 5 years starting from Go Live date.

#### 6.1.1. Finalization and Submission of a Detailed Technical Architecture

MSI will be required to prepare detailed Technical Architecture for various components of smart city solution as mentioned and finalize the detailed architecture for the overall system, incorporating findings of site survey. MSI shall submit the detailed technical architecture and description of each component, along with the bid, ensuring compliance to the following guiding principles:

1) **Scalability:** Important technical components of the architecture must support scalability to provide continuous growth to meet the growing demand of the city. The system should also support vertical and horizontal scalability so that depending on changing requirements from time to time, the system may be scaled upwards. There must not be any system imposed restrictions on the upward scalability in the number of field devices, data centre equipment or other smart city components. Main technology components requiring scalability are storage, bandwidth, computing performance (IT Infrastructure).

   The architecture should be scalable (cater to increasing load of internal and external users and their transactions) and capable of delivering high performance till the system is operational. In this context, it is required that the application and deployment architecture should provide for scale up and scale out on the application and web servers, database servers and all other solution components. The Data Centre/Disaster Recovery Centre infrastructure shall be capable of serving at least 1000 concurrent users.

   The Applications proposed for various solutions shall be capable of handling growth for next 5 years from the Go Live date. MSI shall clearly quantify the expansion capabilities of the application software without incurring additional cost**.**

2) **Availability:** The architecture components should be redundant and ensure that are no single point of failures in the key solution components. Considering the high sensitivity of the system, design should be in such a way as to be resilient to technology sabotage. To take care of remote failure, the systems need to be configured to mask and recover with minimum outage. The MSI shall make the provision for high availability for all the services of the system. Redundancy to be considered at DC/DR Centre components level. The system should be designed to have uptime for 99.982%.

3) **Security:** The architecture must adopt an end-to-end security model that protects data and the infrastructure from malicious attacks, theft, natural disasters etc. MSI must make provisions for security of

field equipment as well as protection of the software system from hackers and other threats. Using firewalls and intrusion prevention systems such attacks and theft should be controlled and well supported (and implemented) with the security policy. The virus and worm attacks should be well defended with gateway level anti-virus system, along with workstation level anti-virus mechanism. There should also be an endeavor to make use of SSL/VPN technologies to have secured communication between Applications and its end users. Furthermore, all the system logs should be properly stored and archived for future analysis and forensics whenever desired. The ASCL would carry out the security audit of the entire system upon handover and at regular interval during O&M period.

Field equipment installed through this project would become an important public asset. During the contract period of the project, the MSI shall be required to repair/replace any equipment, if stolen/damaged/faulty. Appropriate insurance cover must be provided to all the equipment supplied under this project. The systems implemented for project should be highly secure, considering that it is intended to handle sensitive data relating to the city and residents of the city. The overarching security considerations are described below.

- The security services used to protect the solution shall include: Identification, Authentication, Access Control, Administration and Audit and support for industry standard protocols.
- Solution shall support advanced user authentication mechanisms including digital certificates and biometric registration through Aadhar database whereas authentication post registration can be local.
- Security design should provide for a well-designed identity management system, security of physical and digital assets, data and network security, backup and recovery and disaster recovery system.
- Solution should provide for maintaining an audit trail of all the transactions and should also ensure the non-repudiation of audit trail without impacting the overall performance of the system.
- The overarching requirement is the need to comply with ISO 27001 standards of security.

4) **Manageability:** Ease of configuration, ongoing health monitoring, and failure detection are vital to the goals of scalability, availability, and security and must be able to match the growth of the environment. Network should be auto/manual configurable for various future requirements for the ease of maintenance/debugging.

5) **Interoperability:** The system should have capability to take feed from cameras installed by private/Govt. at public places. If required, MSI will also be responsible to digitize and compress the images and feeds and search as per requirements.

6) **Open Standards:** MSI to ensure that all the systems should use open standards and protocols to the extent possible like Hadoop in case of Big Data and Analytics. No additional cost for licenses on proprietary tools shall be incurred by ASCL.

7) **Single-Sign On:** The application should enable single-sign-on so that any user once authenticated and authorized by system is not required to be re-authorized for completing any of the services in the same session. For employees of the department concerned, the browser based application accessed on the intranet, through single-sign-on mechanism, will provide access to all the services of the departments concerned (based on their roles and responsibilities), Help module, basic and advanced reporting etc. Similarly, for external users (citizens, etc.), based on their profile and registration, the system shall enable single-sign on facility to apply for various services, make payments, submit queries /complaints and check

status of their applications.

8) **Interoperability Standards:** Keeping in view evolving needs of interoperability, the possibility that the solution shall become focal point of delivery of services, and may also involve cross-functionality with the e-Government projects of other departments/businesses in future, the solution should be built on open standards. The MSI shall ensure that the application developed is easily integrated with the existing applications. The code should not build dependency on any proprietary software, particularly, through use of proprietary 'stored procedures' belonging to a specific database product. The standards should:
    - At least comply with published e-Governance standards, frameworks, policies and guidelines available on http://egovstandards.gov.in (updated from time-to-time); and
    - Be of leading industry standards and/or as per standards

9) **GIS Integration:** MSI shall undertake detail assessment for integration of all field level ICT interventions proposed. MSI is required to carry out seamless integration to ensure ease of use of GIS in Dashboards in Command Control Centre and Operation Command Centre. If this requires field survey, it needs to be done by MSI. If such a data is already available with city, it shall facilitate to provide the same. MSI to check the availability of such data and suitability for the project. MSI is required to update GIS maps from time to time.

10) **SMS Gateway Integration:** MSI shall carry out SMS Integration with the smart city system and develop necessary applications to send mass SMS to groups/individuals. Any external/third-party SMS gateway can be used, but this needs to be specified in the Technical Bid, and approved during bid evaluation.

- **Application Architecture:** The applications designed and developed for the departments concerned must follow best practice and industry standards. To achieve the high level of stability and robustness of the application, the system development life cycle must be carried out using the industry standard best practices and adopting the security constraints for access and control rights. The various modules/application should have a common Exception Manager to handle any kind of exception arising due to internal/external factors.
  Standards should
- At least comply with published e-Governance standards, frameworks, policies and guidelines available on http://egovstandards.gov.in (updated from time-to-time); and
- Be of leading industry standards and/or as per standards

The modules of the application are to be supported by the Session and Transaction Manager for the completeness of the request and response of the client request. The system should have a module exclusively to record the activities/create the log of activities happening within the system/application to avoid any kind of irregularities within the system by any user/application.

MSI shall design and develop the smart city system as per the functional and system requirement specifications finalized.

1. The Modules specified will be developed afresh based on approved requirement.
2. Apart from this, if some services are already developed/under development phase by the specific department, such services will be integrated with the smart city system. These services will be processed through department specific application in backend.

## 6.2. Adaptive Traffic Control System (ATCS)

### 6.2.1. Brief Scope

- Study existing traffic management systems and processes deployed by the traffic police, MIS reporting requirements, problem areas and expectations of Agra Traffic Police.
- Collect data of existing operating conditions, traffic volumes across various time periods of a day, which will cover all peak and non-peak hours, weekends, etc., saturation flow rates, free flow travel time through the junction and actual travel time in peak operating conditions.
- Journey time surveys for as-is conditions should be conducted along designated corridors which should be designed such that all junctions are picked in at least one corridor. For major junctions, both directions (e.g., east-west and north-south) and key turning movements should also be covered.
- Develop feasibility report for finalization of detailed technical architecture and project plan along with following KPI's
    - Volume of vehicles moving on the road network
    - Vehicle type distribution
    - Directional distribution
    - Physical and visual characteristics of the area
    - Travel times, delays between different points of the network
    - Vehicle Emission based on emission measurement requirements of the city
    - Additional dependencies with respect to available infrastructure and geometry at junctions
    - Any other relevant data which MSI anticipates will assist in establishing benchmarks for the project
    - Expected Measurable Improvements against each KPI
- MSI shall identify customization or additional installations needed to deploy a standardized ATMS solution as per the functional specifications.
- Feasibility report will include as-is study, improvements, gap analysis

### 6.2.2. Design, Integration and Maintenance of ATMS

This shall consist of the following activities:

- Preparation of solution architecture and gap analysis.
- Installation of vehicle detectors, controllers and other required accessories for successful operation of the ATMS for ASCL.
- Installation of ATMS software application as per functional requirements specified by ASCL.
- Procurement and supply of necessary software required for successful functioning of the ATMS sub module.
- Integration of ATMS infrastructure with existing traffic applications.
- Configuration of traffic signal at each junction along with development of signal control plan for individual operations, coordinated signal plan for junction in sync with area wide signal plan for different operating conditions. Operating conditions may include peak, off-peak conditions, special events, contingency plans etc.
- MSI shall supply, install, commission and maintain the following:

- Adaptive Traffic Management System (ATMS) – Vehicle detectors, signal controllers, traffic light aspects and poles, power supply and related accessories and associated civil work including cabling for successful operation of the system.
- Provide software platforms in Data Centre (DC) /Disaster Recovery Centre which would aggregate incoming data streams on to a single platform, provide traffic flow estimates for near term future on a real-time basis and assist in analysing impact of alternate traffic management strategies.
- Develop individual signal control strategies including definition of signal grouping, setting of potential strategies for traffic control under various scenarios, specification of traffic management strategies for planned and unplanned events.
- Develop a consolidated database of incoming real time data for future analysis and evaluation purposes. It is envisaged that the proposed adaptive traffic management system will incorporate historic trends for development of traffic management strategies and adaptive control strategies.
- Field Equipment: Design, Supply, Installation, Commissioning and Maintenance of following field equipment envisaged in ATMS:
  - Adaptive Traffic Control/Management System at specified signalized traffic junctions
  - Network Connectivity: Will use network as a service from the ISP to connect to the Data Centre and CCC/OCC.

### 6.2.3.**Functional Specification**

**General:**

- The system would be used to monitor and control traffic signals, including signalized pedestrian crossings, using a traffic responsive strategy based on real-time detector data.
- All signal controllers under Adaptive Traffic Management System shall be provided with inputs from non-intrusive vehicle detection sensors for detecting traffic state and communicating demand data to central ATCS server and to receive control instructions on the control strategy in near real-time.
- The system should be extensible to add more signals whenever required.
- Existing infrastructure at the junctions that might help in traffic control (e.g. ANPR cameras, CCTV cameras etc.), where possible, should be integrated with the proposed ATMS.

**Traffic Detectors:**

- For major roads: Non-intrusive video based traffic detectors for detecting traffic demand on major road approaches to junctions.
- It shall provide presence detection for a minimum of 4 zones.
- The detector shall be able to detect the presence of vehicles near stop-line in non-lane based mixed traffic flow conditions.
- It shall provide both non-directional and directional detection in up to 4 directions, user-configured for each zone.
- The sensor firmware shall be capable of being upgraded after installation.
- For minor roads: Non-intrusive video based traffic detectors or microwave radar based traffic detectors for detecting traffic demand on minor road approaches to junctions.

**Traffic Signal Controller:**

- The controller should support the required number of phases and stage for 3-way, 4-way and 5-way junctions for operation during different times of the day and day of the week and for special day types.
- The ATCS controller should define common inter-green period formed by the clearance Amber and Red extension period. It shall also be possible to program individual inter-green period from 3 Seconds to 10 Seconds.
- The controller shall have a facility to list all conflicting phases at an intersection. After configuration, a traffic engineer shall verify that the signal aspects are functioning as expected for all signal plans before go live.
- During power up the controller shall initially execute the Flashing Amber/Flashing Red plan for a time period of 3 Seconds to 10 Seconds.
- Fault monitoring should be available for the traffic controller and the signal aspects under all modes of operations. The fault data should be communicated to the central ATCS server in near-real-time.
- A hardware failure leading to a conflict condition (due to faulty devices or short circuit in the output) shall force the signal into Flashing Amber/Flashing Red. The conflict data should be communicated to the central ATCS server in near-real-time.
- The controller shall be able to interface with a wide variety of detectors having industry standard open collector interface.

The controller shall support the following modes of operation:

  - Fixed time mode – the controller shall execute a pre-set signal plan based on the time of the day and day of the week. Signal timings will not be modified dynamically using real-time traffic detector data under this mode.
  - Vehicle Actuated (VA) mode – the controller shall execute a pre-set VA logic and not have fixed stage durations. The green time for each stage shall be bound by the constraints of specified minimum green and maximum green times. The actual green time is determined based on the vehicular demand obtained from the traffic detectors at the given approach and conflicting approaches using VA logic.
  - ATCS mode – the controller shall execute optimized signal timings determined by the ATCS application in the control centre using inputs from traffic detectors, including cycle time, splits, and offsets. The traffic signal controller can optionally have the ability to locally override the signal timings determined by the central ATCS.

- The controller shall provide either a fixed operator console or support a portable one to allow traffic engineers to program the controller on-site.
- No proprietary protocols shall be used for communication between the traffic signal controller and ATCS server.

**ATCS Application:**

- The ATCS application should determine optimal signal timings dynamically using near-real-time detector data for a group of junctions using any suitable algorithm. The system should be able to determine a common cycle time for a group of junctions, splits and offsets between adjacent signals.

- The application should support selective vehicle priority for movement of buses and other important vehicles such as ambulances, fire engines etc. To avoid queue build-ups, the system shall also provide compensated green to the other stages after the passage of a priority vehicle.
- The application shall allow specification of green corridors for movement of emergency response vehicles, such as ambulances, VIP vehicles, fire engines and police vehicles.
- The application support interfacing with a commonly used microscopic traffic simulation software for pre and post implementation analysis and study of the proposed ATCS control strategy.
- The application shall optionally be able to estimate a common operational view of the network state by fusing data from multiple sources such as detectors as well as ANPR, GPS or any other such data collected from other third-party sensors/detectors/cameras.
- The application should be capable of operating in the following four modes:
    - **Fixed-time mode:** This mode should enable traffic police personnel to select and run fixed-time traffic signal timing plans using the ATCS interface available in the CCC. The signal timing plans should be able to support fixed offsets between pairs of adjacent traffic signals.
    - **VA mode:** Individual signals should be able to run on stand-alone VA mode.
    - **Fully adaptive mode – tactical:** Signal timings for a group of junctions should be dynamically optimized using near-real-time detector data.
    - **Remote operation:** Traffic police personnel should be able to remotely control (change stages) using the ATCS interface from the control room.

The application shall have a Graphical User Interface (GUI) with an underlying GIS map that shall display the road network and the traffic signals, traffic cameras/detectors, Variable Message Sign (VMS) boards and Public Address (PA) systems deployed.

The GUI shall provide:

- Flexibility to the operators to zoom and navigate with ability to interact with objects on the map.
- Interoperability across multiple platforms.
- Web browser based access
- Graphically present signal plan execution and traffic flow at the intersection on a desktop.

The GUI shall have the following features:

- User Login – Operator authentication shall be verified at this screen with login name and password.
- Network Status Display – This online display shall indicate with appropriate color coding on site map whether an intersection under the ATCS is online or off. On double clicking the intersection a link shall be activated for the traffic flow display for the intersection.
- Traffic Flow Display – This online display shall indicate the current traffic flow with animated arrows, mode of operation, stage number being executed and elapsed stage time.
- Saturation Snapshot – This display shall show the current saturation levels of all intersections in a corridor.
- Reports Printing/Viewing – This link shall allow selection, viewing and printing of different reports available under ATCS.
- Time-Space Diagram – The time-space diagram shall display the current stages being executed at every intersection in a corridor with immediate previous history. Junctions shall be plotted proportional to their distance on Y-axis and time elapsed for the stage in seconds on X-axis.

ATCS application shall graphically show the execution of the signal plans, in near-real-time.

The solution should include the following reports at a minimum:

| Sr. No. | Reports | Sr. No. | Reports |
|---|---|---|---|
| **1** | Stage Timing Report | 6 | Plan Change Report |
| **2** | Cycle Timing Report | 7 | Mode Change Report |
| **3** | Mode Switching Report | 8 | Lamp Status Report |
| **4** | Power On and Down | 9 | Loop Failure Report |
| **5** | Corridor Performance Report | 10 | Corridor Cycle Time Report |

**Adaptive Traffic Management Software**

Adaptive Traffic Management Software (ATMS) would be chosen which implements SCOOT (Split Cycle & Offset Optimization Techniques), CoSiCoSt (Composite Signal Control Strategy) or any other dynamic signal timing plan selection or adaptive system that uses near-real-time detector data. ATC must be chosen to provide accuracy as required for successful functioning of ATMS as per SLAs defined. ATMS software should have a centralized user interface accessible from control room and it should support remote/manual operation of traffic signals from control room. In addition, ATMS software should support selective vehicle (fire engines, ambulances, and VIP vehicles) priority at traffic signals using GPS data.

The controller should provide at least one ethernet interface as per requirement to communicate with ATCS server over TCP/IP.

The controller should provide at least 8 open-collector interfaces for interfacing with traffic detectors.

The ATCS application shall provide selective vehicle priority and compensation to avoid queue build-ups at the other approaches.

The ATCS system shall also be provided with a mobile application to provide congestion and network state information to the citizens using data from the ATCS system.

**Adaptive Traffic Control – Traffic Light Aspects**

**Key Features:**

- Low power consumption for all colours
- Meets or exceeds intensity, colour and uniformity specifications
- Temperature compensated power supplies
- Uniform appearance light diffusing
- ITE products shall be Intertek/ETL/EN/Equivalent certified
- All units operate on AC or DC as the per the suggested solution by MSI

**LED aspects:**

- Red, Amber, Green-Full (300 mm diameter): Hi Flux
- Red, Amber, Green-Arrow (300 mm diameter): Hi Flux

- Red, Green-Pedestrian (300 mm diameter): Hi Flux with mask or Hi-Brite with discrete LEDs with suitable mask/stencil

## 6.3. Intelligent Traffic Management System (ITMS) and City-wide CCTV Surveillance Solution

### 6.3.1. Solution Requirements

MSI shall be responsible for Supply, Installation, Implementation and Operation and Maintenance of Agra CCTV based Surveillance System for a period of five (5) years from the date of Go Live.
The standards should

- at least comply with published eGovernance standards, frameworks, policies and guidelines available on http://egovstandards.gov.in (updated from time-to-time); and
- be of leading industry standards.

### 6.3.2. Public Address system

Public Address system shall be used at intersections, public places, market places or those critical locations as identified by Purchaser to make important announcements for the public.

It shall be able to broadcast messages across all PA systems or specific announcement could be made to a particular location supporting single zone/multi zone operations. The system shall also deliver pre-recorded messages to the loud speakers attached to them from CD/DVD players and pen drives for public announcements.

The system shall contain an IP based amplifier and uses PoE power that could drive the speakers. The system shall also contain the control software that could be used to control/monitor all the components of the system that includes controller, calling station and keypad, amplifier (mixer and booster).

The MSI shall describe in detail the design, operational and physical requirements of the proposed public announcement system to demonstrate compliance with all the specified requirements of RFP.

### 6.3.3. Variable Message Signboards

Variable Message Signboard (VaMS) shall be installed at identified strategic locations. The VaMS shall communicate information and guidance about traffic, diversions, etc. to the citizens/public on the road. They shall also be used for showing emergency/disaster related messages as and when required. The MSI shall describe in detail the design, operational, and physical requirements of the proposed Variable Message Signboards to demonstrate compliance with all the specified requirements in this RFP.

The VaMS unit shall be able to communicate with the Command Control Centre system using GSM Data/SMS Channel. GSM data channel (GPRS)/Ethernet shall be used to send online messages and SMS channel shall be used to send configuration packets to configure the SIM.

Ethernet port shall also be extended to ground level using necessary cables for local troubleshooting. Each unit shall be provided with a unique identification number and shall communicate with the Command Control Centre system.

VaMS shall be managed and operated from the Command Control Centre/City Operations Centre, handled by a server where information in the form of data messages shall be fed in a manner to be displayed on a specific VaMS installed at a particular location or across all locations. The VaMS boards shall be viewable from a distance of 100 m and various angles on the road.

For installing VaMS Signboards, the MSI shall provide gantry with spans, as required at various locations (single lane road, double lane road). Spans need to be specified depending on the number of lanes that need to be bridged. MSI shall consider additional space for lateral clearance as well as a vertical clearance height as per NHAI (National Highway Authority of India) guidelines.

#### 6.3.4.**Emergency Call Box System or Panic Box**

- A high quality digital transceiver, to be placed at certain key locations determined by Agra Police Department.
- Key is to make it easily accessible to the public.
- The unit shall preferably have a single button which when pressed, shall connect to the Integrated Command and Control Centre over the existing network infrastructure setup for CCTV Surveillance system.
- At some locations, this can be also used for public address.
- These shall be installed at select locations such as traffic junctions, smart bus stops, and pedestals or within the vicinity of constant supervision to avoid misuse and vandalism of the call box.

#### 6.3.5.**On site Local Processing Unit with Communication and Electrical Interface**

- System should automatically reset in the event of a program hang up and restart on a button press. The system should start automatically after power failure.
- System should have secure access mechanism for validation of authorised personnel.
- Deletion or addition and transfer of data should only be permitted by authorised users.
- A log of all user activities should be maintained in the system.
- Roles and rights of users should be defined in the system as per the requirements of the client.
- All formats of the stored data with respect to the infractions should be non-proprietary.
- Communication between the on-site outstation processing unit housed in the junction box and the detection systems mounted on the cantilever shall be through appropriate secured technology.
- System should have the capability to transfer the data to CCC through proper encryption in real-time and batch mode for verification of the infraction and processing of challan. Call forwarding architecture shall be followed to avoid any data loss during transfer.
- In the event that the connectivity to CCC is not established due to network/connectivity failures, then all data pertaining to the infraction shall be stored on site and will be transferred once the connectivity is re-established automatically. There shall also be a facility of physical transfer of data on portable device whenever required. There should be a provision to store minimum one week of data at each site on a 24x7 basis.

#### 6.3.6.**Automatic Number Plate Recognition**

MSI shall provide Automatic Number Plate Recognition (ANPR) solution at the identified locations. MSI shall describe in detail, the design, operational and physical requirements of the proposed ANPR system, to demonstrate compliance with all the specified requirements in this RFP.

ANPR cameras shall provide the feed to the command control centre, where the ANPR server shall be located. The ANPR server shall process the image using OCR software for getting the registration number of the vehicle with highest possible accuracy. The system shall be able to detect, normalize, and localize the image of the number plate for detection of alpha numerical characters. System shall be able to identify stolen/ suspected vehicles by cross checking the numbers with vehicle database like Vahaan. ANPR software shall be integrated with video management system.

ANPR system shall provide a user interface with live view of vehicle entry point 24x7, event notification, image captured, number detection and recognition, event reports customized report generation etc.

The analysis of image captured shall be done in real time. Database so created from the images captured and analysis shall store the following:

- Details of vehicle
- Number and time of entries and exits
- License plate numbers
- Validation/Analysis results etc.

#### 6.3.7.**Red Light Violation Detection (RLVD) system**

Red Light Violation Detection (RLVD) system is a system for capturing details of vehicles that have crossed the stop line at the junction while the traffic light is red. System shall be able to automatically detect red light through evidence camera units and other equipment. The information so captured shall be used to issue challans to the violators.

MSI shall describe in detail, the design, operational and physical requirements of the proposed Red Light Violation Detection system, to demonstrate compliance with all the specified requirements mentioned in this RFP.

RLVD solution shall have an overview camera to capture the zoomed out picture of the entire area when there is a red light violation. Light sensors shall be placed to detect the change in traffic light. Once the traffic light has turned red, the sensors shall activate the camera to capture images of the vehicles that jumped the traffic light.

RLVD system, in case of an offence detected, shall capture details such as site name, location details, lane number, date and time, registration number of car, and type of offence on the image itself. The system shall also be able to generate number of reports for analysis such as the traffic light with maximum offenders, peak time of traffic offence and other reports in discussion and as per the customization requirement of the ASCL.

#### 6.3.8.**E Challan System**

The objective of E Challan application is as follows:

- Issuing challan for traffic violations to a traffic violation defenders.
- Maintaining details pertaining to all activities of traffic circles/violations/violators.
- Providing requisite structured/unstructured information to traffic management officials as and when required.
- Generating various statutory reports for administrative use and functioning of traffic unit in matters of prosecution of violators and monitoring functioning of field officers.
- Integrating and networking the system with state-of-the-art hardware and application software for traffic police to access and use information in their day-to-day work.
- E Challan System should allow for spot payment of fines using handheld terminal.

#### 6.3.8.1. Functional Requirements of E Challan System

- E challan software shall work in client-server mode, where the handheld (HH) devices units, workstation units will act as clients connected to the server through cellular network for data transfer.
- E challan system shall be able to retrieve vehicle owner details and vehicle data from RTO data base to minimise data entry.
- E challan system shall be able to retrieve vehicle registration details and driving license details by reading appropriate smart card to minimize data entry.
- Server should maintain log of all current devices. Any access to the system must be recorded along with date, time, user ID and IP address.
- Traffic officer should log in to the handheld device through the unique user ID and password or smart card issued for the purpose.
- A unique challan number should be generated through client software for each challan.
- As soon as a vehicle registration number is entered, the handheld device should automatically check from the server if the vehicle is stolen, wanted in any criminal case or is in the list of suspicious vehicles.
- The most frequent traffic offences should be kept at the top in the drop down menu and offence ingredients should be available if required by an officer.
- Date, time and GPS coordinates of place of challan should be automatically populated in the relevant fields of client software.
- Compounding amount must populate in the field automatically from master table.
- MSI should develop GUI and functionality as per requirements of traffic police.
- GUI should be multi-lingual i.e., English and Hindi.
- It should be possible to integrate as an enhancement when required for payment gate way operator with the system for facilitation of payment.
- Application Software should work in a web-based environment.
- Application software should be user friendly, easy to operate.
- Software must provide comprehensive data back-up and restoration capability.
- System will function in web-based system where the handheld device shall work as a node.
- Application software should maintain logs of user activities to facilitate audit trail.
- System should have sufficient security features such as firewall, access control system, biometrics,

password protection, audit trail, anti-virus etc.

- Database server should be able to handle the activities of all the handheld devices at one time simultaneously with huge database size of prosecution, ownerships, driving license, etc. without affecting the performance.
- Software should be able to generate various periodical reports, summaries, MIS reports, query reply, etc. as per the requirements of traffic police.
- Administrator should be able to modify the master tables as and when required and should have the capability to push the changes to handheld devices.
- All database tables, records etc., required for various dropdown menus etc., shall also be created by the vendor.
- Application software is to be provided by the vendor to handle various processes of the prosecution required by the office of senior police officers, courts, etc.
- MSI to ensure that e challan system is able to integrate through available APIs with third-party applications which are available by Government of UP and follow guidelines of MORTH (Ministry of Road Transport and Highway).

#### 6.3.8.2. **Handheld Devices**

- Once the application is loaded on the handheld device there should be no possibility to modify the application by the user. Reloading and modifying of application should be possible only by an administrator.
- On switching on the handheld device, the system must give access only after validation through user ID and password.
- The communication between the server and handheld device would be through GSM/GPRS/ 3G or better connectivity etc.
- Every challan created must have a unique self-populated number.
- HH application must be able to access information from the main server and display upon request, pop- up tables/codes, vehicle and license details, all types of offences, compounding amount, challan types, vehicle details, court calendar etc., to minimize the typing by the prosecuting officer.
- HH device should be able to access data/information on the basis of driving license number, vehicle registration number etc. from the main server data relating to previous offences.
- HH application software should also suggest date of challan, place of challan, name of the court and court date, etc., to further reduce typing by the officer. These fields should be designed in consultation with traffic police.
- When a challan is issued, the name and ID of the officer should be printed on the challan.
- HH device must be able to input and print multiple offences on the same challan.
- HH software must validate challan fields automatically before the challan is printed. The system must ensure that certain fields are properly completed before allowing the challan to be printed.
- When downloading application software or pop-up tables or lists to the HH, or uploading challan records to the server, synchronization of HH system must be automatic, to minimize human intervention.
- Uploading data to the database server should be automatic in consistent manner.
- Application should provide features wherein when a driving license/vehicle registration number is entered, it should be able to pull from the server all the details relating to the driving license

holder/vehicle owner including history of previous offences.

- Software should capture the list of documents seized during prosecution and such list must be reflected on the printed court challan.
- HH application software shall allow the user to generate a summary report to facilitate evaluation of his daily work.
- Once the challan is complete and saved any further editing should not be possible unless so authorized by administrator.
- Each hand-held device should be provided with original printed user manual and appropriate carry case for HH device with charger.
- Application software should allow online payment and direct payment at HH device.
- There should be automatic rejection of payment for the settlement of expired notices or challans. Partial payment of an offence must not be accepted by the system.
- Software should update driving license/vehicle registration smart card of the violator with the booked offence.
- Mobile swiping of credit and debit cards should be possible, and violator can enter the PIN number on the HH device keypad securely.

#### 6.3.9.**Face Recognition System**

Face Recognition System (FRS) shall be designed for identifying or verifying a person from various kinds of photo inputs from digital image file to video source. The system shall offer logical algorithms and user-friendly, simple graphical user interface making it easy to perform the facial matching.

The system shall be able to broadly match a suspect/criminal photograph with database created using photograph images available with Passport, CCTNS, and Prisons, State or National Automated Fingerprint Identification System or any other image database available with police/other entity.

The FRS algorithm/engine should have appeared in top 10 listing of latest NIST benchmark test.

The system shall be able to:

- Capture face images from CCTV feed and generate alerts if a blacklist match is found.
- Search photographs from the database matching suspect/people features.
- Match suspected criminal face from pre-recorded video feeds obtained from CCTVs deployed in various critical identified locations, or with the video feeds received from private or other public organization's video feeds.
- Add photographs obtained from newspapers, raids, sent by people, sketches etc. to the criminal's repository tagged for sex, age etc. for future searches.
- Investigate to check the identity of individuals upon receiving such requests from police stations.
- Enable handheld mobile with app to capture a face on the field and get the matching result from the backend server.

The facial recognition system shall be enabled at cameras identified by the Purchaser.

Functional requirement:

- The facial recognition system should be able to integrate with IP Video Cameras as required in the solution and shall be able to identify multiple persons of interest in real-time, through leading-edge face recognition technology. The system shall be able to recognize subjects appearing simultaneously in multiple live video streams retrieved from IP surveillance cameras. The facial recognition system should seamlessly be integrated to the network video recorders or the video management system.
- The facial recognition system should be able to work on the server/desktop OS as recommended by OEM and provided by the System Integrator.
- The user interface of the facial recognition system should have a report management tool without installation of any additional client software. It should be able to generate real time report such as Audit Log Report, Hit List Report, Daily Statistics Report, and Distribution Report.
- The facial recognition system should be accessible from 5 different desktop/laptops at any given time. When choosing a distributed architecture, the system shall be able to completely centralize the events and galleries from each local station into a unique central station, devoted to management and supervision.
- The system should have ability to handle initial real-time watch list of 100,000 faces (should be scalable to at least 1 million faces) and 50 camera feeds simultaneously and generate face matching alerts.
- The algorithm for facial recognition or the forensic tool should be able to recognize partial faces with varying angles.
- The system should be able to detect multiple faces from live single video feed.
- The system should have combination of eye-zone extraction and facial recognition.
- The system should have short processing time and high recognition rate.
- The system should be able to recognize faces regardless of vantage point and any facial accessories/hair (glasses, beard, expressions).
- Face detection algorithms, modes and search depths should be suitable for different environments such as fast detection, high accuracy etc. The FRS system shall use of GPU technology instead of traditional CPUs, to greatly improve the computational performance in crowded environments.
- The system should be able to identify and authenticate based on individual facial features.
- The system should be compatible with the video management system being proposed by the System Integrator.
- The system should have capability for 1:1 verification and 1:N identification matching.
- The system should be able to integrate with other systems in the future such as 'Automatic Fingerprint Identification System (AFIS)' etc.
- The system should be able to support diverse industry standard graphic and video formats as well as live cameras.
- The system should be able to match faces from recorded media.
- The system should be able to detect a face from a group photo.
- The system should be able to detect a face from stored videos of any format.
- The system should have bulk process of adding faces in the system.
- The system should be an independent system, with capability to integrate with industry standard Video Management Systems (VMS) for alert viewing.
- The system should allow users to search or browse captured faces (based on date or time range), export any captured image for external use with a capability to support a handheld mobile with app

for Windows OS or Android OS to capture a face on the field and get the matching result from the backend server.

- The proposed solution should provide the ability to assign different security levels to people and places. It should alert security staff when someone is spotted in an area where they are not permitted, whilst allowing them free access to non-restricted/public areas.
- The system should have the facility to categorize the images like "Remember this person" or "hit-list" or "wanted".
- The OEM should have a support facility in India.

### 6.3.10. **No Helmet Detection System**

- System shall have capability to capture image of two wheeler riders not wearing helmet and shall have automatic number plate recognition (ANPR) of violating vehicle with auto-localization and OCR conversion.
- On detection of No-Helmet system shall generate events, store them, and shall allow retrieval of such events on need basis for later analysis.
- System shall have capability to identify and eliminate riders covering their face using scarf and mark them as invalid.
- System shall integrate with challan generation software and RTO database to generate challans for No-Helmet violation event with details like violation image, time stamp, date, vehicle number.
- No-Helmet detection system shall seamlessly integrate with traffic management systems like ANPR, RLVD, Speed Detection and shall have unified user interface.
- System shall make available event reports such as number of detections per day, list of repeat offenders, etc. for further analysis by traffic department.
- Proposed system shall support single server architecture or distributed network architecture with possibility of cloud based deployment in future.
- System shall have dedicated camera units for no-helmet detection in field of view of that camera unit to be installed at identified locations within city limits. Such cameras shall be independent of existing city surveillance and traffic violation detection cameras.
- System shall use high computing unit to analyze huge amount of visual data from multiple cameras efficiently and accurately for automatic detection of riders without helmet.

### 6.3.11. **Operating Conditions**

- **Reliability:** Proposed equipment must be designed to cater for 24x7 round-the-clock operations.
- **Maintainability:** MSI shall maintain the uptime for entire system as mentioned in SLA. This uptime is exclusive of regular maintenance. The minimum down-time for all the components, factors such as ease of replacement, mean-time-to-repair (MTTR) shall be incorporated in the system design.
- **User-friendly:** System server should be based Linux or Unix OS. At the same time, administrative and dispatch console should be world-wide-web based, the multi-channel PTT SW client should operate on Windows XP/Vista/7/8/10 operating systems. Server system can be based on Windows/Linux/Unix OS.
- **Security:** System should be fully secured so that system can’t be hacked or compromised by anybody in any circumstances.
- **Upgradeability:** each part of the system produced should be modular and easily re-configurable and

upgradeable. System should be based on an open system concept.

- **Electromagnetic compatibility:** IP interoperability and collaboration system shall be able to operate without any complication due to any electromagnetic interference exists in or between sub-systems. At expiry of contract, for smooth handing over/transfer of the system, all system with detailed diagrams and drawings (software, hardware, connectivity, control room, field equipment, components and subcomponents, etc., used in the project) shall be fully functional.
- **Scalability:** Network and bandwidth capacity should be expandable. Hardware, software for control room shall be expandable.

### 6.3.12. Mobile Enforcement Solution for Police

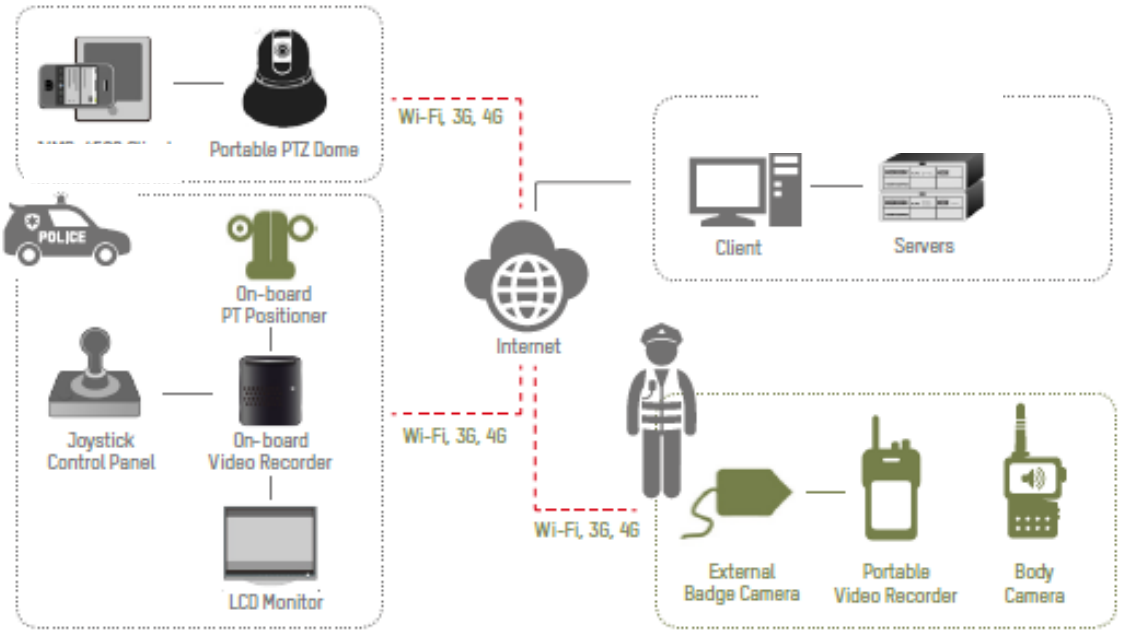
Public security and law enforcement personnel have to be in the right place, at the right time, every time. Your communication devices have to be completely mobile, as well as rugged and reliable. Permanently installed surveillance systems are great, but it can be limited in scope. In the real world, surveillance systems need to be completely mobile, too. When you need surveillance equipment and support to go where you go.

#### 6.3.12.1. Police Vehicles

Packed with gear for emergency response vehicles, temporary security installations, wearable tech, and more, Smart Mobile Enforcement arms you for every situation. Keep personnel accountable, track events for forensics, and safely secure data for smart analysis.

Extreme weather can cause major traffic disasters. Peaceful public demonstrations can turn into unlawful events. Earthquakes, floods, and lightning storms can interrupt power and water supplies. The unpredictability of these incidents requires civic authority personnel to be mobile, nimble, and always ready to go. And the equipment has to be just as mobile, too. Turn enforcement vehicles into temporary mobile monitoring stations and move your gear to where it's most needed with our on-board systems.

In Uttar Pradesh, there is an existing robust infrastructure for UP Dial 100 meant 'to take prompt action in a fixed minimum time limit by sharing the information received through phone calls with the concerned police station/police post of concerned district and other officers.' The intent of the project is to use the existing infrastructure of UP Dial 100, and make technology up gradations for the 48 vehicles in the city of Agra which shall even have supporting peripherals of smartphones, tablets which complement the E Challan System along with breath analyzer to detect the defaulters for enforcing stringent actions.




### 6.3.12.2. **Temporary Monitoring**

When permanent surveillance installations are not possible, mobile enforcement solutions have to fill in the gap. On the roads, at the public squares, in rural areas – wherever you need surveillance equipment to go. Tripod-mounted dome cameras, for example, reliably capture everything in view.

### 6.3.12.3. **Wearable Monitoring**

Rugged, wearable body cameras record activities of citizens and civil authorities as they happen. Their advanced technology, portability, and ease-of-use make them extremely effective companions for law enforcement. Equipped with GPS locators, you'll know where the emergency exists as it happens. These cameras build forensic evidence with safely stored data, and play back video footage clearly and accurately. Protect people and peacekeepers with wearable video recording devices.

### 6.3.12.4. **Modern Infra and Peripherals**

Considering the need of immediate response system for police to detect and identify the event, with the upcoming technology advancement, it requires a basic infra in terms of OFC to have all the major police

stations and chowkis connected in a mesh for faster resolution of event. This should be accompany with basic peripherals like smartphones, tablets, high-end computers, and screens for local monitoring the visuals.

### 6.3.13. CCTV Surveillance Cameras – Functional Specification

#### 6.3.13.1. Surveillance System Infrastructure at Field Locations

This component covers planning and implementation of the surveillance system comprising cameras and other field equipment at identified locations. Actual placement of poles and number of cameras at each location, type of cameras, fixation of height, and angle for the cameras to ensure maximum coverage shall be done in consultation with Agra Police Department.

| Category | Scope of Work |
|---|---|
| **Surveillance System Infrastructure at Field Locations** | Supply, install, implement and maintain:<br>▪ Full HD IP Pan–Tilt–Zoom (PTZ) Camera<br>▪ Full HD IP Fixed Box Camera for ANPR/ RLVD<br>▪ Face Recognition Camera<br>▪ Pole, Junction Box, LPU, UPS, LAN Switch, Passive Items, etc. |
| | Other Components:<br>▪ Public Address System<br>▪ Variable Messaging System<br>▪ Panic/Emergency Button |
| **Surveillance System Application** | ▪ Video Management System (VMS)<br>▪ Video Analytics (VA)<br>▪ Red Light Violation Detection (RLVD) System<br>▪ Automatic Number Plate Recognition (ANPR) System<br>▪ No -Helmet Detection<br>▪ Wrong Lane Intrusion Detection<br>▪ E Challan System with Payment integration |

A detailed survey shall be conducted, by the MSI along with a team of ASCL and Agra Police, at each of the strategic locations. This survey shall finalize the position of all field equipment and the orientation/field of view of the cameras. Appropriate field of view snapshot shall be taken by a handheld camera for future reference at the time of survey. The surveyors shall also finalize the approximate location of foundation for junction box and camera poles.

The route for all the underground cable laying shall be finalized during this survey (wherever required). Every detail, finalized during the survey, shall be demarcated on an AutoCAD drawing by the SI and submitted to the Purchaser in the form of a detailed site survey report along with other details for its approval.

System shall provide inter-operability of hardware, operating system, software, networking, printing, database connectivity, reporting, and communication protocols. SI shall prepare the detailed report for field level requirements e.g. cameras (types and numbers), camera mounting requirements, power requirements, Connectivity requirements etc., for perusal of the Purchaser. Indicative list of the field level hardware to be provided by SI is as follows:

- Cameras (Fixed Box Cameras, PTZ Cameras, ANPR Cameras etc.)
- IR Illuminators
- Local processing unit for ANPR/RLVD Cameras
- Switches
- Outdoor Cabinets
- Pole for Cameras/Mast
- Junction Box
- UPS

#### 6.3.13.2. Networking and Power Cables and Other Related Infrastructure

The indicative list of locations for the camera installation is mentioned in Annexure in the RFP document along with minimum technical requirements of associated hardware to implement a complete Surveillance system.

#### 6.3.13.3. Supply and Installation of CCTV Surveillance Infrastructure

Based on detailed field survey as mentioned above, MSI shall be required to supply, install and commission the surveillance system at the identified locations and thereafter undertake necessary work towards its testing.

MSI shall use industry leading practices during the implementation phase w.r.t positioning and mounting the cameras, poles and junction boxes. Some of the check points that need to be adhered to by the MSI while installing/commissioning cameras are as follows:

- Ensure surveillance objective is met while positioning the camera such that the required field of view is being captured as finalized in field survey.
- Ensure camera is protected from the on-field challenges of weather, physical damage, and theft.
- Make proper adjustments to have the best possible image/video captured.
- Ensure that the pole is well placed for vibration resistance adhering to the road safety norms.
- Collusion preventive barriers around the junction box and pole foundation in case it's installed in a collision-prone place.
- Appropriate branding or colour coding (Police/Purchaser branding) of poles and junction boxes, to warn mischief mongers against tampering with the equipment at the junction.

#### 6.3.13.4. Installation of Poles/Cantilevers/Gantry

- MSI shall ensure that all installations are done as per satisfaction of the Purchaser.
- For installation of variable message system (VaMS), CCTV cameras, PTZ cameras, public address system, etc. MSI shall provide appropriate poles and cantilevers and any supporting equipment.
- MSI shall be required to supply, install, configure, and integrate surveillance cameras at the identified locations and thereafter undertake necessary work towards their commissioning.
- MSI shall ensure that the poles erected to mount cameras are good, both qualitatively and aesthetically.
- MSI shall use the industry leading practices while positioning and mounting the cameras and ensure that the pole/mast implementation is vibration resistant. Arrangements for bird scare spikes on top of camera shall be made to prevent birds from sitting on top of camera box.
- The poles shall be installed with base plate, pole door, pole distributor block and cover.

- Base frames and screws shall be delivered along with poles and installed by the MSI.
- In case the cameras need to be installed beside or above the signal heads, suitable stainless steel extensions for poles need to be provided and installed by the MSI so that there is clear line of sight.
- MSI shall be responsible to undertake required structural analysis regarding the regulated load conditions and considering the respective wind load while installing the poles/cantilevers for variable messaging sign boards.
- MSI shall provide structural calculations and drawings for the approval of the Purchaser. The design shall match with common design standards as applicable under the jurisdiction of purchaser/authorized entity.
- MSI shall coordinate with concerned authorities/municipalities for installation.
- Poles and cabinet shall be so designed that all elements of the field equipment could be easily installed and removed.
- MSI shall ensure that physical look of the installation area returns to neat and tidy conditions after installation of poles, cantilevers etc. The placement shall be designed keeping in mind the normal flow of vehicular traffic and pedestrian movement is not disturbed.

#### 6.3.13.5. **UPS for Field Locations**

- UPS shall serve as a backup for commercially available utility power at the intersections and shall ensure no-break functioning of all field components at each intersection in event of failure of utility power supply.
- MSI shall carry out a study and identify locations to provide UPS backup, depending upon power situation across city, to meet the camera uptime requirements.
- MSI shall install UPS at the identified intersections in secure, tamper-proof housing in corrosion resistant cabinets.
- MSI shall ensure that the UPS is suitably protected against storms, power surges and lightning.
- MSI shall provide UPS for efficient heat dissipation without air conditioning. It shall be able to withstand temperatures prevalent in Agra throughout the year.

#### *6.3.13.6.* **Outdoor Cabinets/Junction Boxes**

- Each intersection shall be fitted with outdoor cabinets dimensioned to host all equipment necessary to operate enforcement systems and traffic surveillance systems as defined in this RFP.
- MSI shall reserve additional room in the intersection controller cabinet to accommodate the future system requirements
- The size of outdoor cabinet/junction boxes shall be sufficient to house all the system components, which may be installed at the intersection or nearby. Boxes shall be dustproof and impermeable to splash-water. They shall be suitable for Agra ’s environmental conditions. They shall have separate lockable doors for:
    - Power Cabinet: This cabinet shall house the electricity meter, online UPS system, and the redundant power supply system.
    - Control Cabinet: This cabinet shall house the controllers for all the field components at that particular location e.g. ANPR, PTZ, RLVD, fixed cameras etc.
- Internal cabinet cabling shall be designed for an easy connection and disconnection of the equipment and power.

- The cabinets shall be of robust construction and shall include 3-point security-locking mechanisms to prevent unauthorized access to the field equipment.
- Temperature and Humidity Control: All enclosure compartments shall be equipped with a natural convection air circulation system via provision of air circulation filters, that shall not require maintenance and shall allow free circulation of air inside the enclosures to prevent overheating as well as the build-up and effects of humidity and heat, without permitting the entry of elements that might endanger system operation.
- MSI shall ensure that all the hardware is placed inside the junction boxes that can withstand temperatures prevalent in Agra city throughout the year.

#### 6.3.13.7. Civil and Electrical Works

MSI shall be responsible for carrying out all the civil work required for setting up all the field components of the system including:

- Preparation of concrete foundation for MS poles and cantilevers.
- Laying of GI Pipes (B Class) complete with GI fitting.
- Hard soil deep digging and backfilling after cabling.
- Soft soil deep digging and backfilling after cabling.
- Chambers with metal cover at every junction box, pole and at road crossings.
- Concrete foundation from the ground for outdoor racks.
- MSI shall provide electricity to the cameras through the aggregation point. Since this component has dependency on approval from local authorities, it is recommended that SI plans this requirement well in advance and submits the application to the concerned electricity distribution agency with requisite fees, if applicable.

MSI shall carry out all the electrical work required for powering all the components of the system

- Electrical installation and wiring shall conform to the electrical codes of India.
- MSI shall make provisions for providing electricity to the cameras (ANPR, PTZ, and Fixed) via SJB (Surveillance Junction Box), housing the UPS/SMPS power supply, with minimum backup as defined in this RFP.
- For the wired box cameras, MSI shall provision for drawing power through PoE (Power over Ethernet), while PTZ cameras shall be powered through dedicated power cable laid separately along with STP/SFTP cable.
- Registration of electrical connections at all field sites shall be done in the name of ASCL as agreed and finalized in the contract agreement.
- MSI shall house the electricity meters inside the power cabinet as mentioned in the controller cabinet section as above.

#### 6.3.13.8. Earthing and Lightning Proof Measures

- MSI shall comply with the technical specifications taking into account lightning-proof and anti-interference measures for system structure, equipment type selection, equipment earthing, power and signal cable laying. MSI shall describe the planned lightning-proof and anti-interference measures in their technical bid.
- Corresponding lightning arrester shall be erected for the entrance cables of power line, video line, data transmission cables.

- All interface board and function board, interfaces of equipment shall adopt high-speed photoelectric isolation to reduce the damage to integrated circuit CMOS chip due to the surge suppression.
- Install the earthing devices for the equipment, including lightning earthing, protection earthing and shielded earthing. All earthing shall meet the related industry standards.
- The earthing cable shall be installed in a secure manner to prevent theft and shall be rust proof. Earthing down lead and the earthing electrode shall be galvanized.

#### 6.3.13.9. **Miscellaneous**

- ASCL shall assist in obtaining all necessary go ahead, legal permissions, NOC (No Objection Certificate) from various departments to execute the project. MSI shall have to identify and obtain necessary legal/statutory clearances for erecting the poles and installing cameras, for provisioning of the required power, etc. MSI shall provide and mange all necessary paper work to pursue permission from respective authorities. No commercial/legal fees shall be applicable to ASCL for obtaining the necessary permissions. These shall be provisioned for by MSI in their financial bid.
- The MSI shall provide all material required for mounting of components such as cameras, VaMS and other field equipment. All mounting devices for installation of CCTV cameras to enable pan and tilt capabilities shall be included in the costs of the respective component. The same is also applicable to crossheads and cross arms, mounting brackets, stainless steel bands, screws, and other accessories.
- All the equipment, software and workmanship that form a part of the service are to be under warranty throughout the term of the service contract from the date of service acceptance and commencement. The warranty shall require the SI to be responsible to bear all cost of parts, labor, field service, pick-up and delivery related to repairs, corrections during the Project Period, or any and all such incidental expenses incurred during the warranty period.
- MSI shall also get comprehensive insurance from reputed insurance company for the project duration for all the equipment/components installed under this project.
- MSI shall ensure all the equipment's installed in the outdoor locations are vandal proof and in case the equipment get damaged/stolen for reasons whatsoever, it shall repair/replace the same in the specified time as per SLAs at no extra cost to the Purchaser. All such costs shall be factored in the comprehensive insurance of field equipment for the duration of the contract.
- Preventive maintenance shall be carried out once in a quarter along with corrective maintenance and when calls are placed by ASCL or its designated agency.
- MSI shall be responsible for operations and maintenance of all the supplied and installed equipment's during the entire O&M phase.
- In addition to above, MSI shall be fully responsible for all maintenance activities for the period between installation of equipment and roll out of the system.
- During implementation, if observed that any camera/field equipment requires change in the field of view/orientation, it shall be done by SI without any extra cost.
- In case of request for change in location of field equipment post installation, the same shall be borne by the Purchaser at either a unit rate as per commercials or a mutually agreed cost.

#### 6.3.13.10. **Mounting Structure**

- Should be cantilever mounted and shall have minimum 6 m height with appropriate vertical clearance under the system from the road surface to ensure no obstruction to vehicular traffic.

- Should be capable to withstand high wind speeds and for structural safety, the successful bidder has to provide structural safety certificate from qualified structural engineers approved/certified by Govt. Agency.
- Shall be painted with one coat of primer and two coats of PU paint. The equipment including poles, mountings should have an aesthetic feel keeping in mind the standards road Infrastructure (e.g. poles, navigation boards, etc.) currently installed at these locations. The equipment should look "one" with the surroundings of the location and not look out of place.
- Rugged locking mechanism should be provided for onsite enclosures and cabinets.

## 6.4. ICT Enabled Solid Waste Management Solution

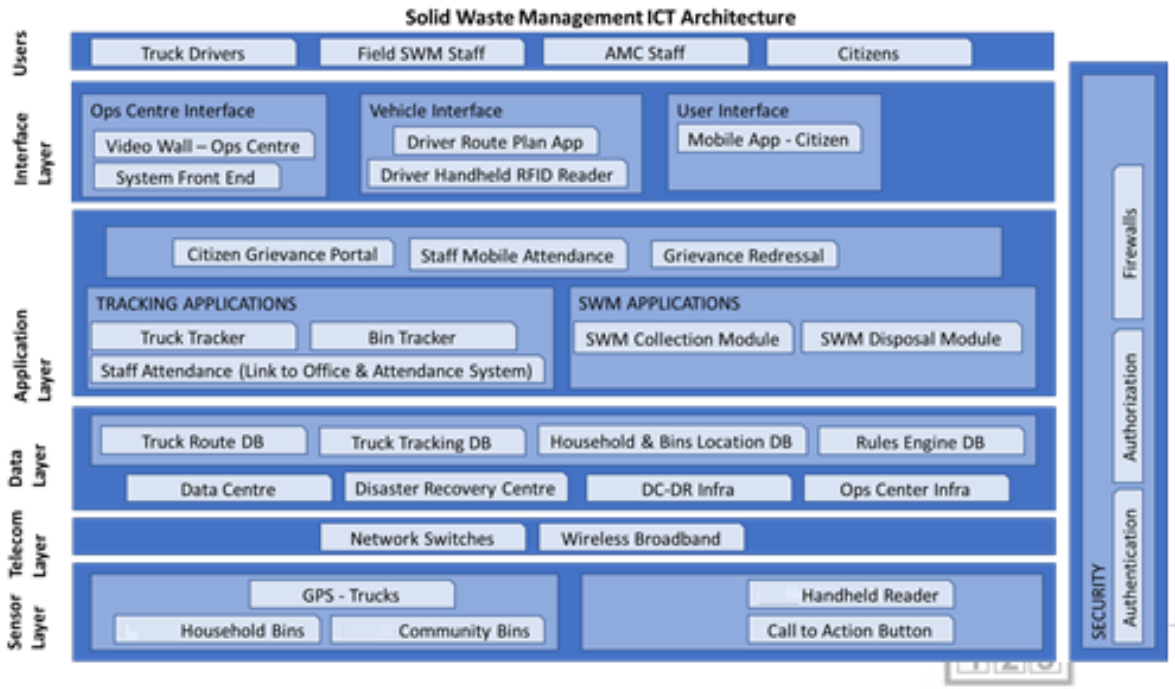
### 6.4.1. Scope of Work

Solution should use latest GPS, RFID Tag/QR Code, Biometric system and sensor based technology for real-time tracking and monitoring of operational vehicles at garbage collection process throughout the city. It should enable ease and transparency in operation of collection municipal solid waste.

Provide end-to-end ICT solutions to implement and provide support services and maintenance.

- Implementation of "Door-to-door Collection Monitoring System".
  - Supply and installation RFID tags/QR Code and GPRS Based RFID readers/smart phones.
  - Design and integrate Door-to-door Tracking and Monitoring System.
  - Registration of each household/floor/commercial establishment for master data.
- MSI should provide Automatic Vehicle Locator solution to vehicles to track the complete traverse path round the clock with any state of movement or non-movement.
- MSI should provide GPS and pictorial based attendance management system to the staff.
- MSI should install surveillance cameras at bulk waste generation/collection points.
- MSI shall provide an MIS system, which shall be capable of recording details of daily waste collection, waste processed and waste disposed in terms of tonnage. Solution shall be automated with a computerized weigh bridge. Data from the weigh bridge shall be transmitted online to OCC.
- Integrating data feed from waste disposal site (data feed access would be provided by BSCL/BMC) like feeds from CCTV camera and data from weigh bridge.
- Sizing of hardware, software, and network devices required in DC/DR for using the Integrated SWM.
- Supply and installation of hardware (servers), software, and network devices required in DC/DR for using the Integrated SWM.
- Design, Development, supply, and deployment and implementation of web-based application software integrated with GPS, RFID devices, QR codes and Vehicle Tracking Management System (VTMS) and complaint management modules.
- Mobile apps for both Android and iOS for citizens for complaint and Door-to-door Solutions and also integrated with Meragra Citizen App or other available SWM Solution.
- Maintenance of RFID devices and other provided hardware and after warranty period including the replacement of devices in case of damage, new vehicle or any other change.
- Maintenance of web based application/mobile apps for Integrated SWM, during and after warranty for a period of 5 years.
- Real time management of missed garbage transfer
- Daily report of door-to-door collection efficiency combined with complaints raised by public.

- Monitoring and Reporting Application – reports of vehicles, garbage collection status, bin status etc.
- Provide resources for support, maintenance, and administration of the system.
- Integration of ISWM with City Operation Command Centre
- Provide training to ASCL resources for operating the SWM system.




### 6.4.2. Mandatory H/W for Real-time Monitoring of Solid Waste Collection Process

- All garbage collecting and transferring vehicles need to be fitted with GPS devices and RFID reader/QR code reader/smartphones and GPS device must be capable of accepting the data from such readers and transfer on commend centre/servers.
- All the vehicles will also be fitted with RFID tag/QR code as well.
- RFID tags/QR code tags on door-to-door collection points/bins and on commercial establishments.
- All community bins/container bins need to be fitted with level sensors and communication modules for data transfer.
- RFID readers at strategic locations such as key entry/exit points, parking areas, waste transfer stations, regional/zonal offices, Weigh bridges, dump sites and waste recycling plants.
- Automated weighing scales needs to be fitted and integrated with RFID readers.
- Biometric attendance devices have to be given to supervisor staff.
- Premise GPRS based biometric attendance devices needs to be fitted at office location.
- All STP and road sweeping vehicles should have GPS device fitted into it.
- Central control centre should have facility of audio- discussion and display unit.

### 6.4.3. Functional Specifications

#### 6.4.3.1. Automated Vehicle Tracking Management System

- GPS tracking of waste pick up vehicle for real-time tracking.
- System should help in coordination between primary and secondary collection vehicles for transferring dump.
- Route optimization will help in reduction of trip time, fuel saving, and serving more locations.
- System should ensure that complete coverage of door-to-door and community collections served by vehicles.
- Record history of vehicle routes, attended sites, and other details.
- Monitoring and Reporting Application – reports of vehicles.
- Alert/Alarm management for ignition/over speeding/power cut and tempering
- Solution should be integrated into the GIS map

#### 6.4.3.2. Mobile GPS Based Staff Attendance Management System

GPS based device like smartphone or any handheld terminal having biometric capture function shall enable AMC's field staff to register their attendance/presence throughout the day. System shall periodically track location (with time stamping) of staff through their GPS based mobile device and shall map it in the system with pre-defined area coordinates. Device shall feed data through GPRS/GSM network to the city operation command centre central application for reporting generation and alerts. The system should provide:

- Mobile device/Smartphones to staff who are doing activities like door-door collection via pushcarts/tricycle/street sweeping.
- Provide ability to the staff to update job completion reports along with pictures.
- Pictures should be stored on historical mode in the GIS Map for a period of 1 month.
- Solution should be integrated into the GIS map.
- Solution should be able to mark route attended by staff along with allocated route.

#### 6.4.3.3. Mobile Application for Customers

MSI should integrate with Meragra Application or other available solid waste management solution to be provided to the citizens/public, which will help them raise complaints for the following:

- Garbage piles on the roads.
- Missed garbage collection at residential, commercial, industrial, and other areas.
- Crowd sourcing application for compliant registration and grievances.
- Request for garbage collection.
- Other issues like street Wweeping and blocked nala/nali etc.

#### 6.4.3.4. Unified Dashboard View for Solid Waste Management

- A unified view should show the primary and secondary collection.
- Included all vehicles tracked via AVL or Mobile based.
- Collection percentage achieved daily – co-relating with the final dumping process.
- Co-relation with the complaints raised/area, along with photographic evidence.

- System should be capable of providing missed collection.
- System should be capable of marking areas where waste is generated or high to low basis.
- System should be capable of showing only a single selected process for a particular area.
- System should be capable of showing complaints raised by citizen tagged to a particular location.
- System should be capable of showing CCTV footages from bulk waste generation points and inside the waste treatment plant on the GIS map.
- Unified view should be capable of being integrated with other departments.
- Unified view goal will be to improve waste collection efficiency using the field infrastructure deployed.
- Any other reports aiding to perform the same shall be in scope of MSI.

#### 6.4.3.5. Infrastructure Solution – Field Devices

MSI shall be responsible for the supply, installation and commissioning of the following field equipment as per technical specifications mentioned in the RFP document:

- GPS Tracking System with all fittings and fixtures in all vehicles.
- GPS Based Mobile Attendance Aanagement.
- CCTV Cameras at Waste Processing Site and at Bulk Waste Generation Points.
- RFID Tags/QR Code at households /RFID Tags/QR Code on collection vehicles.
- Automated Weigh Bridge.

| Sr. No. | Type of Vehicle/ Staff | Field Devices |
|---|---|---|
| 1 | Auto Tipper (Primary Collection) | GPS Tracking System |
| 2 | Push Carts + Tricycle (Primary Collection) | Tracking via GPS Based Attendance System |
| 3 | Twin Dumpers (Secondary Collection) | GPS Tracking System |
| 4 | Tipper (Secondary Collection) | GPS Tracking System |
| 5 | Tractor (Secondary Collection) | GPS Tracking System |
| 6 | Field Staff – Collecting Waste | Tracking via GPS Based Attendance System |
| 7 | Field Staff Sweeping Roads | Tracking via GPS Based Attendance System |

The solution should have below mentioned indicative functional requirements.

| Common Functional Requirements |
|---|
| **Dashboard:** |
| Dashboard Module should give a quick and easy view to know overall fleet status on real-time basis. It should display status information of all vehicles i.e., Running, Idle or Standby. Dashboard view should provide following information:<br>• For each department, separate authentication based vehicle tracking module. |

<table>
<tr><td colspan="2">
<ul>
<li>Within department section, there shall be an aggregated view of all department specific vehicles, its location, movement and other real-time details shall be available.</li>
<li>There should be a facility to club area specific and category specific vehicles in groups.</li>
<li>Zone name, ward name, vehicle number, vehicle type, current location and last updated date and time of each vehicle.</li>
<li>It should give alert message if GPS device gets disconnected from a vehicle.</li>
<li>Dashboard should have search parameter where different searches i.e., vehicle number wise, zone and ward wise, running/idle/standby vehicle wise and “no communication” wise searches can be done.</li>
<li>Running km and Idle km related parameters also required on daily basis.</li>
<li>It should also give an indication regarding running speed of vehicle i.e., Normal speed, Alarming speed and above Alarming speed.</li>
<li>There should be a provision to see route followed by a vehicle on a GIS map.</li>
</ul>
</td></tr>
<tr><td colspan="2">Map Based Analysis:</td></tr>
<tr><td>Integration with:<ul><li>GIS</li><li>Vehicle Tracking System</li></ul></td><td>Functionality:<ul><li>Creating buffers along emergency site and working site.</li><li>Creating and sending alerts in case SUB’s reach particular level for vehicle movement, which can be shown on the map.</li></ul></td></tr>
<tr><td colspan="2">Functional Requirements – SWM</td></tr>
<tr><td colspan="2">Area Details:</td></tr>
<tr><td colspan="2">
<ul>
<li>Area information (Zone/Ward/Colony/Society)</li>
<li>Population Details</li>
<li>Volume of Solid Waste which Includes Wet and Dry Waste (recycled and non-recycled)</li>
<li>Resources Required</li>
<li>Collection Procedure (i.e., Primary: House to House and Secondary: Community Bin to Garbage Transport Centre or Mix)</li>
</ul>
</td></tr>
<tr><td colspan="2">Garbage Collection Scheduling:</td></tr>
<tr><td>Integration with:<ul><li>GIS</li><li>Vehicle Tracking System</li></ul></td><td>Functionality:<ul><li>Assign SWM Vehicles to pick-up garbage. Category wise assignment like A: Highly in demand, B: Medium, C: Low Demand.</li><li>Assignment of dynamic routes using vehicle initial route and bins attended.</li><li>Location-wise assignment of sanitation staff.</li><li>Scheduling of garbage collection and cleaning activities with the objective of maximizing citizen friendliness and optimum use of resources.</li></ul></td></tr>
<tr><td colspan="2">Primary Garbage Collection and Disposal:</td></tr>
<tr><td>Integration with:<ul><li>Weigh Bridge</li></ul></td><td>Functionality:<br>Record volume of garbage collected/disposed on daily basis.</td></tr>
</table>

| Integration with:<br>• Vehicle Tracking System | Functionality:<br>Keeping certain checks as per environmental regulations, like minimum frequency of lifting garbage etc. |
|---|---|
| **Management Information System (MIS)** | |
| • Monitor deployment of pickup trucks and personnel based on schedule originally drawn.<br>• Info on use of transfer stations/quantity of garbage received.<br>• door-to-door collection, ward wise/dashboard for all activities<br>• Reports of ward wise weight/Any other custom report as per department. | |

## 6.5. City and Enterprise GIS Solution

### 6.5.1. Scope of Work

#### 6.5.1.1. Geospatial Data Creation and Updating Base Map for PAN Area

The bidder have to create GIS Base map using satellite imagery and utility layers and update the existing base map and utility data and also create new data.

#### 6.5.1.2. Data Collection

Selected Bidder will collect the available maps and secondary data (if any) from ASCL (soft copy and or hard copy) namely; municipal boundary, zone boundary, town survey maps, field measurement book (if available), ward boundary maps, slum related data, sanitation, and basic infra-structural facilities and land marks, details of town planning schemes to be incorporated superimposed/synchronized and corrected suitably to match current field data;

- Existing base map.
- Town planning schemes showing proposed land use zoning, transport network and sites designated for various public purposes.
- Maps showing administrative boundaries ward boundaries, census boundaries, slum boundaries.
- Revenue maps showing cadastral boundaries.
- Soft copy maps/drawings of utilities like water supply, sewerage, storm, water drainage, solid waste disposal, roads and street lights, along with the data available with other concerned departments.
- Location of State and Central Government offices, railways and highways, police stations, primary and high schools, colleges, universities, primary health centres, hospitals, banks, theatres etc. also need to be located on the maps through field verification.
- All the details that ASCL desires to include.

#### 6.5.1.3. Data Validation and Gap Analysis

Selected Bidder will conduct QA, QC and check the quantity, quality, accuracy, source, and reliability of the collected data from ASCL, whether the data (spatial or non-spatial) is recent or accurate enough to be used and not obsolete.

#### 6.5.1.4. Positional Accuracy

Selected Bidder will check whether the positional accuracy of the existing data available (if any) with ASCL is in sync with the satellite imagery provided by ASCL. Selected Bidder will prepare base map using the available

and fetched data and validation of the same will be carried out by the authorized officials of ASCL. In case of Field Measurement Books, they are to be built and super imposed on the base maps.

- **Accuracy Requirement:** The 10% of GCPs will be randomly selected as sample for the accuracy of 0.3 m. On the data and see whether data fits on the projection of baseman in case data doesn't fit ASCL will provide data which can be used.
- **Reliability:** Selected Bidder will check from the available legacy data with ASCL, whether the data (spatial or non-spatial) is recent or accurate enough to be used and not obsolete. In case data is rejected bidder will be responsible to rectify data.
- **Attribute Validity:** Selected Bidder will validate attribute data accuracy, whether the data accurate enough to be used and not obsolete.

#### 6.5.1.5. Procurement of High Resolution Satellite Imagery – Pan Area

The selected bidders have to procure and supply ortho rectified having 5 m or better solution latest satellite imagery. Only procured imagery shall be used for the preparation of base maps, data from alternative online sources such as Google Earth/Google Maps is strictly prohibited as this is strictly against the usage policies of the respective services.

ASCL will provide necessary NOC/Approvals for procurement of satellite imagery to the successful bidder. Cost of the satellite imagery would be quoted in the Price Bid. Bidder will provide the details of satellite imagery proposed in the Technical Solution.

#### 6.5.1.6. Geo Referencing and Post Processing of Satellite Imagery – PAN area

Geo-referencing is the process of assigning real-world coordinates to each pixel of the raster. It is the process of scaling, rotating, and translating the image to match a particular size and position.

For Geo-referencing the Bidder needs to take the Ground Control Points (GCPs). GCPs are basically taken as a road intersection points, building corners, permanent locations etc. Bidder shall generate the grid of 1 x 1 sq. km. on the satellite image and collect GCPs per sq. km. GCPs need to be collected using DGPS. The locations identified on the image and real ground should be verified with the authorized representative appointed by the corporation. The data should have following:

1) Projection: Universal Transverse Mercator (UTM), Spheroid: WGS 84, Zone: 43N. Observation time for DGPS instruments has to be minimum 12 (twelve) hours at base station and minimum 30 (thirty) minutes at each GCP using DGPS.

2) The horizontal accuracy of GCPs should be 0.1-0.3 ms. 5% of GCPs would be randomly selected as sample for the accuracy. If the incorrectness in accuracy found in any sample, the entire work shall be rejected and shall be required to rework.

3) To correct various geometric anomalies in raw satellite imagery, Ground Control Points (GCP) collected through Differential Global Positioning System (DGPS) survey will be used for geo referencing of the imagery.

#### 6.5.1.7. Data Modelling Pan Area

Data Model for storing the spatial and non-Spatial data shall be decided by the ASCL in consultation with the successful Bidder/SI in accordance with the National Large Scale mapping Policy. "Bidder will modify the data model and update the same with the help of detailed round of discussion with each concerned ASCL department officials. Bidder will understand existing data model of ASCL and will use proper tools to create the data model like CASE tools and UML etc. The final data model will be approved by the ASCL and before proceeding further the data model will be finalized. Once the data model is finalized, bidder will give the details of the data model diagram (ER Diagram) to ASCL for future references or for any modifications in future.

#### 6.5.1.8. Digitization of Satellite Imagery, Updating and Capturing of Various Layers

Bidder will create/update all geographical features class required as per RFP/SRS by digitizing from satellite imagery of PAN area.

The satellite image/scanned map will be digitized using the suitable COTS software. This process includes creation of standard template initially; a standard template will be created and inserted into each digitized map. In this template the layer name, line type, and color for each feature present on the map will be standardized. This system helps when a number of sheets and village maps are to be mosaicked. This process maintains uniformity in all the maps, which will be digitized.

Post the processing of the satellite imagery by removing the geometric anomalies (if any), the bidder will prepare a grid of 1 km x 1 km for positioning bidder with respect to its geographic Location. These grids then further will be divided into 250 m x 250 m scenes for future usage like Map Book creations, Smart Asset ID creation etc., and future analysis. All the grids and scenes will have unique IDs.

Bidder will then take sufficient number of Ground Control Points (GCPs) collected through Differential Global Positioning System (DGPS) survey. Bidder will prepare an up-to-date large-scale base map (Scale 1:2000) of all the wards/zones of Agra city using satellite imageries and then will prepare a new database using the existing database available with Agra Municipal Corporation, as unified geo-spatial data with infrastructure details.

Bidder will carry out mapping on the rectified satellite data using heads up digitization process. The features that would be taken for mapping includes buildings, vacant plots, Roads, bridges, Railway tracks, parks, gardens, stadiums, slums, traffic qquares, water bodies (river, lake, pond, drainage, canal etc), overhead tanks, etc. While doing the digitization, a special care of data correctness to be taken like no overshoots/undershoots, proper layering, proper symbology etc.

#### 6.5.1.9. Property Survey and Property Tagging – ABD Area

ASCL is already in process of property assessment survey bidder have tag this property survey data to GIS and for this bidder may have to do field survey, the field teams will visit door-to-door to cover all properties in the area of interest. The teams will contact the occupant/owner or any other responsible person in the family. And identify the property data and tag it with GIS property maps using mobile/tablet/handheld application.

#### 6.5.1.10. Final Base Map Preparation – PAN Area

Bidder will integrate information of utilities features such as street lighting, water supply line, sewerage network, wastewater, storm water drain, sanitation facility (household/public/private), Solid waste management and unauthorized properties as provided by ASCL as layers with base map.

The layer list would be exhaustive taking into consideration of the features to be captured, the attributes will added etc., The layer list and the database layers would be created using programs, appropriately. All the data captured would be checked and validated using custom-built routines for its accuracy and logical correctness. The rigorous QC process of bidder would help in achieving accurate feature capturing, required accuracy in coding and classification.

Final base maps will be prepared at 1:2000 scale incorporating the data collected, processed, and digitized after survey process. The base maps will be prepared in various layers as defined by ASCL.

#### 6.5.1.11. Tentative GIS Data Layers Required for Geospatial Smart City Project

Satellite Imagery

- Latest High Resolution Ortho rectified, Geo Referenced Satellite Image of .5mor Better Resolution

Administrative Boundaries

- State Boundary
- District Boundary
- Metropolitan Regional Development Authority
- Municipal Corporation Boundary
- All Zone Boundaries
- All Ward Boundaries (Old and New)
- MP Constituency Boundaries
- MLA Constituency Boundaries
- SLUM Boundaries
- Gamtal/Village Boundaries lying in MC Area
- Police Thana Jurisdiction Boundaries.
- Heritage Boundaries/Corridor
- Area of Interest Boundaries
- TP Boundaries
- Non TP Boundaries

Town Planning Schemes (TP Sheets)

- TP Scheme Georeferenced with Total Station Survey done
- TP Scheme Total Surveyed done but not geo referenced
- TP Scheme Digitized
- Hard copy and no digital
- Survey Maps for TP Scheme
- F Form and B Form softcopy in XLS format
- Survey Plots, Original Plots and Final Plots

- TP Reservation Plots
- Town Planning Sheets
- Zone Type R3/ R2 etc.
- Town Planning Survey Data
- Field Measurement Books

Development Plan (DP)

- Development Plans ( Latest approved for 10 years)
  - Land Use
  - Cadastral Map
  - Revenue
- Historic DP

Important Features

- Road
  - National Highway
  - State Highway
  - Street and Society Road
  - BRTS Corridor
  - TAR Road/Cement Road/Other Road Type
  - Road Divider
  - Road Centre Line
  - Foot Path
  - Traffic Square
  - Traffic Signals
  - BRTS Station
- Railway
  - Railway Property Boundary
  - Railway Track Meter Gauge Line
  - Railway Track Broad Gauge Line
  - Railway Station
  - Metro Line
  - Metro Station
- Bridges
  - Flyover
  - Under Bridge
  - Railway Bridge
  - Culvert
  - Foot over bridge
- Building
  - Building Boundary
  - Building Footprint
  - Building Type
  - Tenement
  - Flat

    - Bungalow
    - Slum
    - Society
    - Multi Storey
    - Single Storey
    - Commercial
    - Residential
    - High Rise
    - Low Rise
    - Government
    - Private
- Water Bodies
    - River
    - Lake
    - Ponds
    - Canal
- Open Sewerage/Drainage Garden/Parks
    - Private
    - UDA
    - MC
    - Forest
- Stadium, Swimming Pool and Plagrounds
    - MC
    - UDA
    - Private
- Parking
    - MC
    - UDA
    - Private
    - Pay Parking
    - Free Parking

- Entertainment/Worship Places
    - Theaters
    - Temples
    - Mosque
    - Church
    - Shopping Malls and Shopping Centres
    - Market
    - Water Park
    - Clubs
- Important Features
    - Petrol Pump
    - Hospital
    - Clinics

- ATM
- Banks
- Hotel
- Restaurants
- Fire Station
- Govt Offices
- MC Office
- PMRDA Office
- City Civic Centres
- College
- School
- Recreational Centres
- Training Centres
- Vetnary Hospital/Clinic
- Police Station
- Police Chowki
- CCTV Camera
- Taxi Stands
- Rickshaw Stands

- Utilities
  - Power
    - HT Line
    - Towers
    - Street Light
      - Poles Locations
      - Fixtures
      - Transformer
    - Power Stations
    - GIS/ CAD /Paper Drawings
  - Water Supply Network
    - Mains
    - Distribution Line
    - Wells
    - Overhead Tanks
    - Water Supply Pipeline
    - Waste Water Supply
    - Public tTaps
    - Storage
    - Street Taps
    - GLSR (Ground Level Dump Reservoir)
    - Direction of Flow
    - Meters
    - GIS / CAD /Paper Drawings
  - Strom Water Drain Network

- Manholes
- Flow Direction
- Network up to tank if available with MC including all components
- Construction Type (whether permanent or temporary)
- Place of Disposal and Distance
- Location of Culvert and Condition
- Location and Alignment of Drain/Channels
- Invert Level L section of the Drain, Channel indicating Slope
- GIS /CAD /Paper Drawings

- Sewerages Network
  - Septic Tanks
  - Household Connection
  - Pit
  - Manhole
  - Open Drainage
  - Derivation Line of Underground Pipe using Manhole and Well Locations
  - Connectivity Household Network and Flow Direction to be taken up to STP (including all components)
  - Disposal Sites
  - GIS / CAD /Paper Drawings
- Sanitation
  - Material, Size, lLength, and Condition of Sewage Line
  - Connectivity to Town Wide Sewerage System
  - Septic Tank, Condition and Point of Disposal
  - Community/Public Toilets
  - GIS/ CAD /Paper Drawings
- Solid Waste Management
  - Bin of all Categories
  - Yard
  - GIS/CAD/Paper Drawings

#### 6.5.2.Data Migration

Bidder will migrate updated base map and utility data at ASCL into centrally located Enterprise GIS Database.

#### 6.5.3.Design and Development of Enterprise Web GIS Smart City Department Application

Bidder will Design and Develop web GIS application for ASCL using Enterprise GIS platform. This application will cater to the viewing, analyzing, and utilizing the geographic information needs of the different departments of ASCL. And will also play a role of decision support system and backbone for Smart City Command Control System.

The required features to be developed for web GIS application is as follows:

- Will be based on Enterprise GIS Platform.
- OGC Open Geospatial data standards compliant.

- Existing server, client, web, mobile/tablets to be supported.
- Application will be open to integrate additional functionalities in future.
- Visualization of data e.g., Land Parcel Data DEM on Satellite image.
- Will support multiple relational database connections.
- Shall have query based results.
- Application will have facility of historical data analysis for land parcel information, property tax information, building information using time series.
- Will support distributed transaction. This allows multiple users to edit the map data at a same time.
- Application will support DBMS spatial index and R-tree index for better system performance.
- Creation of server clusters with load balancing and fail-over functionality will be supported.
- Application will support data compression and asynchronous map view, static and dynamic cache.
- Application will have facility to configure additional menus for future functionality.
- User authorization and authentication should be GUI based.
- Application will have the facility to monitor application operations and status: logged in user status, server load, data access status.
- Application will have the facility to create custom GUI without business customization, through designated application the selected bidder is expected to follow the complete SDLC for the development of the GIS application.
- Proposed/Developed GIS application software will follow National Spatial Data Infrastructure (NSDI) Meta standards and should be compatible with National Urban Information System (NUIS) Scheme. Tightly integrate the spatial data with the existing system at ASCL.

**The Smart City Application should have the Following Modules**

| | Department Modules |
|---|---|
| 1) | GIS Module for Estate Management |
| 2) | GIS Module for Parks and Gardens |
| 3) | GIS Module for Water Supply |
| 4) | GIS Module for Sewerage Operation |
| 5) | GIS Module for Road and Traffic |
| 6) | GIS Module for Strom Water Drainage |
| 7) | GIS Module for Street Light Management |
| 8) | GIS Module for Education |
| 9) | GISModule for Health Services |
| 10) | GIS Module for Advertisement and Hoardings |
| 11) | GIS Module for Disaster Fire & Emergency Services Management |
| 12) | GIS Module for Capital Project Monitoring and Control |

#### 6.5.3.1. Modules and Sub Modules of Land and Estate Management System

**Map Handling Module:** User can view municipal plot details along with plot dimensions, details of heritage structure with buffer analysis and ward, village and election boundaries. He/She can also view and asses the

area under slum and location of ULB owned vacant lands. Upload GIS/CAD drawing on the system for permission.

**Municipal Service Query Module:** Query module will support users to access details about the plan and gap analysis. Query system will also support user to see information based on plinth area, floor wise details.

**Spatial Query Module:** This will support user to analyze area under slum and the zone, ward and other information regarding location of vacant land of ULB.

**Reports:** Reports will be generated for Building Permission/Building Use Certificate.

#### 6.5.3.2. Estate Management

This solution will help ASCL officials to manage the estate related information along with analysis of slum area and ULB owned vacate land.

**Modules and Sub Modules of Land and Estate Management System**

**Map Handling Module:** User can view municipal plot details along with plot dimensions, details of heritage structure with buffer analysis and ward, village and election boundaries. He/She can also view and asses the area under slum and location of ULB owned vacant lands.

**Municipal Service Query Module:** Query module will support users to access details about encroachment and legal information of plots. Query system will also support user to see information based on plinth area, floor wise details.

**Spatial Query Module:** This will support user to analyze area under slum and the zone, ward and other information regarding location of vacant land of ULB.

**Reports:** Reports will be generated queries results based on city survey number, built-up area, plinth area, floor details, date of possession, details of encroachment, slum details, ward boundaries etc.

#### 6.5.3.3. Disaster Fire and Emergency Services Management

This system will enable user to do the advance planning of all possible disasters to control the situation effectively and rapidly locating the incident location, which requires immediate rescue and administrative support.

**Map Handling Module:** In map viewer user can view all required spatial features such as road plan including lanes and by lanes, position of water hydrants, high rise buildings, and location of fire stations along with other relevant layers.

**Incident Locating and Tracking:** To track incident location in a faster manner this module will provide intelligent location search by implementing fuzzy logic to search the location input by user without matching the exact words system will show the possible matches as per input given by user. User can relate the information and zoom to the location as required.

**Query Module:** This module will help user to access information about necessary emergency services such as nearby fire stations, police stations, hospitals and other related information. User can also get information about facilities available in hospitals such as no of beds etc. Query module will also provide information current project status.

**Spatial Query Module:** Spatial query module will enable user to perform nearest neighbor analysis to find out closest facility available from incident site, also spatial routing will enable users to find out shortest path to display transportation routes for responding equipment's with commutable roads.

**Reports:** Reports will be generated on queries based on location of numbers of nearest health care centres, hospitals; those are nearest to the incident occurred.

#### 6.5.3.4. Park and Gardens Management System

This solution will enable ASCL officials for effective management of development sheet with the garden department. It will provide detail information about the garden and parks available in the city such as location detail, garden area, number of trees etc.

**Map Handling Module:** In this module map viewer will show garden and parks, stadium location, and plot boundaries which can be measured with the help of measuring tool on the map interface. User can also view other associated information such as number of trees, services availability, water bodies inside the garden, and shopping area details.

**Query Module:** Query module is designed to provide maximum information associated with garden and parks, user can locate all parks and garden and open spaces through query search and then zoom the exact location of selected garden and park on the map viewer. He/She can extract information about number of taps provided in park/garden.

**Spatial Query Module:** This module will enable user to perform buffer analysis to get information around park/garden as well as services availability such as water connection, sewerage facility, telephone etc.

**Reports:** This module will allow the users to generate report on query results based number of public taps provided, lease period/adoption period with expiry date of lease or adoption of individual park/garden.

#### 6.5.3.5. Water Management System

It will enable user to identify, isolate, and map areas of concern during a leak or outage. He/She can also trace the network to identify customers who are downstream of a main break, complete valve isolation traces, create leak reports, and reroute resources in an outage with detection of spots where leakage in the pipe have occurred. Through GIS system user can communicate leak or outage information with customers and related agencies such as public works and water companies. System will create all city water pipe line networks along with diameter and valves information to calculate flow and pressure at junction.

**Map Handling Module:** Map viewer will show entire water pipeline network along with valves in legends user can view information related to diameter, length, and depth of a particular water line segment. User can also

view different water bodies such as lakes, open wells, bore wells etc. User can click on the water pipeline segment to know the material and condition of pipe.

**Routing and Utility Network:** Routing will enable user to find out shortest route from source to the particular pump station.

**Query Module:** User can extract data through queries base on diameter of pipelines and resultant can further be select to see position of valves on the select water pipe line. Depth of pipeline from road level and inverted level can also be fetch through queries. He/She can locate all water bodies and valves throughout the municipal area along with details like maintenance history, repair and replacement of water pipeline and type of material of construction.

**Spatial Query Module:** This sub module will allow user to get population statistics of the selected area and generate buffer along with water pipeline to analyze nearby other utilities in the area.

**Reports:** This will allow the users to generate report on query results based on numbers of leakage spots, pipe having more numbers of leakage spots etc., and also will allow selection of the diameter of pipeline based on the, population statistics of the area, lines of diameter and above/below, lines of diameter and above/below, depth of pipeline from road level and invert level, repairs/replacement history, types of material, location of valves with select material of construction etc.

#### 6.5.3.6. Sewerage Operation

This system will support ASCL officials to manage collection treatment and disposal of sewerage effectively by using GIS application. User can plan and track maintenance schedule of sewage lines, calculate flow capacity based on diameter of sewage pipeline along with overall capacity of sewer line.

**Map Handling Module:** On map viewer user can view entire network of sewerage pipeline, he/she can also run network trace and could view the output on the viewer part of the application. Position of manholes will also be shown as point location on the map.

**Query Module:** User can execute queries base on diameter of pipeline, material of construction, slippage in maintenance schedule flow capacity, and status of pumping mains, shutdown status, present capacity of sewer line, locations of landfill, transfer stations and waste handling facilities etc.

**Spatial Query Module:** With spatial query user can get the details of bypass line direction of flow, position details of ventilation column, user can also run sewerage line network trace between two points and view result on map viewer.

**Reports:** Reports will be generated on queries on type manholes including depth and size, slippages in maintenance schedule, flow, capacity, and current status of pumping mains, status of shutdown in attribute attached etc.

#### 6.5.3.7. Road and Traffic Management

It will enable ASCL users to planning and tracking of maintenance of all roads with in the municipal limits including all types of bus stands, taxi stands, and petrol pumps. The application system will enable users to identify position of road divider, position of U-turn boards and speed breakers, number of speed breakers in a stretch, and road partition along with road street light information.

**Map Handling Module:** Map viewer will show all the roads within the municipal limits of ASCL with footpath surface as well as it will show traffic lights as point location. User can identify bus stand, bus route, and petrol pumps location on map.

**Query Module:** With queries user can identify position of road divider, U-turn boards, and speed breakers, road partition for light and heavy vehicles, number of street lights, and number of speed breakers on a stretch of road. User can also query bus stand, bus routes, location of petrol pumps.

**Routing and Network:** Routing will enable user to find out alternative route in case of jam, emergency, or certain festivals, user can also user routing for identifying routes of all petrol filling vehicle.

**Spatial Query Module:** Spatial analysis will enable user to get information of speed breaker, number of street lights, and other relevant features based on selected area.

**Reports:** It will be generated on query results based on getting numbers of street lights per km in a road, number of speed breakers on a stretch of road, Identifying roads with number of street lights less than per km.

#### 6.5.3.8. Strom Water Drainage Management System

This solution will enable users to perform effective management of storm water drains.

**Map Handling Module:** Map viewer will show main town level drains with thematic view based on their type such as “Nalla” or “Outfall” along with cross sections.

**Query Module:** User can perform queries based on size, slope, and materials of drains. Maintenance schedule data can also be extracted for effective tracking de-silting achievements.

**Spatial Query Module:** Through spatial queries user can locate cross section of all drains with details like width and depth levels.

**Reports:** Reports will be generated based on the queries on details of cross-section of all drains with clear width and depth levels, and information about type of drain.

#### 6.5.3.9. Street Light Management System

It will enable ASCL users to planning and tracking of maintenance of all street lights with in the municipal limits including all types of street lights, traffic signals, high mast lights, installation policy and failure statistics . The application system will enable users to identify position and numbers of street lights, high mast lights, traffic signals on roads and partitions along with road street light information.

**Map Handling Module:** Map viewer will show all the roads within the municipal limits of ASCL with high mast lights, street lights it will also show traffic lights as point location.

**Query Module:** With queries user can identify position and numbers of street lights per km in a road, Identifying roads with number of street lights less than per km, traffic signals, and high mast lights on stretch of a road. User can also query failure statistics, installation policy etc.

**Spatial Query Module:** Spatial analysis will enable user to get information of traffic signals, number of street lights, within the buffer area or within the ward boundaries of the municipal limits and other relevant features based on selected area.

**Reports**: It will be generated on query results based on getting numbers of street lights per km in a road, number of traffic signals on a stretch of road, identifying roads with number of street lights less than per km and failure statistics analysis based on user input to the GIS application.

#### 6.5.3.10. Capital Project Monitoring and Control

This module will capture request coming for development project in SMC like road repair, new road construction, building construction, flyover construction, Toilet construction, park/garden construction, laying of sewerage line, laying of water line , laying of storm water drainage etc.

Request for all development projects can compile and a proper GIS view will be provided to do analysis on exiting geo location and requested project so that decision can be taken looking at GIS View for suitability of the project.

Once its decided that a project is feasible and approved for implementation, the same project can be monitored and controlled through application by incorporating GIS/Project Work in Progress through GPS base tagging and GPS enabled photos etc., and functions for analysis like buffer, measurement, vector overlay, color symbology. With following sub modules:

- Project Analysis and Decision Support System for Project as Request
- Project Analysis and Decision Support System for Project as Plan
- Project Analysis and Decision Support System for Project Work in Progress
- Project Analysis and Decision Support System for Final

### 6.5.4.Integration GIS with Existing and Proposed/Future Smart Systems

1 Video Surveillance System
2 Smart Lighting
3 CT Enabled Solid Waste Management
4 Intelligent Transportation System
5 Smart Education
6 Smart Water Supply System
7 Smart Health Management System
8 BRTS/MRTS and City Bus Services
9 Public Bike Sharing
10 Central Command Control Centre

11 Smart Parking Management System
12 Environmental Sensors
13 Enterprise Project Management
14 Any other Municipal e-Governance Application
15 Incident – Response Management

## 6.6. Smart Public Transport System

### 6.6.1. Scope of Work

- MSI will install GPS based Automated Vehicle Locator System (AVLS) in city buses and integrate with ICCC.
- MSI will install VMS at the bus shelters and integrate the AVLS on the GIS maps.
- MSI should also provide a mobile/smart kiosk based information to passengers about the real-time location of bus.
- MSI should provide Passenger Information System (PIS) in the bus, and also at the Smart Bus Stops.

### 6.6.2. Functional Specifications – Vehicle Location System and Passenger Information System

- Ability to locate a bus at a given time in its track to estimate its arrival/departure time at the next destination, based on traffic density, distance, speed, bus occupancy, run-time information from the previous bus arrival time for the same location etc.
- Ability to receive SOS and alerts from moving/stranded buses en route.
- Facility to track defined vs. actual movement of vehicles, capture deviations if any.
- Facility to view vehicle movement in a real-time mode on GIS maps.
- Ability to provide dynamic location specific information as the vehicle approaches bus stop/station for the benefit of passengers.
- Facility to generate information such as travel time estimation, average time at bus stop, passenger traffic at different location, alerts on exceptions, and logging of the journey details of the bus for each trip.
- Facility for citizens to access and view position/location information on GIS maps near-real-time through web interface with historic data displayed on maps.
- Facility for providing current information location on demand.
- It should enable operational managers to create locations, routes, schedules, vehicle service alerts for service and maintenance.
- Provide daily maintenance schedule, pending insurance and pending pollution check status.
- Vehicle fleet summary dashboard – quick view on vehicle fleet performance based on fuel consumption, it should provide average fuel consumed per kilometre.
- System should also be able to record bus break down instances along with other exception recording/actions (over-speeding, off-route detection, non-stoppage at bus stops, trip cancellation).
- System should generate reports.
  - Depot, vehicle and route wise reports
  - Missed stops reports
  - Route deviation reports
  - Trip status reports (cut/short/missed)

- Distance travelled
- Register a bus on unscheduled route from backend on real-time basis

### 6.6.3. Functional Specifications – Mobile Application

- Real-time bus tracking system (support third-party application provider).
- Complete information on bus routes and stops to commuters.
- Real-time ETA for a combination of bus route and stop.
- Real-time tracking for the bus on the map.
- Mobile application for iOS, Android and Windows mobile devices.
- MSI shall develop mobile apps, which shall include a mobile application to help passengers to get information about the buses, search and view bus schedules on various routes, and deliver ETA based on their real-time location.
- System shall show the timetable of the buses, fare structure etc.

### 6.6.4. Module: Multi Fleet System

| Functionality | Public Transport Requirements Served |
|---|---|
| Information about all running and idle vehicle with following information:<br>Driver Name, Contact Number, Speed, Current Location, Schedule Time to reach next destination, Number of trips till now, Current Trip Number, Number of Delayed trips, Current Trip Sstatus | Multi-fleet systems:<br>• All-in and simultaneous management of several fleets. The sharing of resources (communications system, control centre and human management resources) creates beneficial economies of scale.<br>• A section that enables users to have a full view of all activities of the fleet on a single console. The dashboard shall form part of the UI delivery, which shows all key performance and tracking indicators enabling control centre staff and management team of Public Transport to take proactive decisions to manage transportation operations in a highly efficient manner.<br>• Application development and customization of screens, forms, reports, and queries of data specifically include:<br>○ Locating a particular bus in the fleet.<br>○ Auto pan facility for tracking a particular bus.<br>○ Sending online messages to an individual bus or group of buses selected on a map. |

### 6.6.5. Module: Live Vehicle/Real Time Tracking

| Functionality | Public Transport Requirements Served |
|---|---|
| Tracking and Monitoring Bus Status | • Integration of GPS with digitized map for tracking of |

| | |
|---|---|
| (Running, Stopped, Ignition Off) Running Speed Route Source and Destination Stoppages Visited, Current Location Stoppages to Visit<br>Bus Identity, Route Identity and Name | vehicles on a real-time basis including distress messaging between vehicle and control station.<br>• To monitor whether the buses are adhering to its scheduled route and time table throughout the route and identify if there are any deviations.<br>• Real-time two-way messaging between buses and Central Control Room.<br>• To monitor whether the buses halt at all the scheduled bus stops.<br>• Generating messages pertaining to speed violation, skipped bus stops etc., to Public Transport officials at the Central Control Station, online along with the geographical position and the violated vehicle number. |
| Punctuality | |
| Current Location and Time | |
| Transit Diagram and ETA | |
| Tracking Bus Actual Transit against Scheduled Transit | |

### 6.6.6. Module: Reports and MIS

| Functionality | Public Transport Requirements Served |
|---|---|
| Different Analytical, Revenue Management and Alert Reports (Through Data Received from Legacy Revenue Collection System) | • Generation of exception reports like deviations from schedule route, timing, missing bus stops, punctuality factor, etc., based on captured vehicle data.<br>• Calculation of actual distance (in kms) travelled by vehicle, using map.<br>• Reports:<br>○ Speed Log<br>○ Stoppage Log<br>○ Summary Report Day Wise Vehicle Wise<br>○ Performance Day Wise Vehicle Wise<br>• Statistics: Monthly Performance<br>• Alerts:<br>○ Fleet Summary<br>○ Vehicle Status<br>○ Speed Violation<br>○ Real-time Application Data Delivery for PIS |
| Speed Log | |
| Stoppage Log | |
| Summary Report Day Wise | |
| Performance Day Wise, Week Wise, Monthly | |
| Performance Vehicle Wise | |
| Summary Report Vehicle Wise | |
| Monthly Performance | |
| Calculation of Actual Distance (in kms) Travelled by Vehicle using Digitized Map. | |
| Depot Report | |
| Deviation from Schedule Route or Timing. | |

### 6.6.7. General Requirement of the Application Software

1. The proposed system will be capable of data communication with all the system components in real time.
2. Uploaded data will not be deleted from device readers or workstations until the central system has provided confirmation acknowledgement that the transactions have been successfully received.

3. The proposed system will be able to update its date and time using time synchronization application of servers. Also the date and time on all system devices and workstations should also be updated.
4. All active equipment will have an internally maintained date and time clock that is synchronized using a time interval via the communications medium with the system date and time clock
5. System should be driven by configurable parameters and should provide flexibility for maximum configuration. Configurations will be for, but not limited to:
    - User groups and users privileges.
    - Time based messages/reports.
    - Addition and deletion of equipment, nodes, stations, user groups, users.
    - Reports Access.
    - Configurable messages.
6. System should handle all degraded conditions which can be, but not limited to the following:
    - Power failures.
    - Data connection lost.
    - Central server down.
    - Bus station switch non-functional.
7. Software should provide controls to view the entire sequence of reported locations from the beginning of the time or to step through the sequence incrementally forwards or backwards.
    - Replay data will include location and headway adherence data.
    - System will allow replay for a single vehicle, selected set of vehicles or all vehicles, or cluster wise vehicle or route wise vehicle on the selected map view for selected time period.
    - All users accessing the AVL software will be able to access the playback function.
    - System will be able to store a playback in a format that can be exported for viewing on any computer.
    - System will allow the ability to use playback without exiting from the current AVL operational view.
8. Software will be accessed on workstations and ICCC of all users identified by ASCL. All communications and AVL data will be stored in a manner that allows direct access by the software for at least 90 days and reporting data for 12 months live in the system. MSI will provide utilities to support archive and restore functions for older data.
    - System will only be accessible by authorized persons, controlled using login and password protection. Single sign on will be provided for all modules in ICCC
    - System will maintain a transaction log that records all users that access system reports. The pages/reports accessed, edits and changes to the database and the system logon and logoff times. The transaction log will maintain this information for a minimum of one year.
9. System will allow selection of any time for the historical data. All data will be the property of ASCL.
10. Central system shall be delivered with a fully functioning Graphical User Interface.
11. Graphical User Interface shall be based on standard web based browser controls or an equivalent system.
12. It shall be possible to create different user classes/categories/roles with different access level.
13. System security will provide features to maintain data integrity, including error checking, error monitoring, error handling and encryption.
14. Features will be provided to ensure that all system-created files are uniquely identified, and that no files are lost or missed during data transfer.
15. System will have verification features to confirm that there have been no losses of data at any point in the

transfers.

16. System needs to be tamper proof and MSI should build features to confirm that there have been no unauthorized changes to, or destruction of, data.
17. Features will be provided to automatically detect, correct and prevent the propagation of invalid or erroneous data throughout the system.
18. All systems, sub-systems and devices will only allow access to authorized user classes.
19. All security breach detections will be confidential, and accessible only to users of the appropriate class.
20. Web-based system and all equipment (on-board equipment, PIS displays in stations etc.) will support a maintenance mode during repair, replacement and testing of equipment.
21. All the functions that are carried out in the maintenance mode will be reported separately similar to exception transactions.
22. Maintenance mode will be possible to be activated based on a particular node wise system.
23. Maintenance mode can be activated only by a person having the highest user privilege in terms of system operations.
24. Logins and logouts will be transmitted to the system, along with associated date/time, employee ID, equipment ID etc.
25. It will be possible to upgrade the firmware/software from the central server using the internet communication available at the station level.
26. Central software will be scalable to accommodate for buses, bus-station/smart bus stops/terminal PIS, without any modifications to the central software except minor configuration changes, the details of how scalable the system is will be provided in the proposal by the MSI at the time of inception report.
27. Software will provide standard reports based on the AVL data. MSI will provide details in their proposal related to reports that are offered and the degree to which they can be configured (at minimum all report will be configurable for a specified date/time range and route). Some of the expected standard reports are as follows:
    - Headway Adherence
    - Active Fleet (Weekday and Weekend)
    - Service Hours and Mileage
    - Schedule Adherence
    - Speed Reports
    - Route Deviation Reports
28. All reports will use standard reporting tools (e.g., RDBMS or SQL or Crystal Reports etc.) and will have the ability to export data into file formats that can be exported to and edited with standard tool i.e., Microsoft Excel, etc. The MSI shall provide the relational database layout including related fields, key fields and definitions for all fields in all tables in the database.
29. Any portion of transactional database will be exportable in standard formats (such as comma-separated variables) (.CSV, xls, xlsx files etc.) for analysis in third-party programs.
30. It will be possible for users to build custom reports from the data in the transactional database with tools such as RDBMS or SQL. The reports will be capable to be exported to pdf, xls, xlsx formats easily.
31. Data dictionary will be provided to ASCL to facilitate development of custom reports.
32. MSI will be responsible for the design and development of the website, including all required HTML, scripting, and integration with the AVL system. The website GUI will allow for the graphical presentation of vehicle locations on GIS-based maps.

### 6.7. Environmental Sensors

#### 6.7.1. Scope of Work

Smart environment sensors will gather data about pollution, ambient conditions (light, noise, temperature, humidity, and barometric pressure), weather conditions (rain), levels of gases in the city (pollution), and any other events on an hourly and subsequently daily basis. It is for information of citizens and administration to further take appropriate actions during the daily course/cause of any event.

#### 6.7.2. Functional Specifications

1) The environment sensors should have the following capabilities:
    - They should be ruggedized enough to be deployed in open air areas, on streets, roads, coastal areas, parks etc.
    - They should be able to read and report at least the following parameters: air quality, sunlight, noise, weather conditions etc.
2) Smart environment sensors will notify and allow citizens and administrators to keep a check on their activities, which impact the environment, and enable the city to take remedial action if required.
3) These environmental sensors can be connected via 3G/4G wireless network or Wi-Fi/LORA networks based on connection availability.
4) The data should be collected on a data analytics cloud application. In addition, the data should be integrated in third-party CCC (Command and Control Centre) Software. Various environment sensors shall sense the environment conditions and send the data to the integrated control system where real-time data resides and the same shall be made available to various other departments and applications for decision-making. The platform must include intelligent analytical engines that make information meaningful to all stakeholders and helps ease decision-making.
5) The environmental data should be submitted in a print ready PDF report format on daily, weekly, and monthly basis to at least 5 designated emails of the authorities of various departments.
6) In a situation where environmental deterioration crosses a threshold limit set by the concerned authorities in the software system, the system should be able to notify the concerned authorities of various departments by means of SMS and emails.
7) MSI can also make use of the nearby variable messaging displays wherever possible (need to be finalized post detailed survey of locations).
8) The sensor management platform should allow the configuration of the sensor to the network and also location details etc.
9) The sensors should be able to be managed remotely. This includes sensors being updated with calibration parameters and software upgrades.
10) Apart from information provision, the sensors must ensure data is transmitted securely and have security measures from sensors to the software platform. It must also ensure tamper alerts are provided in cases of vandalism, security breaches, etc.

### 6.8. Data Centre (DC) and Disaster Recovery (DR) Centre

#### 6.8.1. Scope of Work

The physical location provided for Integrated Command and Control Centre shall not be recommended for

implementing Data Centre site within the premises due to nature and condition of building since it is not Tier III building. Hence, it is suggested to either have a separate building within the city which is as per Data Centre specifications where space and power shall be provided by ANN/ASCL to the selected bidder for installation and commissioning of devices (servers, switches etc.). In case if ANN/ASCL agrees to not have a separate building, which is Data Centre compliance, then PMC team proposes to have a co-located/hosted mechanism where MSI can avail cloud-based services (like Infrastructure as a Service (IaaS)) from an empanelled list of MEITY. Even for Disaster Recovery site which will be located in different seismic zone and other types of services can be availed from MEITY empanelled cloud service provider.

The Data Centre where all the ICT infrastructure along with the network infrastructure are installed. The Data Centre will host all the software applications for various smart city components. The Data Centre shall provide private cloud-like functionalities that allows agility and seamless expansion, which is non-disruptive and helps infuse the new technologies into the existing landscape as and when available. The Data Centre is to have adequate provision for data security through implementation of firewalls, IPDS, anti-virus systems, etc. The physical access to the data centre shall be managed through a biometric access system.

The Disaster Recovery Centre is a mirror image of all the applications hosted at the Data Centre and will be 50% of the compute, however, the data of video feeds is to be 100% available in case of a disaster. In case of non-availability of Data Centre, the DR Centre should be able to operate all the applications for the smart city components. The DR Centre will have all the functionality and infrastructure similar to the Data Centre.

Disaster Recovery Centre will be 50% of Data Centre site, it is mandatory to have two separate physical locations and distance itself through seismic zones.

#### 6.8.2. Design, Configuration, Installation and Commissioning of DC and DR

1. MSI shall be responsible for detail designing and solutions architecture of the required infrastructure, setup, and applications of ASCL. The premise shall be a software defined data centre, which has zero dependency on the proprietary hardware.
2. Understanding the existing infrastructure, setup, software, applications of ASCL, and planning for DC-DR solution.
3. MSI must ensure that the virtual machine is on a separate network tenant and virtual LAN. Also, micro segmentation shall be part of solution architecture which enables the fine grained security policies to be assigned to data centre applications down to workload level.
4. MSI must ensure that virtual machines have private IP networks assigned to VM.
5. MSI must ensure that all the managed hosted VMs are in same network segment (VLAN) even if they are spread across DC-DR.
6. In case of scalability like horizontal scalability, the MSI should ensure that additional required networks are provisioned automatically from the same network segment.
7. MSI must ensure that ASCL has the ability to map private IP addresses of VM to public IP address as required from portal.
8. MSI must ensure that public IP addresses of VMs remains same even if VM gets migrated to another datacentre due to any incident.
9. MSI must ensure that public IP addresses of VMs remains same even if VM network is being served from DC-DR.

10. MSI must ensure that the public network provisioned for VMs is redundant at every point.
11. MSI must ensure that VMs are accessible from ASCL private networks if private links P2P/MPLS is used.
12. MSI must ensure that there is access to VMs if there is a requirement to access it using IPSEC/SSL or any other type of VPN.
13. MSI should ensure that VM network is IPv4 and IPv6 compatible with segregated ports.
14. MSI should have provision of dedicated virtual links for data replication between their multiple data centres in order to provide secure data replication for DR services.
15. MSI should ensure use of appropriate load balancers for network request distribution across multiple VMs.
16. MSI shall propose the system that has capacity planning built into the system, which provides ASCL the transparent view of the system resources used and required for future expansion.
17. MSI shall provide the capabilities to assign role based access and ability to templatelize the VM, applications based on the workload.
18. MSI shall propose the system that has ability to define redundancy levels for each workload across the cluster.
19. Reduction in data centre footprint over traditional silos architecture for power, cooling and space savings.
20. MSI shall require while architecting the solution which works on the software defined data centre conceptualization inside the firewall & further workloads which cannot be virtualized on bare metal or physical server that shall be used for the software defined storage pool.
21. MSI is required to locate all hardware/software and related items as per design offered for smart city infrastructure including SLA monitoring and help desk management, in above Data Centre complying with standard guidelines as per Telecommunications Infrastructure UPTIME/TIA-942.
22. Data Centre shall be available for 24 x 365 operation.
23. Smart city infrastructure shall have built-in redundancy and high availability in computing and storage to ensure that there is no single point of failure.
24. MSI shall submit to ASCL adequate documentation/evidence in support of the choice of the Data Centre to meet the project requirements.
25. Minimum guiding factors for selection of data centre: Following are benchmark requirements which should act as guiding factors for MSI to select and propose locations for Data Centre

- There should be dedicated rack space available in the data centre for entire smart city solutions/infrastructure.
- Access to data centre space where the smart city project infrastructure is proposed to be hosted should be demarcated and physical access to the place would be given only to the authorized personnel.
- Racks to be caged.
- Smart City Data Centre should be as per Telecommunications Infrastructure Standard for data centres and should be 27001 certified. The required certification to be enclosed along with the technical bid response.
- It should have an access control system implemented for secured access.
- Indoor CCTV cameras would be required to be installed to monitor the physical access of the system from a remote location.
- If required, it should be possible to depute police personnel for physical security of the premises.

26. Video feeds shall be stored for 30 days online/real-time and shall be securely archived for 1 year, which is flagged or is registered in evidence. The transaction data for minimum 1 year shall also be stored within the data centre infrastructure.
27. In case the data centre services are to go down due to any unforeseen circumstance, the Command Centre should have access to video feeds of previous 30 days and transaction data for min 1 year from this data backup facility.
28. Access logs to be stored for entire duration of contract and handed over to ASCL upon termination/expiry of the contract.
29. MSI must provision for storage and availability of archived/flagged video data of incidents and events on an archival server at the Police Control Room. Admin/Operator in the police control room should have access to this data though client workstations or web enabled clients.
30. The operator should be able to export archived video directly from the archival server and produce the same when needed in court of law or for other requirements.

**DC Minimum Characteristics:**

1) Data Centre Availability: The availability of data from the hardware at a location must be guaranteed to 99.982% availability.
2) Redundancy and concurrent maintainability. It requires at least n+1 redundancy as well as concurrent maintainability for all power and cooling components and distribution systems. Any such component's lack of availability due to failure (or maintenance) should not affect the infrastructure's normal functioning.
3) No more than 1.6 hours of downtime per year.
4) N+1 fault tolerant providing at least 72-hour power outage protection.
5) All IT equipment should be dual-powered and fully compatible within the topology of site architecture.

**Data Centre shall primarily be divided into two zones:**

1) Server Infrastructure Zone: This zone shall host servers, server racks, storage racks and networking components like routers, switches to passive components. All the Data Centre LAN connections shall be provided through switches placed in this area. Access to this zone, where the surveillance project IT infrastructure is hosted, shall be demarcated and physical access to the place shall be given only to authorized personnel. Indoor CCTV Cameras shall be installed to monitor physical access of the system from remote location.

2) UPS and Electrical Zone: This zone shall house all the Un-Interrupted Power Supply units, Main Power Distribution Units (PDUs) to feed the components such as PAC, UPS, lighting, fixtures etc. This shall also house all the batteries accompanying the UPS components. As these generate good amount of radiation, it is advised to house these components in a room separate from server infrastructure zone.

### 6.8.3.DR Plan and Implementation

Disaster Recovery as a Service

1. MSI is responsible for Disaster Recovery Services so as to ensure continuity of operations in the event of failure of primary data centre meet the RPO (Recovery Point Objective) and RTO (Recovery Time Objective) requirements.
2. RPO should be less than or equal to 1 hour i.e., the replication cycle should run at maximum 1 hour that needs to reconsidered as it will be dependent on application to application.
3. RTO shall be less than or equal to 4 hours.
4. During the change from primary DC to DR or vice-versa (regular planned changes), there should not be any data loss.
5. Support for synchronous and asynchronous data replication.
6. Automated site to site failover and failback.
7. Support for non-identical server and storage configurations at the remote site.
8. The primary managed hosted DC-DR should be in different seismic zones.
9. MSI should provision VM's for both DC and DR.
10. During normal operations, the Primary Data Centre will serve the requests. The Disaster Recovery Site shall will not be performing any work but will remain on standby.
11. During this period, the compute environment for the application in DR shall be available on demand basis for a functional DR and minimum compute if required, as per the solution offered. The application environment shall be installed and ready for use.
12. DC Data shall be replicated on an ongoing basis at DR, as per designed RTO/RPO and replication strategy, data consistency. and integrity should be maintained.
13. Database should be in active mode at DC and passive mode at DR, data consistency and integrity should be maintained.
14. In the event of a site failover or switchover, DR site will take over the active role, and all the requests will be routed through that site. Application data and application states will be replicated between data centres so that when an outage occurs, failover to the surviving data centre can be accomplished within the specified RTO. This is the period during which the compute environment for the application shall be equivalent to DC. The installed application instance and the database shall be usable and the same SLAs as DC shall be provided. The use of this full compute DR environment can be for specific periods during a year for the purposes of DC failure or DR Drills or DC maintenance or DC major software upgrades or DC high peak load support.
15. Self-remediating security implementation which allows systems to revert to approved security state at designated interval.
16. Website and live application (both external and internal) should be routed seamlessly from MHDC site to MHDR site.
17. The MSI shall conduct DR drill one in every six months, of operation wherein the primary DC has to be deactivated and complete operations shall be carried out from the DR site. However, during the change from DC to DR or vice-versa (or regular planned changes), there should not be any data loss.
18. The MSI shall clearly define the procedure for announcing DR based on the proposed DR solution. The MSI shall also clearly specify the situations in which disaster shall be announced along with the implications of disaster and the time frame required for migrating to DR. The MSI shall plan all the activities to be carried out during the Disaster Drill and issue a notice to the Department at least 15 working days before such drill.

19. RPO monitoring, reporting and events analytics for disaster recovery solutions should be offered as part of the offering. Any lag in data replication should be clearly visible in dashboard and alerts of same should be sent to respective authorities.
20. Training should be provided to the staff members and System Administrator on DR.
21. Services provider should provide the solution document of DR.
22. Selected bidder should have proper escalation procedure and emergency response in case of failure/disaster at DC.
23. Selected bidder shall provide support for all server maintenance activities. This would include periodic health check, on-demand troubleshooting, etc. from certified vendors. ITIL processes named problem, change, incident and configuration will be followed by the selected bidder at DR site.
24. Selected bidder shall provide disaster recovery services during the event of a disaster.
25. The selected bidder shall configure all the components and sub-components for end-to-end user access to all Windows applications/services.
26. The selected bidder will have to demonstrate the DR site to run on thirty% capacity for proving successful implementation of the DR site.
27. ASCL reserves the right, on its own or via a third-party auditor, to conduct overall testing at any point of time for the services delivered by the selected bidder.
28. The selected bidder shall make provisioning of requisite software licenses, database licenses and other required monitoring software, tools for IT setup at DR site.
29. The selected bidder shall undertake installation and configuration of operating systems, databases, and storage solution and replication mechanism for all in-scope business application systems.
30. The selected bidder shall undertake installation and configuration of any other specialized applications/ software solution/hardware solution required for the disaster recovery setup.
31. The selected bidder would be solely responsible for implementation of all applications at DR site. All costs including licenses for application, OS, replication tools or databases if any shall be borne by the selected bidder
32. Automated switchover/ failover facilities (during DC failure & DR Drills) to be provided and ensured by selected bidder. The switchback mechanism shall also be automated. The selected bidder shall also provide a tool/ mechanism for ASCL DC to trigger DR switchover (MHSP to deliver Switch Over and Switch back)
33. Selected bidder shall provide support for the development of detailed activity plans for recovery for all systems.
34. Selected bidder shall provide support for the development of a detailed disaster recovery plan. This plan document will contain steps/procedures to switch over services to DR site in the event of invocation of disaster at DC site. Selected bidder shall also document steps for restoring services from DR site to DC site.
35. Selected bidder shall provide support with the development of detailed operating manuals for the implemented replication solution from system administrator's perspective.

#### 6.8.4.Testing and Validation

Following resource deployment/provisioning, the testing of the same at DC DR site becomes very important. Therefore, the service provider must perform following testing:

1) Infrastructure testing – The bidder should perform various testing procedures listed below on infrastructure (server, storage and network infrastructure) provided at managed hosted site. Indicative list of test parameters are as follows:
    - VM testing
    - Storage/Disk IO testing.
    - Network throughput and latency testing
    - CPU and RAM benchmarking testing
    - Read/Write latency testing
    - Data Replication Testing
    - Firewall policy and configuration testing
2) Data Integrity Testing, Reverse Replication Testing and Switch over testing: The MH service provider will facilitate the application vendor of ASCL to carry out these/such testing, whenever required.

#### 6.8.5.Post Implementation Maintenance and Support

The service provider shall maintain and manage the system for the entire period of the contract and shall be fully responsible for ensuring adequate CPU processing power, memory, storage, network, internet bandwidth and monitoring of the MH services for optimum performance of the entire managed hosted solution conforming to SLAs as per the Contract. The successful bidder has to provide post implementation support to maintain SLAs. During the O&M period (defined as period of 5 years), if the successful bidder is unable to comply with the support terms as mention in later section, the bidder will have to a pay a Penalty as specified under the SLA of this project. Post implementation support would also include support during scheduled DR drills (once every 6 months, which shall be monitored by ASCL), during regular operations while only replication is taking place, in disaster scenario when DR is active and operational, and during switchover and switchback.

#### 6.8.6.Security Audit

The service provider shall conduct vulnerability and penetration test (to be conducted by a third-party testing agency which should be CERT-IN empanelled and which is approved by ASCL) on the proposed managed hosted solution in every one year and reports should be submitted to ASCL. Corrective action should be taken by the service provider within 3 months of the date of submission of the report. Compliance review should be done within 4 months of the date of submission of the report. Any non-compliance in the reports may lead to penalty clauses. The service provider needs to update the system in response to any adverse findings in the report. ASCL may also depute auditors to conduct security check/vulnerability test/penetration test.

#### 6.8.7. Managed Hosting DataCentre Specification

1. The primary managed hosting datacentre location should not cause a latency of more than 15 millisecond (roundtrip) of access time from the ASCL ICC.
2. The access network to the primary hosting location should be redundant, resilient and sufficiently provisioned to ensure a near real-time operational response with no single point of failure.
3. The primary site must have a redundant architecture for all applications and ensure no single point of failure.

4. The hosting locations for primary and DR site should be spread across different geolocation in different seismic zones within India.
5. The MHSP data centres should have adequate physical security in place.
6. The MHSP data centres should comply/certified Tier III datacentre norms.
7. The Data Centre should conform to at least Tier III standard (preferably certified under TIA 942 or Uptime Institute certifications by a third party) and implement tool-based processes based on ITIL standards.

### 6.8.8. IT Infrastructure at Data Centre/ Disaster Recovery Centre

Scope of Work for Design, Supply and Deployment of IT Infrastructure for DC and DR:

**1) Hardware and Network Provisioning:**

MSI shall be responsible for following but not limited to:

- Appropriate initial sizing and provisioning of IT infrastructure like servers/storage, network devices (like routers/switches, etc.), security equipment including firewalls, etc. with the required components/modules considering redundancy and load balancing in line with minimum technical requirements.
- After deployment the MSI shall have capacity planning tool which provides the complete picture of resources used and resources required for future expansion.
- Warranty for all IT hardware assets procured to comply with the requirements as defined in this RFP.
- Size the bandwidth requirements across all locations considering the application performance, replication, data transfer, internet connectivity for DC and DR and other requirements.
- Furnish a schedule of delivery of all IT tnfrastructure items.
- Ensure all hardware requirements of application suite (including third-party applications), databases, OS and other software are met.
- ASCL may, at its sole discretion, evaluate the hardware sizing. The MSI needs to provide necessary explanation for sizing to ASCL.
- Ensure that the servers should accommodate newer versions of processors, memory, etc. that support enhanced capability (e.g., lower power footprint, higher working temperature, smaller process architecture, higher frequency, etc.) of operation if required, whenever they are available. To further clarify, motherboard, controllers, etc., provided shall be of latest architecture available that supports such newer version. MSI shall substantiate with proof; preferably with an undertaking to replace the processors as and when such processors of highest level of frequency are supported.
- Server models wherever applicable shall be blade mount servers with keyboard, monitor, etc. shared to minimize the requirement of rack space in DC and DR considering any space constraints.
- Broad range of different server footprint supporting high-density configurations and high-performance/large-capacity/storage-only configurations.
- Qualified hardware from more than 1 server vendor.

**2) Provisioning Switches:**

- MSI shall size and propose requisite switch at DC and DR with the required components/modules considering redundancy and load balancing.
- MSI shall size and propose other switches required for interconnecting various segments, operations centre, work area, etc.

**3) IP Address Schema:**

- MSI shall design suitable IP schema for entire Local Area Network including DC and DR and interfaces to external systems/network. MSI shall ensure efficient traffic routing irrespective of link medium.
- MSI shall maintain the IP schema with required modifications from time to time during the project period.
- MSI should provide unique identity schema similar to addressing schema for all hardware components.

**4) Sub-Networks and Management of Network Operation**

- Architecture of DC & DR shall be divided into different sub-networks. These networks shall be separated from other networks through switches and firewalls. Logical separations of these sub-networks shall be done using VLAN.
- Separate VLAN shall be created to manage the entire network. This network shall have systems to monitor, manage routers, switches, Firewalls, etc. The MSI shall provide necessary hardware/server for loading the monitoring software if required.

**5) Provisioning Storage**

- Storage requirements for the application suite shall have to be assessed by MSI and the storage solution shall be sized and procured accordingly. MSI shall propose appropriate storage mechanism to accommodate proposed application suite requirement of ASCL.
- Proposed storage shall be configured with appropriate redundancy to maintain business continuity based on the application and workload.

**6) Network Equipment Level Redundancy**

- MSI shall provide real-time redundancy at the network equipment level in data centre, and there shall not be any single point of failure.
- All equipment shall be provided with dual power supply modules. Each of the two supply modules shall be connected to alternate power strips of the network rack (two power strips to be provided in each network rack).
- Network equipment redundancy stipulations wherever prescribed are minimum requirements that MSI needs to consider. However, MSI needs to estimate and plan actual requirements considering service level requirements specified in this RFP.

**7) Provisioning IT Security Equipment**

- MSI shall size and propose firewalls with required components/modules for DC/DR.
- Necessary IDS/IPS shall be provided for monitoring traffic of all VLANs at DC/DR.
- Necessary devices for log capture from servers, network equipment and other devices shall to be provisioned.

- MSI shall implement DNS server so that the URL can be used instead of accessing web server using IP address directly. The required Hardware and Software for DNS server at DC and DR shall be provisioned by MSI.
- MSI shall implement management systems and procedures that adhere to ASCL's security policies.
- MSI shall secure network resources against unauthorized access from internal or external sources.
- MSI shall also provide a mechanism for tracking security incidents and identifying patterns, if any. The tracking mechanism shall, at a minimum, track the number of security incident occurrences resulting in a user losing data, loss of data integrity, denial of service, loss of confidentiality or any incident that renders the user unproductive for a period of time.
- MSI shall ensure that all firewall devices are staged and comprehensively tested prior to deployment. In addition, SI shall conduct a vulnerability scan and analysis of the network to ensure that the optimal policies are instituted on the firewall.
- MSI shall ensure that all firewall management is initiated from a segregated management rail on the network.
- MSI shall provide intrusion management services to protect ASCL's resources from internal and external threats.
- MSI shall provide ASCL with the necessary hardware/software required for efficient intrusion management.

Both DC and DR sites shall have built-in redundancy and high availability in compute and storage to ensure that there is no single point of failure. There shall be no loss of video recording in a CCC in case of failure of any single server and storage component.

MSI shall establish dedicated connectivity between DC and DR sites for replication and failover. MSI shall design the DC and DR solution with the necessary load balancing, replication and recovery solution that provide 1 hour RPO (Recovery Point Objective) and RTO (Recovery Time Objective) of 4 hours.

DC and DR site shall be periodically audited, updated and mock drills shall be performed along with the findings and improvement/corrective steps to be taken to concern ASCL.

MSI shall submit the detailed solution document for DC and DR Site solution with justification for the proposed design meeting the requirements along with the bid.

6.8.9. **Back Up Solution**

1) Backup solution shall have same GUI across heterogeneous platforms to ensure easy administration and available on various OS platforms such as Windows, Linux and UNIX platforms and be capable of supporting backup/restores from various supported platforms.
2) Backup solution should have ability to backup data from one server platform and restore it to another server platform to eliminate dependence on a particular machine and for disaster recovery purposes.
3) Backup solution should support various level of backups including full, incremental, and user-driven backup along with various retention period.

4) Backup clients should be updated automatically using the client push feature.
5) Backup should support agentless backup for virtualization platform with non-staged granular recovery.
6) Backup software should support intelligent policy for virtualization.
7) Backup software must provide source (client and media server) and target base data deduplication capabilities.
8) Backup Solution should Integrate with third-party VTL, NAS, SAN which has data deduplication capabilities and robotic/automated tape library.
9) Backup solution must have wizard-driven configuration and modifications for backup, restoration and devices.
10) Backup solution shall have in-built frequency and calendar based scheduling system.
11) Backup solution must have optimized way for data movement from client to disk target.
12) Backup solution should support (inflight and at rest) encryption and data encryption from more than three algorithms.
13) Backup solution shall support tape mirroring of the same job running concurrently with primary backup.
14) Backup solution shall allow creating tape clone facility after the backup process.
15) Backup solution should have capability to do trend analysis for capacity planning of backup environment.
16) Backup solution must offer user/capacity-based licensing. License should be for the front-end capacity rather than back-end. There should be no incremental cost associated with longer retention periods.
17) Backup solution should not require purchase of additional licenses for DR sites (copies of original data), also should not require purchase of additional licenses for replication to DR sites.
18) Software license should be independent of hardware so replacing hardware should not incur new software license cost.
19) Backup solution must include agent/modules for online backup of files, applications and databases natively for PostgreSQL, MS SQL, Oracle, DB2, Sybase, Exchange, SharePoint and File Share Backup(SMB)
20) Backup solution should provide recovery from physical servers to virtual and image level recovery.
21) Backup solution should have DC/DR plug-ins for backup data replication.
22) Backup solution should have Inbuilt feature for extensive alerting and reporting with pre-configured and customizable formats.
23) Backup replication at DR site, DC/DR. Replication license should be included as part of solutions.
24) Backup software should support multiplexing and multi streaming and shall support the capability to write up to minimum 32 data streams.
25) Backup solution should have capabilities to tape/disk out backup catalogue and deduplication catalogue.
26) Backup solution should have integrated data de-duplication engine with multi-vendor storage support to save de-duplication data. De-duplication engine should also facilitate IP base replication of de-dupe data; without any extra charge.
27) Backup solution must have built-in capability to protect the backed up disk volumes from malware.

### 6.8.10. Enterprise Management System (EMS)

To ensure ICT systems are delivered at the performance level envisaged, it is important that an effective monitoring and management system be put in place. It is thus proposed that a proven Enterprise Management System (EMS) is proposed by the bidder for efficient management of the system, reporting, SLA monitoring and resolution of issues. Various key components of the EMS to be implemented as part of this engagement are:

1) Network Monitoring System
2) Server Monitoring System
3) Helpdesk System

The solution should provide a unified web based console, which allows role based access to the users.

#### 6.8.10.1. **Network Management System**

Solution should provide fault and performance management of server side infrastructure and should monitor IP\SNMP enabled devices like routers, switches, PA systems, emergency call boxes, sensors, etc. Proposed network management shall also help monitor key KPI metrics like availability to measure SLA's. Following are key functionalities that are required which will assist administrators to monitor network faults and performance degradations to reduce downtimes, increase availability and take proactive actions to remediate and restore network services.

1) Proposed solution must automatically discover manageable elements connected to the infrastructure and map the connectivity between them. Solution should provide centralized monitoring console displaying network topology map.
2) Proposed solution should provide customizable reporting interface to create custom reports for collected data.
3) System must use advanced root-cause analysis techniques and policy-based condition correlation technology for comprehensive analysis of infrastructure faults.
4) System should be able to clearly identify configuration changes and administrators should receive an alert in such cases.
5) Tool must be able to track all network flow (including NetFlow v1-v9, Jflow, Sflow and IPFix) of traffic on the network and identify malicious behavior with all IP to IP and IP to Application conversations

Tool must provide high availability, simple backup and restore options in disaster recovery situations

#### 6.8.10.2. **Server Performance Monitoring System**

1) Tool should integrate with network performance management system and support operating system monitoring for various platforms supplied as part of this project.
2) Tool must provide information about availability and performance for target server nodes.
3) Tool should be able to monitor various operating system parameters such as processors, memory, files, processes, file systems, etc. where applicable.
4) Tool must support SNMP v1-3, WMI, PowerShell, SSH, JDBC, HTTP, JMX, collected agents, Rest API based monitoring interface for monitoring various type of devices and systems.
5) Tool must provide application monitoring capabilities to monitor application response time and usage behavior.

6) Tool must support logs collected from commercial and proprietary applications. For assets not natively supported, the solution should provide the collection of logs through customization of connectors or similar integration.
7) Tool must provide the ability to store/retain both normalized and the original raw format of the log data for the period of 3 months and allow to extend it to further without any disruption to the ongoing data collection.
8) Tool must provide SDK/Rest API for North bound and South Bound Integrations e.g., forwarding specific metric data to third-party database, notifications to third-party systems,

#### 6.8.10.3. **Centralized Help Desk System**

1) Proposed help desk solution must provide flexibility of logging, viewing, updating and closing incident manually via web interface for issues related to surveillance project.
2) Help desk system should provide incident management, problem management templates along with help desk SLA system for tracking SLA's pertaining to incident resolution time for priority/non-priority incidents.
3) Helpdesk system shall support ITIL processes like request management, problem management, knowledge base management and change order management with out-of-the-box templates for various ITIL service support processes.
4) Help desk solution must have a built-in workflow engine to define escalations or tasks to be carried out after issues or change order are logged pertaining to surveillance project.
5) Solution should provide a clustered view of recurring themes hidden in the huge quantities of data for spotting service desk trends easily.
6) Help desk should have capability to automatically categorize, understand the impact, and assign the service desk ticket to relevant helpdesk team members.
7) Centralized Help Desk System should have integration with network/server monitoring systems so that the help desk operators can associate alarms with service desk tickets to help surveillance operators with thich alarms corresponding helpdesk tickets got logged.
8) The proposed solution should tightly integrate with monitoring system to provide two-way integration.For example, when a system down alarm is created, it should automatically create a ticket and assign it to a technician. In case the system comes up before the ticket is resolved by technician, it should automatically close the ticket to minimize human effort. Help desk should have an integrated CMDB to automatically collect and manage accurate and current business service definitions, associated infrastructure relationships and detailed information on the assets.
9) It must be a centralized monitoring solution for all IT assets (including servers, field level infrastructure etc.).
10) Solution should provide inventory of all the discovered devices. Out of box inventory fields should be available and it should have provision to add additional fields as required.
11) SLA and contract management module of help desk should be able to capture all the system based SLAs defined in this RFP and then calculate quarterly (or for any duration) penalty automatically. Measuring service performance requires incorporation of a wide variety of data sources. SLA solution should support the collection data from various sources in order to calculate uptime/performance/security SLAs.
12) Help desk must have integrated dashboard providing view of non-performing components/issues with related to service on any active components.

13) Solution must support service level agreements version control and audit trail to ensure accountability for the project.
14) Solution should support requirements of the auditors requiring technical audit of the whole system.
15) Solution most have an integrated dashboard, view of contract parties and current SLA delivery levels and view of services and current SLA performance.
16) Solution should support SLA Alerts escalation and approval process.
17) A general process flow for the help desk management is depicted in the flow chart given as follows. Systems Integrator shall prepare a detailed Helpdesk Policy in consultation with ASCL prior to Go Live date.

#### 6.8.11. Reporting

1) Solution should provide historical and concurrent service level reports to ensure accountability of the service provider's performance.
2) Automatic report creation, execution and scheduling, must support variety of export formats including Microsoft Word, Adobe PDF etc.
3) Support real-time reports (like at-a-glance status) as well as historical analysis reports (like Trend, TopN, Capacity Planning Reports etc.).
4) Solution must support security for drill-down capabilities in dashboard reports ensuring visibility for only relevant personnel of the surveillance project.
5) Resource utilization exceeding or below customer-defined limits.
6) Resource utilization exceeding or below predefined threshold limits.
7) Network management function should be able to do traffic analysis. Traffic analysis must include bandwidth utilization patterns by protocol/source/destination, Network response time patterns for various applications over the network. It should help with out-of-the box analysis reports to understand top bandwidth consumers by application, source, or destination. It should help with advanced reporting features to provide various reports that help understand capacity needs of the network bandwidth based on current utilization and response time trends.
8) Solution should be able to also provide a threshold and profile capability on the KPIs monitored on the network to understand the impact of failures and degradations, which eventually results in revenue loss.
9) Should support automatic base lining on historical data, and thresholds that can be adjusted as required, based on data collected.
10) Solution should offer off-the-shelf reports for KPIs such as availability, uptime, and resource.

#### 6.8.12. Centralised Anti-virus Solution

The following features are required for centralized anti-virus solution, to protect all computing resources (servers, desktops, other edge level devices, etc.):

1) Ability to scan through all file types and various compression formats. Ability to scan for HTML, VBScript viruses, malicious applets and ActiveX controls.
2) Must update itself over internet for virus definitions, program updates etc. (periodically as well as in push-updates in case of outbreaks).
3) Able to perform different scan actions based on the virus type (Trojan/Worm, Joke, Hoax, Virus, other).
4) Shall provide real-time product performance monitor and built-in debug and diagnostic tools, and context-sensitive help.
5) The solution must provide protection to multiple remote clients.

6) Shall provide for virus notification options for Virus Outbreak Alert and other configurable conditional notifications.
7) Should be capable of providing multiple layers of defense.
8) Shall have facility to clean, delete and quarantine the virus affected files.
9) Should support online update, where by most product updates and patches can be performed without bringing messaging server off-line.
10) Should support in-memory scanning so as to minimize disk IO.
11) Should support multi-threaded scanning.
12) Should support scanning of nested compressed files.
13) Should support heuristic scanning to allow rule-based detection of unknown viruses.
14) All binaries from the vendor that are downloaded and distributed must be signed and the signature verified during runtime for enhanced security.

#### 6.8.13. Central Identity Management Service

This service will handle user life cycle management and governance that will enable all smart cities to manage the lifespan of the user account from its initial stage of provisioning to the end stage of de-provisioning. Typically user provisioning and de-provisioning is workflow driven that will require approval. The solution should cover user role discovery and entitlement. Similarly, it should be capable of integrating with privileged user account. User management service will cover user administrative functionalities like creation, propagation and maintenance of user identity and privileges.

Self Service feature will allow end users (e.g., members) to maintain their user identity account including self-password reset, which will significantly reduce help desk/admin effort to handle password reset requests.

The central user repository will store the user identity data and deliver it to other services (e.g., central authentication service) for credential verification. Adherence to LDAP v3 standard has been the dominant standard for central user repository. Enforce a robust and strong password policies that will allow users to change/reset password with password expiry and account lockout features, define and implement complex password rules and session timeout policies.

#### 6.8.14. Authorization

Authorization of system users should be enforced by access controls. It is recommended to develop access control lists. Consider the following approach for developing access control list -

1) Establish groups of users based on similar functions and similar access privilege.
2) Identify the owner of each group
3) Establish the degree of access to be provided to each group

#### 6.8.15. Unified Collaboration Solution

The proposed Unified Collaboration Solution should be software (virtual) based PBX capable of providing following functionalities: The collaboration client application must enable streamline communications and enhances productivity with integrated presence, IM, voice and video, voice messaging, call queuing, desktop sharing, and conferencing capabilities. The System must be capable of calling between operators and outside

PSTN or mobile networks. The system should have capabilities of achieving collaboration between any users of control room. It must be possible to record all session audio, video, data for training/records purpose. Also, the system should have capabilities of enabling meetings between admin/other users for taking updates on day to day operations. The collaboration solution should natively comply with TRAI Regulations. The collaboration solution should have capability to integrate with emergency response/radio sispatch systems.

The solution must comprise of following equipment with quantities as specified in the RFP document at respective locations: IP phones, soft phone clients, fully integrated HD video conferencing unit, advanced collaboration interactive unit, multipoint control unit, and an IP PBX capable of managing all devices present in the system. The proposed system should be capable of recording a minimumof 10 concurrent meetings/sessions (audio, video, and data). A PRI Voice Gateway should be provided in high-availability mode to interface with the external world.

- **Soft Phones / IP Phones:** The IP based telephone exchange system shall also provide following Unified Communication Services/Facilities as a minimum. The OEM of this UC services/facilities shall be same as that of IP based telephone exchange system and integration of UC server with the basic Communication Server shall be purely on IP. The UC application shall have a friendly, intuitive, and easy to use graphical interface that informs in real time the multiple states of presence using the user-defined list.

- **Integrated HD Video Conferencing Unit with Built-in HD Display, Audio System and Microphone**

- **Three Screen Telepresence System**

- **IP PBX Solution:** The network must have SIP based call control system. The solution architecture must support call control functionality either centralized or distributed across multiple nodes across WAN for enhanced redundancy. The system should have IP capability for interfacing and communicating with voice, video and data infrastructure along with GUI support for web based management console. Further, it should be possible to monitor the call control system i.e., system performance, device status, device discovery, CTI applications, voice messaging ports etc.

- **High Definition Multipoint Control Unit (MCU)**

## 6.9. City Communication and Network Infrastructure

### 6.9.1. Scope of Work

1) MSI should tie up with an Internet Service Provider or Telecom Service Provider to provide connectivity from field device infrastructure to physical location of ICCC and Data Centre/Disaster Recovery Centre at Cloud.
2) MSI should use public internet for transmission of information between field devices infrastructure to the core router. Required security applications should be factored in to avoid hacks at field devices infrastructure level.
3) MSI should estimate the bandwidth requirement for connectivity to desired Cloud Service of DC/DR and the same shall be clearly provisioned in the technical proposal with detailed calculations.
4) Connectivity between ICCC and Data Centre/Disaster Recovery Centre shall be mentioned explicitly and approved from ASCL.

5) Bandwidth provisioned needs to adhere to following minimum benchmark requirements:
    - Latency should be less than 15 ms.
    - Jitter should be less than 2% of one-way latency.
    - Packet loss should be less than 0.01%.
6) MSI shall meet the parameters of video feed quality, security, and performance. MSI should factor the same while designing the solution.

### 6.9.2. Security Requirements for Network as a Service

1) Every field device should be authenticated in the IoT Platform before being able to access to the network resources
    - Field devices should use X.509 certificate based authentication.
    - Certifying Authority chosen, should be mutually agreed upon.
    - Along with X.509 certification, device should also support authentication.
2) Other information regarding the security is mentioned in IoT Platform section.

### 6.9.3. Network Operations Centre

It is proposed that a Network Operations Centre (hereinafter referred to as "NOC") shall be established for monitoring the network infrastructure through which the connectivity to be established with Service Provider. MSI will have to discuss and get into an agreement with concerned ISP (providing connectivity and bandwidth) for extending their NOC to the City Operation Control Centre.

The NOC shall analyze network problems, perform troubleshooting, communicate with various AMC officials/technicians, and track problems through resolution. The key objective of the NOC is to ensure the health and availability of components. When necessary, NOC shall escalate problems to the appropriate stakeholders. The MSI shall develop service catalogue for NOC and get a sign off on the same from purchaser/authorized entity.

The overall Scope of Work (SoW) for the MSI shall be establishing a Network Operation Centre (NOC). Primary responsibilities of NOC personnel shall include but not limited to:

1) **Network Supervision and Monitoring**: Monitor the complete network 24/7, to keep network and systems functioning in a stable operation mode.
2) **Configuration Management:** Ensure the proper configuration of network, systems, and applications for the provision of reliable and high-quality end-user services.
3) **Change Management, Network Extension**: Ensure efficient day-to-day management of short-term network changes and optimization, including their implementation. This activity shall be synchronized with the maintenance scheduled activities.
4) **Performance Management:** Provide efficient performance management procedures ensuring a reliable, high-quality network performance and service.
5) **Service and Network Provisioning:** Define all necessary actions to be performed when a request for a new customer service is issued by customer care, and control the actions performed at NOC level or field level until completion.

6) **Scheduled Activities Planning**: Provide regular plans for all scheduled activities, including preventive maintenance. Respect a schedule, and achievement of the plan. This is linked to the change management function which ensures overall synchronization of all network activities
7) **Security Management:** Define and implement security policies, guidelines, and best practices, and check for compliance with security regulations.
8) **Quality Management:** Define quality management policies, and ensure implementation and usage for competitive quality of service.
9) **Workforce Management:** Manage field personnel to ensure timely interventions and respect of the preventive maintenance plan
10) **Network Inventory Management:** Ensure consistent management of network equipment, and accurate, up-to-date documentation of it.
11) **Repair and Return:** Receive and repair defective boards, return repaired or replacement boards.

**Features of NOC**

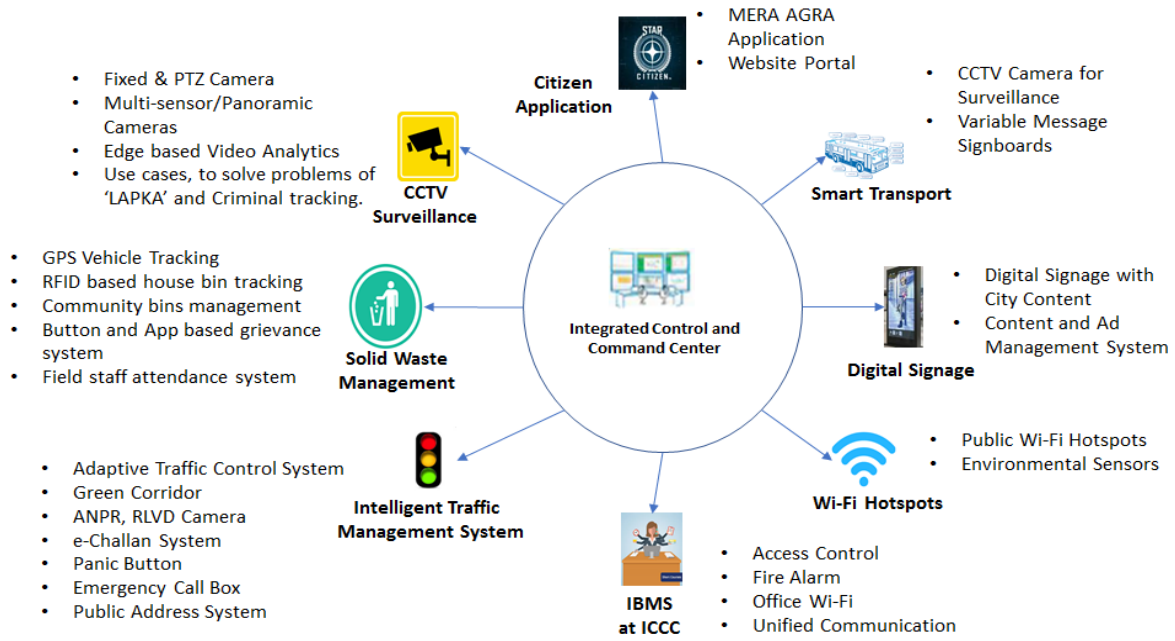
1) Incident Management based on resource workload, incident category etc.
2) Tracking and reporting of all contractual SLAs in an automated way.
3) Updateable knowledge base for technical analysis and further help end-users to search solutions for previously solved issues.
4) The NOC shall escalate issues in a hierarchical manner, so if an issue is not resolved in a specific timeframe, the next level is informed to speed up problem remediation.

## 6.10. Integrated Centralized Command and Control Centre (CCC)

### 6.10.1. Scope of Work

City Operation Command Centre (OCC) main objective is to break silos between departments and in departments, make processes integrated to serve public in an efficient manner. As part of Agra Smart City; it is proposed to build one common operation centre. This centre will provide an integrated view of all smart component projects identified in this document, its primary focus is to serve as a decision support engine for city administrators in day-to-day operations or during emergency situations.
This centre, shall leverage information provided by various departments and provide a comprehensive response mechanism to the day-to-day challenges across the city. City Operation Centre will be a fully integrated, client-server/web-enabled solution that provides seamless incident-response management, collaboration, and geo-spatial display. Various ICT projects shall be able to use the data and intelligence gathered from operations of other elements so that civic services are delivered more efficiently and in an informed fashion.

MSI shall develop application module for the smooth operation of City Operation Command Centre, and shall deploy support and maintenance manpower at the OCC. To ensure that ICT systems are delivered at the performance level envisaged, it is important that an effective monitoring and management system be put in place. It is thus proposed to have a proven Enterprise Management System (EMS) for the efficient management of the system, reporting, SLA monitoring and resolution of issues.




A state-of-the-art Command Control Centre is required to be established as part of the City Surveillance solution. The proposed CCC shall handle feeds from field cameras and display them on the video wall in the CCC and shall provide necessary interface for integrating with other applications and response mechanism as required by ASCL, it shall present a Common Operating Picture (COP) of real-time events in the area of surveillance. Functions of the Command Control Centre shall include but not limited to the following:

- Video Surveillance
- Video Investigations
- Emergency Response Activities
- Video Data Storage and Retrieval

Command Control Centre shall work in fully automated environment for optimized monitoring, regulation and enforcement of traffic with various law enforcement services. Various applications/ modules like ANPR/RLVD/E-Challan specified in this RFP shall be integrated into one functional system and shall be accessible by operators and concerned agencies with necessary login credentials. The operators shall be able to access master data like Vahan and Sarathi databases (that are available with the government agencies, which can be integrated). The integration with such systems will be in the scope of MSI.

Location for Command Control Centre shall be provided by ASCL. Responsibilities of MSI shall include site preparation activities. MSI shall ensure that the Command Control Centre shall manage, control and integrate various systems in a seamless manner. Command Control Centre shall provide a comprehensive system for planning, optimizing resources, and response. The system shall thus be an "end-to-end" solution for safeguarding and securing people and assets.

MSI shall be required to undertake detailed assessment of requirements at Command Control Centre and prepare a plan to implement Command Control Centre and commission required IT and non-IT infrastructure and civil/structural/electrical work as required.

Data and surveillance network shall share the same physical infrastructure with guaranteed bandwidth for each individual segment. The software components should provide comfortable monitoring experience, easy extraction of clips and management of storage.

The video feed from surveillance cameras shall be received at Command Control Centre where a video wall shall be installed for viewing. The surveillance team shall receive live feeds from surveillance camera and shall also control PTZ camera using joysticks. They shall be alerted if an incident is detected through video content analytics, ANPR/RLVD system, events generated from various sensors sending feeds to Command Control Centre, and shall be able to view relevant feeds from surveillance cameras. The operator on each workstation shall be able to work on multiple monitors at the same time, for which there multi screens with one computer (specifically three) to be installed on work desks (with appropriate furniture) with appropriate multi monitor mounts.

### 6.10.2. Design and Implementation of ICCC Control Room

#### 6.10.2.1. General Requirements/Overview of Proposed Facility

The specification covers Design-Build, transportation to site, site installation, and site acceptance of control room consoles.

The desking solution shall conform to high standard of engineering as mentioned in the document; meeting the specified codes, standards and designs. It shall be capable of performing 24X7 operations under the specified environmental condition.

Workmanships shall be of highest standards meeting the specified requirement/purpose.

The supplier shall refer country specific anthropomorphic data and ergonomic standards to define the dimensions and equipment layouts, to suits the 95th percentile of country's population.

#### 6.10.2.2. Scope of Work – Control Desk

1. The scope of the work shall be Design-Build-Install basis but shall not be limited to the following:
   - Designing, manufacturing, testing, integration etc., all complete, preparation of the related drawings, documents, etc., of the consoles shall be in the supplier's scope. The consoles shall confirm the requirements and specifications of this bid document.
2. In broad, the scope of work and supply shall consist of the following parts:
   - Design, engineering of consoles.
   - All related services for supply, installation, testing.
   - Spares and documentation.
3. Detailed scope of work and supply shall include but not be limited to the following:
   - Data collection: Gather all information related to design of the control desk.
   - Design Proposal: Submission of various options of control desk layout for client’s approval, strictly complying to latest ISO 11064 ergonomic norms.
   - General:
     - The tentative control room area shall be provided to the desk manufacturer to develop various options.

- Supply of the product catalogue, technical proposals including but not limited to drawings, documentation, 3D views, color pallets, for the complete desking solution.

- Spares: A list of manufacturer's recommended spares for operation and maintenance shall be provided.
- Provide commissioning and warranty spares (Contractor shall utilize these spares of all the equipment that may be required during commissioning and warranty period separately).
- MSI shall be responsible for safety and security of the installed items till commissioning and final acceptance by Owner (before start of warranty period).
- Quality assurance and commissioning of the complete system at site to the complete satisfaction of the Owner/Consultant.

#### 6.10.2.3. **Scope of Work – Control Room**

The scope of the project includes designing; engineering, supply and installation of 24X7 mission critical Control Centre Interiors. As the Control Room is a significant place, it is imperative that it is designed properly in terms of aesthetics, ergonomics and functionality. Various aspects should be considered while designing the control room area to create an ideal work place, considering physiological aspects such as line of sight and field of vision, and cognitive factors such as concentration and perceptivity as per ISO 11064.

The design of systems, equipment and facilities shall reflect human factors requirements including the following:

- Satisfactory environmental conditions for operator personnel. Including noise, air flow, temperature and humidity, and precautionary measure under uncontrolled conditions (like fire) beyond acceptable limits.
- Adequate space for personnel and equipment for the movements and activities they are required to perform during operation and maintenance, under both normal and emergency conditions.
- Adequate visual/auditory status information and other communication links between personnel and equipment under normal and emergency conditions.
- Adequate illumination for the performance of operation, control, maintenance and training.
- The control room shall be built as per the criteria of "Human Factor Engineering" to improvise the efficiency utilization of the operators and provide them fatigue-free working environment.
- Objective: -
    - Ensure maximum standard of safety.
    - Allow flexibility.
    - Minimize maintenance.
    - Improve operator's efficiency and alertness.
- Designing, manufacturing, testing, integration etc., all complete, preparation of the related drawings, documents, etc. of the control room shall be in the supplier's scope. The controls design shall confirm the requirements and specifications of this bid document.
- In broad, the scope of work and supply shall consist of the following parts:
    - Interior design, engineering of controls.
    - All related services for supply, installation, testing.
    - Spares and documentation.

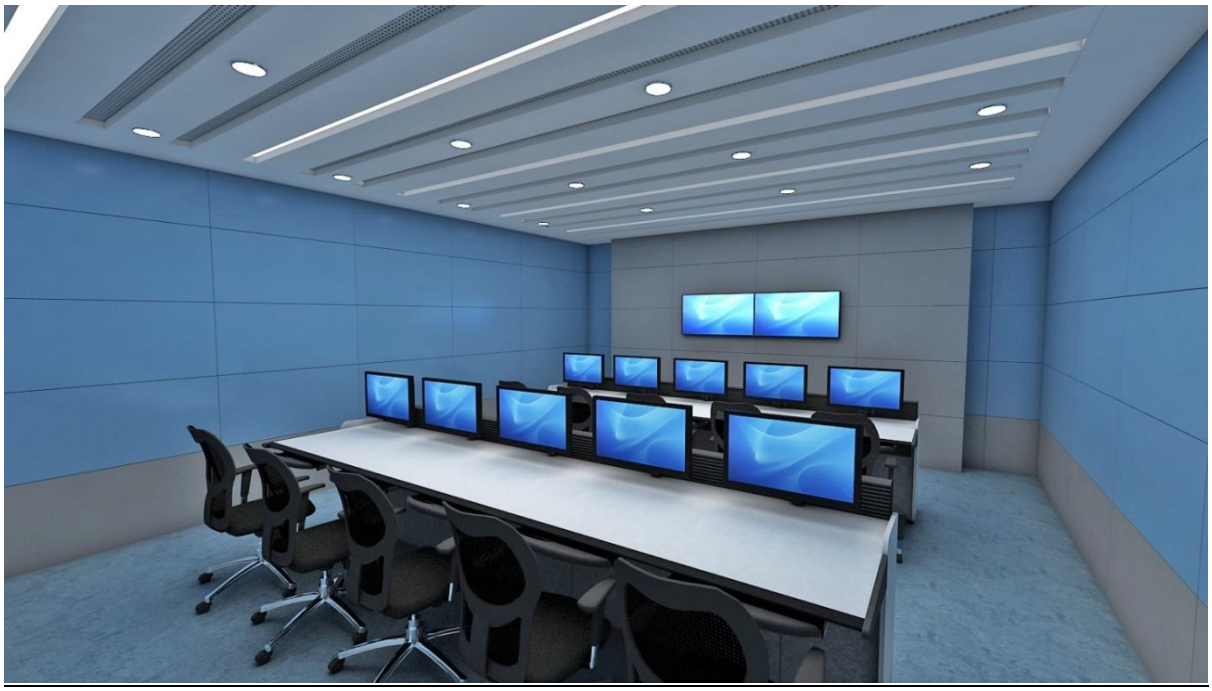
- Detailed scope of work and supply shall include but not be limited to the following:
    - Data Collection: Gather all information related to design of the control rooms.
    - Design Proposal: Submission of ISO 11064 ergonomic compliance report of console in reference to the control room layout.

### 6.10.3. Indicative Representations of Command and Control Centre

a. 3D Top View of Command Centre

b. 28-30 Seater Control Room with Viewing Gallery

c. Police Control Room for UP Dial 100



### 6.10.4. UP Dial 100 Control Room

At present there is an existing UP Dial 100 Control Room at Police Lines, Agra. The MSI should provide for display screens in the existing UP Dial 100 Control Room and/or provide for additional new UP Dial 100 Control room as part of command control Centre in the city.

A UP Dial 100 based police control room would empower people to connect to police and get police assistance anytime, anywhere at very short "response time". The objective of UP Dial 100 Police Control Room in ICCC is to receive and respond immediately to emergency calls made by public seeking police assistance by directing the patrolling police vehicles available for the purpose. The centre will be equipped with latest technological tools like GIS Map, CAD (Computer Aided Dispatch) and GPS enabled PCR VANs to handle public distress calls.

UP Dial 100 control room shall be provided with one PRI line inline hunting-single telephone number (100) to a group of 30 lines. The UP Dial 100 control system shall ensure that:

- Calls can be made to 100 from any phone whether landline or mobile.
- System has multiple caller interface and capable of receiving 30 calls at a single instance.
- Caller's name and address is automatically visible.
- Exact location of incident and nearest available police vehicle identified on GIS map.
- Status of response by police vehicle can be monitored by control room.
- Information received, police action taken shall be automatically logged into the system, generating a foolproof database of events.
- System should have facilities such as cell ID, Observed Time Difference of Arrival (OTDOA) and assisted GPS to acquire and push accurate location information for both wireless and wire line phone to emergency.

All communications in the call centre shall be recorded for future reference. A 50 TB storage capacity shall be allocated for recording voice communication through telephone line and radio gateway. The stored communication shall be available for hearing at any future point of time. The UP dial 100 control room shall be equipped with IT and Non-IT hardware and software.

#### 6.10.4.1. **Functional Requirements**

1) Basic requirements of police for setting up UP Dial 100 Control Room include but are not limited to:
    - Establishing a quick and efficient emergency response system.
    - Dispatching vehicles rapidly to required location.
    - Automation of call-taking and dispatching.
2) Computer Aided Dispatch (CAD) software platform integrates various modules:
    - CAD framework
    - Call Reception System
    - Call Recording and Logging
    - GIS (Geographical Information System)
    - AVLS (Automatic Vehicle Location System)
    - Responder Systems (Mobile Data Terminals)
    - Incident Reporting System
    - Video Interface (CCTV Video Integration to GIS)
    - Converged Communication Platforms [PSTN, Wireless (Cell Phone), SMS, email]
3) Integrated Software Platform should support all features required for efficiently handling all stages of a call made in emergency.

#### 6.10.4.2. **Operational Requirements**

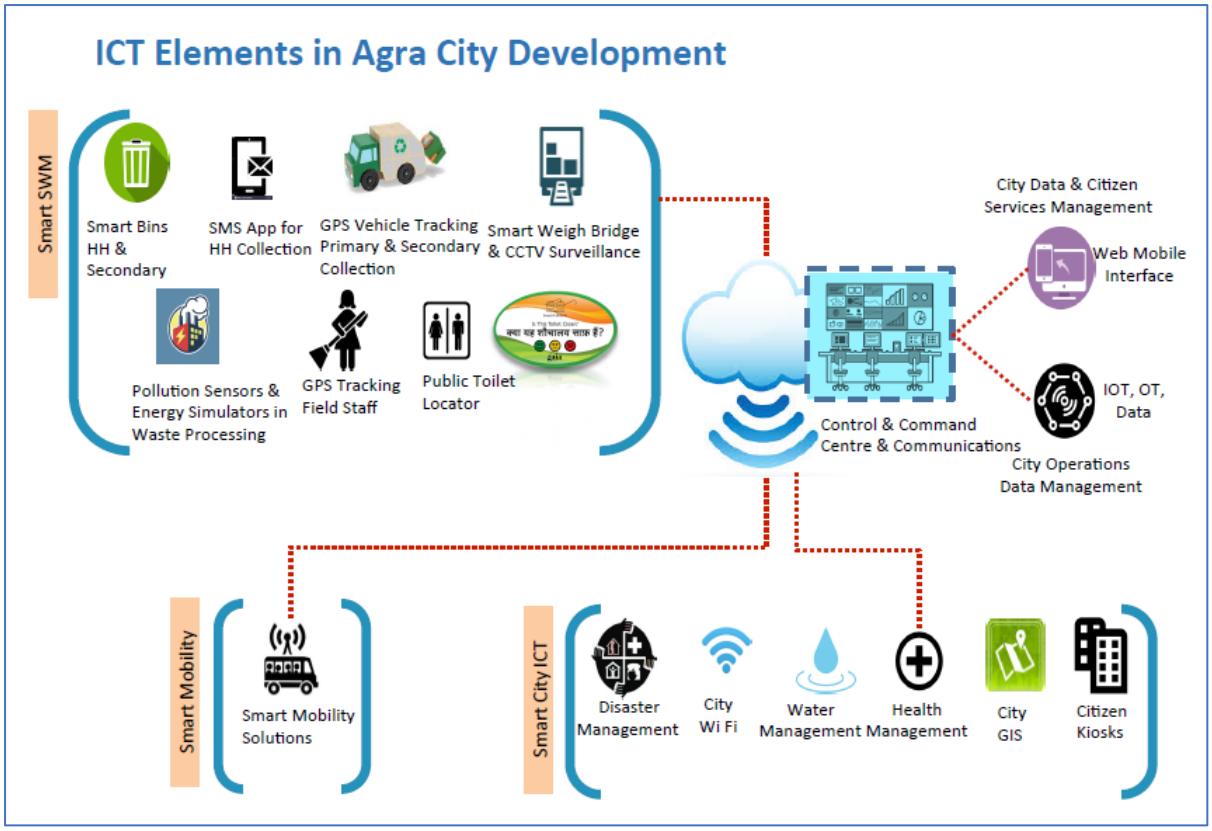
1) UP Dial 100 control room shall be equipped with EPABX comprising of 1 PRI line inline hunting-single telephone number (100) to a group of 10 lines.
2) Control room shall have seating capacity of minimum 10 operators.
3) Citizen can dial 100 for any complaints related with police. The system shall have capability to display name, address, and find the geographical position of the caller at the time of receiving call in call centre.
4) All phone calls shall be recorded for future references. The phone calls of last at least 90 days shall be stored in suitable storage system.
5) Dial 100 operators shall be able to receive call, dispatch calls, use GIS maps and can send the alerts to the nearby free patrolling vehicles on their MDT and also inform the nearest police station about the event.
6) Dial 100 operator shall be able to view the nearest fire station, hospital, blood bank for providing additional assistance at the site of incident.
7) Dial 100 operator shall also be able to use police radio network for emergency handling and for communication with PCR Vans etc.
8) A web based incident analytic software shall be made available that will help the police to do detailed analysis so that the response can be made proactively and also the effectiveness of the service is improved.
9) After the Call has been logged in by the call taker, the UP Dial 100 System shall send a SMS to the caller stating the CFS/Tracking Number along with a password as acknowledgement to the call made to the

control room. The caller can use this number on department website to access the event progress details such as Action Taken Reports (ATR), file attachments, remarks, or other information's as per the prevailing departmental policy for data sharing.

10) The analytics should have Social Media Analytics as one of the components. The city police and public functionalities need to be in touch with and accessible to general citizens especially youth, older citizens, media, etc., especially through social media. Analytics would leverage highly unstructured social media data in real time by using streaming social media analytics to identify rumors, potential threats and evolving events, find evidence through photos or track down witnesses. Analytics would also acquire location and tactical information of victims or criminals from information posted on Twitter, Facebook or other social media

### 6.10.5. City Operations Platform

1) Integrated Operations Platform (IOP) shall have IoT Platform Software (Data Normalization software) and City Operation Centre Software Functionalities.
2) All applications which have field infrastructure like – CCTV and Surveillance Components, Smart Traffic, Solid Waste Management, etc., proposed to be built as part of Smart City initiative shall pass information processing via IoT Platform.
3) IoT Layer must integrate lots of services in the current scenario and must deliver an architecture which will be future scalable and can accommodate more Services/Utility Solution Integration as available in future.
4) IoT shall be a common layer and is required for the normalization of the data from different edge applications. This layer will aggregate and integrate utilities and sensors data to ensure that device management, analytics, reporting, dash boarding and integration of the different authorities data can be performed from a single operational screen. This layer shall also integrate with different Independent Software Vendor (ISV) applications hosted at the Data Centre.




### 6.10.6. Forensic Investigation Room

1) Analysis in CCC would be graphical user interface for search, replay and to simultaneously search and replay recorded video feeds, recorded telephone systems, VOIP, Screen recording, GPS data on GIS maps, conventional and digital radio channels as well as trunked radio communications. All communications regarding a specific incident should be replayed together in the sequence in which communications occurred on a synchronized timeline to support time-coded playback of event. The solution should support event logs including operator's onscreen activities, voice and video events, etc. for further analysis, training and similar activities.
2) The software must allow simple and quick search based on frequently used search parameters.
3) The software must be capable of displaying multimedia search results graphically arranged by time of recording to allow a full view of the incident picture.
4) The software must be capable of replaying an unlimited number of multimedia channels in synchronized mode. The software must allow the user the capability of selecting and replaying part of a call, transmission, and video in either single item selection or when selecting multiple items.
5) The software should support upload of incident related information into a single folder. The information should include recordings made by the system, as well as other related files – documents, photos, video clips, etc. The software must present the incident folder storage usage.
6) The software must enable remote access to information for authorized users. This could be used by investigators, for example, in order to review evidentiary material in an organized manner rather than replay it from CD or DVD.
7) The distribution process and created incident folders must support an authentication mechanism to ensure the integrity of the incident information including audio and video recording as well as files such as

documents, photos, video clips, etc. The software must enable traceability of actions history taken on any of the incident information items.

8) The software system should provide detailed incident reporting and debriefing with time-coded playback of incident data on a single timeline.
9) It should allow synchronized playback – Exactly as it happened for postmortem analysis and review.
10) It should enable the authorities to find gaps in the incident handling and improve or rewrite SOPs.
11) CCC should have facility of integrating operator screen recording, Police (100), Fire (101) and Health (102/108) Services (whenever they are available). Coordination with these agencies is critical. The integration shall be for recording of all the data types of the above services as well as for real time transactions and response. The CCC should also be able to group locations and connect surveillance systems to respond quickly to any emergency.
12) The suite of software modules would be required to be scaled up to support any number of cameras, control rooms and client operators and would have multiple redundancy and security level options.

#### 6.10.6.1. **Functional Requirements**

1) Forensic Investigation Room shall be equipped with one video wall, four workstations, IP telephone and at least 5 operators in the city.
2) The forensic investigation room shall have seating capacity for a minimum of 5 operators.
3) The forensic operators shall have facility to see live as well as playback videos of any camera. They shall keep a special watch on few selected cameras.
4) Video analytics software shall run on selected camera feeds to be further investigated by forensic operators.
5) Forensic operators shall be equipped with software for:
   - Examination of authenticity of uploaded photos and videos.
   - Repair and recover videos.
   - Match photographs.
   - Provide forensic video enhancement of video evidence for identifying suspects.
   - Provide recorded and archived media to authorized persons.
   - Transfer the evidence into a format that can be used for legal purposes etc.
   - Post analysis of video provided through secondary source through various attributes like identified object, size, color etc.
6) Forensic operators shall also have access to recorded voice communications of dial 100 control room and radio gateway.
7) Forensic Analyst/Operator shall have following roles and responsibilities:
   - Examine, enhance and authenticate digital and analogue CCTV video evidence for both criminal and civil litigation.
   - Assist the police in respect of preparation of evidence for legal and judicial purpose in court.
   - Providing recorded and archived media to authorized persons.
   - Transfer the evidence into a format that can be used for legal purposes.
   - Provide Forensic video enhancement of video evidence for identifying suspects.
   - Attending and examining scenes of crimes.
   - Repair and recovery of evidence.

### 6.10.7. Integrated Operation Platform (IOP)

With the increasing urbanization, the operational issues are increasing which in turn affect the quality of services offered to the citizens. Various government agencies provide multiple services to the citizens. These agencies function in silos and provide a wealth of information, which can be utilized for efficient services across the city in making decisions anticipating the problems and by ensuring cross-agency responsive actions to the issues with faster turnaround time.

Integrated Operation Platform (IOP) involves leveraging on the information provided by various departments and providing a comprehensive response mechanism for the day-to-day challenges across the city. IOP shall be a fully integrated portal-based solution that provides seamless incident – response management, collaboration and geo-spatial display.

IOP shall provide real-time communication, collaboration and constructive decision making amongst different agencies by envisaging potential threats, challenges and facilitating effective response mechanisms. Thus, the Integrated Operation Platform (IOP) provides a Common Operating Picture (COP) of various events in real-time on a unified platform with the means to make better decisions, anticipate problems to resolve them proactively, and coordinate resources to operate effectively.

IOP solution should be capable of seamless integration to various government and emergency services such as law enforcement, disaster and emergency services, utility services etc., the proposed solution should support recording of external mobile video feeds, data communication, telephony etc.

MSI should ensure and support scenario reconstruction and analytics capabilities with event timelines. The solution should support event logs including operator's onscreen activities, voice and video events etc., for further analysis, training, and similar activities. This can be in an integrated manner or through a standalone solution integrated with central platform.

Built-in analytical tools provide real-time analysis of individual events, and also a measure of the incidents for each of the silos integrated on the platform. These help the decision-makers with the in-situ challenges and facilitate immediate responsive actions to mitigate/control multiple complex challenges.

Under the Agra Smart City initiative, it is intended to cover various disparate systems including:

- Smart and Adaptive Traffic Signal Management (ATMS)
- Intelligent Traffic Management System like ANPR, RLVD, No-Helmet Detection, Face Recognition System etc.
- CCTV Based City Surveillance
- ICT Enabled SWM
- Integrated Command and Control Centre
- GIS Application
- Meragra Citizen Engagement Application
- Integrations with other systems which may arise in future like SCADA, Water Meter, City Wi-Fi, and Smart Components at Bus Shelters etc.

However, the platform shall support adding more layers of solutions seamlessly with minimal effort which purchaser intends to develop in time to come. On the Integrated Operation Platform (IOP), the system shall provide Standard Operating Procedures (SOPs), step-by-step instructions based on ASCL policies and tools to resolve the situation and presents the relevant situation information in a quick and easily digestible format for an operator to verify the situation. The system shall provide reporting and audit trail functionalities to track all the information and monitor operator interactions with the system and to impart necessary training to the users.

#### 6.10.7.1. **Data Aggregation, Normalization and Access**

1) The city will be using various device vendors for various smart services. For example, in the smart city journey of the city, various vendors of smart elements will be used for deployment and each will be generating data in their own format. This platform should be able to define its own data model for each smart service like waste, lighting, transport, etc., and map data from different device vendors to the common data model.
2) Data from the IoT platform must be exposed to application eco system using secure APIs or any other secure methodology.
3) Platform should be able to integrate with any type of sensor platform being used for the smart services irrespective of the technology used. Agnostics to sensor technologies such as LoRA, ZigBee, GPRS, Wi-Fi, IP Camera.
4) Platform should also allow the manufacturers of the sensors to develop integrations themselves using the platform SDKs without affecting the northbound applications and existing integration.
5) Platform should be able to normalize the data coming from different devices of same type (i.e. Different lighting sensor from different OEMs, different energy meters from different OEMs etc.) and provide secure access to that data.
6) Platform should support distributed deployment of functions (workflows and policies) across city's network and compute infrastructure with centralized management and control.
7) Platform should be able to handle high data volume, handle a high events rate (upto 10,000 events per sec) with low-latency processing.
8) Platform should be able to correlate and handle multiple data streams, while providing real-time logic, analysis and routing applied to incoming data streams and aggregating data over time.
9) Platform should store data in-memory (or to an external database) for use by other components or flows inside platform.
10) Platform should an interface to graphically build and edit complex workflows that include data transforming, analysis, filtering, and routing to destination system or using your output stream as input to other workflows. Adding an input or output device shall be as easy as dragging an adapter from a template and connecting it to flow.

#### 6.10.7.2. **GIS Map Support**

System should support GIS supported solutions like ESRI, etc.

1) Provides geographical coordinates of specific facilities, roads, and city infrastructure assets, as well as unmapped facilities.
2) Calculates distance between two, or more, locations on the map.
3) Locates and traces devices on the map
4) Software shall include an inherent Geographic Information Systems (GIS) view, supporting real-

world coordinates with predefined coordinate systems and DATUMs.

5) Software shall provide integrated capability with maps from survey of India and ESRI.
6) Software shall provide integrated capability to display high-resolution satellite imagery and vector maps. To show the camera location on the map the map scale required is 1:1000 and to be created from high resolution satellite imagery of 0.5m
7) The GIS view shall provide a common operational picture enabling information sharing in real time between different users filtered according to predefined organization hierarchy. All GIS entities shall be automatically synchronized in the background between all client workstations.
8) The software shall display the building outline for all important buildings.
9) The GIS map shall support easy navigation operations such as pan, zoom in/out, zoom to extent, previous zoom and next zoom.
10) Software shall enable system administrators to define different data layers for displaying on GIS maps. Different layer types supported including geo referenced raster images, lines, zones, location of sensors and other objects (tracked vehicles for example).
11) Defined data layers can be turned on/off on demand or automatically according to predefined rules.
12) Software shall enable authorized users to edit the vector data presented within the defined layers.
13) When displaying layers, the software shall enable administrators to turn their layers on/off when they are displayed.
14) Software shall support saving of multiple GIS map views for later on demand or automatic pop-up. These views shall determine the selected layers and the exact map zoom level. The system shall support the ability to automatically bring up these predefined map views or locations most relevant to an incident.
15) Software shall support the customization and real time activation of multiple-level drill downs by linking objects placed on map layers to other GIS views.
16) Software shall support the placement of action map objects on layers. Whenever these objects are clicked, the predefined action shall take place.
17) Software shall support the placement of predefined objects on map locations.
18) Software shall allow for region of interest areas to be drawn on the map and pull out all the camera view simultaneously along with alerts like boundaries of police stations etc.
19) Software shall enable operators to add points, polylines and polygons to maps in order to identify multiple locations related to an incident.
20) Software shall enable users to open up a new incident and directly associate it with a map location or to associate an already opened incident with a new map location. The system shall also be capable to receive an API call, which will open up a new incident and automatically place it on the map using a map location passed via the API. The relevant map location shall be displayed on the map for as long as the incident is open.
21) Software shall support display of heat maps, pin map, trend map, repeat incident count map etc., over GIS maps based on incident data.
22) Software shall support for configuration and display of cameras Field of View (FOV) overlay. It shall be possible to display the FOV for a single camera or for all cameras at once.
23) Users' (responders) map context menus shall include the capability to send other users messages, assign tasks and initiate phone calls. It shall also be possible to view the tasks presently assigned to selected users.
24) Software shall allow administrators to define and draw zones of arbitrary shapes and sizes. These

zones shall be used for triggering various activation rules. The GIS shall be able to show/hide these zones as layers.

25) Software shall provide the ability to track movements and status of all location-based technologies (e.g., GPS, RFID, etc.). Software shall also support the on-demand visual display of historical movement path.
26) Software shall support the searching of objects on the GIS map by name. The search shall support wild cards and shall highlight the found objects for easy identification.
27) Software shall support the ability to easily capture and send snapshots of the GIS maps.
28) Software shall provide users with a map 'Toolbox' with the most frequently used map operations for selected map entity types. The Toolbox operation buttons shall be customizable.
29) Software shall support the searching of a geographical location on the map, via entry of ZIP code, street address, milestone etc. ("Geo-coding").
30) Software shall support the calculation and map representation of the nearest geographical route between two locations. The calculation shall be capable of including factors such as street directionality.

#### 6.10.7.3. **IOT platform Shall Enable Online Developer Program Tools**

It should help produce new applications, and/or use solution APIs to enhance or manage existing solution free of cost. The IoT platform vendor shall provide the platform SDK to such new application/system developers for such requirements.

#### 6.10.7.4. **Authentication**

Authorization system should support standard authentication and authorization methodology

#### 6.10.7.5. **Resiliency**

- Architecture should provide smart city use cases much needed resiliency.
- Platform must support fault tolerance, load balancing and high availability.
- Provides ways to define policies that make applications or things respond to external environments.
- Schedule actions to happen at future time points.
- Platform should have integrations with the network layer to proactively monitor any incidents on the network for active troubleshooting and triaging.
- Platform should be able to alert any incidents in the network proactively on City Operation Command Centre.

#### 6.10.7.6. **API Repository/API Guide**

- SDK/APIs should be available for the smart system domains (outdoor lighting, traffic, environment, urban mobility etc.) to monitor, control sensor and/or actuators functionality to enable app developers to develop apps on the platform.
- For example – Vendor agnostic SDK/API to control lighting functionality.
- Platform OEM should provide the SDK/ APIs for the smart system domains (parking, outdoor lighting, traffic, environment, urban mobility etc.) to allow sensor vendors and app developers to

develop their connectors/adaptors to the platform.

#### 6.10.7.7. Platform Upgrade and Maintenance

- OEM should be able to securely access the platform remotely for platform updates/upgrades and maintenance for the given duration.
- Platform should be able to be deployed on DC/DR for disaster recovery.

#### 6.10.7.8. Platform Functionality API Management and Gateway

Provides secure API lifecycle, monitoring mechanism for available APIs.

- User and Subscription Management: should provide different tier of user categorization, authentication, authorization, and services based on roles and responsibilities.
- Application Management: should provide role-based access view to applications.
- Enabling Analytics: time shifted and real-time data available for big data and analytics.
- Platform should also be able to bring in other e-governance data in City Operations Command Centre dashboard.
- All data should be rendered/visualized on Command and Control Centre dashboard.

#### 6.10.7.9. SDK/API Based Open Platform

- Provides SDK/API to develop applications for each of the smart city services domains.
- Platform should have API Management capabilities like API Security.
- Platform should be able to provide SDK/API access based on roles and access control policies.
- MSI should have already documented the platform SDK/APIs using which applications can be developed.
- MSI should be able to demonstrate existing applications that are developed using these platform SDK/ APIs.

#### 6.10.7.10. Trending Service

System should provide trends in graphical representation from data sources over a period. Trends should allow to monitor and analyse device performance over time.

#### 6.10.7.11. Policies and Events

- System should allow policy creation to set of rules that control the behavior of infrastructure items. Each policy should a set of conditions that activate the behavior it provides. System should allow default, time-based, event-based and manual override polices creation. For example, an operator might enforce a "no parking zone" policy manually to facilitate road repairs.
- System should provision to defines a set of conditions that can be used to trigger an event-based policy.

### 6.10.8. Visualization Layer

#### 6.10.8.1. ICCC Operations

Solution should be implemented and compliant with industry open standard commercial-off-the-shelf (COTS) applications that are customizable.

- Solution should have the capability to integrate with GIS.
- Solution shall integrate with GIS and map information and be able to dynamically update information on the GIS maps to show status of resources.
- Solution should allow defining key performance indicators and visualize the indicators on a web based configurable dashboard infrastructure.
- Solution should allow configuration and monitoring of service levels for key performance indicators and triggering of actions towards the incident management system when those service levels are breached.
- Solution should provide current business status (snapshot) of city's facilities, departments and a holistic perspective of incidents and situations. Including incident handling time, number of false alerts, number of active, and closed incidents.
- Solution event engine shall at minimum allow ingestion and processing of 10,000 events a second and provide a mechanism to scale to 100,000 events a second.
- Solution should provide operators and managers with a management dashboard that provides a real-time status and is automatically updated when certain actions, incidents and resources have been assigned, pending, acknowledged, dispatched, implemented, and completed. The above attributes shall be color coded.
- Solution shall provide the "day-to-day operation", "Common Operating Picture" and situational awareness to the centre and participating agencies during these modes of operation.
- Shall provide complete view of sensors, facilities, e-governance/ERP, video streams and alarms in an easy-to-use and intuitive GIS-enabled graphical interface with a powerful workflow and business logic engine.
- Shall provide a uniform, coherent, user-friendly and standardized interface.
- Shall provide possibility to connect to workstations and visualization layer shall accessible via web browser.
- Dashboard content and layout shall be configurable, and information displayed on these dashboards shall be filtered by the role of the person viewing the dashboard.
- Solution should allow creation of hierarchy of incidents and be able to present the same in the form of a tree structure for analysis purposes.
- Shall be possible to combine the different views onto a single screen or a multi-monitor workstation.
- Solution should maintain a comprehensive and easy to understand audit trail of read and write actions performed on the system.
- Solution should provide ability to extract data in desired formats for publishing and interfacing purposes.
- Solution should provide ability to attach documents and other artefacts to incidents and other entities.
- Solution is required to issue, log, track, manage, and report on all activities underway during these modes of operation:
    - Recovery
    - Incident Simulation

#### 6.10.8.2. Integration Capabilities

Platform shall also be able to integrate, connect, and correlate information from IoT platform and other IT and non-IT systems, providing rule-based information drawn from various sub-systems for an alert. Platform shall have the ability to add/remove sensors including new vendor types as per future business requirements. It should support SDK/API based integration with the smart system elements.

#### 6.10.8.3. Notifications, Alerts and Alarms

System should generate notification, alert and alarm messages that should be visible within the dashboard and the field responder mobile app if required.

1) All system messages (notifications, alerts and alarms) should always be visible from the notifications view, which provides controls that operator can use to sort and filter the messages that it displays.
2) Systems should deliver message to a set of subscribers. The notification service should support min two types of notification methods – email notification and SMS notification.

#### 6.10.8.4. Users and Roles

Users access the platform to perform various tasks, such as adding new locations, configuring new devices, managing adapters etc. Each user should be associated with one or more roles and each role is assigned a certain set of permissions.

- Platform should allow different roles to be created and assign those roles to different access control policies.
- Platform should allow single or multiple users to view and manage alarms in defined areas/locations. Users can be part of single or multiple areas/locations.

#### 6.10.8.5. Reports

Platform should have capability to provide access to real time data and historical data from various connected devices for reporting and analytics.

System should have ability to generate reports and have provision to add reports in favourites list.

- Incident Reports
    - Detailed incident reports shall include an incident summary, all the tasks associated with the incident, sensor related activities, relevant snapshots, and maps.
    - Periodic Reports
    - Maintenance Reports
    - Statistical Reports
- Ability to display report on monitor and print report.
- Ability to capture pperators response in text.
- Ability to select information to be included in report at time of report generation.
- Details of alarm including severity, time/date, description, and location.
- Capture the operator response by text.
- Allow operator to transfer the incident report to mobile device/another operator’s console.

#### 6.10.8.6. Standard Operating Procedure

SOP is a standard operating procedure that provides step-by-step instructions in the shape of a drop down menu to the Command and Control Centre Operator on how to handle a particular incident in an organized manner.

- Software shall provide SOP's in English and Hindi language
- SOP tasks should serve as an instructional resource that allows operator to act without asking for guidance.
- There shall be the provision to define various SOPs in Command and Control System such as alert category specific SOPs, Location Specific SOPs.
- It should be possible to write SOPs in Hindi.
- It shall have facility to define more than one SOP for the selected alert category or location.
- There shall be a provision to define multiple tasks under single SOP.
- The system shall select and present the appropriate SOP automatically based on predefined policies.
- Actions taken as part of SOP should be logged in audit trail with date time stamp and operator comments.
- SOP shall contain the lists of tasks to be performed by operator categorized under following headings:
    - Task: Task to be performed by the operator in the sequential order.
    - Description: Task description.
    - Comments: Space for operator to enter the comments.
    - Action: Actions (like email, SMS escalation) to be initiated by operator.
    - Done: Indication by operator that the task is completed.
    - User: User name of the operator for audit trail.
    - Date and Time: Date and time of the action.

#### 6.10.8.7. Collaboration among Stakeholders

- OCC platform should enable multiple stake holder collaboration where incidents/tasks triggered automatically or manually by control room operators are distributed to the correct owners in incident/task context, such collaboration to include:
    - allowing departments to work autonomously.
    - allowing logical locations or project groups to work autonomously.
    - allowing inter-departmentwork.
- Stakeholders can be on various types of devices like computer, smartphones, tablets or normal phones.
- Platform should allow stakeholders to share multi-media content relevant to the issue in the collaboration space.
- Platform should allow stakeholders with various smart devices (smartphones, laptops, analog phones etc.) to invoke/participate in a web conferencing session directly from the collaboration space.
- Platform should allow the stakeholders to acquire data from such devices and to control such devices, subject to access privileges for each user and device.

#### 6.10.8.8. Analytics Engine

Smart city analytics platform module to maximize business value through advanced analytics capabilities. These advance analytics capabilities aid in automating policies that result in better asset and infrastructure management.

- Solution should be flexible to integrate with other city and government software applications.
- Analytics engine module should have below intelligence capabilities;
    - Advanced predictive analytics should be part of the solution.
    - Solution should be flexible to integrate with other city and government software applications.
    - Solution should be able to predict insights consuming data from city infrastructure viz., traffic, parking, lighting etc.
    - Solution should have predictions with acceptable and measurable accuracy solution.
    - Should be able to predict and integrate with smart city solutions helping in driving operational policies creation.
    - Solution should have a visualization platform to view historic analytics.
- Solution should have predictions with acceptable measurable accuracy.
- Application should enable the operators to discover, compare, and correlate data across heterogeneous data sources to unravel the patterns that were previously hidden. At a broader level, system should be do the following tasks:
    - Connect to a variety of data sources.
    - Analyse the result set.
    - Visualize the results.
    - Be capable of linear and empirical prediction using historical data.
- Analytics engine should support multiple data sources. Minimum below standard data sources should be supported from day 1 – CSV, TSV etc.
- Analytics engine should provide analysis of data from a selected data source(s).
- Analytics engine should provide capability to check analysis with multiple predictive algorithms.
- Analytics engine visualizations – Analytics engine should provide visualizations dashboard.
- In the visualization workspace, it should allow to change visual attributes of a graph.
- User should not be allowed to alter the graph/visualization definition.

#### 6.10.8.9. API and Interface Security

- Access to the platform API(s) should be secured using API keys.
- Software should support security standards: OAuth 2.0, HTTPS over SSL, and key management help protect the data across all domains.
- Should support security features built for many of its components by using HTTPS, TLS for all its public facing API implementations. For deployment where OCC Software API(s) exposed to application eco system, API Management, API security features and API key management functions are required.
- Platform vendor should maintain complete inventory of critical production assets. Asset could be defined as source code, documents, binaries, configuration data, scripts, supplier agreements, SW licenses.

#### 6.10.8.10. Business Operations Audit and Logging

Platform should support centralized logging and auditing framework.

- Legal/Supplier chain agreements: Platform provider vendor should have policies and procedures established, and supporting business processes and technical measures implemented, for maintaining complete, accurate and relevant agreements (e.g. SLAs) between providers and customers.
- Critical production assets: Platform vendor should maintain complete inventory of critical production assets. Asset could be defined as source code, documents, binaries, configuration data, scripts, supplier agreements, SW licenses.
- Audit trail must be available in the platform.

#### 6.10.8.11. Field Responder Mobile

Provide integrated mobile application for capturing real-time information from the field response team using mobile-standard operating procedure. Overall integrated operations platform should account for below solution components, city tenant activation license with one lakh device connections.

- Operator client license should be for a minimum of 25 with one city activation license.
- Field responder should be able to acknowledge the incident and provide real time updates from the incident site.
- Field responder should be able to view the recorded stream and image of the event.
- Field responder should be able to view live stream of the camera.
- Field responder should be able to send ATR or action taken for the event to the command and control application.

### 6.10.9. Video Management System

Video Management System (VMS) shall bring together physical security infrastructure and operations and shall use the IP network as the platform for managing the entire surveillance system. End users shall have rapid access to relevant information for analysis. This shall allow operations managers and system integrator to build customized video surveillance networks that meet their exact requirements. Software suite shall be a scalable and flexible video management system that can be easily managed and monitored. Scalable system shall permit retrieval of live or recorded video anywhere, anytime on a variety of clients via a web browser interface.

Video management server, on which the VMS is hosted upon, shall run seamlessly in the background to manage connections, access and storage. Video management server shall either accept directly or indirectly the feed from IP camera installed at field locations. Server shall stream incoming video to a connected storage. VMS shall support directly or indirectly video IP fixed color/B&W cameras, PTZ/ dome cameras, multi-sensor cameras, infrared cameras, low light/IR cameras and any other camera that provides a composite PAL video signal.

VMS shall facilitate situational awareness of the on-ground condition at Command Control Centre or any other view centre. This shall be achieved by transmission of real-time imagery (alarm based or on-demand). This

imagery can be viewed live by operators and/or recorded for retrieval and investigation. Major functionalities are described here:

- VMS shall support a flexible rule-based system driven by schedules and events.
- VMS shall be supported for fully distributed solution for monitoring and control function, designed for limitless multi-site and multiple server installations requiring 24/7 surveillance with support for devices from different vendors.
- VMS shall support IP cameras of different makes.
- All the offered VMS or integrated analytics systems for cameras shall have ONVIF compliance.
- VMS shall be enabled for any standard storage technologies and video wall system integration.
- VMS shall be enabled for integration with any external video analytics systems.
- VMS shall be capable of being deployed in a virtualized environment without loss of any functionality.
- VMS server shall be deployed in a clustered server environment for high availability and failover.
- All CCTV cameras locations shall be overlaid in graphical map in VMS Graphical User Interface. Camera selection for viewing shall be possible via clicking in the camera location on graphical map. Graphical map shall be of high resolution enabling operator to zoom in for specific location while selecting a camera for viewing.
- VMS shall have an administrator interface to set system parameters, manage codecs, manage permissions, and manage storage.
- VMS day-to-day control of cameras and monitoring on client workstations shall be controlled through the administrator interface.
- Whilst live control and monitoring is the primary activity of the operator workstations, video replay shall also be accommodated on the GUI for general review and also for pre and post alarm recording display.
- Solution design for VMS shall provide flexible video signal compression, display, storage, and retrieval.
- All CCTV camera video signal inputs to the system shall be provided to command control centre, and the transmission medium used shall best suit the relative camera deployments and access to the CCTV network.
- VMS shall be capable of transferring recorded images to recordable media (such as CD/DVD and/or DAT tapes) in tamper evident and auditable form. All standard formats shall be supported including, but not limited to:
  - AVI files
  - Motion-Joint Photographic Experts Group (M-JPEG)
  - Moving Picture Expert Group-4 (MPEG-4)
- All streams shall be available in real-time (expecting network latency) and at full resolution. Resolution and other related parameters shall be configurable by administrator to provide for network constraints.
- VMS shall support field sensor settings. Each channel configured in the VMS shall have an individual setup for the following minimum settings, the specific settings shall be determined according to the encoding device:
  - Brightness/Contrast
  - Colour/Sharpness
  - Saturation/Hue

- White Balance

- VMS shall support the following minimum operations:
  - Adding an IP device/Updating an IP device
  - Updating basic device parameters
  - Adding/Removing channels
  - Adding/Removing output signals
  - Updating an IP channel/Removing an IP device
  - Enabling/Disabling an IP channel
  - Refreshing an IP device (in case of firmware upgrade)
- VMS shall support retrieving data from edge storage. When a lost or broken connection is restored, it shall be possible to retrieve the video from SD card and store it on central storage.
- VMS shall support bookmarking the videos. Thus, allowing the users to mark incidents on live and/or playback video streams.
- VMS shall be capable of intrusion detection: Detection of moving objects in selected areas covered by the camera (those that are specified as restricted areas like those before some major events, etc.). Avoid false alarms due to wildlife or other moving objects (e.g., tree leaves).
- VMS shall be capable of tracking of a specific person in multi-camera videos: Track a specific person across several surveillances (e.g., to trace and identify criminals and/or anti-social elements). The operator shall be able to efficiently locate and track a specific person across time and location to minimize search time from hours to minutes when time is of the essence. This application should be opened from the native VMS client application without the need to login again.
- VMS shall be capable of counting of people and detection of abnormal crowd behavior: Detection of people flow and counting of people in selected areas. To identify abnormal crowd behavior and raise alarms to avoid untoward incidences in public places, and maintaining law and order.
- VMS shall provide a seamless integration between all recorders types under the same user interface and management system.
- VMS shall have a central database (AMS) for consistent configuration of site equipment and user data. The centralized management shall be available from remote locations over the network.
- VMS shall allow the user to select the streaming method to workstation running the VMS application. The user shall have the ability to select RTP/UDP, TCP or direct multicast protocol.
- VMS shall support IPv4 and IPv6 at least between the camera and the recording server.
- VMS shall allow the user the ability to define a homepage to be displayed in the local workstation. The homepage shall include a specific layout of video panes and pre-selected cameras either in live or playback modes, as well as other security sensors and maps.
- VMS shall support automatic failover for recording.
- VMS shall support manual failover for maintenance purpose.
- VMS shall support access and view of cameras and views on a smartphone or a tablet.
- VMS shall support integration with the ANPR/RLVD application.
- VMS shall support integration with other online and offline video analytic applications.

#### 6.10.9.1. **VMS Core Components**

- CCTV Camera Management: enables management of cameras associated with VMS.
- Video recording, retrieval and archiving: manages live camera viewing, recording of live feeds for future review, search and retrieval of recorded feeds and archiving of recorded video feeds for

optimum utilization of resources.

- Video Analytics (VA) alert management: enables defining of rules for handling of alerts using the VA handling of events as per the defined rules.
- MIS and Reporting: provides users with business analytics reporting and tools to organize evaluate and efficiently perform day-to-day operations.
- Security and Roles: manages role definitions for internal and external access.

#### 6.10.9.2. **VMS General**

- VMS shall be codec and IP camera agnostic such that it can support devices that are not supplied by manufacturer/developer of VMS software and codec hardware.
- When viewed on GIS map, text description of each camera shall be capable of being positioned anywhere on the monitor screen, on a camera by camera basis, shall afford options for size variations, and display with a flexible solid, semi-transparent or transparent background.
- VMS shall support tamper detection for all cameras to warn of accidental or deliberate acts that disable the surveillance capability.
- For alarm interfacing requirements, VMS shall allow selection of minimum 5 cameras per single alarm source. The designated primary camera shall be automatically displayed as a full-screen image on the main GUI CCTV screen. VMS shall also, on alarm, present associated pre/post event video allowing the operator to assess the alarm cause. Other associated cameras, when called up, shall be displayed as split-screen images on the other monitor of the operator workstation.
- VMS shall provide LoS support in MPEG4 or H.264 for monitoring of dual streaming devices. Therefore, it shall automatically select the most appropriate stream from the edge device in accordance with the workstations/decoder performance and network bandwidth.
- VMS shall provide by the LoS mechanism different streams for recording and monitoring, improving monitoring quality while preserving storage space. The streams can be configured to different resolution, frame rate or bit-rate.
- Playback of any alarm related video, (including pre and post alarm video) shall start at the beginning or indexed part alarm sequence.
- Video management software shall incorporate online video analytics. It shall include the following video analytics detection tools:
    - Loitering detection
    - Improper Parking
    - Camera Tampering
    - Abandoned Objects Detection
- OffLine Video Analytics should allow for quick retrieval of video footage to metadata stored with each image. System should provide results within few seconds, system should support for below listed the user's query.
    - System should allow to specify the following search criteria:
        - Motion in the zone, user-defined with any polyline.
        - Detection of crossing a virtual line in a user-defined direction.
        - Loitering in an area.
        - Motion from one area to another.
- Video clips of specific events via video analytics or by operator action shall be capable of being separately stored and offloaded by operator with appropriate permissions on to recordable media

such as CD or Write Once Read Many (WORM) together with any associated meta-data for subsequent independent playback.

- System shall provide the capability to select duration and resolution of storage by camera, time and activity event and user request. Frequency/Trigger of transfer shall be configurable by user.
- System shall provide the capability to digitally sign recorded video.
- Live video viewing: System shall allow the viewing of live video from any camera on the system at the highest rate of resolution and frame rate that the camera shall support on any workstation on the network.
- Recorded video viewing: System shall allow the viewing of recorded video from any camera on the system at whatever rate the camera was recorded.
- Storage of video: System shall store online 30 days of video for all cameras. Balance 60 days will be on low cost secondary storage/tape library.
- System shall provide the capability to manage the video storage to allow selective deletions, backups, and auto aging.
- VMS shall have an extensive reporting capability with ability for administrator to define reports in a user-friendly manner. The pre-existing reports shall include, but not limited to, the following:
    - Reports on alerts received by type, date and time, location.
    - Reports on system errors and messages.
    - Reports on master data setup including cameras, decoders, locations.
    - Reports on cameras health check.
    - Reports on audit trails such as user actions.
    - Reports on system health including storage availability, server performance, recordings.

#### 6.10.9.3. **VMS GUI Capabilities**

- User interface shall be via a GUI providing multiple video streams simultaneously on multiple monitors.
- GUI shall have the minimum capability of naming locations, users, and cameras events displayed correctly on user's screen.
- System shall have the capability to store and record operator specific options, such as screen layout, video layout, action on alarm, and automatic video transmission settings on events.
- GUI shall conform to standard Windows conventions.
- System shall provide unified GUI camera control at an operator's workstation for all types of cameras installed whether existing or new or connected via another agency. By means of this unified control the following functions shall be provided:
    - Selection
    - Display
    - PTZ
    - Setup and Adjustment
    - Determination of Pre-sets
    - Any other Commissioning and Camera Setup Activity
- All user interfaces shall support English language and shall confirm to standard Windows protocols and practices and allow the control of all functions via a simple easy to use interface.

#### 6.10.9.4. VMS Map Functionality

- System shall support a mode of operation whereby a map of all or part of the map (at operator request) is displayed on a separate or same screen and that status information can be provided via an icon, and access to any cameras shall be accessible by means of an icon on that screen.
- These maps shall be defined so that an operator may select from the same source of mapping that is available to the other systems within the command control centre, displaying whichever map or section the operator needs, and it shall be displayed within 1 second.
- VMS shall allow the user to perform operations on cameras or any other sensors that are placed on a map.
- VMS shall allow the user to "drag and drop" a camera or any other sensor from the map area to a video window or to click on a camera to start viewing it in a pop-up window.
- The map supported formats shall be: BMP, GIF, JPG, PNG and TIFF.

#### 6.10.9.5. VMS Configuration

- VMS shall include a configuration facility to provide system administrators with a single interface utility to configure all VMS operating parameters.
- Configuration tool shall be as sophisticated as necessary to support the following:
    - Log every action so an audit or report can be completed.
    - Only update and log configurations where there is a difference between the system configuration and the new configuration file to be loaded.
    - The import configuration file can contain any amount of data.
    - Ability to run an update on the fly i.e., no or minimal system downtime.
    - Not require a reset or restart after any upgrades.
    - Definable update times.
- VMS configuration tool shall define:
    - Cameras (whether via codec units or directly connected IP cameras) and text based names
    - Camera Groups/User Groups
    - Monitors/Codec parameters
    - Alarms
    - Workstations/Storage
- Configuration utility shall allow the system administrator to:
    - Install new devices
    - Configure all aspects of existing devices
    - Configure and set up users/user groups and their rights/permissions/priorities
    - To define multiple camera groups
    - Each group to be defined for combinations of viewing and control rights
    - Individual operators to be assigned multiple groups
    - Each group to be allocated to multiple operators
    - Each camera may be in multiple groups
    - To program macros for individual and group camera characteristics
    - Program camera/monitor selection and configuration of the video wall(s) in response to an incoming alarm
    - Designate workstation destination for picture presentation in response to alarm initiation

- User permissions/privileges, to be allocated, shall extend from full administrator rights down to basic operation of system, and shall include the ability to designate workstations to an operator, and to designate one or more camera groups to an operator for viewing and/or control.
- Configuration utility shall store all changes to system, including but not limited to:
    - User logins /User logoffs
    - Human interface device inputs (key strokes)
    - External alarm commands/Error messages
- A copy of system configuration shall be stored external to the system to allow system restoration in case of hardware failure.

#### 6.10.9.6. VMS User Hierarchy

- MSI shall request a detailed User Prioritization List (UPL) during the project.
- UPL shall enable programming of CCTV management system with agreed user prioritization.
- Over and above user priority, users shall be enabled for following in varying combinations:
    - Image viewing
    - Image recording
    - PTZ control
- In addition, control location shall be prioritized such that command control centre has full control of all functions and priority one override over all other locations.
- Within the hierarchy, each user's logon password shall not only allow access to varying levels of system functionality, but shall provide for relative priority between users of equal access rights. Operators in above groups shall be individually allocated a priority level that allows or denies access to functions when in conflict with another operator of lower or higher priority level.
- These priority levels and features they contain shall be discussed and defined with the system administrator. MSI shall allow time to carry out this exercise together with relevant configuration of groups, sub-groups, permissions and priorities.

#### 6.10.9.7. VMS Recording Requirements

- All images shall be recorded centrally as a background process at configurable parameters.
- It shall not be possible to interrupt, stop, delay, or interfere with the recording streams in any way, without the appropriate user rights.
- CCTV recording system shall enable Pre and Post Event (PPE) recording, presentation and storage, initiated automatically in response to system alarm sources received by the VMS.
- PPE recording clips shall be provided by the VMS and retrieved from the central video archive on the buffer storage system. This PPE stream shall be totally independent of the background recording stream provided to the central video archive such that central video archive recording, as programmed, continues under all circumstances.
- Information stored shall be full real-time and full resolution from each incoming camera channel. In the absence of a trigger from a manual input or from a programed alarm source, the PPE video recording shall be written to buffer storage on a FIFO basis.
- PPE periods initiated by a single alarm occurrence shall be configurable via the VMS as follows:
    - Pre – 0 to 30 seconds
    - Post – 30 to 300 seconds

- Shall be variable for each camera according to each individual alarm and the alarm type

- In the event of a trigger, VMS shall ensure that the programmed sections of pre and post event video are immediately presented to the operator to complement alarm display and simultaneously saved as an identified indexed video clip, complete with time/date stamp, in a reserved and protected area of storage system. Such PPE recording shall then be capable of retrieval via search criteria.
- Once tagged and saved, the PPE video clip shall NOT be overwritten except by an operator with the required permissions i.e., it is excluded from the normal FIFO regime of the bulk storage system. Recording shall also be initiated on-demand by manual triggers from system operators e.g., keyboard key-stoke.
- VMS shall support the following recording modes:
    - Total recording – VMS shall constantly record video input. VMS shall allow for continuous recording of all video inputs.
    - Event based recording – VMS shall record video input only in case an event has occurred
        - The recorder shall allow for event recording mode, recording upon an alarm, on all or some of the channels.
        - Each event-configured channel shall have the ability to be triggered by multiple triggers
        - Marked events shall include the pre and post alarm recording time.
        - The user will be able to query for all events per channel, per time, per triggers, per comments, and to playback the selected event.
- VMS shall support following triggers to initiate a recording:
    - Scheduler – recorder will record video inputs based on a specified schedule.
        - VMS shall allow recording based on a time schedule for all or some video channels.
        - VMS shall allow for multiple recording periods per day, per channel.
        - VMS shall have option to set any available trigger in the system (VMD, TTL and/or API) to trigger the channel.
        - VMS shall have option for individual channel setup of pre/post alarm recording for defined interval (e.g. up to 10 minutes pre-alarm and 30 min post-alarm recording).
        - VMS shall have ability to enable/disable triggers through a daily time schedule.
    - Manual – user shall be able to initiate a manual recording upon request.
    - VMS shall work in conjunction to the any previous alarm operations.
    - VMS shall allow API triggers.
    - All trigger information shall be stored with the video information in the VMS data set and shall be made available for video search.
    - VMS shall support the following recording modes:
    - Total recording – VMS shall constantly record video input. VMS shall allow for continuous recording of all video inputs.
    - Event based recording – VMS shall record video input only in case an event has occurred.
        - The recorder shall allow for event recording mode, recording upon an alarm, on all or some of the channels.
        - Each event-configured channel shall have the ability to be triggered by multiple triggers.
        - Marked events shall include the pre and post alarm recording time.
        - The user will be able to query for all events per channel, per time, per triggers, per comments, and to playback the selected event.

- VMS shall support following triggers to initiate a recording.
- VMD (Video Motion Detection) – Video motion detection running on the edge device.
- The recorder shall support VMD per video channel.

#### 6.10.9.8. Manual or On-demand Recording

- Recording shall also be initiated on-demand by manual triggers from system operators e.g., keyboard key-stoke (subject to user rights).
- System shall allow for an operator to initiate recording on any live stream being viewed.

#### 6.10.9.9. VMS Review System

VMS recording and replay management systems shall support the following features and operations:

- Playback shall not interfere with recording in any way.
- Support either analogue cameras connected via codecs or IP-cameras directly connected to the network.
- Stream live images through the network using IP multi-cast techniques.
- Stream images from the codec to the attached storage system.
- Store the recording stream from all cameras simultaneously with no degradation to any individual camera recorded image stream unless the system is configured by administrator to allow for change in quality.
- Deliver live video to VMS workstation within a period of one second from manual call up.
- Deliver live video to VMS workstation within a period of three seconds from automatic alarm receipt on alarm interface.
- Storage of each camera's images at a rate and resolution as defined in the codec or IP camera configuration. VMS programming shall automatically vary these rates in response to time profiles, alarm inputs.
- Support multiple, configurable recording time schedules per camera. Each schedule shall support different recording parameters and automatically implement against configured time schedule e.g. operational and non-operational hours shall be scheduled with different recording parameters on designated cameras.
- Support streaming of recorded files using IP unicast directly to hardware decoders for display on analogue monitors or software decoder when/if required.
- Playback multiple, synchronized recorded streams at differing speeds and frame rates.
- Record and playback a video stream simultaneously at differing speeds and frame rates.
- Time stamping of every recorded video field based upon Network Time Protocol (NTP) time.
- Support video streaming directly from the edge devices.
- When streaming directly from the edge devices the workstation shall receive a multicast stream directly from the edge device for monitoring purposes. The recorder shall register to the same multicast group for recording.
- Selectable on-screen-display of time and camera title during playback.
- Security file lock to prevent specific recorded files from being overwritten regardless of their date and time, in addition to those records stored as PPE clips. The duration and policy for retention of such videos would be same as that of the PPE clips.
- Configurable granularity of video files.

- Generate alarm when storage medium has fallen below a user selectable threshold.
- Stored video files can be "downloaded" directly to DVD or WORM for replay using VMS video replay application and shall incorporate proof of authenticity.
- Download video records in common (e.g. AVI) file format for remote, cursory review and assessment prior to generating tamper-evident auditable copies.

#### 6.10.9.10. **VMS Alarm Handling**

- Actions Associated with Alarms
  - VMS shall allow associating a system action to an alarm.
  - Each alarm shall change the icon of the alarmed sensor indicating its alarmed state.
  - Each alarm shall have the capability to be assigned to individual users or to user groups (roles).
  - User shall have the ability to set or filter cameras and any other sensor in the cameras/sensors list/tree according to the alarm state or that sensor.
- Alarm Notification
  - VMS shall support the following methods of notifying users that a video alarm has occurred:
    - Indicate the alarm of a camera or sensor in the main cameras/sensors list.
    - Alarm video pop-up on local or external monitors.
    - Audio notification may be sounded when the event occurs.
    - API – Notifies a third-party security system that a video alarm has occurred.
    - TTL/Relay – Activates a TTL/Relay to drive an external alarm device.
  - VMS shall support standard SNMP v3 for notifying that a maintenance alarm has occurred.
- Alarm Display on Local Workstation
  - User shall have the ability to associate each video alarm with a pre-defined alarm page which contains a video pane layout and pre-configured cameras in live or playback mode.
  - User shall have the ability to configure a different alarm page for each alarm in the system.
- Automatic Actions upon Alarm
  - User shall have the ability to define rules to automatically execute actions upon an alarm condition.
  - Automatic actions upon an alarm condition shall include the following actions: send command to sensor, play page locally, play page on external monitor, display live video, display playback video, close video, move camera to PTZ preset, start/stop virtual tour, start/stop recording, play a predefined sound, send an HTTP request, execute an external application locally on the operator workstation.
- Alarm/Incident Workflow
  - User shall have the ability to define a workflow for each event.
    - User shall have the ability to define a procedure containing a list of tasks instructing the operator what actions to take when an alarm occurs. Other users shall be able to see the status of each task for a specific event on the respective workstation.
    - The workflow shall be adaptive to the user's selections and change the remaining tasks in the workflow based on conditional tasks that present multiple options to proceed.
    - The workflow shall support simple tasks that can be managed (e.g., completed) manually, as well as automatic tasks that execute an automatic action that performs a system command and/or a sensor command.

- Automatic actions executed as automatic tasks in a workflow procedure shall support creating, closing and changing incidents.
- User shall have the ability to change the state of each task to: Suspend, In Progress, Complete, Cancel and Fail.

- User shall have the ability to acknowledge, reject or reset each alarm – after the alarm has been acknowledged all authorized users shall see the alarm status change on their respective workstations.
- The system administrator shall have the ability to audit user alarm actions (acknowledge/reject/reset).
- User shall be able to comment on an alarm.

#### 6.10.9.11. **VMS Integration Requirements**

- VMS shall be integrated with the Command and Control System via SDK/API. All events and alarms that occur with the VMS and its sub systems will be available in the Command and Control System as required based on the SDK/API integration.
- Either OPC or SDK shall manage interface between VMS, GUI and other city management systems as required.
- OPC or SDK shall allow the operator workstations to control the VMS irrespective of the vender chosen by duplicating all control functionality of the VMS used for normal day-to-day activities.
- Alarm linking between VMS sub-systems shall be done at VMS sub-system level to, for example, call up relevant pictures to screens and move PTZ units to pre-set positions in response to alarm and activate video recordings, modifying recording parameters as necessary.
- All OPC software shall be fully compliant with the OPC specification as set down by the OPC foundation. Any software or products that are not compliant shall be highlighted in the Technical Proposal return. MSI shall indicate in the technical proposal return how the OPC interface shall be implemented.
- If an OPC interface cannot be provided, an alternative solution shall be provided for this data using a standard open protocol and confirmation as to how this shall be implemented shall be provided in the technical proposal return.
- If an SDK solution is provided the system shall allow reconfiguration by (City) and end users without recourse to special languages. A system SDKs shall be supplied with all required supporting software to allow the integration of the system with new devices and systems.

#### 6.10.9.12. **VMS System Size**

VMS shall enable handling of all the cameras, on day one, as well as future scalability as may be required.

### 6.10.10. Video Analytics

Surveillance system shall have capability to deploy intelligent video analytics software on any of the selected cameras. This software shall have capability to provide various alarms and triggers. The software shall essentially evolve to automate the suspect activity capture and escalation; eliminate need of human observation of video on a 24x7 basis.

Analytics software shall bring significant benefit to review the incidences and look for suspicious activity in both live video feeds and recorded footages.

Minimum video analytics that shall be offered on identified cameras are:

- Attribute Based Search
- Loitering Detection
- Improper Parking
- Camera Tampering
- Abandoned Objects Detection
- Unattended Object
- Tripwire/Intrusion

### 6.10.11. Access Control System – Functional Specifications

Access Control System shall be deployed with the objective of allowing entry and exit to and from the premises to authorized personnel only. The system deployed shall be based on biometric technology. An access control system consisting of a central PC, intelligent controllers, power supplies and all associated accessories is required to make a fully operational online access control system. Access control shall be provided for doors. These doors shall be provided with electric locks, and shall operate on fail-safe principle. The lock shall remain unlocked in the event of a fire alarm or in the event of a power failure. The fire alarm supplier shall make potential free contacts available for releasing the locks in a fire condition especially for staircase and main doors. Entry to the restricted area shall be by showing a proximity card near the reader and exit shall be using a push button installed in the secure area. The system shall monitor the status of the doors through magnetic reed contacts. The system should be designed and implemented to provide following functionality:

- Controlled entries/exits to defined access points.
- Controlled entries and exits for visitors.
- Configurable system for user defined access policy for each access point.
- Record, report, archive each and every activity (permission granted and/or rejected) for each access point.
- User defined reporting and log formats.
- Fail safe operation in case of no-power condition and abnormal condition such as fire, theft, intrusion, loss of access control, etc.
- Day, date, time and duration based access rights should be user configurable for each access point and for each user.
- One user can have different policy/access rights for different access points.

### 6.10.12. Edge Analytics and Artificial Intelligence with Continuous Learning

These use cases are to be implemented using Artificial Intelligence through various cameras, sensors etc., at the edge/field devices with continuous learning capabilities. Following use cases shall be part of implementation and shall have capability to integrate with common platform used for monitoring purpose (considering future and not necessary at day one):

- **Property of Interest**

- Camera Tampering
- Abandoned Objects Detection
- Object Classification
- Tripwire/Intrusion Detection
- Vehicle attributes Detection (Color/Make/Model)
- Automatic Number Plate Detection
- Tracking Vehicle across Cameras
- Speed of Car/Vehicle
- Helmet Detection on Two Wheelers
- Wrong Way Driving Detection
- Illegal Turn by Vehicle
- Triple Riding
- No Seat Belt
- Triple Riding on Two Vehicles
- Smoking in Car while Driving
- Use of Mobile Phones while Driving
- Improper/Illegal Parking
- Authorized Vehicle Entry
- Municipal Parking Management
- Automatic Anomaly Detection
- Integrated Traffic Management System
- Graffiti and Vandalism

- **Person of Interest**
  - Loitering Detection
  - Face Recognition
  - Person Tracking over Network of Cameras
  - Gender Identification: Male or Female
  - Hair Identification: Long or Short Hair
  - People Counting
  - Person Collapsing
  - Incident Detection: Fight (action)
  - Person Waving (gesture recognition)
  - Dwell Time for Person of Interest
  - Threat Detection
  - Forensic Analytics

# 7. Minimum Technical Requirement

## 7.1. Adaptive Traffic Control System (ATCS)

**Adaptive Traffic Management Software**

Adaptive Traffic Management Software (ATMS) would be chosen which implements SCOOT (Split Cycle & Offset Optimization Techniques), CoSiCoSt (Composite Signal Control Strategy) or any other dynamic signal timing plan selection or adaptive system that uses near-real-time detector data. ATC must be chosen to provide accuracy as required for successful functioning of ATMS as per SLAs defined. ATMS software should have a centralized user interface accessible from control room and it should support remote /manual operation of traffic signals from control room. In addition, ATMS software should support selective vehicle (fire engines, ambulances and VIP vehicles) priority at traffic signals using GPS data.

The controller should provide at least one Ethernet interface as per requirement to communicate with ATCS server over TCP/IP.

The controller should provide at least 8 open-collector interfaces for interfacing with traffic detectors.

The ATCS application shall provide selective vehicle priority and compensation to avoid queue build-ups at the other approaches.

The ATCS system shall also be provided with a mobile application to provide congestion and network state information to the citizens using data from the ATCS system.

**Adaptive Traffic Control- Traffic Light Aspects**

**Key Features:**

1) Low power consumption for all colours
2) Meets or exceeds intensity, colour and uniformity specifications
3) Temperature compensated power supplies
4) Uniform appearance light diffusing
5) ITE products shall be Intertek/ETL/EN/Equivalent certified
6) All units operate on AC or DC as the per the suggested solution by MSI

**LED aspects:**

1) Red, Amber, Green-Full (300 mm diameter): Hi Flux
2) Red, Amber, Green-arrow (300 mm diameter): Hi flux
3) Red, Green-Pedestrian (300 mm diameter): Hi Flux with mask or Hi-Brite with discrete LEDs with suitable mask/stencil

| **INTEGRATED PRESENCE DETECTION AND DATA COLLECTION SENSOR – VIDEO BASED** | | |
|---|---|---|
| **Sr. No.** | **Category** | **Minimum Requirement Description Compliance** |
| IPDD.01 | Camera Type | Sensor Size: 1/4”<br>Frame Rate: 25 FPS Black & White Camera |

| | | |
|---|---|---|
| IPDD.02 | Lens Type | Wide Angle: Focal Distance 2,1mm<br>Narrow Angle: Focal Distance 6,0mm<br>Should support motorized zoom via configuration tool |
| IPDD.03 | Electrical Specifications | Open collector (dry contact) interface<br>Average Power Consumption ≤ 10W<br>Operating Voltage - 12 to 26 V AC or DC<br>Average Current Consumption 140mA @ 24VDC<br>Electromagnetic Compatibility: 2004/108/EG<br>FCC: FCC Part 15 class A<br>Shock & Vibration NEMA II specs |
| IPDD.04 | Housing & Temperature Rating | Protection Grades: Housing - IP65 or above, Connectors - IP65 or above<br>Temperature Range: from 0°C to +60°C |
| IPDD.05 | Sensor Firmware & Software | Shall provide presence detection for up to 4 zones<br>Shall provide both non-directional and directional detection in up to 4 directions, user-configured for each zone.<br>Shall be capable of being upgraded via the PC software. |
| IPDD.06 | Single Sensor Controller Interface Module (CIM) | Shall be DIN rail mountable can easily be fitted in Traffic controller.<br>Shall have LED detection output indicators.<br>Shall provide optical isolation.<br>Shall have a port for PC connection. |
| **INTEGRATED PRESENCE DETECTION SENSOR – MICROWAVE RADAR BASED** | | |
| IPDS.01 | General | 24GHz Doppler vehicle radar detector<br>Open collector (dry contact) interface |
| IPDS.02 | Technical | • Technology: CW Doppler Radar<br>• Range/Zone Up to 150m (user selectable)<br>• IP65<br>• Operating Temp 0°C to +60°C<br>• Power 0.8W - 1.0W @ 24Vac<br>• Approved to: ETSI EN 301 489 BS EN 50293 ETSI EN 300 440 BS EN 60950 |

| **Area Based Traffic Management System** | | |
|---|---|---|
| **Sr. No.** | **Category** | **Minimum Requirement Description Compliance** |
| ATMS.001 | General Requirement | Monitor and control traffic signals, including signalled pedestrian crossings, using a traffic responsive strategy based on real time traffic flow and vehicle presence information. However, the system shall also be capable of operating under fixed time plan. |
| ATMS.002 | General Requirement | All junctions under Adaptive Traffic Control System shall be provided with vehicle detection system & communication equipment. Allow each intersection controller to be monitored from city operation system for proper functionality. Any corrective action can be initiated either automatically based on status information or by an operator. The real time detection data shall be communicated to the city operation |

| | | |
|---|---|---|
| | | centre by each controller. |
| ATMS.003 | General Requirement | ATCS shall be driven central control system in real time with the capacity to calculate the optimal cycle times, effective green time ratios, and change intervals for all system traffic signal controllers connected to it which in turn can also work in configurable manner. These calculations shall be based upon assessments carried out by the ATCS central application software running on a City Operation Centre based on the data and information gathered by vehicle detectors at strategic locations at the intersections controlled by the system |
| ATMS.004 | General Requirement | Signal Synchronization - manage network of signals to synchronize timing cycle to ensure probability of maximum greens to the vehicle moving in a particular direction. |
| ATMS.005 | General Requirement | Pedestrian Priority<br>▪ The controller site-specific data shall provide independent control for each of the pedestrian movements. It is also possible for a pedestrian phase to be configured to appear alone, in conjunction with other pedestrian phases, with non-conflicting vehicle phases, or in conjunction with a combination of pedestrian and non-conflicting vehicle phases.<br>▪ Allow pedestrian movements to be introduced automatically or by demand, whichever is required. Vehicle movements configured to run in parallel with a pedestrian phase shall continue to hold right of way until the end of the pedestrian clearance interval.<br>▪ Shall allow the pedestrian green and/or flashing red intervals to overlap between one or more stages with non-conflicting phases if so required. |
| ATMS.006 | General Requirement | Emergency Vehicle Priority Provision to make way for emergency vehicle priority like fire, police and ambulance in some exceptionally important situations. The priority could be assigned by the central system and could be activated using an incident response system. |
| ATMS.007 | General Requirement | Should be able to integrate with Integrated Operation Platform for complete dashboard view |

## 7.2. Intelligent Traffic Management System and City Wide CCTV Surveillance Solution

### A. On site Local Processing Unit with communication & Electrical Interface (Junction Box)

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| LPU.001 | Data Storage on site | System should be equipped with appropriate storage capacity for 24 x 7 recording, with overwriting capability. Images should be stored in tamper proof format only. |
| LPU.001 | Network Connectivity | Wired/GPRS based wireless technology with 3G upgradable to 4G capability. |
| LPU.00 | Communicatio | Minimum 2(two) USB Port to support latest external mass storage devices and |

| | | |
|---|---|---|
| 1 | n port | Ethernet (10/100) Port for possible networking. All logs of data transfer through the ports shall be maintained by the system. |
| LPU.001 | Operating range | ambient temperature range of -5°C to 60°C. |
| LPU.001 | Lightening arrester | shall be installed for safety of system (As per BIS standard IS 2309 of 1989). |
| LPU.001 | Housing | should be capable of withstanding vandalism, harsh weather conditions and should meet IP66, IK10 standards (certified). |
| LPU.001 | Violation Transmission and Security | Encrypted data, images and video pertaining to violations at the onsite processing unit should be transmitted to CCC electronically through wired or GPRS based wireless technology with 3G upgradable to 4G, in jpeg format. |
| | | Advanced Encryption Standard (AES) shall be followed for data encryption on site and CCC, and its access will be protected by a password. |
| | | Data from onsite local processing unit shall be transferred to CCC within one day. |
| LPU.001 | Video Recording | System should be capable of continuous video recording in base station for 7 days. System shall automatically overwrite data after 7 days. Any point of time, local storage at base station should have data of previous 7 days. |
| | | Direct extraction through any physical device like USB, Hard disk shall be possible |

**B. Fixed Box Surveillance Camera (HD)**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| FBC.001 | General Requirements | The camera should be manufacturer's official product line designed for commercial / industrial 24x365 use. The camera and camera firmware should be designed and developed by same OEM |
| FBC.002 | Image Sensor with WDR | 1/3.2” with True WDR, Progressive CMOS Sensor or better |
| FBC.003 | Lens Specs | Compatible to image sensor, Focal length 8-50 mm or better, Full HD (1080P), Auto IRIS / P IRIS, Corrected IR, CS Mount with IR cut filter |
| FBC.004 | Resolution | Active Pixels 1920(w) x 1080(h) |
| FBC.005 | Minimum illumination | Colour: 0.3 lux or better, B/W: 0.05 lux or better |
| FBC.006 | Video Encoder | H.265 or H.264//Motion JPEG compression |
| FBC.007 | Frame Rate | min. 25 FPS or higher |
| FBC.008 | Local Storage | 32 GB SD Card or higher |
| FBC.009 | Ethernet | 10/100/ Base-T ports |
| FBC.010 | Image Compression | H.265 or H.264//Motion JPEG compression |
| FBC.011 | Protocols | Minimum of the following protocols to be supported RTSP, RTP/TCP, RTP/UDP, HTTP, HTTPS, DHCP |
| FBC.012 | Industry Standards | ONVIF Compliant |
| FBC.013 | Power Supply | POE IEE 802.3af compliant |
| FBC.014 | Operating | 0° C to 50° C or better |

| | | |
|---|---|---|
| | Temperature | |
| FBC.015 | Operating Humidity | Humidity 10–100% RH (condensing) |
| FBC.016 | Enclosure | IP 66 |
| FBC.017 | Certifications | UL, CE, FCC, ONVIF 2.x/S |

### C. Fixed Box Surveillance Camera (HD)

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| FBC.018 | Support | System should not be an end of life / end of service product. |
| | | Camera shall be able to setup and stream out minimum |
| FBC.019 | Streaming | two (2) stream profiles. Each stream profile should have its own compression, resolution, frame rate and quality independently. |
| FBC.020 | White Balance | Auto / Manual |
| FBC.021 | Back Light Compensation | Auto |
| FBC.022 | Security | Security Password protection |
| FBC.023 | Miscellaneous | Vandal and impact resistant housing, IK 10, IP66/ NEMA 4X |
| FBC.024 | | Detection of camera tampering and Detection of Motion should be possible using either camera or VMS |

### D. Surveillance Camera - PTZ (HD)

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| PTZ.001 | General Requirements | Camera should be manufacturer's official product line designed for 24x365 use. Camera and camera firmware should be designed and developed by same OEM. |
| PTZ.002 | General Requirements | Camera should be based upon standard components and proven technology using open and published protocols |
| PTZ.003 | Image Sensor with WDR | 1/3.2” with True WDR, Progressive CMOS Sensor or better |
| PTZ.004 | Resolution | Camera should be HD PTZ 1920 (w) x1080 (h) |
| PTZ.005 | lens specs | Compatible to image sensor, Focal length 30x, 4.3-129 or 4.7–129 mm or better, Auto Iris, Full HD (1080P), F/1.6, IR Corrected – Day / Night mode- Colour |
| PTZ.006 | Minimum illumination | Colour: 0.3 lux, B/W: 0.05 lux or better |
| PTZ.007 | Pre-set Positions | 100 or better, Pre-set tour |
| PTZ.008 | Pan | 360° endless, 300°/s |
| PTZ.009 | Tilt Range | Manual/programmable; speed: 300°/sec; angle :0-180° or proportional speed needs to be provided |

| | | |
|---|---|---|
| PTZ.010 | Zoom | 30x optical zoom and should support digital zoom feature |
| PTZ.011 | General | Camera shall be able to setup & stream out minimum two (2) stream profiles. Each stream profile shall have its own compression, resolution, frame rate and quality independently. |
| PTZ.012 | Outdoor Protection | Camera should be complete with IP 66 rated housing, Connectors, Camera Mounts, Power Supply and all Ancillary Equipment & all accessories. |
| PTZ.013 | Protocol | IPv4, TCP/IP, HTTPS, FTP, SMTP, SNMP, RTP, RTSP, DDNS, DHCP, DNS, NTP, UDP |
| PTZ.014 | Compression Capability | H.265 or H.264 /Motion JPEG compression @ 25fps |

**E. Surveillance Camera - PTZ (HD)**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| PTZ.015 | Certificate | FCC, CE, UL, ONVIF 2.x/S |
| PTZ.016 | Industry Standards | ONVIF Compliant |
| PTZ.017 | Miscellaneous | Compliance to Vandal and impact resistant housing – IP66 / NEMA 4X, IK10 |
| PTZ.018 | | Power Supply: External 12V /24V/48V DC/ POE |
| PTZ.019 | | Connectors: 10Base-T/100Base-TX |
| PTZ.020 | | Cable routing through base or rear of housing |
| PTZ.021 | | Operating conditions unit: 0° C to 50° C or better, humidity Humidity 10–100% RH (condensing) |
| PTZ.022 | | Tamper Proof |
| PTZ.023 | | Detection of camera tampering and Detection of Motion should be possible using either camera or VMS |
| PTZ.024 | Support | The system should not be an end of life / end of service product. |
| PTZ.025 | Audio | Audio capture Capability |
| PTZ.026 | Local Storage | 32GB or higher |
| PTZ.027 | Security | Password Protection |

**F. IP Dome Camera**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| IPDC.001 | Image Sensor with WDR | 1/3.2” with True WDR, Progressive CMOS Sensor or better |
| IPDC.002 | Resolution | 2 MP HD or higher |
| IPDC.003 | Minimum Illumination | 0.3 lux in colour mode; 0.2 lux or better in B/W with IR |
| IPDC.004 | Lens | Min 3 to 10 mm fixed/vari-focal lens with Remote focus |
| IPDC.005 | Ethernet | 10/100/ Base-T ports |
| IPDC.006 | Frame Rate | min 25fps or better |
| IPDC.007 | Image | H.265 or H.264 /Motion JPEG compression |

| | | |
|---|---|---|
| | Compression | |
| IPDC.008 | Protocols | Minimum of the following RTSP, RTP/TCP, RTP/UDP, HTTP, DHCP protocols to be supported |
| IPDC.009 | Operating Temperature | 0°C to 50°C degrees or better |
| IPDC.010 | Power supply | POE IEE 802.3af compliant |
| IPDC.011 | Support | System should not be an end of life / end of service product. |
| IPDC.012 | Industry Standards | ONVIF Compliant |
| IPDC.013 | Certifications | UL, CE, FCC, ONVIF 2.X/S |
| IPDC.014 | Storage | 32 GB or higher |
| IPDC.015 | White Balance | Auto / Manual |
| IPDC.016 | BLC | ON/OFF |
| IPDC.017 | Security | Password protection |
| IPDC.018 | Casing | IP 66 vandal resistant |
| IPDC.019 | Camera Tampering | Detection of camera tampering and Detection of Motion should be possible using camera. Functionality to be enabled vide VMS |
| IPDC.020 | Streaming | Camera shall be able to setup and stream out minimum two (2) stream profiles. Each stream profile shall have its own compression, resolution, frame rate and quality independently. |

### G. Multi Sensor /Panoramic 360° Camera

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| MSC. 001 | General Requirements | Camera should be manufacturer's official product line designed for commercial / industrial 24x365 use. |
| MSC.002 | General Requirements | Camera should be based upon standard components and proven technology using open and published protocols |
| MSC.003 | Image Sensor | Minimum 4 x 2MP, 1/3.2" CMOS - (Total) 8 MP or better |
| MSC.004 | Lens Specs | F2.0, IR Corrected; Options of 2.8/4/8/12/16 MM Lens |
| MSC.005 | Maximum Resolution | 4 K Vision |
| MSC.006 | Minimum illumination | Colour: 0.6 lux or better, Monochrome: 0.05 Lux or better with IR |
| MSC.007 | Video Compression | H.265 and H.264/ Motion JPEG |
| MSC.008 | Frame Rate | 15fps or better |
| MSC.009 | Wide Dynamic Range | 100 dB or better |
| MSC.010 | Network Interface | 100 Base-T ports |
| MSC.011 | Power Supply | POE IEE 802.3af compliant |
| MSC.012 | Industry Standards | ONVIF Compliant |

| | | |
|---|---|---|
| MSC.013 | Certifications | UL, FCC |
| MSC.014 | Enclosure Type | IP66; IK 10 or NEMA 4X |
| MSC.015 | Operating Temperature | 0° C to 50° C or better |
| MSC.016 | Operating Humidity | Humidity 10–100% RH (condensing) |
| MSC.017 | Supported Network protocols | Minimum of the following RTSP, RTP/TCP, RTP/UDP, HTTP, DHCP protocols to be supported |
| MSC.018 | Support | System should not be an end of life / end of service product. |

### H. IR Illuminator - Field Location

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| IRI.001 | Range Distance | Minimum 80 m |
| IRI.002 | Angle | 60 degrees minimum Adjustable |
| IRI.003 | Power | Input 100-240V AC, or 12/24 V AC/DC |
| IRI.004 | Casing | IP66 rated / NEMA 4X vandal resistance |
| IRI.005 | Operating Condition | 0° to 50°C or better |
| IRI.006 | Certification | CE, FCC, ETL/UL, RoHS |
| IRI.007 | Lighting | High Definition LED's |
| IRI.008 | Required Accessories | Power Supply, Mounting Clamps, U-bracket |
| IRI.009 | Support | System should not be an end of life / end of service product. |

### I. Variable Message Sign Board – VaMS

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| VaMS.001 | Dimension Requirements | VaMS shall be full-matrix type (adjustable text size and allow both upper and lower case). |
| VaMS.002 | Display Requirements | Electronic-High Luminosity wide viewing angle oval LEDs (Only Nichia LED) for outdoor ambient light shall be used. |
| VaMS.003 | Display Requirements | Long life LEDs with minimum working of 1,00,000 hours to Half Life |
| VaMS.004 | Display Requirements | VMS shall automatically adjust their brightness under varying light conditions to maintain legibility |
| VaMS.005 | Display Requirements | Luminance of VaMS's should meet industry criteria for daytime and night time conditions |
| VaMS.006 | Display Requirements | VaMS unit shall have the provision to display online messages received from the command control centre for the duration specified by the user. |
| VaMS.007 | Display Requirements | Minimum vertical clearance between the finished road surface and the bottom of the support structure/bottom of the VaMS (whichever is |

| | | |
|---|---|---|
| | | lower) shall be 6.5 m. |
| VaMS.008 | Required Size for Surveillance | 2.88 m x 0.96 m |
| VaMS.009 | Required Size | 1.92 m x 0.96 m |
| VaMS.010 | Refresh Rate | Minimum 800 Hz |
| VaMS.011 | Temp Range | 0 to +45 Degrees |
| VaMS.012 | Native Brightness | Minimum 5000 NITs |
| VaMS.013 | Contrast Ratio | Minimum 1200:1 |
| VaMS.014 | Pixel Requirements | The pixel pitch shall be not more than 16 mm. |
| VaMS.015 | Pixel Density | Minimum 3096 pixel / $m^2$ |
| VaMS.016 | LED Configuration | R/G/B 3 in 1 SMD |
| VaMS.017 | Power Input | 100 ~ 240 VAC, |
| VaMS.018 | Max Power Consumption | ≤ 1000 W/Tile |
| VaMS.019 | Dimming Capabilities | Minimum 64 Levels |
| VaMS.020 | Humidity | 10% ~ 90% |
| VaMS.021 | IP Level | IP65 Front IP54 Rear |
| VaMS.022 | Image Processor for Each LED Wall Display | Signal Input – DVI; Signal Output - RJ - 45 |
| VaMS.023 | Communication | The communication protocols supported shall be TCP/IP, RS 232 |
| VaMS.024 | Communication | The signboard unit shall be able to communicate with central command centre computer using GSM data channel (GPRS) / Ethernet will be used to send online messages. |
| VaMS.025 | Communication | GPRS/ Ethernet port shall also be extended to ground level using necessary cables for local trouble shooting. |
| VaMS.026 | Communication | Each unit shall be provided with a unique identification number and shall communicate with the designated central command centre system and a local device loaded with relevant software |
| VaMS.027 | Communication | VMS shall have self-test diagnostics features to test the VMS for correct operation during power on. |
| VaMS.028 | Display Protection | The front of VaMS display board should be weather resistant IP 65 rated w.r.t various climatic conditions |
| VaMS.029 | Power Requirements | 230V AC + 15%, 50 Hz single phase power supply (Automatically re-start in the event of an electricity failure) |
| VaMS.030 | Power Requirements | Equipment components shall have adequate surge and lightning protection. |
| VaMS.031 | Power Requirements | Necessary earthing for electrical and lightning protection to be provisioned as per the industry standards |

**J. Support Structure for Variable Message Signboards**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| SSVMS.001 | General Requirement | Support structure for the VaMS shall be of MS IS: 2062 Gantry type |
| SSVMS.002 | General Requirement | Structure should be supported on the ground (shoulder/foot-path) on both the sides of the road through appropriate concrete foundation. |
| SSVMS.003 | General Requirement | Minimum vertical clearance between the finished road surface and the bottom of the support structure/bottom of the VaMS (whichever is lower) shall be 6.5 m as per NHAI guidelines |
| SSVMS.004 | General Requirement | Support structure shall provide adequate support to the VMS from all four sides as well as top and bottom (at least six to eight connections for mounting the VMS) |
| SSVMS.005 | Load Requirement | Structure for display board mounting should withstand wind-speeds upto**150km/hr** and support the weight of at least two VMS along with structure's self-weight. This should be certified by a structure engineer |
| SSVMS.006 | Load Requirement | Display board should be secured sufficiently with fasteners and fixtures to the support structure to withstand the mentioned loads. |
| SSVMS.007 | Painting | Structure shall be painted with one coat of primer and two coats of PU paint. Grey/silver paint or as described by Noida authority |
| SSVMS.008 | General Requirement | RCC foundation with M20 Grade Ready-mix RCC and required IRON bar structure to take load of Structure weight as well as VMS approved by Structure Engineer |
| SSVMS.009 | Access | All access panels shall be limited in size so they can be opened or closed by person shall be designed to prevent unauthorized access. |

### K. Public Address System

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| PAS.001 | PAS system | a) Should have the capability to control individual PAS i.e. to make announcement at select location (1:1) and all locations (1: many) simultaneously.<br>b) The PAS should also support both Live and Recorded inputs. |
| PAS.002 | Speaker | Minimum 2 speakers, To be used for Public Address System |
| PAS.003 | Connectivity | IP Based |
| PAS.004 | Access Control | Access control mechanism would be also required to establish so that the usage is regulated. |
| PAS.005 | Integration | With VaMS and Command and Control Centre or any other component if required |
| PAS.006 | Construction | Cast Iron Foundation and M.S. Pole, Sturdy Body for equipment |
| PAS.007 | Battery | Internal Battery with different charging options (Solar/Mains) |
| PAS.008 | Power | Mains Power 230V AC and Backup 24VDC |
| PAS.009 | Casing | IP-55 rated for housing |
| PAS.010 | Operating | 0° to 55°C |

| | | |
|---|---|---|
| | conditions | |
| PAS.011 | Central Server/Software | Redundant central application server/software |
| PAS.012 | Integration | Integration with command and control centre |
| PAS.013 | Amplifier Type | Class D |
| PAS.014 | Amplifier output | 250 Watts |
| PAS.015 | Connectivity | IP-Based, No conversion of Analogue amplifier to IP allowed |
| PAS.016 | Power | Mains Power 230V AC and Backup 24VDC |
| PAS.017 | Operating temperature | 0°C and +55°C at a maximum relative ambient humidity of 95%. |
| PAS.018 | Certification | CE |
| PAS.019 | Monitoring functionality | Line monitoring |
| PAS.020 | Environment protection | IP 55 or better |
| PAS.021 | Audio transmission bandwidth | 16 kHz |

### L. Network Switch Ruggedized

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| NSR.001 | General Requirement | The switch should be Industrial Grade ruggedized in nature that provides minimum 8 x 10/100/1000 BASETX access ports, additional 2 x 1000 Base-X SFP & 2x 1GE Uplink ports. One (1) ruggedized single mode SFP should be supplied with the switch. |
| NSR.002 | General Requirement | The switch should have non-blocking wire-speed architecture with support for both IPv4 & IPv6 from day one with wire-rate switching fabric of minimum 16 Gbps or more. Switch should have minimum 1GB RAM/DRAM & 1GB removable flash card. |
| NSR.003 | General Requirement | The switch should support backup storage drives, which will store the last known configuration of the switch, in the case of hardware failure and replacement. Reinserting the storage drive should restore the switch to original working condition without any manual intervention. |
| NSR.004 | Layer 2 Features | 802. 1Q VLAN on all ports with minimum 10k MAC address |
| NSR.005 | Layer 2 Features | Spanning Tree Protocol as per IEEE 802.1d, ring protection protocol like REP or equivalent |
| NSR.006 | Layer 2 Features | Should support Jumbo frames up to 9000 bytes & Link Aggregation Control Protocol (LACP) as per IEEE 802.3ad. |
| NSR.007 | Layer 2 Features | The switch should support IGMP v1/v2/v3 &up to 1000 IGMP groups as well as IGMP snooping & IGMP filtering. Should also support MLD v1/v2. |

| | | |
|---|---|---|
| NSR.008 | Layer 3 Features | Static, Inter-VLAN routing must be enabled from day one |
| NSR.009 | Layer 3 Features | The switch should support Dynamic Routing – RIPv1/v2, OSPF for both IPv4 & IPv6, PBR, network address translation etc. protocol by enabling/upgrading the license as & when required |
| NSR.010 | Quality of Service (QoS) | Switch should support classification and scheduling as per IEEE 802.1P on all ports with minimum four egress queues per port |
| NSR.011 | Features | The switch should provide traffic shaping and rate limiting |

**M. Pole for Cameras**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| POLE.001 | General Requirement | Shall be minimum 6.5m height as per NHAI norms |
| POLE.002 | General Requirement | Hot dip galvanized pole with silver coating of 86 micron as per IS:2629 min 10 cm diameter pole and suitable bottom and top thick HT plate along with base plate size 30x30x15 cms suitable for wind speed 50 m/sec with suitable arm bracket and with J type foundation bolts. Fabrication in accordance with IS 2713 (1980) |
| POLE.003 | Foundation | Pole would be fixed on an adequate and strong foundation to withstand city weather conditions and wind speed of 150 km/hr |
| POLE.004 | Foundation | Casting of civil foundation with foundation bolts to ensure vibration free (video feed quality should not be impacted due to wind in different climatic conditions) Expected foundation depth of minimum 100 cms or better |
| POLE.005 | Sign Board with number plate | Sign board depicting the area under surveillance and with serial number of pole |
| POLE.006 | Height | Height of the pole shall be as per requirement of the location varying from 6 m to 12/15 m. |
| POLE.007 | Electrical Connection | Electrical power requirement for the systems/devices installed on the pole should be available with metering and protection equipment |
| POLE.008 | Lightning Protection | Lighting arrestors with proper grounding |
| POLE.009 | Earthing | Pole should have proper earthing system |
| POLE.010 | Network Communication | All communication passive & active devices should be housed in enclosure of adequate standards and protection |

**N. Pole for Cameras - Junction Box**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| POLJB.001 | General Requirement | All the junction boxes shall be out door type with **IP65** protection from rain, water. Provision for theft prevention. (Expected outdoor temperature 500C). |

| | | |
|---|---|---|
| POLJB.002 | General Requirement | ▪ 1.5 mm steel sheet, profiled frame construction consisting of 9 folded rolled hollow sections punched on a 25 mm DIN Pitch pattern with load carrying capacity of 500 kgs.<br>▪ Front and rear 2 mm thick sheet steel door with PU Foamed Seal (Gasketing) with removable galvanized rectangular frame with holes on a 25 mm DIN pitch pattern with 3 point locking system.<br>▪ Hinges and retainers should be made of die cast, copper nickel chrome plated with SS hinge pins.<br>▪ Doors should be swapped to LH if required with door opening angle 130°C to VDI.<br>▪ Top panel made of 1.5 mm thick sheet steel with PU foamed (Gasketing) bolt able from inside.<br>▪ Bottom panel made of 1.5 mm thick sheet steel with PU foamed (Gasketing) with provision for fixing 4 nos of PG 29 glands.<br>▪ Side panels in double walled construction with air gap of minimum 20 mm between two walls with PU foamed(Gasketing) for IP 55 protection. Painting: Electro-phoretic dip coat priming to 20 Microns and then powder coated to RAL 7035 textured Pure Polyester (PP) to 80 to 120 Microns. powder coated with surface finishing nano coating, for the best possible surface protection and corrosion resistance.<br>▪ Side and Wall Panels shall be double wall constructed, with fixing bolts internal to the cabinet. |
| POLJB.003 | General Requirement | Should be outdoor type, Floor mounting with 3 point locking option, suitable to mount the switches and required UPS.<br>Opening lever/handles shall be made of metal. Each Cabinet will be mounted on a raised height concrete Plinth, 600 -1000 mm high, as per site requirements. |
| POLJB.004 | General Requirement | Cabinet will be provided with a dimension of 800mmW x 1200mmH (24UH) x 800mmD with 19" mounting arrangement suitable for the mounting of associated network, power, UPS and Split Battery components securely and safely within the cabinet. |
| POLJB.005 | General Requirement | Junction box shall have floor mount type with required mounting accessories to provide a flexible solution for space constrained traffic applications. |
| POLJB.006 | General Requirement | 2 x 5 way/15 Amp PDU's will be provided to support the site equipment. 2 x thermostat controlled 230V AC Fans with 100% Duty Cycle with Filter and 2X Filter units with IP55 Rating with rain Canopy shall be fitted to front door of cabinet to provide ventilation to cool the equipment. |
| POLJB.007 | General Requirement | 75 mm Rain canopy on Top with all around projection of the enclosure such that that rain water, water logging shall not penetrate in the junction box and hamper working of the system, cable entry with glands. |
| POLJB.008 | General Requirement | Small Junction box for mounting Electrical Meter, Fuse and MCB with separate lock for utility power connection |

| | | |
|---|---|---|
| POLJB.009 | General Requirement | Protection from ants, bugs and other small insects entering the enclosure |
| POLJB.010 | Standard and Support | Regulatory Standard Compliance: IP55 to EN60529/09.2000, ISO 9001, 14001, 18001 comply with EIA 310, DIN 41494 and IEC 297 standards. The system should not be an end of life / end of service product. |

### O. Automatic Number Plate Recognition (ANPR)

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| ANPR.001 | General Requirements | Cameras shall cover single lanes of 3.5 m each. For places where more than two lanes are to be monitored, lane cameras to be increased in proportion to the lane |
| ANPR.002 | General Requirements | System shall have IR illuminators to provide illumination for night-time scenario. Camera with IR illuminators should be deployed at heights between 20 feet to allow HMV (high motor vehicle) to pass underneath it, and to minimize occlusion. |
| ANPR.003 | General Requirements | System should have the facility to provide the live feed of the camera at the central command centre or as per user requirement. |
| ANPR.004 | General Requirements | System should be able to provide video clips of the transaction from the ANPR lane cameras as evidence |
| ANPR.005 | General Requirements | For each detected violation, the system would store 5 snapshots of both cameras, date and time, location, ANPR recognized license plate number, thumbnail of the license plate region |
| ANPR.006 | General Requirements | System should perform ANPR on all vehicles passing the site and send alert to central command centre on detection of any Hot-listed vehicles (whose numbers marked as Stolen, Wanted, etc. at the Central server). |
| ANPR.007 | General Requirements | With detected number plate text, picture should also be sent of hot listed vehicle. It is likely to misread similar alphabets like 7/1/L or 8/B |
| ANPR.008 | General Requirements | System should work 24 x 7 in both day and night conditions with good accuracy for the duration of the project |
| ANPR.009 | General Requirements | System should be able to detect and recognize the English alpha numeric License plate standard fonts and formats, defined under CMVR 1989 |
| ANPR.010 | General Requirements | System should have ANPR/ OCR to address the Alpha numerical character of irregular font sizes. |
| ANPR.011 | General Requirements | System should capture standard HSRP (high security registration plate, as per Govt of India notification) vehicle's number plates with an accuracy of at least 85% at day time and at least with an accuracy of 80% at night time. (On basis of number of vehicles) |
| ANPR.012 | General Requirements | System should have an option for the user to enter Hot-Listed vehicles at the Central Server and the same should be sent to all the sites automatically over the network. |
| ANPR.013 | General Requirements | Bidder to provide system with local processing unit at site and send only processed data |

| | | |
|---|---|---|
| ANPR.014 | General Requirements | Local processing unit should be industrial grade capable of working up to 70° C |
| ANPR.015 | Vehicle detection by Colour | System shall have options to search historical records for post event analysis by vehicle colour or vehicle colour with license plate and date time combinations |
| ANPR.016 | Alert Generation | System should have option to input certain license plates according to hot listed categories like “Wanted”, “Suspicious”, “Stolen”, etc. by authorized personnel. |
| ANPR.017 | Alert Generation | System should be able to generate automatic alarms to alert the control room personnel for further action, in the event of detection of any vehicle falling in the Hot listed categories. |
| ANPR.018 | Logs | System shall enable easy and quick retrieval of snapshots, video and other data for post incident analysis and investigations. |
| ANPR.019 | Logs | System should be able to generate suitable MIS reports that will provide meaningful data to concerned authorities and facilitate optimum utilization of resources. A) Report of vehicle flow at each of the installed locations for Last Day, Last Week and Last Month. B) Report of vehicles in the detected categories at each of the installed locations for Last Day, Last Week and Last Month. C) Report of Vehicle Status change in different Vehicle Categories. |
| ANPR.020 | Logs | System shall have Search option to tune the reports based on license plate number, date and time, site location as per the need of the authorities. System shall have option to save custom reports for subsequent use. |
| ANPR.021 | Logs | System shall have option to export report being viewed to common format for use outside of the ANPRS or exporting into other systems. |
| **P. Red Light Violation Detection** | | |
| Sr. No. | Item | Minimum Requirement Description |
| RLVD.001 | General Requirements | One single installation system should consist of cameras out of which one camera should be an overview camera providing evidence of the violation by capturing the offending vehicle and status of the traffic light in the same field of view |
| RLVD.002 | General Requirements | System should have the facility to provide the live feed of the camera at the central command centre as per user requirement. |
| RLVD.003 | General Requirements | System should generate Alarms at control room software if any signal is found not turning RED within a specific duration of time. |
| RLVD.004 | General Requirements | The system should be able to provide video clips of the transaction from the overview and lane cameras as evidence |
| RLVD.005 | General Requirements | For each detected violation, system Should store 5 snapshots of both cameras, date, time, location, ANPR recognized license plate number, thumbnail of license plate region, phase of light (red, amber), time since phase change (red, amber). |
| RLVD.006 | General Requirements | System should not use signal from traffic controller but use sensors instead. Should work without any lane based intuitive sensors like loops, piezo etc. |
| RLVD.007 | General Requirements | Should generate alarm if cameras get misaligned or dysfunctional including images- multiple images for pre and post infraction for red light over jumping, data, time, location, speed, with automatic number plate detection mechanism (to recognize vehicle automatically) |

| | | |
|---|---|---|
| RLVD.008 | General Requirements | ANPR provided with RLVD should be capable of also searching for hot listed vehicles during green light. Accuracy of 85% in Day and 80% in Night for Standard HSRP plates. |
| RLVD.009 | General Requirements | Local processing unit should be industrial grade type (700 C) |
| RLVD.010 | General Requirements | local site should send transaction data for all violations and alerts of Hot listed vehicles to the central server. Alerts should be sent immediately, whereas violation data should be sent in batch mode as per available bandwidth |
| RLVD.011 | General Requirements | System should provide facility to search for the cases of violations occurred during any specific span of time, and provide a statistical analysis of the number of such incidences occurring during various days of the month, various months of the year in graphical forms. A report of all such incidences should be available and transferable in hard copy during any selected span of time. |
| RLVD.012 | General Requirements | Additionally, the system should be able to store license plates numbers of at least 10,000 suspected vehicles at a time and should generate an Alert is any one of the vehicles is found crossing the stop line (irrespective whether the signal is GREEN or RED) |

**Q. Face Recognition System**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| FRS.001 | General Requirements | Facial recognition system should be able to integrate with IP Video Cameras as required in the solution and shall be able to identify multiple persons of interest in real-time, through leading-edge face recognition technology. The system shall be able to recognize subjects appearing simultaneously in multiple live video streams retrieved from IP surveillance cameras. The Facial recognition system should seamlessly be integrated to the network video recorders and the video management system. |
| FRS.002 | General Requirements | The facial recognition system should be able to work on the server/ desktop OS as recommended by OEM and provided by the System Integrator |
| FRS.003 | General Requirements | The user interface of the facial recognition system should have a report management tool without installation of any additional client software. It should be able to generate real time report such as Audit log report, Hit List Report, Daily Statistics Report, and Distribution Report. |
| FRS.004 | General Requirements | Facial recognition system should be accessible from 5 different desktop/ laptops at any given time. When choosing a distributed architecture, the system shall be able to completely centralize the events and galleries from each local station into a unique central station, devoted to management and supervision. |
| FRS.005 | General Requirements | System should have ability to handle initial real-time watch list of 100,000 Faces (should be scalable to at least 1 Million faces) and 50 Camera Feeds simultaneously and generate face matching alerts. |
| FRS.006 | General Requirement | The algorithm for facial recognition or the forensic tool should be able to recognise partial faces with varying angles |

| | | |
|---|---|---|
| | s | |
| FRS.007 | General Requirements | System should be able to detect multiple faces from live single video feed |
| FRS.008 | General Requirements | System should have combination of eye-zone extraction and facial recognition |
| FRS.009 | General Requirements | System should have short processing time and high recognition rate |
| FRS.010 | General Requirements | System should be able to recognize faces regardless of vantage point and any facial accessories/ hair (glasses, beard, expressions) |
| FRS.011 | General Requirements | Face detection algorithms, modes and search depths should be suitable for different environments such as fast detection, high accuracy etc. The FRS system shall use of GPU technology instead of Traditional CPUs, to greatly improve the computational performance in crowded environments. |
| FRS.012 | General Requirements | System should be able to identify and authenticate based on individual facial features |
| FRS.013 | General Requirements | System should be compatible with the video management system being proposed by the system integrator |
| FRS.014 | General Requirements | System should have capability for 1:1 verification and 1:N identification matching |
| FRS.015 | General Requirements | The system should be able to integrate with other systems in the future such as 'Automatic fingerprint identification system (AFIS)' etc. |
| FRS.016 | General Requirements | The system should be able to support diverse industry standard graphic and video formats as well as live cameras |
| FRS.017 | General Requirements | The system should be able to match faces from recorded media. |
| FRS.018 | General Requirements | The system should be able to detect a face from a group photo |
| FRS.019 | General Requirements | The system should be able to detect a face from stored videos of any format |
| FRS.020 | General Requirements | The system should have bulk process of adding faces in the system |

| | | |
|---|---|---|
| FRS.021 | General Requirements | The system should be an independent system, with capability to integrate with industry standard Video Management Systems (VMS) for alert viewing. |
| FRS.022 | General Requirements | The system should allow users to search or browse captured faces (based on date or time range), export any captured image for external use with a capability to support a Handheld mobile with app for windows OS or android OS to capture a face on the field and get the matching result from the backend server. |
| FRS.023 | General Requirements | The proposed solution should provide the ability to assign different security levels to people and places. It should alert security staff when someone is spotted in an area where they're not permitted, whilst allowing them free access to non-restricted/public areas. |
| FRS.024 | General Requirements | The system shall be able to detect faces in different environmental changes like rain, wind, fog and poor light. |
| FRS.025 | General Requirements | The system should have the facility to categorize the images like "Remember this person" or "hit-list" or "wanted". |
| FRS.026 | General Requirements | The OEM should have deployed the solution in India |

### R. E Challan Handheld Device

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| ECHH.001 | Operating System | Latest Windows or Android OS or iOS |
| ECHH.002 | Processor | Min 1.2GHz Quad Core |
| ECHH.003 | Memory (Flash ROM) | Minimum 8 MB |
| ECHH.004 | RAM | 1GB Min |
| ECHH.005 | Extend Slot | Micro SD 32 GB |
| ECHH.006 | Display | Min 3.5 inch TFT LCD (Trans reflective screen VGA/QVGA) |
| ECHH.007 | Touch Screen | Yes |
| ECHH.008 | Form Factor | Any |
| ECHH.009 | GPS | Yes |
| ECHH.010 | Bluetooth | Yes |
| ECHH.011 | Wi-Fi | Wi-Fi (802.11 b/g/n) |
| ECHH.012 | Thermal Printer | Direct thermal line printing 3 inch |
| ECHH.013 | Barcode | 1D and 2 Scanner |

| | | |
|---|---|---|
| | scanner | |
| ECHH.014 | External Interface | USB HOST/RS232(Customized) |
| ECHH.015 | Drop resistance level | 1.5m |
| ECHH.016 | Camera | 3 MP Min |
| ECHH.017 | Camera-Video | Support still image and video capture |
| ECHH.018 | Keypad Front | QWERTY 42 Keys / touch screen keypads |
| ECHH.019 | Mini-USB Connector | USB2.0 connection |
| ECHH.020 | Credit/Debit Card Slot | Yes |
| ECHH.021 | SIM card slot | Yes |
| ECHH.022 | TF card slot | Yes |
| ECHH.023 | Power jack | Yes |
| ECHH.024 | Audio Jack | Yes |
| ECHH.025 | Battery Type | rechargeable Li-ion battery 3000mAh |
| ECHH.026 | Operating temperature | 0 deg C to 50 deg C |
| ECHH.027 | Storage temperature | 0 deg C to 60 deg C |
| ECHH.028 | Operating humidity | 10%--80% |
| ECHH.029 | Storage humidity | 10%--90% |
| ECHH.030 | Payment PINPAD | Device should have/be supplied with (in case of wireless bluetooth printer) lPCI, EMV certified PINPAD as per RBI guideline for accepting payment through Credit / Debit card |

**S. Camera Specification for Police VAN with NVR**

| S. No. | Features | Description |
|---|---|---|
| PVNR.001 | Camera Type | Mobile Speed PTZ |
| PVNR.002. | Standard | ONVIF Profile S Compliant |

| | | |
|---|---|---|
| PVNR.003. | Certification | UL,CE/BIS ,FCC and RoHS |
| PVNR.004. | Image Sensor | 1/2.8" CMOS or better |
| PVNR.005. | Resolution | 2MP (Min.1920 x 1080) at 25 FPS or better |
| PVNR.006. | Max. Mbps CVBR | 5 |
| PVNR.007. | Compression | H.264 and H.265 |
| PVNR.008. | Streaming | Min. Dual compressed stream (Individually Configurable) |
| PVNR.009. | Encryption | HTTP(SSL/TLS)/HTTPS |
| PVNR.010. | Video Authentication | For video authentication, digital signature must be embedded in Video Stream along with name, time, date stamped which cannot be tampered |
| PVNR.011. | Physical Layer | 10/100 base Tx Ethernet |
| PVNR.012. | Protocol | Minimum TCP, HTTP, RTP, RTSP, SNMP, IPV4, IPv6,FTP, NTP,DHCP, RTP, SMTP, UDP, UPnP, ICMP, IGMP, SSL, QoS, 802.1x, DNS,DDNS, HTTPS |
| PVNR.013. | IP Support | Static/dynamic or both |
| PVNR.014. | Remote Administration | Remote configuration and status using web based tool |
| PVNR.015. | System Update | Remote system update over Network using web client |
| PVNR.016. | PC Client | PC application client with a channel recording feature support |
| PVNR.017. | Web Client | Viewer through HTTP(min.) System Configuration Setting / Streaming |
| PVNR.018. | Simultaneous Connection | 5 users or more |
| PVNR.019. | Lens Type | 4.7 – 94mm, 20x motorized, Autofocus, Autoiris, Varifocal |
| PVNR.020. | Dynamic Noise Reduction | 3D |
| PVNR.021. | Auto Exposure | Automatic Level Control/Electronic Level Control |
| PVNR.022. | Intelligent Defog | Yes |
| PVNR.023. | Illumination | Color: 0.05 lux, F1.6 B/W: 0.01 lux, F1.6 At 30 IRE Inbuilt IR (60 mtrs. or better) |
| PVNR.024. | Signal Process | Digital Signal Process |
| PVNR.025. | Auto Gain Control | Yes |
| PVNR.026. | Back Light Compensation | Yes |
| PVNR.027. | High Light Compensation | Yes |
| PVNR.028. | Electronic Shutter | 1/10000s to 1 s or better |
| PVNR.029. | White Balance | Yes |
| PVNR.030. | Wide Dynamic Range | min 120 db (Sensor based) |
| PVNR.031. | Day and Night | Yes, (ICR) |
| PVNR.032. | Operating | 0 °C to 60 °C |

| | | |
|---|---|---|
| | Temperature | Humidity 20–80% RH (non-condensing) |
| PVNR.033. | Power Source | Suitable adaptor shall be supplied to make the equipment work on 230V ±10%, 50Hz and Power over Ethernet (POE 802.3 at) or 12 V DC through NVR |
| PVNR.034. | Internet protocol Support | IPv4 and IPv6 |
| PVNR.035. | Housing | Poly Carbonate/ Aluminum Construction with IP-66 Including pole mount/wall mount accessories, Power and data cables |
| PVNR.036. | Presets | 100 presets or higher |
| PVNR.037. | Edge based video content Analytics | Video motion detection and Active tampering alarm |
| PVNR.038. | Accessories | All required accessories at site for installation of camera to be provided like Pole Mount, Corner brackets, Connector kit, screws etc. |
| PVNR.039. | Display | 7inch/ 10 inch display/tablet to be provided along with all necessary cables for connecting with NVR/Camera for display and power adapter etc. |
| PVNR.040 | Accessories | All required accessories for installation of Display in PCR VAN to be provided like brackets, Connector kit, screws etc. |
| PVNR.041 | Warranty | 5 Years Comprehensive OEM Warranty |

**T. Body Worn Camera**

| S. No. | Features | Feature Description |
|---|---|---|
| BWC.001 | Display | Shall have inbuilt min 2.0'' TFT LCD with 16:9/4:3 aspect ratio for viewing camera video and Configuration of the device. Must be Visible under sun light. |
| BWC.002 | CCTV camera | Shall be embedded with wide angle CMOS image sensor of min. 16 MP |
| BWC.003 | Compression technique | H.264/H.265 |
| BWC.004 | Resolution | Shall support capture at min. 16MP with .jpg format and recording up to 2MP resolution with .mp4 format H.264/H.265 |
| BWC.005 | Recording Frame rate | Min.1920 x 1080 at 25 FPS or better |
| BWC.006 | ICR | Shall support auto IR switch function |
| BWC.007 | Night View | white LED, IR LED, Min. 10M Infrared Distance |
| BWC.008 | Network Support | 3G (WCDMA, TD-SCDMA, EVDO) and 4G (FDD-LTE, TD-LTE) |
| BWC.009 | Satellite positioning | Built in GPS/GPSS module |

| | | |
|---|---|---|
| BWC.010 | Transmission | Shall transfer real time video/audio to management system via Wi-fi 802.11a/b/g/n module and 4G module |
| BWC.011 | Storage | Inbuilt Min. 128 GB |
| BWC.012 | Audio i/o | Shall support 2 way audio communication, shall also have built in mic and speaker provision |
| BWC.013 | Interface | Min. One USB 2.0/USB 3.0 port to backup stored files and charging battery |
| BWC.014 | Battery Capacity | min 2700mAh |
| BWC.015 | Accessories | Battery Charger to be provided |
| BWC.016 | Alarm button | SOS button, in case of danger or emergency, should send alarm signal using this button |
| BWC.017 | Physical button | Button for IP based, Power On/Off, Video recording, Audio recording, Snapshot, Event tag |
| BWC.018 | Protection | Waterproof with IP66 protection |
| BWC.019 | Shock Absorption | upto 2 meters drop |
| BWC.020 | Weight | Should not be more than 220 gm |

### 7.3. ICT Enabled Solid Waste Management

#### A. GPS Device Unit

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| GPS.00 1 | GPS Receiver | Minimum 16 channels |
| GPS.002 | GPS re-acquisition functionality | Cold start <= 42 Sec, Warm Start < 35 sec, Hot Start <= 2 Sec |
| GPS.003 | GPS Tracking Sensitivity | -165 dBmtyp |
| GPS.004 | GPS Velocity Accuracy | < 0.01 m/sec |
| GPS.005 | GPS Navigation Sensitivity | -148 dBmtyp |
| GPS.00 6 | GPS Navigation Update | 1 Second |
| GPS.007 | GPS Data Format | Support WGS – 84 |
| GPS.008 | GSM/GPRS Band | GSM/GPRS SMT quad band and UMTS (3G) |
| GPS.009 | GSM/GPRS Network Support | Support all GSM Network |
| GPS.010 | Data Acquisition | Data packets shall have configurable fields - Unit ID, Latitude, Longitude, |

| | | |
|---|---|---|
| | and Transmission | Speed, Time Stamp, Orientation, GPS fix, Alert Status. |
| GPS.011 | Data Acquisition and Transmission | Shall be configurable for Data Transmission at varying minimum time intervals of few seconds and minutes to a central computer application |
| GPS.012 | Data Acquisition and Transmission | Shall support GPS data storage up to 10000 logs (based on string size) during non GPRS coverage area and forward the same when GPRS coverage is available. Shall be capable of storing 150 or more route geofences with facility to update route geofence master in the device over the air |
| GPS.013 | Data Acquisition and Transmission | Shall transmit data in SMS mode when GPRS is not available |
| GPS.014 | Micro Controller Module support for Interface | 16 bit RISC architecture based Micro Controller system for interface with various sub systems |
| GPS.015 | Antennas | Built -in GPS and GSM Antenna. |
| GPS.016 | Audio Interface | 16 Watts Audio Amplifiers 4 Loud Speaker (4 Watts each) |
| GPS.017 | Power Supply | Power Supply input support 7 V to 32 V DC battery and shall be powered by vehicle battery and not ignition |
| GPS.018 | Internal Battery Back Up | 6-8 hours backup |
| GPS.019 | Environment | Shall be heat resistant, dust resistant and water / rain splash resistant, dustproof, shock proof and tamper proof. Shall have at least IP65 or higher protection classification Operate between 0°C to +55 °C |
| GPS.020 | Status LEDs | Power, GPS, GSM, VMU Status |
| GPS.021 | Alerts & Notifications | Shall be programmed to provide Alerts on power supply disconnect, speed violation, device tampering etc. |
| GPS.022 | Configuration | Shall support Over The Air (OTA) firmware upgrade and shall be remotely configured for the required GSM Service Provider, Server IP connection, GPS data Update Interval etc. |
| GPS.023 | Packaging & Accessories | Dimensions: 121mm (L) x 102mm (W) x 30mm (H) with power supply cable |
| GPS.024 | Rating | 22 tracking / 66 acquisition minimum |
| GPS.025 | General Requirement | GPS tracking device should have adequate intelligence and programmability to run custom edge applications and analytics on the edge device. |
| GPS.026 | General Requirement | GPS tracking device should have embedded storage and compute and should offer SDK/API for custom tools and application portability into the same. |
| GPS.027 | Device I/O | GPS tracking device should have minimum 3 digital input and One Analog input and One input for SOS |

**B. RFID Reader**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| RFIDR.00 | Protocol | ISO18000-6C EPC GEN2 |

| | | |
|---|---|---|
| 1 | | |
| RFIDR.002 | Configuration | Shall support Over The Air (OTA) firmware upgrade Shall be configurable for mixed or single tag-type operation |
| RFIDR.003 | Frequency Range | Standard ISM 902 928MHz or 915 MHz (US FCC), 865 MHz (ETSI 302-208), and 869 MHz (ETSI 300-220) |
| RFIDR.004 | Operation Mode | FHSS |
| RFIDR.005 | RF Power | 0~30dBm, software adjustable |
| RFIDR.006 | Reading Speed | Software Programmable Average Reading per 64Bits <6ms |
| RFIDR.007 | Reading Mode | Timing or Touch, Software Programmable (reading shall be such that the reader does reads two tags at a time) |
| RFIDR.008 | Communication Mode | TCP/IP and GPRS/GSM/2G or higher |
| RFIDR.009 | Data Input Port | Trigger input one time |
| RFIDR.010 | Reading Range | Max 12 m (able to calibrate) |
| RFIDR.011 | Communication Interface | RS232 |
| RFIDR.012 | Accessories | Vehicle-mount DC power cable kit Antennas, and antenna cables |
| RFIDR.013 | Environmental Rating | IP68 |
| RFIDR.014 | Humidity | 10% to 90% |
| RFIDR.015 | Shock and Vibration Protection | Withstands standard material handling vehicle environments. Meets or exceeds MIL STD 810F |
| RFIDR.016 | Operating Temperature: | 0°C to 55°C |
| RFIDR.017 | Storage Temperature: | 0°C to 65°C |
| RFIDR.018 | Power Supply | Vehicle DC power 12 to 60V, 4.5 A maximum |

### C. RFID TAG

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| RFIDTAG.001 | Type | ABS, High Quality Engineering Plastic |
| RFIDTAG.002 | Supported Transponde | ISO18000-6C EPC Class 1 GEN2 |

| | | |
|---|---|---|
| | rs | |
| RFIDTAG.003 | Frequency Range | ISM 865~928 MHz |
| RFIDTAG.004 | Operation Mode | Fixed Frequency or FHSS Software Programmable |
| RFIDTAG.005 | Memory capacity | Tag shall support ISO18000-6C protocol standard 2K Bits storage capacity, 1728 Bits (216bytes) writable user area; MR6730B metal supports EPC C1 GEN2 (ISO18000-6C), with 96Bits writable EPC Code area, 512Bits writable user area, and 32Bits password area, EPC 128 bit user 512 bit TID 96 bits. |
| RFIDTAG.006 | Reading Rate | Software Programmable, Average Reading per 64 Bits < 10ms |
| RFIDTAG.007 | Tags material | Metal material |
| RFIDTAG.008 | Reading Range | Shall be able to be calibrated (to be kept as 4 - 6 m max) based on the site visit |
| RFIDTAG.009 | Operation Temp | 0°C to 60°C |
| RFIDTAG.010 | IP Classification | IP 68 |
| RFIDTAG.011 | Weather | Heat, dust proof, UV resistant & sea water resistant |
| RFIDTAG.012 | Chemical Resistance | No physical or performance changes in -168 hour Motor oil exposure 168 hour Salt water exposure (salinity 10%) 5 hrs Sulfuric acid (10 %Ph 2) 1 h Naoh (10 % Ph 14) exposure |

### D. Automated Vehicle Locator System – AVLS

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| AVLS.001 | General Requirement | Each vehicle, using the GPS vehicle tracking (VTS) device, shall determine its precise location through GIS based GPS System and transmit the same to the City Operation Centre at defined intervals of time. The location shall be displayed on GIS based route maps at City Operation centre |
| AVLS.002 | General Requirement | AVLS shall be able to give ETA in real time based on speed and distance measured. System shall update ETA on all PIS accordingly. |
| AVLS.003 | General Requirement | System shall be able to compare the actual location of the vehicle, at any given time, with its scheduled location |
| AVLS.004 | General Requirement | System at the control rooms shall be able to calculate the time for the vehicle to reach all subsequent stops along the route, factoring in the current vehicle and any deviations from the schedule and reported traffic congestion enroute |
| AVLS.005 | General Require | Shall provide inputs/feeds to Passenger Information System (PIS) with the real-time data to be displayed at various display units and announcement systems |

| | | |
|---|---|---|
| | ment | |
| AVLS.006 | General Requirement | Information elements that need to be captured and transmitted to City Operation Centre at the minimum include longitude, latitude, and physical location enroute with date and time stamps, vehicle number, route number, and Driver ID, etc. |
| AVLS.007 | General Requirement | Shall provide these data on real time basis at pre-determined and configurable intervals (10 seconds) over GPRS/GSM network |
| AVLS.008 | General Requirement | Tracking of vehicle that deviate from the scheduled route based on definition of permitted geographic regions of operation |
| AVLS.009 | General Requirement | Vehicle Fleet Summary Dashboard – Quick view on vehicle fleet performance |
| AVLS.010 | General Requirement | Register a vehicle on unscheduled route from backend on real time basis |
| AVLS.011 | General Requirement | Application must have the functioning fort planning/scheduling/Rostering/Dispatching of any vehicle using Software |
| AVLS.012 | General Requirement | Option should be there on Driver Console to accept the route assigned by dispatch manager at which vehicle has to ply |
| AVLS.013 | General Requirement | Real Time ETA based Trip Management showing trips in progress/completed trips and scheduled trip and Missed Stoppage Details etc |
| AVLS.015 | General Requirement | Exception Recording/ Actions (Over-Speeding, Harsh Acceleration, Harsh Braking, Off-route Detection, unscheduled stoppage, Non-Stoppage at collection points |
| AVLS.016 | General Requirement | Real-time Running Trip Line diagram of vehicle on a particular route, for headway detection. |
| AVLS.017 | General Requirement | Auto headway detection and notification. |
| AVLS.018 | General Requirement | Applications Software shall have a facility to define the Masters. |
| AVLS.019 | General Requirement | New routes shall be created in the application. |
| AVLS.020 | General Requirement | Business rules engine various routes etc. shall be configurable. |
| AVLS.021 | General | Officials shall be able to access the application as per the pre-defined roles and |

| | | |
|---|---|---|
| | Require ment | responsibilities |
| AVLS.022 | General Require ment | Application shall provide facility to query the data and generate the customized reports as per the requirements. |
| AVLS.023 | General Require ment | System shall display the contact details of the bus driver / conductor so that the operation centre staff can communicate with them directly. |
| AVLS.024 | General Require ment | Operation Centre operator shall be able to drill down to the exact location of the event by clicking on the alert and see the position of event drawn over the map along with driver, vehicle and standard description of event details related to the business rule. |
| AVLS.025 | General Require ment | The system be able to integrate with the City IOP/City Operations Platform with all the available data like Location, route information, Vehicle telemetry information, Speed etc. |
| AVLS.026 | General Require ment | The system should allow programmability, allowing actions to be triggered based on events. e.g. speed metric can trigger API call to GIS Maps pulling speed limit on the road based on GPS or GTFS location. |
| AVLS.027 | General Require ment | The platform should offer an Application builder for developing custom Applications as needed and should support an Interactive Development Environment that can facilitate in-house expertise to develop widgets and create API extensions |

### E. Mobile Device for Biometric Attendance

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| MDT.001 | Processor | At least Dual core, 1 GHz or more |
| MDT.002 | Memory | RAM at least 1 GB or better |
| MDT.003 | Storage | At least 8 GB or higher |
| MDT.004 | Operating System | Android v 4.1 and above |
| MDT.005 | Network | 2G bands: GSM 900 / 1800 / 1900 3G bands: HSDPA 900 / 2100 Speed: HSPA 14.4/5.76 Mbps GPRS: Yes EDGE: Yes SIM: Single or dual sim |
| MDT.006 | Display | Capacitive touchscreen, 16M colours Resolution: 480 x 800 pixels (~217 ppi pixel density) |
| MDT.007 | Generation | 2G and 3G support |
| MDT.009 | GSM | Yes |
| MDT.REQ.010 | Screen size | minimum 4" with touch support |
| MDT. 011 | Camera & Video | at least 3MP Front & 5 MP rear with LED Flash (integrated) Geo-tagging, face/smile detection Video: Yes |
| MDT. 012 | Feature | Should work as Location Tracker device for Attendance Management System |
| MDT. 013 | Screen luminosity | Daylight readable |

| | | |
|---|---|---|
| MDT.014 | Speakerphone | Hands free Support |
| MDT. 015 | Keyboard | Virtual on Screen |
| MDT. 016 | Communication | GPS: Yes with GLONASS, WLAN: Wi-Fi 802.11 b/g/n, Wi-Fi Direct, hotspot, DLNA, Bluetooth: v4.0, A2DP, apt-X, USB: microUSB v2.0 |
| MDT. 017 | Audio Playing Format | With 3.5 mm Jack MP3, wav files format etc. |
| MDT. 018 | Ports | Micro USB * 1 version 2.0 and above and same for charging and Headset port etc. |
| MDT. 019 | Power Supply | 230V, 50 Hz AC Supply |
| MDT. 020 | Bluetooth | Yes |
| MDT. 021 | Battery | minimum 1500 mAh and above |
| MDT. 022 | Charger | Suitable charger shall be supplied, Built-in rechargeable battery pack/battery. USB Charger |
| MDT. 023 | Mobile Device Monitoring | Should support the ability to disable access to public App Stores based on a policy configuration |
| MDT.REQ.024 | Mobile Device Monitoring | Should have configuration Policies to allow individual Components of the mobile device to be enabled or disabled. |

**F. Quick Response Code (QR Code)**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| QR.001 | Video Compression & Resolution | Encode up to 7,089 numerals with its maximum version being 40 (177 x 177 modules). |

**G. Pan Tilt and Zoom CCTV Cameras for SWM**

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| PTZCA.001 | Video Compression & Resolution | H.264 or better & 1920 X 1080 |
| PTZCA.002 | Frame rate | Min. 25 fps |
| PTZCA.003 | Image Sensor & Lens | 1/3" OR ¼" Progressive Scan CCD / CMOS & Auto-focus, 4.7 – 84.6 mm |
| PTZCA.004 | Minimum Illumination | Colour: 0.5 lux, B/W: 0.1 lux (at 30 IRE) |
| PTZCA.005 | Day/Night Mode | Colour, Mono, Auto |
| PTZCA.006 | S/N Ratio | ≥ 50dB |

| | | |
|---|---|---|
| PTZCA.007 | PTZ | Pan: 360° endless/continuous, 0.2 to 300°/s (auto), 0.2 to 100°/s (Manual)<br>Tilt: 90°, 0.2 to 100°/s (Auto), 0.2 to 40°/s (Manual)<br>18 x optical & 10 x digital zoom, 16 pre-set positions, Auto-Tracking, Pre-set tour |
| PTZCA.008 | Auto adjustment & Remote Control | Colour, brightness, sharpness, contrast, white balance, exposure control, backlight compensation, Gain Control, Wide Dynamic Range |
| PTZCA.009 | Protocol | HTTP, HTTPS, FTP, RTSP, RTP, TCP, UDP, RTCP, DHCP, SNMP |
| PTZCA.010 | Security | Password Protection, IP Address filtering, User Access Log, HTTPS encryption |
| PTZCA.011 | Operating conditions | 0 to 50°C |
| PTZCA.012 | Casing | NEMA 4X / IP-66 rated |
| PTZCA.013 | Certification | UL / CE / FCC / EN |
| PTZCA.014 | Auto Detection & Configuration | Camera should be automatically discovered & configured when connected to VMS or Network Switch, to set right network parameters for video stream on the network |
| PTZCA.015 | Activity detection | Camera should support User- definable alerts with configurable sensitivities and thresholds, email alert, HTTP notifications. Camera should support for IEEE 802.1X authentication |

### 7.4. City and Enterprise GIS Solution

| General Functions | | |
|---|---|---|
| **#** | **Component** | **Functional Description** |
| GIS.001 | **Components in Supply of Desktop GIS and Image Processing Software** | 1. Multiple Document Interface (MDI)<br>2. Project, View and Layer Management<br>3. Geo-Linked Multiple Views<br>4. Well known Raster, Vector and Tabular file formats support<br>5. On the Fly Map Projection Transformation<br>6. Large set of Library for Projection & Geographic Coordinate System<br>7. Advance Map Navigation and Visualization<br>8. Seamless data handling using ORDBMS<br>9. Identification and Measurement Tools<br>10. Customizable GUI<br>11. Extensive Map Composition Tool<br>12. Raster and Vector Catalogue<br>13. GIS Software should be able to operate on Windows<br>14. The proposed software should have functions of GIS and Image Processing along with advance functions such as network analysis, terrain analysis, 3D analysis, change analysis, etc.<br>15. The proposed GIS software could be any Industry standard COTS GIS platform and should be easy to handle, operate, maintain & also train the authority staff/end users.<br>16. The customized software for authority should have simple user interface both for departmental users as well as for citizens with easy navigation and querying facility.<br>17. On-line help shall be provided at all functions and tools.<br>18. The proposed software should be OGC compliant and follow the interoperability.<br>19. The software should support all types of raster formats and services like ERDAS IMAGINE, ENVI, PIX, DTED, DEM, CEOS, JPEG, JP2, PNG, GeoTIFF, |
| GIS.002 | **GIS Functions** | 1. Advance Drawing and Editing<br>2. Topology Creation<br>3. Edge Matching and Rubber Sheeting<br>4. Geometric Correction<br>5. Database Management<br>6. Query Builder for Simple and Complex Query<br>7. Legend Creator for thematic mapping<br>8. A large library of symbols<br>9. Rule Based Labelling and Annotation<br>10. Geo-processing and Overlay Analysis<br>11. Vector to Raster |

| | | |
|---|---|---|
| | | 12. Advanced Report Generation with wizard<br>13. The proposed software should support multiple document interface (MDI), User should be able to create multiple views in single project.<br>14. The application framework of the software should be such that it should have Dockable/Floating Toolbars, Dockable and Auto Hiding Windows, Unicode<br>15. Support for Multilanguage Attributes, Drag and Drop to Rearrange Tools/Toolbars, Create New Toolbars or Menus without Programming, Extend the Applications with Add-ins built with .NET, Java, or Python, Build New GIS Components with .NET or Java or other development platforms.<br>16. The proposed software should have capability to create layer as per the data model defined by the authority. User should be able create table structure as per the requirement.<br>17. The software should have provision for definition of map projection system and geodetic datum to set all the maps in a common projection and scale.<br>18. It should have facility to create custom projection using 3 to 7 parameters.<br>19. It should have the facility to display multiple projection coordinates on map click.<br>20. The software should provide facility to click on any feature of the map and return a select set of attributes for feature i.e. Identify tool along with pop-up.<br>21. Software should have rich geo-processing functions such buffer generation, clip, erase, intersection, dissolve, union, polyline to polygon, etc. It should have facility to perform the spatial intersection analysis like plot area with buffer zone to calculate road-widening impact on adjacent land.<br>22. The Software should be able to import / export data from / to various formats like .dwg, ,dxf, .dgn, .shp (shape files), coverage file, .mif (MapInfo), .mdb (GeoMedia), .gml, .kml, .gpx. , Geo PDF GeoJSON, interlis, GeoRSS, SqlLite etc.<br>23. The proposed software should have function to import / export tabular data such as .xlsx, .csv, .dbf, etc.<br>24. Support of IFC object for BIM applications.<br>25. Integrated GPS module for desktop and mobile GIS.<br>26. Support of Coordinate Geometry (COGO) description for GIS objects creation and store in GIS database.<br>27. Facility to define joins between the two tables (graphic / non-graphic) of the database to get integrated information in the table and perform GIS analysis.<br>28. The system should provide facility to exchange the GIS Data with other platform applications like Microsoft Word, and Excel to |

| | | |
|---|---|---|
| | | use GIS data and generate reports like graph and charts.<br>29. Software should have rich display and navigation tools. It should have zoom in, zoom out, fixed zoom in, fixed zoom out, pan, real time pan, bookmark, Geo link multiple views, swipe, flicker, search by location, cross hair, cursor location value, numeric dump, query cursor etc. It should have support of continuous panning i.e. real time pan.<br>30. Software should allow the user to perform undo / redo operations during edits.<br>31. The software should have module for geo-referencing of vector and raster data.<br>32. Facility to capture the geometry from the layout maps, Building maps by maintaining the coincident geometry i.e. when a new polygon is captured simply by selecting an existing polygon to digitize the common boundary thereby ensuring no slivers or gaps between adjacent area features like parcels.<br>33. The software should provide a complete set of drawing & editing tools in order to enable the user to Draw & Modify any or parts of various geographical objects (point, line and polygon) on the map.<br>34. The software should have topology creation tool to remove the topological errors from vector data.<br>35. The software should have the ability to add data from internet or intranet users to the existing map data so that data from other sources.<br>36. The software should allow user to create layers or shortcuts to geographic data that store symbology for displaying features.<br>37. A rich legend creation tool should be required in proposed application for thematic mapping. User should apply color and symbology using the attribute attached with the layer based on single, quantile and unique values functions.<br>38. A rich annotation tool should be available such as add label, edit label, move label, rotate label, remove all label, etc.<br>39. The software should have module of Dynamic Labeling and Rule based Labeling.<br>40. The software should have a provision of hyper linking the GIS feature as well as its attribute fields with existing documents, URLs, Images, drawing files or scanned maps related to that feature.<br>41. Software should have versioning capability for history tracking.<br>42. Query builder tool should be available with the software to perform simple and complex queries.<br>43. The customized application should provide the user facility to make dynamic queries on GIS GUI. The application should allow users to store and retrieve standard queries used by them in day |

| | | |
|---|---|---|
| | | to day operation.<br>44. Software should have various query tools for queries based on attributes, location, etc.<br>45. Software should have map composition / layout tool for printing spatial data at different scales and at adjustable print quality.<br>46. Software should allow users to export results to various file formats like EMF, BMP, TIFF, JPEG, PDF, etc. |
| GIS.003 | **Image Processing Functions** | 1. Image Enhancement and Filtering<br>2. Image Analysis Tools<br>3. Image Geo-referencing<br>4. Image Extraction and Mosaicking<br>5. Atmospheric and Radiometric Correction<br>6. Image Transformation<br>7. Image Classification<br>8. Advance Segmentation<br>9. Advanced Change Detection<br>10. Raster To Vector<br>11. The proposed software should support HRSI (High Resolution Satellite Imagery) and low resolution satellite images (panchromatic & multispectral) such as IKONOS, Quick bird, Geoeye, Worldview, CARTOSAT, EROS, LISS-IV, LISS-III, AWIFS, RISAT-1, KALPANA-1, INSAT3A, INSAT3D, PROVA-V, etc..<br>12. The software should have capability to process optical satellite data as well as microwave image data.<br>13. The software should be capable to process and visualize the stereo pair data. It should be able to create DEM from stereo pair and perform ortho-rectification.<br>14. The software should support images with More than 8 bits, 11 bit, 16 bits, and 24 bits per band.<br>15. The software should support image format such .tif, geotiff, .img, .pix, .hdr, .h4, .h5, DTED, DEM, CEOS, .bmp, .jpeg, etc.<br>16. The software should be also support LiDAR data file format such as *.las, *.isd, *.pcg etc…<br>17. The software should have projection transformation tool to reproject the image from one projection to other projection system.<br>18. Image extraction module should be available in the proposed software which can be performed by defining the extent, inquire box and polygon layer.<br>19. The software should have module for image mosaicing and splitting.<br>20. Geometric Correction and atmospheric correct module should be available to remove the geometric distortion in the image and atmospheric anomalies such as haze.<br>21. It should have Layer stacking to create composite image from a |

| | | |
|---|---|---|
| | | number of band of the satellite imageries.<br>22. The software should have image enhancement module to enhance the imageries. It should have enhancement algorithm such as<br>23. Linear, Logarithmic, Histogram Equilize, Histogram Matching, Density Slice, Gaussian, Squire root, Tone Balancing<br>24. The software should have Image filtering algorithm such as Convolution, Texture, Adaptive, Crisp, Laplacian, Statistical, FFT, etc.<br>25. The software should have image transformation module such Vegetation Index, Principal Component Analysis (PCA), Inverse PCA, Pan sharpening, Wavelet fusion, etc.<br>26. The software should have Natural Color image generation module using NIR, Red and Green band of high resolution multispectral image data. This module should have capability to stretch the natural color image into 8 bit.<br>27. Proposed software should have image classification modules such as supervised and unsupervised classification along with image segmentation.<br>28. The software should be capable to process the temporal or time series image data. The software should provide change detection module such as: Basic Change Detection, Advance Change Detection Auto Change Detection and Site Monitoring<br>29. The advance change detection module should be capable to ingest multiple input images to find the change. It also handles the multi resolution satellite image along with mis-registration. It should supports various methods of advance change detection such as single band differencing, cross correlation, Image regression, Image ratioing, PCA, Change Vector Analysis (CVA), Magnitude Differencing, Vegetation Index Differencing, Tasseled Cap, Chi-Square, Unsupervised Change Detection, etc.<br>30. The change detection module should have capability of Object Library Creation for Object Identification and Automatic Feature Extraction (AFE).<br>31. The software should have functions like Linear Algebraic Combination, Change resolution, Bit Conversion, proximity analysis, etc.<br>32. The software should have function called Dynamic threshold for analyzing change detection using image. This function is used to categorize the pixels in input image based on the threshold value.<br>33. The software should have raster catalog and vector catalog tool for raster and vector data management.<br>34. The software should have network analysis module to find the shortest and Optimum path using the topologically corrected |

| | | |
|---|---|---|
| | | road network.<br>35. The software should have tools for terrain analysis and 3D analysis. The module should be able to create slope/aspect, hillshade, elevation profile, topographic normalize, line of sight, viewshed analysis.<br>36. The software should have algorithm for surface generation such as Linear, IDW and Krigging.<br>37. Software should support fully automatic and semi-automatic raster to vector conversion tools. |
| **Network Analysis** | | |
| GIS.004 | **Network Analysis** | 1. Defining Network Rules<br>2. Add Network Location<br>3. Remove Network Location<br>4. Find Shortest and Optimum Path<br>5. Location Analysis<br>6. Multi Location Analysis<br>7. Service Area<br>8. Dynamic Segmentation |
| **3D Modelling** | | |
| GIS.005 | **3D Modelling** | 1. Terrain Extraction<br>2. Flythrough & Walkthrough Creation<br>3. Drape Raster, Vector and 3D Object<br>4. Line of Sight and Radio Line of Sight<br>5. View Shed Analysis<br>6. Stereo Viewing<br>7. Environmental Effect Like Fog, Fire, Cloud, Sun, etc<br>8. Particle emitter<br>9. Save Image & Animation [*.avi] |
| **Raster GIS Analysis** | | |
| GIS.006 | Raster GIS Analysis | 1. Spatial Analysis<br>2. Distance Tools:<br>3. Math Tools<br>4. Conditional Tools<br>5. Extraction Tools<br>6. Local<br>7. Generalization<br>8. Multivariate<br>9. Neighbourhood<br>10. Weighted Overlay |

| | | |
|---|---|---|
| GIS.007 | **Terrain Analysis** | 1. DEM to Contour and DEM from Point and Contour Line<br>2. Slope and Aspect<br>3. Hill Shade and Topographic Normalize<br>4. Cut & Fill Analysis<br>5. View Shed, Route Indivisibility and Line of Sight<br>6. Best Path<br>7. Area/Volume Calculation<br>8. Hypsometry<br>9. Semi Variance<br>10. Surface Specification Points<br>11. Anaglyph |
| GIS.008 | **Global Positioning System** | 1. Interface with GPS device<br>2. GPS Tracking and Navigation<br>3. Extract feature using GPS<br>4. Simulate GPS file<br>5. GPS data validation<br>6. GPS error correction<br>7. Satellite sky-view<br>8. Speed and Bearing Indication<br>9. Way-Path generation and storing<br>10. Geo-fencing<br>11. Different File formats support<br>12. Export to KML/KMZ |
| GIS.009 | **Tracking Analysis** | 1. Simulate and analyse time-based data<br>2. Report on patterns related to time and defined rules.<br>3. Monitoring of mobile resources<br>4. Analyse patterns of movement |
| GIS.010 | **Neural Network Classification** | Supervised and Unsupervised |
| GIS.011 | **Detail Specification of Enterprise GIS Platform** | 1. OGC Certified<br>2. User Management Tools<br>3. Main Page Login, Registration, Forgot Password<br>4. Map Tools<br>5. Vector and Raster Data Support (Display)<br>6. Zoom In<br>7. Zoom Out<br>8. Zoom to Extent<br>9. Previous View<br>10. Next View<br>11. Pan<br>12. Zoom to box<br>13. Book Mark<br>14. Layer Visibility on/off<br>15. Data Management Tool |

| | | |
|---|---|---|
| | | 16. Data Import and Export<br>17. Measure Tool<br>18. Measure Distance<br>19. Measure Area<br>20. Advanced Tools<br>21. Select Tool<br>22. Unselect<br>23. Identification<br>24. Buffer<br>25. Get XY coordinates<br>26. Find XY coordinates<br>27. Labelling<br>28. Query Tools<br>29. Basic Query<br>30. Feature Query ( Spatial and Non Spatial)<br>31. Advance Query<br>32. Spatial Editing Tools<br>33. Feature Creation<br>34. Add Feature<br>35. Edit Feature<br>36. Delete feature<br>37. Non Spatial Editing Tools<br>38. Attribute Information Editing<br>39. Printing Tool<br>40. Report Generation Tool<br>41. Should support std DBMS like SQl, Oracle, Postgres<br>42. Geo-processing<br>43. Versioning<br>44. Network Analysis<br>45. Developer SDK<br>46. Data Publishing<br>47. Real Time Data Support<br>48. Should support WMS, WFS, WCS<br>49. Seamless Data Handling<br>50. Online Spatial Data Creation and Updation Support<br>51. Should support internet, intranet, cloud<br>52. Multiuser data editing<br>53. The GIS server should be based on a Services Oriented Architecture (SOA).<br>54. Should support Java /VB Script, .Net etc. and other latest technologies.<br>55. OGC certification and capability to serve and consume OGC complied web services including WMS, WFS, WCS, CSW, INSPIRE, etc.<br>56. Should be based on 64 bit architecture or better. |

| | | |
|---|---|---|
| | | 57. Should support Windows/Linux platform.<br>58. Should be able to support broad range of clients including Interoperability and browsers, desktops, Mobile Handsets.<br>59. The application should be highly interoperable with the ability to import and export to a wide range of industry standard formats including CAD (DGN, DXF,DWG), ArcGIS geo databases, Geo Media Warehouse, MapInfo, GML(GEOGRAPHY MARKUP LANGUAGE) , XML, SHP, ArcInfo Coverage, ESRI Arc Info Export (EOO), Micro Station V7/V8, Geo PDF GeoJSON, interlis, GeoRSS, SqlLite etc.<br>60. Should support unlimited number of Editing and viewing clients. It should also allow multiuser editing with Advanced Editing Functionalities.<br>61. Should support standard Web server/application server like IIS, Apache, Tomcat, Oracle HTTP server, etc.<br>62. Should supports unlimited Desktop client connection. Desktop GIS applications with the capability to consume WMS/ WFS services should be able to connect and use data from the server.<br>63. Should support multiple DBMS for database storage including Oracle, DB2, SQL Server, Postgre SQL, Informix, Windows Azure SQL Database, IBM Netezza, Tera data.<br>64. Should be capable of maintaining data history, version management and conflict detection / resolution.<br>65. Should have geo-processing framework, geo-processing core analysis functionalities, spatial and statistics analysis functionalities.<br>66. Should have capability of centrally managed data, models, tools, maps and applications.<br>67. Should have the capability to link documents like Adobe pdf, word/power-point JPEG, GIF, PNG, DTED and TIFF files etc to map features.<br>68. Should support database check in–check out/replication functionalities hence maintaining the parent child relationship of Master Database.<br>69. Should have open access to extensive GIS capabilities so as to enable organizations to publish and share geographic data(2D&3D),maps, analysis tools, Manipulate data, 3D models etc.<br>70. The publisher should have capability to publish the project/data on GIS server and enable OGC services such as WMS, WFS, WCS and CSW in the data layer.<br>71. All the Geo-processing and Image processing function such as buffer creation, clip, erase, image enhancement, image filtering, Vegetation Indices Calculation, Linear Algebraic Combination, Band Math, change detection, image extraction, mosaicing, etc |

| | | |
|---|---|---|
| | | should be performed at server end by sending the request using the web client and should enable the WMS service to display the processed data on web.<br>72. Application Server must support Time aware data for Trends / Time Series Analysis. Application Server must support network and perform Routing analysis, Service Area Analysis, and Tracking Analysis.<br>73. Should support for GML, RSS (Real Simple Syndication) and KML/KMZ (Keyhole Markup Language).<br>74. The server should have in built map caching capability.<br>75. It should provide imagery access quickly after acquisition with dynamic mosaicing and on- the-fly processing.<br>76. Should support standard Web server/application server<br>77. Should have Web Application Functionalities like pan, zoom, identifying features on a map, feature based hyperlink, measure distance, overview window, find place, query attribute, search attribute, editing and geo processing task.<br>78. The software should allow visualization of data in 2D, 3D in web as well as desktop application.<br>79. The application should support LDAP (Light weight Directory Access Protocol) or Active directory based authentication.<br>80. Control user access and credentials to data by assigning roles.<br>81. Hide data completely, prevent manipulation, or allow editing, based on role Compartmentalize data based on accessibility.<br>82. Define which groups of users can view and access data through Discretionary Access Control (DAC).<br>83. Logging records all transactions including log-ins, searches, downloads, uploads, edits, and deletions.<br>84. Should support Single sign-on, authentication module.<br>85. Should support SSL and signed certificates to ensure complete security from browser to server.<br>86. Should enable a secure, private sharing of confidential data that can be deployed on private network to promote collaboration on maps and applications within the organization.<br>87. Support to Connect securely Operate the Web application over a Hypertext Transfer Protocol Secure (HTTPS) Connection. Optional Lockdown mode to remove anonymous access and require all users to log in.<br>88. Should provide a web publishing wizard so that registered users can publish websites without coding/programming.<br>89. Should be able to create and manage groups to control publishing the data and its services on Data store/workspaces.<br>90. Should have the facility of customizable reports and map layout as per the requirements.<br>91. Print server application for online printing in different formats |

| | | |
|---|---|---|
| | | with desired GIS Map scale and customized templates.<br>92. Platform for GIS Application Software should be able to operate on Windows<br>93. The proposed software should have functions of GIS and Image Processing along with advance functions such as network analysis, terrain analysis, 3D analysis, change analysis, etc.<br>94. GIS Software must allow authority to implement a centrally managed GIS providing the advantage of lower cost of ownership through single, centrally managed, focused GIS applications (such as a Web application) that can be scalable to support multiple users and saves the cost of installing and administering desktop applications on each user's machine.<br>95. Proposed customized GIS Application Software should be able to integrate with the eGovernance Solution being developed at authority.<br>96. The web based GIS software shall be usable for viewing the GIS data over internet/ intranet and shall be functional with all type of standard browser like Internet Explorer®, Apple® Safari, GoogleTM Chrome, Mozila® Firefox®, etc. The database shall be developed on any standard RDBMS.<br>97. ODBC compliance enabling interface with RDBMS like Oracle, SQL server, Access etc. should be available.<br>98. GUI shall be highly user friendly, self-explanatory and eye catching. It shall provide the sample example wherever it seeks user input and also preserve the history of the inputs. GUI can be made good looking and beautiful by making use of good color scheme and putting functions indicative image (drawing) on button.<br>99. The proposed GIS software could be any Industry standard COTS GIS platform and should be easy to handle, operate, maintain & also train the authority staff/end users.<br>100. The customized software for authority should have simple user interface both for departmental users as well as for citizens with easy navigation and querying facility.<br>101. On-line help shall be provided at all functions and tools.<br>102. The proposed software should be OGC compliant and follow the interoperability.<br>103. The software should support OGC Services such as WMS, WFS, WCS, CSW, INSPIRE, etc along with GML, KML, etc.<br>104. The software should support all types of raster formats and services like ERDAS IMAGINE, ENVI, PIX, DTED, DEM, CEOS, JPEG, JP2, PNG, GeoTIFF, & Web Coverage Service (WCS, OGC standard), Web Map Service (WMS), OGC standard.<br>105. Should be able to support broad range of clients including browsers, desktops, Mobile Handsets, Palmtops, |

| | | |
|---|---|---|
| | | Tough books, etc.<br>106. Data Preparation Image Processing<br>107. Create Blank Image<br>108. Reproject<br>109. Image Statistics<br>110. Subset Image<br>111. Subset Image using Vector Polygon<br>112. Split Image<br>113. Mosaicking<br>114. Layer Stacking<br>115. Fill Area Using Vector Polygon<br>116. Data Analysis<br>117. Look up Table Update<br>118. Image Enhancement<br>119. Linear<br>120. Gaussian<br>121. Logarithmic<br>122. Density slice<br>123. Square Root<br>124. Histogram Equalize<br>125. Histogram Matching<br>126. Tone Balancing<br>127. Image Filtering<br>128. Texture<br>129. Adaptive<br>130. Crisp<br>131. Statistical<br>132. Convolution<br>133. Image Classification<br>134. Unsupervised Classification<br>135. Supervised Classification<br>136. Threshold<br>137. Generate Statistics of ROI/ Create Signature File<br>138. Post Classification Smoothing<br>139. Contingency Matrix<br>140. Signature Reparability<br>141. PCT Edit<br>142. Scatter Plot<br>143. Class Information<br>144. Fuzzy Classification<br>145. Fuzzy Convolution<br>146. Segmentation<br>147. Change Detection<br>148. Cut and Fill Analysis<br>149. Conversion |

| | | | |
|---|---|---|---|
| | | 150. | Raster To Vector |
| | | 151. | Vector To Raster |
| | | 152. | Raster GIS Analysis |
| | | 153. | Spatial Analysis |
| | | 154. | Distance Tools |
| | | 155. | Generalization |
| | | 156. | Neighbourhood |
| | | 157. | Weighted Overlay |
| | | 158. | Zonal Tools |
| | | 159. | Record by Vector |
| | | 160. | Locate DEM Position |

### 7.5. Smart Public Transport System

**A.** GPS Device Unit

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| GPS.00 1 | GPS Receiver | Minimum 16 channels |
| GPS.002 | GPS re-acquisition functionality | Cold start <= 42 Sec, Warm Start < 35 sec, Hot Start <= 2 Sec |
| GPS.003 | GPS Tracking Sensitivity | -165 dBmtyp |
| GPS.004 | GPS Velocity Accuracy | < 0.01 m/sec |
| GPS.005 | GPS Navigation Sensitivity | -148 dBmtyp |
| GPS.00 6 | GPS Navigation Update | 1 Second |
| GPS.007 | GPS Data Format | Support WGS – 84 |
| GPS.008 | GSM/GPRS Band | GSM/GPRS SMT quad band and UMTS (3G) |
| GPS.009 | GSM/GPRS Network Support | Support all GSM Network |
| GPS.010 | Data Acquisition and Transmission | Data packets shall have configurable fields - Unit ID, Latitude, Longitude, Speed, Time Stamp, Orientation, GPS fix, Alert Status. |
| GPS.011 | Data Acquisition and Transmission | Shall be configurable for Data Transmission at varying minimum time intervals of few seconds and minutes to a central computer application |
| GPS.012 | Data Acquisition and Transmission | Shall support GPS data storage up to 10000 logs (based on string size) during non GPRS coverage area and forward the same when GPRS coverage is available. Shall be capable of storing 150 or more route geofences with facility to update route geofence master in the device over the air |
| GPS.013 | Data Acquisition and Transmission | Shall transmit data in SMS mode when GPRS is not available |
| GPS.014 | Micro Controller Module support for Interface | 16 bit RISC architecture based Micro Controller system for interface with various sub systems |
| GPS.015 | Antennas | Built -in GPS and GSM Antenna. |

| | | |
|---|---|---|
| GPS.016 | Audio Interface | 16 Watts Audio Amplifiers 4 Loud Speaker (4 Watts each) |
| GPS.017 | Power Supply | Power Supply input support 7 V to 32 V DC battery and shall be powered by vehicle battery and not ignition |
| GPS.018 | Internal Battery Back Up | 6-8 hours backup |
| GPS.019 | Environment | Shall be heat resistant, dust resistant and water / rain splash resistant, dustproof, shock proof and tamper proof. Shall have at least IP65 or higher protection classification Operate between 0°C to +55 °C |
| GPS.020 | Status LEDs | Power, GPS, GSM, VMU Status |
| GPS.021 | Alerts & Notifications | Shall be programmed to provide Alerts on power supply disconnect, speed violation, device tampering etc. |
| GPS.022 | Configuration | Shall support Over The Air (OTA) firmware upgrade and shall be remotely configured for the required GSM Service Provider, Server IP connection, GPS data Update Interval etc. |
| GPS.023 | Packaging & Accessories | Dimensions: 121mm (L) x 102mm (W) x 30mm (H) with power supply cable |
| GPS.024 | Rating | 22 tracking / 66 acquisition minimum |
| GPS.025 | General Requirement | GPS tracking device should have adequate intelligence and programmability to run custom edge applications and analytics on the edge device. |
| GPS.026 | General Requirement | GPS tracking device should have embedded storage and compute and should offer SDK/API for custom tools and application portability into the same. |

**B.** RFID Reader

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| RFIDR.001 | Protocol | ISO18000-6C EPC GEN2 |
| RFIDR.002 | Configuration | Shall support Over The Air (OTA) firmware upgrade Shall be configurable for mixed or single tag-type operation |
| RFIDR.003 | Frequency Range | Standard ISM 902 928MHz or 915 MHz (US FCC), 865 MHz (ETSI 302-208), and 869 MHz (ETSI 300-220) |
| RFIDR.004 | Operation Mode | FHSS |
| RFIDR.005 | RF Power | 0~30dBm, software adjustable |
| RFIDR.006 | Reading Speed | Software Programmable Average Reading per 64Bits <6ms |
| RFIDR.007 | Reading Mode | Timing or Touch, Software Programmable (reading shall be such that the reader does reads two tags at a time) |
| RFIDR.008 | Communication Mode | TCP/IP and GPRS/GSM/2G or higher |
| RFIDR.009 | Data Input Port | Trigger input one time |
| RFIDR.010 | Reading Range | Max 12 m (able to calibrate) |
| RFIDR.011 | Communication Interface | RS232 |
| RFIDR.012 | Accessories | Vehicle-mount DC power cable kit Antennas, and antenna cables |
| RFIDR.013 | Environmental Rating | IP68 |
| RFIDR.014 | Humidity | 10% to 90% |
| RFIDR.015 | Shock and Vibration Protection | Withstands standard material handling vehicle environments. Meets or exceeds MIL STD 810F |
| RFIDR.016 | Operating | 0°C to 55°C |

| | | |
|---|---|---|
| | Temperature: | |
| RFIDR.017 | Storage Temperature: | 0°C to 65°C |
| RFIDR.018 | Power Supply | Vehicle DC power 12 to 60V, 4.5 A maximum |

**C.** RFID Tag

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| RFIDTAG.001 | Type | ABS, High Quality Engineering Plastic |
| RFIDTAG.002 | Supported Transponders | ISO18000-6C EPC Class 1 GEN2 |
| RFIDTAG.003 | Frequency Range | ISM 865~928 MHz |
| RFIDTAG.004 | Operation Mode | Fixed Frequency or FHSS Software Programmable |
| RFIDTAG.005 | Memory capacity | Tag shall support ISO18000-6C protocol standard 2K Bits storage capacity, 1728 Bits (216bytes) writable user area; MR6730B metal supports EPC C1 GEN2 (ISO18000-6C), with 96Bits writable EPC Code area, 512Bits writable user area, and 32Bits password area, EPC 128 bit user 512 bit TID 96 bits. |
| RFIDTAG.006 | Reading Rate | Software Programmable, Average Reading per 64 Bits < 10ms |
| RFIDTAG.007 | Tags material | Metal material |
| RFIDTAG.008 | Reading Range | Shall be able to be calibrated (to be kept as 4 - 6 m max) based on the site visit |
| RFIDTAG.009 | Operation Temp | 0°C to 60°C |
| RFIDTAG.010 | IP Classification | IP 68 |
| RFIDTAG.011 | Weather | Heat, dust proof, UV resistant & sea water resistant |
| RFIDTAG.012 | Chemical Resistance | No physical or performance changes in -168 hour Motor oil exposure 168 hour Salt water exposure (salinity 10%) 5 hrs Sulfuric acid (10 %Ph 2) 1 h Naoh (10 % Ph 14) exposure |

**D.** Automated Vehicle Locator System – AVLS

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| AVLS.001 | General Requirement | Each vehicle, using the GPS vehicle tracking (VTS) device, shall determine its precise location through GIS based GPS System and transmit the same to the City Operation Centre at defined intervals of time. The location shall be displayed on GIS based route maps at City Operation centre |
| AVLS.002 | General Requirement | AVLS shall be able to give ETA at next bus stops in real time based on speed and distance measured. System shall update ETA at each bus stop on all PIS accordingly. |
| AVLS.003 | General Requirement | System shall be able to compare the actual location of the vehicle / bus, at any given time, with its scheduled location |
| AVLS.004 | General Requirement | System at the control rooms shall be able to calculate the time for the vehicle / bus to reach all subsequent stops along the route, factoring in the current vehicle / bus and any deviations from the schedule and reported traffic congestion enroute |
| AVLS.005 | General Requirement | Shall provide inputs/feeds to Passenger Information System (PIS) with the real-time data to be displayed at various display units and announcement |

| | | |
|---|---|---|
| | | systems |
| AVLS.006 | General Requirement | Information elements that need to be captured and transmitted to City Operation Centre at the minimum include longitude, latitude, and physical location enroute with date and time stamps, vehicle / bus number, route number, and Driver ID, etc. |
| AVLS.007 | General Requirement | Shall provide these data on real time basis at pre-determined and configurable intervals (10 seconds) over GPRS/GSM network |
| AVLS.008 | General Requirement | Tracking of vehicle / buses that deviate from the scheduled route based on definition of permitted geographic regions of operation |
| AVLS.009 | General Requirement | Vehicle Fleet Summary Dashboard – Quick view on vehicle fleet performance |
| AVLS.010 | General Requirement | Register a vehicle / bus on unscheduled route from backend on real time basis |
| AVLS.011 | General Requirement | Exception Recording/ Actions (Over-Speeding, Harsh Acceleration, Harsh Braking, Off-route Detection, unscheduled stoppage, Non-Stoppage at Bus stops/collection points, Trip Cancellation). |
| AVLS.012 | General Requirement | Real-time Running Trip Line diagram of vehicle / buses on a particular route, for headway detection. |
| AVLS.013 | General Requirement | Auto headway detection and notification. |
| AVLS.014 | General Requirement | Applications Software shall have a facility to define the Masters. |
| AVLS.015 | General Requirement | New routes shall be created in the application. |
| AVLS.016 | General Requirement | Business rules engine for fare stages, fare structures, various routes etc. shall be configurable. |
| AVLS.017 | General Requirement | Facility shall be provided to collate the transactional data received from Depots and Bus Stations. The transaction data shall be uploaded once every day for the previous day. |
| AVLS.018 | General Requirement | Officials shall be able to access the application as per the pre-defined roles and responsibilities |
| AVLS.019 | General Requirement | Application shall provide facility to query the data and generate the customized reports as per the requirements. |
| AVLS.020 | General Requirement | System shall display the contact details of the bus driver / conductor so that the operation centre staff can communicate with them directly. |
| AVLS.021 | General Requirement | Operation Centre operator shall be able to drill down to the exact location of the event by clicking on the alert and see the position of event drawn over the map along with driver, vehicle and standard description of event details related to the business rule. |
| AVLS.REQ .022 | General Requirement | The system be able to integrate with the City IOP/City Operations Platform with all the available data like Location, route information, Vehicle telemetry information, Speed etc. |
| AVLS.REQ .023 | General Requirement | The system should allow programmability, allowing actions to be triggered based on events. e.g. speed metric can trigger API call to GIS Maps pulling speed limit on the road based on GPS or GTFS location. |
| AVLS.REQ .024 | General Requirement | The platform should offer an Application builder for developing custom Applications as needed and should support an Interactive Development Environment that can facilitate in-house expertise to develop widgets and create API extensions |

**E.** Passenger Information System

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| PIS.001 | General Requirement | It shall manage the content on all the on Bus and Bus Stops LED display and shall show Bus number, route, schedule and ETA on LED screens. The ETA shall be calculated and refreshed at selectable refresh rate |
| PIS.002 | General Requirement | Display of PIS in a display unit at bus station shall be configurable based on bus station and platform. Single unit shall display services of more than one platform. |
| PIS.003 | General Requirement | It shall send the route files and schedule details from City Operation Centre (OCC) to on bus & bus stop LEDs with synchronized voice announcement |
| PIS.004 | General Requirement | PIS information shall be displayed in Marathi, Hindi and English alternatively (single or multiple language shall be configurable). Specifically, all display technologies and software shall support the Unicode (http://www.unicode.org/) character set. |
| PIS.004 | General Requirement | It shall have provision to show advertisement on bus stops & in-bus passenger facing display along with audio from speakers installed in bus. |
| PIS.005 | General Requirement | Bus stations display units shall be able to receive/display transmitted contents from the central system through a gateway or mention other suitable means |
| PIS.006 | General Requirement | The frequency and period of information display on PIS display shall be configurable from central location for advertisements and other transit information It shall manage the next stop announcements in on-bus passenger facing display along with audio from speakers based on GPS location received from AVLS system |
| PIS.007 | General Requirement | |
| PIS.008 | General Requirement | It shall have provision to integrate with Smart Transport Mobile Application which shall show bus route, schedule, real time bus location and ETA details |
| PIS.009 | General Requirement | Should be able to integrate with Integrated Operation Platform for complete dashboard view |

**F.** Fleet Management System

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| FMS.001 | General Requirement | System shall have list of all the buses, routes, drivers & conductors available for duty allocation |
| FMS.002 | General Requirement | Provision to enter duty for driver, conductor and buses and shall be able to assign to all buses. |
| FMS.003 | General Requirement | It shall have provision to send SMS to respective driver and conductor about their duty. |
| FMS.004 | General Requirement | It shall have provision to create report for the vehicles available for duty, under maintenance and on casual duty to manage the fleet effectively |
| FMS.005 | General Requirement | It shall keep records of KM run of bus to monitor and plan the maintenance of the bus after certain run. The system shall have provision to set the KM manually in the system if required. |
| FMS.006 | General Requirement | Provision to alter driver and conductor duty in system and in such scenario immediate SMS shall go to driver and conductor about the change in their duty |

| | | |
|---|---|---|
| FMS.007 | General Requirement | Should be able to integrate with Integrated Operation Platform for complete dashboard view |

**G.** Indicative MIS Report

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| MIS.001 | General Requirement | Stops skipped. |
| MIS.002 | General Requirement | Speed violation, Harsh braking, Harsh Acceleration. |
| MIS.003 | General Requirement | Driver duty performance daily/weekly/monthly. |
| MIS.004 | General Requirement | Driver wise improper stopping. |
| MIS.005 | General Requirement | Details of Missed trips. |
| MIS.006 | General Requirement | On-going dynamic analysis from archived data for operating and strategic decisions through summarized reports and graphic representation. |
| MIS.007 | General Requirement | Position of the particular vehicle at any given point of time mapped to the land mark location, area, bus stop, etc. |
| MIS.008 | General Requirement | Tracking the complete route taken by particular vehicle on time scale |
| MIS.009 | General Requirement | Route specific distance travelled by a bus on a given date & time |
| MIS.010 | General Requirement | Monitor start time of the trip, completion of the trip, number of trip(s) completed, etc |
| MIS.011 | General Requirement | Monitor in-shedding /out-shedding of buses from depot automatically without human intervention. |
| MIS.012 | General Requirement | Time taken to complete a trip by specific bus, route based, within specified time slots in a day |
| MIS.013 | General Requirement | Deviations taken by specific bus during trip related to routes, stoppages at bus stops, over speeding, distance travelled between stops within specific time, etc |
| MIS.014 | General Requirement | Bus operations specific reports |
| MIS.015 | General Requirement | Position of vehicle at any point of time and complete route taken by vehicle along with time scale. |
| MIS.016 | General Requirement | Route wise, time period wise, bus wise, driver wise, conductor wise, trip wise, exception reports (e.g. speed over limit incidents, route diversion incidents). |
| MIS.017 | General Requirement | Category of bus wise, route wise, time period of day wise, bus wise, trip wise, duty wise scheduled/actual distance travelled on the time scale, summary & detailed reports along-with exceptions (e.g. actual distance travelled due to route diversion because of traffic jams, etc). Category of bus wise, depot wise, route wise, time period of day wise, trip wise, duty wise actual fuel & oil consumption, summary & detailed reports if this information is available on bus. |
| MIS.018 | General | Category of bus wise, depot wise, route wise, time period of the day |

| | | |
|---|---|---|
| | Requirement | wise, trip wise, duty wise, bus stop wise/ location wise actual passenger flow pattern, summary as well as detailed reports. |
| MIS.019 | General Requirement | Category of bus wise, depot wise, route wise, time period of day wise, bus stop wise/ location wise scheduled/actual number of buses, summary reports with exceptions like cancellation of buses, route diversions due to road works, etc. |
| MIS.020 | General Requirement | Query based reports, as per the user requirements |
| MIS.021 | General Requirement | VTS wise data transfer logs on time scale and with date & time stamps |
| MIS.022 | General Requirement | Data logs for PIS unit wise information distributed to various locations. |

**H.** Indicative Analytics and Decision Support System

| Sr. No. | Item | Minimum Requirement Description |
|---|---|---|
| ADSS.001 | General Requirement | Average peak & lean demand in passenger load during various times of typical day (non-seasonal). |
| ADSS.002 | General Requirement | Average peak & lean demand in passenger load during various times of special day seasonal). |
| ADSS.003 | General Requirement | Peak and lean revenue collections during various times of a typical day (non-seasonal). |
| ADSS.004 | General Requirement | Peak and lean revenue collections during various times of a special day (Seasonal). |
| ADSS.005 | General Requirement | Average peak & lean time from start to destination of a route during various times of day. |
| ADSS.006 | General Requirement | Peak and lean bus-stop utilization rate – no. of passengers boarding at different bus stops enroute |
| ADSS.007 | General Requirement | Route planner / optimizer system shall incorporate: • Route planning, scheduling and analysis • Real time scheduling and routing of buses • Demographic analysis and route restructuring • Transportation planning & modelling |
| ADSS.008 | Map Based Analysis | Creating buffers along the emergency site, working site etc. |
| ADSS.009 | Map Based Analysis | Creating Geo-fence dynamically and sending alerts in case of vehicle moves out of the geo fence. |
| ADSS.010 | Map Based Analysis | Halt time within the geo-fences. |
| ADSS.011 | Map Based Analysis | Geofences to be created at every bus stop location. |
| ADSS.012 | Map Based Analysis | Geo routing the assigned routes and sending alerts in case of route deviation. |
| ADSS.013 | Map Based Analysis | Map shall have facility to flash or show messages sent by vehicle communication unit. |

7.6. Environmental Sensors

| Sr. No. | Parameter | Specification |
|---|---|---|

| | | |
|---|---|---|
| ENV.001 | Measurement parameters and range (must measure required ranges) | PM 2.5: 0 to 600 micrograms / m3<br>PM 10: 0 to 900 micrograms / m3<br>NO2: 0 - 10 ppm (minimum detection 10 ppb)<br>SO2: 0 - 10 ppm (minimum detection 10 ppb)<br>O3: 0 - 5 ppm (minimum detection 10 ppb)<br>CO: 0 - 500 ppm (minimum detection 100 ppb)<br>Light: up to 50,000 Lux<br>UV Radiation: up to 50,000 uW/cm2<br>Noise: up to 135 dB (A)<br>Rainfall Monitoring : in inch/mm of rain per day ( Upto 40 inch) |
| ENV.002 | Temperature, Humidity and Atmospheric Pressure Sensors | Real-time Temperature Range: outdoor -10ºC ~ 70ºC<br>Real-time in Air Humidity Level 0-100% RH<br>Real-Time Atmospheric Pressure (in Bars or millibars) |
| ENV.003 | Connectivity (Minimum) | GPRS (2G) / GSM (3G) / LTE (4G) / Wi-Fi / LORA<br>Sensors shall have provision to interchange between GSM and LORA. |
| ENV.004 | Power | The sensor should be consuming power as low as 3 Watt and fully operated using Solar Power with minimum of 24 Hours of Battery Backup. |
| ENV.005 | Data Frequency | Each environmental sensor should be sending data every 120 to 600 seconds. The data frequency should be changeable from sensor management platform. |
| ENV.006 | Measurement Principle | The sensors should be measuring air-quality and noise parameters from downward (ground) direction to capture vehicular pollution and noise.<br>The sensors should be measuring light parameters from top direction to capture maximum sunlight.<br>The sensors should be measuring particulates from the sideward direction to avoid the effect of gravity on the measurement. |
| ENV.007 | Measurement Flow-rate | The system should have a suction based air measurement system.<br>For Particulate monitoring should be having 1 Liter / Min as the minimum required flow rate. Where for Gas monitoring should be having 100 ml/min as the minimum required flow rate. |

| | | |
|---|---|---|
| ENV.008 | System backup | The system should have an internal memory for the data backup for minimum 7 days in case of network failure or system maintenance cycles |
| ENV.009 | Sensor Configuration and Geo-tagging | Smart environmental sensors should be centrally configurable and updated from Command and Control Center Software.<br>Geo location tagging of each environmental sensor should be done from Command and Control Center Software. |
| ENV.010 | Weather Protection | The mechanical enclosure should be weather resistant with IP65 grade protection. |
| ENV.011 | Mechanical Enclosure | Smart Environment Sensor System should be inside a single enclosure (keeping only necessary parts outside for measurement constraints) without exceeding exterior dimensions 400mm X 400mm X 250mm for better aesthetic value.<br>Mechanical Enclosure should be made of tamper proof material preferably engineering metal. |
| ENV.012 | Data Validation (OPTIONAL) | Every sensor data should be validated by Nationally accredited environmental laboratory with certification and test-report before installation. |
| ENV.013 | Quality Certification | The Hardware manufacturer should be having Quality standards with ISO-9001-2015 and Environmental Standards with ISO-14001-2015. |

### 7.7. Data Centre (DC) and Disaster Recovery (DR) Centre

| **Data Center Specifications** | | |
|---|---|---|
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| DC.001 | Data availability | 99.982% |
| DC.002 | Receiving Power | Commercial power substation next to DC |
| DC.003 | UPS | UPS system with N+N redundancy |
| DC.004 | Generator | Gen-set with N+1 redundancy |
| DC.005 | Power Provision | Dual power feed, PDU sources to each rack, Power supply to a rack as per requirement |
| DC.006 | Cooling Features | ▪ System: Air-cooling system with N+2 redundancy, Management of temperature and humidity<br>Blow-out Type: Raised flooring air conditioning system, Down-blow below raised floor |

| | | |
|---|---|---|
| | | and drawn into ceiling |
| DC.007 | Fire Protection : | High Sensitive Smoke Detectors, Fire Suppression System |
| DC.008 | Security | CCTV surveillance cameras, 24x7 on-site security presence, building Access (Photo ID Card must) along with biometric authentication |
| **Online UPS** | | |
| **Sr. No.** | **Item** | **Description** |
| ONUPS.001 | Capacity | ▪ Adequate capacity to cover all above IT Components at respective location |
| ONUPS.002 | Output Wave Form | ▪ Pure Sine wave |
| ONUPS.003 | Input Power Factor at Full Load | ▪ >0.90 |
| ONUPS.004 | Input | ▪ Three Phase 3 Wire for over 5 KVA |
| ONUPS.005 | Input Voltage Range | ▪ 305-475VAC at Full Load |
| ONUPS.006 | Input Frequency | ▪ 50Hz +/- 3 Hz |
| ONUPS.007 | Output Voltage | ▪ 400V AC, Three Phase for over 5 KVA UPS |
| ONUPS.008 | Output Frequency | ▪ 50Hz+/- 0.5% (Free running); +/- 3% (Sync. Mode) |
| ONUPS.009 | Inverter efficiency | ▪ >90% |
| ONUPS.010 | Over All AC-AC Efficiency | ▪ >85% |
| ONUPS.011 | UPS shutdown | ▪ UPS should shutdown with an alarm and indication on following conditions 1) Output over voltage, 2) Output under voltage, 3) Battery low, 4) Inverter overload, 5) Over temperature, 6) Output short |
| ONUPS.012 | Battery Backup | ▪ 30 minutes in full load |
| ONUPS.013 | Battery | ▪ VRLA (Valve Regulated Lead Acid) SMF (Sealed Maintenance Free) Battery |
| ONUPS.014 | Indicators & Metering | Indicators for AC Mains, Load on Battery, Fault, Load Level, Battery Low Warning, Inverter On, UPS on Bypass, Overload, etc.<br>▪ Metering for Input Voltage, Output Voltage and frequency, battery voltage, output current etc. |

| | | |
|---|---|---|
| ONUPS.015 | Audio Alarm | Battery low, Mains Failure, Over temperature, Inverter overload, Fault etc. |
| ONUPS.016 | Cabinet | Rack / Tower type |
| ONUPS.017 | Operating Temp | 0 to 50 degrees centigrade |
| ONUPS.018 | Management Protocol | SNMP Support through TCP/IP |
| **DG Set** | | |
| **Sr. No.** | **Item** | **Description** |
| DGS.001 | General Specifications | ▪ Auto Starting DG Set mounted on a common base frame with AVM (Anti-Vibration) pads, residential silencer with exhaust piping, complete conforming to ISO 8528 specifications and CPCB certified for emissions.<br>KVA rating as per the requirement |
| DGS.002 | Engine | ▪ Radiator cooled, multi cylinder, 1500 RPM diesel engine, with electronic/manual governor and electrical starting arrangement complete with battery, conforming to BS5514/ ISO 3046/ IS 10002 |
| DGS.003 | Fuel | ▪ High Speed Diesel (HSD) |
| DGS.004 | Alternator | ▪ Self-exciting, self-regulating type alternator rated at 0.8 PF or better, 415 Volts, 3 Phase, 4 wires, 50 cycles/sec, 1500 RPM, conforming to IS 4722/ BS 5000, Windings of 100% Copper, class H insulation, Protection as per IP 23. |
| DGS.005 | AMF (Auto Main Failure) Panel | AMF Panel fitted inside the enclosure, with the following:<br>It should have the following meters/indicators<br>▪ Incoming and outgoing voltage / Current in all phases<br>▪ Frequency, KVA and power factor<br>▪ Time indication for hours/minutes of operation<br>▪ Fuel Level in fuel tank, low fuel indication<br>▪ Emergency Stop button<br>▪ Auto/Manual/Test selector switch<br>▪ MCCB/Circuit breaker for short-circuit and overload protection<br>▪ Control Fuses, Earth Terminal<br>▪ Any other switch, instrument, relay etc. essential for Automatic functioning of DG set with AMF panel |
| DGS.006 | Acoustic Enclosure | ▪ DG set shall be provided with acoustic enclosure / canopy to reduce the sound level and to house the entire DG set (Engine & Alternator set) assembly outside (open-air).<br>Enclosure must be weather resistant powder coated, with insulation designed to meet latest MOEF/CPCB norms for DG sets, capable to withstand Hyderabad climate. The enclosure must have ventilation system, doors for easy access for maintenance, secure locking arrangement, complete and |
| DGS.007 | Fuel Tank Capacity | • It should be sufficient & suitable for containing fuel for minimum 12 hours continuous operation, Complete with level indicator, fuel inlet and outlet, air vent, drain plug, inlet arrangement for direct filling and set of fuel hoses for inlet |

| | | |
|---|---|---|
| | | and return. |
| **Structured Cabling Components** | | |
| **Sr. No.** | **Item** | **Description** |
| SCC.001 | Standards | • ANSI TIA 568 C for all structured cabling components |
| SCC.002 | OEM Warranty | • OEM Certification and Warranty of 15-20 years as per OEM standards |
| SCC.003 | Certification | • UL Listed and Verified |
| **Electrical Cabling Components** | | |
| **Sr. No.** | **Item** | **Description** |
| ECC.001 | Standards | • All electrical components shall be design manufactured and tested in accordance with relevant Indian standards IEC's |
| **Data Centre Specifications** | | |
| DC.001 | Data availability | 99.982% |
| DC.002 | Receiving Power | Commercial power substation next to DC |
| DC.003 | UPS | UPS system with N+N redundancy |
| DC.004 | Generator | Gen-set with N+1 redundancy |
| DC.005 | Power Provision | Dual power feed, PDU sources to each rack, Power supply to a rack as per requirement |
| DC.006 | Cooling Features | ▪ System: Air-cooling system with N+2 redundancy, Management of temperature and humidity<br>Blow-out Type: Raised flooring air conditioning system, Down-blow below raised floor and drawn into ceiling |
| DC.007 | Fire Protection: | High Sensitive Smoke Detectors, Fire Suppression System |
| DC.008 | Security | CCTV surveillance cameras, 24x7 on-site security presence, building Access (Photo ID Card must) along with biometric authentication |
| **Hyper Converged Infrastructure** | | |
| HCI.001 | General Requirement | The proposed HCI solution should be software defined and should not use any hardware based RAID, Compression or De-duplication |
| HCI.002 | | The proposed solution independently scale storage and compute as and when needed without any downtime. HCI should support storage expansion and compute expansion to extend storage/compute capacity as and when needed. |
| HCI.003 | | The proposed HCI solution must have metadata distributed within a cluster i.e. cluster should carry information about data lying in the cluster |
| HCI.004 | | The proposed solution must have capability to support nodes with same/different CPU & Memory configurations in the same cluster |
| HCI.005 | | The proposed solution must have capability to support SSD & SAS/SATA |
| HCI.006 | | Thin provisioning of both storage entities and virtual machine hard disks |

| | | |
|---|---|---|
| HCI.007 | | The solution should provide automatic failover for hardware failure |
| HCI.008 | | The proposed HCI should support File Services or block storage any of these industry protocols over NFS/CIFS/SMB/iSCSI and should support applications across clusters and Data Centers |
| HCI.009 | | Shall support automated chassis redundancy and survive the failure of entire chassis containing multiple nodes. In a multi-chassis configuration the infrastructure must intelligently distribute data across chassis so no redundant copies of data exist on the same chassis or node. |
| HCI.010 | | Shall support minimum 8 nodes or higher in a same cluster. |
| HCI.011 | | The solution support for automated upgrades of storage controllers through management GUI with no downtime and major impact on production |
| HCI.012 | | Support for layer-2 VLAN for networking and integrated VM IP's Management capabilities |
| HCI.013 | | Shall distribute data intelligently across all nodes and capacity utilization across all nodes has to be uniform at all times. |
| HCI.014 | | Shall be capable of adding additional combined server and storage components with high performance GPU capabilities, seamlessly, with no downtime, to scale performance and capacity on demand |
| HCI.015 | | Native storage level snapshots with no impact to guest performance or using any additional storage capacity |
| HCI.016 | | The solution should support data replication with disk space optimization |
| HCI.017 | | The platform should have support for rack /chassis awareness to support redundant data should go to different rack/chassis nodes |
| HCI.018 | | The proposed HCI should support native File Services over NFS/CIFS/SMB and file replication across clusters and data centers |
| HCI.019 | | The proposed HCI solution must provide operations management and provide performance, storage, CPU utilization per VM |
| HCI.020 | | Platform must provide management through a web based HTML 5 console. Must provide storage, compute & hypervisor metrics on a per VM level as well as health and monitoring of entire platform. Platform should support LDAP Active Directory integration |
| HCI.021 | | Platform must support monitoring via SNMPv3 and email alerting via SMTP |
| HCI.022 | | Shall be capable of creating instant snapshots of virtual machines and maintaining multiple copies of snapshots & clones |
| HCI.023 | | Proposed HCI solution should support fault tolerance of at least two nodes failure within a cluster |
| HCI.024 | | Solution must support native VM level replication for installed Hypervisor |
| HCI.025 | | The solution should have call home capability for remote log collection and proactive support for predictive failure hardware component |
| HCI.026 | | Proposed HCI solution should have inline deduplication and compression for the proposed capacity |
| HCI.027 | | The proposed solution should provide a minimum of 200TB of usable storage. Any additional storage required for successful solution deployment should be considered and provided by the bidder. |

| | | |
|---|---|---|
| **Server for Non Virtualize / Non HCI environment** | | |
| S.001 | General Requirement | Minimum 1 numbers of Intel(R) Xeon(R) 64Bit Processor upgradable to 2 Processors on the same system, each with minimum of 8 cores, 2.10GHz Speed, 20M Cache or above.<br><br>Latest Intel Chipset supporting above Process<br>Graphics integrated with chipset |
| S.002 | | Minimum 256 GB Memory with 32/64GB /DDR4 2133 MHz or above Memory modules, should be scalable up to 768 GB per server |
| S.003 | | Minimum 4 PCI-e (Express) slots in which minimum 2 x PCI-e8Xslots<br>SAS/SATA/SSD Raid controller capable of providing RAID 0, 1, 5 configurations.<br>Min 3 x USB 2.0, 1 x Management port, 1 x VGA and 4X network ports |
| S.004 | | Minimum 2 x 600GB SFF 15K RPM, 6Gbps SAS HDD / SSD Hot Pluggable Hard Drive with min 1 TB usable space. The server should support SAS, SATA and SSD hard disk drives |
| S.005 | | The Server to support Microsoft Windows Server, Redhat Enterprise Linux, SuSE Linux Enterprise Server and other major industry standard operating systems |
| S.006 | | Minimum 4 X 10 GbE Ethernet Ports and use of proprietary interconnects leading to vendor lock-in is unacceptable. |
| S.007 | | Redundant hot pluggable Fans and Power supplies |
| S.008 | | Server should be either blade enclosure or Rack mountable systems |
| **Minimum recommended Technical Specifications for Node / Server for HCI environment** | | |
| T.001 | General Requirement | Minimum 2 numbers of Intel(R) Xeon(R) 64Bit Processor each with minimum of 8 cores, 2.10GHz Speed, 20M Cache or above.<br>Latest Intel Chipset supporting above Process<br>Bare metal Virtualization Hypervisor |
| T.002 | | Minimum 256 GB Memory with 32/64GB /DDR4 2133 MHz or above Memory modules, should be scalable up to 1 TB per server |
| T.003 | | The total physical core and memory comprising all the physical nodes in Converged / Hyper Converged Environment should be basis the applications , workload performance and availability requirements to be architected by MSI<br>Min 200 TB Usable space across, excluding the OS partition and cache, if any. |
| T.004 | | Minimum 4 PCI-e (Express) slots in which minimum 2 x PCI-e8Xslots<br>SAS/SATA/SSD Raid controller capable of providing RAID 0, 1, 5 configurations.<br>Min 2 x USB 2.0, 1 x Management port, 1 x VGA and 4X network ports |
| T.005 | | Minimum of 2 SSD drives per server. Each server should support SATA/NL-SAS and SSD hard disk drives. multiple levels of data block level replication across node / controllers to prevent multi node / controller failures. Single logical unit of storage should be shared across nodes / controllers at the same time within a given cluster. It should support thin provisioning, Clone volumes. |
| T.006 | | The Server to support Microsoft Windows Server, Redhat Enterprise Linux, SuSE Linux Enterprise Server and other major industry standard operating systems |

| | | |
|---|---|---|
| T.007 | | Minimum 4 X 10 GbE Ethernet Ports and use of proprietary interconnects leading to vendor lock-in is unacceptable. |
| T.008 | | The system should be managed with a GUI based management software tool with storage monitoring tool integrated in the toolset, locally and remotely.<br><br>The management software should provide real time monitoring, and historical analysis of storage performance and capacity such as total no. of IOPS, read/write %, CPU Utilization, Network Utilization and throughput etc. for analysing the performance of the system. should have audit log for recording all service/maintenance and host log actions on the storage. |
| T.009 | | Redundant hot pluggable Fans and Power supplies |
| T.010 | | Rack space max up to 2 U per enclosure |
| **SAN Storage Minimum Specifications** | | |
| SAN.001 | Capacity | The Usable capacity of min 650 TB of each SAN Storage should be proposed using RAID 6 (10+2) or better for NL-SAS Disk using 6 TB or 10TB Capacity Disk along with 8 Nos. of 1.6 TB SSD Disk in RAIDS. |
| SAN.002 | | The storage capacity should be scalable to double the capacity by adding the disk. No Controller hardware upgrades shall be done required |
| SAN.003 | Fault Tolerant | The Disk controller offered should have minimum support for RAID 0,1,5,6,10 levels. |
| SAN.004 | | The offered Storage controller should have minimum 32 GB cache per controller (total 64 GB) and support cache backup mechanism to protect the data on cache to SSD or de-stage to disk in case of power failure. |
| SAN.005 | | The Disk controller or expansion units should have redundant power supplies. Fan and controller should be redundant and hot swappable |
| SAN.006 | Supported Disk Types | The offered disk controller shall support for SSD, SAS and NL-SAS disk types of maximum capacity available. |
| SAN.007 | Host Interface | The offered storage shall support for minimum 8 or more nos. of 16Gbps Fiber channel host interfaces and should support scalability to 32Gbps Fiber channel host interfaces. |
| SAN.008 | | The host interface module shall be inter- changeable or support 10Gbit or iSCSI or SFP+ interface |
| SAN.009 | Performance | The offered storage should be configurable to provide throughput & IOPS as per solution provided. |
| SAN.010 | Others | Remote Replication along with full volume copy and Snapshot of the stored data to another logical drive for backup purposes, within and across connected external storages. Appropriate Licenses should be proposed with the storage for the same. |
| SAN.011 | LUN Size | Up to 60TB LUN size |
| SAN.012 | Protocol Supported | SNMP, FC, iSCSI |
| SAN.013 | Thin Provisioning | Proposed array must be supplied with thin provisioning for the configured capacity |

| FC SAN SWITCH | |
|---|---|
| FCS.001 | Power Specification - 200-240V, 50-60 Hz |
| FCS.002 | Operating temperature range - 0° to 40° C |
| FCS.003 | Operating Relative Humidity range (non-condensing) - 10 to 90% relative humidity |
| FCS.004 | Total no. of ports on the proposed switch - 24<br>(No. of SAN Switch to be calculated and proposed as per the consumption) |
| FCS.005 | Throughput of each FC port - 16 Gbps |
| FCS.006 | Support for 4/8 Gb/s HBAs |
| FCS.007 | Aggregate backplane Switch bandwidth - 384 Gbps |
| FCS.008 | Protocol supported FC & FCP |
| FCS.009 | Shall be designed for high availability with no Single Point of Failure |
| FCS.010 | should have Hot Swappable Power supply |
| FCS.011 | Should have (N+1) redundant power supply |
| FCS.012 | Should have Hot Swappable Cooling Fans |
| FCS.013 | Should have (N+1) redundant Cooling Fans proposed |
| FCS.014 | Capability for streaming the data in multiple paths with Optimization algorithms for streaming data through shortest available path. |
| FCS.015 | Capabilities for cascading of switches |
| FCS.016 | Non-disruptive firmware update |
| FCS.017 | Should have End to end performance monitoring |
| FCS.018 | Capability to interface with host based adapters (HBA) of multiple OEM, supporting multiple Operating System including but not limited to AIX, HP-UX, Linux, Solaris, Windows, etc. |
| FCS.019 | Support all leading SAN disk arrays and tape libraries including but not limited to Dell EMC, Hitachi, Quantum, HP, StorageTek, Sun, etc.. |
| FCS.020 | Support for hardware -enforced zoning |
| FCS.021 | Policy based security and centralised fabric management |
| FCS.022 | Support for Encrypted password |
| FCS.023 | Support for PKI Digital certificates |
| FCS.024 | Support for FCAP authentication |
| FCS.025 | Support for RADIUS, SSL / HTTPS, SSH, SNMP V3 |
| FCS.026 | Support for LUN masking |
| FCS.027 | Support for dynamic Load balancing of links with no overhead |
| FCS.028 | Compatibility with proposed network devices |

| | | |
|---|---|---|
| FCS.029 | Compatibility with proposed servers | |
| FCS.030 | The system should not be an end of life / end of service product. | |
| **Fabric Controller** | | |
| FC.001 | **Fabric Definition** | Fabric is the Close Architecture defined using Spine, Leaf and VXLAN + ISIS or VXLAN + EVPN Protocol. |
| | | Fabric should have following functionalities to be achieved:<br>• Flexibility: allows workload mobility anywhere in the DC.<br>• Robustness: while dynamic mobility is allowed on any authorized location of the DC, the failure domain is contained to its smallest zone.<br>• Performance: full cross sectional bandwidth (any-to-any) – all possible equal paths between two endpoints are active.<br>• Deterministic Latency: fix and predictable latency between two endpoints with same hop count between any two endpoints, independently of scale.<br>• Scalability: add as many Leaf as needed to achieve desired scale in terms of number of servers while maintaining the same oversubscription ratio everywhere inside the fabric. |
| FC.002 | **Optics** | Fabric should have Switch and Optics from same OEM. |
| FC.003 | **Fabric Features** | Fabric must support various Hypervisor encapsulation including VXLAN, NVGRE and 802.1q natively without any additional hardware/software or design change. |
| | | Fabric must auto discover all the hardware and auto provision the fabric based on the policy. |
| | | The fabric architecture must be based on hardware VXLAN overlays to provide logical topologies that are abstracted from the physical infrastructure with no performance degradation. Fabric must support VXLAN Switching/Bridging and VXLAN Routing. |
| | | Fabric must provide open programmable interface using phython SDK, Jason SDK, XMLS or COBRA etc. from the Central Management appliance / SDN Controller for programming/configuring the entire fabric. |
| | | Fabric must provide open scripting interface using Bash, powershell, NetConf, YANG from the central management appliance / SDN Controller for configuring the entire fabric. |
| | | Fabric must support Role Based Access Control in order to support Multi - Tenant environment. |
| | | Fabric must integrate with different virtual machine manager and manage virtualise networking from the single pane of Glass - Fabric Controller/SDN Controller. |
| | | Fabric must integrate with best of breed L4 - L7 Physical and virtual appliances and manage using single pane of glass - Fabric Controller / SDN Controller. |
| | | Fabric must provide deeper visibility into the fabric in terms of latency and packet drop between VM to VM, VM to Physical server and vise versa, Leaf to another leaf etc. |

| | | |
|---|---|---|
| | | Fabric must act as single distributed layer 2 switch, Layer 3 router and Stateless distributed firewall etc. |
| | | Fabric must provide REST APIs from the Central management appliance/SDN Controller in order to integrate with best of breed Management, Monitoring, Hypervisor and Cloud automation & Orchestration software. |
| FC.004 | **Fabric Layer 2, Layer 3 and Misc. Features** | Fabric must support Layer 2 features like LACP, STP /RSTP /MSTP, VLAN Trunking, LLDP etc. |
| | | Fabric must support multi chassis ether channel/MLAG i.e. Host connects to two different Leaf switches and form ether channel using LACP/NIC Teaming on Host. |
| | | Fabric must support Jumo Frame upto 9K Bytes on 1G/10G/25G/40G/100G ports. |
| | | Fabric must support Layer 2 Multicast i.e. IGMP v1, v2 and v3. |
| | | Fabric must support IP v4 and IP v6 FHRP using HSRP or VRRP. |
| | | Fabric must support IP v4 and IP v6 Layer 3 routing protocol OSPF and BGP |
| | | Fabric must support IP v6 dual stack. |
| | | Fabric must support traffic redistribution between different routing protocols. |
| | | Fabric must support IP v4 and IP v6 management tools like - Ping, Traceroute, VTY, SSH, TFTP and DNS Lookup. |
| | | Fabric must support IP v4 and IP v6 SNMP V1 / V2 / V3. |
| | | Fabric must support RMON/RMON-II for monitoring. |
| | | Fabric must support integration with the centralised Syslog server for monitoring and audit trail. |
| | | Fabric must support NTP |
| FC.005 | **Fabric Security Features** | Fabric must have zero trust policy model for connected systems or hosts to help in protecting against any kind of attacks like Unauthorized Access, Man - in - the - middle - attack, Replay Attack, Data Disclosure, Denial of Service. |
| | | Fabric must provide RBAC policies and support AAA using Local User authentication, External RADIUS, External TACACS+, External LDAP, External AD. |
| | | Fabric must support VM attribute based zoning and policy. |
| | | Fabric must support Micro Segmentation for the Virtualize and Non - Virtualize environment. |
| | | Fabric must support true multi - tanency. |
| | | Fabric must be accessible using CLI over SSH and GUI using HTTP/HTTPS |
| | | Fabric must support SNMP v2/3 with HMAC-MD5 or HMAC-SHA authentication and DES encryption. |
| | | Fabric must act as a State-less distributed firewall with the logging capability. |
| FC.006 | Fabric Service Features | Fabric must be capable to provide services of L 4 - L7 services using physical or virtual appliances i.e. Firewall, ADC, IPS etc. |
| | | Fabric must have zero trust policy model for connected systems or hosts to help in protecting against any kind of attacks like Unauthorized Access, Man - in - the - |

| | | |
|---|---|---|
| | | middle - attack, Replay Attack, Data Disclosure, Denial of Service. |
| FC.007 | Fabric Scale and Performance | Fabric should support scale up and scale out without any service disruption. |
| | | Fabric must support for 500 VRF/Private network without any additional component or upgrade or design change. |
| | | Fabric must scale from 100 Tenant to 500 Tenant without any additional component or upgrade or design change. |
| | | Fabric must integrate with minimum 3 Virtual Machine Manager (i.e. vCenter, SCVMM, OpenStack etc.) of different Hypervisors simultaneously and scalable to 5 in future with or without common orchestrator. |
| | | Fabric must be capable of connecting 2500 physical servers and scale to 5000 physical servers.. |
| | | Fabric must be capable of integrating minimum of 8 nos. of L 4 - L7 services physical or virtual appliances (i.e. Firewall, ADC, IPS etc.) and scale upto 16 nos of L4 - L7 Services appliances. |
| | | Fabric must support minimum of 4 Leaf switches and scale upto 250 Leaf switches without any design change. |
| | | Fabric must support minimum of 2 Spine Switches and scale upto 6 Spine switches without any design change. |
| | | Spine Switches must have adequate number of line rate 40/100G ports to support desired Leaf Scale. |
| | | Each Leaf connects to Each Spine using minimum 1 x 40/100 G ports connectivity i.e. Each Spine must have 128 nos. of line rate 40G/100G ports with consideration of leaf to SPINE over subscription ration of 4:1. |
| | | Fabric must support 20K IPv4 and 10K IPv6 routes scalable to 30K IPv4 and 15K IPv6 routes. |
| | | Fabric must support 4K multicast groups scalable to 8K multicast groups. |
| | | Fabric must support 256 nos. of MLAG/VPC scalable to 384 nos. Each MLAG/VPC must support maximum 8 member links. |
| | | Fabric must support 256 nos. of Port Channel scalable to 384 nos. Each Port Channel must support maximum of 8 member links. |
| FC.008 | **Fabric management** | Fabric must provide Centralised Management Appliance or SDN Controller - Single pane of Glass for managing, monitoring and provisioning the entire Fabric. |
| | | Fabric must Auto discover all the Spine and Leaf switches and auto provision them based on the Fabric policy using Centralised Management appliance or SDN Controller. |
| | | Centralised management appliance or SDN Controller must manages and provision L4 - L7 Services physical or virtual appliance as well as integrate with Virtual Machine manager. |
| | | Centralised management appliance or SDN Controller should not participate in Data |

| | | |
|---|---|---|
| | | plane and control plane path of the fabric. |
| | | Centralised management appliance or SDN Controller must provide necessary report for compliance and audit. |
| | | Centralised management appliance or SDN Controller must communicate to south bound devices using open standard protocol i.e. OPFLEX, OPENFLOW, OVSDB etc. or using Device APIs. |
| | | Centralised management appliance or SDN Controller communication with the south bound devices must be encrypted |
| | | Centralised management appliance or SDN Controller must communicate with the south bound devices using more than one path i.e. in-path connectivity and out of band management connectivity |
| | | Centralised management appliance or SDN Controller provide dynamic device inventory of the Fabric as well as current network topology of the fabric. It must also validate the cabling connectivity and generate alarms in case of wrong or faulty connectivity. |
| | | Centralised management appliance or SDN Controller provide dynamic device inventory of the Fabric as well as current network topology of the fabric. It must also validate the cabling connectivity and generate alarms in case of wrong or faulty connectivity. |
| | | Centralised management appliance or SDN Controller must run in "N + 1 or N + 2" redundancy to provide availability as well as function during the split brain scenario. |
| **Internet and Intranet Router** | | |
| IIR.001 | Internet Router | Router should be chassis based device with minimum 10 Gbps of throughput scalable upto 20 Gbps. It should have minimum 4 GB of RAM/ DRAM |
| IIR.002 | | Router supports management protocol: SNMP v1/v2/v3, CLI (Telnet/Console), TFTP update and configured file management |
| IIR.003 | | Router must have inbuilt state full firewall,zone-based firewall and 3 DES capability technologies to support the access controller strategy based source and destination IP protocol port and time parameters |
| IIR.004 | | Router should have tunneling protocols like IPsec VPN, GET VPN or equivalent, Multi Point VPN and encryption mechanisms like DES, 3DES, AES (128 and 256Bit).It should support minimum 300 IPsec tunnels from day one. |
| IIR.005 | | Router has support for the following routing /WAN protocols PPP/MLPPP, HDLC |
| IIR.006 | | Router should be modular chassis based device and should accommodate a combination of high-density , 10G, Gigabit Ethernet, Fast Ethernet |
| IIR.007 | | Router should support protocols like RIP, OSPF, BGP, VRRP/HSRP, 802.1q, GRE, ACL's and NAT MPLS, traffic engineering, EoMPLS or VPLS or equivalent, L2 VPN from day one |
| IIR.008 | | Shall support the RIPng & BGP for IPv6, OSPFv3, MPLS, BGP from day one. |
| IIR.009 | | Router should have minimum 18000 IPv4 and IPv6 with 50K multicast route support from day one |
| IIR.010 | | The router supports state full packet inspection supporting H.323, SIP and other |

| | | |
|---|---|---|
| | | application level gateway support |
| IIR.011 | | System shall support to provide the ability to filter and gather application information in a flexible manner from day one xflow/jflow |
| IIR.012 | | Router should support QoS Classification and marking policy based routing, IP precedence, DSCP |
| IIR.013 | | QoS -congestion management WRED/RED, Priority queuing, class-based weighted for fair queuing |
| IIR.014 | | IP Access list to limit Telnet SNMP access to router |
| IIR.015 | | Multiple privilege level authentication for console and telnet access |
| IIR.016 | | Time-based ACL for controlled forwarding based on time of day for offices |
| IIR.017 | | Should have extensive support for SLA monitoring for metrics like delay latency, jitter, packet loss and MoS |
| IIR.018 | | Provides QoS features like traffic prioritization, differentiated services, and committed, and committed access rate, QoS Support, RSVP/WFQ/MRED. Router should be able to take pre-configured action on these events like changing routes, changing routing metric |
| IIR.019 | | Router supports for QoS Features for defining the QoS policies. Support for low latency queuing, Layer 2 and Layer 3 CoS/DSCP |
| IIR.020 | | Router should have multicast routing protocols support: IGMPv1, v2 (RFC2236) PIM-SM (RFC2362) and PIM-DM/ Multicast VLAN Registration |
| IIR.021 | | The following interface required from Day-1: 2x 10G SFP+ based ports loaded with single mode transceiver, 3*1GE & 3*1G SFP-based transceiver. |
| IIR.022 | | The router should be IPv6 ready |
| IIR.023 | Architecture | Router should have redundant controller cards and should support stateful switchover, non-stop forwarding, Non-stop routing and Graceful restart. |
| IIR.024 | | Router should be CE2.0/MEF14.0 certified |
| IIR.025 | | Router shall support MEF for Ethernet based services like PW, VPLS or ATOM. |
| IIR.026 | | Router shall support sync any configurations from previous modules to new modules with hot-swap event occurred |
| IIR.027 | | The router should have redundant control & data plane. |
| IIR.028 | | The router shall support following type of interfaces – 10GE, 1GE interfaces, 10G, Ch.STM1 |
| IIR.029 | | All the Ports and card on Router should be hot swappable and field replacement of port or card should not require to bring down the chassis. |
| IIR.030 | Performance | Router shall support non-blocking capacity of 64 Gbps full duplex |
| IIR.031 | | Router shall support 60 Mpps forwarding performance for IPv4 & IPv6 performance |
| IIR.032 | | The router should support 20Gbps per slot throughput. |
| IIR.033 | | Router shall support 16000 Mac addresses |
| IIR.034 | | Router shall support minimum 18000 IPv4 and IPv6 with 50K multicast routes |
| IIR.035 | | router shall support 4000 queues and 128 MPLS VPN's |
| IIR.036 | | Router shall support aggregation of links. Minimum 8 links should be supported as part of single aggregation |
| IIR.037 | | Router shall support IPSLA or equivalent and Y.1731 for performance monitoring |
| IIR.038 | High | Router should support Redundant Power Supply and should also support Online |

| | | |
|---|---|---|
| | Availability | insertion and removal of same. |
| IIR.039 | | Fan tray should be hot-swappable and should be a Field Replaceable Unit (FRU). The node can run indefinitely with a single fan failure. Shall Support hot-swappable for all modules. And secure normal operations when hot-swap event occurred |
| IIR.040 | | Router shall support MPLS-TE with FRR for sub 50 msec protection. |
| IIR.041 | | Router must support Traffic Engineering for node and link protection. |
| IIR.042 | Protocol Support | Router shall support IPV4 and IPV6, IGMP V2/V3, MLD, IGMP and PIM, 6PE and 6VPE |
| IIR.043 | | mode for IPV6 transport over IPV4, ECMP, LDP, BGP Prefix independent control (EDGE and Core) for IPV4 and IPV6, BGP, ISIS, OSPFv2 and V3, RSVP, VRRP and Traffic Engineering |
| IIR.044 | | Router should support high availability for all BFD,BGP ,OSPF and IS-IS and no packet loss during controller switch over. |
| IIR.045 | | Router should support RFC 3107 of Carrying Label Information in BGP-4 |
| IIR.046 | | The Router should support Point to Point and Point to Multipoint LSP for Unicast and Multicast traffic. |
| IIR.047 | | Router shall support layer3 and layer2 MPLS VPN. |
| IIR.048 | QoS Features | Router shall support HQOS on all kind of interface in both ingress and egress direction. Similar QOS shall be supported for all type of interface including Bundled interfaces. |
| IIR.049 | | Shall support Ingress classification, marking and policing on physical interfaces and logical interfaces using source/destination IP subnet, protocol types (IP/TCP/UDP),source/destination ports, IP Precedence, MPLS EXP, DSCP,802.1p |
| IIR.050 | | Shall support Strict Priority Queuing or Low Latency Queuing to support real-time application like Voice and Video with minimum delay and jitter. |
| IIR.051 | | Congestion Management: WRED, Priority queuing, Class-based weighted fair queuing |
| IIR.052 | Security & Management | Support Access Control List to filter traffic based on Source & Destination IP Subnet,Source& Destination Port, Protocol Type (IP,UDP, TCP, ICMP etc.) and Port Range etc. Should Support per-user Authentication, Authorization, and Accounting through RADIUS or TACACS and SNMPv1/v2/V3 |
| IIR.053 | Operating Environmental Requirements | 0ºC to 40ºC operating temperature and 10 to 90%, non-condensing |
| IIR.054 | Interface | The proposed router should support the following from day1: - 2x10G SFP+ ports supplied with 1x10G single mode transceiver, 1x10G multi-mode transceiver, 8x1G SFP ports supplied with 4x1G single mode transceiver, 4x1G multi-mode transceiver & minimum 12 no's of 10/100/1000 Base- T ports. |
| IIR.055 | Certifications/ OEM Criteria | The proposed router should be EAL2/ NDPP certified by common Criteria body at the time of delivery. The router should be IPv6 ready from day-1. |
| Spine and Leaf Architecture – Spine Switch | | |
| SSW.001 | General Requirem | The core/spine layer switches should have hardware level redundancy (1+1) in terms of data plane and control plane. Issues with any of the plane should not impact the |

| | | |
|---|---|---|
| | ent | functioning of the switch. |
| SSW.002 | | The switch should have redundant CPUs working in active-active or active-standby mode. CPU fail over/change over should not disrupt/impact/degrade the functioning the switch. |
| SSW.003 | | The Switch should support non-blocking Layer 2 switching and Layer 3 routing. Switch with different modules should function line rate and should not have any port with oversubscription ratio applied |
| SSW.004 | | Switch should support in line hot insertion and removal of different parts like modules/power supplies/fan tray etc. This should not require rebooting of the switch or create disruption in the working/functionality of the switch |
| SSW.005 | | Switch should support the complete STACK of IP V4 and IP V6 services. |
| SSW.006 | | Switch and optics must be from the same OEM |
| SSW.007 | | Switch should support non blocking, wire speed performance per line card |
| SSW.008 | Hardware and Interface Requirement | Switch should have the following interfaces: |
| SSW.009 | | a. Minimum 30 nos of line rate and Non - Blocking 40/100G ports fully populated with 100G |
| SSW.010 | | Switch should have adequate power supplies for the complete system usage, providing N+1 redundancy |
| SSW.011 | | Switch should support IEEE Link Aggregation and Ethernet Bonding functionality to group multiple ports for redundancy |
| SSW.012 | Performance Requirement | The switch should support 1,20,000 IPv4 and IPv6 routes entries in the routing table with multicast routes |
| SSW.013 | | The switch should support hardware based load balancing at wire speed using LACP and multi chassis ether channel/LAG |
| SSW.014 | | Switch should support total aggregate minimum 28 Tbps minimum of switching capacity |
| SSW.015 | Virtualization Features | Switch should support Network Virtualization using Virtual Over Lay Network using VXLAN (RFC 7348)/NVGRE as per RFC 2890 |
| SSW.016 | | Switch should support VXLAN (RFC7348) and EVPN or equivalent for supporting Spine - Leaf architecture to optimize the east - west traffic flow inside the data center through integration with Orchestration layer / VM manager. |
| SSW.017 | | Switch should support Open Flow/Open Day light/Open Stack controller |
| SSW.018 | | Switch should support Data Center Bridging |
| SSW.019 | | Switch should support multi OEM hypervisor environment and should be able to sense movement of VM and configure network automatically |
| SSW.020 | | Switch must support VXLAN Switching/Bridging and VXLAN Routing without any performance degradation |
| SSW.021 | Layer2 Features | Switch should support minimum 160,000 no. of MAC addresses |
| SSW.022 | | Switch should support Jumbo Frames up to 9K Bytes on 1G/10G Ports |
| SSW.023 | | Support for broadcast, multicast and unknown unicast storm control to prevent degradation of switch performance from storm due to network attacks and vulnerabilities |
| SSW.024 | Layer3 | Switch should support MPLS routing |

| | | |
|---|---|---|
| SSW.025 | Features | Switch should provide multicast traffic reachable using: |
| SSW.026 | | a. PIM-SM |
| SSW.027 | | b. PIM-SSM |
| SSW.028 | | c. Bi-Directional PIM |
| SSW.029 | | d. Support RFC 3618 Multicast Source Discovery Protocol (MSDP) |
| SSW.030 | | e. IGMP V.1, V.2 and V.3 |
| SSW.031 | | Switch should support Multicast routing |
| SSW.032 | Availability | Switch should support for BFD For Fast Failure Detection |
| SSW.033 | Quality of Service | Switch should have a minimum buffer of 80 Mb or more |
| SSW.034 | | Switch should support Flow control of Ethernet ports to control traffic rates during congestion by allowing congested nodes to pause link operation at the other end for receiving traffic |
| SSW.035 | Security | Time based ACL |
| SSW.036 | | Switch should support for Role Based access control (RBAC) for restricting host level network access as per policy defined |
| SSW.037 | | Switch should support for external database for AAA using: |
| SSW.038 | | a. TACACS+ |
| SSW.039 | | b. RADIUS |
| SSW.040 | | Should support Standard / Extended ACLs |
| SSW.041 | Manageability | Switch should support for predefined and customized execution of script for device mange for automatic and scheduled system status update for monitoring and management |
| SSW.042 | | Switch should provide different privilege for login in to the system for monitoring and management |
| SSW.043 | | Switch should support Real time Packet Capture using Wire shark in real time for traffic analysis and fault finding |
| **Spine Leaf Architecture – Leaf Switch (OFC)** | | |
| LSWO.001 | Solution Requirement | The Switch should support non-blocking Layer 2 switching and Layer 3 routing |
| LSWO.002 | | There switch should not have any single point of failure like power supplies and fans etc should have 1:1/N+1 level of redundancy |
| LSWO.003 | | Switch and optics must be from the same OEM |
| LSWO.004 | | Switch should support the complete STACK of IP V4 and IP V6 services. |
| LSWO.005 | Hardware and Interface Requirement | Switch should have the following interfaces: |
| LSWO.006 | | a. 48 x 10G/25G Multi Mode Fiber Interface populated with required transceivers |
| LSWO.007 | | b. 6 x 40/100GbE QSFP ports populated with trans receivers |
| LSWO.008 | | Switch should support IEEE Link Aggregation and Ethernet Bonding functionality to group multiple ports for redundancy |
| LSWO.009 | Performance Requirement | The switch should support atleast 60000 IPv4 and IPv6 or more routes entries in the routing table with multicast routes. The bidder may propose best specification as per the proposed solution and city requirements. |
| LSWO.010 | | The switch should support hardware based load balancing at wire speed using LACP and multi chassis ether channel/LAG |
| LSWO.011 | | Switch should support minimum 3 Tbps of switching capacity |

| | | |
|---|---|---|
| LSWO.012 | | Each leaf should have connectivity to all spine switches and the over subscription should not be less then 4:1 |
| LSWO.013 | Advance Features | Switch should support Network Virtualization using Virtual Over Lay Network using VXLAN (RFC 7348) |
| LSWO.014 | | Switch should support VXLAN (RFC7348) and EVPN or equivalent for supporting Spine - Leaf architecture to optimize the east - west traffic flow inside the data center |
| LSWO.015 | | Switch should support Open Flow/Open Day light/Open Stack controller |
| LSWO.016 | | Switch must support VXLAN Switching/Bridging and VXLAN Routing without any performance degradation |
| LSWO.017 | | Switch should support Data Center Bridging |
| LSWO.018 | | Switch should support multi OEM hypervisor environment and should be able to sense movement of VM and configure network automatically through integration with Orchestration layer / VM manager. |
| LSWO.019 | Layer 2 Features | Switch should support minimum 80000 no. of MAC addresses. The bidder may propose best specifications as per the proposed solution and city requirements. |
| LSWO.020 | | Switch should support Jumbo Frames up to 9K Bytes on 1G/10G Ports |
| LSWO.021 | | Support for broadcast, multicast and unknown unicast storm control to prevent degradation of switch performance from storm due to network attacks and vulnerabilities |
| LSWO.022 | Layer 3 Features | Switch should support MPLS |
| LSWO.023 | | Switch should provide multicast traffic reachable using: |
| LSWO.024 | | a. PIM-SM |
| LSWO.025 | | b. PIM-SSM |
| LSWO.026 | | c. Bi-Directional PIM |
| LSWO.027 | | d. Support RFC 3618 Multicast Source Discovery Protocol (MSDP) |
| LSWO.028 | | e. IGMP V.1, V.2 and V.3 |
| LSWO.029 | | Switch should support Multicast routing |
| LSWO.030 | Quality of Service | Switch should have a minimum buffer of 12 Mb |
| LSWO.031 | | Switch should support Flow control of Ethernet ports to control traffic rates during congestion by allowing congested nodes to pause link operation at the other end for receiving traffic as per IEEE 802.3x/VOQ |
| LSWO.032 | Security | Switch should support control plane i.e. processor and memory Protection from unnecessary or DoS traffic by control plane protection policy |
| LSWO.033 | | Switch should support for external database for AAA using: |
| LSWO.034 | | a. TACACS+ |
| LSWO.035 | | b. RADIUS |
| LSWO.036 | | Switch should support for Role Based access control (RBAC) for restricting host level network access as per policy defined |
| LSWO.037 | | Should support Standard / Extended ACLs |
| LSWO.038 | Manageability | Switch should support for predefined and customized execution of script for device mange for automatic and scheduled system status update for monitoring and management |
| LSWO.039 | | Switch should support Real time Packet Capture using Wire shark in real time for traffic analysis and fault finding |

| Spine Leaf Architecture – Leaf Switch (Copper) | | |
|---|---|---|
| LSWC.001 | Solution Requirement | The Switch should support non-blocking Layer 2 switching and Layer 3 routing |
| LSWC.002 | | There switch should not have any single point of failure like power supplies and fans etc should have 1:1/N+1 level of redundancy |
| LSWC.003 | | Switch and optics must be from the same OEM |
| LSWC.004 | | Switch should support the complete STACK of IP V4 and IP V6 services. |
| LSWC.005 | Hardware and Interface Requirement | Switch should have the following interfaces: |
| LSWC.006 | | a. 48 x 100mb/1G RJ45 Interface |
| LSWC.007 | | b. 2 x 40/100GbE QSFP ports populated |
| LSWC.008 | | Switch should support IEEE Link Aggregation and Ethernet Bonding functionality to group multiple ports for redundancy |
| LSWC.009 | Performance Requirement | The switch should support atleast 60000 IPv4 and IPv6 or more routes entries in the routing table with multicast routes. The bidder may propose best specification as per the proposed solution and city requirements. |
| LSWC.010 | | The switch should support hardware based load balancing at wire speed using LACP and multi chassis ether channel/LAG |
| LSWC.011 | | Switch should support minimum 690 Gbps of switching capacity |
| LSWC.012 | | Each leaf should have connectivity to all spine switches and the over subscription should not be less then 4:1 |
| LSWC.013 | Advance Features | Switch should support Network Virtualization using Virtual Over Lay Network using VXLAN (RFC 7348) |
| LSWC.014 | | Switch should support VXLAN (RFC7348) and EVPN or equivalent for supporting Spine - Leaf architecture to optimize the east - west traffic flow inside the data center |
| LSWC.015 | | Switch should support Open Flow/Open Day light/Open Stack controller |
| LSWC.016 | | Switch must support VXLAN Switching/Bridging and VXLAN Routing without any performance degradation |
| LSWC.017 | | Switch should support Data Center Bridging |
| LSWC.018 | | Switch should support multi OEM hypervisor environment and should be able to sense movement of VM and configure network automatically through integration with Orchestration layer / VM manager. |
| LSWC.019 | | Switch should support minimum 80000 no. of MAC addresses. The bidder may propose best specifications as per the proposed solution and city requirements. |
| LSWC.020 | | Switch should support Jumbo Frames up to 9K Bytes on 1G/10G Ports |
| LSWC.021 | | Support for broadcast, multicast and unknown unicast storm control to prevent degradation of switch performance from storm due to network attacks and vulnerabilities |
| LSWC.022 | Layer 3 Features | Switch should support MPLS |
| LSWC.023 | | Switch should provide multicast traffic reachable using: |
| LSWC.024 | | a. PIM-SM |
| LSWC.025 | | b. PIM-SSM |
| LSWC.026 | | c. Bi-Directional PIM |
| LSWC.027 | | d. Support RFC 3618 Multicast Source Discovery Protocol (MSDP) |
| LSWC.028 | | e. IGMP V.1, V.2 and V.3 |
| LSWC.029 | | Switch should support Multicast routing |

| | | |
|---|---|---|
| LSWC.030 | | Switch should support for BFD For Fast Failure Detection |
| LSWC.031 | Quality of Service | Switch should have a minimum buffer of 12 Mb |
| LSWC.032 | | Switch should support Flow control of Ethernet ports to control traffic rates during congestion by allowing congested nodes to pause link operation at the other end for receiving traffic as per IEEE 802.3x/VOQ |
| LSWC.033 | Security | Switch should support control plane i.e. processor and memory Protection from unnecessary or DoS traffic by control plane protection policy |
| LSWC.034 | | Switch should support for external database for AAA using: |
| LSWC.035 | | a. TACACS+ |
| LSWC.036 | | b. RADIUS |
| LSWC.037 | | Switch should support for Role Based access control (RBAC) for restricting host level network access as per policy defined |
| LSWC.038 | | Should support Standard / Extended ACLs |
| LSWC.039 | Manageability | Switch should support for predefined and customized execution of script for device mange for automatic and scheduled system status update for monitoring and management |
| LSWC.040 | | Switch should support Real time Packet Capture using Wire shark in real time for traffic analysis and fault finding |
| **Next-generation Firewall with IPS and anti-APT** | | |
| NFW.001 | Hardware Architecture | The proposed solution/appliance MUST be upto Layer 7 protection. There should be no performance degradation in the overall transaction processing. The solution shall be deployed in HA mode in the DC/ICCC. |
| NFW.002 | | The appliance based security platform should be capable of providing firewall, application visibility, and control, VPN functionality in a single appliance. |
| NFW.003 | | The proposed firewall appliance should have at least 12 ports of 10/100/1000 and minimum 4 ports of 10 Gig SFP+ ports with separate management and 2 * 40 G ports from Day one |
| NFW.004 | | Proposed Firewall should not be proprietary ASIC based in nature & should be open architecture based on multi-core cpu's to protect & scale against dynamic latest security threats. The appliance hardware should be a multicore CPU architecture with a hardened 64 bit operating system to support higher memory |
| NFW.005 | | The proposed solution should have dual redundant power supply and redundant hot swappable fans. |
| NFW.006 | | Firewall Should consume 1RU Form Factor. |
| NFW.007 | Performance & Scalability | Should support at least 10 Gbps NGFW throughput under real world production Conditions. This throughout should include FW,IPS/Threat Prevention and AVC. |
| NFW.008 | | Should support minimum 5 Gbps of IPSec VPN throughput. |
| NFW.009 | | Firewall should support at least 8 Million concurrent sessions with AVC feature turned on. |
| NFW.010 | | Firewall should support at least 65,000 connections per second with AVC feature turned on. |
| NFW.011 | | Firewall should support at least 1000 VLANs |
| NFW.012 | Next Generatio | Firewall should provide application detection for DNS, FTP, HTTP, SMTP,ESMTP, LDAP, MGCP, RTSP, SIP, SCCP, SQLNET, TFTP, H.323, SNMP |

| | | |
|---|---|---|
| NFW.013 | n Firewall Features | Firewall should support creating access-rules with IPv4 & IPv6 objects simultaneously |
| NFW.014 | | Firewall should support operating in routed & transparent mode |
| NFW.015 | | Should support Static, RIP, OSPF, OSPFv3 and BGP |
| NFW.016 | | Firewall should support manual NAT and Auto-NAT, static nat, dynamic nat, dynamic pat |
| NFW.017 | | Firewall should support Nat66 (IPv6-to-IPv6), Nat 64 (IPv6-to-IPv4) & Nat46 (IPv4-to-IPv6) functionality |
| NFW.018 | | Firewall should support Multicast protocols like IGMP, PIM, etc |
| NFW.019 | | Should support security policies based on security group names in source or destination fields or both |
| NFW.020 | | Should support capability to limit bandwidth on basis of apps / groups, Networks / Geo, Ports, etc |
| NFW.021 | | The detection engine must be capable of detecting and preventing a wide variety of threats (e.g., malware, network probes/reconnaissance, VoIP attacks, buffer overflows, P2P attacks, zero-day threats, etc.). |
| NFW.022 | | The solution must be capable of passively gathering information about network hosts and their activities, such as operating system, services, open ports, client applications, and vulnerabilities, to assist with multiple activities, such as intrusion event data correlation, elimination of false positives, and policy compliance. |
| NFW.023 | | The solution must be capable of dynamically tuning IDS/IPS sensors (e.g., selecting rules, configuring policies, updating policies, etc.) with minimal human intervention. |
| NFW.024 | | Should support Application Visibility and Control (AVC) supports more than 10000 application-layer and risk-based controls that can invoke tailored intrusion prevention system (IPS) threat detection policies to optimize security effectiveness. |
| NFW.025 | | Proposed appliance should also provide Reputation- and category-based URL filtering offers comprehensive alerting and control over suspect web traffic and enforces policies on hundreds of millions of URLs in more than 50 categories |
| NFW.026 | | The solution must provide a full-featured capability to detect threats |
| NFW.027 | | The NBA capability must provide the option of supplying endpoint intelligence to the IPS for correlation against intrusion events to aid in event impact prioritization. |
| NFW.028 | | The solution shall provide on-premise/cloud based sandbox technology where the objectionable content may be executed and inspected. |
| NFW.029 | High-Availability Features | NG Firewall should support Active/Standby failover. |
| NFW.030 | | Firewall should support ether channel or equivalent functionality for the failover control & date interfaces for provide additional level of redundancy |
| NFW.031 | | Firewall should support redundant interfaces to provide interface level redundancy before device failover |
| NFW.032 | | Firewall should support 802.3ad Ether channel or equivalent functionality to increase the bandwidth for a segment. |
| NFW.033 | Management | The management platform must be accessible via a web-based interface and ideally with no need for additional client software |
| NFW.034 | | The management platform must provide a highly customizable dashboard. |
| NFW.035 | | The management platform must be capable of integrating third party vulnerability information into threat policy adjustment routines and automated tuning workflows |

| | | |
|---|---|---|
| NFW.036 | | The management platform must be capable of role-based administration, enabling different sets of views and configuration capabilities for different administrators subsequent to their authentication. |
| NFW.037 | | Should support REST API for monitoring and config programmability |
| NFW.038 | | The management platform must provide multiple report output types or formats, such as PDF, HTML, and CSV. |
| NFW.039 | | The management platform must support multiple mechanisms for issuing alerts (e.g., SNMP, e-mail, SYSLOG). |
| NFW.040 | | The management platform must provide robust reporting capabilities, including a selection of pre-defined reports and the ability for complete customization and generation of new reports. |
| NFW.041 | | The management platform must risk reports like advanced malware, attacks and network |
| NFW.042 | | The management platform must include an integration mechanism, preferably in the form of open APIs and/or standard interfaces, to enable events and log data to be shared with external network and security management applications, such as Security Information and Event Managers (SIEMs), and log management tools. |
| GLAV.001 | General | The solution should provide a comprehensive email security solution that integrates against inbound and outbound, Internal defences against email threat such as spam, virus, etc. Solution should cater to minimum 2,000 User. The solution shall be hardware appliance based. |
| GLAV.002 | | The solution should be appliance based. Appliance should support ant-spam, anti-virus , outbreak filter, on appliance detail reporting and on- appliance quarantine handling. Same appliance should have provision to integrate or run Advance malware protection for future requirements. |
| GLAV.003 | | The appliance based Solution should be provided with Proprietary Operating System and MTA on appliance and not open source operating system (send mail, qmail or postfix). |
| GLAV.004 | | Appliance should have 1.8 TB hot swappable HDD and RAID support |
| GLAV.005 | | Appliance should have at least 2 hexa core processor and 32 GB RAM |
| GLAV.006 | | The solution should have performance capability of processing at least 1,00,000 message per hour. The salutation should support at least 4 * 10/100/1000 copper interface. |
| GLAV.007 | | Appliance have option for DC power, if require |
| GLAV.008 | | The solution should be IPV6 ready |
| GLAV.009 | | The solution should be protect Directory Harvesting attacks. |
| GLAV.010 | | The solution should support LDAP integration and synchronization. LDAP integration should be used defining policies and when delivering mails. |
| GLAV.011 | | The solution should support multiple email domains on the same system for each domain a specific destination mail server can assigned for delivery. |
| GLAV.012 | | The solution should be supplied including all hardware, accessories, license, software with pre-hardened operating system. Hardware should be from same OEM |
| GLAV.013 | Inbound SMTP | The solution should combine sophisticated content based Anti-Spam technology ,IP reputation and RBL to effective block spam |

| | | |
|---|---|---|
| GLAV.014 | Protection (SPAM) | The solution should accurately filter/detect more than 99% of spam |
| GLAV.015 | | The solution should support email authentication using SPF (Sender Policy Framework). |
| GLAV.016 | | The solution should support Domain Key Identified Mail(DKIM) verification of email messages. |
| GLAV.017 | | The solution should support lookup to the cloud/on appliance to perform sender, message and IP reputation to effectively block spam. |
| GLAV.018 | | The solution should support defining custom bypass for the sender IP for the IP reputation. |
| GLAV.019 | | The solution should support anti-relay. It should have capability to configure domain to which to solution accept or refuse mail. |
| GLAV.020 | | The solution should support RBL lookup .It should support adding of multiple RBL list. |
| GLAV.021 | | The solution should have an option to block mail by sender domain address . |
| GLAV.022 | | The solution should have an option to block mail by sender email address. |
| GLAV.023 | | The solution should support scouring or signature to detect spam. Based on a severity a different action should be configured . |
| GLAV.024 | | The solution should support anti-phish scanning. |
| GLAV.025 | | The solution should offer various action offers for spam detect such as monitor, block, quarantine, forward etc. |
| GLAV.026 | Anti-virus Protection | The solution should proposed contain a network level solution for the SMTP traffic. |
| GLAV.027 | | The solution should have ability to block Malware etc. |
| GLAV.028 | | The solution should protect against mass mailing worm. |
| GLAV.029 | | The solution should contain an option to configure scan all file or specific file type. |
| GLAV.030 | | The solution should contain an option to scan archive file. |
| GLAV.031 | | The solution should have ability to perform reputation analysis. It should ability to send to suspicious file information to the cloud analysis. |
| GLAV.032 | | The solution should contain an option to configure the maximum size of attachment file, in case size is exceeds the antivirus solution block all or pass all files. |
| GLAV.033 | | The solution should contain an option to configure the maximum nesting level of attachment file. in case size is exceeds nesting level the antivirus solution should block all or pass the file. |
| GLAV.034 | | The solution should offer various actions for virus detect clean, quarantine, deliver or forward etc. |
| GLAV.035 | | Outbound SMTP Protection |
| GLAV.036 | | The solution should able to monitor and protect mail flowing out of network in SMTP traffic. |
| GLAV.037 | | The solution should allow to administrator to automatically add text to outbound mail such as legal disclaimer. |
| GLAV.038 | | The solution should perform image based filtering. It should analyse image to determine attributes that indicate the image has malicious targeted attack payload and zero day malware by removing exploitable content from office and pdf attachments along with pornographic or non-pornographic images. |
| GLAV.039 | | The solution should contain an option to configure maximum message size. In case message size exceed the mail should be blocked or quarantine. |

| | | |
|---|---|---|
| GLAV.040 | | The solution should contain an option to configure maximum attachment size. In case attachment size exceed the mail should be blocked or quarantine. |
| GLAV.041 | | The solution should support file category/file extension wise filtering/blocking. Categories should include document, database, multimedia, archive etc. |
| GLAV.042 | | The solution should support handling of encrypted content. |
| GLAV.043 | | Appliance should support integration with DLP |
| GLAV.044 | | Appliance should support Email encryption on the same appliance |
| GLAV.045 | Policy Creation & Management | The solution should provide granular policy for Inbound, Outbound and Internal traffic. |
| GLAV.046 | | The solution should be able to create specific policy based on. |
| GLAV.047 | | 1. Source/Destination IP address. |
| GLAV.048 | | 2. Sender/Recipient email address. |
| GLAV.049 | | 3. Alias recipient email address list. |
| GLAV.050 | | 4. LDAP user group. |
| GLAV.051 | | 5. Masquerade sender email address |
| GLAV.052 | | The solution should be able to create specific policy message security such as TLS |
| GLAV.053 | Email Management | The solution should able to manage the email in the message queue though the GUI. |
| GLAV.054 | | The solution should able to view the status of all messages in the queue for the GUI. |
| GLAV.055 | | The solution should able to filter and view message that was |
| GLAV.056 | | 1.Block, 2.Bounced, 3.Delivered, 4.Quarantined, 5.Queued |
| GLAV.057 | | The solution should able to filter and analyse message using: |
| GLAV.058 | | 1.Sender, 2.Reciepent, 3.Subject, 4.Inbound/Outbound, 5.Date, 6.Source IP |
| GLAV.059 | | The solution should offer a wide range option to the message in the queue such as Delete, Retry, Forward, etc. |
| GLAV.060 | | The solution should support end-user quarantine. Is it with buttons and click boxes that enable the user to release e-mail, report false positives, add senders to allow-or-block lists and direct links to personal email management portal. |
| GLAV.061 | | The solution should support on box quarantine or dedicated quarantine appliance. |
| GLAV.062 | | The solution should have configurable retention period for spam email or events. |
| GLAV.063 | System Administration | The solution should support restricted access to the system for management though SSH/web GUI. Administrator should able to specify a list of authorize access. |
| GLAV.064 | | The solution should provide the real-time health status of all modules on the dashboard for CPU, memory utilization, total number of concurrent connections etc. |
| GLAV.065 | | The solution should automatically backup all configurations on the system at specific time. |
| GLAV.066 | | The solution should offer various built in report etc. |
| GLAV.067 | | 1. Overall message summary |
| GLAV.068 | | 2. Inbound message summary |
| GLAV.069 | | 3. Outbound message summary |
| GLAV.070 | | 4. Spam and virus summary |
| GLAV.071 | | 5. Message transfer summary |
| GLAV.072 | | 6. System capacity |
| GLAV.073 | | The solution should offer alerting capabilities, including e-mail and SNMP/SIEM |
| GLAV.074 | | The solution should be automatically security update . Vendor should provide update |

| | | |
|---|---|---|
| | | and security enhancement to operating system, MTA, and supporting software include antivirus and anti-spam engine. |
| GLAV.075 | | The solution should able to generate report in PDF/HTML/Other Format. |
| GLAV.076 | | The solution should support inbuilt troubleshooting tools to troubleshoot issue. |
| GLAV.077 | | i. Built-in command to consolidate diagnostic information and configuration and send to customer support |
| GLAV.078 | | ii. Ability to enable remote tunnel support for remote diagnosis |
| GLAV.079 | | The solution should analyze email content and attachment of various file type (true file type) to remove malicious active content including embedded URLs that pose a security risk and reconstruct clean document as attachment. Solution must execute on premise all potentially malicious URLs and allow only safe content to be sent to user. |
| **Web Security Appliance** | | |
| WSA.001 | Appliance Requirement and Functionality | The solution should be a hardened Web Proxy, Caching, Web based Reputation filtering, URL filtering, Antivirus and Anti-malware appliance. All the functionalities should be in a single appliance only. |
| WSA.002 | Hardware | Minimum of 1 * 6-core CPUs, Minimum 2.4 TB storage, RAID 5 or 10, 32 GB or more, hot-swappable hard drive |
| WSA.003 | Operating System | The appliance based Solution should be provided with hardened Operating System. |
| WSA.004 | Operating System Performance | The underlying operating system and hardware should be capable of supporting atleast 2000 users from day with licenses & scalable upto 5000 users. |
| WSA.005 | Operating System Security | The operating system should be secure from vulnerabilities and hardened for web proxy and caching functionality. |
| WSA.006 | Forward proxy mode | The solution should support explicit forward proxy mode deployment in which client applications like browsers are pointed towards the proxy for web traffic. |
| WSA.007 | Transparent mode | The solution should also support transparent mode deployment using WCCP v2 and L4 switches/PBR (Policy based Routing) |
| WSA.008 | Pac File support | The appliance should support hosting proxy auto-config files that defines how web browsers can automatically choose the appropriate web proxy for fetching a URL. |
| WSA.009 | Support multiple deployment options | The solution should allow to deploy the appliance in explicit proxy as well as transparent mode together. |
| WSA.010 | Proxy Chaining | The solution should support proxy configuration in a Chain. The Lower end proxies at spoke locations should be able to forward the request to an Higher end proxies at Hub Location forming a Chain of Proxies |
| WSA.011 | DNS | The solution should support configuration to use Split DNS. It should be able to refer |

| | | |
|---|---|---|
| | Splitting | to different DNS for Different Domains e.g. (root dns for all external domains and internal DNS for organization domain |
| WSA.012 | IP Spoofing support in transparent mode deployments | The solution should have facility to do IP spoofing. When enabled, requests originating from a client should retain the client's source address and appear to originate from the client instead of the appliance. This is useful in scenarios where policies are based on original IP and logging/reporting is required to track activity of individual IP basis. |
| WSA.013 | High Availability | Provision of active/active High Availability is required |
| WSA.014 | Proxy support | The proposed solution should be a Fast Web Proxy and should support HTTP, FTP and HTTPS proxy. |
| WSA.015 | HTTPS Decryption | The solution should support HTTPS decryption |
| WSA.016 | HTTPS decrypted traffic scanning | The solution should support scanning of the https decrypted traffic by the on-board anti-malware and/or anti-virus engines. |
| WSA.017 | HTTPS decryption policy | HTTPS decryption should provide flexibility to have multiple decryption policies and should not be just a Global action |
| WSA.018 | File download and size restrictions | The solution should be capable of blocking specific files downloads and based on size and per user group basis. It should also provide option to block object using MIME File types. |
| WSA.019 | IP based Access Control | The solution should allow administrator to define access to internet based on IP addresses OR range of IP addresses subnet OR CIDR basis. It should also support to be forced for Authentication from Specific IP addresses, Subnet or CIDR's |
| WSA.020 | User based Access Control | The solution should support integration with active directory and/or LDAP. This should allow administrator to define user or group based access policies to Internet |
| WSA.021 | Multiple Authentication Server Support | The solution should support Multiple Auth Servers / Auth Failover using Multi Scheme Auth (NTLM and LDAP). It should also support authentication exemption. |
| WSA.022 | Application and Protocol | The solution should support granular application control over web eg. Facebook controls like block file upload, block posting text, enforcing bandwidth limits on application types. |

| | | |
|---|---|---|
| | Control | |
| WSA.023 | Layer 4 Traffic Monitoring | Should detect Phone Home attempts occurring from the entire Network. It should support actions to allow traffic to & from known allowed & unlisted addresses & block traffic to & from known malware addresses & should support monitoring suspected malware addresses. |
| WSA.024 | Bandwidth restrictions | The solution should support providing bandwidth limit/cap for streaming media application traffic. This should be possible at the Global level as well as at a per policy level. |
| WSA.025 | Anti Malware | The appliance should support Anti Malware/Anti-Virus engine that can scan HTTP, HTTPS and FTP traffic for web based threats, that can range from adware, browser hijackers, phishing and pharming attacks to more malicious threats such as rootkits, Trojans, worms, system monitors and Keyloggers and as defined by the organizations policy. Please mention the antimalware engine. |
| WSA.026 | Anti-Malware | AV/Anti-Malware engine scanning when a URL causes different verdicts from the scanning engine the appliance should perform the most restrictive action. |
| WSA.027 | Web Reputation | The solution should provide Web Reputation Filters that examine every request made by the browser (from the initial HTML request to all subsequent data requests) – including live data, which may be fed from different domains to assign a web based score to determine the likelihood that it contains url-based malware. |
| WSA.028 | Customizable Web Reputation | The Appliance should have customizable setting in the Web Based Reputation Services, like Allow, Scan and Block based on the scoring settings by the Administrator. |
| WSA.029 | Incoming/ Outgoing Traffic scanning | The solution should scan for Incoming and outgoing traffic. |
| WSA.030 | Outbound connection control on all ports and protocols | The solution shall provide option to scan all HTTP/HTTPS/FTP ports detecting and blocking spyware activity trying to connect to the outside Internet. |
| WSA.031 | Custom URL filtering | The solution should support creation of custom URL categories for allowing/blocking specific destinations as required by the Organisation. |
| WSA.032 | Url Filtering Options | The web Proxy should support following actions like allow, monitor, block, time-based access. Should also support displaying a warning page but allows the user to continue clicking a hypertext link in the warning page. |
| WSA.033 | Dynamic Categorization | Provision should be available to enable Real Time Dynamic categorization that shall classify in real time in case the URL the user is visiting is not already under the pre-defined or custom categories database. |
| WSA.034 | Reporting | The solution should have facility for End User to report Miscategorisation in URL |

| | | |
|---|---|---|
| | Mis-categorization | Category. |
| WSA.035 | URL check & submission | Support portal should give facility to end user to check URL category and submit new URL for categorization |
| WSA.036 | Filtering Content | Solution should support filtering adult content from web searches & websites on search engines like Google. |
| WSA.037 | Signature based application control | The solution should support signature based application control. |
| WSA.038 | End User Notification | Solution should support following end user notification functionalities. |
| WSA.039 | | The proxy should support the functionality to display a custom message to the end user to specify the reason the web request is blocked. |
| WSA.040 | | When the website is blocked due to suspected malware or URL-Filters it should allow the end user to report that the webpage has been wrongly misclassified. |
| WSA.041 | | The solution should support the functionality of redirecting all notification pages to a custom URL to display a different block page for different reasons. |
| WSA.042 | | Should support the functionality to force users to explicitly agree to the terms and conditions for browsing the World Wide Web from the organization's network to let the user know that the Organization is monitoring their web activity. |
| WSA.043 | Remote support | The remote support from principal company should be available via India Toll Free and Email. The Support Portal access should be provided for Case management, knowledgebase, new version information, tools etc. |
| WSA.044 | Secure Remote Access | The Support Engineers should be able to login to appliance using secure tunneling methods such as SSH for troubleshooting purposes |
| WSA.045 | Diagnostic Tools | The appliance should have diagnostic network utilities like telnet, trace route, nslookup and tcpdump/packet capture. |
| WSA.046 | Updates and Upgrades | The appliance should provide seamless version upgrades and updates. |
| WSA.047 | Secure Web Based management | The appliance should be manageable via HTTP or HTTPS |
| WSA.048 | CLI based management | The appliance should be manageable via command line using SSH |

| | | |
|---|---|---|
| WSA.049 | Serial Console access | For emergency, the appliance should have serial console access |
| WSA.050 | Ethernet Management | Should have provision for separate Ethernet for managing the appliance |
| WSA.051 | Web Logs | The Proxy Log should be scalable. The log formats shall include Apache, Squid and W3C. |
| WSA.052 | Retention Period | The retention period should be customizable. Options should be provided to transfer the logs to an FTP server using FTP or SCP. |
| WSA.053 | User Reports | Informative and exhaustive set of reports on User Activity and URL filtering activities (GUI to report past activity, top usage users and top malware threat) |
| WSA.054 | Bandwidth Reports | Reports on Bandwidth Consumed / Bandwidth Saved |
| WSA.055 | Detailed logging | Product to maintain detailed proxy access logs that can be searched via filters, for easy location of any desired access of the user and to see how the product dealt with it |
| WSA.056 | Blocked by reputation &malware reports | It should support reporting web requests blocked due to web reputation & blocked by malware |
| WSA.057 | Report Formats | Solution should support generating a printer-friendly formatted pdf version of any of the report pages. Should also support exporting reports as CSV files. |
| WSA.058 | Scheduling of Reports | Solution should support to schedule reports to run on a daily, weekly, or monthly basis. |
| WSA.059 | System Reports | Should support system reports to show CPU usage, RAM usage, percentage of disk space used for reporting & logging. |
| **Network Behavior Analysis** | | |
| NBA.001 | General Requirement | Perform Full Packet Capture of network traffic with zero packet loss |
| NBA.002 | | Support the retrieval of relevant packets to a cyber security incident |
| NBA.003 | | Support importing archived PCAP files for analysis |
| NBA.004 | | Support importing other structured and unstructured content for analysis |
| NBA.005 | | Index all the data in the packets to simplify navigation across data silos |
| NBA.006 | | Enable search-driven data discovery of packet metadata AND content for incident |
| NBA.007 | | Allow for retracing the activities of an entity in a chronological order |
| NBA.008 | | Perform full reconstruction of assets transferred, accessed and transmitted |
| NBA.009 | | Provide a visual representation of relationships between entities (IP, email ids, etc) |
| NBA.010 | | Highlight potentially malicious or suspicious content |
| NBA.011 | | Allow for assigning security analysts to specific security incident investigations |
| NBA.012 | | The solution should have capability to integrate with SIEM to have unified visibility |
| NBA.013 | | Solution should be sized for traffic rate of 1Gbps or higher |

| | | |
|---|---|---|
| NBA.014 | | Raw packet capture and meta data should be retained for desired duration |
| NBA.015 | | The solution must have feature for root cause analysis and while PCAP import the System is performing LIVE packet capture of the network |
| NBA.016 | | Anomaly Detection – find anomalous traffic patterns occurring in your network |
| NBA.017 | | -Provide a visual representation of relationships between entities (IP, email ids, etc) |
| NBA.018 | | -Highlight potentially malicious or suspicious content |
| NBA.019 | | 3rd Party Threat Feed integration – add live-feeds, like Snort, quickly and easily. Reputation Services provide added value and threat intelligence |
| NBA.020 | | Should be able to remediate Endpoints from the same console |
| NBA.021 | | Should have ability to filter, view timeline, or readily access Email and IM artifacts in one pane of glass |
| NBA.022 | | 3rd Party Threat Feed integration – add live-feeds, like Snort, quickly and easily. Reputation Services provide added value and threat intelligence |
| NBA.023 | | Should be able to remediate Endpoints from the same console |
| NBA.024 | | Should provide Regeneration and Playback functionality: Ability to create shadow networks. Regeneration and Playback: Point and click to instantly regenerate traffic (at configurable speeds) to a chosen NIC on a shadow network for further analysis in 3rd party systems. Without interruption of regular services |
| NBA.025 | | Should be an on-premise appliance-based solution with capability to do packet capture, storage, protocol dissection for 3000+ applications |
| NBA.026 | | Should capture all packets from network in real time and be able to classify, extract and analytics, reconstructs network activity and forensics over IPv4 and, IPv6 |
| NBA.027 | | Should be able to provide complete packet-by-packet details pertaining to one or more session of interest including voice/video replay, page reconstruction, image views, artifact & raw packet extractions |
| NBA.028 | | Should include Directly Attached Storage with minimum 300TB capacity and should be scalable to 1.5 PB |
| **Privileged Identity Management** | | |
| 1 | PIM.001 | The solution should have preventions policies applied in breach scenarios or as a way tomove from monitoring to prevention for privileged password & The solution must enables organization to closely control and monitor all applications within the environment. |
| 2 | PIM.002 | The solution should provide fined grained User Control. The proposed solution must allow controlling actions and access to resources such as target servers/network devices of all privileged accounts such as root / administrator. The solution must track the "real user" even in case of surrogates. |
| 3 | PIM.003 | The solution should provide Rights Delegation. The proposed solution must provide the ability to designate specific users as Administrators, Auditors, and Password Managers etc. with appropriate rights. The proposed solution must also provide the ability to designate specific users as Subordinate or Group Administrators, to manage users and file permissions for their group. |

| | | |
|---|---|---|
| 4 | PIM.004 | The solution should support cross platform management. The proposed solution must support management and policy distribution across various OS platform like Windows, Linux,UNIX, Windows application (Windows Service, Schedule tasks, IIS etc.) security (firewall, IPS, Proxy etc.) & network device (router & switches platforms from a central management console. It must support the deployment of the same policies across multiple servers ensuring consistency of security policies across machines in the enterprise. |
| 5 | PIM.005 | The solution should intercept and verify every request to change user identity and maintain a reliable audit trail. |
| 6 | PIM.006 | The solution must provide support for IPv6. |
| 7 | PIM.007 | The solution should provide exploit prevention techniques to shield the OS, applications and services by defining acceptable behaviours and limited false positives. |
| 8 | PIM.008 | The solution should support high availability and should not have a single point of failure |
| 9 | PIM.009 | The solution should also support multifactor authentication while logging in utilizing tokens, OTP and passphrases. |

Proposed Cyber Security Solutions should be fully compliant to MoUD guidelines (Circular reference number K- 1s016/6U2016-SC-I) and the people, process & technology deployed should be provisioned accordingly. Following are the minimum security solutions to be proposed by the bidders as part of the solution. The sizing and the capacity of the equipment should commensurate to the overall business requirement and technical solutions proposed.

**I. WAF – Web Application Firewall**

1. Solution should be deployed in HA (High Availability) mode and protect the web applications from attacks. WAF solution should filter the HTTP/S traffic based on the rules set defined. Proposed WAF should be able to address top 10 OWASP vulnerabilities.
2. Proposed solution shall prevent the following attacks (but not limited to): Brute force, Access to predictable resource locations, Unauthorized navigation, HTTP request format and limitation violations (size, unknown method, etc.) and File upload violations
3. Solution should be able to inspect web application output and respond (allow, block, mask and/or alert) based on the active policy or rules, and log actions taken.
4. Support dynamic source IP blocking and should be able to block attacks based on IP source.
5. Support automatic updates (if required) to the signature database, ensuring complete protection against the latest application threats.
6. Proposed WAF should be from different OEM than Firewalls or Load Balancers for better security

7. Should have positive security model with machine learning capabilities to detect and prevent anomaly in application traffic and unknown attacks. Machine learning should be based on true ML algorithms, and not just automation of dynamically learnt rules.
8. Should have 4-10Gig ports and storage capability of 2 TB
9. Proposed solution should have integrated Redundant power supply

**II. Anti-DDOS**

1. The Anti DDoS module is expected to constantly monitor the behavior of the application visitors and prevent common application layer attacks.
2. The proposed solution should detect and mitigate both traditional network- layer DDoS attacks and more advanced application layer attacks.
3. The proposed solution should have the capability to be configured in detect as well as protect mode.
4. The proposed solution should prevent suspicious outbound traffic for threats and blocking malicious traffic.
5. The proposed solution must support the ability to blacklist a host, domain, URL
6. The proposed solution must provide the ability to block bot-originated traffic according to system- supplied signatures
7. The Solution must have 50K SSL TPS for RSA 2K key, 35K SSL TPS for ECDSA P25 with 45 Gbps SSL Throughput
8. The DDoS solution should be a dedicated hardware with dual power supply . The appliance should have 8 X 10GE SFP+ ports.

**III. Anti -APT Threat Prevention**

1. Solution must be custom built Anti-APT Appliance and should integrate with network perimeter security component devices like firewall/UTM , and IDS/IPS. The proposed threat prevention & internet NGFW OS should not have any reported vulnerability in last 3 years.
2. The proposed solution should able to work with the existing technologies for advance threat protection through web & email protocol. For email APT solution should act as MTA for extraction of active malicious active content and provide real time threat prevention.
3. The proposed solution should support to monitor traffic from multiple segments/Devices.
4. The proposed solution should have capabilities to configure files, IP, URLs and Domains to Black list or white list.
5. The Proposed solution must provide a web service interface/API for customer to customize integration.
6. The Proposed solution should provide correlated threat data such as: IP addresses, DNS domain names, URLs, Filenames, Process names, Windows Registry entries, File hashes, Malware detections and Malware families through a portal.
7. The proposed solution must be able to provide intelligence portal for malware information, threat profile and containment remediation recommendations where applicable.
8. Anti-APT appliance shall have integrated redundant power supply and minimum of 4 GE & 2-10GE ports and 2x10GE bypass card for fail open configuration. This shall integrate with NextGen Firewall & should support SSL Inspection.
9. The APT appliance should have real world effective throughput of 30K files per day and scalable to support 80k by stacking additional appliance

10. The manufacture of the offered Anti-APT threat prevention solution shall have successfully completed 2017 NSS breach prevention (BPS) test with security effectiveness of 99% and above. Breach prevention should utilize malware identification – using signature, heuristics -, network traffic analysis, sandboxing, threat emulation & extraction, centralized management, response mechanism, robust logging & monitoring mechanism for cyber threats.

**IV. SIEM - Security Information & Event Management**

1. The SIEM solution is expected to collect logs from security and network devices, servers and application security logs.
2. The proposed solution must have an automated backup/recovery process.
3. In the proposed solution, all logs should be Authenticated (time-stamped across multiple time zones) encrypted and compressed before transmission.
4. The proposed solution should provide time based, based store and forward feature at each log collection point
5. The proposed solution should have the ability to gather information on real time threats and zero day attacks issued by anti-virus vendors or audit logs and add this information as intelligence feed in to the SIEM solution via patches or live feeds
6. The proposed solution should generate the following reports (but not restricted to): User activity reports, Configuration change reports, Incident tracking report, Attack source reports etc. In addition, the proposed solution should have a reporting writing tool for development of any ad-hoc reports.
7. The proposed solution should provide the ability to monitor and alert on non-compliance events in real-time and provide necessary reports and dashboards. Dashboard should support reporting for consolidated relevant compliance across all major standards and regulatory requirements.
8. Should provide out of the box reports for PCI-DSS, HIPAA, SOX, NERC, FISMA, ISO, GLBA, GPG13, and SANS critical controls
9. The proposed solution should have a mechanism to track security incidents across a wide range of relevant attributes (i.e. IP addresses, usernames, MAC address, log source, correlation rules, user defined, etc.).
10. The proposed solution should be possible to define purging and retention rules for log storage & should have 60TB storage.
11. The proposed solution should support creation of automated incident management workflows to track incident from creation to closure, provide reports on pending incidents.
12. Proposed solution should be provisioned for 100 collector points, 10000 EPS and shall be scalable to 20,000
13. Proposed solution should show raw packets and logs correlation on a single dashboard from same OEM along with management, administration and monitoring from single unified GUI for detecting attacks emerging from logs and raw packets data.

**V. DLP – Data Leakage Prevention**

1. DLP for Endpoints – Proposed solution should addresses the risks associated with the storage and use of confidential /sensitive data on laptops and desktops across organization. It should prevent confidential/sensitive files from downloading, copying to and from any kind of portable storage device & removable media. Proposed solution should monitor data being copied and pasted from the clipboard to prevent confidential/sensitive data from being pasted to specific application.
2. DLP for Web – Proposed solution must block or remove sensitive data from outbound web communications if they violate security policy.
3. DLP for Network – Proposed solution must passively inspect network traffic for confidential data that is being sent in violation of security policy.
4. DLP for Files shares, Databases and Document Repositories (Storage) – Proposed solution must discover stored confidential data throughout the enterprise; monitor the ownership and use of stored data; and protect sensitive data according to centrally administered policies.
5. Proposed solution is expected to be deployed in HA (High Availability) mode.
6. The Solution should not use any third party proxy Server to provide DLP functionality
7. The solution must have identity and role based policy capability.
8. The solution should be capable of segmentation of duties, automatic access control.
9. The Solution should have comprehensive auto-classification methodology.
10. The Solution should built in automated policy synthesis mechanism and ability to monitor APT

| **Server Load Balancer** | |
|---|---|
| **Sr No.** | **Minimum Technical Specification** |
| SLB.001 | The Load Balancer shall deliver the high availability required by modern data centers. It should support Active/Passive or Active / Active HA configurations. The Load Balancer shall automatically synchronize configurations between the pair and automatically failover if any fault is detected with the primary unit. The device should be multi-tenanted Network Function Appliance with support upto 16 virtual instances. Should have internal redundant Power supply with 2 TB hard disk and support other 3rd party and open source virtual network Functions like SSL VPN, web application firewall etc. |
| SLB.002 | The Load Balancer shall support offloading of SSL connections and should deliver 20 Gbps of SSL throughput on 2048 key |
| SLB.003 | To maximize outbound bandwidth, the Load Balancer shall automatically compress content to minimize network traffic between application servers and the end user. The appliance should support 5 Gbps of compression throughput. This capability shall be compatible with most modern browsers, requiring no additional software |
| SLB.004 | The server load balancer should deliver 6 Gbps of Layer 7 throughput |
| SLB.005 | The server load balancer should deliver 18 Million concurrent sessions |
| SLB.006 | The server load balancer should cater up to 20,000 SSL connections per second on 2K key |
| SLB.007 | Local Application Switching, Server load Balancing, HTTP,TCP Multiplexing, HTTP Pooling, HTTP Pipelining, Compression, Caching, TCP Optimization, Filter-based Load Balancing, Transparent Deployments, Content-based Load Balancing, Persistency, HTTP Content Modifications, Band |

| | |
|---|---|
| | Width Management(BWM), Support for connection pooling to TCP request, Support for distributed denial-of-service (DDoS) protection |
| SLB.008 | The solution should support XML-RPC for integration with 3rd party management and monitoring. Should also support SAA, SAML, Hardware binding and AAA support along with SSO. Solution must support machine authentication based on combination of HDD ID, CPU info and OS related parameters i.e. mac address to provide secure access to corporate resources. |
| **Link Load Balancer** | |
| **Sr No.** | **Minimum Technical Specification** |
| LLB.001 | The solution should aggregate WAN links from a single or multiple ISPs, and support up to 20 WAN links for inbound/outbound traffic load balancing & redundancy. WAN Links must support IPv4 or IPv6 addressing or both simultaneously. Proposed device should be multi- tenanted Network Function Appliance with support upto 16 virtual instances. Should have internal redundant Power supply with 2 TB hard disk and support other 3rd party and open source virtual network Functions like WAN Optimization, DDoS etc. |
| LLB.002 | Must support IP connectivity across all kinds of network infrastructure, including Ethernet (10Mbps/100Mbps/1 Gbps - copper or fiber) |
| LLB.003 | Should support minimum 6 Gbps of WAN links & scalable by 50% |
| LLB.004 | Should support minimum 2 Million concurrent connections & 500,000 Connections per second |
| LLB.005 | The solution should be able to provide at least 8x 10G SFP+ SR interfaces from day one |
| LLB.006 | The solution should support user-defined IP and Service Group functions for configuring firewall, bandwidth management and routing policies. |
| LLB.007 | Should support XML-RPC for integration with 3rd party management and monitoring. Should also support SAA, SAML, Hardware binding and AAA support along with SSO. Solution must support machine authentication based on combination of HDD ID, CPU info and OS related parameters i.e. mac address to provide secure access to corporate resources. |
| LLB.008 | The solution should support Multi-homing function for inbound IPv4 and/or IPv6 traffic Load Balancing and fault tolerance across up to 20 WAN links by enabling DNS relay or DNS authoritative server function. |
| LLB.009 | Should have IPV6 support with IPv6 to IP4 and IPv4 to IPv6 translation and full IPv6 support. Also should have IPV6 support with DNS 6 to DNS 4 & DNS 4 to DNS 6 translation based health check for intelligent traffic routing and failover |
| LLB.010 | The solution should support DHCP and DHCPv6 server function |
| LLB.011 | The Should provide comprehensive and reliable support for high availability with Active- active & active standby unit redundancy mode. Should support both device level and VA level High availability |
| LLB.012 | The solution should support VRRP for HA interconnection over network. |

***1.*** **Laptop Specifications:**

- Processor - Latest generation Intel Core i5 (2 Ghz) or higher OR AMD (2 Ghz)
- Processor or higher OR Equivalent 64 bit x86 processor

- Display - Minimum 14" Diagonal TFT Widescreen with minimum 1366 x 768 resolution (16:9 ratio)
- Memory - 8 GB DDR3 RAM @ must be free for future upgrade
- Hard Disk - Minimum 1TB SATA HDD @ 5400 rpm
- Wireless Connectivity - Wireless LAN - 802.11b/g/n/ Bluetooth 3.0
- Audio - Built in speakers
- Operating System - Pre-loaded Windows 8.1 (or latest) Professional 64 bit, licensed copy with certificate of authenticity (or equivalent authenticity information) and all necessary and latest patches and updates. All Utilities and driver software, bundled in CD/DVD/Pen-drive media
- Accessories - Laptop carrying Back-pack. It must be from same OEM as laptop
- Other pre-loaded software (open source/free) - Latest version of Libre-office, Latest version of Adobe Acrobat Reader, Scanning Software (as per scanner offered).
- These software shall be preloaded (at the facility of OEM or any other location) before shipment to Authority offices/locations.

***2.*** **Mini PC Specifications:**

- Platform Intel® Apollo Lake Celeron® N3350 SOC
- Memory 2 x SO-DIMM Memory, DDRR3L 4gb expandable Up to 8GB
- Expansion Slot 1 x M.2 for SSD (SATA), Storage Support 1 x eMMC 32GB/64GB
- Support 1 x 1 TB 2.5” HDD
- Audio 1 x Combo Jack, 1 x Digital Mic, LAN 2 x Gigabit LAN, USB
- 3 x USB 3.1 Gen1 Type-A Ports, 1 x USB 3.1 Gen1 Type-C Port
- Video Output 1 x HDMI Port (HDMI 1.4), 1 x mDP Port
- Wireless Intel® WiFi 802.11ac & Bluetooth 4.0
- PCB Size 115 x 111 mm, Dimension 117 x 128 x 51 mm
- VESA Supports 75mm / 100mm
- Adapter Input: AC 100-240V,Output: DC 19V / 3.42A
- OS Support - Ubuntu 16.04 LTS, Pre-loaded Windows 8.1 (or latest) Professional licensed copy with certificate of authenticity (or equivalent authenticity information) and all necessary and latest patches and updates. All Utilities and driver software, bundled in CD/DVD/Pen-drive media
- Windows 10, Accessory 1 x Power adapter
- 1 x VESA Bracket, 6 x VESA Mount Screws
- Quick Guide & Driver DVD

**3. All in One Printer Specifications**

- Print speed black: Normal: Up to 22 ppm or above
- First page out (ready)
- Black: As fast as 7.3 sec
- Duty cycle (monthly, A4)
- Up to 20,000 pages 8
- Print technology: Laser
- Print quality black (best): Up to 600 x 600 dpi
- Print Resolution Technologies: 600, 1200
- Print languages: PCLmS, URF, PWG
- Display: ICON LCD
- Processor speed: 600 MHz

**Held Desk Solution**

| **Soft Phone Specifications** | | |
|---|---|---|
| **Sr. No.** | **Item** | **Revised Specification** |
| SPSS.001 | Unified Communications Client Features | The presence shall use icons and colours and shall include at least: On-Line Telephony |
| SPSS.002 | | Presence/Status, User-Choice Presence (Busy, be right back, Away, out to lunch / meeting etc), Calendar Presence, coming from Microsoft Outlook calendar (if integrated). |
| SPSS.003 | | The solution must be able to support one-to-one and multi-party messaging |
| SPSS.004 | | It must support ability to send Multimedia (Text, voice, video and photo) messages between users |
| SPSS.005 | | Conversation persistency should be maintained so that users can view and participate in active conversations from multiple messaging applications, until they leave the conversation |
| SPSS.006 | | It must support notification events for all new messages |
| SPSS.007 | | It must support user search for current and active conversations |
| SPSS.008 | | It should support synchronization with Microsoft Active Directory 2013 |
| SPSS.009 | | It should support multiple devices like Windows Desktop, Android and IOS on iPhones and iPads. |
| SPSS.010 | | Users should be able to paste objects, files and URLs into IM message and send it to his contacts |
| SPSS.011 | | The IM messages must be time-stamped. |
| SPSS.012 | | The UC Client should be able to IM to group of Users defined by AD. |
| SPSS.013 | | The UC Client should provide Visual & Audio Tone Alerts on incoming Alerts |
| SPSS.014 | | Should provide the Presence indicator in IM buddy list and from email message |
| SPSS.015 | | Should provide Location Indicator: For Ex: Set your own locations like “Work”, “Home”, “Campus”, “Sales Office” etc. so that next time the user signs-in from that office UC Client must remember the location |
| SPSS.016 | | Should Provide Alert When Available: User should be able to Set the client to notify him/her when a contact becomes available. User should be notified the first time the user next becomes available. A message notification should be given to alert the user that the user is available. |
| SPSS.017 | | Spell Check must be available in chat |
| SPSS.018 | | Print Chat: The user should have the ability to print a conversation with a right-click from a chat window with another user or by pressing CTRL + P. the user can also highlight a portion of the text to print it. |
| SPSS.019 | | AutoSave Chat: From the Options menu, the user should be able to automatically save chats to the user computer, when the user closes a chat window. Once the chats are saved to the user computer, search the chat files or use the windows file search capability to search the chat files. The user can save peer-to-peer and group chat conversations |
| SPSS.020 | | Client Behaviour at Start Up: The client should have the capability to open in a minimized state to open in the same state that it was in when it was last closed. |

| | | |
|---|---|---|
| SPSS.021 | | Group chat: UC Client must allow users to define custom groups with support upto 600 groups. A group chat session must support up to 1000 users. |
| SPSS.022 | | Persistent chat: Persistent chat rooms should be supported to share ideas and information in a chat room and should be active even after participants leave the room. When participants come back to the room, they can scroll back to read the messages that they missed. Persistent chat room should have the capability to be password protected |
| SPSS.023 | | Remove Group Chat Participants: The person who starts a group chat should have the capability to remove group chat participants. Removed chat participants can be re-invited to the chat room at any time. |
| SPSS.024 | | Size Limit for File Transfers Administrator should be able to configure the file size limit for UC Client users when transferring files. |
| SPSS.025 | | Screen Capture: UC Client must support screen capture allows a user to capture an area of their screen into an image and then send the image as part of an IM conversation. The image is automatically shown at the far end. |
| SPSS.026 | | Screen share and Remote Desktop Sharing in Group Chat (1 : Many): Users must have the capability to share screen with up to 5 people in group chat session using the IM-Only-desktop-sharing feature. |
| SPSS.027 | | The UC Client must support three Default Presence status and should have support for multiple states. |
| SPSS.028 | | Should have the Provision to adjust presence status |
| SPSS.029 | | Presence status should be available for communication options |
| SPSS.030 | | The user profile for IM and Presence is maintained in a common enterprise directory, e.g. existing active directory |
| SPSS.031 | | IM/Presence system should be able to link with other IM systems (known as Federation) as and when required |
| SPSS.032 | | Ability to add trusted domains for people outside the company. |
| SPSS.033 | | Should provide user an option to add external contacts with telephone number only for example add home phone number. |
| SPSS.034 | | User can conduct separate IM conversations with multiple other Federated IM system users |
| SPSS.035 | Voice Integration with IP PBX | The Proposed system, apart from providing IM and presence functionality, should be able to integrate with IP PBX on SIP platform to allow click to call functionality on proposed same client. |
| SPSS.036 | | Should support basic call control with a consistent client interface on PC, web interface, and mobile device. |
| SPSS.037 | | Integration should be able to provide: Initiate Call, terminate (Hang-Up Call), Hold, Transfer, Divert if Busy |
| SPSS.038 | | Should provide mobile VoIP clients on popular smart phone platforms such as Apple iOS and Google Android. Should also provide support for Apple iPad tablets and Android based tablets. |
| SPSS.039 | | Call Conferencing Capability |
| SPSS.040 | | Should be able to Initiate a conference call involving multiple participants. |
| SPSS.041 | | Should be able to Conference with participants using computer audio for voice |

| | | |
|---|---|---|
| SPSS.042 | | Should be able to Conference with participants using IP phone for voice |
| SPSS.043 | | Should be able to Conference with participants using PBX extension for voice |
| SPSS.044 | Video Calling | Video Standard - H.264 and above Should support h.239 or BFCP for content sharing. |
| SPSS.045 | | Should have the capability of Sending and receiving of video upto 30 fps with 720 p video quality |
| SPSS.046 | | Ability to put a call on hold and resume the call from a different client associated with that user e.g. Hold the call from a PC and resume the call onto an iPad/Tablet or mobile phone. |
| SPSS.047 | | The video calling capability to be part of the same client for IM and Presence. |
| SPSS.048 | | UC clients for Desktop, iOS or Android based tablets should be able to participate in the video conferencing call. |
| SPSS.049 | | The Desktop client should support easy firewall traversal solution such that there is no need to use VPN client when the user is outside the enterprise network -- Internet. |
| SPSS.050 | | The Desktop client solution should be ready for a to scale for more than 800 users, without any hardware upgrade |
| SPSS.051 | | The user should be able to make point-to-point video calls without utilizing the MCU. |
| SPSS.052 | | The video conferencing capability to be part of the same client for IM and Presence. |
| SPSS.053 | | Ability to put a call on hold and resume the call from a different client associated with that user e.g. Hold the call from a PC and resume the call onto an iPad/Tablet or mobile phone. |
| **Integrated HD Video Conferencing unit with built in HD display, Audio System and Microphone** | | |
| **Sr. No.** | Item | **Revised Specification** |
| VCU.001 | Set Delivered Complete With: | The system should be an integrated system with Codec, Dual HD 1080p camera with 12x total zoom or higher, Mic , touch screen/ panel, cables and power supply, single 70" or higher LCD/LED and a floor mount kit." |
| VCU.002 | | The 70" screen, codec, cameras, microphones, floor mounted kit should be from same OEM with a single OEM part code.The system should not be a locally fabricated unit. |
| VCU.003 | | The system should be capable giving HD 1080p @60fps. |
| VCU.004 | | The system should deliver 1080p@60fps in motion/ sharpness video mode day one. |
| VCU.005 | Bandwidth | H.323, SIP at least 4 Mbps point-to-point |
| VCU.006 | Firewall Traversal | H.460.18, H.460.19 Firewall Traversal |
| VCU.007 | Video Standards | H.263, H.264, H.265/H.264 High Profile |
| VCU.008 | Video Features | Native 16:9 Widescreen |
| VCU.009 | | Advanced Screen Layouts so as to view the presentation and presenter in different quadrants and sizes. |
| VCU.010 | | Local Auto Layout |
| VCU.011 | Video | Must have a total of at least 2 FHD inputs |

| | | |
|---|---|---|
| VCU.012 | Inputs | The system should have required Video Inputs to connect 2 x HD Camera (1080P) (either directly or through Speaker Tracking array) and 2 PC Inputs (One HDMI and/or one DVI/VGA) for presentation sharing. |
| VCU.013 | Video Outputs | The system should have an integrated LED/LCD/Plasma screen which is at least 70 inches or higher. |
| VCU.014 | | Additionally, the unit must have at least one HDMI/DVI outputs to connect additional displays. |
| VCU.015 | Live Video Resolutions (Encode/Decode) | The system should supports Video resolutions from CIF, QCIF, 4CIF, 448p/576p/w448p/w576p/HD 720p@30fps, 720p@60fps , 1080p@30fps and HD 1080p@60fps. The PC resolution should be WXGA or 720p. |
| VCU.016 | Audio Standards | G .711, G.722, G.722.1, 20KHz or better |
| VCU.017 | Audio Features | CD-Quality audio |
| VCU.018 | | acoustic echo canceller |
| VCU.019 | | Automatic Gain Control (AGC) |
| VCU.020 | | Automatic Noise Reduction |
| VCU.021 | | Active lip synchronization |
| VCU.022 | Audio Inputs | should support at least 4 microphones. |
| VCU.023 | | The system should have one additional Audio line-in Input to connect PC audio and line in audio |
| VCU.024 | Audio Outputs | Built-in audio speaker for the far end audio. No external audio system is acceptable. |
| VCU.025 | Dual Stream | The system should have the capability to support H.239 in H.323 and BFCP for SIP Mode |
| VCU.026 | | The system should support 1080p30 resolution during H.239 call |
| VCU.027 | | The system must have the ability to pair with laptop for sending content without any wires to the VC system. |
| VCU.028 | | In case the above feature is not available natively, then additional components can be provided to achieve this. |
| VCU.029 | Protocols | The system should have H.323 and SIP capability |
| VCU.030 | Embedded Encryption | The system should support AES Encryption. H.239 capability should be supported in an encrypted call. AES encryption is required for complete secure call between locations |
| VCU.031 | IP Network Features | The system should have features such as QoS, RSVP, standards based packet loss based downspeeding, TCP/IP, DHCP , Auto gatekeeper discovery, Dynamic playout and lip-sync buffering, H.245 DTMF tones in H.323, Date and Time support via NTP |
| VCU.032 | | Packet Loss based Downspeeding |
| VCU.033 | | URI Dialling |
| VCU.034 | | Must support IPv4 and IPv6 from day one. |
| VCU.035 | Security Features | The administration of the Video endpoint should be through Web Interface using HTTPS/HTTP |

| | | |
|---|---|---|
| VCU.036 | Network Interfaces | 2 x LAN/Ethernet (RJ-45) 10/100/1000 Mbit |
| VCU.037 | Camera (1080P) | 1/3" CMOS Camera, 12x Total zoom, +15°/-15° tilt, +/- 90° pan, 1920 x 1080 pixels, minimum 65 deg horizontal field of view |
| VCU.038 | | Dual cameras must provide the ability of automatically tracking the speaker in a meeting room and zooming onto that person. External disturbances and noise such as mobile phone ringing should not cause the camera to move. |
| VCU.039 | | The camera tracking mode must be such that in the event the far end is talking, the cameras must automatically zoom out to capture the entire room. |
| VCU.040 | Adhoc Multipoint Capability | Must have built-in Multiconference capability to connect at least 1+4 sites at 720p in a continuous presence mode |
| VCU.041 | | It should be possible to view the presentation in a separate quadrant as well as each of the far end sites in individual quadrants. The far end sites must not appear in only one quadrant together. |
| VCU.042 | System Management | Total management via embedded SNMP, Telnet, SSH/XML/ SOAP |
| VCU.043 | | Remote software upload: via web server, SCP, HTTP, HTTPS, Remote control and on-screen menu system |
| VCU.044 | Directory Services | Remote software upload: via web server/SCP/ HTTP/HTTPS, Remote control and on-screen menu system |
| VCU.045 | Cables and Connectors | The video endpoint should be accompanied with all the required cables. |
| VCU.046 | User Interface | In order to provide a good user experience, the unit must be equipped with an intuitive Touch Screen/Panel for controlling the VC unit. |
| VCU.047 | | Must have ability to browse the directory, search a contact, Enable / disable speaker tracking, change layouts, mute/ unmute, increase-decrease volume. |
| **Three Screen Telepresence System** | | |
| **Sr. No.** | Item | **Revised Specification** |
| TST.001 | | The proposed TP solution should be high definition 1080p@30 fps video. |
| TST.002 | | The proposed TP solution should support high definition 1080p@30 fps content. |
| TST.003 | | The Telepresence system should accommodate minimum 9 participants, with life-size images, around a virtual table, to support an interactive and collaborative, virtual face to face immersive meeting over the network. |
| TST.004 | | Minimum of three High Definition Cameras (1080 P) to cover all the 9 participants in each location. Cameras should be able to provide segmented view of the rooms. The room at each location should be divided into atleast 3 segments. Each segment should be covered by atleast one HD camera. |
| TST.005 | | The Telepresence camera should be 1080p60 cameras or better with min. 50 lux illumination |
| TST.006 | | The video conferencing will have business quality transmission. The business quality transmission is defined as 1080p high-definition video resolution at 30 frames per second and 20 kHz or more wide-band spatial audio. |

| | | |
|---|---|---|
| TST.007 | | Minimum Three Plasma/ LCD screens, each of atleast 65 inches or more at each location supporting atleast HD 1080P@30fps. The screens should be able to display life size images of the participants. At any given instance the screens should be able to display Life like image of at least 6 participants. |
| TST.008 | | Solution should support following video standards H.264 and H.265/H.264 High Profile. |
| TST.009 | | Video frame rate should be minimum 30 frames and 60 fps is desirable |
| TST.010 | | Should support voice-activated switching of either site-by-site or by individual segment with integrated elimination feature to avoid changes due to stray noises. Additionally, it should also be possible to view continuous presence of sites connected to the conference with the help of continuous presence layouts supported by MCU. |
| TST.011 | | Should support voice-activated switching of either site-by-site or by individual segment with integrated elimination feature to avoid changes due to stray noises. |
| TST.012 | | Support audio-only participant by integrating audio conferencing bridge into point to-point and multipoint calls |
| TST.013 | | The user must have the ability to view the presentation on any of the three screens simply by dragging and dropping the required content via a touch interface . Additionally, the Teleprsence unit must have the ability to view the presentation on a dedicated screen of 55" inch. |
| TST.014 | | The user must have the ability to view the presentation on any of the three screens simply by dragging and dropping the required content via a touch interface . Additionally, the Teleprsence unit must have the ability to view the presentation on a dedicated screen. |
| TST.015 | | The solution must comply with standard based video formats like HD 720p and HD 1080p. |
| TST.016 | | The telepresence should be operated using the touch panel for call initiation, disconnection, presentation sharing, volument control etc. |
| TST.017 | | The TP unit should allow the ability to connect a presentation source via a laptop or PC. |
| TST.018 | | The system must also have the ability to share presentation without any wires. A laptop on the network must be able to share a presentation if it is in the same room by using an application on the laptop. This feature can be available as a built-in feature or using any third party component. However bidder has to take full responsibility of the entire set up. |
| TST.019 | | It should be possible to share a 'WhiteBoard' as a presentation source during a meeting. This whiteboard can be wall mounted. This feature can be built-in or can be achieved using additional cameras such as document camera etc or additional third party components. However, bidder has to take full responsibility of the entire set up. |
| TST.020 | | The system must also have the ability to view the presentation on any of the 3 large 65 inch (or higher) LED screen or on a dedicated 55" inch screen. In case this feature is not available as part of the OEM offering, additional hardware and software components can be added. However bidder has to take full responsibility of the |

| | | |
|---|---|---|
| | | entire set up. |
| TST.021 | | Solution should use standards TIP control signaling protocol as well as H.323 and SIP to allow for flexibility for interoperability. The solution must comply with standard based video formats like HD 720p and HD 1080p. |
| TST.022 | | The bidder should provide all the relevant software and hardware to achieve above mentioned conferencing requirement. |
| TST.023 | | The proposed system should able to integrate with HD document camera for sharing document during the Telepresence call. |
| TST.024 | | The proposed solution should be IPV6 enabled |
| TST.025 | | The system is required to ensure End to End AES 128 bit encryption for Telepresence calls. |
| TST.026 | | Telepresence system components including 65 inch display screens & 55" content screen, speakers, cables & accessories should be single OEM sourced. For moveable accessories like Table, Chair and collaboration screens like document camera, Vendors may quote third party sourced equipment. Bidders are required to provide supporting documentation from OEM website for the same. Customised solution such as HD video conferencing based boardroom solutions will not be accepted as telepresence system. |
| **IP PBX Specifications** | | |
| **Sr. No.** | Item | **Revised Specification** |
| IPBX.001 | General Specifications | A comprehensive IP based solutions based on a Server Gateway Architecture. |
| IPBX.002 | | Support for integrated telephony solution for Video conferencing through Video Phones, Analog & IP Phones, PSTN gateways over IP architecture. |
| IPBX.003 | | The solution should offer users the ability to use their UC clients and IP Phones outside of the enterprise (Internet) to make audio and video calls along with IM/Presence with or without VPN. |
| IPBX.004 | | The solution should allow for business to business (B2B) video calls using SIP, H.323 with other organizations without bypassing existing firewalls. |
| IPBX.005 | | The solution should allow provisioning of gateways with redundant power supplies. |
| IPBX.006 | System Architecture | The call control system should be fully redundant solution with NO single point of failures & should provide 1:1 redundancy. Both the server should do call processing all the time and act as backup in case of the failure of one server. |
| IPBX.007 | | The call control should support clustering over WAN |
| IPBX.008 | | The proposed system should be Integratable with ACD, IVR. |
| IPBX.009 | | The call control system should support IPv4 and IPv6 from day one. |
| IPBX.010 | | The system should natively support tenant partitioning so as to comply with TRAI regulations for not allowing VoIP (CUG calls) and PSTN calls to be bridged. Any third party applications to manage tenant partioning should not be quoted in the architecture. |
| IPBX.011 | | The proposed call control server should provide support for standards based SIP IP Phones (Wired & Wireless), Analog Phones, Video Phones and soft clients to provide centralized management and unified dial plan. |

| | | |
|---|---|---|
| IPBX.012 | | Conference Bridge—provides software conference bridge resources that can be used by IP EPABX. |
| IPBX.013 | | The system should support an inbuilt reporting tool for calls. Reports that are provided include Calls on a user basis, Calls through gateways, Simplified Call Quality. |
| IPBX.014 | | Should support signaling standards/Protocols – SIP, MGCP, H.323, Q.Sig. |
| IPBX.015 | | CODEC support - G.711, G.729, G.729ab, g.722 |
| IPBX.016 | | The system should provide the ability to perform tasks in bulk i.e. Add, Remove, Update users, phones, gateways, dial plan etc. |
| IPBX.017 | | The system should support creation of users and their authentication locally and via an integration with LDAP. |
| IPBX.018 | | The system should support an inbuilt reporting tool for calls. Reports that are provided include Calls on a user basis, Calls through gateways, Simplified Call Quality. |
| IPBX.019 | | The system should support call admission control to configure number of calls that can be active between locations – intercluster and intracluster. |
| IPBX.020 | | Call preservation – redundancy and automated failure – on call-processing failure. In progress PSTN calls at each of the locations should not be interrupted in the event of any WAN failure or call control server failure. |
| IPBX.021 | | Open API should be provided when required which will help to develop customized IP applications which will integrate with call processing. |
| IPBX.022 | | It is required to provide Survivable Call Control functionality so that the survivable system at the remote location i.e. Media Gateway shall provide fall back call control service in case the remote site looses all connectivity to the main Call Control system placed. It is expected that the survivability call control system will provide a minimal set of essential telephony features to the end-users that could be a subset of the feature that are available from the main call control system. |
| IPBX.023 | Security | All the appliances in the call control system should have dual redundant and hot swappable power supply (internal or external) and fans for high availability. |
| IPBX.024 | | All appliances in the call control system should have hot swappable storage media to ensure high availability. |
| IPBX.025 | | Support for configuration database (contains system and device configuration information, including dial plan) |
| IPBX.026 | | Having inbuilt administration web based administration. No additional thick client for administration on the Admin PC. Should also support HTTPS for management. |
| IPBX.027 | | Access to the system should be secure for the purpose of access over IP network. The protection of signaling connection over IP by means of authentication, Integrity and encryption should be carried out using TLS. |
| IPBX.028 | | There should be provision of defining password aging, one time passwords. Provision shall be available to bar unauthorized user to connect to the system. The system should monitor and report the following types of security \ violation login Violations, authorization code violation Station security code violations etc. |
| IPBX.029 | | IP Phones should not support direct, external initiated, connections via HTTP, telnet, FTP, TFTP or any other protocol as means to prevent distributed Denial of Service attack exploitation, except those required for routine firmware upgrades. |

| | | |
|---|---|---|
| IPBX.030 | | Role Based Account Management to define different levels of administrator access depending on specific function responsibility |
| IPBX.031 | | The system should support complete encryption capabilities with the ability to encrypt all traffic (media and call control signaling) between IP phones, softphones, call controllers, gateways and all other associated endpoints using a strong Hardware based encryption as and when required in future. |
| IPBX.032 | | All management traffic between the remote console/session and control server should be encrypted (SSH for Direct Command Line Sessions, Interface, HTTPS (SSL) for Web Sessions, SFTP for File Transfer Etc.). |
| IPBX.033 | | Should support SSL for LDAP directory integration. |
| IPBX.034 | | All Hardware & Software with license required for providing above Security measures must be incorporated. |
| IPBX.035 | System Capabilities Summary | The architecture should support a minimum of 12500 IP phones and video phones in hybrid mode per call server |
| IPBX.036 | | The architecture should support cluster architecture to provide scalability to offer support for 100,000 IP devices and also to provide redundancy. All the users to be managed in a single database which is managed centrally, no multiple databases. |
| IPBX.037 | | The System should support Alternate Call Routing |
| IPBX.038 | | System backups: The management system should have the provisioning for taking manual as well as scheduling of automatic periodic backup of complete system & data. |
| IPBX.039 | | Should support SNMP v2, v4 |
| IPBX.040 | IM & Presence | Solution should provide a "presence" application for users, so that they can see the availability status of their contacts in their contact list. |
| IPBX.041 | | The common supported status for this application should be available, busy, idle, away etc. |
| IPBX.042 | | Should support the users to see other user's IP phone's on/off hook states |
| IPBX.043 | | Shall provide support for open protocols like XMPP. |
| IPBX.044 | | Presence based desktop application shall allow escalation of Instant Message to Audio call and further to Video call |
| IPBX.045 | | Should support management of contact list and personal settings from Presence based desktop application |
| IPBX.046 | | Should support click to call, click to Video and click to conference features. |
| IPBX.047 | | The Soft Client should have soft phone capability and should support desktop and iPad based point to point video calls. |
| IPBX.048 | Video Telephony Support | The users should be able to transfer video calls as audio calls |
| IPBX.049 | | Call-Server should provide a common control agent for signaling, configuration, and serviceability for voice or video end points. |
| IPBX.050 | End user Features required | Extension mobility |
| IPBX.051 | | Call forward all |
| IPBX.052 | | Do not disturb |
| IPBX.053 | | Hunt groups |
| IPBX.054 | | Dial-plan partitioning |
| IPBX.055 | | Distributed call processing |

| | | |
|---|---|---|
| IPBX.056 | | Deployment of devices and applications across an IP network |
| IPBX.057 | | "Clusters" of Call-Servers for scalability, redundancy, and load balancing |
| IPBX.058 | | Forced authorization codes and client matter codes (account codes) |
| IPBX.059 | | H.323 interface to selected devices |
| IPBX.060 | | Hotline and private line automated ringdown (PLAR) |
| IPBX.061 | | Interface to H.323 gatekeeper for scalability, CAC, and redundancy |
| IPBX.062 | | Multi-Level Precedence and Preemption (MLPP) |
| IPBX.063 | | Multilocation—dial-plan partition |
| IPBX.064 | | Multiple ISDN protocol support |
| IPBX.065 | | Prepackaged alerts, monitor views, and historical reports with Real Time Monitor Tool (RTMT). |
| IPBX.066 | | Trace setting and collection utility |
| IPBX.067 | | Cluster wide trace setting tool. |
| IPBX.068 | | Single System to support CAC |
| IPBX.069 | | Q.SIG (International Organization for Standardization [ISO]) |
| IPBX.070 | | User should have same extension no for Audio as well as Video call. Video Phone should offer both Audio as well as Video calling functionality and call initializing process should be same |
| IPBX.071 | | Call-Server should support new video end points. |
| IPBX.072 | | SIP Video endpoints which should inherit the functionality of audio calls which gives the user the same call model for both video and audio calls. |
| IPBX.073 | | Call-Server should provide a common control agent for signaling, configuration, and serviceability for voice or video end points. |
| | | |
| **High Definition Multipoint Control Unit (MCU) Specifications** | | |
| **Sr. No.** | Item | **Revised Specification** |
| MCU.001 | General | All necessary hardware to support the required capacity needs to be supplied from day one . The server supplied for the MCU must have a redundant power supply from day1 and should not require mutliple servers, cascading. All the ports should be supported on single hardware of MCU with no virtualization. |
| MCU.002 | | The MCU must have 90 HD ports @720p 30 fps with H.264 AVC and Continuous presence from day1. |
| MCU.003 | | All the 90 ports must be able to connect different sites at different bandwidths and protocols. H.264 AVC & H.264 High Profile standard must be supported at the minimum to connect all the 90 sites. |
| MCU.004 | | The MCU must be able to host at least 4 simultaneous conferences each having different capacities restricted by the maximum port capacity of the MCU |
| MCU.005 | | The MCU must also support Full HD mode and it must provide a capacity of connecting at least 40 sites @1080p30 fps |
| MCU.006 | | MCU should be capable of supporting participants using various means i.e. via video enabled phones, room based video endpoints, soft clients on mobile/tablet or via the compatible browsers in a single conference. The meeting quality has to be consistent and of high quality. The end points can be present on the WAN network or on the internet. In case additional components are required for this functionality, |

| | | |
|---|---|---|
| | | all additional components required to have this functionality has to be included in the solution |
| MCU.007 | | The MCU should have the capability to host meetings with internal and external participants in a secure way such that it should co-exist with the enterprise security policies |
| MCU.008 | | The MCU and the complete solution should support H323 and SIP protocols. |
| MCU.009 | | The MCU should support geographical redundancy, so that MCU could be placed in DC/DR setup in case future expansion is needed. |
| MCU.010 | | The MCU must support the concept of virtual meeting rooms to users who Hosts meeting frequently. Such meeting rooms should support dialing in from standard based video end points, internal and external users and browser based clients. The system should allow one Virtual meeting room per employee, however it should not consume resources when not in use. |
| MCU.011 | | The MCU should be able to maintain the capability to connect endpoints at 1080p, 720p and SD participants simultaneously without having to reboot or change any configuration. |
| MCU.012 | | The MCU should support 90 ports or more at HD 720p (transmit and receive) up to 4Mbps on IP in continuous presence mode with 30fps, H.264 resolution and AES encryption on the same MCU. |
| MCU.013 | | The MCU should display a security icon on the endpoint if the conference is secure. |
| MCU.014 | | The administrator should be able to specify maximum resolution for main video content. |
| MCU.015 | | Video conferencing endpoints deployed at other organization must be able to take part in video conferencing. The endpoints can be of various makes such as Polycom, Cisco, LifeSize etc using open standards. |
| MCU.016 | | Interoperability with all organization must be possible using standards based dialing methodology using the Internet. |
| MCU.017 | | The MCU should support on-screen text messaging on video endpoints, so that if there's a delay in starting a meeting, participants can be informed. |
| MCU.018 | | The solution should be able to integrated with existing IP PBX to provide audio conferencing ports to phones. |
| MCU.019 | | The MCU should be able to integrate with Call Control system using SIP. |
| MCU.020 | Video Standards | Should support H.263/H.263+/H.263++, H.264 AVC, H.264 SVC/H.264 High Profile video algorithms |
| MCU.021 | Video Resolution | Should support video resolution from SD to Full HD to join into a conference |
| MCU.022 | | The proposed MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints. The MCU shall interoperate with multiple vendors' endpoints. The supported mediums should be IPv4 and IPv6. |
| MCU.023 | Audio Standards | Along with the support for basic algorithms like G.711 and G.722.1 the MCU should also support wideband Audio protocols like MPEG 4 AAC - LC/MPEG 4 AAC - LD |
| MCU.024 | Transcodi | The MCU should support transcoding of different Audio/video Protocols. |

| | | |
|---|---|---|
| MCU.025 | ng & Rate Matching | MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints. |
| MCU.026 | Dual Video | The MCU should have H.239/BFCP protocol for sending and receiving dual video streams (Presenter + Presentation). |
| MCU.027 | Video Layouts | At least 16 sites to be seen simultaneously on the screen in traditional Continuous Presence mode. |
| MCU.028 | | The MCU must also support advanced continuous presence such that the site that is "on-air" to be seen on a larger window and the other sites are seen in smaller quadrants. |
| MCU.029 | Security | The MCU must be a secure Non-PC Hardware with a strong operating system. The Hardware and software must be from the same OEM. |
| MCU.030 | | The MCU should support 128 Bit strong AES encryption for calls and H.235 for authentication |
| MCU.031 | | The MCU must support encryption for calls on SIP. |
| MCU.032 | Network /USB Interface | At least 1 LAN /Ethernet--10/100/1000 Mbps full duplex and dedicated serial/USB connection for maintenance/upgrade. |
| MCU.033 | Conferenc e Layout | MCU Solution should support minimum of 10 layouts |
| MCU.034 | Firewall Traversal | Should support firewall traversal solution for Business to Business (B2B) Video Calling. |
| **IP Phones** | | |
| **Sr. No.** | Item | **Revised Specification** |
| IP.001 | | The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option |
| IP.002 | | Should feature a LCD display of at least 2.4" for information such as calling party name, calling party number, and digits dialled to be displayed. |
| IP.003 | | The phone should have two ethernet ports of at least 10/100 BASE-T Ethernet ports, one for the LAN connection and the other for connecting to PC/laptop. |
| IP.004 | | Corporate directory and Lightweight Directory Access Protocol (LDAP) integration. |
| IP.005 | | Ready access to missed, received or placed calls (plus intercom history and directories). |
| IP.006 | | The phone should support QoS mechanism through 802.1p/q. |
| IP.007 | | IP address Assignment by DHCP or statically configured |
| IP.008 | | Hands-free operation with full-duplex speaker-phone |
| IP.009 | | The phone should be a SIP based Phone i.e session Initiation protocol (SIP) supported |
| IP.010 | | Should have a distinct LED indicator for message waiting. |
| IP.011 | | Keys for specific functionalities such as – voicemail, directories, settings, transfer, speakerphone, mute on/off, headset etc |
| IP.012 | | Media Encryption (SRTP) using AES |
| IP.013 | | Signalling Encryption (TLS) using AES |
| IP.014 | | Should support 802.1x |
| IP.015 | | Encryption of Configuration Files |

| | | |
|---|---|---|
| IP.016 | | The phone should have the ability to register to call control server over an internet link with or without VPN. |
| IP.017 | | The phone should support IPv4 and IPv6 from day1. |
| IP.018 | | Phone should support atleast 10 entries of Call history and more enteries of corporate directory |
| IP.019 | | It should support the following codecs: G.711a/μ-law, G.722,G.729ab |
| IP.020 | | The phone should have RJ9 headset port to connect any standards based headset. The phone should also have a separate headset key |
| IP.021 | | The phone also includes the following settings - Display contrast, Ring type, Network configuration, Call status |
| IP.022 | | The Phone should support the ability to provide different ringtones for internal and external calls. |
| IP.023 | | Should have volume control button for easy volume adjustments for the speakerphone, handset and ringer. |
| IP.024 | | The phone should support mounting against a wall |
| IP.025 | | The phone should support 3 Line display with 6 programmable lines keys. |
| IP.026 | | The phone should the following features: |
| IP.027 | | i. Call forward |
| IP.028 | | ii. Call pickup |
| IP.029 | | iii. Call waiting |
| IP.030 | | iv. Extension Mobility |
| IP.031 | | v. Auto answer |
| IP.032 | | vi. Message waiting indicator |
| IP.033 | | vii. Music on hold |
| IP.034 | | viii. Forced Authorization Code (Account Code/FAC) |
| IP.035 | | ix. Conference |
| IP.036 | | x. Music on Hold (MoH) |
| IP.037 | | LDAP and AD integration should be supported by System and NMS to which Phones are registered. |
| IP.038 | | xii. Auto-detection of headset |
| IP.039 | | xiii. Busy Lamp Field (BLF) |
| IP.040 | | xiv. Callback |
| IP.041 | | xv. Immediate Divert |

### 7.8. Integrated Centralized Command and Control Centre (CCC)

Integrated Building Management System (iBMS)

| Sr. No. | Specifications |
|---|---|

| | |
|---|---|
| IBMS.001 | **Solution for iBMS:** Solution should provide a pre-integrated, centralized and consolidated platform for end to end management of a building, which includes Facility infrastructure (HVACs, LT Panel-AMF, DG, UPS, Fuel Tank, CCTV, Fire Alarm and suppression system). System should have the service dependency engine that allows to take intelligent decisions, as per the business needs/requirements. The tool should have the service oriented architecture layer and the mediation layer in a single plane. iBMS should be open for third party integration via (soap, xml, web service, snmp-v1, v2,v3). NO/NC ports (IO ports) and Modbus (TCP/IP&RTU) integration should be standard. For other industrial protocols, gateway integration should be available. Solution should perform the following general functions. Should be scalable with ready device certifications to accommodate new infrastructure getting added to the building |
| IBMS.002 | **Visibility –** It should get a single platform to manage the entire building and its components. The way ahead should be drilling down to the component, which is under performing / about to fail or has failed. The impact of the failed equipment on others should get highlighted. We should get a Hawkeye view to know, how are all the building components working at any point of time. So that issues are addressed as quickly as possible. |
| IBMS.003 | **Capacity Planning -** End equipment's in the building, should be set with thresholds to get an idea of how well they are rendering services to the people in the building. It should be able to proactively Identify potential area's which may need to be upgraded/downgraded (cooling, power, storage, etc.) with time. All MSI (end equipment vendors) SLA's and their respective maintenance contracts would be part of the OMS (operations and maintenance) plan. |
| IBMS.004 | **Third Party Integration -** Seamless Data Sharing to build a "Collaborative Decision Making System". |
| IBMS.005 | **Salient Dependencies -** Monitor & Control salient interdependencies between safety and security systems like: In case of fire, other than a fire alarm, we could get confirmatory information from the zonal camera. Multiple current surges in any particular zone should lead to an inspection of the electrical cables in the zone. Any sectional power failure, should help us to find the failure of the end equipment, by tracing down the LT panel SLD to the end equipment. |
| IBMS.006 | **System with CMDB -** Integrate people, process & technology. Decreasing the likelihood of downtime in the building by facilitating communication across all equipment's (part of the facility). A definite inventory management tool with a workflow system connecting responsible people, should be part of the solution. |
| IBMS.007 | **Root-Cause Analysis -** Isolate and pinpoint problem area before it impacts the building operations & business continuity while suppressing down the unwanted events. |
| IBMS.008 | Energy sources should always keep in check on the rated power consumption vs the power available for consumption. Since one of the big reasons for fire is higher load than the power distribution capability. |
| IBMS.009 | System should be capable enough to store the raw data or as polled data, for at-least for 365 days. It should also have the facility to automate the backup process or allow to take manual backup, in case if it is required. |
| IBMS.010 | System should be capable of getting supported by the administrators at different levels. The system should provide individual and group rights and privileges. Normal users may have read access only, that too only to specific areas. |
| IBMS.011 | Support for email and SMS both (integration with SMS-gateway & GSM communication). |

| | |
|---|---|
| IBMS.012 | **Energy Management**<br>System should be capable of integrating with the mains (LT panel), DG, UPS, PDU, rectifier, energy meters for continuous monitoring of its health. The battery health of the UPS would also be needed.<br>System should be able to do continuously monitor the quality of power, supplied to the electricity board and by the Generators (PF, frequency, harmonics distortion etc.), to avoid downtime.<br>System should have the feature to setup thresholds on each of the monitored energy parameter.<br>System should be able to clearly provide load trend for each rack, if need be in the building which would enable setup practical thresholds to get alerted on overload situations, to avoid any breakdown. |
| IBMS.013 | **Fire Alarm System Monitoring and Management**<br>Should proactively alert in case of electrical fire (short circuit or over current)<br>System should have the capability to integrate with different makes of fire alarm systems in the DCs and provide alarms generated by system on Central Dashboard.<br>System should be able to plan and process a proper evacuation plan in case of fire<br>Trigger Audio and Visual alarm<br>Co-relate with the nearest camera in the site with the zone of the FAS.<br>Switching ON of lights on the evacuation pathway. |
| IBMS.014 | **Centralized Reporting & Dashboard**<br>Dashboard and reporting engine should provide centralized view for the entire infrastructure (physical security, safety & energy) in the building.<br>It should provide business users with highly interactive and power-users with highly sophisticated, pixel-perfect reports.<br>It should provide Web-based interactive reporting for business users, Rich graphical report designer for power users, Parameterized reports with powerful charting, Output in popular formats: HTML, CSV, PDF.<br>It should provide Analysis to explore data by multiple dimensions such as customer, product, network and time into the hands of business users.<br>It should provide Intuitive & rich graphic designer to create customized reports, such as: DC-PUE (enables to measure how much energy is getting consumed in IT and how much in DC infrastructure).<br>Solution should provide a comprehensive centralized dashboard for health monitoring of DC (Infrastructure) components like: Electrical Panels, PAC, UPS, DG, Fuel etc.) |

| | |
|---|---|
| IBMS.015 | **DG Monitoring**<br>Proposed system should be able to integrate with diesel generators for measuring fuel level and run hours of the DG. System should also allow monitoring of various alarms (like: LLOP, dg on, etc.) including quality of power of the DG.<br>System should be capable to do fuel level monitoring of diesel tanks installed for gensets in the DC/DR building, to have a proactive estimation of fuel availability.<br>Parameters - Generator and Fuel Supply Automation<br>▪ Mains Fail<br>▪ DG On<br>▪ DG Failed to start / DG Failed to stop<br>▪ DG Fuel Level Low<br>▪ High Water Temperature / High Coolant Temperature<br>▪ Low Battery Voltage<br>▪ Low Lube Oil Pressure(LLOP)<br>▪ Automate Fuel Supply Process to reduce fuel consumption cost. |

| Integrated Operation Platform | | |
|---|---|---|
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| IOP.001 | General Requirements | IOP shall be open architecture based, highly scalable and able to integrate multiple disparate systems seamlessly on a common platform |
| IOP.002 | General Requirements | IOP system shall provide a real time Common Operating Picture (COP) of the area involving all agencies using a simple GUI |
| IOP.003 | General Requirements | Some of incidents that IOP responds to include but are not limited to the following:<br>· Hazards / Calamities: Natural, Man-made, Environmental<br>· Epidemics (Health)<br>· Transportation (Road, Rail etc)<br>· Public Utility (Water, Electricity, Street Lighting, Solid Waste Management)<br>· Public Safety (Crime, Law & Order) |
| IOP.004 | General Requirements | System shall integrate with various emergency response services such as Ambulance, Fire, Disaster Management Systems, etc., |
| IOP.005 | General Requirements | System shall integrate with various social media applications such as Facebook, Twitter etc., and provide intelligent dashboard functions as required |
| IOP.006 | General Requirements | System shall support various sensors like Cameras, GPS, Voice devices (Analog & Digital), Storage devices, Sensor inputs from other applications/ systems |
| IOP.007 | General Requirements | System should provide tool to define/create any event/rule based Standard Operating Procedure (SoP) for decision making by optimizing the time to resolution for emergency and crisis situations |
| IOP.008 | General Requirements | IOP platform shall provide a dashboard functionality to manage workflows by integrating information from different agencies and systems to facilitate responsive decision making |
| IOP.009 | General Requirements | IOP platform should provide a cross-agency collaboration tool to support instant communication between various user groups and authorities via sms and email |
| IOP.010 | General Requirements | IOP platform should facilitate training mechanism |
| IOP.011 | Location Requirements | Platform shall have a GIS based map to provide the location detail |
| IOP.012 | Location Requirements | Multiple layer maps to be supported as required for various applications |
| IOP.013 | Location Requirements | GIS maps to comply OGC standards |
| IOP.014 | Location Requirements | Maps to support Drag & Drop functionality of various sensors at any given point of time |
| IOP.015 | Location Requirements | Map functionality to provide search options on basis of events, sensors, time etc., |

| | | |
|---|---|---|
| IOP.016 | Location Requirements | GIS to support addition/removal of sensors/ systems on need based |
| IOP.017 | Location Requirements | Map to support event based response actions for decision making in case of any emergency / critical situation |
| IOP.018 | Location Requirements | GIS based application to support Role based authentication for effective management of the system |
| IOP.019 | Realtime Requirements | CCTV feeds to be viewed on the Map in case of any event triggers |
| IOP.020 | Realtime Requirements | System to provide instant threat/event management based on the triggers generated |
| IOP.021 | Realtime Requirements | System shall provide view and availability of various systems/ sensors on the map at any given time |
| IOP.022 | Realtime Requirements | System shall facilitate communication between various agencies and personnel to address the situations |
| IOP.023 | Realtime Requirements | System shall support tracking of real time devices integrated |
| IOP.024 | Realtime Requirements | System shall trigger alerts for any of the sensors/ applications |
| IOP.025 | Incident Response | System shall facilitate setting the priority of the event and enable triggering the incidents automatically |
| IOP.026 | Incident Response | System shall allow setting up multiple triggering rules per incident type |
| IOP.027 | Incident Response | System shall enable associating response procedures to incident types. The associated procedures should be available for selection to operators upon manual incident creation. |
| IOP.028 | Post Incident Requirement | Shall have a recording mechanism that includes all the activities such as voice, telephony, Location, triggers etc., including the operator activities for analysis |
| IOP.029 | Post Incident Requirement | Shall have an event reconstruction functionality to give a complete overview of the synchronous events in the timeframe |
| IOP.030 | Post Incident Requirement | Shall provide a facility to export all the event scenario as a playable media file |
| IOP.031 | Post Incident Requirement | System shall support sorting and filtering the list of incidents |
| IOP.032 | Assets Management | System should present the operator with a logical tree that contains devices from different types |
| IOP.033 | Assets Management | System shall allow searching the device tree by device name or device type |
| IOP.034 | Assets Management | System shall indicate the device type by an icon |
| IOP.035 | Assets Management | System should display a pop-up for a device with its details |
| IOP.036 | Health | System should be able to monitor of both physical servers and system |

| | | |
|---|---|---|
| | Management | components (e.g. services, plug-ins) including CPU/Memory/Disk utilization and network connectivity performance |
| IOP.037 | Web Intelligence | System should have a tool for monitoring websites and social networks like twitter, facebook, google+, whatsapp (data for whatsapp shall be provided by GoUP) any publicly accessible web site for topics of interest over time from multiple sources in one platform. |
| IOP.038 | Web Intelligence | System should allow capability to analyse, corelate and represent the subject-matter under investigation. |
| IOP.039 | Web Intelligence | System should periodically query web sites and should be able to log-in to the sites if needed, given proper credentials. |
| IOP.040 | Web Intelligence | System should allow Incoming data to be processed, analysed, filtered and matched against the defined requirements |
| IOP.041 | Web Intelligence | |
| IOP.042 | Web Intelligence | It should allow all the data in the system to be accessible by role based mechanism |
| IOP.043 | Web Intelligence | System should support technology like BIG Data platform to enable easy search, filter and handle massive amounts of social data thereby transforming data to intelligence |
| IOP.044 | Web Intelligence | System should be used to integrate data from existing databases and data gathered from the web about entities like people, organizations, groups, concepts etc. as well as the relationships between them. |
| IOP.045 | Web Intelligence | Should provide notifications to multiple agencies and departments (on mobile) that a new intelligence has been gathered through open source/social media. |
| IOP.046 | Web Intelligence | System should have the capability of employing pre-existing knowledge (such as found in internal databases) as Ontology of the system, improving knowledge extraction and PIR (Priority Intelligence Requirements) matching across the board. |
| IOP.047 | Web Intelligence | System should be able to correlate the external data (structured and unstructured) with internal data from multiple internal databases and then should be able to initiate SOP. Should be able to identify the critical information and should be able to link it to an existing SOP or a new SOP should be started. |
| IOP.048 | Web Intelligence | System should be able to search across data from different silos, across many data types (new items, blog postings, people, tweets, and more) |
| **Video Wall for Command and Control Centre** | | |
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| VWCCC.001 | General | Video Wall and Controller from the same make is preferred |
| VWCCC.002 | Video wall | 26 Cubes (LED Based projection) -10X2 for Command Control Centre -3X2 for Police Control Room |
| VWCCC.003 | Technology | Single chip DLP Technology |
| VWCCC.004 | Resolution | 1920x1080 |

| | | |
|---|---|---|
| VWCCC.005 | Brightness | 240 Cd/m² or better |
| VWCCC.006 | On-screen contrast | 1,200,000:1 (dynamic) or better |
| VWCCC.007 | Display technology | DLP rear projection with DMD Chip |
| VWCCC.008 | Colour gamut | >15 mill |
| VWCCC.009 | Brightness uniformity | >90% or better |
| VWCCC.010 | Screen | 180° viewing angle screen |
| VWCCC.011 | Screen Gap | Less than 1 mm at ambient temperature in Control room |
| VWCCC.012 | Colour stability | Self-calibration with advanced colour sensor |
| VWCCC.013 | Dimensions | Diagonal: 50 " |
| VWCCC.014 | Light source | LED - 6x redundancy |
| VWCCC.015 | Light source lifetime | > 60,000h Typical usage mode |
| VWCCC.016 | | > 80,000h Economy usage mode |
| VWCCC.017 | Operating Conditions | 10°C-40°C, 80% humidity (Non-Condensing) |
| VWCCC.018 | Input voltage | 90 – 240 V, 50-60Hz |
| VWCCC.019 | Signal input/output | Single l link DVI in / Single link DVI out |
| VWCCC.020 | Direct Ethernet access | IP control |
| VWCCC.021 | Graphical user interface | All settings and operational parameters |
| VWCCC.022 | Third party interface | Should be open to third party interface |
| VWCCC.023 | Warranty | 5 years |

| **Video Wall Controller** | | |
|---|---|---|
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| VIWCO.001 | Display controller | Controller to be able to control maximum number of inputs |
| VIWCO.002 | Redundant Controller | Controller should be based on the latest architecture. |
| VIWCO.003 | Platform | Windows 7 Professional (64 bit) or higher |
| VIWCO.004 | Processor & RAM | i7 with 3 GHz or higher processor & Minimum 16 GB |
| VIWCO.005 | Chassis Type | 19" Rack mount industrial chassis |
| VIWCO.006 | Network | 2 Network Ports |
| VIWCO.007 | Resolution Support | 1920 x 1080 or higher |
| VIWCO.008 | RSS Feed | Controller should be able to show the RSS feed as required |

| | | |
|---|---|---|
| VIWCO.009 | Ticker | There should be a possibility in the controller to create user defined multiple tickers. It should also be possible to place these tickers anywhere on the wall |
| VIWCO.010 | Scalability | System should be able to add additional inputs as required in the future |
| VIWCO.011 | Control | System should have capability of Monitoring & Control with various applications on different network through single Operator Workstation. It shall be possible to launch, change layouts in real time using Tablet |
| VIWCO.012 | Fans | Chassis should have minimum 2 fans for adequate cooling |
| VIWCO.013 | Redundancy | Redundant Hot Swappable HDD in RAID 1 Configuration & Power Supply |
| VIWCO.014 | Keyboard & Mouse Extension | Keyboard and Mouse along with mechanism to extend them to 20 m operator desk from display controller to be provided |
| VIWCO.015 | 24 x 7 operation | Controller shall be designed for 24 x 7 operation |
| VIWCO.016 | Others | Video Wall and the Controller should be of the same make to ensure better performance and compatibility |
| VIWCO.017 | OEM Certification | All features and functionality should be certified by the OEM. The Display Modules, Display Controller & Software should be from a single OEM. |

| **Video Wall Management Software** | | |
|---|---|---|
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| WMS.011 | Client & Server based Architecture | Should support Multiple clients / Consoles to control the Wall layouts |
| WMS.012 | Collaboration | Software should be able to share layouts comprising of multiple sources with workstations / Displays over LAN/WAN for remote monitoring |
| WMS.013 | Scaling | Software should enable user to display multiple sources (both local & remote) up to any size and anywhere on the display walls (both local & remote). |
| WMS.014 | Display | Software should be able to create layouts & launch them as and when desired |
| WMS.015 | Remote Control | Display Wall and sources (both local & remote) should be controlled from Remote PC through LAN without the use of KVM Hardware. |
| WMS.016 | Layout Management | Should support for Video, RGB, DVI, Internet Explorer, Desktop Application and Remote Desktop Monitoring Layouts |
| WMS.017 | Support of Meta Data | Software should support display of Alarms |
| WMS.018 | Authentication | Software should provide at least 2 layer of authentication |
| WMS.019 | Scenarios | Software should able to save/load desktop layouts from Local/remote machines |
| WMS.020 | Layout Scheduler | All the Layouts can be scheduled as per user convince. |
| WMS.021 | Layout Scheduler | Software should support auto launch of Layouts according to specified time event by user |

| | | |
|---|---|---|
| WMS.022 | User friendly | Software should be user friendly |
| WMS.023 | OEM Certification | All features and functionality should be certified by OEM. Display Modules, Display Controller & Software should be from a single OEM. |

| **Video Management System – VMS** | | |
|---|---|---|
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| VMS.001 | General Requirements | VMS shall work on ONVIF Open Platform catering to all the security needs of the city |
| VMS.002 | General Requirements | VMS shall be open to any ONVIF IP cameras integration so that it would be able to cater future requirements of the project |
| VMS.003 | General Requirements | VMS shall support interoperability of IP cameras from multiple vendors |
| VMS.004 | General Requirements | MSI shall clearly mention in their proposal the brands and models integrated into VMS |
| VMS.005 | General Requirements | VMS system shall be compatible to single and multiple processor servers. The server processor & hardware shall be optimized in all cases. |
| VMS.006 | General Requirements | VMS system shall cluster the processing & memory load across several machines. The failure of any one server in the solution shall not cause a failure in the entire system. |
| VMS.007 | General Requirements | System shall allow the frame rate, bit rate and resolution of each camera to be configured independently for recording. |
| VMS.008 | General Requirements | System shall support H.265, H.264and MJPEG compression formats for all IP cameras connected to the system. |
| VMS.009 | General Requirements | VMS shall support high availability of recording servers. A failover option shall provide standby support for recording servers with automatic synchronization to ensure maximum uptime & minimum risk of lost data. |
| VMS.010 | General Requirements | VMS software shall have multicast and multi-streaming support. It shall have the ability to take a snapshot from any online live camera and export to a standard graphic file format. |
| VMS.011 | General Requirements | VMS shall support archiving for optimizing recorded data storage through unique data storage solutions by combining performance and scalability with cost efficient long-term video storage. |
| VMS.012 | General Requirements | Video Management System shall incorporate intuitive map functions allowing for multi layered map environment. The map functionality shall allow for the interactive control of the complete surveillance system, at-a-glance overview of system integrity, and seamless drag-and-drop integration with video wall module |

| | | |
|---|---|---|
| | | option. |
| VMS.013 | General Requirements | System should support Maps integration with below features;<br>i. Click on an indicator on the map and drill down to additional linked maps.<br>ii. Zoom into the map<br>iii. To “drag & drop” a camera or any other sensor from the map area to a video window or to click on a camera to start viewing it in a pop-up window. iv. Add cameras to the map images. v. The map supported formats shall be: BMP, GIF, JPG, PNG and TIFF |
| VMS.014 | General Requirements | Video Management System shall incorporate fully integrated matrix functionality for distributed viewing of any camera in the system from any computer with the client viewer. |
| VMS.015 | General Requirements | VMS shall be ONVIF compatible |
| VMS.016 | General Requirements | VMS shall be scalable to support minimum 5000 or more cameras, which can be added into the system by only addition of software licenses and servers |
| VMS.017 | General Requirements | It shall be possible to integrate VMS into the Command & Control system. In that respect bidders shall provide their SDK/API (or any other integration means) libraries and documentation to ensure a seamless integration with any other system. |
| VMS.018 | General Requirements | VMS shall be open to any standard storage technologies integration. |
| VMS.019 | General Requirements | VMS shall already support Storage system from multiple vendors. |
| VMS.020 | General Requirements | VMS shall provide the ability to save any event that was tagged as an alarm (video motion detection, video loss or input) received, to be saved in a manner in which it cannot be overwritten. |
| VMS.021 | General Requirements | VMS shall be open to any video wall system integration |
| VMS.022 | General Requirements | VMS shall offer possibility to integrate external Video Analytics systems. |
| VMS.023 | Distributed Architecture | It shall be possible to access VMS without installing dedicated client software (e.g. through the use of common web browser such as Internet Explorer…) |
| VMS.024 | Distributed Architecture | VMS shall be designed to offer a full IP based distributed architecture |
| VMS.025 | Distributed Architecture | VMS shall have the capability to handle software clients (operators) connected in different locations on the same network. |

| | | |
|---|---|---|
| VMS.026 | Distributed Architecture | Simultaneous quantity of operators per location shall not be limited |
| VMS.027 | Management | VMS shall store the system's configuration in a relational database, either on the management server computer or on the network. |
| VMS.028 | Management | VMS shall authenticate user access, user rights and privileges of all operators through Active Directory |
| VMS.029 | Management | Access rights and privileges shall consist in but not limited to<br>a. Visibility of devices, live view, playback, **AVI/ MP4** export, JPEG export, database export, sequences, smart search, input status, output control.<br>b. PTZ control, PTZ priority, PTZ pre-set control<br>c. Smart/Remote Client, live playback/setup, status API, service registration API and<br>d Privileges for the map feature |
| VMS.030 | Management | Registration of the system shall allow for on line activation and off line activation of licenses |
| VMS.031 | Management | The system shall support automatic failover for Recording Servers. This functionality shall be accomplished by one Failover Server as a standby unit for max 10 servers that shall take over, if one of a group of designated Recording Servers fails. Recordings shall be synchronized back to the original Recording Server once it is back online |
| VMS.032 | Management | VMS shall operate in multicast / unicast / bandwidth throttling protocol to minimize the network bandwidth |
| VMS.033 | Multicasting | VMS shall support video streams up to at least 25fps |
| VMS.034 | Multicasting | Monitoring module shall allow for continuous monitoring of the operational status and event-triggered alarms from servers, cameras and other devices. |
| VMS.035 | Monitoring Module | The Monitoring module shall provide a real-time overview of alarm status or technical problems while allowing for immediate visual verification and troubleshooting. |
| VMS.036 | Monitoring Module | Module shall include flexible access rights and allow each user to be assigned several roles where each shall define access rights to cameras. |
| VMS.037 | Monitoring Module | Viewing live video from cameras on the surveillance system with Playback recordings from cameras on the surveillance system, with a selection of advanced navigation tools, including an intuitive timeline browser. |
| VMS.038 | Monitoring Module | The system shall allow views to be created which are only accessible to the user, or to groups of users based on different layouts optimized for 4:3 and 16:9 display ratios. It should be able to create and switch between an unlimited number of views and able to display video from up to 25 cameras from multiple servers at a time. |
| VMS.039 | VMS Storage | It shall be possible to schedule recording and archiving by a recurrence pattern (daily, weekly, specific time and dates) and by specific time ranges (all day, time range, daytime, night time) |
| VMS.040 | VMS Storage | It shall be possible to schedule recording on per camera basis (Continuous, manual or motion based) |

| | | |
|---|---|---|
| VMS.041 | VMS Storage | VMS shall allow the control of the amount of used disk space. |
| VMS.042 | VMS Storage | It shall be possible to protect specific video streams against any deletion and for any time |
| VMS.043 | Log Management | system log shall be searchable by Level, Source and Event Type. |
| VMS.044 | Log Management | Alert Log records alerts triggered by rules (searchable by Alert type, Source, Event type) |
| VMS.045 | Management | system shall have smart recording wherein no recording or recording at lower frame rate is done when there is no movement. The VMS shall be able to record higher-quality video and shall reduce fps when not in use during VAS. night time. |
| VMS.046 | Management | System should support recording management to view the recordings available on a camera's local storage device (such as an SD card), and copy them to the server. |
| VMS.047 | Management | |
| VMS.048 | Management | System should support Clip/Playback Management—Use Clip/Playback Management to view and download video files that are stored on the server. |
| VMS.049 | Management | No of operators shall not be software licenses dependent. In case of emergency, threats, natural catastrophe the control room shall be able to reconfigure the VMS by adding more operators without any Contractor's intervention. |
| VMS.050 | Management | Security Platform shall have strong security mechanism such as the use of advance encryption, digital certificates and claims-based authentication to ensure that only authorized personnel have access to critical information, prevent man-in-the-middle attacks, and that the data is kept private. |

| **Video Content Analytics** | | |
|---|---|---|
| **Sr. No.** | **Item** | **Minimum Requirement Description** |
| VAS.001 | General Requirements | System shall be a real-time video analytics engine that utilizes advanced image processing algorithms to turn video into actionable intelligence. |
| VAS.002 | General Requirements | System shall provide configurable detection zones and lines to detect events of interest, Detection zones define an area of interest and Detection lines define a perimeter instead of a region. |
| VAS.003 | General Requirements | System shall facilitate creating multiple zones and lines in a single scene to trigger various alerts |
| VAS.004 | General Requirements | System shall allow configuration of applicable rules and manage them. |
| VAS.005 | General Requirements | System shall also enable editing Zones and lines to desired shape or size. |
| VAS.006 | General Requirements | Triggers generated by the applied rules shall provide visual indicators to identify the event. Such as a yellow coloured target changing the colour to red on event |
| VAS.007 | General Requirements | System shall enable masking of areas which interfere detection zones in other areas of the scene |
| VAS.008 | General Requirements | System shall enable detecting rules in the defined areas (zones/ lines) |

| | | |
|---|---|---|
| VAS.009 | General Requirements | System shall provide a functionality for configuring timelines for various events such as abandoned object, camera tampering etc |
| VAS.010 | General Requirements | System shall be able to filter large amounts of video and focus on human attention appropriately |
| VAS.011 | General Requirements | System shall have Automated PTZ camera control/preset for zooming in on interesting events like motion Detection etc. as picked up by Camera without the need for human intervention. |
| VAS.012 | General Requirements | VCA shall provide secured feeds with encryption for data authenticity |
| VAS.013 | General Requirements | VCA shall be able to, vehicle parked in defined zones etc., |
| VAS.014 | General Requirements | System shall have a report generation functionality to provide inputs on various instances of events triggered in the system |
| VAS.015 | General Requirements | VCA should allow to add, edit, delete or disable and enable Policies. |

| | | |
|---|---|---|
| VAS.016 | Features | Definable and available triggers should be for citywide surveillance, system needs to have capability to deploy intelligent video analytics software on any of selected cameras. Software should have capability to provide various alarms & triggers. solution should offer following triggers:<br>1) Parking Violation<br>2) Wrong Direction<br>3) People loitering<br>4) Camera Tampering (In case this is an inherent feature of the camera, this may not be provided as a separate line item in VA)<br>5) Unattended Object<br>6) Crowd detection<br>7) Attribute Based Search<br>a. Track a specific person across several surveillance cameras. The application shall allow access to all relevant associated VMS recordings with following<br>b. Search initiators:<br>○ VMS recorded content;<br>○ Photographic images i.e. System shall also provide the option to initiate such search just by clicking on the image of a human during video playback;<br>○ Artificial sketch builder allowing selection of various attributes i.e. body color, body figure, Hair styles, Texture and color of cloths, various accessories i.e. Spectacles, Shoes, bag/suitcase, Tie etc.<br>c. When initiating a query by VMS recorded content, the operator shall be able to initiate the query for a specific VMS video channel and time range in order to get results of extracted individual's thumbnails from the image database that was generated in real-time by the analytics application.<br>d. The application shall support a list of at least 20 different textures types.<br>e. The application shall support map images and GIS maps.<br>The application users shall be integrated with the VMS users and user privileges shall be derived from the VMS. |
| VAS.017 | General Requirements | Motion Detection component that automatically detects moving objects in the field of view of a camera & is capable of filtering movement in configurable directions & movement due to camera motion (e.g. from wind) |
| VAS.018 | General Requirements | System shall have a sophisticated rule-based engine with powerful analytics capabilities that provides automatic event notification, |
| VAS.019 | Log Management | System should have a proper MIS system for recording of various video analytics as per need. There should be provisions for acknowledging the events with remarks in the system itself & print out of a period specific list can be taken for recording purpose. |

## 8. Testing and Acceptance Procedures

Testing and quality assurance in software development and systems integration projects has to be more rigorous since each component has to work with many other systems for the whole system to be more reliable. A system is tested at various stages of development and deployment. For example, each component is tested as a unit for checking the correctness of its own code. The component shall be tested with its dependent components. After final release of the entire set of components, system is tested for the correctness of system functionality. The components shall be tested in simulated production load for performance and load analysis. The MSI along with consortium partners shall be responsible for the testing processes such as **planning** (includes preparing test plans and defining roles and their responsibilities), **preparation** (consists of preparing test specification, test environment and test data) and **execution** (includes testing at various levels like unit level, integration level, system level and production).

## 8.1. Test Plan

Test plans are prepared for each phase of testing. The initial test plan is created during the Project Planning phase. The initial test plan describes who performs which type of testing and when. Ideally master test plan covers all types of test i.e. from unit testing to production testing. The MSI along with consortium partners is expected to submit the test plans to ASCL for approval. Any changes made to the test plan during the project life cycle should be communicated to ASCL for approval. Test plans should contain following items:

- Roles and Responsibilities of Test Team
- Approach to Testing
- Function Testing (including Regression Testing)
- Security Testing
- User Interface and Reports Testing
- Concurrency Testing
- Performance and Load Testing
- Test Scenarios along with Entry and Exit Criteria
- Test Specifications
- Suspension and Resumption Criteria

## 8.2. Test scenarios

The MSI along with consortium partners should prepare test scenarios for testing each business scenario. A test scenario when executed should fulfil a business requirement as per the scope of business functionality. Test scenarios shall include following:

- Test Specification – During the test specification phase, the test cases are specified. It consists of description of the input, process to be executed and a prediction of output results.
- Test Environment Component developer does unit testing and integration testing. Integration testing can be delegated to a specialized testing group. Each of the members in the testing group is provided with testing environment according to his/her role and responsibilities. Following is sample testing environment for testing:

- A set of dedicated workstations for testing.
- A set of tools and applications required on workstation like access to user interface, browser etc.
- Access to centralized document database (where all the project related documents are maintained).
- Access to testing tools (including test management and performance testing) and defect logging tools.
- Access to the central database or repository for development and unit testing (this database contains sample test data).
- Access to deployed components.

- Test Data – Test data is prepared for testing at each stage. The test data should be prepared in such a way that it covers basic path and every alternate path of the code. The basic path and alternate paths are prioritized to capture relevant data. Tools can also be used to generate test data.

## 8.3. Test Execution

The following testing steps are required to be part of the project lifecycle. The MSI along with consortium partners are expected to create their individual and integrated testing plan and follow the following steps.

### 8.3.1. Unit Testing

In unit testing, each piece of code has to be rigorously tested. At this stage testing is done according to the priority of path of code. All the test results are logged in the defect logging tools. After completion of testing, code is corrected for defect logs. This process is iterative till criteria for successful testing is reached.

### 8.3.2. Integration Testing

Upon completion of unit testing, integration testing begins. The purpose is to ensure distinct components of the application still work in accordance to customer requirements. Test sets will be developed with the express purpose of exercising the interfaces between the components. This activity is to be carried out by the Test Team. Integration test will be termed complete when actual results and expected results are either in line or differences are explainable/acceptable based on client input.

### 8.3.3. Incremental Integration Testing

Continuous testing of an application as new functionality is added. This will include the regression testing of any and all components that were deployed before.

### 8.3.4. System Testing

System testing is performed when all the components are delivered to central repository prior to the release of the software. The testing is done on priority basis of business processes. All the defects are logged and assigned to respective component owners. The component and unit testing shall be performed after the correction of code. However, it may depend on size and type of individual test specifications. Impact analysis is useful to narrow done testing efforts by identifying critical test cases affected due to code change.

#### 8.3.5. Pre-Production Testing

Pre-Production testing is done simulating the production load. Test data is either prepared or generated from the tools. This testing is used to evaluate performance, load capacity and concurrency. Load testing tools can also be used for this purpose. Following special type of testing are done during Pre-production Testing Phase:

#### 8.3.6. Regression Testing

The objective of regression testing is to ensure software remains intact. A baseline set of data and scripts will be maintained and executed to verify changes introduced during the release have not "undone" any previous code. Expected results from the baseline are compared to results of the software being regression tested. All discrepancies will be highlighted and accounted for, before testing proceeds to the next level.

#### 8.3.7. Performance Testing

Although performance testing is described as a part of system testing, it can be regarded as a distinct level of testing. Performance testing will verify the load, volume, and response times as defined by requirements.

#### 8.3.8. Load Testing

Testing an application under heavy loads, such as the testing of a web site under a range of loads to determine at what point the systems response time degrades or fails.

#### 8.3.9. Installation Testing

Testing full, partial, or upgrade install/uninstall processes. The installation test for a release will be conducted with the objective of demonstrating production readiness. This test is conducted after the application has been migrated to the client's site. It will encompass the inventory of configuration items (performed by the application's System Administration) and evaluation of data readiness, as well as dynamic tests focused on basic system functionality. When necessary, a sanity test will be performed following the installation testing.

#### 8.3.10. Security/Penetration Testing

Testing how well the system protects against unauthorized internal or external access, willful damage, etc. This type of testing may require sophisticated testing techniques. The MSI will get a CERT.in certified auditor to do a Vulnerability Audit across all the systems and provide a certificate to the ASCL for completion of the testing.

#### 8.3.11. Recovery/Error Testing

Testing how well a system recovers from crashes, hardware failures, or other catastrophic problems.

#### 8.3.12. Acceptance Testing

During the test scenarios definition, for each of the business scenario, an acceptance criterion is defined. Acceptance criteria include expected behavior of the s/w component and the expected results (data). Expected results form a part of the Exit Criteria. In addition to expected result and behaviors, some conditions are also specified in the exit criteria. They can be:

- Number of bugs to be discovered for a functional module. This depends on size of the functionality and is an indicator of amount of testing done. If any medium or low-priority errors are outstanding – the implementation risk must be signed off as acceptable by ASCL and Lead Partner along with consortium partners.
- All High Priority errors from System Test must be fixed and tested by MSI along with consortium partners needs to get the acceptance criteria approved from ASCL for all the functional components of the system. The Acceptance Criteria for each release into production environment will be agreed upon by MSI along with consortium partners in consultation with ASCL prior to release from Testing to production environment. After installation, if any bug is reported or there is non-compliance to requirements then a proper procedure should be followed. End-user should report ("Change Request") to his/her supervisor about the bug that will in turn get forwarded to Project Manager (PM). PM will forward the List of change request to Lead Partner along with consortium partners. After the bug is fixed, it should be reflected in the production copy after testing it.

#### 8.3.13. Performance Testing

The MSI has to test and demonstrate the operational performance requirement as per specification after completion of entire scope. This will be part of acceptance testing. The system will be taken over by owner only after successful operational performance testing. The MSI has to arrange necessary hardware / software to demonstrate the performance testing. MSI should note that ASCL can appoint a third party agency for conducting any part of above testing procedures (in addition to the testing carried out by the bidder).

#### 8.3.14. Field Acceptance Testing

Each piece of equipment needs to be integrated and tested before being brought into production in a live environment. The MSI needs to create an environment where such testing can be done before deployment in the field. Once deployed a final sanity test needs to be performed before bringing the system online.

### 8.4. Testing, Commissioning and Successful Operation

The scope includes testing and commissioning and implementation of all equipment, sub-systems and systems of the project and putting them into successful technical and commercial operation. The scope shall include but not limited to the requirements given elsewhere in the specification. The MSI shall be responsible to provide all necessary testing and commissioning personnel, tools/kits, test equipment etc.

Each field equipment will be tested and deployed in the field after successful commissioning. A comprehensive testing and commissioning report will be provided per type of field equipment in each component.

User acceptance testing will be conducted in the entire system in conjunction with the field test report.

## 9. Training and Capacity Building

To strengthen the knowledge of ASCL staff, structured capacity building programs shall be undertaken for multiple levels in the organizational hierarchy like foundation process/soft skills training to the staff for pre-defined period. Refresher trainings for Command Control Centre/City Operation Staff and designated Authorities and Police staff shall be included as a part of Capacity Building Program. It is important to understand that training needs to be provided to each and every staff personnel of such operation centres. These officers shall be handling emergency situations with very minimal turnaround time.

- MSI shall prepare and submit detailed Training Plan and Training Manuals to ASCL/authorized entity for review and approval.
- Appropriate training shall be carried out as per the User Training Plan prepared in detail stating the number of training sessions to be held per batch of trainees, course work for the training program, coursework delivery methodologies and evaluation methodologies in detail.
- MSI shall be responsible for necessary demonstration environment setup of all ICT solutions in this RFP to conduct end user training. End user training shall include all the equipment including but not limited to all the applications and infrastructure at operation centres, data centres and field Locations. End user training shall be conducted at a centralized location or any other location as identified by ASCL with inputs from MSI.
- MSI shall conduct end-user training and ensure that the training module holistically covers all the details around hardware and system applications expected to be used on a daily basis to run the system.
- MSI shall impart operational and technical training to internal users on solutions being implemented to allow them to effectively and efficiently use the surveillance system.
- MSI shall prepare the solution specific training manuals and submit the same to authority for review and approval. Training Manuals, operation procedures, visual help-kit etc. shall be provided in English language.
- MSI shall provide training to selected officers of ASCL covering functional, technical aspects,

usage and implementation of the products and solutions.

- MSI shall ensure that all concerned personnel receive regular training sessions, from time to time, as and when required. Refresher training sessions shall be conducted on a regular basis.
- An annual training calendar shall be clearly chalked out and shared with ASCL along with complete details of content of training, target audience for each year etc.
- MSI shall update training manuals, procedures manual, deployment/installation guides etc. on a regular basis (quarterly/biannual) to reflect the latest changes to the solutions implemented and new developments.
- MSI shall ensure that training is a continuous process for the users. Basic computer awareness, fundamentals of computer systems, basic, intermediate and advanced application usage modules shall be identified by MSI.
- Systematic training shall be imparted to the designated trainees that shall help them to understand the concept of solution, the day-to-day operations of overall solution and maintenance and updating of the system to some extent. This shall be done under complete guidance of the trainers provided by MSI.
- Time schedule and detailed program shall be prepared in consultation with ASCL and respective authorized entity (Police). In addition to the above, while designing the training courses and manuals, MSI shall take care to impart training on the key system components that are best suited for enabling the personnel to start working on the system in the shortest possible time.
- MSI is required to deploy a Master Trainer who shall be responsible for planning, designing and conducting continuous training sessions.
- Training sessions and workshops shall comprise of presentations, demonstrations and hands-on mandatorily for the application modules.
- ASCL shall be responsible for identifying and nominating users for the training. However, MSI shall be responsible for facilitating and coordinating this entire process.
- MSI shall be responsible for making the feedback available for the authority/authorized entity to review and track the progress, in case, after feedback, more than 30% of the respondents suggest that the training provided to them was unsatisfactory or less than satisfactory then the MSI shall re-conduct the same training at no extra cost.

## 9.1. Types of Trainings

Following training needs is identified for all the project stakeholders:

### 9.1.1. Basic IT Training

This module shall include components on fundamentals of: Computer Usage, Network, Desktop Operations, User Admin, Application Installation, Basic Computer Troubleshooting etc.

### 9.1.2. Functional Training

Basic IT Skills, Software Applications (City Operation Centre and Command and Control

Centre), SWM Application, Traffic Management Application, Vehicle Tracking, Networking, Hardware Installation, Centralized Helpdesk, Feed Monitoring

#### 9.1.3. Administrative Training

System Administration Helpdesk, FMS, BMS Administration etc., Master Trainer Assistance and Handling Helpdesk Requests etc.

#### 9.1.4. Senior Management Training

Usage of all the proposed systems for Monitoring, Tracking and Reporting, MIS Reports, Accessing Various Exception Reports.

### 9.2. Post-Implementation Training

Refresher Trainings for the Senior Management, Functional/Operational Training and IT Basics for New Operators, Refresher Courses on System Administration, Change Management Programs.

### 9.3. Capacity Building

Some of the strategies to ensure quick-wins would be:

- Creation of a dedicated Capacity Building and Training Team for managing operations of each of the implemented Safe and Smart City interventions.
- Identification of tie ups with training institutions.
- Identification of stakeholders.
- Identify training objectives for various stakeholders.
- Training needs assessment.
- Training content preparation.
- Training Delivery channels – Self learning, Classroom, Train the trainer approach etc.
- Developing training calendar.
- Implementation of training as per the training calendar.
- Monitoring and evaluation of training in progress.

## 10. Project Implementation

**Implementation Strategy**

While charting the implementation strategy for Agra City, it is essential to reiterate that one of the objectives of implementation is to create an underlying infrastructure that will bring about enablement of various smart city services that will be implemented over a period of time within Agra Municipal Corporation limits. Given the strong dependence on Smart City interventions that are

being currently implemented for rolling out smart city services, successful implementation of the city-wide OFC network to enable CCTV Camera Infrastructure, Adaptive Traffic Control System, Smart Public Transport and ICT enable Solid Waste Management will only propel ability of Agra Smart City Limited and Agra Nagar Nigam in deriving its benefits that will lead to a significant change. The implementation plan is, therefore, designed around addressing the various change management challenges from an IT perspective in a structured way.

In creating the implementation strategy for Agra Smart City, following key organizational/environmental aspects have been considered:

- City-wide CCTV Surveillance, ICT Enabled Solid Waste Management, Intelligent Traffic Management System, Adaptive Traffic Control System and City Wide GIS Solution shall be undertaken in parallel and all initiatives shall be first operated utilizing bandwidth from third party telecom service providers for the complete period of project until city decides to have dedicated OFC or RF network for the city. Utilization of bandwidth from third-party Internet Service Providers shall gradually reduce as parts of Network Backbone are commissioned and operationalized.
- As and when the rollout phase of various smart city initiatives such as City-wide CCTV Surveillance, ICT Enabled Solid Waste Management, Intelligent Traffic Management System, Adaptive Traffic Control System and City Wide GIS Solution, a provision for the integration of Third Party smart city solutions for each of the initiatives has been envisaged. It is well understood that the City Network Backbone solution may not have all the required functionalities of handling all the smart city requirement aspects in preliminary stage, hence, the solution shall be designed to accommodate the future requirements of integration and customization with third-party smart city solutions.
- Implementation Plan for all Smart City interventions shall be tied up with major infrastructure and Sewage projects that will be undertaken within Agra City – these projects may or may not be covered under Smart City Plan.
- As on date, there is a no formal structured IT Department within ASCL and therefore, capacity would need to be built up to manage a large scale initiatives' rollout as envisaged in overall Agra Smart City Project. This IT Department would need to incorporate functional area experts, IT experts/managers and key decision makers of ASCL in a Project-oriented organization structure during the pre-commissioning stage.
- Given the relatively lower levels of technology-orientation within ASCL, well-designed take-off measures are required for enablement of all Smart City initiatives' implementation and the respective Operations and Maintenance. Also, the employees need to be given a certain amount of lead time to learn working with such technologically advanced interventions at such a large scale before they can handle all Smart City interventions independently.
- Handholding and "Train the trainer" strategies would need to be adopted to ensure that the employees feel comfortable for operations and management of the all Smart City interventions during the initial 6 months post completion of the rollout.

The overall implementation has been planned in four phases:

**Phase I Implementation:** Phase I should be executed within 2 months and it shall comprise of Mobilization and Submission of detailed Design document which have project study for all ICT solution.

- Submission as part of Detailed Project Study for all ICT solution:
  a) Detailed Survey of Identified Sites, Network and Power Requirements
  b) Hardware and Software Deployment Plans
  c) Detailed Project Plan including Operations management, Contract Management, Risk Management, Information Security and Business Continuity
  d) FRS, SRS, SDD Documents for all Work Streams and Components

**Phase II Implementation:** Phase II is planned for 6 months and it shall comprise of the Supply, Installation, Commissioning and Operationalization of:

- Readiness of Data Centre and Disaster Recovery Site – IT Passive Components
- City Communication Network
- Geographical Information System for City
- Adaptive Traffic Signals Control System
- Intelligent Traffic Management Systems
- CCTV and Surveillance Based System for City
- Smart Public Transport System
- Environment Sensors
- ICT Enabled Solid Waste Management
- Integrated City and Command Control Centre (ICCC) for ASCL
- Existing Integration Components

**Phase III Testing and Go Live:**

Phase 3 which is planned for 3 months majorly comprises of rigorous testing and following complete testing cycle which shall be approved by ASCL and it follows process from Unit Testing, Functional and Integration Testing, Load and Performance Testing, Failover and Rollback testing and User Acceptance testing.

**Phase IV Operations and Maintenance:**

Phase IV which shall is planned to be managed and operations for 5 years after Go Live by selected bidder. Operations and maintenance for all Smart City interventions in accordance with predefined Service Level Agreement with the selected System Integrator shall be undertaken.

Following are the benefits of this approach:

- This approach provides time for ASCL to prepare for Smart City initiatives and lays out a graduated path for ramping up. This will allow employees to get familiarized with an integrated way of working and will also provide sufficient lead time for ASCL management to address concerns of various stakeholders, especially citizens, from a change management point of view.

- The key challenge posed by this approach is the vendor/solution selection phase. It is unlikely that any single vendor in the market would be able to provide all the services alone and therefore, it is anticipated that respondents would be primarily in the form of consortia. On the positive side, given the size of the potential engagement with ASCL, this would ensure that all major players in the market would be interested in participating in the procurement process.

## 11. Project Timelines

It is proposed that the complete Smart City ICT shall be created in a time frame of 12 months. This will include the setting up of IT/Non-IT infrastructure, Network Operations Centre, City Operations Centre at Central level, access nodes with the links, services nodes connectivity for various Smart city services. **Project shall have predefined milestones and the project shall be monitored and tracked against those milestones.**

### 11.1. Phase I – T + 2 months (T is the date of signing of the contract with MSI)

| A | Phase I: Mobilization and Design | D + 2 months |
|---|---|---|
| **1** | Resource Mobilization | D + 1 months |
| **2** | Detailed Project Study for all ICT solution:<br>a) Detailed Survey of identified Sites, Network and Power Requirements<br>b) Hardware and Software Deployment plans<br>c) Detailed Project Plan including Operations management, Contract management, Risk Management, Information Security and Business Continuity<br>d) FRS, SRS, SDD Documents for all work streams and components | D + 2 months |

### 11.2. Phase II – T + 6 months

| B | Phase II: Supply, Installation, Testing andGo Live | D + 6 months |
|---|---|---|
| **1** | Data Centre and Disaster Recovery Site | D + 5 Months |
| **2** | City Communication Network | D + 2 Months |
| **3** | Geographical Information System for City | D + 4 Months |
| **4** | Adaptive Traffic Signals and Management System (Exceptional) | D + 9 Months |
| **5** | Intelligent Traffic Management Systems | D + 4 Months |
| **6** | CCTV and Surveillance Based System for City | D + 4 Months |
| **7** | Smart Public Transport System | D + 4 Months |
| **8** | Environment Sensors | D + 4 Months |
| **9** | ICT Enabled Solid Waste Management | D + 6 Months |
| **10** | Integrated City and Command Control Centre (ICCC) for ASCL | D + 6 Months |
| **11** | Existing Integration Components | D + 6 Months |

### 11.3. Phase III – T + 9 months

| C | Phase III: Testing and Go Live | | T + 9 Months |
|---|---|---|---|
| 1 | Functional Testing | Compliance Report | T + 8 Months |
| 2 | Load and Performance Testing | Compliance Report | T + 8 Months |
| 3 | Failover and Rollback Testing of DC and DR Sites | Compliance Report | T + 8 Months |
| 4 | User Acceptance Testing | - | T + 9 Months |
| 5 | Go Live | - | T + 9 Months |

### 11.4. Phase IV – T1 + 60 months (T1 is the date of Go Live of all application)

| D | Phase IV: Operations and Maintenance Phase for a Period of 60 Months from the Date of Go Live | | |
|---|---|---|---|
| **1** | Operation and Maintenance | SLA Compliance Report | Every Quarter |

## 12. Project Risk and Mitigation

The objective of this section is to identify the risks associated with the project during early stage and also plan the mitigation for the same. The project is dependent on the active participation of all the stakeholders. In this regard, response time and review time would be very critical to the completion of the project.

- Preserve the integrity of the work plan:
  - To handle change requests and issues.
  - To manage and record scope changes.
  - To manage and mitigate project risks.
- Identify risks and develop mechanisms for tracking and mitigation of risk at start of project.
- Identify probable internal and external obstacles and taking steps to reduce the impact.
- Bringing risk issues to the attention of management and advise on probable resolution on periodic basis, as decided.

## 13. Project Controls, Measurement and Targets

### 13.1. Implementation phase related performance levels

| Sr. No. | Measurement | Definition | Target | Penalty |
|---|---|---|---|---|
| **Commencement of Work** | | | | |

| | | | | |
|---|---|---|---|---|
| 1. | Team Mobilization and Commencement of Work | MSI is expected to mobilize project team for commencement of work Commencement of work would mean reporting and availability of MSI's resources (90% Key Personnel as per the RFP requirement) at ASCL's office for the project within defined period of 15 days and remaining 10% in next 15 days) | Within 15 days of issuance of LoI or contract agreement, whichever is earliest | Delay beyond 15 calendar days = 0.2% of the contract value<br>Delay between 15 to 30 calendar days = 0.5% of the contract value<br>Delay beyond 30 days may lead to Termination of the Contract at the discretion of ASCL |

### 13.2. Data Centre (DC) / Disaster Recovery (DR) Centre

| Sr. No. | Measurement | Definition | Target | Severity Level |
|---|---|---|---|---|
| 1 | Network -<br>▪ Wired and Wireless Networks<br>▪ Covering routers and switches<br>▪ Storage<br>▪ Backup drives<br>▪ VM ware<br>▪ IOT platform<br>▪ Enterprise network firewalls/Intrusion Prevention System<br>▪ Modular Servers | DC/DR components (availability for a month is defined as total time (in minutes) in a month less total down time (in minutes) in a month excluding planned data centre downtime.<br>DC/DR is considered available when all the services in full capacity are available.<br>DC/DR Availability (%) = (Total minutes during the month – Planned downtime - Downtime minutes during the month) *100 / Total minutes during the month<br>Total Time shall be measured 24x7 basis for DC/DR depending upon functional requirement.<br>Planned data centre Downtime refers to unavailability of data centre services due to infrastructure maintenance activities such as configuration changes, upgradation or changes to any supporting infrastructure. Details related to such planned outage shall be agreed with ASCL | 99.98% | > 99.98 = 0<br>< 99.98 to 97 = 5<br>< 97 = 9 |

| | | | | |
|---|---|---|---|---|
| | | and data centre<br>Measurement Tool: Reports from EMS | | |

### 13.3. Network related performance levels

| Sr. No. | Measurement | Definition | Target | Severity Level |
|---|---|---|---|---|
| 1. | Network Availability for all field level devices to CCC/ OCC and DC/DR - MSI to take network as a service to ISP | Network components (availability for a month is defined as total time (in minutes) in a month less total down time (in minutes) in a month excluding planned network downtime. Network is considered available when all services in full capacity are available.<br>Network Availability (%) = (Total minutes during the month – Planned downtime - Downtime minutes during the month) *100 / Total minutes during the month<br>Total Time shall be measured 24x7 basis.<br>Planned Network Component Downtime refers to unavailability of network services due to infrastructure maintenance activities such as configuration changes, upgradation or changes to any supporting infrastructure Details related to such planned outage shall be agreed with ASCL.<br>Measurement Tool: Reports from EMS | > 98.5% up time measured on a monthly basis | 0 |
| | | | ≤98.5% to >97.0% up time measured on a monthly basis | 4 |
| | | | ≤97.0% to >95.0% up time measured on a monthly basis | 5 |
| | | | ≤95.0% to >93.0% up time measured on a monthly basis | 7 |
| | | | < 93.0% up time measured on a monthly basis | 8 |
| 2. | Network Quality of Service | Quality of Service (QoS) refers to the capability of a network to provide traffic engineering to selected network traffic from<br>• Field Level Infrastructure and Access Point Access point to DC/ DR and CCC /OCC switch and optical fibre Leased Line between Switch at CCC/OCC and DC / DR. | 99% throughput of minimum stipulated bandwidth during 24*7 hours | 0 |
| | | | ≥97% and <99% | 5 |
| | | | <97% | 6 |
| | | The primary goal of QoS is to provide priority including dedicated bandwidth, controlled jitter, latency and improved loss characteristics.<br>Measurement Tool: Reports from EMS | Average Packet loss exceeding 0.5% over a month (at Data Centre and | 4 |

| | | | | |
|---|---|---|---|---|
| | | | LAN/WAN level) | |
| | | | Latency Delay > 150 ms (every instance) (at Data Centre and LAN/WAN level) | 4 |

13.4. Service Level for ICT Solutions

| Sr. No. | Measurements | Definitions | Target | Severity Level |
|---|---|---|---|---|
| 1 | Availability of various Application Software for/at:<br>1) Command Control Centre (CCC) for City and Police<br>▪ Video Management System<br>▪ Video Analytics System<br>▪ RLVD Application System<br>▪ ANPR Application System<br>▪ No Helmet Detection<br>▪ Face Recognition System<br>▪ Wrong Way Detection<br>▪ Illegal Car Parking<br>▪ Object Detection<br>▪ eChallan System<br>▪ Adaptive Traffic Management System<br>▪ GIS Map for Agra City<br>▪ Variable Messaging Signboard Management system<br>▪ Public Address Management System<br>▪ Emergency Box/Panic Box Management System<br>▪ Mobile Surveillance Vehicle Management System<br>▪ Applications and Systems for Solid Waste Management<br>▪ Applications and Systems for Smart Transport & Smart Bus Stops<br>▪ Applications and Systems for management of Wi-Fi hot spots<br>▪ Applications and Systems for Management of Digital Display | Uptime = {1 - (Application downtime-maintenance downtime) / (Total Time – maintenance downtime)}<br>Application Downtime shall be measured from the time the equipment becomes unavailable (due to any reasons whatsoever attributable to MSI) for Business processing to the end user to the time it becomes fully available.<br>Any downtime for maintenance shall be with prior written intimation to ASCL.<br>Please note that continuous downtime of every 2 hours (from 7am to 12 midnight) would raise the severity by one level. e.g. the severity level will raise from 0 to 1<br>Please note that continuous downtime of every 4 hours (from midnight to 7 am) would raise the severity by one | Minimum 98% uptime measured on monthly basis | 0 |
| | | | ≥96% to < 98% uptime measured on monthly basis | 5 |
| | | | ≥93% to < 96% uptime measured on monthly basis | 7 |
| | | | < 93% uptime measured on monthly basis | 9 |

| | | | | |
|---|---|---|---|---|
| | Signages<br>▪ Applications and Systems for Management of Biometric Attendance System<br>▪ Applications and Systems for Management for IP Telephony System<br>▪ Meragra Citizen Mobile Application<br>▪ Applications and Systems for Integration and Management of other smart components | level. e.g. the severity level will raise from 0 to 1<br>Measurement Tool: Reports from EMS | | |
| 2 | Availability of other software including:<br>▪ Anti-virus<br>▪ SLA, helpdesk and EMS<br>▪ Virtualization software<br>▪ IBMS | Uptime = {1 - (Application downtime-maintenance downtime) / (Total Time – maintenance downtime)}<br>Application Downtime shall be measured from the time the equipment becomes unavailable (due to any reasons whatsoever attributable to the Bidder) for Business processing to the end user to the time it becomes fully available.<br>Any downtime for maintenance shall be with prior written intimation to ASCL.<br>Please note that continuous downtime of every 2 hours (from 7am to 12midnight) would raise the severity by one level. e.g. the severity level will raise from 0 to 1<br>Please note that continuous downtime of every 4 hours (from midnight to 7am) would raise the severity by one level. e.g. the severity level will raise from 0 to 1 | Minimum 97% uptime measured on monthly basis | 0 |
| | | | ≥96% to < 97% uptime measured on monthly basis | 4 |
| | | | ≥95% to < 96% uptime measured on monthly basis | 6 |
| | | | < 95% uptime measured on monthly basis | 7 |

| | | | | |
|---|---|---|---|---|
| | | Measurement Tool: Reports from EMS | | |
| 3 | Availability of Command and Control Centre (CCC) including<br>1. Work Stations<br>2. Video Wall<br>3. Cameras<br>4. Phones<br>5. Biometric Access Control System<br>6. UPS/DG sets<br>7. Air Conditioner | Uptime = {1 - (Equipment downtime-maintenance downtime) / (Total Time – maintenance downtime)}<br>Equipment Downtime shall be measured from the time the equipment becomes unavailable (due to any reasons whatsoever attributable to the Bidder) for Business processing to the end user to the time it becomes fully available.<br>Any downtime for maintenance shall be with prior written intimation to ASCL.<br>Please note that continuous downtime of every 2 hours (from 7am to 12midnight) would raise the severity by one level. e.g. the severity level will raise from 0 to 1<br>Please note that continuous downtime of every 4 hours (from midnight to 7am) would raise the severity by one level. e.g. the severity level will raise from 0 to 1<br>Measurement Tool: Reports from EMS | Minimum 99% uptime measured on monthly basis | 0 |
| | | | ≥96% to < 97% uptime measured on monthly basis | 4 |
| | | | ≥95% to < 96% uptime measured on monthly basis | 6 |
| | | | < 95% uptime measured on monthly basis | 7 |
| 4 | Fire Detection and Suppression System Uptime | Availability of fire detection and suppression system in the CCC/COC. Periodic audits | 100% availability measured periodically | 0 |

| | | | | |
|---|---|---|---|---|
| | | would be done by the agency to check the availability of these system<br>Measurement Tool: Random Check | Any incident of non-compliance | 5 |
| 5 | Availability of Field Infrastructure including:<br>• CCTV Cameras and including poles<br>• GPS/GSM Unit<br>• Public Address System – Loudspeakers<br>• GPS based handheld/Mobile Device<br>• Environmental Sensors<br>• Smart Traffic Detectors, Sensors and Controllers<br>• Variable Message Signboard<br>• Wi-Fi access points and related infrastructure<br>• GPS device on vehicle<br>• RFID Tags/RFID Readers<br>• Digital Display Signages<br>• Passenger Information System – Display units<br>• Electricity supply to all field devices<br>• UPS at all field devices<br>• IP Phones<br>• Biometric Attendance devices (fixed & mobile)<br>• All sensors and IoT devices | Uptime = {1 - (Equipment downtime-maintenance downtime) / (Total Time – maintenance downtime)}<br>Equipment Downtime shall be measured from the time the equipment becomes unavailable (due to any reasons whatsoever attributable to the Bidder) for Business processing to the end user to the time it becomes fully available.<br>Any downtime for maintenance shall be with prior written intimation to ASCL.<br>Please note that continuous downtime of every 2 hours (from 7am to 12midnight) would raise the severity by one level. e.g. the severity level will raise from 0 to 1<br>Please note that continuous downtime of every 4 hours (from midnight to 7am) would raise the severity by one level. e.g. the severity level will raise from 0 to 1<br>Measurement Tool: Reports from EMS | Minimum 97% uptime measured on monthly basis | 0 |
| | | | ≥96% to < 97% uptime measured on monthly basis | 4 |
| | | | ≥95% to < 96% uptime measured on monthly basis | 6 |
| | | | < 95% uptime measured on monthly basis | 7 |

| | | | | |
|---|---|---|---|---|
| 5 | Battery Replacement for all equipment/devices procured | Replacement of various equipment batteries. This excludes the regular maintenance of the UPS and its Batteries<br>Measurement Tool: SLA Monitoring Tool for inventory Management. | Batteries to be replaced every 3rd Year | 5 |
| 6 | Repair/replacement of field/CCC/OCC/DC/DR infrastructure including but not limited to:<br>▪ CCTV Cameras and including poles<br>▪ GPS/GSM Unit<br>▪ Public Address System – Loudspeakers<br>▪ GPS based handheld/Mobile Device<br>▪ Environmental Sensors<br>▪ Smart Traffic Detectors, Sensors & Controllers<br>▪ Variable Message Signboard<br>▪ Wi-Fi access points and related infrastructure<br>▪ GPS device on vehicle<br>▪ RFID Tags/RFID Readers<br>▪ Digital Display Signages<br>▪ Passenger Information System – Display units<br>▪ UPS<br>▪ IP Phones<br>▪ Biometric Attendance devices (fixed and mobile)<br>▪ All sensors and IoT devices<br>▪ Servers, active and passive devices<br>▪ Other equipment | Bidder should keep minimum 10% spare at any given point of project execution.<br>Infrastructure equipment should be replaced or repaired after complaint login from ASCL officials<br>Measurement Tool: System Generated Call Log at Help Desk | Within 4 business hours of logging compliant | 0 |
| | | | 2 to 4 business days of logging compliant | 5 |
| | | | More than 4 days of logging compliant | 7 |
| 7 | Asset/Inventory Management | Provide Monthly MIS of Asset Inventory to check Asset Inventory level<br>Measurement Tool: SLA Monitoring Tool for Inventory Management | ≥ 95% of the minimum required inventory level should be available measured on monthly | 0 |

| | | | | |
|---|---|---|---|---|
| | | | basis | |
| | | | <95% of the minimum required inventory level | 3 (Severity level would increase by 1 for every 5% drop in inventory level) |
| | | Conduct Annual Physical Asset verification once in a year and give report within 2 months from the date of verification | 100% Management approval of physical asset verification report | 5 |

Note: During post-implementation period, in case the pole/outdoor cabinets or any other field equipment is damaged by a vehicular accident (or due to any other reason outside the control of MSI) and needs repair/replacement, then the corresponding equipment to be replaced by Bidder as per the SLAs defined in this section. In such cases, damages are to be borne by MSI through proper comprehensive insurance for all the equipment (in the field or at CCC/OCC/DC/DR) during contract period.

### 13.5. Help Desk / Extension of UP Dial 100

| Service | Parameter | SLA | Validation | Penalty | Tools used |
|---|---|---|---|---|---|
| Help Desk Availability | Help Desk should be available and all incidents/events raised with the IT Help Desk shall; be logged into the system and service ticket number should be provided to the employee | 100% calls to be logged and service ticket no, shall be generated | Reports generated from ticket logging system | 95%-99% calls are logged and ticket is generated: Penalty of 2% of O&M Charges | Automated Monitoring Tool |
| | | | | 90%-95% calls are logged and ticket is generated: Penalty of 5% | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | of O&M Charges | |
| | Resolution of ticket logged as per the severity definition chart | 99% | Reports generated from ticket logging system | 95%-99% calls resolved in specified time: Penalty of 2% of O&M Charges | Automated Monitoring Tool |
| | | | | 90%-95% calls resolved in specified time: Penalty of 5% of O&M Charges | |
| | | | | < 90% calls resolved in specified time: Penalty of 10 % of O&M Charges | |
| Problem Management | Supplier shall analyze all the incidents and provide a root cause report every month if there are more than 10 incidents of the same type. | 100% timely submission covering all incidents logged in that month | Root cause report | 5% penalty on monthly of O&M charges of that project area, if the supplier does not submit a problem report for that month | |
| | | | Incident Report stating problems faced by the User | 5% penalty on monthly of O&M charges of that project area if the supplier does not submit a problem report for that month | |

13.6. Camera Feed and Quality

| Sr. No. | Measurements | Definitions | Target | Severity Level |
|---|---|---|---|---|
| 1 | Ratio of Live cameras v/s Total Cameras at any point of time (To be measured every 1 hour) | Number of live working cameras divided by total number of cameras<br>Measurement Tool: Log from VMS tools wherein alerts to the control room shall be generated on non-functioning of camera | ≥98% | 0 |
| | | | ≥95 % to <98% | 3 |
| | | | < 95% | 5 |
| 2 | Average Frame rate maintained for viewing | Average frame rate is 25 FPS to be maintained by all cameras calculated on a Monthly Basis<br>Measurement tool: Log from VMS | ≥90% | 0 |
| | | | ≥85 % to <90% | 3 |
| | | | < 85% | 4 |
| 3 | Average Frame rate maintained for Recording | Average frame rate is 12.5 FPS to be maintained by all cameras calculated on a Monthly Basis<br>Measurement tool: Log from VMS | ≥95% | 0 |
| | | | ≥90 % to < 95% | 3 |
| | | | < 90% | 4 |
| 4 | Video stream Latency | Time required for transmission of video feed from one point to another<br>Measurement tool: Report from EMS | ≤40ms | 0 |
| | | | >40ms to ≤60ms | 3 |
| | | | >60ms | 4 |
| 5 | Change of Screen from one camera Source to another | Time required for transmission of screen from one camera source to another<br>Measurement tool: Log from VMS | ≥2s | 0 |
| | | | >2s to ≤5s | 3 |
| | | | >5s | 4 |
| 6 | Video Feed Query Retrieval Response Time | Time taken for receiving response to a query raised for video feed<br>Measurement tool: Log from VMS | ≤10s | 0 |
| | | | >10s to ≤20s | 3 |
| | | | >20s | 4 |

## 14. Project Governance Committee

**Composition**

Agra Smart City Steering Committee is proposed to comprise of the following at minimum:

- Agra Divisional Commissioner: Chairman

- Agra Municipal Commissioner: CEO
- IT, General Manager: Member
- Nodal Officer: Member
- Agra Inspector General of Police: Member
- Project Director, PMU: Member
- Project Director, SI: Member
- Representative from NHAI, PWD, ASI, Tourism: Member
- Other invitees, as per approval of Chairman: Member

**Frequency of Meeting**

It is proposed that the Steering Committee meets every 15 days at least. The Steering Committee may also meet as and when required for addressing critical issues impeding the progress of the Project.

**Roles and Responsibilities – Composition**

Following shall be the proposed roles and responsibilities of the Steering Committee:

- Provide overall leadership, vision and direction for the implementation of the project.
- Overall planning, co-ordination, monitoring and progress review of the project.
- Overall strategic control and take decisions on regulatory matters and provide guidance for successful execution of the project.
- Creating a supporting environment for the success of the project.
- Consideration of matters arising out of the Change Control Note and approval of the same.
- Review budgetary requirements and financial monitoring of allocated funds.
- Provide direction on strategic matters related to the progress of the project.
- Smart City Governance and facilitate issue resolution.

**Roles and Responsibilities – Project Monitoring**

Following shall be the proposed roles and responsibilities of the Project Monitoring Committee:

- Reviewing the overall progress of the project.
- Resolve and provide direction on operational matters.
- Review SI milestone/deliverable sign off report and provide its recommendations in consultation with implementation cell.
- Review site readiness status and provide recommendation.
- Ensure proper training and capacity building of AMC, Police department and concerned stakeholders.
- Conducting regular meetings with project key stakeholders for issue resolution.
- Coordination between different stakeholders as per the guidance of Steering Committee.

**Roles and Responsibilities – Implementation**

Following shall be the proposed roles and responsibilities of the Smart City Implementation Cell:

- Responsible for providing operational support to the SI project team.
- Review and provide site readiness reports in consultation with PMU to Project Monitoring Committee.

- Responsible for assisting SI in site survey, facilitating administrative permissions, and day to day project activities completion.
- Conducting regular meetings with SI project team & PMU for issue identification & resolution.

## 15. Indicative Bill of Material for City Requirement

| S.No. | Line Item | Unit of Measurement | Indicative Quantity |
|---|---|---|---|
| **A. Integrated Command and Control Center** | | | |
| 1 | Control Room Interior | No. | 1 |

| | | | |
|---|---|---|---|
| 2 | Control Room Desk / Furniture | No. | 1 |
| 3 | Integrated Command and Control Center Solutions | Set | 1 |
| **B. Data Center and Disaster Recovery Core Infrastructure** | | | |
| **HCI Solutions, Physical Server and Software Licenses** | | | |
| 1 | HCI appliance | Set | 2 |
| 2 | Centralized Management tool for all HCI nodes | Set | 2 |
| 3 | Physical Servers for Non HCI environment | Set | 2 |
| 4 | Hypervisor License | Set | 2 |
| 5 | Operating systems for the compute environment | Lot | Actual Quantity Arrived as per Solution |
| 6 | Virtualization Software License | Lot | Actual Quantity Arrived as per Solution |
| 7 | Database Server Licenses | Lot | Actual Quantity Arrived as per Solution |
| 8 | PIM License | Lot | Actual Quantity Arrived as per Solution |
| **Switches and Routers** | | | |
| 1 | Spine Switch | No. | 2 |
| 2 | Leaf Switch (OFC and/or Copper) | No. | 6 |
| 3 | Fabric Controller | No. | 1 |
| 5 | PoE L2 Access Switch for DC | No. | 4 |
| 6 | Internet Router | No. | 2 |
| 7 | Intranet / WAN Router | No. | 2 |
| 8 | Server Load Balancer | No. | 2 |
| 9 | Link Load Balancer + Global Load Balancer | No. | 2 |
| **Storage Requirement** | | | |
| 1 | SAN Storage | No. | Actual Quantity Arrived as per Solution |
| 2 | SAN Switch | No. | Actual Quantity Arrived as per Solution |
| 3 | Secondary Storage (Tape/Disk/NAS or Equivalent) | No. | Actual Quantity Arrived as per Solution |
| 4 | Backup Software | No. | 1 |
| **Security Solutions** | | | |
| 1 | Next-generation Firewall for Internet | No. | 2 |
| 2 | Next-generation Firewall for Intranet | No. | 2 |
| 3 | Web and Email Security Appliance | No. | 2 |
| 4 | Gateway level anti-virus and anti-spam security solution | No. | Actual Quantity Arrived as per Solution |
| 5 | Server Anti-Virus License | No. | Actual Quantity Arrived as per Solution |
| 6 | Enterprise Management System including NMS for DC and DR environment: License | No. | Actual Quantity Arrived as per Solution |
| 7 | DDoS | No. | 2 |
| 8 | WAF | No. | 2 |
| 9 | SIEM | No. | Actual Quantity Arrived as per Solution |
| 10 | Network Behavior Analysis | No. | Actual Quantity Arrived as per Solution |

| | | | |
|---|---|---|---|
| 11 | Anti – APT | No. | 2 |
| 12 | DLP | No. | Actual Quantity Arrived as per Solution |
| **Passive Components and other IT Infrastructure** | | | |
| 1 | Video Wall Cubes | No. | 28 |
| 2 | Video Wall Controller with wall management software | No. | 2 |
| 3 | Video Conferencing Unit | No. | 2 |
| 4 | Workstations (Desktop) | No. | 40 |
| 5 | Laptops (Latest Configuration) | No. | 10 |
| 6 | Multifunction Laser Printer | No. | 4 |
| 7 | Complete Electrical, Power and Networking Cost (Passive Components) (Pl. specify the details like Junction Box, Patch Panel, LIU, OFC, Cat6 Cable, Power Cable, Patch Cords, GI, HDPE Pipes, Installation & Labor Charges, etc. | lumpsum | Actual Quantity Arrived as per Solution |
| 8 | Public Address System | No. | 4 |
| 9 | Fire Alarm and Extinguisher System | Set | 1 |
| 10 | Biometric access control system along with Cage | Set. | 2 |
| 11 | CCTV cameras for internal surveillance | No. | 6 |
| 12 | Rodent Repellent system | Set | 1 |
| 13 | UPS (sizing as per proposed solution) | No. | 2 |
| 14 | Diesel Generator | No. | 2 |
| 15 | Building Management system | Set | 1 |
| 16 | Bidder to estimate redundant power requirement at DC and DR | lumpsum | As per requirement |
| 17 | DC - Core IT Infra System Integration | Lumpsum | As per requirement |
| 18 | Support L1, L2 Manpower for DC Operations 5 Years | lumpsum | As per requirement |
| **C. Helpdesk** | | | |
| 1 | Complete Contact Center and IVRS Solution with IP Phones, Headsets and other accessories for 40 Operators | Lumpsum | 1 |
| **D. Intelligent and Adaptive Traffic Signal** | | | |
| 1 | ATCS Controller with cabinet and other accessories | No. | 63 (Per Junction) |
| 2 | Traffic Signal Aspects -Red | No. | 450 |
| 3 | Traffic Signal Aspects - Amber | No. | 450 |
| 4 | Traffic Signal Aspects -Green Arrow | No. | 1016 |
| 5 | Vehicle Countdown Timer | No. | 212 |
| 6 | Pedestrian Countdown Timer with Red/Green Man | No. | 424 |
| 7 | Detectors | No. | 212 |
| 8 | ATCS Software (including but not limited to integration, APIs, etc.) | No. | 1 |
| 9 | Power Cables | Lumpsum | Per Junction |
| 10 | Electrical Supplies (including but not limited to UPS, RCBO, Earthing, etc.) | Lumpsum | Per Junction |
| 11 | Cantilever Poles along with foundation | No. | Per Junction |
| 12 | Straight Pole along with foundation | No. | Per Junction |
| 13 | Other civil works (including but not limited to trench, filling, ducts, junction box, chambers, mounting structures, etc) | Lumpsum | Per Junction |

| | | | |
|---|---|---|---|
| 14 | Other services (including but not limited to surveys, installation, commissioning, testing, traffic engineering, etc.) | Lumpsum | Per Junction |
| **E. City CCTV Surveillance System** | | | |
| 1 | Fixed Camera | No. | 790 |
| 2 | PTZ Camera | No. | 326 |
| 3 | Video Management Software with License | Lot | 2 |
| 4 | Video Analytics Software with License | Lot | 2 |
| 5 | Network Switch Ruggedized (Industrial Aggregation Switch) | No. | As per requirement |
| 6 | Junction box | No. | As per requirement |
| 7 | Rack Mounted LIU | No. | As per requirement |
| 8 | UPS – 2 KVA | No. | As per requirement |
| 9 | Power Cable | Meter | As per requirement |
| 10 | Passive Components and Site Preparation | Lump sum | As per requirement |
| 11 | Up gradation for UP 100 Police Vehicle (Surveillance Cameras with Display Mechanism) | No. | 50 |
| 12 | Body Worn Camera | No. | 50 |
| 13 | Face Recognition System | No. | 150 Channels |
| 14 | Peripherals for Police at each Police Thana (Mini PCs, Video Display Walls and Printers) | No. | Total 86 Police Stations:<br>Mini PCs – 268 (8*16,70*2)<br>Video Display - 1 Each<br>Printers - 1 Each |
| 15 | Attribute Based Search | No. | 250 Channels |
| **F. Intelligent Traffic Management System** | | | |
| 1 | Fixed Box Cameras | Nos | 56 |
| 2 | PTZ Camera | Nos | 77 |
| 3 | ANPR Camera | Nos | 213 |
| 4 | RLVD Camera | Nos | 110 |
| 5 | Public Address System – IP based PA with speakers | No. | 43 |
| 6 | ANPR Software with License | Lot | 1 |
| 7 | RLVD Software with License | Lot | 1 |
| 8 | PA Software with License | Lot | 1 |
| 9 | Emergency Panic Button License | Lot | 43 |
| 10 | Emergency Panic Button Software License | Lot | 1 |
| 11 | Gantry Pole Set up | No. | As per requirement |
| 12 | Passive Components and site preparation | Lump Sum | As per requirement |
| 13 | eChallan Handheld Device | Nos | 100 |
| 14 | Illegal Parking/No Helmet/Wrong Way Detection Camera/Software License | Nos | MSI to check functional compliance through Hardware / Software at given locations in Annexure |
| 15 | Variable Message Signboards | Nos. | 12 |
| **G. Solid Waste Management system** | | | |
| 1 | Number of Households | Nos. | 3,50,000 |
| 2 | Number of Wards | Nos. | 100 |
| 3 | Number of Community Bins | Nos. | 444 |
| 4 | Vehicle Tracking System (VTS) GPS device | Nos | 150 |
| 5 | RFID/QR Based Reader Devices or Smart Phones | Nos | 1968 |
| 6 | RFID/QR Based Tags for Commercial Establishments (500), Community Bins, Collection | Nos | 1044 |

| | | | |
|---|---|---|---|
| | Containers | | |
| 7 | RFID/QR Based Tags for Households | Nos. | 3,50,000 |
| 8 | RFID/QR Based Tags for Garbage Collection Vehicles | Nos. | 150 |
| 9 | Bin Volume Sensors | Nos | Per Bin |
| 10 | CCTV Cameras for Surveillance | Nos | 150 |
| 11 | GPS and Biometric based handheld device with Attendance management system application | Nos | As per requirement |
| 12 | GPRS/GSM Connectivity - SIM Card & Service Plan | Nos | As per requirement |
| 13 | GPRS/GSM based device to send real time Weigh bridge data from treatment site to ICCC | Nos | 1 |
| **H. Smart Public Transport System (Number of Buses = 170nos)** | | | |
| 1 | IP Dome Cameras | Nos. | 340 |
| 2 | Vehicle Tracking System (VTS) GPS device for Buses (170) and Ambulances (75) | Nos. | 245 |
| 3 | Public Address System – IP based PA with speakers with Software | Nos. | 170 |
| 4 | Emergency Panic Button with Software | Nos. | 170 |
| 5 | Fleet Management and Analytic Solution for Decision Support | Nos. | 2 |
| **I. Environment Sensors** | | | |
| 1 | Central Environment System | Nos | 1 |
| 2 | Environmental Sensors | Nos | 39 |
| **J. GIS** | | | |
| 1 | Base Map preparation | Set | 1 |
| 2 | GIS and Image Processing Hardware and Software | Set | As per solution |
| 3 | Development of Enterprise GIS Portal and 12 Department Applications | Nos. | 12 |
| 4 | Integration of GIS with existing and proposed system | Set | 15 |
| **K. Network Bandwidth** | | | |
| 1 | Cost estimate for Bandwidth requirement as per the requirement (implementation and Maintenance period) | Lumpsum | 1 |
| **L. Any Current or Future Integrations** | | | |
| 1 | Multiple Integrations and with all type of sensors (shall be planned in future too) | Lumpsum | 1 |

## 16. Proposed Financial Estimates

This section is prepared in separate excel sheet and will be shared separately.

## 17. Annexures

17.1. Annexure 1: Junctions for Intelligent and Adaptive Traffic Signals

| S.No. | List of Junctions |
|---|---|
| 1 | Agra Cantt Railway Station |
| 2 | Amar Singh Gate (Red Fort) |
| 3 | Bhagwan Talkies |
| 4 | Bhogi Pura Chauraha |
| 5 | Bijlighar Chauraha |
| 6 | Bodhla Chauraha |
| 7 | Collectorate Tiraha |
| 8 | Entry point inner Ring Road Fatehabad Road |
| 9 | Hariparvat Chauraha |
| 10 | Itmad-Ud-Daulah Tiraha |
| 11 | Phool Sayyad Chauraha |
| 12 | Purani Mandi Chauraha |
| 13 | PWD Club Chauraha |
| 14 | Rambaugh Chauraha |
| 15 | Sai Ka Takiya Chauraha |
| 16 | Shahdra Chauraha, Bajrang Petrol Pump, Entry Point |
| 17 | Shamshan Ghat Chauraha |
| 18 | Sikandra Tiraha |
| 19 | Soor Sadan Tiraha |
| 20 | St Johns Chauraha |
| 21 | Subhash Park Tiraha |
| 22 | Taj View Tiraha |
| 23 | Targhar Chauraha |
| 24 | TDI Mall |
| 25 | Water Works Junction |
| 26 | 100 Ft Kalindi Road |
| 27 | 100 Ft Tiraha PS Shah Ganj, Fatehpur Entry Point |
| 28 | Agra College Tiraha |
| 29 | Amar Hotel Tiraha |
| 30 | Belanganj Chauraha |
| 31 | Chimman Puri Chauraha |
| 32 | Deewani Tiraha, New Agra |
| 33 | Dhakran Chauraha |
| 34 | Gurudwara Cut |
| 35 | Idgah Chauraha |
| 36 | Kalakriti Tiraha |
| 37 | Kargil Petrol Pump Tiraha |
| 38 | Khandhari Chauraha |
| 39 | Kothi Meena Chauraha |
| 40 | Loha Mandi Chauraha |

| | |
|---|---|
| **41** | Madina Tiraha |
| **42** | Maruti Estate Chauraha |
| **43** | Nalband Chauraha |
| **44** | Nammer Chauraha |
| **45** | Pratapura Chowk |
| **46** | Raja Mandi Chauraha |
| **47** | RBS Chauraha |
| **48** | Rooi Ki Mandi Chauraha |
| **49** | Sadar Bazaar Road |
| **50** | Sadar Bhatti |
| **51** | State Bank Tiraha |
| **52** | Sultan Ganj Ki Pulia |
| **53** | University Gate Khandari Campus |
| **54** | Victoria Park Tiraha |
| **55** | Fauwara Tiraha |
| **56** | Gadha Pada Chauraha |
| **57** | Ghatia Azam Khan Chowk (Kinari Bazaar Chowk) |
| **58** | Guru Agrasen Chowk (Raja Ki Mandi Railway Station) |
| **59** | Haathi Ghat Chowk |
| **60** | Paliwal Chowk |
| **61** | Ram Nagar Ki Pulia Chauraha |
| **62** | Saket Tiraha |

## 17.2. Annexure 2: Intelligent Traffic Management System with General Surveillance

| S.No. | List of Junctions | Only ANPR | ANPR + RLVD | No Helmet | Wrong Way | Illegal Parking |
|---|---|---|---|---|---|---|
| **1** | Amar Singh Gate (Red Fort) | Y | N | N | N | N |
| **2** | Bhagwan Talkies | - | Y | Y | N | Y |
| **3** | Bijlighar Chauraha | N | Y | Y | Y | Y |
| **4** | Bodhla Chauraha | - | Y | Y | N | N |
| **5** | Collectorate Tiraha | - | Y | Y | Y | N |
| **6** | Entry point inner Ring Road Fatehabad Road | - | Y | Y | N | N |
| **7** | Hariparvat Chauraha | - | Y | Y | Y | N |
| **8** | Itmad-Ud-Daulah Tiraha | - | Y | Y | N | Y |
| **9** | Kerawali Tiraha, Runakta, Entry Point | Y | N | N | N | N |
| **10** | Keriya More, Sarai Khawaja,Entry Point(Traffic) | Y | N | N | Y | N |
| **11** | Nunihai Tiraha | Y | N | N | N | N |
| **12** | Panchkuia | Y | N | N | N | N |
| **13** | Purani Mandi Chauraha | - | Y | Y | Y | y |

| | | | | | | |
|---|---|---|---|---|---|---|
| **14** | PWD Club Chauraha | - | Y | Y | Y | N |
| **15** | Rambaugh Chauraha | - | Y | Y | Y | Y |
| **16** | Sai Ka Takiya Chauraha | - | Y | Y | Y | N |
| **17** | Shahdra Chauraha, Bajrang Petrol Pump, Entry Point | - | Y | Y | N | y |
| **18** | Shamshan Ghat Chauraha | Y | N | N | N | N |
| **19** | Sikandra Tiraha | - | Y | Y | N | N |
| **20** | Soor Sadan Tiraha | - | Y | Y | Y | N |
| **21** | St Johns Chauraha | - | Y | Y | Y | N |
| **22** | Subhash Park Tiraha | - | Y | Y | Y | N |
| **23** | Taj View Tiraha | - | Y | Y | Y | N |
| **24** | Targhar Chauraha | - | Y | Y | N | N |
| **25** | TDI Mall | - | Y | Y | N | N |
| **26** | Tedhi Baghiya, Entry Point | Y | N | N | Y | Y |
| **27** | Water Works Junction | - | Y | Y | N | Y |
| **28** | 100 Ft Tiraha PS Shah Ganj, Fatehpur Entry Point | Y | N | N | N | N |
| **29** | Agra College Tiraha | - | Y | Y | Y | N |
| **30** | Deewani Tiraha, New Agra | - | Y | Y | N | N |
| **31** | Dhakran Chauraha | - | Y | Y | Y | N |
| **32** | Gurudwara Cut | Y | N | N | Y | Y |
| **33** | Idgah Chauraha | - | Y | Y | Y | y |
| **34** | Kargil Petrol Pump Tiraha | Y | N | N | N | N |
| **35** | Khandhari Chauraha | - | Y | Y | Y | N |
| **36** | Loha Mandi Chauraha | Y | N | N | N | N |
| **37** | Maruti Estate Chauraha | - | Y | Y | N | N |
| **38** | Nalband Chauraha | - | Y | Y | N | N |
| **39** | Pratapura Chowk | - | Y | Y | N | N |
| **40** | Raja Mandi Chauraha | - | Y | Y | N | N |
| **41** | State Bank Tiraha | - | Y | Y | N | N |
| **42** | Sultan Ganj Ki Pulia | - | Y | Y | Y | Y |
| **43** | University Gate Khandari Campus | - | Y | Y | N | N |

| | | | **Count of Cameras** | | | | | **General Surveillance** | |
|---|---|---|---|---|---|---|---|---|---|
| S.No. | **List of Junctions** | **Phases** | **Requirement for Only ANPR Cameras** | **Requirement for ANPR + RLVD Cameras** | | **Requirement for No Helmet Cameras** | **Requirement for Illegal Parking** | **Fix Camera** | **PTZ Camera** |
| | | | | **ANPR Cameras** | **RLVD Cameras** | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** | Amar Singh Gate (Red Fort) | 1 | 4 | - | - | - | - | 2 | 1 |
| **2** | Bhagwan Talkies | 1 | - | 8 | 4 | 8 | 4 | 8 | 2 |
| **3** | Bijlighar Chauraha | 1 | - | 5 | 5 | 5 | 5 | - | 2 |
| **4** | Bodhla Chauraha | 1 | - | 4 | 4 | 4 | - | - | 1 |
| **5** | Collectorate Tiraha | 1 | - | 5 | 3 | 5 | - | - | 1 |
| **6** | Entry point Inner Ring Road Fatehabad Road | 1 | - | 3 | 3 | 3 | - | - | 1 |
| **7** | Hariparvat Chauraha | 1 | - | 8 | 4 | 8 | - | - | 1 |
| **8** | Itmad-Ud-Daulah Tiraha | 1 | - | 4 | 3 | 4 | 3 | - | 1 |
| **9** | Kerawali Tiraha, Runakta, Entry Point | 1 | 3 | - | - | - | - | - | 1 |
| **10** | Keriya More, Sarai Khawaja, Entry Point(Traffic) | 1 | 4 | - | - | - | - | - | - |
| **11** | Nunihai Tiraha | 1 | 3 | - | - | - | - | - | 1 |
| **12** | Panchkuia | 1 | 5 | - | - | - | - | 2 | 2 |
| **13** | Purani Mandi Chauraha | 1 | - | 4 | 4 | 4 | 4 | - | 1 |
| **14** | PWD Club Chauraha | 1 | - | 8 | 4 | 8 | - | - | 1 |
| **15** | Rambaugh Chauraha | 1 | - | 8 | 4 | 8 | 4 | 8 | 2 |
| **16** | Sai Ka Takiya Chauraha | 1 | - | 6 | 4 | 6 | - | - | 1 |
| **17** | Shahdra Chauraha, Bajrang Petrol Pump, Entry Point | 1 | - | 5 | 3 | 5 | 3 | 4 | 2 |
| **18** | Shamshan Ghat Chauraha | 1 | 4 | - | - | - | - | - | 1 |
| **19** | Sikandra Tiraha | 1 | - | 5 | 3 | 5 | - | - | 1 |
| **20** | Soor Sadan Tiraha | 1 | - | 6 | 3 | 6 | - | - | 1 |
| **21** | St Johns Chauraha | 1 | - | 7 | 4 | 7 | - | - | 1 |
| **22** | Subhash Park Tiraha | 1 | - | 5 | 3 | 5 | - | - | 1 |
| **23** | Taj View Tiraha | 1 | - | 5 | 3 | 5 | - | - | 1 |
| **24** | Targhar Chauraha | 1 | - | 6 | 4 | 6 | - | - | 1 |
| **25** | TDI Mall | 1 | - | 5 | 3 | 5 | - | - | 1 |
| **26** | Tedhi Baghiya, | 1 | 3 | - | - | - | 3 | - | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Entry Point | | | | | | | | |
| **27** | Water Works Junction | 1 | - | 6 | 4 | 6 | 4 | 8 | 2 |
| **28** | 100 Ft Tiraha PS Shah Ganj, Fatehpur Entry Point | 2 | 4 | - | - | - | - | - | 1 |
| **29** | Agra College Tiraha | 2 | - | 5 | 3 | 5 | - | - | 1 |
| **30** | Deewani Tiraha, New Agra | 2 | - | 4 | 2 | 4 | - | - | 2 |
| **31** | Dhakran Chauraha | 2 | - | 4 | 2 | 4 | - | - | 1 |
| **32** | Gurudwara Cut | 2 | 4 | - | - | - | 4 | - | 1 |
| **33** | Idgah Chauraha | 2 | - | 4 | 4 | 7 | 4 | - | 1 |
| **34** | Kargil Petrol Pump Tiraha | 2 | 3 | - | - | - | - | - | 1 |
| **35** | Khandhari Chauraha | 2 | - | 6 | 4 | 6 | 4 | 6 | 2 |
| **36** | Loha Mandi Chauraha | 2 | 4 | - | - | - | - | - | 1 |
| **37** | Maruti Estate Chauraha | 2 | - | 4 | 2 | 2 | - | - | 1 |
| **38** | Nalband Chauraha | 2 | - | 6 | 4 | 6 | - | - | 1 |
| **39** | Pratapura Chowk | 2 | - | 6 | 4 | 6 | - | - | 1 |
| **40** | Raja Mandi Chauraha | 2 | - | 5 | 3 | 5 | - | - | 1 |
| **41** | State Bank Tiraha | 2 | - | 5 | 3 | 5 | - | - | 1 |
| **42** | Sultan Ganj Ki Pulia | 2 | - | 4 | 4 | 4 | 4 | 8 | 2 |
| **43** | University Gate Khandari Campus | 2 | - | 6 | 3 | 6 | - | - | 1 |
| TOTAL | | | **41** | **172** | **110** | **173** | **46** | **46** | **52** |

**Only Surveillance at Traffic Junctions**

| S.No. | List of Junctions | Traffic Signals | Fix Camera | PTZ Camera |
|---|---|---|---|---|
| **1** | Agra Cantt Railway Station | Y | - | 2 |
| **2** | Bhogi Pura Chauraha | Y | 4 | 1 |
| **3** | Phool Sayyad Chauraha | Y | - | 1 |
| **4** | 100 Ft Kalindi Road | Y | - | 1 |
| **5** | Amar Hotel Tiraha | Y | 1 | 1 |
| **6** | Belanganj Chauraha | Y | - | 2 |
| **7** | Chimman Puri Chauraha | Y | - | 1 |
| **8** | Kalakriti Tiraha | Y | - | 1 |
| **9** | Kothi Meena Chauraha | Y | - | 1 |

| | | | | |
|---|---|---|---|---|
| **10** | Madina Tiraha | Y | - | 1 |
| **11** | Nammer Chauraha | Y | - | 1 |
| **12** | RBS Chauraha | Y | - | 1 |
| **13** | Rooi Ki Mandi Chauraha | Y | 4 | 1 |
| **14** | Sadar Bazaar Road | Y | - | - |
| **15** | Sadar Bhatti | Y | 1 | 1 |
| **16** | Victoria Park Tiraha | Y | - | 1 |
| **17** | Fauwara Tiraha | Y | - | 1 |
| **18** | Gadha Pada Chauraha | Y | - | 1 |
| **19** | Ghatia Azam Khan Chowk (Kinari Bazaar Chowk) | Y | - | 1 |
| **20** | Guru Agrasen Chowk (Raja Ki Mandi Railway Station) | Y | - | 1 |
| **21** | Haathi Ghat Chowk | Y | - | 1 |
| **22** | Paliwal Chowk | Y | - | 1 |
| **23** | Ram Nagar Ki Pulia Chauraha | Y | - | 1 |
| **24** | Saket Tiraha | Y | - | 1 |
| | TOTAL | | **10** | **25** |

## 17.3. Annexure 3: CCTV for City Surveillance System

| Sr No | Junction Name | Area/Thana | No of Arms | No of Fixed Box camera | No of PTZ Camera |
|---|---|---|---|---|---|
| **1** | Hing Ki Mandi Tiraha | Kotwali | 3 | 3 | 1 |
| **2** | Rawatpada Tiraha | Kotwali | 3 | 3 | 1 |
| **3** | Roxy Cinema Tiraha | Kotwali | 3 | 3 | 1 |
| **4** | Fubbara Tiraha Kotwali | Kotwali | 3 | 3 | 1 |
| **5** | Seth Gali Tiraha | Kotwali | 3 | 3 | 1 |
| **6** | Kashmiri Bazaar Tiraha | Kotwali | 3 | 3 | 1 |
| **7** | Sindhi Bazar Tiraha | Kotwali | 3 | 3 | 1 |
| **8** | City Station Tiraha | Kotwali | 3 | 3 | 1 |
| **9** | Tilak Bazar Chauraha | Kotwali | 4 | 4 | 1 |
| **10** | Roshan Mohalla Choraha | Kotwali | 4 | 4 | 1 |
| **11** | Nalla Mahavir Pulia Tiraha | Kotwali | 3 | 3 | 1 |
| **12** | Subhash Bazar Tiraha | Kotwali | 3 | 3 | 1 |
| **13** | Lohargali Tiraha | Kotwali | 3 | 3 | 1 |
| **14** | Fubbara Tiraha Kinari Bazaar | Kotwali | 3 | 3 | 1 |
| **15** | Chaubey Ji Ki Fatak | Kotwali | 2 | 2 | 1 |
| **16** | Seb Ka Bazaar Tiraha | Kotwali | 3 | 3 | 1 |
| **17** | Johari Bazaar Tiraha | Kotwali | 3 | 3 | 1 |
| **18** | Emergency Tiraha | MM Gate | 3 | 3 | 1 |
| **19** | Purani Emergency Tiraha | MM Gate | 3 | 3 | 1 |
| **20** | Kaliwadi Chauraha | MM Gate | 4 | 4 | 1 |
| **21** | Collectorate Gate | NAI Ki Mandi | 3 | 3 | 1 |
| **22** | Vishwa Vidyalay Main Gate | HARI PARVAT | 3 | 3 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **23** | Paliwal Main Gate | HARI PARVAT | 3 | 3 | 1 |
| **24** | Sahyog Vatika Main Gate | HARI PARVAT | 3 | 3 | 1 |
| **25** | Vishwa Vidyalay Main Gate (Chauraha) | HARI PARVAT | 4 | 4 | 1 |
| **26** | Wazirpura | HARI PARVAT | 3 | 3 | 1 |
| **27** | Big Bazaar | HARI PARVAT | 4 | 6 | 1 |
| **28** | GG Nursing Home | HARI PARVAT | 3 | 3 | 1 |
| **29** | Sanjay Talkies | HARI PARVAT | 3 | 3 | 1 |
| **30** | LIC Building | HARI PARVAT | 4 | 3 | 1 |
| **31** | Vikash Bhawan | HARI PARVAT | 5 | 5 | 1 |
| **32** | Kapda Market | HARI PARVAT | 3 | 3 | 1 |
| **33** | Max Mall | HARI PARVAT | 4 | 4 | 1 |
| **34** | SBI Zonal Karyalay | HARI PARVAT | 4 | 4 | 1 |
| **35** | Shoe Market | NAI Ki Mandi | 4 | 4 | 1 |
| **36** | Guffa Baar Parking | HARI PARVAT | 3 | 3 | 1 |
| **37** | ICICI Bank Parking | HARI PARVAT | 3 | 3 | 1 |
| **38** | Pratik Centre Parking | HARI PARVAT | 3 | 3 | 1 |
| **39** | Delhigate Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **40** | Hanuman Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **41** | Diwani Chauraha | NEW AGRA | 4 | 7 | 3 |
| **42** | Radhakrishna Choraha | HARI PARVAT | 4 | 4 | 1 |
| **43** | Abhinandana Tiraha | HARI PARVAT | 3 | 3 | 1 |
| **44** | Vijaynagar Chowki | HARI PARVAT | 4 | 4 | 1 |
| **45** | Shah market | HARI | 2 | 6 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| | | PARVAT | | | |
| **46** | Anjaana Market | HARI PARVAT | 0 | 4 | 1 |
| **47** | Opposite Thirrah Khandari Chemps in front of University Gate | HARI PARVAT | 3 | 3 | 1 |
| **48** | Langde Ki Chowki Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **49** | Char Khamba Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **50** | Ratanpura Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **51** | Chauraha Ganda Nala (near Bijar Nagla) | HARI PARVAT | 4 | 4 | 1 |
| **52** | Masta Ki Bagichi Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **53** | Sanjay Palace | HARI PARVAT | 2 | 6 | 1 |
| **54** | DhuliaGanj Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **55** | Hanuman Temple Chauraha | HARI PARVAT | 4 | 4 | 1 |
| **56** | Church Road Suresh Chandra Chandra Dinesh Chandi in front of the showroom | HARI PARVAT | 4 | 4 | 1 |
| **57** | Bhagwaan Talkies Chauraha | NEW AGRA | 4 | 4 | 1 |
| **58** | Shakya Market | NEW AGRA | 2 | 2 | 1 |
| **59** | Tejnagar mode | NEW AGRA | 3 | 3 | 1 |
| **60** | Hydel Chauraha | NEW AGRA | 4 | 4 | 1 |
| **61** | Central Bank cut | NEW AGRA | 3 | 3 | 1 |
| **62** | Shriram Check | NEW AGRA | 4 | 4 | 1 |
| **63** | Shreeji Guest House Cut | NEW AGRA | 3 | 3 | 1 |
| **64** | Agarwal Hospital Cut | NEW AGRA | 3 | 3 | 1 |
| **65** | Janak Park Chauraha | NEW AGRA | 4 | 4 | 1 |
| **66** | Aadarsh Nagar Mode | NEW AGRA | 3 | 3 | 1 |
| **67** | Agarwal Seva Sadar Tiraha | NEW AGRA | 3 | 3 | 1 |
| **68** | Hiralal Halwai Tiraha | NEW AGRA | 3 | 3 | 1 |
| **69** | Water Works from Chairla to the guest house on the road to Bulkeshwar | NEW AGRA | 3 | 3 | 1 |
| **70** | Chandi Chowki Chauraha | NEW AGRA | 4 | 4 | 1 |
| **71** | Shakti Market Chauraha | NEW AGRA | 4 | 4 | 1 |
| **72** | Shalimar Extenson Chairah | NEW AGRA | 4 | 4 | 1 |
| **73** | Subhash Nagar Chairah | NEW AGRA | 4 | 4 | 1 |
| **74** | Dayalbauh Road (Nagla Padi Road) | NEW AGRA | 3 | 3 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **75** | Chitalamata Temple Garden JPNagar Mode | NEW AGRA | 3 | 3 | 1 |
| **76** | Mau Road Nirbhaya Nagar Terraha Mode | NEW AGRA | 3 | 3 | 1 |
| **77** | Lions Colony Mode Madhusudan Motors | NEW AGRA | 3 | 3 | 1 |
| **78** | Near NH-2 Gupta Overseas | NEW AGRA | 3 | 3 | 1 |
| **79** | Dayalbagh Road Sabzi Mandi Choraha | NEW AGRA | 4 | 4 | 1 |
| **80** | Dayalbagh Road Post Office (Tiraha) | NEW AGRA | 3 | 3 | 1 |
| **81** | Abulula Tiraha | NEW AGRA | 3 | 3 | 1 |
| **82** | Abulula's Pulia | NEW AGRA | 3 | 3 | 1 |
| **83** | HI-2 slope before Dia Komplex | NEW AGRA | 3 | 3 | 1 |
| **84** | Bhagwan Talkies Flyover (Parking Stand) | NEW AGRA | 3 | 3 | 1 |
| **85** | Sultanganj's Puliyya Fly A over Mughal Road | NEW AGRA | 4 | 4 | 1 |
| **86** | Manoj Dhaba Tiraha Dayalbagh Road | NEW AGRA | 3 | 3 | 1 |
| **87** | Near Mughal road Chor Road | NEW AGRA | 3 | 3 | 1 |
| **88** | Union Bank Dayalbagh Road | NEW AGRA | 3 | 3 | 1 |
| **89** | Nagla budi chirahah | NEW AGRA | 4 | 4 | 1 |
| **90** | Kalyani Height K Samne | NEW AGRA | 3 | 3 | 1 |
| **91** | Sanjivani Tiraha 100 Ft Road | NEW AGRA | 3 | 3 | 1 |
| **92** | BOI Cut 100 Ft Road | NEW AGRA | 3 | 3 | 1 |
| **93** | Service road cut near Omex Mal | NEW AGRA | 3 | 3 | 1 |
| **94** | Diwani Chauraha (Mandir ke Paas) | NEW AGRA | 3 | 3 | 1 |
| **95** | Badawar House | NEW AGRA | 3 | 3 | 1 |
| **96** | Kendriya Hindi Sasthan | HARI PARVAT | 4 | 4 | 1 |
| **97** | Charchit Chauraha Shastripuram | SIKANDRA | 4 | 4 | 1 |
| **98** | Kailash Mode Guru | SIKANDRA | 3 | 3 | 1 |
| **99** | Kailas Mandir | SIKANDRA | 3 | 4 | 1 |
| **100** | Bhavna State Mode | SIKANDRA | 3 | 3 | 1 |
| **101** | Gurdwara Cut | SIKANDRA | 3 | 3 | 1 |
| **102** | Kirawali Tiraha | SIKANDRA | 3 | 3 | 1 |
| **103** | Sikandra Sabzi Mandi | SADAR | 2 | 4 | 2 |
| **104** | Sultanpura chirahah | SADAR | 4 | 4 | 1 |
| **105** | Mustafa Quarter (Bhappa Chawlai Tiraha) | SADAR | 3 | 3 | 1 |
| **106** | Shahid nagar terrah | SADAR | 3 | 3 | 1 |
| **107** | Bhagat Murthy Chairla | SADAR | 4 | 4 | 1 |
| **108** | Safoota chirahaha | SADAR | 4 | 4 | 1 |
| **109** | Outside railway cant station | SADAR | 2 | 4 | 1 |
| **110** | Rajpur bagiya | SADAR | 2 | 2 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| **111** | Takkar Road Tiraha | SADAR | 3 | 3 | 1 |
| **112** | Ukhra Pulia | SADAR | 3 | 3 | 1 |
| **113** | Madhunagar | SADAR | 4 | 4 | 1 |
| **114** | BD Jain Inter College Campus | SADAR | 2 | 2 | 0 |
| **115** | Nand Tackies Chairah | SADAR | 4 | 4 | 1 |
| **116** | R. M. O Choraah | SADAR | 4 | 4 | 1 |
| **117** | Allabakh Chirahah | SADAR | 4 | 4 | 1 |
| **118** | Kotli Bagchi Semari Taj Chorrah | SADAR | 4 | 4 | 1 |
| **119** | Rajeshwar Temple | SADAR | 2 | 2 | 1 |
| **120** | Eklavya Stadium | SADAR | 2 | 3 | 1 |
| **121** | Cariappa chirahah | SADAR | 4 | 4 | 1 |
| **122** | Veeragana Jhalkarvi Chairah | TAJ GANJ | 4 | 4 | 1 |
| **123** | Basai chirah | TAJ GANJ | 3 | 3 | 1 |
| **124** | Double Tree Y Hilton Chorahah | TAJ GANJ | 4 | 4 | 1 |
| **125** | Vibhav Nagar Chauraha | TAJ GANJ | 4 | 4 | 1 |
| **126** | ADA Heights | TAJ GANJ | 2 | 3 | 1 |
| **127** | Todra Chowki Tiraha | TAJ GANJ | 3 | 3 | 1 |
| **128** | Canara Bank Crossroads Idgah | RAKABGANJ | 3 | 3 | 1 |
| **129** | Mayur Talkies Railway Colony Thiraha Idgah | RAKABGANJ | 3 | 3 | 1 |
| **130** | Railway Station Idgah Colony | RAKABGANJ | 3 | 3 | 1 |
| **131** | Gostwali Gali | | 3 | 3 | 1 |
| **132** | Idgah Katgarh Terraha | | 3 | 3 | 1 |
| **133** | Mohanpura turn corp compound | | 2 | 2 | 1 |
| **134** | Ravli Mandir Terrah | | 3 | 3 | 1 |
| **135** | Ghoulpur house | | 3 | 3 | 1 |
| **136** | Petrol pump intersection Baluganj | | 2 | 3 | 1 |
| **137** | Chauki Baluganj Chauraha | | 4 | 4 | 1 |
| **138** | Targhar Chauraha Baluganj | | 4 | 4 | 1 |
| **139** | Chilagarh Chauraha Baluganj | | 4 | 4 | 1 |
| **140** | Auliya Tiraha | | 3 | 3 | 1 |
| **141** | Sai Ki Takiya Chauraha | | 4 | 4 | 1 |
| **142** | Dhaulpur House Raipur Terraha | | 3 | 3 | 1 |
| **143** | Red Fort Terah Man Gate | | 2 | 2 | 0 |
| **144** | Victoria Park Terrahae | | 3 | 3 | 1 |
| **145** | Chhalkara Devi cremation ground crossing | | 4 | 4 | 1 |
| **146** | Yamuna Kinara Road | | 3 | 3 | 1 |
| **147** | Fort railway station | | 3 | 3 | 1 |
| **148** | Bhairo Temple Chandappan Alleyaha Biography Mani Mandi | | 3 | 3 | 1 |
| **149** | Garib Nagar Tiraha | | 3 | 3 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **150** | Patel Nagar Kali Mata Temple Krishna Kaloni Thiraha Biography Mandi | | 3 | 3 | 1 |
| **151** | Motiganj Market Division | | 3 | 3 | 1 |
| **152** | Kala Mahal Peepal Mandi | | 3 | 3 | 1 |
| **153** | Stretchy Bridge | | 3 | 3 | 1 |
| **154** | Ambedkar Pool (Below) | | 3 | 3 | 1 |
| **155** | Bijlighar Dhuliaganj | | 4 | 4 | 1 |
| **156** | Gudgi Chauraha (Mansoor Khan) | | 4 | 4 | 1 |
| **157** | BP Oil Mill | | 3 | 3 | 1 |
| **158** | Naya Pool Tiraha | | 4 | 4 | 1 |
| **159** | Royal Cut Tiraha | | 3 | 3 | 1 |
| **160** | Niraich near Bhatia Petrol Pump | | 3 | 3 | 1 |
| **161** | Nunihai in front of the Dauji Misthan | | 3 | 3 | 1 |
| **162** | Saufhuta road in front of RB degree college | | 3 | 3 | 1 |
| **163** | Roshan Mohalla Tiraha | | 3 | 3 | 1 |
| **164** | Subhash bazar | | 3 | 3 | 1 |
| **165** | Peepalwala Tiraha | | 3 | 3 | 1 |
| **166** | Hotel Lalas | | 3 | 3 | 1 |
| **167** | Haathi Gate Tiraha | | 3 | 3 | 1 |
| **168** | Mahaveer Nala Mode Meera Hussaini | | 3 | 3 | 1 |
| **169** | Near Mahavir Nalla temple | | 3 | 3 | 1 |
| **170** | Mantola Terahaha | | 3 | 3 | 1 |
| **171** | Barfwali Lane | | 4 | 4 | 1 |
| **172** | Mutwir Masjid Terah Pipal Mandi | | 3 | 3 | 1 |
| **173** | Naubasta Chairah | LOHA MANDI | 4 | 4 | 1 |
| **174** | Besan Basti Chauraha | LOHA MANDI | 4 | 4 | 1 |
| **175** | Telipada Terahaha | LOHA MANDI | 3 | 3 | 1 |
| **176** | Pirabahabuddin Chauraha | LOHA MANDI | 4 | 4 | 1 |
| **177** | Madia Katra Chairla | LOHA MANDI | 4 | 4 | 1 |
| **178** | Kidwai Park Chirahah | LOHA MANDI | 4 | 4 | 1 |
| **179** | Rajamandi Chairah | LOHA MANDI | 4 | 4 | 1 |
| **180** | St. Jans Chairah | LOHA MANDI | 4 | 4 | 1 |
| **181** | Panchkuya Chirahah | LOHA MANDI | 4 | 4 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **182** | Jaipur House | LOHA MANDI | 0 | 4 | 1 |
| **183** | Baldevganj Sarafa Bazar | LOHA MANDI | 2 | 2 | 1 |
| **184** | Lohamandi Main Market | LOHA MANDI | 4 | 4 | 1 |
| **185** | Arya Samaj Temple Chirah Jaipur House | LOHA MANDI | 4 | 4 | 1 |
| **186** | Tota Ka Taal Tiraha | LOHA MANDI | 3 | 3 | 1 |
| **187** | Syedpada Tiraha | LOHA MANDI | 3 | 3 | 1 |
| **188** | Alamganj police check post | LOHA MANDI | 2 | 2 | 0 |
| **189** | Alamgunj police check old | LOHA MANDI | 2 | 2 | 0 |
| **190** | Avadhpuri Terrah | JAGDISHPURA | 4 | 4 | 1 |
| **191** | Jeevan Jyoti Tiraha | JAGDISHPURA | 3 | 3 | 1 |
| **192** | Pratap Nagar Chairahah | JAGDISHPURA | 3 | 4 | 1 |
| **193** | Tempo Station Sector 7 Tiraha Housing Development Colony | JAGDISHPURA | 3 | 3 | 1 |
| **194** | Bichpuri naharpur | JAGDISHPURA | 4 | 4 | 1 |
| **195** | Jeevan Jyoti Hospital Housing Development | JAGDISHPURA | 2 | 3 | 1 |
| **196** | Vinayak Hospital Housing Development | JAGDISHPURA | 3 | 3 | 1 |
| **197** | Moti Hospital Bidla Bychpuri Road | JAGDISHPURA | 3 | 3 | 1 |
| **198** | Sadar Tehsil Tiraha | Shahganj | 3 | 4 | 1 |
| **199** | Shahganj Chairahah | Shahganj | 4 | 4 | 1 |
| **200** | Speed color lab Chauraha | Shahganj | 4 | 4 | 1 |
| **201** | Panchkuya near GIC School Gate | Shahganj | 2 | 2 | 0 |
| **202** | C News Terra | Shahganj | 3 | 3 | 1 |
| **203** | Shivaji Nagar | Shahganj | 2 | 2 | 0 |
| **204** | Alok Nagar Chairah | Shahganj | 4 | 4 | 1 |
| **205** | Saket Chairah | Shahganj | 3 | 3 | 1 |
| **206** | COD Terra | Shahganj | 3 | 3 | 1 |
| **207** | Shakargadh ki Pulia | Shahganj | 3 | 3 | 1 |
| **208** | Pruthvinath Fatak Police Chowki | Shahganj | 2 | 2 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| **209** | Rajiv Talkies Tiraha | Shahganj | 3 | 3 | 1 |
| **210** | 12 Khamba Double Fatak | Shahganj | 2 | 2 | 0 |
| **211** | 12 Khamba Single Fatak | Shahganj | 3 | 3 | 1 |
| **212** | Arjun Nagar Tiraha | Shahganj | 3 | 3 | 1 |
| **213** | Arjun Nagar near Shishu Bharti School Mode | Shahganj | 1 | 2 | 0 |
| **214** | Ajit Nagar Tiraha | Shahganj | 3 | 3 | 1 |
| **215** | Malpura Terrah | Shahganj | 3 | 3 | 1 |
| **216** | Kamalakhah Dargah Gate | Shahganj | 2 | 3 | 1 |
| **217** | Niripura Tiraha Jaganar Road | Shahganj | 3 | 3 | 1 |
| **218** | CNG Petrol Pump Sarai Khwaja | Shahganj | 3 | 3 | 1 |
| **219** | Idgah chirahah | Shahganj | 3 | 3 | 1 |
| **220** | Dayalu Porshad Mode Nagla Chauya | Shahganj | 3 | 3 | 1 |
| **221** | Vayubihar Tiraha | Shahganj | 3 | 3 | 1 |
| **222** | Shah Market Tiraha | HARI PARVAT | 2 | 6 | 1 |
| **223** | Ayodhayakunj Tirahah | Shahganj | 3 | 3 | 1 |
| **224** | Shah Market Nehru Nagar Tiraha | HARI PARVAT | 3 | 3 | 1 |
| **225** | Shashtri Puram Chauraha | Sikandara | 0 | 4 | 1 |
| **226** | Shahganj Chauraha | Shahganj | 4 | 4 | 1 |
| **227** | Shastri Puram ROB Chauraha | Sikandara | 0 | 4 | 1 |
| **228** | Rooi Ki Mandi Chauraha | Shahganj | 0 | 4 | 1 |
| **229** | Kariappa Chauraha | Rakabganj | 4 | 0 | 1 |
| **230** | Shankar Gargh Puliya Tiraha | Shahganj | 0 | 3 | 1 |
| **231** | Subhash Murti Chauraha | Tajganj | 4 | 0 | 1 |
| **232** | Malpura Nahar Chauraha | Shahganj | 4 | 0 | 1 |
| **233** | Rohta Neher Chauraha | Shahganj | 4 | 0 | 1 |
| **234** | Amar hotel Tiraha | Tajganj | 3 | 1 | 1 |
| **235** | Loha Mandi Chauraha | Laha mandi | 4 | 0 | 1 |
| **236** | Kerawali Tiraha, Runakta, Entry Point | Sikandara | 3 | 0 | 1 |
| **237** | Victoria Park Tiraha | Rakabganj | 3 | 0 | 1 |
| **238** | Madiya Katra Tiraha | Hari parvat | 3 | 0 | 1 |
| **239** | Delhi Gate | Hari parvat | 4 | 0 | 1 |
| **240** | State Bank Tiraha | Rakabganj | 3 | 0 | 1 |
| **241** | New Nyayalaya Deewani, New Agra | New Agra | 2 | 1 | 1 |
| **242** | Barrier Gate SN Medical College | MM Gate | 4 | 1 | 1 |
| **243** | ISBT | Hari parvat | 0 | 12 | 2 |
| **244** | Bhawna Tower | Sikandara | 3 | 0 | 1 |
| **245** | Idgah Railway Station | Rakabganj | 3 | 0 | 1 |
| **246** | Maruti State Chauraha | Jagdishpura | 4 | 0 | 1 |
| **247** | SN Medical College, SBI Gate | MM Gate | 2 | 2 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **248** | Rajpur Chungi | Tajganj | 3 | 0 | 2 |
| **249** | Kalakriti tiraha | Tajganj | 3 | 0 | 1 |
| **250** | Nyayala Gate, Cemetary | New Agra | 2 | 1 | 1 |
| **251** | Agrsen Murti Tiraha | Tajganj | 3 | 0 | 1 |
| **252** | Belanganj Chauraha | Chhatta | 4 | 0 | 2 |
| **253** | Chimman Puri Chauraha | Mantola | 3 | 0 | 1 |
| **254** | Sadar Bhatti | Nai Ki Mandi | 4 | 1 | 1 |
| **255** | Nunihai Tiraha | Aetma-ud-daulha | 3 | 0 | 1 |
| **256** | Chhipitola Chauraha | Rakabganj | 4 | 0 | 1 |
| **257** | Baluganj Chauraha | Rakabganj | 5 | 0 | 2 |
| **258** | University Gate Khandari Campus | Hari parvat | 3 | 0 | 2 |
| **259** | Jivani Mandi | Chhatta | 4 | 0 | 2 |
| **260** | Basai tiraha | Tajganj | 3 | 0 | 2 |
| **261** | Patholi nehar Chauraha | Shahganj | 4 | 0 | 2 |
| **262** | G.P.O Chauraha | Sadar | 4 | 0 | 2 |
| **263** | Trydent Tiraha | Tajganj | 3 | 0 | 2 |
| **264** | Mankameshwar Tiraha | Kotwali | 3 | 0 | 2 |
| **265** | Pani Ki Tanki, Ghatia Azam Khan, Sanjay Palace | Hari parvat | 3 | 0 | 2 |
| **266** | 100ft, Shamshabad Rd, Entry Point | Shahganj | 3 | 0 | 2 |
| **267** | Fatehabad Road/Tohra Chowki Tiraha | Tajganj | 3 | 0 | 2 |
| **268** | Shah Market, Tiraha | Hari parvat | 3 | 0 | 2 |
| **269** | Shah Market, Nehru Nagar Tiraha | Hari parvat | 3 | 0 | 2 |
| **270** | DayalBagh, Radhaswami Temple | New Agra | 2 | 0 | 2 |
| **271** | SSP Residence Office | | 3 | 2 | 2 |
| **272** | Main Market Kamla Nagar | New Agra | 4 | 0 | 2 |
| **273** | Kamla Nagar Chauraha | New Agra | 4 | 0 | 2 |
| **274** | Dhulia Ganj Chauraha | Kotwali | 4 | 0 | 2 |
| **275** | Fauwara Chauraha | Kotwali | 4 | 0 | 2 |
| **276** | Madina Tiraha | Mantola | 3 | 0 | 2 |
| **277** | Meera Husaeni Chauraha | Mentola | 4 | 0 | 2 |
| **278** | Amar Pura Chauraha | Jagdishpura | 4 | 0 | 2 |
| **279** | Karbala/Motilal Nehru Road Chauraha Near University | Hari parvat | 4 | 0 | 2 |
| **280** | Awas Vikas chowki k Paas | Jagdishpura | 3 | 0 | 2 |
| **281** | Awas Vikas Sector 8 | Jagdishpura | 3 | 0 | 2 |
| **282** | Karkunj Chauraha | Sikandara | 4 | 0 | 2 |
| **283** | Gadha Pada Chauraha | Hari parvat | 3 | 0 | 2 |
| **284** | Kinari Bazar Tiraha | Kotwali | 3 | 0 | 2 |
| **285** | SSP Residence Office | | 2 | 0 | 2 |
| **286** | Panchvati Chauraha | Tajganj | 3 | 0 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| **287** | Re-trit Tiraha | Tajganj | 3 | 0 | 2 |
| **288** | Bagh Farjana Chauraha | Hari parvat | 4 | 0 | 2 |
| **289** | Hanuman Mandir Chauraha | Hari parvat | 4 | 0 | 2 |
| **290** | St. poal Tiraha | Hari parvat | 3 | 0 | 2 |
| **291** | Shaket Tiraha | Shahganj | 4 | 0 | 2 |
| **292** | Free Ganj | Chhatta | 3 | 0 | 2 |
| **293** | Yamuna View Park | Rakabganj | 2 | 0 | 2 |
| TOTAL | | | | **790** | **326** |

## 17.4. Annexure 4: Emergency Panic Button with Public Addressing System

| S.No. | List of Junctions | Public Addressing System with Emergency Panic Button |
|---|---|---|
| **1** | Amar Singh Gate (Red Fort) | 1 |
| **2** | Bhagwan Talkies | 1 |
| **3** | Bijlighar Chauraha | 1 |
| **4** | Bodhla Chauraha | 1 |
| **5** | Collectorate Tiraha | 1 |
| **6** | Entry point inner Ring Road Fatehabad Road | 1 |
| **7** | Hariparvat Chauraha | 1 |
| **8** | Itmad-Ud-Daulah Tiraha | 1 |
| **9** | Kerawali Tiraha, Runakta, Entry Point | 1 |
| **10** | Keriya More, Sarai Khawaja, Entry Point (Traffic) | 1 |
| **11** | Nunihai Tiraha | 1 |
| **12** | Panchkuia | 1 |
| **13** | Purani Mandi Chauraha | 1 |
| **14** | PWD Club Chauraha | 1 |
| **15** | Rambaugh Chauraha | 1 |
| **16** | Sai Ka Takiya Chauraha | 1 |
| **17** | Shahdra Chauraha, Bajrang Petrol Pump, Entry Point | 1 |
| **18** | Shamshan Ghat Chauraha | 1 |
| **19** | Sikandra Tiraha | 1 |
| **20** | Soor Sadan Tiraha | 1 |
| **21** | St Johns Chauraha | 1 |
| **22** | Subhash Park Tiraha | 1 |
| **23** | Taj View Tiraha | 1 |
| **24** | Targhar Chauraha | 1 |
| **25** | TDI Mall | 1 |
| **26** | Tedhi Baghiya, Entry Point | 1 |
| **27** | Water Works Junction | 1 |
| **28** | 100Ft Tiraha PS Shah Ganj, Fatehpur Entry Point | 1 |
| **29** | Agra College Tiraha | 1 |

| | | |
|---|---|---|
| **30** | Deewani Tiraha, New Agra | 1 |
| **31** | Dhakran Chauraha | 1 |
| **32** | Gurudwara Cut | 1 |
| **33** | Idgah Chauraha | 1 |
| **34** | Kargil Petrol Pump Tiraha | 1 |
| **35** | Khandhari Chauraha | 1 |
| **36** | Loha Mandi Chauraha | 1 |
| **37** | Maruti Estate Chauraha | 1 |
| **38** | Nalband Chauraha | 1 |
| **39** | Pratapura Chowk | 1 |
| **40** | Raja Mandi Chauraha | 1 |
| **41** | State Bank Tiraha | 1 |
| **42** | Sultan Ganj Ki Pulia | 1 |
| **43** | University Gate Khandari Campus | 1 |

## 17.5. Annexure 5: Environment Sensors

| S. No | Location | Type of Monitoring |
|---|---|---|
| **1** | Rajdeep Bhawan, NH2, Transport Colony | Urban Monitoring |
| **2** | Sanjay Place, Civil Lines, | Urban Monitoring |
| **3** | Rambagh, Ramnagar Colony, Civil Lines, | Urban Monitoring |
| **4** | Shri Mahabaleshwar Mandir, Babu Gulab Rai Marg, | Urban Monitoring |
| **5** | Moti Katra, Mantola | Urban Monitoring |
| **6** | Namner, Rakabganj | Urban Monitoring |
| **7** | Phulatti Bazar, Rawatpara | Urban Monitoring |

| | | |
|---|---|---|
| **8** | Raja Mandi, Mantola | Urban Monitoring |
| **9** | Rajpur Chungi, Indrapuram | Urban Monitoring |
| **10** | Sadar Bazar, Agra Cantt. | Urban Monitoring |
| **11** | Shahganj | Urban Monitoring |
| **12** | Shiv Nagar, Naripura | Urban Monitoring |
| **13** | Nai ki Mandi, Mantola | Urban Monitoring |
| **14** | Tajganj | Urban Monitoring |
| **15** | Dalihai, Paktola, Tajganj | Urban Monitoring |
| **16** | Dhandhupura | Urban Monitoring |
| **17** | Kaserat Bazar, Tajganj | Urban Monitoring |
| **18** | Vibhav Nagar | Urban Monitoring |
| **19** | Indrapuram, Tajgan | Urban Monitoring |
| **20** | Defence Estate | Urban Monitoring |
| **21** | Jodha Bai Ka Roza | Urban Monitoring |
| **22** | Shanti Nagar, Ashok Nagar | Urban Monitoring |
| **23** | Dhuliya Ganj, Mantola | Urban Monitoring |
| **25** | Mandi Said, Civil Lines | Urban Monitoring |
| **26** | Model Town, Idgah Colony | Urban Monitoring |
| **27** | Agra Fort, Rakabganj | Urban Monitoring |
| **28** | Agra Fort-1, Bhogipura | Urban Monitoring |
| **29** | Delhi Gate, SH 39, Agra Fort | Urban Monitoring |
| **30** | Chhipitola Rd, Rakabganj | Urban Monitoring |
| **31** | Sadar Bhatti, Dhawlikar | Urban Monitoring |
| **32** | Ghatiya Chauraha, Chilli Int Rd, Mandi Said | Urban Monitoring |
| **33** | Lajpat Kunj, Civil Lines | Urban Monitoring |
| **34** | Dharmapuri, Forest Colony | Taj Mahal Monitoring |
| **35** | Taj Museum | Taj Mahal Monitoring |
| **36** | Maa Sarawali Mandir | Taj Mahal Monitoring |
| **37** | Great Gate | Taj Mahal Monitoring |
| **38** | The Garden, Taj Mahal | Taj Mahal Monitoring |
| **39** | The Mosque-Kau Ban | Taj Mahal Monitoring |

## 17.6. Annexure 7: List of Location for Variable Message System

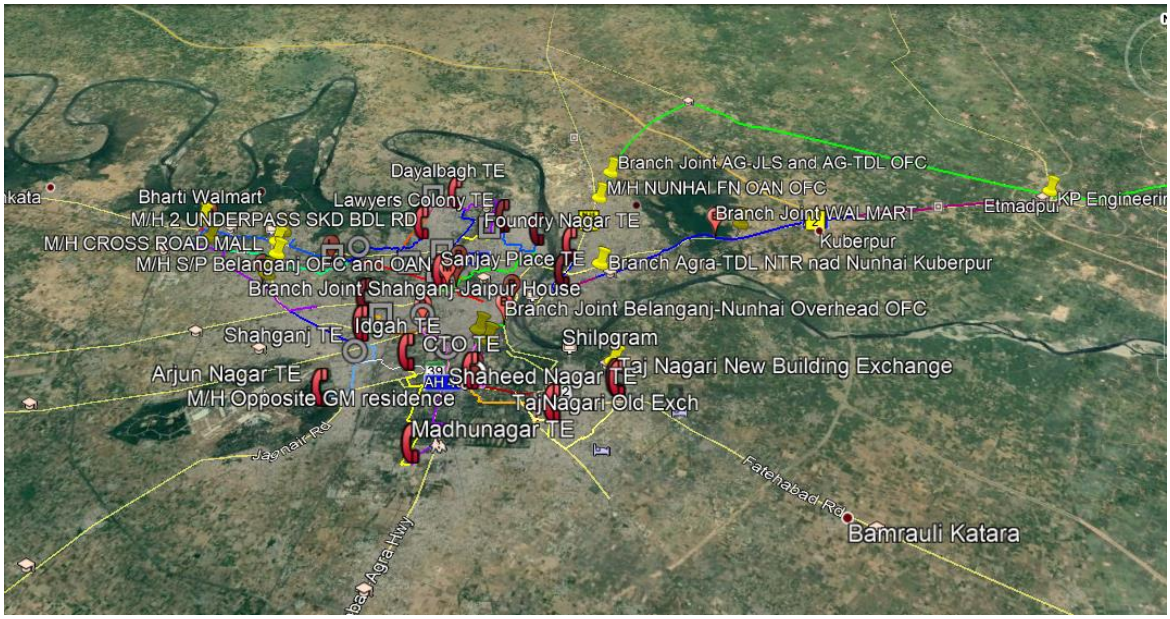
| S.No. | List of Junctions | Latitude | Longitude |
|---|---|---|---|
| 1 | VMS (MG RD Southbound) - 1 | 27.20772 | 78.00392 |
| 2 | VMS (MG RD Southbound) - 2 | 27.19798 | 78.00257 |
| 3 | VMS (MG RD Northbound) - 3 | 27.19479 | 78.00131 |
| 4 | VMS (MG RD Southbound) - 4 | 27.18276 | 78.00116 |
| 5 | VMS (MG RD NorthBound) - 5 | 27.16276 | 78.00867 |
| 6 | VMS (Fatehbd RD Eastbound) - 6 | 27.16088 | 78.03101 |

| | | | |
|---|---|---|---|
| 7 | VMS (Fatehbd RD Westbound) - 7 | 27.16068 | 78.04155 |
| 8 | VMS (Fatehbd RD Westbound) - 8 | 27.15726 | 78.06449 |
| 9 | VMS (Fort RD Westbound) - 9 | 27.17517 | 78.026 |
| 10 | VMS (NH-2 RD Westbound) - 10 | 27.21249 | 78.07157 |
| 11 | VMS (NH-2 RD Eastbound) - 11 | 27.2164 | 77.9488 |
| 12 | VMS (Puranimandi Xing RD Northbound) - 12 | 27.17391 | 78.02526 |

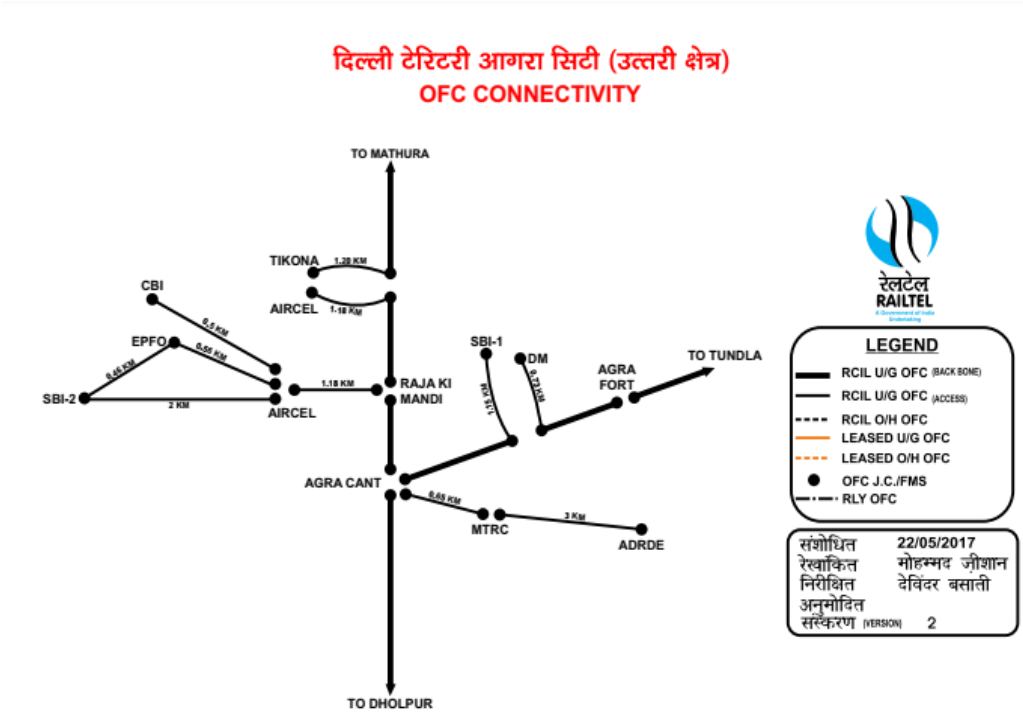
## 17.7. Annexure 6: OFC Network Availability

Please find the Optical Fiber availability in Agra from BSNL and Railtel in trailing. There are also various other operators (Telecom and Local MSO) who have optical network availability and MSI may approach directly.

**BSNL Network**




**Railtel Network**




17.8. Annexure 7: List of Police Stations and Chowkis

All the police stations and chowkis need to be connected over the network and shall be well equipped with desired peripherals to support the analytics and also receive events/alarms for immediate response with local monitoring and visuals.

| SR NO | POLICE STATIONS | PERSON IN CHARGE | POLICE CHOWKI |
|---|---|---|---|
| 1 | KOTWALI | SONVIR SINGH | FOLATI |
| 2 | KOTWALI | SUESH KUMAR SAGAR | SIEB BAZAAR |
| 3 | KOTWALI | CANDRIS GUTAM | PAYI |
| 4 | KOTWALI | SUDIR SINGH | RAVAT PADA |
| 5 | KOTWALI | RAKISH KUMAR | HIG KE MANDI |
| 6 | NAIE KE MANDI | SANTOSH KUMAR | DIVIGAN |
| 7 | NAIE KE MANDI | MANOJ KUMAR | COLLECTORATE |
| 8 | M.M GETA | RAHUL KUMAR | AMARGENC |
| 9 | M.M GETA | SATISH CHAND | KHIKI KALE KHAN |
| 10 | M.M GETA | SUDIR KUMAR | DIVIGAN |
| 11 | HARI PARVAT | SRIKAHSNH | KHANDARI |
| 12 | HARI PARVAT | RAKISH KUMAR | NAHRU NAGAR |
| 13 | HARI PARVAT | DINESH KUMAR | T.P.NAGAR |
| 14 | HARI PARVAT | CHANDVIR SINGH | RING ROAD |
| 15 | HARI PARVAT | HARIND MALIK | SANJAY PALIS |
| 16 | HARI PARVAT | ASUVANI KUMAR | PALIVAL |
| 17 | HARI PARVAT | KRAPAL SINGH | DELHIGATE |
| 18 | HARI PARVAT | PUSPIND KUMAR | HATIYA AJAM |
| 19 | HARI PARVAT | ROSANLAL | JILA GIL |

| | | | |
|---|---|---|---|
| 20 | NEW AGRA | RAGWIND SINGH | BALKISWAR |
| 21 | NEW AGRA | RAJKUMAR | KAMLA NAGAR |
| 22 | NEW AGRA | OMPRAKASH SINGH | AMAR VIHAR |
| 23 | NEW AGRA | GANVIR SINGH | BRAJ BIHAR |
| 24 | NEW AGRA | MUKESH SHARMA | DIVISION |
| 25 | NEW AGRA | YOGENDRA | DAYAL BAGH |
| 26 | NEW AGRA | MANOJ KUMAR | DIWANI |
| 27 | SIKANDRA | ARVIND KUMAR | SHASTRIPURAM |
| 28 | SIKANDRA | PRAMOD KUMAR | FACTORY AREA |
| 29 | SIKANDRA | ARUN KUMAR | RONAKTA |
| 30 | SIKANDRA | RAJ KUMAR YADAV | PEEPAL MANDI |
| 31 | CHATTA | BHARAT BHUSHAN | BHATTI |
| 32 | CHATTA | RAJESH KUMAR | KUDRI MANSOOR KHAN |
| 33 | CHATTA | CHANDRA PAL SINGH | DIVISION |
| 34 | CHATTA | AMIT KUMAR | JEEVANI MANDI |
| 35 | CHATTA | AVNEESH TYAGI | BELANGANJ |
| 36 | MANTOLA | RAMKRISHNA | DIVISON |
| 37 | MANTOLA | BORENDRA SINGH | SUBHASH BAZAAR |
| 38 | AETMA-UD-DAULHA | SANJAY KUMAR SHARMA | TRANS YAMUNA |
| 39 | AETMA-UD-DAULHA | VINOD KUMAR YADAV | MANDI SAMITI |
| 40 | AETMA-UD-DAULHA | NITYANDRA PANDEY | FOUNDRY NAGAR |
| 41 | AETMA-UD-DAULHA | JATINDRA PRASAD | DIVISION |
| 42 | AETMA-UD-DAULHA | VIRENDRA KUMAR | LUNIHAI |
| 43 | SADAR | NEERAJ SINGH | SAUDAGAR |
| 44 | SADAR | RAJEEV KUMAR | LAL KURTI |
| 45 | SADAR | SUKHVEER SINGH | FACTORY LINE |
| 46 | SADAR | YOGENDRA KUMAR | BINDOO KATRA |
| 47 | SADAR | GYANENDRA SOLANKI | CANT |
| 48 | SADAR | PRASHANT TYAGI | SHAHEED NAGAR |
| 49 | RAKABGANJ | CHANDRASHEKHAR GAUTAM | BALUGANJ |
| 50 | RAKABGANJ | NARENDRA SHARMA | FORT |
| 51 | RAKABGANJ | VINOD KUMAR | IDGAH |
| 52 | RAKABGANJ | ARVIND | TORA |
| 53 | TAJGANJ | BHUVNESH KUMAR DIXIT | EKTA |
| 54 | TAJGANJ | YOGENDRA KUMAR YADAV | NEETIBAGH |
| 55 | TAJGANJ | ARVIND KUMAR | VIBHAV NAGAR |
| 56 | TAJGANJ | ANUP SAROJ | TAJ MAHAL DEPOT |
| 57 | TAJGANJ | RAJEEV KUMAR | DIVISON |
| 58 | TAJGANJ | MANOJ PAWAR | JAIPUR HOUSE |
| 59 | TAJGANJ | ANUJ MALIK | GOKULPURA |
| 60 | LOHA MANDI | ASHOK KUMAR | RAJA MANDI |
| 61 | LOHA MANDI | RAJEEV KUMAR | ALKA POORI |

| | | | |
|---|---|---|---|
| 62 | LOHA MANDI | NAVEEN KUMAR | AWAAS VIKAS |
| 63 | LOHA MANDI | PRADEEP KUMAR | DIVISION |
| 64 | LOHA MANDI | MAHESH YADAV | BODHLA |
| 65 | JAGDISPURA | RUPENDRA MISHRA | BICHPURI |
| 66 | JAGDISPURA | NADEEM | AWADHPURI |
| 67 | JAGDISPURA | SHIV BHAN SINGH | KEDAR NAGAR |
| 68 | JAGDISPURA | NITYANAND PANDEY | KHERIA |
| 69 | JAGDISPURA | DINESH SHARMA | SARAI KWAJA |
| 70 | JAGDISPURA | PUSHPENDRA KUMAR | PRATHVINATH |
| 71 | SHAHGANJ | VEGH RAM | DIVISION |
| 72 | SHAHGANJ | RAJEEV KUMAR GAUTAM | PATHAULI |