DPR: Integrated Command and Control Center for Namchi Municipal Council

Smart City Solutions for Namchi Smart City

CONTENTS

ABBREVIATIONS
1.INTRODUCTION 1
1.1. Title of Project 1
1.2. Objective of the Project 1
2. Scope of the project 1
2.1. Integration Platform 1
2.2. Smart Governance and Citizen Services 1
2.3. Video Surveillance – Summarizer and Indexing 2
2.4. Information Dissemination & Redressal System 2
2.5. Disaster Management 2
2.6. Web-based SDN application development platform 2
2.7. Smart Utility Solution 3
2.8. Communication Infrastructure 3
2. Brief Description 4
3.1. Brief outline of the project with specific technology fall-outs 7
3.1.1. Integration Platform 7
3.1.2. Smart Governance and Citizen Services 8
3.1.3. Video Surveillance – Summarizer and Indexing 8
3.1.4. Information Dissemination & Redressal System 9
3.2. Disaster Management 10
3.3. Disaster Management System 10
3.4. Web-based SDN application development platform 10
3.5. Smart Utility Solutions 11
3.6. Communication Infrastructure 13
4. Detailed description of the Project 14
4.1. Integration Platform 14
4.2. Functional Architecture and Building Blocks of Integration Platform for City Services 15
5. Smart Governance and Citizen Services 18
5.1. Unified Portal 18
5.2. Property Development, Approval, Assessment & Management System | Auto-DCR 25
5.3. Stamp Duty & Registration of Land 26
5.4. Web based Land Management System 19
5.5. Document Management System 19
5.6. Video Surveillance – Summarizer and Indexing 20
5.7. Information Dissemination & Redressal System 23
5.8. Disaster Management 29
5.8.1. Proposed study Area: Namchi 29
5.8.2. Disaster Management 29
5.9. Disaster Management System 30
5.9.1. Disaster Management Cycle 30
5.9.2. Phases in Disaster Management 31
5.9.3. Role of ICT in Disaster Management 32
5.9.4. Module in the proposed study 33
5.10. Web-based SDN application development platform 33
5.11. Smart Utility Solutions 35
5.12. Communication Infrastructure 40
6. Year wise Deliverables: 41
7. Duration of Project 44

8. Total Budget outlay 44
9. Integrated City Command and Control Centre 46
9.1. Importance of Command and Control Center 46
9.2. Evolution of Control Rooms 47
9.3. Namchi City Command and Control Center 48
9.4. C4 Design Standards 49
9.5. ISO 11064 51
9.6. Design Process of Control Room 51
9.7. Factor-1: Ergonomics 52
9.8. Factor-2: Video Walls 53
9.9. Factor 3: Consoles 57
9.10. City Command and Control Platform (CCCP) 61
9.10.1. CCCP Core Components 61
9.10.2. General Functional Description and Features 62
9.10.3. Standard Operating Procedures -Functional Capabilities 63
9.10.4. Common Operational Picture (COP) -Functional Capabilities 64
9.10.5. Incidence Management - Functional Capabilities 64
9.10.6. Dash boarding and KPI – Functional Capabilities 65
9.10.7. Business Rules Engine – Technical Capabilities 66
9.10.8. Workflow - Technical Capabilities 66
9.10.9. Analytics and Reporting – Technical Capabilities 67
9.10.10. CCCP Graphical User Interface (GUI)- Technical Capabilities 67
9.10.11. Integration Layer – Technical Capabilities 68
9.10.12. General System Development Functionality- Technical Capabilities 68
9.10.13. General System Display Functionality- Technical Capabilities 69
9.10.14. GIS Display – Technical Capabilities 69
9.10.15. Asset Management – Technical Capabilities 70
9.11. C4 Integration Matrix 70
10. Water 72
10.2. Ideation 72
10.2 Solution Requirements 74
10.3. Objectives for Intelligent Water Supply & Monitoring Systems 74
10.4. Program Management & Project Execution Model 76
10.5. System Study 76
10.3. Network Analysis 77
10.3.1. Dashboard 78
10.3.2. Leakage Management 78
10.4. SCADA Specifications (Centralized System) 79
10.4.1. Foreword 79
10.4.2. General Considerations 79
10.4.3. Operator Displays 80
10.4.4. Graphic Builder Software 81
10.5. Alarming 84
10.5.1. Alarm Display 84
10.5.2. Alarm Sorting 85
10.5.3. Alarm Management 85
10.6. Trending 86
10.6.1. Trend Display 86
10.6.2. System Specifications 87
10.6.3. Historical Data 87
10.6.4. Reports 87
10.6.5. System Security & Access 88

10.6.6. Web Clients 89
10.7. Process Historian 89
10.7.1. Foreword 89
10.7.2 Software Details 89
10.7.3 Reports & Alarms 91
10.7.4 Contingency Management - Pollutants 91
11. Energy 96
11.1 Ideation 96
11.2. Solution Requirements 98
11.3. Used Cases - Power 100
12. Intelligent Traffic Management System (ITMS) 101
12.1. Ideation 101
12.2. Solution Requirements 103
12.2.1. Operator Workflow 105
12.2.2. User Workspace Customization 105
12.2.3. Investigation & Forensic Analysis 107
12.3. Functional Requirement 108
12.3.1. Automatic Number Plate Recognition System (ANPR) 108
12.3.2. Red Light Violation System (RLVD) 109
12.3.3. Over Speed Detection System 110
12.3.4. E-Challan System 110
12.4. Use Cases: Intelligent Transport System 112
13. . City Surveillance 113
13.1. Ideation 113
13.2. Components/Architecture 116
13.3. Solution requirements 117
13.4. Functional Specifications 118
13.4.1. Video Management System: 118
13.4.2. Human Machine Interface (HMI) 119
13.4.3.. Health Monitoring 120
13.4.4. Operator Workflows 120
13.4.5. Use Cases - Surveillance 121
14. Solid Waste Management (SWM) 122
14.1. Ideation 122
14.2. Solution Requirements 124
14.3. Functional Specifications 126
14.3.1. Automated Vehicle Locator Management System 126
14.3.2. Mobile GPS based Staff Attendance Management System 127
14.3.3 Mobile Application for Customers 127
14.3.4 Unified Dashboard View for Solid Waste Management 127
14.3.5 Infrastructure Requirements 128
15. Technical Specification 131
15.1 GPS/GSM Tracker 131
15.2 RFID Tag and Reader 133
15.3. RFID Reader Specifications 134
15.4. Pan Tilt and Zoom – based Cameras CCTV 134
15.4 Use Cases (SWM) 135
16. Smart Pole with Environment Sensors 136
16.1 Ideation 136
16.2 Solution Requirements 138
16.3 Functional Specifications 139
16.3.1 Environment Sensors 139

16.3.2 Public Address System (PAS) ... 140
16.3.3 Variable Messaging System (VMS) ... 141
16.3.4 Digital Billboard ... 142
16.3.5 Panic Button ... 142
16.3.6 CCTV Cameras for Surveillance ... 142
16.4 Technical Specification ... 143
16.4.1 Environment Sensor ... 143
16.4.2 Public Address System (PAS) ... 143
16.4.3 Digital Billboard ... 145
16.4.4 Panic Button ... 145
16.4.5 Wi-fi Hotspots at Public Places ... 146
16.4.6 CCTV Cameras Type 1 - 360° Panoramic Camera ... 150
16.4.7 CCTV Cameras Type 2 - Fixed Box Camera ... 151
16.4.8 Video Analytics for IP Box Camera ... 153
17. Intelligent Transport System (ITS) ... 156
17.1 Ideation ... 156
17.2 Solution Requirements ... 156
17.3 Functional Specifications ... 157
17.3.1 Vehicle Location System & Passenger Information System ... 157
17.3.2 PIS at Taxi and Bus Queue Shelter (TBQS) ... 158
17.3.3 Mobile Application ... 158
17.4 Module Wise Functionality Requirements ... 159
17.5 General Functional Requirement of the proposed Application Software ... 160
17.6 Technical Specifications for AVL System ... 163
17.6.1 GPS/GSM Tracker ... 163
17.6.2 Technical Specs for RFID Tag and Reader ... 165
17.6.3 RFID Reader Specifications ... 166
17.6.4 VMS ... 167
17.6.5 Application Software for VMS (Control Messaging Application at Data Center) ... 169
17.7 Use Cases ... 169
18. E Governance ... 170
18.1 Ideation ... 170
18.2 Solution Requirements ... 175
18.2.1 Integration with C4 ... 175
18.3 Use Cases ... 178
19. Geographical Information System (GIS) ... 179
19.1 Ideation ... 179
19. Solution Requirements ... 184
19.1, GIS Applications ... 185
20. Smart Lighting ... 187
20.1 Ideation ... 187
20.2 Functional Requirements ... 190
20.3 Connectivity / Network Requirements ... 190
20.4 Use Cases ... 196

ABBREVIATIONS

API	**Application Program Interface**
ANPR	Automated Number Plate Recognition

BPP	Blue Print Plan
CCTV	Close Circuit Television
CPU	Central Processing Unit
DCR	Development Control Regulations
GPU	Graphical Processing Unit
HD	High Definition
ICCC	Integrated Command and Control Center
ICT	Information and Communication Technology
IoT	Interner Of Things
IT	Information Technology
ITMS	Integrated Traffic Management System
LED	Light Emitting Diode
MoH&UA	Ministry of Housing and Urban Affairs
NMC	Namchi Municipal Council
NOC	No Objection Certificate
OFC	Optical Fiber Cable
REST	Representational State Transfer
SCADA	Supervisory Control and Data Acquisition
SDN	Software Defined Networking
SI	System Integrator
SOA	Service Oriented Architecture
UDHD	Urban Development and Housing Department
VMS	Video Messaging Services
Wi-Fi	Wireless Fidelity

LIST OF FIGURES

FIGURE 1: INTEGRATION PLATFORM 4
FIGURE 2: INTEGRATION PLATFORM - COMPONENTS 7
FIGURE 3: VIDEO STREAMS GENERATED BY WEBCAMS AND CCTV CAMERAS 9
FIGURE 4: SDN LAYERS 11
FIGURE 5: INTEGRATION PLATFORM FOR CITY SERVICES 14
FIGURE 6: CORE BUILDING BLOCKS OF IOE PLATFORM 15
FIGURE 7: VIDEO SYNOPSIS 21
FIGURE 8: VIDEO INDEXING & RETRIEVAL FRAMEWORK 22
FIGURE 9 : MULTI-LINGUAL INFORMATION DISSEMINATE & REDRESSAL SYSTEM 24
FIGURE 10: MULTI-LINGUAL COMMUNICATION THROUGH SPEECH & SCRIPT SUPPORT 26
FIGURE 11: INFORMATION FLOW DURING EARLY WARNING SYSTEM 31
FIGURE 12: SDN ARCHITECTURE 33
FIGURE 13: AUTOMATED SURVEILLANCE 34

1. NTRODUCTION

1.1. Title of Project

ICCC: Integrated Command and Control Center for Namchi Smart City, Sikkim

1.2. Objective of the Project

I. To develop the digital eco-system that will enable development of smart solutions
II. Use of ICT for improving the livability& sustainability
III. Development of Smart ICT solutions for improving the efficiency and quality of life
IV. Improve the ease of doing business and enable economic development through digital transformation

2. Scope of the project

2.1. Integration Platform

The proposed Integration platform focuses to provide an integrated and holistic view across the relevant vertical for a given use-case. The integration platform would provide centralized view specific applications and deliver associated services accordingly. This will enable sharing of data and capabilities across the systems so as to delivery inter-domain use case scenario or service delivery.

2.2. Smart Governance and Citizen Services

- The components envisaged to be included in Smart Governance are:
- Unified portal (to support all the citizen services provided by Namchi Municipal Council and later integration with other utilities billing)
- Auto-DCR (Online BPP approval system), Land use monitoring and management system
- App based incident management
- App based Grievance Redressal System
- Document Management System
- Mission Jyoti App (App based on POCSO Act)
- The features under Citizen Services shall include the following:
- Universal Identity (Aadhaar)
- Utility Services
- Ground Rent (UDHD Allotted Site)
- Registrations & Certification
- Issuance of NOCs for various purposes from Namchi Municipal Council
- Any other existing and future services that would be provided by NMC

2.3. Video Surveillance – Summarizer and Indexing

- The deliverable of the pilot is a system to demonstrate the summarized surveillance video including:
- Short summarized surveillance video showing multiple activities occurred at different times, while preserving the essential activities of the original video.
- Index of the synopsis video pointing to the original video and the original time of activity
- Detection of moving objects in selected areas covered by the camera, where the object of interest could be tracked across several videos or it could simply be an object that has been left unattended in restricted areas covered by the cameras.
- Detection of illegal parking in no parking zones. Detection of vehicles driving in wrong way or reversing.
- ANPR- Automated Number Plate Recognition
- Detection of people flow and counting of people in selected areas.
- Parallelization of above modules across intra-video (multiple videos) and inter-frame (single video) on CPUs/GPUs

2.4. Information Dissemination & Redressal System

This system will provide citizens, a direct access to the Namchi Municipal Council and other Government departments. It will be a shared system for information handling for all Government departments and agencies thereby reducing redundancy, operational overheads & costs.

It will provide centralized help-desk for guidance/information to citizens on various services offered by the Government departments and as well as by Namchi Municipal Council. Set up a single access point having sufficient number of trained staffs to reply to the citizens' queries received through telephonic call, mobile app, and web.

It will generate a database to provide long-term solution, and systemic policy improvement for the problems of citizens ensuring that the Government is more accountable to the citizens.

2.5. Disaster Management

The objective is to build a safe and disaster-resilient Namchi Municipal Council by developing a holistic, proactive, multi-disaster oriented & technology-driven strategy through a culture of prevention, mitigation, preparedness & response.

2.6. Web-based SDN application development platform

The aim is to deliver a web-based integrated development environment for developing SDN (Software Defined Networking) applications. The system provides a platform for experimentation, development, debugging, simulation, emulation, deployment, testing, verification and execution of SDN applications.

The envisioned system comprises of a web-interface, IDE, Controller Engine, and network elements to support the actual deployment. IDE and Controller Engine will communicate through Representational State Transfer (REST) Application Program Interface (API).

Controller engine and network elements will communicate through Open Flow protocol. In the first phase, support for Open Day Light and ONOS controller will be provided.

2.7. Smart Utility Solution

- The aim of the system is to Integrate, Monitor and Control the following solutions:
- Smart street lighting
- Smart Energy metering solution
- Intelligent Water Management or integration of SCADA System in ICCC
- Smart Poles
- Intelligent Parking Lot Management | ITMS
- Electric Vehicle Charging Station: Monitoring and Analysis of Power Quality
- Solar Power Operated Vehicle Actuated Wireless Traffic Signal Controller
- Pelican Controllers (Pedestrian operated signal control for mid-block crossings)
- Environmental Sensors | Air Quality Monitoring Nodes
- Smart Garbage Bins
- Video Messaging Services (VMS- Dashboard)
- Environmental Sensors

2.8. Communication Infrastructure

Fiber optics is a major building block in the telecommunication infrastructure and is the most advanced communication system available in the world today; it will be the way to deliver communications in the future. The citywide Wi-Fi will be used for the providing communication for utility infrastructure.

3. Brief Description

Namchi, district headquarter of South-Sikkim, India is one of the cities currently selected to be developed as a Smart City under the national flagship mission of incumbent federal government of India under Ministry of Housing and Urban Affairs (MoH&UA). Therefore it is proposed to develop and use of robust ICT infrastructures to improve the governance, promptness in delivery of services by the NMC thereby improving the livability, ensure sustainability and finally translating into the economic development of the region. Therefore to ensure such vision, it's imperative for a city to find smarter ways to manage complexities, reduce expenses, increase efficiency of the governance and enable the transparency in the governance.

As a paramount of core of smart city, Namchi Municipal Council envisages developing robust ICT infrastructures and desirous to adopt the digital transformation to achieve its vision of such smarter growth. The transforming digital technology envisages creating conducive environment to investors in the city's core physical infrastructures and scale up in the ease of doing business.

Keeping in view the core concept of Smart City, this report is about developing ICT infrastructure (eco-system) on which various smart solutions listed in the reports will have to be integrated in ICCC.

The proposed smart city solutions are for analysis, monitoring, management and dissemination of information collected from various intelligent systems deployed across the city consisting of IoT like sensors, CCTV cameras etc. It helps in near real-time management of situations and generates faster and effective responses. It also enables the collection of data and analysis leads to more accurate forecasting, action and allocation of resources. The decisions thus made would be evidence based and data driven.

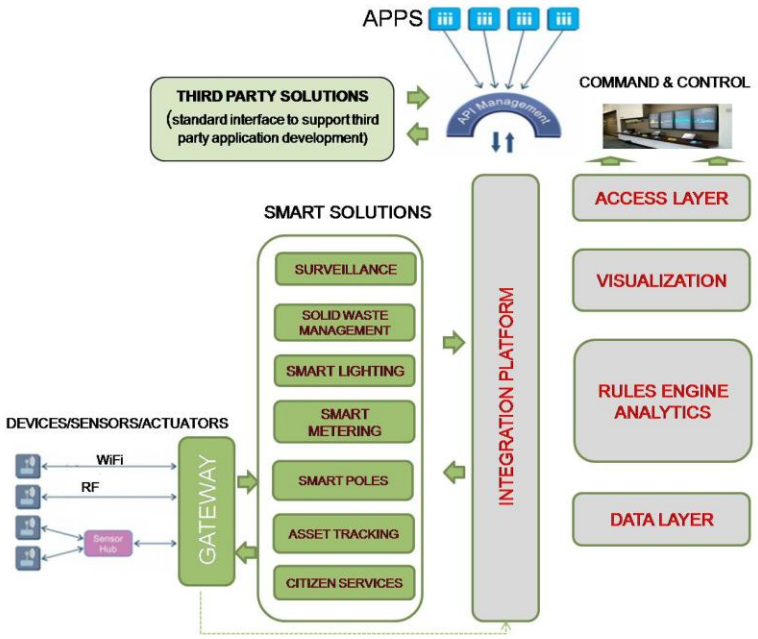


Figure 1: Integration Platform

Integration platform: The integration is envisaged using the SOA (Service Oriented Architecture). This is to support the independent architectures for different systems and the data exchange. This framework will also expose certain services/APIs for future integration with the third party systems and also for developing mobile applications.

API Management: This is a component to expose generic APIs/services for integrating with the third party systems or for developing mobile applications. A list of services / APIs should be provided along with documentation to help developers in integration

Data Layer: Data can be from various sources from sensors, camera feeds, IT systems etc. Integration framework should support all types of data that include data from devices and sensors, transactional data, data warehouse, unstructured content like videos, images, geo-spatial data. This data is supposed to be on secured data storage located in Data centers. Data centers are the heart of the smart city projects. The data centre acts as a warehouse for the data collected from the surveillance sensors and other data. It is responsible for providing continuous, real-time data to command viewing centre for seamless, efficient and effective operations. Generally, a primary and a secondary data centre are established in order to ensure that operations remain uninterrupted even if one is down. The SI will have responsibility of sizing the data, defining the storage types and securing the data.

Analytics: Analytics platform provides IoT-specific analytics that reduce the time, cost and required expertise to develop analytics-rich, vertical IoT applications. Platform's IoT-specific analytics uncover insights, create new information, monitor complex environments, make accurate predictions, and optimize business processes and operations.

The applications of the IoT Big Data Platform can be classified into four main categories

- Deep understanding and insight knowledge
- Real time actionable insight
- Performance optimization and
- Proactive and predictive applications

Visualization: This layer helps in data mapping and defining the visualization patterns. The display can be with data overlaid on maps with certain highlighting and in the form of dash boards. The visualization formats can be discussed and defined but the goal of visualization is decision making

Access Layer: In a system as complex as a smart city, that has large numbers of sensors and multiple layers of network and equipment, a secure user management system is important. There can be numerous users who need to access the system for various actions. Provision for role-based access to individuals through a single or multiple sign in for different roles

Gateway: This is interface between the sensing layer and the IT systems. It can be any gateway to support the underlying sensor network. By placing various types of sensors, we can monitor the environment, collect information and upload the data. A common sensing layer can integrate and

provide access to various types of sensors. The on-field sensor network help to visualize, sense situations, relay situational awareness to the command control center, perform automated or informed actions based incidents. A massive volume of information is generated from a variety of different sensors and is forwarded to the command control center and human operators to take necessary actions based on standard procedures or custom commands.

Command control center: it is based on decision-making capabilities which enable the system to perform an intelligent enrichment of data from multiple concurrent and/or correlated information sources (surveillance cameras, ANPR cameras, road sensors) and provide the safety operators with efficient real-time understanding of situations. The city operations centre supports dynamic alarming, HD video recording, voice control, and cooperation with other systems, which enable pre-event prediction and warning, intra-event surveillance and command as well as post-event retrospective analysis and evaluation. For a smart city, the city operations centre will help in integrated city management thus improving resource utilization, response time and decision-making.

3.1. Brief outline of the project with specific technology fall-outs

3.1.1. Integration Platform

As seen in the Figure below, multiple systems can be interfaced with Integration platform. The systems can expose their desired data or information via standard services or methodologies that can be consumed by Integration platform. The interfacing is done through pre-defined standard based specifications guidelines. The building blocks of Integration Platform can further collect the suitable data from the desired systems and provide appropriate information to the stakeholders. It is important to adopt the technology that would help in capturing and integrating data from various sources using sensors, kiosks, appliances, cameras, meters, web and social networking platforms.

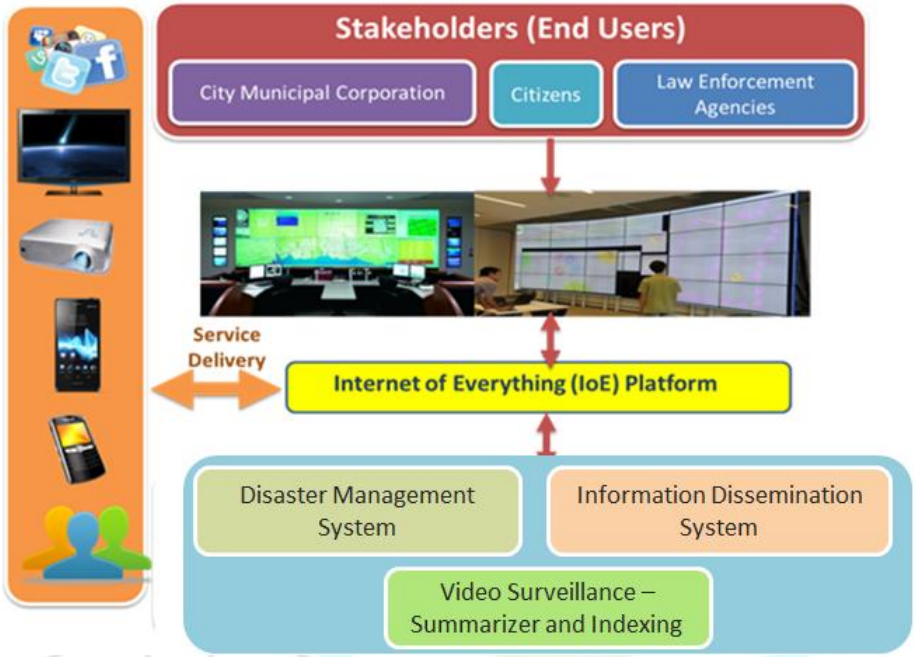


Figure 2: Integration Platform - Components

3.1.2. Smart Governance and Citizen Services

The aim of smart or e-governance is to make the system more transparent and citizens more informed. Government information will no longer be a repository of few public officials or servants but accessible by all sections of society. With the help of ICT, objective is to provide a single window service for enabling the citizens to interact with the city administration for any information, approvals, payments, grievances etc. and for maintaining the records in electric form so that they could be accessed easily to Web portals, online forums, mobile apps and their unified services will help public to directly share their questions, suggestions and grievances to government authorities.

3.1.3. Video Surveillance – Summarizer and Indexing

Video analysis software developers and suppliers are currently addressing innumerable scenarios in both the commercial and public sectors. In order to cater to the challenging demands of the end-users, the algorithms and behavioral analysis must develop continually, since the type of deviation from normal behavior against which the end-users wish to discriminate is infinite. Another challenge is the use of audio analysis in tandem with video analysis. For example, audio analysis can cover detection of gunshots, airplanes, or abnormal mechanical processes (such as car engine malfunctioning, rowdy behavior, or human voices calling for help). This project aims to undertake an application oriented research, design and development work having a huge production potential for the benefit of the community.

Video Synopsis can be applied to create a synopsis of an endless video streams, as generated by webcams and by surveillance cameras. Video Synopsis is a technology that enables the simultaneous presentation of multiple objects and activities that have occurred at different times. Video is analyzed and separated into background (all static, non-moving objects) and foreground (moving objects). Moving objects are extracted and descriptions inserted into a database. Real time rendering is then used to display objects and events simultaneously in a condensed video clip.

Video surveillance, audio analysis, object recognition, object tracking, motion detection, video summarization, etc., are the state-of-the-art research areas currently being pursued worldwide. Hence, this project would have tremendous research potential that would spawn across several disciplines in science and engineering.

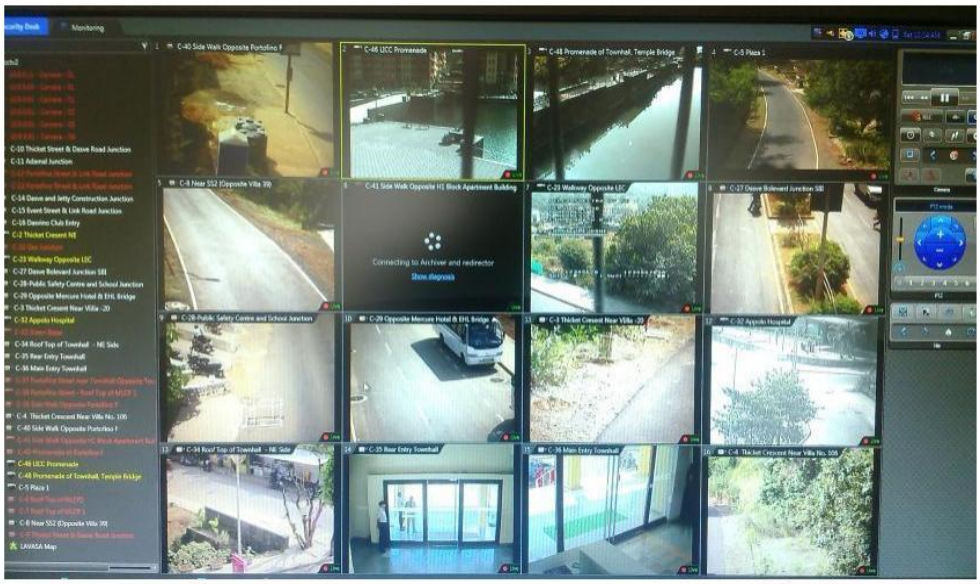


Figure 3: Video streams generated by Webcams and CCTV Cameras

This application aims to track and analyze moving objects, converting video streams into a database of objects and activities, with the ability to distinguish between objects of different movement parameters. Important technical aspects of this project are:

Short summarized surveillance video showing multiple activities occurred at different times, while preserving the essential activities of the original video.

- Index of the synopsis video pointing to the original video and the original time of activity
- Detection of moving objects in selected areas covered by the camera, where the object of interest could be tracked across several videos or it could simply be an object that has been left unattended in restricted areas covered by the cameras.
- Detection of illegal parking in no parking zones. Detection of vehicles driving in wrong way or reversing.
- Detection of people flow and counting of people in selected areas.
- Parallelization of above modules across intra-video (multiple videos) and inter-frame (single video) on CPUs/GPUs

Initially the prototype will be developed for single shot surveillance video, which can further be extended to multiple shots.

3.1.4. Information Dissemination & Redressal System

This system will provide citizens, a direct access to the Government bodies. It will be a shared system for information handling for all Government departments and agencies thereby reducing redundancy, operational overheads & costs.

It will provide centralized help-desk for guidance/information to citizens on various services offered by the Government. Set up a single access point having sufficient number of trained staff to reply to the citizens' queries received through telephonic call, mobile app, and web.

It will generate a database to provide long-term solution, and systemic policy improvement for the problems of citizens ensuring that the Government is more accountable to the citizens.

3.2. Disaster Management

The proposed system will aim is to combine all data and make better informed decisions through the use of advanced analytics which translate the raw data into actionable intelligence resulting in a dynamic management system, which will cater to potential Landslide zones

3.3. Disaster Management System

Disaster is an event or series of events, which gives rise to casualties and damage or loss of properties, infrastructure, environment, essential services or means of livelihood on such a scale, which is beyond the normal capacity of the affected community to cope with.

There are two types of disasters - Natural and man-made.

Natural disasters are natural processes or phenomena of atmospheric, earth processes, biological, hydrologic / oceanographic nature that may cause loss of life or injury, property damage, social and economic disruption or environmental degradation. These include landslides, earthquakes, heavy rainfalls in the local context.

Man-made disasters are caused by chemical or industrial accidents, environmental pollution, transport accidents, political unrest, terrorism, arms conflict. Since, they are the direct result of human action; they are often classified as ‘man-made’ or ‘human-induced’ disasters.

3.4. Web-based SDN application development platform

For the proposed solution, the initial deliverable, at the end of one year, will be a web-based IDE providing support for simulation using the developer toolkit and support for Open Day Light controller.

The second deliverable, at the end of two years, will be a web-based IDE providing SDN infrastructure support for deployment of the SDN applications so that a developer can write, debug, simulate, emulate, test, verify and deploy the application.

Final version will support two controllers, namely Open-Day-Light and ONOS. In future, support for other upcoming controllers can be added.

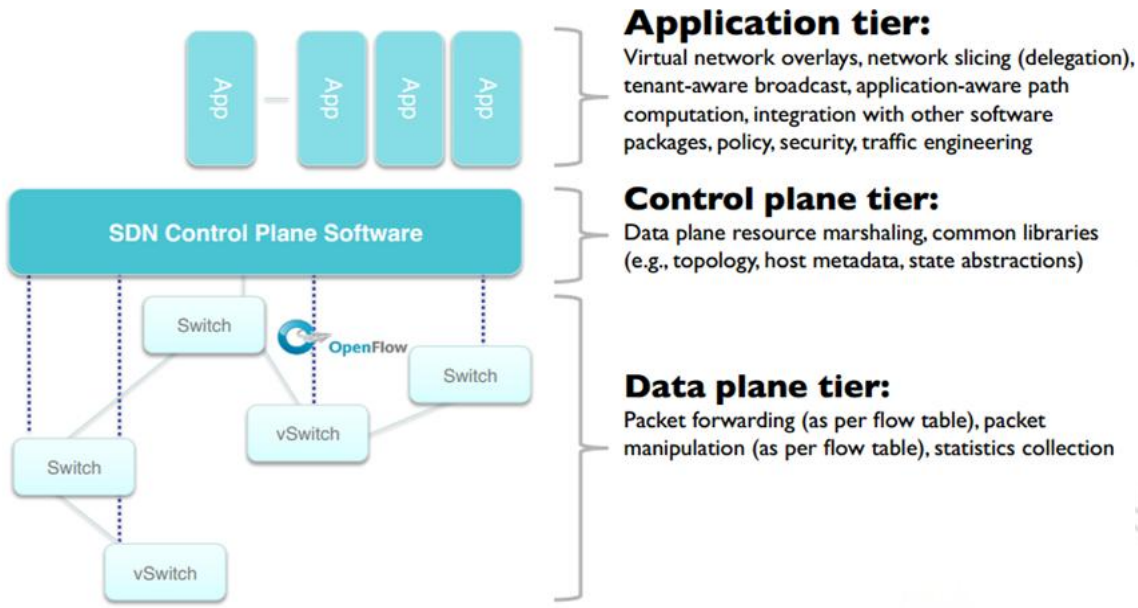


Figure 4: SDN Layers

3.5. Smart Utility Solutions

Smart street lighting

The system will have the installation of street lights and connecting street lights together in a computer-controlled network that opens the door to a wide range of innovative capabilities that save energy and improve the performance of the lighting system. Lighting controls provide elementary features such as remote on-off control, dimming and scheduling functions.

Smart energy metering solution

The proposed system will have centralized dashboards, which will display the data analytics using the data acquired from sources. The Smart Metering System has three simple functionalities as follows,

Smart Energy Meter senses the actual energy consumption at the consumer premises. Individual energy consumption data will be periodically transferred to Energy department over the internet/private network. The received data at the Energy department will be consolidate and customer-wise bill gets generated

Intelligent Water Management System | SCADA

The project intends to integrate the proposed Smart Metering for the water consumption and the introduction of rational tariff on water usage based on the nature of use of supplied potable water by the consumer. By implementing 100% Smart Metering City can conduct water audit and systematic leakage detection and repair activity to bringing down the level of water loss to the desired level. Since the proposed Water meters is of wireless connectivity for the data transfer to the server, the data collected could be in real time and visualize, monitor and intervene for effective supply. The data

transfer to the central server will be either through the handheld/pre-installed data concentrator or directly through the city wide wireless network.

Smart Poles- multi-utility

The smart pole combines the capabilities of LED lighting with those of telecom connectivity so as to provide multiple value added services across the city. Integration of newer technologies with conventional street poles can indeed be more than a wattage saver. These poles act as a 'gateway' that connects many IoT technology solutions/ services deployed across the city. Some of the features that can be attached to the smart pole are CCTV camera, pollution monitoring sensors, digital display board, Wi-Fi router, panic button, electrical vehicle charging point etc. In addition to this, the LED lamps would be utilizing solar energy for city lighting needs.

Intelligent Parking Lot Management System | Intelligent Traffic Management System (ITMS)

Easy Park (e-PARK) is an Intelligent Parking Lot Management System that helps the drivers to locate the vacant parking. ePARK include elements ranging from traditional traveler information systems to quick and automated gate control systems, individual bay monitoring electronics, advanced parking management applications, pre-trip web-based information systems, VMS display boards, driver guidance and navigation systems that provide directions all the way to an individual parking space.

Solar Power Operated Vehicle Actuated Wireless Traffic Signal Controller

Vehicle actuated traffic signal controller help in reducing junction delay to a great extent. The wireless traffic signal controller is a novel concept of controlling the Road Traffic Signal without physical connection between the Traffic Controller equipment and the signal lamps. Wireless is normally used in the traffic signal application for networking the traffic signal controller at the junction to the remote server at the Traffic Monitoring Centre (TMC for centralized control.
Solar power is abundant and solar photovoltaic (SPV) panels are commercially available at affordable cost. Design of SPV and battery requirement is based on the load, backup requirement and the Annual

(DNI) in the area. The standard wireless traffic controller generally operates with 3.5w for the Master and 3W for the Slave controller. For a typical four-arm Junction having primary, secondary and tertiary signal aspects (Primary signal on the pole at stop line, Secondary signal across the junction; and Tertiary on the cantilever pole). Standard wireless traffic controller requires only less than 180w for its operation.

Pelican Controllers (Pedestrian operated signal control for mid-block crossings)

A Pelican Signal Controller is typically installed at zebra crossings and other intersections where pedestrians cross the road and a standard Traffic Signal Controller is not viable to install (for e.g. on one way roads and pedestrian crossings in between two distant traffic signal controllers).

3.6. Communication Infrastructure

Fiber optics is a major building block in the telecommunication infrastructure and is the most advanced communication system available in the world today, it will be the way to deliver communications in the future. Its high bandwidth capabilities and low attenuation characteristics make it ideal for gigabit transmission and beyond. For smart city applications OFC play major important role. Smart city is one that is effectively interconnected via a networked infrastructure to optimize the efficiency of various services and improve sustainability. The right infrastructure will affect the way each city will be created and evolve. It helps deliver services like

- City administration: streamline management and deliver new services in an efficient way
- Education: increase access, improve quality, and reduce costs
- Healthcare: increase availability, provide more rapid, accurate diagnosis, provide wellness and preventive care, and become more cost-effective
- Public safety: use real-time information to anticipate and respond rapidly to emergencies and threats

NSCL
NAMCHI SMART CITY LIMITED

4. Detailed description of the Project

4.1. Integration Platform

The proposal consists of multiple systems, which focuses on laying down the infrastructure in order to gather data of interest to deliver applications. It is essential to propose a method for data gathering for some of the key areas that will give more clear idea about the parameters to be focused on.

The proposed Integration Platform serves the major purpose of coordinating the connected systems. This platform will provide the ability to monitor and proactively manage multiple services form a centralized location. It will also be extended to the emergency response teams to take quick steps in emergencies when the infrastructures are pushed to their limits. The proposed Integration platform is a nerve or fusion center, a hub for the analysis, monitoring, management and dissemination of allied information received from relevant intelligent systems. It helps in near real-time or on demand situational responses.

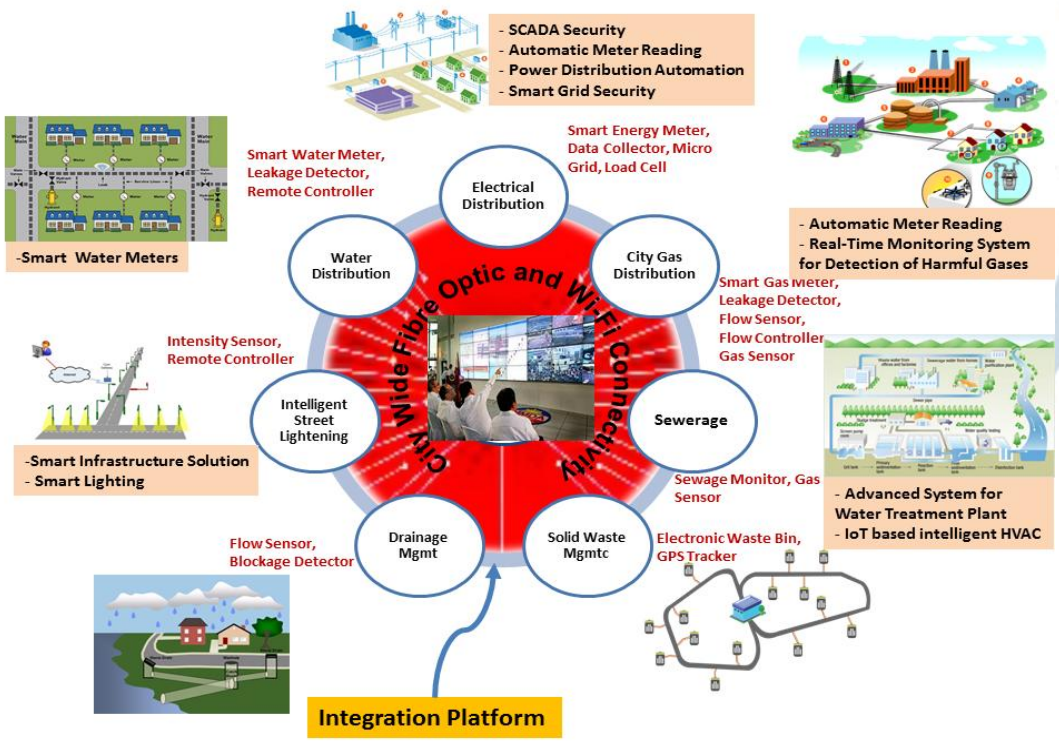


Figure 5: Integration Platform for City Services

4.2. Functional Architecture and Building Blocks of Integration Platform for City Services

As seen below, the lowest layer of the Integration Platform consists of the deployed infrastructure for various connected systems. The backbone communication network like city wide Wi-Fi or hotspots is already in place, acts as a carrier of data or information for these systems, and delivers it to the proposed platform. It is also envisaged to have software defined capabilities embedded in this backbone network, storage and likewise which will allow suitable on demand provisioning and similar capabilities as per requirements of application or systems.

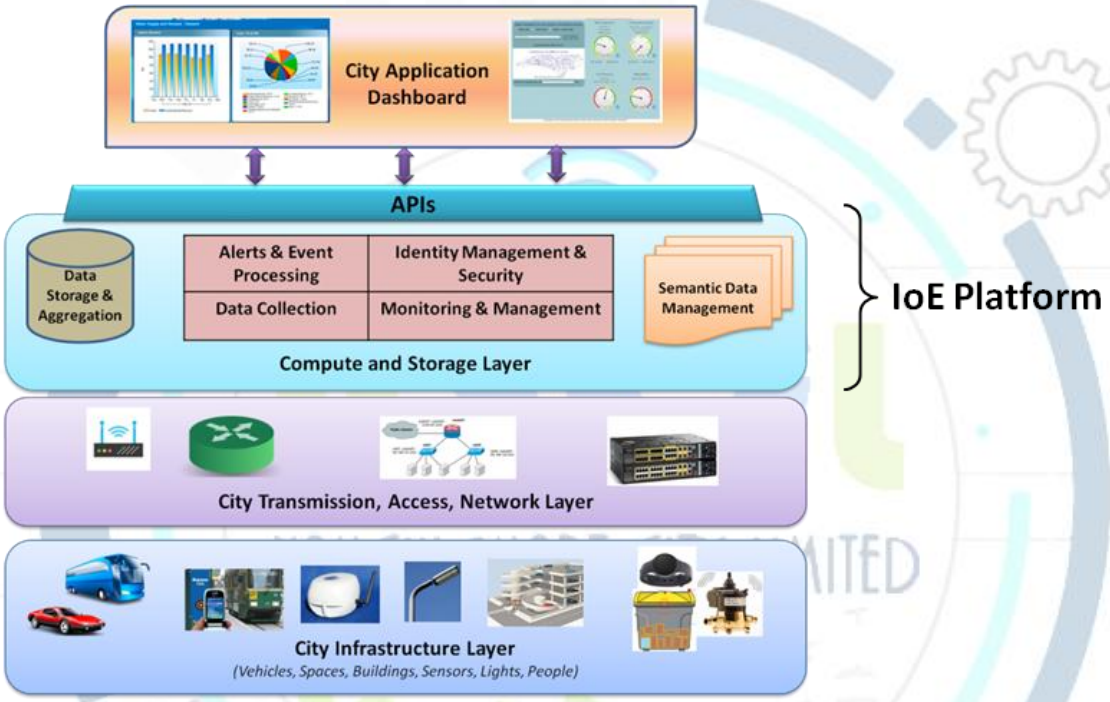


Figure 6: Core Building Blocks of IoE Platform

The integration platform (not limited to) is a set of software services that provides various functionalities. Following are the details of each block:

(a). Data Collection

The Data Collection Layer facilitates collection of data from various heterogeneous devices and systems connected with the City Integration Platform. The data collection is facilitated using services which will fetch the data from the devices. The data collection can also happen from other sources like Open Government Data or Open Services/ APIs exposed by other government departments. Other source of data could be the Social Networking Platforms which are extensively used by the citizens.

(b). System Abstraction

As and when a physical resource joins the integration platform through the underlying network, this layer provides a virtual identity to this device/ system. It enables the device in order to interact with various services and provides the device abstraction in terms of hiding the technology communication details from the application and management plane. The dependency on underlying communication protocol is eliminated in this layer and devices can share information using a common information exchange format.

c) Data Storage and Aggregation

The layer is majorly the Database layer in which the data collected from the devices or the stakeholders is stored, aggregated and searched based on the request received. The database used would be scalable and NoSQL DB in order to align with Smart City Applications that are forecasted to generate huge data sets.

d) Monitoring and Management

The layer serves the purpose of managing the devices, users and various applications connected to the integration platform. It also manages the services catering to various applications. The monitoring of these resources in terms of their status etc. is also done at this layer.

NAMCHI SMART CITY LIMITED

e) Service Interface

This layer provides a set of services in order to exploit the information gathered from the sensor networks and utility systems. It also allows the interactions with the deployed actuators based on the rules that are set. It facilitates the requirement of integration platform with SOA (Service Oriented Architecture). These services cater to the underlying devices, systems and stakeholders to perform various functions using the integration platform.

f) Alerts and Notification

This layer facilitates the configuration of alerts and notifications for city applications. The layer provisions with an in-build rules engine to set the rules about when exactly are the alerts/ notifications are to be received. Based on the requirement of the stakeholders like city officials and departments for various applications, the thresholds or events can be configured. Based on the occurrence of these events, the action can be triggered via the Integration Platform.

g) Semantic Data Management

Smart City Applications will generate a huge amount of data. This layer of the Integration Platform provides the capability to manage this data. The data generated is not only larger in volumes but also multimodal in nature, varies in quality, format, representation form and levels of dynamicity. It is essential to pre-process, aggregate and creates a higher-level abstraction from this data to make it suitable for knowledge extraction and event processing.

h) Identity Management and Security

Identity Management is an important aspect for citywide applications. Using this layer, each device/ system can be addressed and networked for exchange of data through the integration platform. The layer assigns unique id to the devices. Identity and access management will play a major role and will supplement the authentication and authorization towards the integration platform. Considering multiple city applications, which render data that is security sensitive, it becomes essential to adopt appropriate security measures in data transmission, access as well as storage. The stated functionalities will be handled at this layer.

NSCL
NAMCHI SMART CITY LIMITED

5. Smart Governance and Citizen Services

The components envisaged to be included in Smart Governance are:

- Unified portal (to support all the citizen services provided by Namchi Municipal Council and later integration with other utilities billing)
- Auto-DCR (Online BPP approval system), Land use monitoring and management system
- App based incident management
- App based Grievance Redressal System
- Document Management System

The features under Citizen Services shall include the following:

- Universal Identity (Aadhaar)
- Utility Services
- Ground Rent (UDHD Allotted Site)
- Registrations & Certification
- Issuance of NOCs for various purposes from Namchi Municipal Council
- Any other existing and future services that would be provided by NMC

5.1. Unified Portal

A unified portal will be developed with content management system that will be central to providing all the citizen services. This portal will have unified interface for interaction either through the mobile devices, desk top machines or kiosks.

Secure database connectivity along with security management system will help in securing the data and making them tamper proof

5.2. Property Development, Approval, Assessment and management system | Auto-DCR

This system will provide a complete work-flow Management right from the filing of application, submission, approval and issuance of construction order. The envisaged function could also be integrated with the LR&DM (Land Revenue and Disaster Management Department) to integrate the functions of land registrations, transaction and correction of land records. It could also have the facility of property assessment and provides the overall picture of the properties in the city and the system enabling the management of the approved properties.

5.3. Stamp Duty & Registration of Land

This is to help the LR&DM, GoS having the mandate to register, transfer etc. of the land in collecting the stamp duty towards 100% automation in the registration process and speedy delivery of registered documents to the citizens.

The application suite shall consists of:

Registration Module

- Valuation Module
- Reports Module
- Vendor Management System (VMS)
- Utilities Module
- Societies, Firms and Marriage Registration Module
- Scan-Archival Module
- Data Transmission Module
- Website

5.4. Web based Land Management System

The proposed ICCC is to have the Web-based enterprise GIS solution which enables the Authorities / Government, Landowners and Public to access and share requisite information with high level of security and data integrity. The system shall incorporate facility to dole out compensation and enhanced compensation information along with the legalities involved in their business process.

It involves scanning, digitizing and geo-referencing of the City Maps, Layout Plans, building footprints and Land use profile. The spatial data and non-spatial data together with the developed application tools and GIS interface has helped the Administration in various aspects like perusing plot information, finding plot of land to be acquired and maintaining the detailed information with high level of integrity. This also would enable the city administration to formulate the land use plan of the city as per the actual scenario of the existing land use pattern. The web enabling capability has enabled the common citizen to access information related to their plot of land through the Internet.

5.5. Document Management System

A Natural Language Processing based Document Management System to manage documents data throughout their lifecycle, right from inception stage through creation, review, storage and finally disseminate all the way to their destruction.

The key features shall be:

- Social networking for Enterprise / Organization
- Individuals, Groups, Events areas (based on templates)
- Integrated calendar, activity stream, dashboard, and more
- Communicate ideas, information, events, artifacts
- Through use of pages, blogs, forums, files (image, document, video)
- Through interactive chat
- Powerful framework to build behavior-analytics, data analytics, etc.

5.6. Video Surveillance – Summarizer and Indexing

Video summarization and analysis comprise methods to create a summary of the video collection, detection or classification of objects of interest, tracking of such objects from frame to frame, and identifying behavior or activities performed by the objects.

These is a need to perform analysis at multiple levels using multiple videos (from detection of moving objects to detection of important events) in order to identify important security threats in video monitoring systems.

Methodology to generate Synopsis of Video: The following methods would be studied and explored to perform the video summarization and indexing:

Video shot boundary detection

- Key frame extraction, structure analysis, and scene segmentation
- Extraction of key frame features, static features, motion features, object features
- Video data mining, video annotation, video retrieval, including similarity measure, query interfaces, relevance feedback, and video browsing
- These would be used to perform the following activities (using video data) as stated in earlier sections of this project proposal:

Generation of Video summary

- Detecting and tracking of objects with time stamp
- Index of the synopsis video pointing to the original video and the original time of activity
- Detection of illegal parking in no parking zones. Detection of vehicles driving in wrong way or reversing.
- Detection of people flow and counting of people in selected areas.
- Parallelization of summarization process: Across intra-video (multiple videos) and inter-frame (single video) on CPUs/GPUs

One of the approaches to video synopsis for single shot surveillance video:

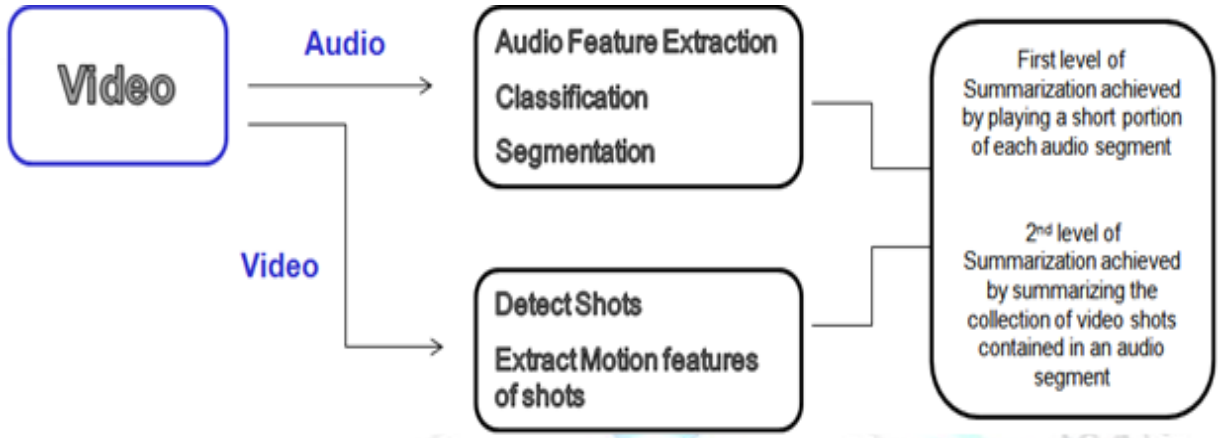


Figure 7: Video Synopsis

Video Synopsis by Object Based Synopsis:

Video Synopsis is constructed from the input video using the following steps:

I. Objects are extracted from the input video.
II. A set of non-overlapping segments is selected from the original objects.
III. A temporal shift is applied to each selected segment, creating a shorter video synopsis while avoiding occlusions between objects.

- Removing temporal redundancy
- Handling noise
- Background Construction
- Activity Detection (Object Extraction)

Implementing Stroboscopic Effect:

It is an effect, which gives the illusion of motion. The stroboscopic effect is a visual phenomenon caused by aliasing that occurs when continuous motion is represented by a series of short or instantaneous samples. It occurs when the view of a moving object is represented by a series of short samples as distinct from a continuous view, and the moving object is in rotational or other cyclic motion at a rate close to the sampling rate.

Tracking the path of Objects

To track the path of the objects in the input video we use a CLUSTERING algorithm. Cluster analysis is a primary method for database mining. Here it is used as a stand -alone tool to get insight into the distribution of the data set i.e. to track the path of an object.

Video Indexing

The basic multimedia information is required for dynamic video indexing and retrieval. There are necessary components for storing, sorting and accessing multimedia contents. Theyalso help in finding the desired components to form a multimedia repository with an ease. Besides many multimedia resources' video is a key component which comprises mainly upon three major parts. The first one is that the vigorous video provides rich contents then that of images. The second is an enormous quantity of raw data. Lastly, the structure of video is very minute. These features have made the retrieval and indexing of video relatively complex.

Previously, database video was diminutive, along with that the retrieval and indexing were also based on manual keyword annotation. In recent times, the database is getting enormous, the content-based retrieval and indexing are needed with less human interaction to analyze videos automatically.

Figure 8: Video Indexing & Retrieval framework

5.7. Information Dissemination & Redressal System

A robust, resilient communication / information dissemination system to meet both pre- & post-disaster requirements has always been the necessity. When a disaster strikes, the first casualty is the communication network, the most vital line for rescue & relief operations, which can be incapacitated for weeks and even more. Creating systems for disaster relief is making sure the systems can remain intact during an emergency. The ICT infrastructure breakdown during and after disaster strikes can be most suitably handled by switching from conventional static networks/infrastructure based networks to dynamic/ad-hoc networks. Alarm Systems can be integrated to pre-empt disasters and send instant information.

The proposed system is envisaged to disseminate the information so that citizens can use mobile phones with app enabled various mechanism along with automatic channelization of demand of information related to disaster from respective departments/authorities and get automatic alerts and audit-trails for each step of their redressal process.

The web portal of the proposed system as well as IVR are equipped with the intelligent automated features as mentioned above and also speech interface and provide facility for differently - abled people in the proposed interfaces as well.

- Auto-classification and channelization of information of both pre- & post- disaster requirements
- Time oriented resolution with auto checks and balances in terms of alerts, escalation
- Multilingual real-time support enabling beyond language barrier accessibility for a multilingual country like India
- Multi-modal access point for submission like mobile apps, web and IVR with audio-visual support enabling real-time problem tracking by citizens and having apt Redressal as effect

For the purpose of proposed project:

- English, Hindi & Nepali will be supported as User-side (interface) language

NAMCHI SMART CITY LIMITED

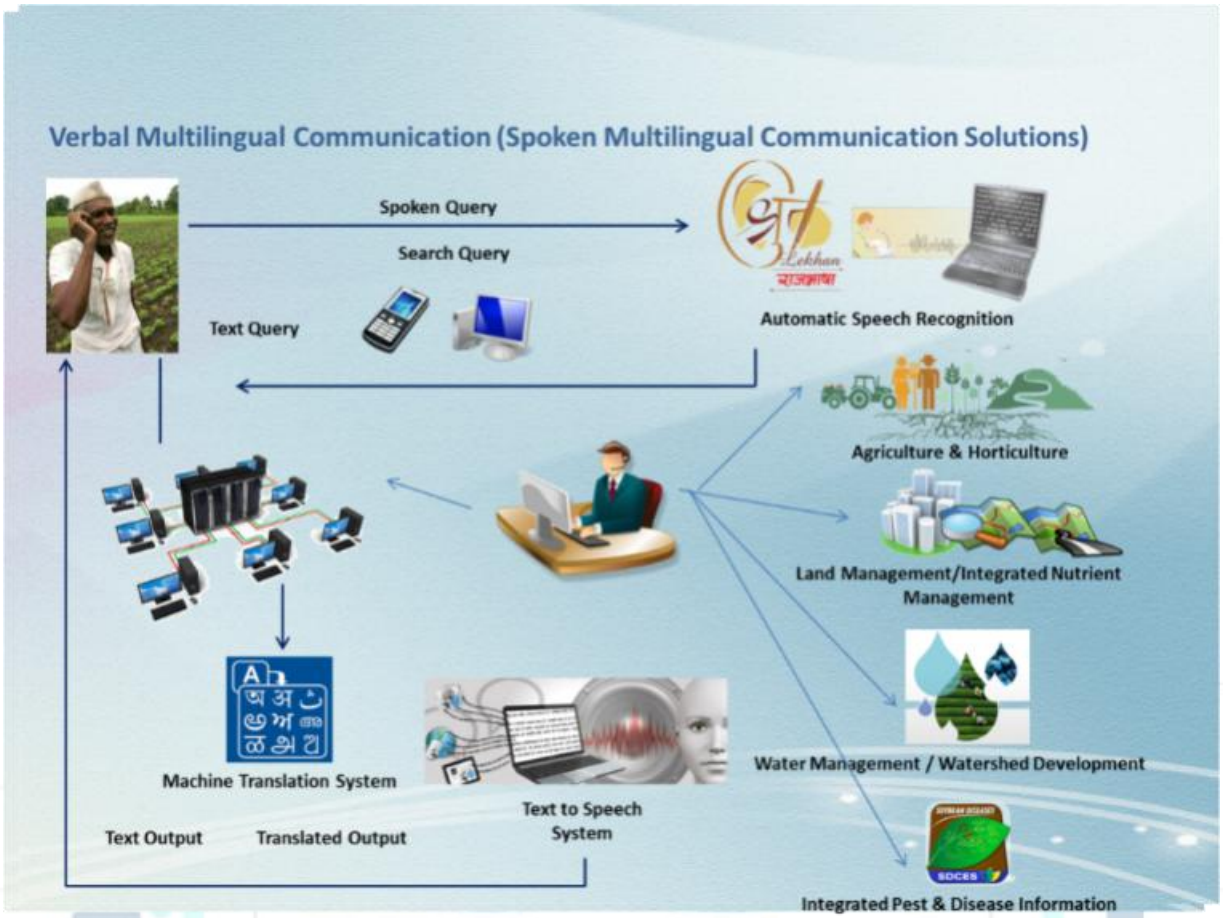


Figure 9 : Multi-Lingual Information Disseminate & Redressal System

NAMCHI SMART CITY LIMITED

Features of the proposed solution:

- Single window solution with simple and user-friendly tools to disseminate & redress information
- Proactive suggestions for precautionary measures in all the services from Government.
- Participation in planning and development in different Government and Social initiatives.
- Framework for both mobile and web-portal to introduce a standard and uniform approach of involving all departments to enable citizens to register and officers to access the information easily.
- A geo-tagged image/audio/video of the information along with brief details will be sent to concerned department/citizen through mobile app automatically.
- The submissions will be identified with a mobile number and/or email id and token id generated without support of any login/password to register for suggestions/information.
- The system will generate an automatic alert with respect to a token for the concerned authorities.
- There will be login and passwords with appropriate security for the officials to access the system to manage.

- A nodal officer (may be at local level or state level) can be identified to monitor the responses from citizens and administration.
- Automatic identification of jurisdictions and officers responsible
- Networking of all the authorities to redress the suggestions/information on a single platform, which facilitates better monitoring at highest level.
- The system will generate automatic alerts for the responsible officer and his/her reporting authority in the cases of delay in resolving the issues w.r.t. to the defined time span.
- Tools for summarizing, generating statistics of the citizen responses as well as actions taken by concerned authority
- The statistics of the suggestions/information for a department or area can be used to assess the quality of work/ constructions/ planning, etc. over a period. This can be further used as an indicator to assess the performance of officials involved, processes followed, contracts executed, etc.
- Linking with social media sites to share problem, give severity of problem/rating/feedback on actions taken to make sure the work completes within time.
- Free access of these statistics to citizens and authorities. This can also be pushed to social networking sites.
- Information in response to the query will be provided to the citizen in language of their choice (project scope limited to Hindi, Nepali & English) using translation, text-to-speech, speech-to-text etc. based technologies.

Information can be disseminating through Mobile /web/IVR system. Input medium can be in text, speech in their respective Indian and local languages (English, Hindi Nepali, Bhutia, Lepcha, Limboo etc.) along with attachment in form of (image, audio or video). The image will be geo-tagged through mobile application only. This request is being send to the centralized server where Unique Token Id (ticket) will be generated and send to the user.

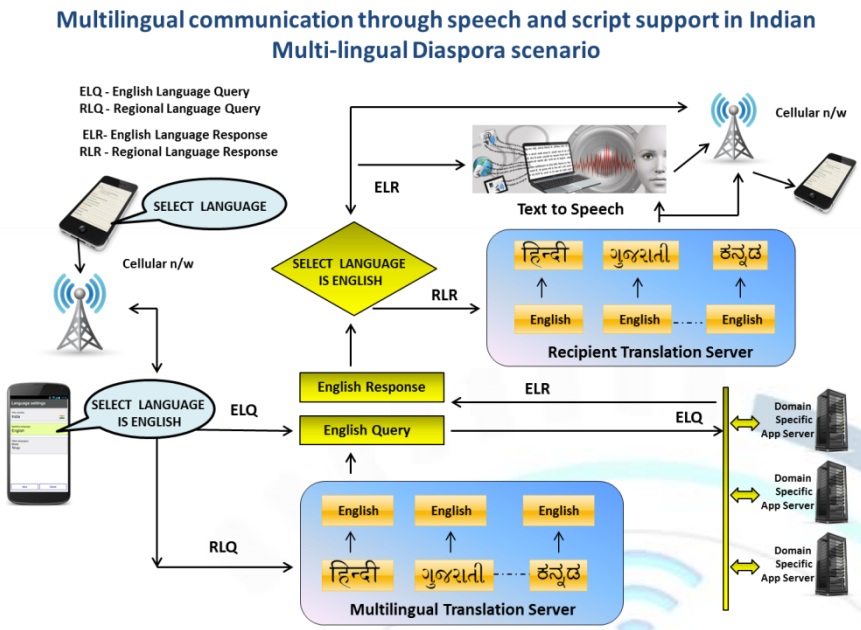


Figure 10: Multi-lingual communication through Speech & Script Support

Following are the System Components:

a). Intelligent/Automatic Components

There are Intelligent/Automatic Components that are USPs of the system which make the proposed information dissemination different and unique from other systems using the niche expertise of MASTER SYSTEM INTEGRATOR | SYSTEM INTEGRATOR like Artificial Intelligence, Natural Language Processing, Multilingual Technologies, e-Governance, spatial technologies, HPC etc.

The features of the Intelligent/Automatic components using the above technological areas of MASTER SYSTEM INTEGRATOR | SYSTEM INTEGRATOR and also R & D scopes of development within the domains as mentioned above are detailed below:

Perspective of Request Initiator (attributes):

- Predictive Text Input/Multilingual keyboard and input
- Spell Checker in both Indian and English
- Speech to Text for Input

Ontology and taxonomy specific segregation of Information as per domain/dept.

- Auto-Indexing and Annotation of efficient retrieval
- Auto-Feedback of complaint/suggestions to registered mobile with
- Perspective of Authority Concerned: Attributes:
- Auto-ticket raise when Department receives the request
- Area-Specific Identification of types of complaints
- Auto-Statistics Generation of Competent Authority's action of each officer

- Auto-Escalation to senior level/super user in case of non-redressal within stipulated time-frame
- Auto-reminder and Alert generation based on such anomaly in case of severity/time frame violation

(b). Multilingual Components

Multilingual perspective is added from font/translation and typing level and also in the speech interface. The Natural Language Processing enabled multilingual capability covering above perspectives in both Indian languages (Hindi & Nepali) and English to Indian Languages (Hindi & Nepali) will be catered. It also covers Machine Translation in Indian Languages as well as from English to Indian Languages.

The System can be divided majorly in the four parts from multilingual perspective:

- Input (Inscript/phonetic)
- Display (Font Format/Unicode)
- Output (Unicode)
- Multilingual enabled data Storage & Retrieval
- Indian language translation
- Speech Interface
- Report Generation, audit trail, Automatic statistical representation of complaint report types/action reports

I. **Multilingual enabled data Storage**

Database like MYSQL or any other which can store images, videos along with Unicode text. So that reports can be generated by firing queries using database for report generation and other statistics calculations.

II. **Indian language translation**

- Translation of text from English to Indian language (Hindi & Nepali) and vice versa.
- Translation of text from one Indian language to other Indian language

III. **Speech Interface**

The speech Interface comprises of Speech Recognition and Text to Speech (TTS) in Hindi, Nepali and English languages. The state-of-art research and development competence of MASTER SYSTEM INTEGRATOR | SYSTEM INTEGRATOR in this domain enables real-time conversion of spoken languages to written texts without training in the selected languages. There is a scope of enhancement in terms of automatic Q-A system through IVR using both ASR and TTS in combination with DSS and NLP technology.

The speech interface provides functionalities in Indian language and features are as shown below:

- Completely speech enabled user interface.
- Speech based QA system with auto learning for IVR.

- FAQ through Speech Interface.
- Voice and text data collection through auto learning for research in different areas.
- Search and retrieval of the contents on the proposed website through voice.
- System is accessible to visually impaired people through proper training.

(c). Report Generation, audit trail, Automatic statistical representation of complaint report types/action reports

The reports are auto-archived with annotation features embedded to them so that using the data mining technology and Ontological Classification they can be clustered for efficient retrieval by concerned authorities through search engine of the proposed system. Moreover, the statistical features using DSS and AI techniques will be used to create graphs and charts as per requirement on department or area wise classifications and geo-tagged based study to be used by both administration and societal study purpose.

This will enhance the improvement scope of the system as well as performance of the respective departments.

- Auto Archiving of data and chart/ statistical bar/pert chart etc.
- Auto-Clustering feature for retrieval of reports for Recipient perusal
- Auto-purging based on set policies
- Audit Trail archival and retrieval facility
- Search Engine for Geo-tagged/ area specific information and generate statistical output on demand
- The system is expected to raise the standards of governance by improving the level of transparency and efficiency of the government departments.

5.8. Disaster Management

5.8.1. Proposed study Area: Namchi

Namchi is situated at an altitude of 1,675 m (5500 feet) above sea level and is the headquarter of South district. Regionally it is situated at a distance of approx.79 kms from the state capital Gangtok. It has a Municipal area of 7.14 sq. kms (Namchi Municipal Council) with a population of 12,190 (*2011 census*). Population density of the city is 1705 persons per km^2.

Source: Google Earth Image of Namchi, Sikkim (2010)

5.8.2. Disaster Management

Disaster is an event or series of events, which gives rise to casualties and damage or loss of properties, infrastructure, environment, essential services or means of livelihood on such a scale, which is beyond the normal capacity of the affected community to cope with. There are two types of disasters - natural and man-made.

Natural disasters are natural processes or phenomena of atmospheric, earth processes, biological, hydrologic / oceanographic nature that may cause loss of life or injury, property damage, social and economic disruption or environmental degradation. These include floods, storms, landslides, avalanches, droughts, earthquakes, tsunamis and volcanic eruptions. Also, some disasters are of organic origin including exposure to pathogenic micro-organisms, toxins and bioactive substances causing epidemics outbreaks, and insect infestations. The economic impact of a disaster usually consists of direct (e.g. damage to infrastructure, crops, housing) and indirect (e.g. loss of revenues, unemployment, market destabilization) consequences on the local economy.

Man-made disasters are caused by chemical or industrial accidents, environmental pollution, transport accidents, political unrest, terrorism, arms conflict. Since, they are the direct result of human action; they are often classified as 'man-made' or 'human-induced' disasters. In many countries, industrial systems have left the environment heavily polluted with dangerous substances at places. The risk from the unintended release of hazardous materials is becoming ever more widespread. Also, rapidly increasing transport of people and commodities across continents are increasing transportation disaster threats to millions.

Worldwide, Cities are giving increasing importance on building up resilience to natural disasters such as extreme weather, flooding, heat and water stress caused by climate change. Confronted by a natural disaster, smart cities can use sophisticated ICT infrastructure and analytical capabilities to enhance and coordinate the information flow between multiple public agencies such as transport authorities, emergency services, energy providers and citizens. With the help of advanced mobile networks, a city municipality can reach majority of its citizens in short time.

5.9. Disaster Management System

5.9.1. Disaster Management Cycle

A disaster may have discrete origins but its effects propagate and interact in such a way that intensifies the complexity and uncertainties in the whole system. Data need to be acquired and analyzed under severe time pressure. The data users and volunteers are also frequently without adequate training and work under difficult circumstances. Further complicating an already highly-dynamic situation are uncertainty and ambiguity, an inherent part of the natural environment, along with several other factors which work on different aspects of the crisis, each one with its own decision structure, administrative culture and quite likely, operating different sets of technical equipment. To handle this high dynamic situation and the uncertainty and ambiguity revolving around it, a multifaceted process has been developed to strategize, and reduce the impact of disasters and provides assistance to affected populations, viz. Disaster Management.

Disaster management primarily involves managing the disaster cycle. It can be defined as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters. Worldwide a number of frameworks or working models are designed each year to manage disasters. A simpler version of such a framework, as seen as fig below, depicts how to manage risk in the event of a disaster arising from various hazard sources and how to respond using various tools to address the emergency situation.

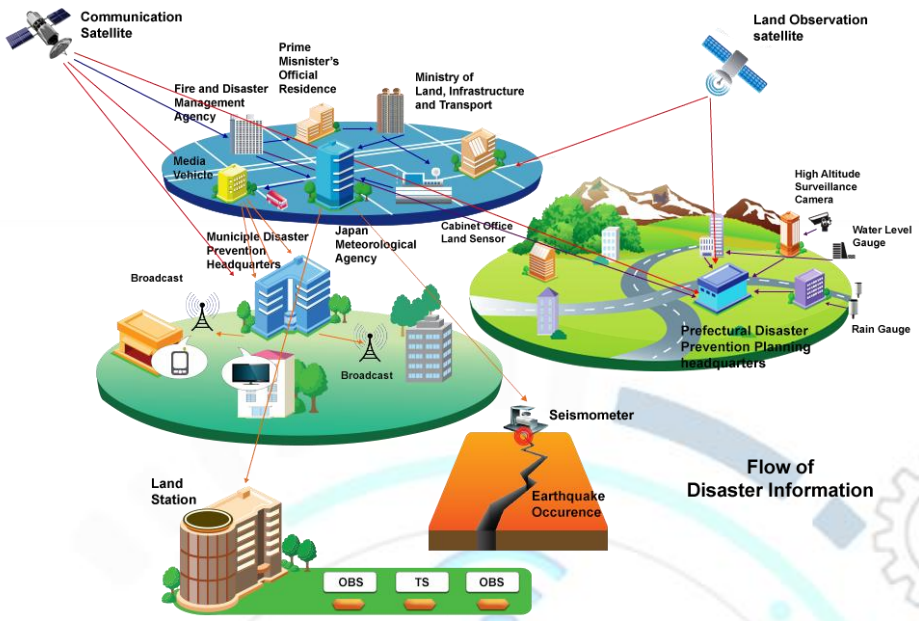


Figure 11: Information Flow during Early Warning System

5.9.2. Phases in Disaster Management

Present thinking defines four phases in disaster management: mitigation, preparedness, response and recovery.

Mitigation: Preventing future emergencies or minimizing their effects includes any activities that prevent an emergency, reduce the chance of an emergency happening, or reduce the damaging effects of unavoidable emergencies.

Mitigation activities take place before and after emergencies.

Preparedness: Preparing to handle a disaster; Includes plans or preparations made to save lives and to help response and rescue operations; Preparedness activities take place before an emergency occurs.

Response: Responding to a disaster; Includes actions taken to save lives and prevent further property damage in an emergency; Response is putting the preparedness plans into action; Response activities take place during an emergency.

Recovery: Recovering from a disaster; Includes actions taken to return to a normal or a safer situation following an emergency; Recovery activities take place after an emergency.

5.9.3. Role of ICT in Disaster Management

ICT can address the following list of features for an effective disaster management. The features can be sub-divided according to its nature of operation and function:

Data/Information Management and Analysis	Querying and filtering on heterogeneous, multi-source streaming disaster data Human-system interactive information extraction Context-awareness information analysis and extraction Data mining from multiple sources on time-evolving and uncertain data Data preparation & compilation Crowd sourcing Uncertainty in data handling and delivery Trust and information credibility in social networks
Geo-Information Technologies and Geo-Collaboration	Integration of data: GIS, RS and building information modeling (BIM) Standardization adoption & control (models, icons, symbols) Visualization of data/information-2D/3D Evacuation and rescue geo-planning Space based resources to support disaster management
Preparation and Mitigation	Prediction, forecasting (early warning) Risk assessment, modeling and simulation tools Damage and loss assessment Post disaster (needs) assessment
Risk Reduction and Rapid Response	ICT in emergency planning, risk reduction Advanced response system (query-able) Disaster/ Hazard zonnation
Coordination and Collaboration Technologies and Systems	Service Oriented Architectures for collaboration Collaborative information systems architectures, frameworks, technologies Contextual and situation-based collaboration Security and privacy concerns in information sharing Cloud computing Mobile computing Social media and networks for participation and collaboration Modeling and simulation of collaboration
Communication Systems	Infrastructures, technologies and services for distributed crisis management teams and organizations Mobile and wireless communication networks (MANETs, Mesh, VANETs, Sensor, etc) Multi-platform and multi-sensor data collection Infrastructure protection and security Interoperability of heterogeneous systems

Table 1: Role of ICT in Disaster Management

5.9.4. Module in the proposed study

(a). Landslide Management will include:

- Landslide Hazard Zonnation
- Geospatial mapping and Geotechnical study of all critical areas for future management strategies
- ICT technologies, such as web services and other IP-based data communication, GPS Google Maps, tablet, Smartphone and beacon technologies
- Non-development zone demarcation as per municipal standards of the particular city and suggestion for construction of geophysical structures

5.10. Web-based SDN application development platform

The proposed system consists of three main components: IDE, controller engine and app-store. To develop an SDN application, users will have to register/login to IDE through the web interface. After successful authentication, users will get access to online-integrated development environment (IDE) which contains all necessary development tools such as editor, compiler, debugger, testing & verification tools, simulator & emulator. The developed applications are stored in app store and can be retrieved later for execution.

The controller engine and network elements allow applications to run on physical test-bed setup of SDN framework, which includes data layer, and control layer. Resource manager keeps track of network elements allocated to users. Controller selector & allocator allow users to select a controller from the given list of controllers. Finally, the system is associated with a server for logging purpose and to maintain database.

NAMCHI SMART CITY LIMITED

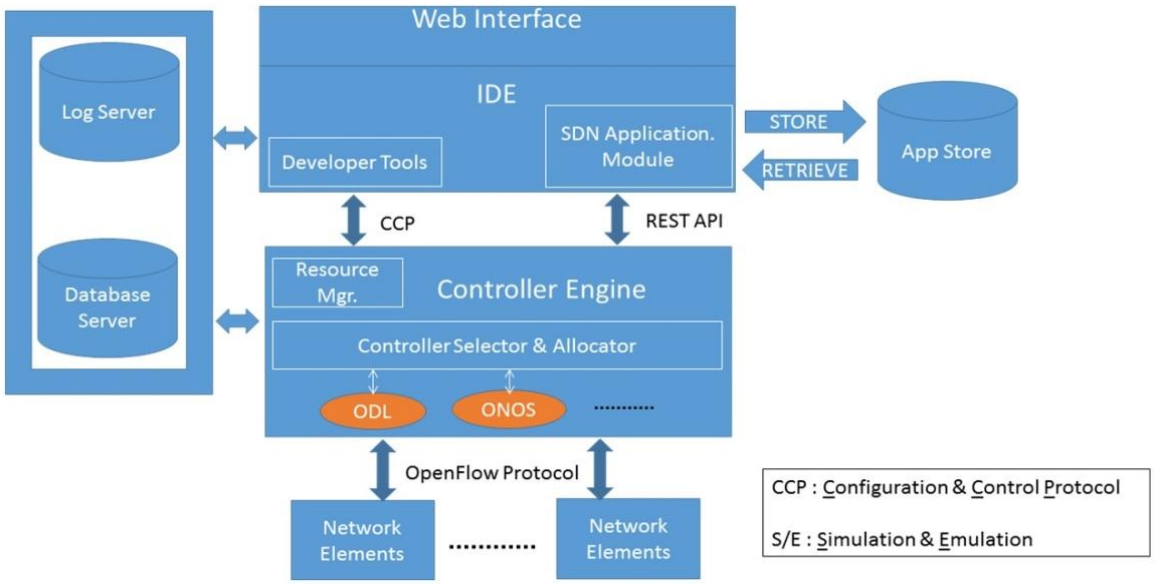


Figure 12: SDN Architecture

Initially, only two controllers will be supported (ODL & ONOS). Support for other controllers will be gradually provided in future versions. Support will be provided for a generic test-bed providing the most common requirements of SDN applications. Specialized hardware components will be provided in future versions on request basis.

Initial version will support only REST-ful APIs for north-bound interface and Open-Flow protocol for south-bound interface.

The system will have below mentioned unique features:

- Web-based IDE
- User can remotely deploy applications on physical SDN infrastructure.
- Application Repository.
- Libraries support for specific type of applications. (E.g. traffic engineering, security, policy management)
- Sample templates will be provided

The solution will promote the establishment of an Open SDN Model based on an Open Community of developers.

Internet of Everything (IoE) is used extensively to efficiently manage community resources/ infrastructure. IoE management is complex and SDN can make it easy to manage. SDN is a key enabler technology for successful deployment of IoE.

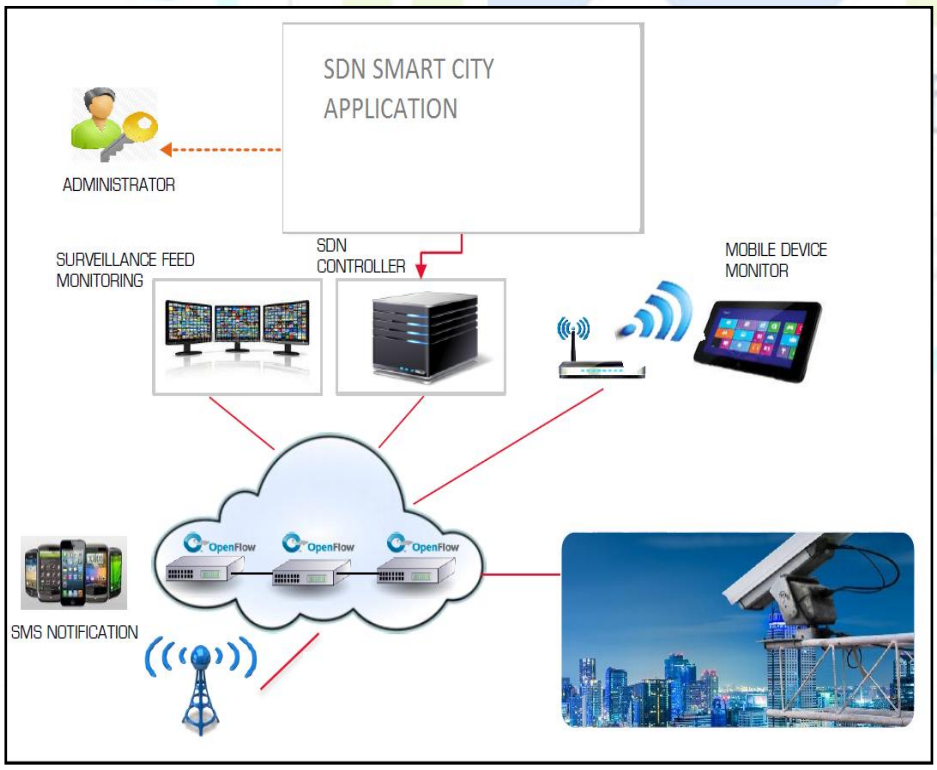


Figure 13: Automated Surveillance

5.11. Smart Utility Solutions

Smart street lighting

Installation of street lights and connecting street lights together in a CCMS (Computer-controlled Management System) that opens the door to a wide range of innovative capabilities that saves energy, improve the performance and prompt in maintenance of the lighting system.Lighting controls provide elementary features such as remote on-off control, dimming and scheduling functions.

Energy monitoring and Billing: Accurate information on energy consumption is an important element in reducing energy costs.

Adaptive lighting: Sensors that monitor local conditions can enable networked systems to adapt the brightness of street lighting as necessary. Linking light controls to traffic volumes, for example, can provide considerable energy savings. If no traffic is present or traffic volume is extremely light, then full brightness street lighting is not necessary. Similar motion detectors can enable lighting levels to match street activity. Weather sensors can also enable adaption to rain, snow, or other conditions. For example, lights may be turned up during rain showers and back down when the weather clears.

Smart energy metering solution | ENERGY

The proposed system will have centralized dashboards, which will display the data analytics using the data acquired from sources. The Smart Metering System has three simple functionalities as follows,

Smart Energy Meter senses the actual energy consumption at the consumer premises. Individual energy consumption data will be periodically transferred to Energy department over the internet/private network. The received data at the Energy department will be consolidate and customer-wise bill gets generated

Intelligent Water Management | SCADA

The project intends to implement universal Smart Metering for the water consumption and the application of water charges based on the effective water consumption by the consumer. By implementing 100% Smart Metering City can conduct water audit and systematic leakage detection and repair activity to bringing down the level of water loss to the desired level. Water meters will have the wireless connectivity for the data transfer to the server. The data transfer to the central server will be either through the handheld/pre-installed data concentrator or directly through the city wide wireless network. The typical communication methods from the meter to the office could be visualized in the following figures. Software at the server will be able to read the meter data periodically. The period could be configured by the administrator. The administrator will be able to visualize the water consumption for the area or the household on the dashboard. Water consumption monitoring system will be able to generate and distribute the bills for each consumer. The billing, payment and the grievance Redressal system will also be part of the software.

Smart Poles | Multi-utility

The smart pole combines the capabilities of LED lighting with those of telecom connectivity so as to provide multiple value added services across the city. Integration of newer technologies with conventional street poles can indeed be more than a wattage saver. These poles act as a 'gateway' that connects many IoT technology solutions/ services deployed across the city. Some of the features that can be attached to the smart pole are CCTV camera, pollution monitoring sensors, digital display board, Wi-Fi router, panic button, electrical vehicle charging point etc. In addition to this, the LED lamps would be utilizing solar energy for city lighting needs.

Following services can be offered through smart poles.

- Wi-Fi Service: This can be a free service for about an hour in a day and for the rest it could be paid service. This service provides the Internet access and the user can use it for all Internet based services However, the government services should be free all the time. As an example, the city portal should be accessible on intranet
- Advertisement: Digital Billboards can be leased for advertisement. The leasing granularity should be possibly hour wise so that revenues can be optimized. The bill boards can also be used as information kiosks during festival time when there are more visitors to the city
- Video Messaging Services (VMS):
- Location Based Services: This is critical if the city aims to become tourist destination. The smart phones, when connected to the city Wi-Fi, the visitor should be able to search for hotels of his choice, wash rooms, places to visit etc. The user need not connect to the Internet for this service. This can be a paid service for the business owners and free for consumers.
- Information Service: Bill boards and the smart phones connected to the city network should be sued for this. The information can either be pulled or in some emergency cases, it should be possible to push also. This actually complements the Location Based Service by giving more information about any monuments in the city where the visitor has visited and seeking more information on it.
- Weather and Air Quality Monitoring: Weather/ Air quality sensors can be fitted on the smart pole will provide real time data for analysis and reporting.
- Mobile / broadband Infrastructure: Renting the space on poles to mobile operators to setup the infrastructure which is 4G/5G compliant would aid the operators in improving data coverage and capacity for citizens so there are no more signal dropouts. This will surely accommodate 9X data traffic growth by 2020.
- Emergency Services: In addition to the above mentioned units for a smart pole, the smart poles can also be fitted with a phone that dials only to the control room. In case of

emergency, the information can be quickly provided to the control room and the duty staff will know the location of the place where the call has come from and act.

Intelligent Parking Lot Management (ePark) | ITMS

Easy Park (ePARK) is an Intelligent Parking Lot Management System that helps travelers find parking. ePARK include elements ranging from traditional traveler information systems to quick and automated gate control systems, individual bay monitoring electronics, advanced parking management applications, pre-trip web-based information systems, VMS display boards, driver guidance and navigation systems that provide directions all the way to an individual parking space.

Solar Power Operated Vehicle Actuated Wireless Traffic Signal Controller

Vehicle actuated traffic signal controller help in reducing junction delay to a great extent. The wireless traffic signal controller is a novel concept of controlling the Road Traffic Signal without physical connection between the Traffic Controller equipment and the signal lamps. Wireless is normally used in the traffic signal application for networking the traffic signal controller at the junction to the remote server at the Traffic Monitoring Centre (TMC) for centralized control.

Solar power is abundant and solar photovoltaic (SPV) panels are commercially available at affordable cost. Design of SPV and battery requirement is based on the load, backup requirement and the Annual

(DNI) in the area. The wireless traffic controller designed by C-DAC operates with 3.5w for the Master and 3W for the Slave controller. For a typical four-arm Junction having primary, secondary and tertiary signal aspects (Primary signal on the pole at stop line, Secondary signal across the junction; and Tertiary on the cantilever pole). C-DAC wireless traffic controller requires only less than 180w for its operation.

Pelican Controllers (Pedestrian operated signal control for mid-block crossings) |Push Button Traffic Signal

A Pelican Signal Controller is typically installed at pedestrian crossings and other intersections where pedestrians crosses the road and a standard Traffic Signal Controller is not viable to install (for e.g. on one way roads and pedestrian crossings in between two distant traffic signal controllers). The primary responsibility of a Pelican Signal Controller is to provide an un-interrupted passage to vehicles till there are no pedestrians to cross the road and to provide safe passage to pedestrians when required.

The Pelican Signal Controller also ensures that vehicles get a minimum amount of un-interrupted passage time despite pedestrians request to cross the road. After the vehicles have been given

sufficient passage time, it allows pedestrians to cross the road safely (only if a request has been registered by pedestrians to cross the road by pressing Push button in the Pedestrian Control Panel).

The controller also ignores short/momentary presses of push button and registers pedestrian's request only if the push button is pressed for 2-3 seconds. These Pelican Signals run on the Solar Energy. In the day time the sun-rays will be absorbed through the Solar Photovoltaic Module installed on top of these signals and passed on to the lights of these Signals and simultaneously store the solar energy in the batteries as battery backup and to run these signals during nights and also in a situation when there is no sun in the day.

Air Quality Monitoring Sensors and Nodes (Eg: Clarity Nodes):

Air quality data are essential for:

- Assessing public health impacts caused by poor air quality
- Determining whether an area is meeting the standards
- Evaluating changes in air quality as a result of state implementation plans

The challenge is to get measurements of air quality in time and space that are useful for public health activities. The advantages of using ambient data collected through the proposed Air Quality Monitoring Sensors and local monitoring networks include:

- The measurements of pollution concentrations are the best characterization of the concentration of a given pollutant at a given time and location
- The data are supported by a comprehensive quality assurance program, ensuring good data of known quality

$PM_{2.5}$ monitors generally collect samples only once every three days, due in part to the time and costs involved in collecting and analyzing the samples

However, monitors that can automatically collect analyze, and report $PM_{2.5}$ measurements on an hourly basis have been introduced over the past several years

Nowadays, the monitors are available having various features with cloud based analytics platforms:

The pollutant like Ozone is monitored daily, but mostly during the ozone season (the warmer months, approximately April through October). However, year-long data would be extremely useful for evaluating whether ozone is a factor in health outcomes during the non-ozone seasons.

The air quality monitor requires to be located at very strategic locations which may not be in the same location as where a person lives, works, or plays. The air quality monitor may not have sampled the air at the time a person experienced a health outcome (e.g. an asthma attack)

Choosing which pollutant to measure

Just as there is no single air pollutant relevant to every discussion, there is no single way to express air quality. Generally, the measure we choose at any given time depends on what our concerns may be. Since frequently we do not know which compounds have the greatest health effects, it can be difficult to know which measure is most important.

Considerations that may go into one's choices of air pollution measures include:

Short-term versus long-term health effects

For example, day-to-day variations in levels of some air pollutants have been shown to correlate with emergency room visits by children with asthma, so number of accidences may be of interest

By contrast, if the concern is with long-term cancer risk, annualized average concentrations may be more informative

Single pollutant versus multi-pollutant measures

When our discussion is driven by specific health concerns, we may choose to discuss all of a certain category (such as cancer-causing compounds) together

Choosing which measure to use

There are a number of measures that can be used to examine air quality.

Single pollutant-- For a single pollutant, one can examine:

Maximum levels of pollutant in a given time period

Averages of pollutant concentrations in a given time period

Number of days the pollutant exceeds a standard in a given time period

Multiple pollutants

The CPCB has an Air Quality Index which incorporates multiple criteria pollutants to give one an overall indication of air quality

Person-days--One can examine the number of person-days that a region has unhealthy air

Person-days are the number of persons living in an exposed region times the number of days the pollutant exceed a health standard. Person-days give an indication of the population burden of air pollution exposure

5.12. Communication Infrastructure

Fiber optics is a major building block in the telecommunication infrastructure and is the most advanced communication system available in the world today, it will be the way to deliver communications in the future. Its high bandwidth capabilities and low attenuation characteristics make it ideal for gigabit transmission and beyond. For smart city applications OFC play major important role. Smart city is one that is effectively interconnected via a networked infrastructure to optimize the efficiency of various services and improve sustainability. The right infrastructure will affect the way each city will be created and evolve.

It helps in delivering services like:

- NMC - City administration: streamline management and deliver new services in an efficient way
- Education: increase access, improve quality, and reduce costs
- Healthcare: increase availability, provide more rapid, accurate diagnosis, provide wellness and preventive care, and become more cost-effective
- Public safety: use real-time information to anticipate and respond rapidly to emergencies and threats

NSCL
NAMCHI SMART CITY LIMITED

6. Year wise Deliverables:

Integration Platform	
6 months - 1st Year	**1st year- 2nd Year**
Study, requirement analysis and system overview **Procurement towards test-bed setup** **Customization of Integration Platform towards phase 1 deployment** **Prototype development and testing of Integration components** **Building and testing Integration test-bed setup** **Phase 1 deployment for Utility solutions**	Customization of Integration Platform towards phase 2 deployment Procurement towards test-bed setup Integration and testing of Integration platform and test-bed Phase 2 deployment of Utility Solutions Documentation/manuals and Training
Smart Governance and Citizen Services	
6 months – 1st Year	1st year - 2nd Year
Beta Version of the following **Unified portal (to support all the citizen services)** **Property development and approval system, Property Assessment and management system** **App based incident management** **Web based Land Management System** **Document Management System**	Final Version of the following Unified portal (to support all the citizen services) Property development and approval system, Property Assessment and management system App based incident management Web based Land Management System Document Management System
Video Surveillance - Summarization& Indexing	
6 months - 1st Year	1st Year - 2nd Year
Video summarization module for a single/multiple videos **Detection of objects of interest** **Tracking of such objects of interest from frame to frame** **Video summarization module for a single/multiple videos based on objects of interests**	Monitoring of Vehicles: Detection of illegal parking in no parking zones. Detection of vehicles driving in wrong way or reversing. Crowd behavior: Detection of people flow and counting of people in selected areas. Create an index of the synopsis video (scene based representation and annotation of video for easy access, visual table-of-contents for video through summarization Parallelization of summarization across intra-video (multiple videos) and inter-frame (single video) on CPUs/GPUs
Information Dissemination & Redressal System	
6 months – 1st Year	1st Year- 2nd Year
Requirement Gathering Data collection System Requirement Specification [SRS]	IVR system Report generation in Hindi, Nepali & English Languages

High level and Low Level Design Documents Ontology and taxonomy Alpha Version of web portal , mobile application with geo-tagged with English and Hindi and language support ASR and TTS for English, Nepali, Hindi and local languages Cloud enable service on available Meghdoot cloud platform or other compatible Cloud Platform Development of DSS for the respective department Development of Predictive input method for mobile and web application Hindi, Nepali and English Beta Version of web portal , mobile application with geo-tagged with Nepali language support	Pre-Processing of image, video for system perusal for retrieval QA system based on ASR through IVR Paper based for information demand registration and OCR system input Voice - Telephone - Landline/Fixed Wireless based input Support for blind - Through voice interface and generation of reports in Braille
Disaster Management	
6months- 1st Year	1st year - 2nd Year
SRS & QA preparation SDD preparation Defining standards for proposed GIS, MIS and metadata Data collection Basic data generation for Landslide Multi criteria analysis for Landslide zonation	Data collection for validation and calibration of different models QC of the modules Landslide hazard zonation map generation Validation and QC Deployment Preparation of Training and User manuals Training
Web-based SDN application development platform	
6 months - 1st Year	1st year - 2nd Year
To explore the state-of-the-art and provide a first draft of the SDN Online Lab architecture. Design and implementation of Developer's Toolkit for developing and simulating network applications. Exploration of Open Daylight controller and developing sample applications Development of web API and controller engine for SDN online lab. Finalizing the architecture of SDN online lab. Integration of web API, IDE and Open Daylight controller. Testing and verification of web-based IDE with some sample applications.	Identification of hardware for infrastructure set up of SDN online lab. Development of Resource Management policy. Actual hardware set-up for SDN-online lab. Integration of ONOS into the existing web-based IDE. Testing and verification of a web-based IDE on deployed hardware set-up. Support for other controllers will be gradually provided in future versions Specialized hardware components will be provided in future versions on request basis
Smart Utility Solution	

6 months - 1st Year	1st year - 2nd Year
Smart street lighting Smart energy metering solution Intelligent Water Management	Smart Poles Intelligent Parking Lot Management Solar Power Operated Vehicle Actuated Wireless Traffic Signal Controller Pelican Controllers (Pedestrian operated signal control for mid-block crossings)
Smart Communication Infrastructure	
6 months - 1st Year	1st year- 2nd Year
Integration of existing Fiber optic network Installation of Public Wi-Fi Network	Augmentation of Optical fiber network

7. Duration of Project

Development and deployment of the project will be maximum of 18 (Eighteen) Months**.**

8. Total Budget outlay

Proposed financial outlay of the project is estimated at **Rs……. Lakhs** (Rupees …… Only) The details are as follows:

(INSERT TECHNO COMMERCIAL PROPOSAL ALONG WITH THE DETAIL ITEMISED COST)

(All Figures in Lakhs of Rupees)

SL No	Description	Detailed Description	Quantity (Ca-Pex)	Amount in INR (Lakhs of Rupee)
1	City Command & Control Centre	C4 interior, hardware, active/passive networking and C4 platform		
2	Data Centre on Cloud	C4 application hosting		
3	Disaster Recovery	C4 Disaster Recovery		
4	Water Smart Metering	Capex Cost for billing management system/Android device with meter reading software/Data transmission unit with GSM		
5	ITMS (Smart Traffic)	Capex Cost for X signals/ software 1/Mob app 1/RLVD/ANPR/Signal controllers/CC cameras/application server.		
6	City Surveillance	Capex Cost for CC cameras/accessories/application server/software.		
7	Solid Waste Management (ICT)	Capex Cost for X? GPS/X? RFID tags/X? RFID receivers/CC cameras/& accessories		
8	Smart Pole/	Capex Cost for X? sensors/panic buttons/2way speakers/billboards/ CC cameras for video analytics/software & application server/accessories		
9	E-Governance	Capex Cost		
10	Installation & Commissioning	Capex Cost for all the tracks excluding DC/DR/C4		
11				
			Total Capex	

9. Integrated City Command and Control Centre

Command and Control Center is a place which gathers all the departments and mind of the city using ICT (Information and communication technology) as a backbone. It's a place where information from various departments and various applications is collected and analyzed for better planning of the city. It has Business Intelligence engine which will process all the information and generate insights. These insights will be helpful in managing incidents across the city and do a better planning for the development. It plays the role of decision support system.

1. General Objectives of CCC under Smart City Mission:
2. Single source of information" for all civic functions.
3. Platform with the ability to receive, intelligently correlate & share information with stakeholders who are into city operations and planning to better predict outcomes.
4. Act as City's emergency and disaster management platform.
5. It is integrated with various IT systems of different stakeholders with the objective of enhancing safety, security and providing better public services in the cities and it helps in :

   (i) Support police to maintain Law and Order

   (ii) Disaster Management

   (iii) Environmental Control/ Pollution Control

   (iv) Efficient user of public resources like electricity and water

   (v) Efficient and timely delivery of public services

   (vi) Better health and education services

9.1. Importance of Command and Control Center

ICT and IoT technology has providing a way to integrate closed proprietary networks, different teams working on different silos independently in different locations and across various departments. In a smart city, it provides single location to monitor and control the overall activities of various departments in the city. This helps in creation of a collaborative workspace regardless of the geographical locations. Provide an Eagle Eye View for the – "the decision makers" and helps in improving strategic & tactical operations. Command and Control Centers provide Convergence and Collaborative Action with Open Scalable Architecture.

Utilisation of IP Based Networks, Non – Proprietary based networks with Automate Policies and Response Plans to Control , Monitor and Maintain disparate networks with a single customized dashboard interface which increases situational awareness.

Command and Control Center promote situational awareness with control and monitoring. An Integrated Command and Control Center (C4) is a place where different technologies come together to create an " efficient and operational" requirements.

9.2. Evolution of Control Rooms

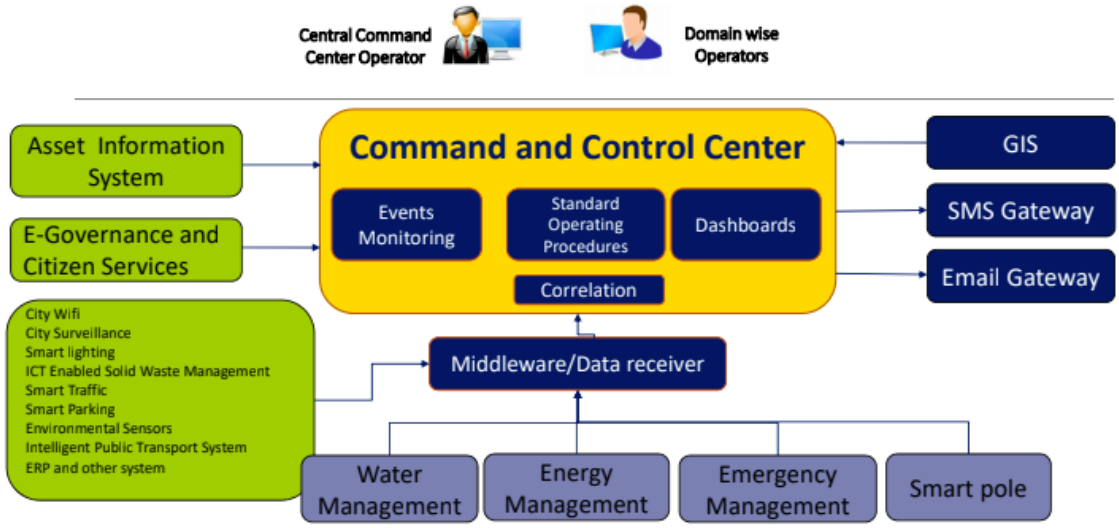
Control Room-THEN:

Control Room-NOW: (Typical Interface)

9.3. Namchi City Command and Control Center

The Namchi Smart City's vision of the Integrated City Command and Control Centre (C4) is to have an integrated approach of all the present and future smart initiative undertaken by NSCL with the focus to server as a decision support and collaboration centre for city administrators in daily operations and during emergency situations. The Command and Control Centre will comprise of various Applications and field level equipments which will provide data and information to the **City Command and Control Platform (CCCP)**. The CCCP shall be fully integrated commercial off the shelf (COTS) software platform that provides seamless integration and control mechanism with various Information Technology, Operational Technologies and IOT sensors/ applications/platforms. To achieve advanced smart city functionalities CCCP should not only integrate with IT solutions like Parking Management, Waste Management System, Street Light , Traffic Management System etc but also the Water SCADA , Energy SCADA, Sewerage/ Drainage System, Gas SCADA etc, to achieve better services to Citizens. It has been envisaged that CCCP should act like a brain of smart city initiatives which should facilitate the optimization of various city operations, interdepartmental collaboration, policies and governance processes to increase the liveability Index of the city. The CCCP should be accessible by operators and concerned authorized government entities with necessary authentication credential. The CCCP should also enable the sharing of critical and key information through dashboards with CMO office, Senior officials and key stakeholders.

NAMCHI SMART CITY LIMITED



9.4.C4 Design Standards

When designing C4, as per Bicsi standards, the following questions need to be addressed during the ideation phase.

- What are the personality types in the control center?
- Are they going to take naturally to collaboration & interaction?
- What are the tasks?Does collaboration help? Where and when does it help?
- What is the nature of the collaboration and communication?

It is important to ask and get answers for the following questions during Planning and Designing phase.

- Is some of it formalized & planned?
- What is informal and spontaneous?
- How does this align with the culture?
- Collaboration not usually key part of Concept of Operations
- What is the vision for collaboration between people & teams?
- What is the leadership like around this area?Does it encourage and foster a culture that is collaborative?
- How does the organizational structure facilitate communications?
- What is the leadership like around this area?Does it encourage and foster a culture that is collaborative?
- What is the objective?

Important physical factors required for establishing a C4 are:

- Flexible
- Dynamic
- Distributed
- Reactive
- Mobile
- Real-time
- Scalable
- Expandable

- Redeploy able

Typical challenges encountered when setting up C4 are:

- Function
- View ability
- Physical room area
- Room layout
- Screen area
- Company “Buy-in”
- Heat, Noise, Power
- Cost
- Through life cost etc.

C4 should enable the following collaborations to happen “REAL TIME” in Control Rooms:

- Information Exchange – quick exchanges that answer questions
- Co-Creation – working together to achieve outcome
- Social Interaction – basis of social relations
- Knowledge Transfer – passing on what you know
- Focus – heads-down work

ISO 11064-1:2000 gives the standard for Ergonomic design of control centers.

9.5. ISO 11064

Driven by demands for safer, more reliable and efficient operations, innovations in information technology have led to the increased use of automation and centralized supervisory control in the design of user-system interfaces and their associated operational environments. Notwithstanding these developments, the operator has retained a critical role in monitoring and supervising the behavior of these complex automated systems. As the scale of automated solutions has grown, so have the consequences of equipment and human failures.

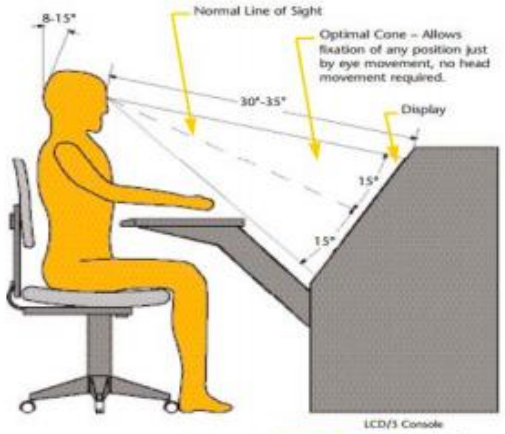
The job of the operator can at times be very demanding. The consequences resulting from inappropriate operator action in control rooms, such as acts of omission, commission, timing, sequence and so on, can be potentially disastrous. ISO 11064 has been prepared to set up a generic framework for applying requirements and recommendations relating to ergonomic and human factors in designing and evaluating control centers with the view to eliminating or minimizing the potential for human errors.

A specific control centre project is often part of a design project for a larger system. The design of the control centre should not be developed separately from the objectives and goals associated with the context of this wider system. Consequently, it is necessary to view the ergonomic aspects of a control room design in relation to issues which, at first sight or by tradition, may seem to fall outside the scope of ergonomic design projects. These judgments will need to be taken on a case by case basis and are not necessarily resolved by a prescriptive approach.

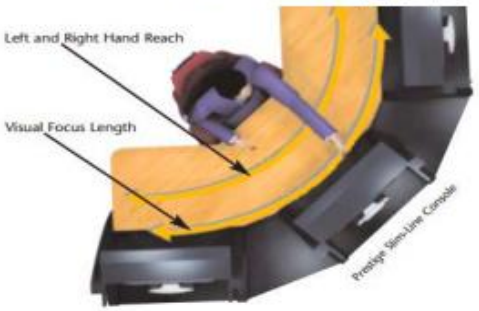
ISO 11064 includes requirements and recommendations for a design project of a control centre in terms of philosophy and process, physical design and concluding design evaluation, and it can be applied to both the elements of a control room project, such as workstations and overview displays, as well as to the overall planning and design of entire projects.

9.6. Design Process of Control Room

Designing of the Control Room as per ISO 11064 has the following phases.



1. Pre-design Analysis
   (a) Site Surveys and Information Gathering Visits
   (b) Audit of existing AV / IT infrastructure
   (c) Analyze clientneeds based on acquired information
   (d) Define goals for design, safety and functionality
   (e) Collect , pool and measure data using surveys, site visits, operations and standards
   (f) Space Planning
2. Control Room Design
   (a) Ergonomics – study of workers and their environment
   (b) Choosing the Right Furniture
   (c) Positioning of the furniture
   (d) Defining Lateral Workspace per workstation (work surface height to be 730mm)
3. Interior Design
   (a) Define colors, textures and materials for an aesthetically pleasing setup



(b) Define Furniture consoles, workstations, lighting ambience and acoustics requirement
(c) Interfacing with MEP to define HVAC , containment and power load requirements
(d) Interfacing with Fit Out Contractor to carry out civil works as per the Authorities requirements
(e) ISO 11064-4:2004 Part 4: Layout and dimensions of workstations
(f) ISO 11064-5:2008 Part 5: Displays and controls
(g) ISO 11064-6:2005 Part 6: Environmental requirements for control centers
(h) Excerpts from ISO Standards :
   i. Noise levels should not exceed 55 dB(A)
   ii. Lighting levels should be task dependent, adjustable and minimize discomfort glare
   iii. Outside view to be provided if possible. If not some form of visual relief such as scenic posters should be provided.
   iv. Adequate provision should be made during the design of the layout/arrangement so that control operations are not interrupted by either visual or auditory instructions made during general circulation

4. Control Room Security & Maintenance

(a) Threat and Risk Assessment
(b) Define Ingress / Egress Procedures and Protocols
(c) Define Administrator and operator rights
(d) Control rooms to be secure and resilient
(e) The layout of the control room should allow for easy and orderly evacuation of the room.
   - Rear access to workstations for maintenance is required with adequate clearance of 52 inches behind the workstation
   - Control room circulation routes should be arranged to avoid cross-circulation.

9.7. Factor-1: Ergonomics

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system.

- Very Important Planning in Productive and Healthy Workspaces
- Promotes Engagement
- Harbours Collaboration & Cooperation
- Design Approaches
- Better Workspaces
- Need for posture change & to move around
- Reflect move to strategic problem solving & decision making

9.8. Factor-2: Video Walls

- Provides an overview of the total system – The “Eagle Eye view”
- Operators have personal data and Interactive processes at their desk
- The Video wall shows the whole process

A video wall more than just the organization’s showpiece or a large, fancy display—it is much more than just “nice to have.” This document will explain how video wall systems benefit operations in control room applications and help make your control room operations run more smoothly and effectively.

The primary purpose of the video wall in a control room is to provide domain experts (operators or control room users) with true situational awareness and a common operating picture where information from real-time sources such as computers, video, networked applications, CCTV or security cameras, etc., may be simultaneously shown and shared. This enables and promotes informed decision making on a unified level.

Utilities

For control room display of SCADA and OMS information along with other critical data and graphics, all utilities control rooms require visually high-resolution display systems where image clarity and reliability is not only critical, but imperative for smooth operations. It is impossible to display high-resolution SCADA on a small monitor without compromising quality and sacrificing readability. High-resolution graphics are displayed continuously for extended hours on the display wall and is monitored by operators who use it to ensure system reliability. The display wall is used not only to monitor operations, but also as a visual reference for critical communications with field operators.

Transportation

Transportation Management Centers need the capability to display high-resolution graphic information from maps, multiple camera feeds, traffic management applications, etc. to ensure safe and continuous traffic flow.

Operators need the ability to monitor various types of information continuously. They also need the flexibility to scale this information or images seamlessly across large areas when the requirement becomes critical. Operators need to collaborate on real-time information from video feeds and other applications for timely dispatch of much needed actions ensuring smooth operations.

Emergency Operations, Management and Response

During emergency operations, management and response teams need high-resolution graphics displayed from multiple applications readily displayable to be simultaneously shared between many different users and operators. With time constraints, multiple agencies often need to get together and collaborate to make informed decisions and take the right course of action. Emergency operations can run continuously for extended hours or even days through various shifts and the uniformity and reliability of the displayed information, as well as the display wall is critical.

Command and Control

When you are tasked to build a display for use in a command and control center, you are tasked with a mission-critical activity where image quality, reliability, scalability, and continuous availability could make the difference between life and death in some emergency situations.

Information from many different types of sources including computers, video, and networked applications, need to be displayed on multiple screens and shared between multiple operators to stay in control and make for efficient management of emergencies.

Security and Surveillance

Security has become central to ensuring that society is kept free from the threat of terrorism and the worries of cyber or physical attacks, antisocial, or criminal behavior. These worries permeate our lives as never before. Control rooms providing situational awareness on a large common operating picture, are core to achieving this state of affairs in an efficient way. As such the technology for this endeavor is rapidly evolving. The continuous availability of shared information on large displays is becoming an operational necessity in keeping all members of society safe and free from these unwanted threats.

Telecommunications and Network Operations

Vast amounts of information and activity need to be continuously monitored for smooth operations in the telecommunications and network operations industry. Data, graphics, and even videos are continuously monitored with the operators needing high-resolution and clear images that can be viewed and managed with ease. Displays for this information need to be flexible and highly reliable to ensure continuous system availability.

Video Wall Design

The video wall is also a central communications hub and show piece of an organization and is often used to demonstrate operational efficiency and capabilities to the stakeholders of the organization. In control rooms, the design of information presented to the operator is often distanced from the real-world process that it should represent. It becomes important for this information to be presented in a way gives operators the correct and optimal feeling for the process and its current status. The display should continuously support and update the operator's mental and tacit model of the ongoing real-life process.

When a process is going well, there is no need for information to be shared on a common display. But when something starts to go wrong (and it often does in real-life), an early warning should show up with all relevant information required to diagnose the problem and take corrective actions to fix the problem. There may also be a need for new types of data and information and more advanced types

of graphics. Operators and users may be required to zoom in visually on an issue when a fault is detected. This is where large-scale overview displays become invaluable.

It is a risk to put too high a degree of emphasis on local desktop displays. The desktop should provide detailed information, which is often a subset of the common operating picture. Frequently an operator works with several desktop displays in parallel with the main control room display and it is important that different displays represent different modalities.

We often hear of business reporting the losses organizations incur due to operator neglect and error. Any unplanned downtime can amount to billions of dollars every year. Similarly, in public service entities such as transport, dispatch, emergency services, and command and control, time lost through error and misdirection can be costly and sometimes, fatal.

Research has proven that majority of such downtime is preventable and more than half is due to operator error caused mainly by poor monitoring and or visualization. This could be due to dramatic increases in sedentary work with little or no need for physical activity, possibly because of the technological advances in the tools used at work. Strain injuries from backache, RSI, and E-thrombosis to headache, mental fatigue, and eye-fatigue or strain, and even sheer boredom can be caused by staring at small screens for extended hours of operation.

Designing and building a good control room with better display and visualization tools create a work environment that promotes high levels of vigilance and situational awareness. Operators are vigilant when they are alert and prepared to act. They have a high level of situation awareness when they have an accurate perception of the current condition of the entire process and related equipment, and an accurate understanding of various key performance indicators.

A video display wall, when used in conjunction with local desktop monitors, provides such an environment where multiple operators can collaborate effectively with common information to jointly make informed decisions and take proper action.

A video wall helps create the optimal visual connection between the operators and the system, process, business, and organization. It helps promote operator alertness and helps minimize fatigue and distraction from reading information on smaller desktop displays, effectively enabling readiness and proactive action promoted by a combination of the large overview display and local desktop monitors.

Display Performance Factors

- Screen Size/Resolution
- How big is the screen
- What type of info will be displayed
- What space is available
- What distance are the viewers
- Screen Type
- Screen Viewing Angles
- Location of viewers
- Ambient light reflection
- Anti Reflection
- Ambient Conditions
- What ambient light is there
- Total avoidance of screen glare
- Contrast ratio delivery
- Display Device Brightness
- Measured in cd/m2 or nits

- Function of screen area and device brightness
- Aim to reduce operator fatigue

Video wall should be able to display flexible contents as given below:

Push / Pull data	Requirement to control multiple display areas from multiple control points
Ability to handle various input types	Direct Digital (DVI/HDMI), IP Based / RTSP H.264 Cameras/IP Video, Network capture (VNC/RDP), Audio
Utilise existing network infrastructure	No additional AV cabling
2K and beyond	H.264 running at 2K, what about greater than 2K & 4K
Same information	Connected data should be available across all control points
Same time	Information should flow across control points and be available at the same time
Multiple locations	Data not limited to single display areas, have the ability to display in multiple locations
Compatible with BYOD	Requirement to connect to an array of BYOD devices

9.9. Factor 3: Consoles

A Control Room Console is one of the most essential elements of a mission-critical control room. It is the support system for controlling and monitoring various task critical operations within a defined territory.

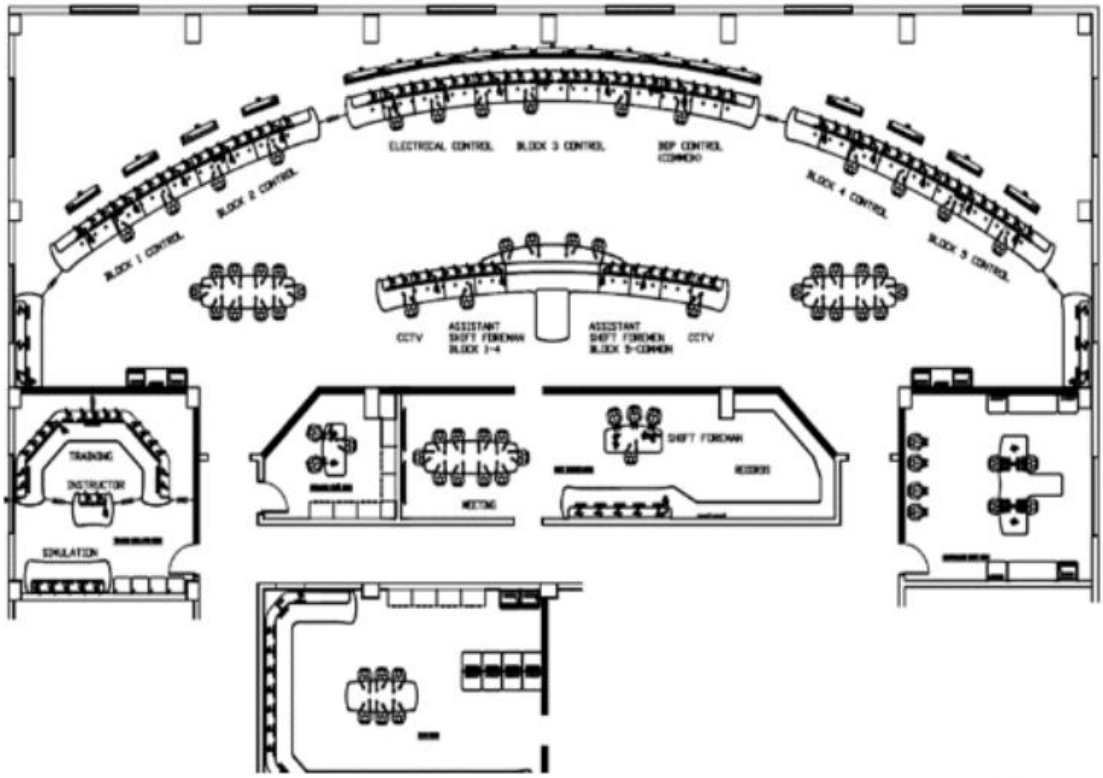
The control room operators, their interaction with the machines, equipment, operations and the tasks assigned to them, contribute to the Human Factors. The control room operations are managed and operated by them, where they are expected to deliver focused performance with minimal distractions and with no margin of errors. In doing so they are required to be healthy in both professional as well as psychological context.

The control room environment plays an important role, as the controls, the alertness, the focused work practices of an operator is what it takes to ensure the correct health of a control room environment.

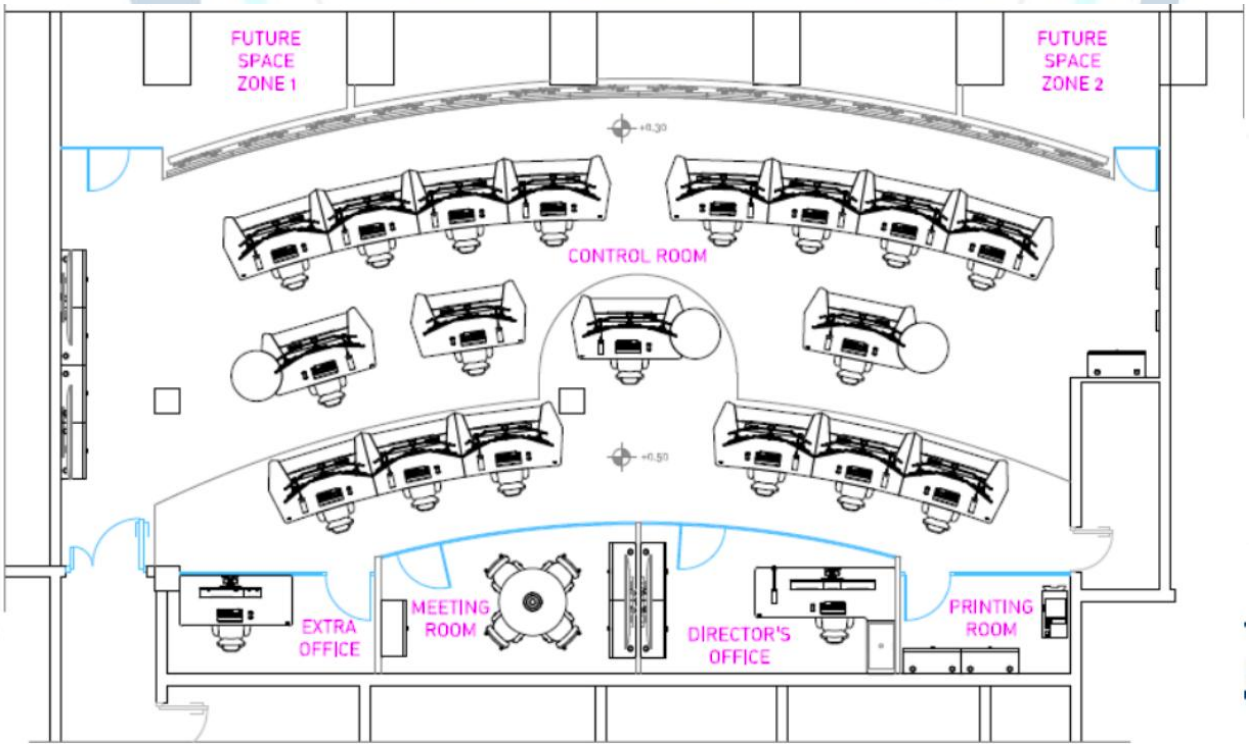
The consoles design parameter should consider of the following factors:

- Function
- Equipment
- Room Size
- Useable Space
- Control Equipment
- Standards & Specifications
- Finishes
- Weight
- Cable Management
- Internal structure
- Equipment mounting
- Distribution
- Ventilation & Temperature control
- Acoustics
- Lighting
- Provision for inspection/repairs
- Equipment position
- Seating
- Leg room for operators

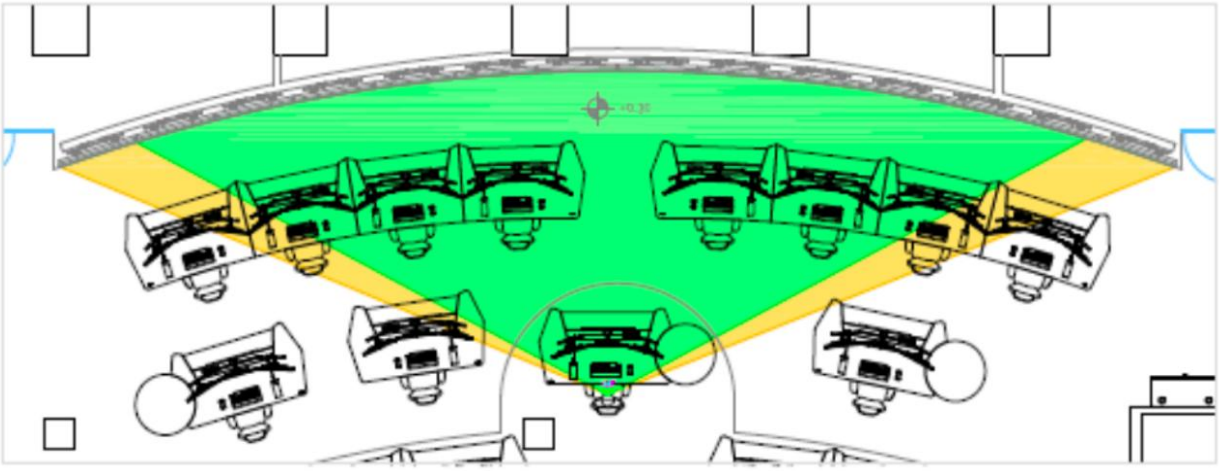
There are two major trends for the consoles used across the world is given in the below diagram.
Generic design of console arrangement in a multi-group centralised command and control center is given below:

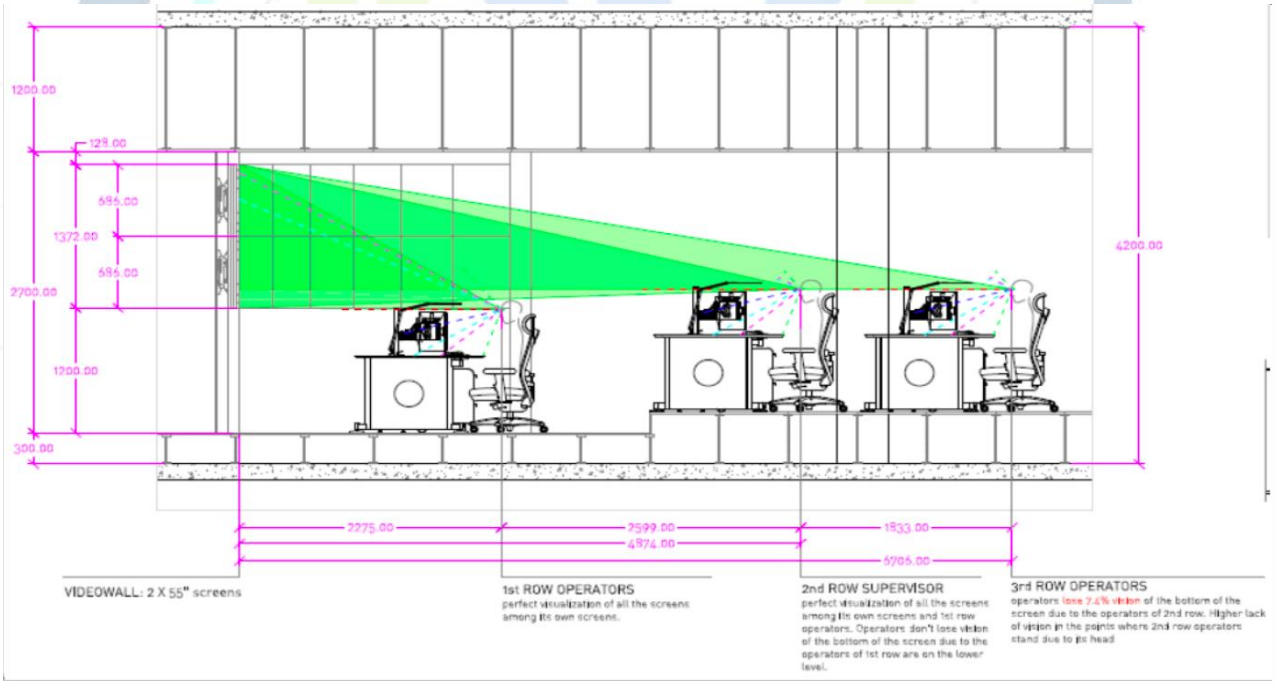


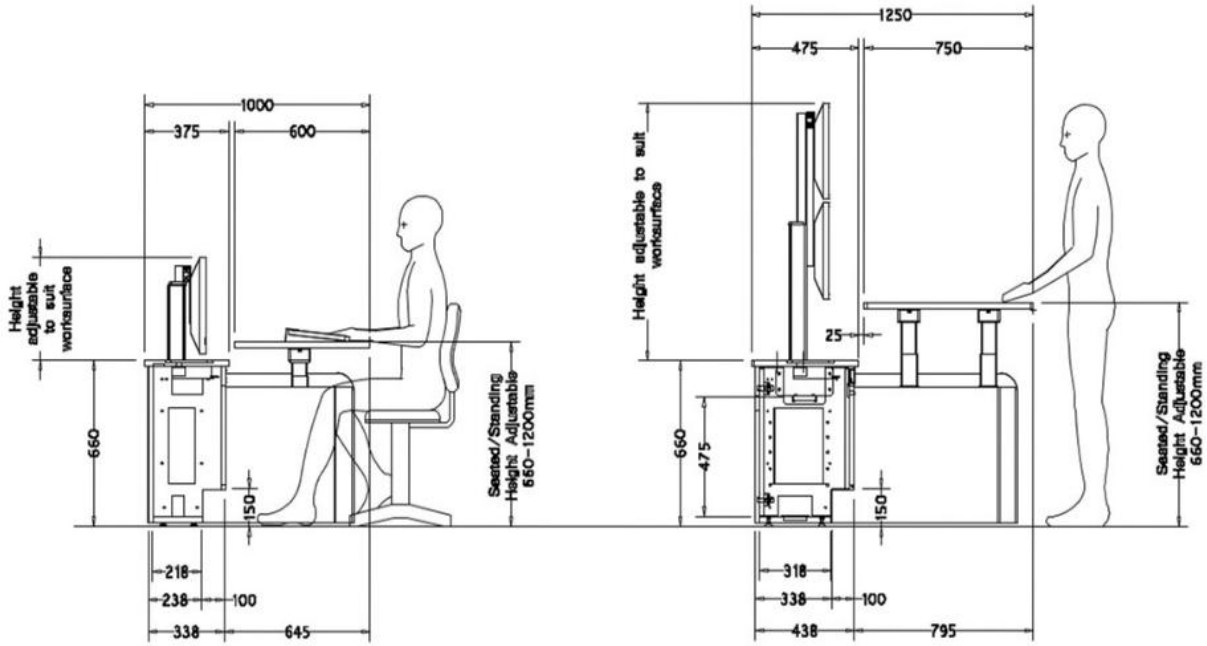
Standard layout diagram of consoles in a command and control center is given below:
Seating position standards along with line of sight/view for the operators is given in the diagram below:



Viewing angle/area for supervisor/master controller of the command and control center is shown in the below diagram:

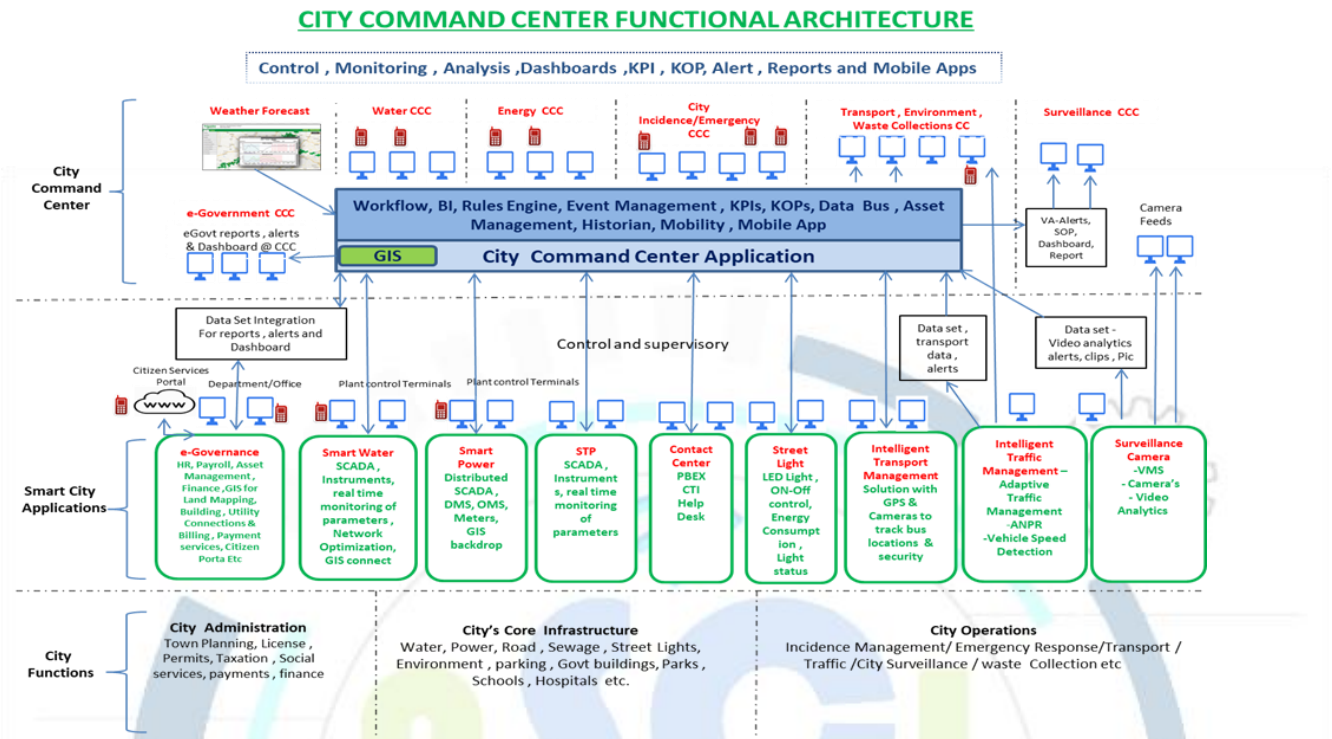






NSCL
NAMCHI SMART CITY LIMITED

9.10. City Command and Control Platform (CCCP)



The below sample architecture diagram shows the interaction of various entities with the various functions of the CCCP:

9.10.1. CCCP Core Components

(a) **Business Rules Engine** – should enable users to define the business rules around incidents handling and Emergency response as per agreed SOPs for the Smart City

(b) **Integration Layer** – Should provide a common data integration layer which can collect and contextualize information from disparate data sources regardless of protocol.

(c) **Workflow Engine** – should manage the life cycle of incidents and related entities via predefined workflows. Workflow should able to write interactive SOPs. The workflow could cut across multiple systems via the interfacing modules. Workflow for operational alerts and escalations should be triggered automatically without human intervention.

(d) **Task Management** – should manage the planning preparations of an incident including resource allocation, tasks management etc.

(e) **Analytics and MIS** – should provide users with business analytics reporting and tools to organize, evaluate and efficiently perform day to day operations

(f) **Reports and Dashboards –** should provide filterable reports and dashboards about critical information pertaining to incidents and KPIs collated in a single view which can be drilled down further for more detailed information

(g) **Security & Roles –** should manage roles definition for internal as well as external access

(h) **Centralized data archiving for operational data:** Should provide facility for centralized storage of operational data (time-series and transactional) with high granularity and data compression capability

(i) **Mobility:** Should enable operators and the crew members to access the workflow task assigned to them and act using the native mobile application. They should be able to close loop of workflow by acknowledging the real-time status of Action assigned to them.

(j) **Command & Control: S**hould have ability to take over control of subsystems wherever it is applicable and required. For eg Water SCADA & Electrical SCADA Systems.

9.10.2. General Functional Description and Features

(a) The software shall consist of a suite of Commercial-off-the-shelf modular components that are tightly integrated together to perform all CCCP functions

(b) The system shall provide CCCP operators and managers with a management dashboard that provides a regular 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 colour coded.

(c) The CCCP shall provide the "day to day operation", "Common Operating Picture" and "Situational Awareness" to participating city department.

(d) The CCCP shall define all the city objects in a hierarchical fashion to segregate data. These objects are city assets that will have all the relevant information in the smart city area. These objects give real time status of assets and update automatically in case of failure.

(e) The CCCP shall have tightly integrated Asset Management/ CMMS System to have all relevant information of all assets in Smart City solutions to give real time status of assets & update automatically in case of failure.

(f) It shall improve scalability for large and geographically distributed environments.

(g) It shall provide complete view of facilities, sensors, and alarms in an easy-to-use and intuitive GIS-enabled graphical interface with a powerful workflow and business logic engine.

(h) It shall provide a uniform, coherent, user-friendly and standardized interface

(i) It shall provide possibility to connect to workstations to be displayed in one or more video wall with one or more module/application/solution being independently and/or simultaneously being displayed and functional.

(j) The dashboard content and layout shall be configurable and information displayed on these dashboards shall be filtered by the role of the person viewing dashboard.

(k) CCCP should allow creation of hierarchy of incidents and can present the same in the form of a tree structure for analysis purposes

(l) The system shall integrate with GIS and map information and can dynamically update information on the GIS maps to show status of resources.

(m) The CCCP shall be available via a VPN as a web-based interface or a thin-client interface.

(n) It shall be possible to combine the different views onto a single screen or a multi-monitor workstation.

(o) CCCP should maintain a comprehensive and easy to understand audit trail of read and write actions performed on the system

(p) CCCP should have instant messaging which should provide the ability to converse virtually through the exchange of text, audio, and /or video based information in real time with one or more individuals with in emergency management community.

(q) The CCCP should have capabilities to integrate seamlessly with following subsystems:

- Water / Wastewater SCADA
- Electricity/smart grid SCADA

- Street Lighting Solution
- Communications Network Management (OFC, Wireless, GSM/GPRS, NFC, IoT spectrums etc.
- Solid Waste Management
- e-Governance Monitoring
- ERP Systems
- Emergency Response
- Education and Healthcare
- Environmental Sensors
- Traffic Management Systems
- any other relevant existing or future systems or sensors
- Flood management system
- Many other present or futuristic systems

(r) CCCP should provide ability to extract data in desired formats for publishing and interfacing purposes.

(s) CCCP should have mobility devices & applications for field staff to ensure fast restoration of services in case of alarms, issues, incidences. In case of non-attending of alarm, decision escalations will be done automatically. After closure of issue the workflow must be closed with feedback from those devices.

(t) System should provide ability to attach documents and other arte facts to incidents and other entities.

9.10.3. Standard Operating Procedures -Functional Capabilities

CCCP should provide for authoring and initiating un-limited number of configurable and customizable Standard Operating Procedures (SOPs) through drag and drop design tool preferably using workflow engine.

(a) SOPs should be established, approved set of actions considered to be best practices for responding to the situations or carrying out an operation.

(b) User should be able to edit SOP, including adding, editing or deleting activities.

(c) Solution should allow provision for automatically logging the actions, changes, and commentary for the SOP and its activities, so that the record will be maintained for after action review.

(d) SOP should be able to define following activities

i. **Manual activities** – The activity initiate by the user manually.

ii. **Automation Activity** – The activity initiated through sensors, control system or any other integrated application without any human intervention.

iii. **If-Then-Else Activity**- A conditional activity that allows branching based on specific criteria. Either enter or select values for if then and else.

iv. **Notification activities** – An activity that displays a notification window that contains an email template for the activity owner to complete, and then send email notification.

v. **SOP activity** – An activity that launches another standard operating procedure.

(e) The SOPs defined in the system should be easily editable by an administrator with drag and drop capabilities.

(f) The CCCP shall present the workflow and task information in a clear and logical manner on the incidents screen.

(g) CCCP system shall include a section that will contain the Policy and standard operating procedures with easy to search functions to support the Operators during a crisis.

(h) CCCP should be able to pass the SOP step on to mobile application for the user to respond based on his role and responsibility in the SOP to achieve faster response to the incidences or events.

9.10.4. Common Operational Picture (COP) -Functional Capabilities

CCCP as the central control function of the integrated city operations should have capabilities to create and watch command operational picture. It is envisaged that CCCP console should able to have the functionalities of monitoring and control of integrated sub-systems. For example during emergency situation like fire outbreak, the CCCP uses should able to view locations on GIS, view first responder movements on the physical locations and also able to take over the controls of surveillance cameras from VMS solution so that he user will be able monitor, command and control the field operations by making use of COP capabilities.

i. The CCCP should be able to combine data from various sources and present it as different views tailored to different operator's needs.
ii. The CCCP should automatically update the information based on alarms and incidents that are presented to it via the business rules engine. The polling and CCCP database refresh cycle shall be configurable to match the status of the situation (whether there is an emergency or crisis or just monitoring only).
iii. The CCCP should able to take over control of integrated sub-systems either passing set points or changing process as applicable. for example, CCCP should have capabilities to pass the trigger in the adaptive traffic solution to initiate the VVIP corridor process.
iv. Common Operational Picture should comprise of a comprehensive view of the incident or a group of related incidents as on a specific date and time which should include but not be limited to the following:
v. Tasks assignment and their status
vi. Agencies involved
vii. Resources deployed
viii. Incident status across relevant parameters of the incident e.g. household affected by a transformer shut down
ix. Timeline view of the situation
x. Suggested actions from the system with their status

9.10.5. Incidence Management - Functional Capabilities

The CCCP must provide incidence management Services to facilitate the management of response and recovery operations to city incidences.

i. Should support comprehensive reporting on event status in real time manually or automatically by sensors and integrated sub-systems
ii. Should support for sudden critical events and linkages to standard operating procedures automatically without human intervention.
iii. Should support for multiple incidents with both segregated and / or overlapping management and response teams
iv. Should support geospatial rendering of events and incidence information.
v. Should support plotting of area of impact using polynomial lines to divide the area into multiple zones on the GIS maps
vi. Should support incorporation of resource database for mobilizing the resources for response.
vii. Should provide facility to capture critical information such as location, name, status, time of the incident and be modifiable in real time by multiple authors with role associated permissions

(read, write) . incidents should be captures in standard formats to facilitate incident correlation and reporting

viii. The system must identify and track status of critical infrastructure/ resources and provide a status overview of facilities and systems

ix. Should provide user-defined forms as well as standard incident command Forms for incident management.

9.10.6. Dash boarding and KPI – Functional Capabilities

CCCP should provide integrated dashboard and KPI tracking capabilities for various city functions. Dashboards should be designed in such a way that user should be easily navigate user interfaces for managing profiles, groups, messages templates, communications, tracking receipts and compliance. Likewise, CCCP should have capabilities to configure and monitor key performance indicators on real time basis.

i. Dashboard should collect major information from other integrated city sensors/ platforms and sub-systems

ii. Should allow multi-display configurations

iii. Should provide tools to assemble personalized dashboard views of information pertinent to incidence, emergencies ad operations of different departments and city divisions

iv. Should provide historical reports, events data, and activity logs. the reports can be exported to PDF or other formats

v. Should provide dashboard filtering capabilities that enable end-users to dynamically filter the data in their dashboard based upon criteria, such as region, dates, products, sub-systems and capability to drill down to the lowers details.

vi. Should be able to facilitate measurement or criteria to access the condition or performance of department process and policies on real time basis.

NAMCHI SMART CITY LIMITED

9.10.7. Business Rules Engine – Technical Capabilities

i. The CCCP system should have a built-in alarm handling facility based on configurable cause and effect rules.
ii. The CCCP system should receive inputs (referred to as “incidents”) from various sources. These incidents when passed through the business rules engine shall trigger an automated response as defined using the business rules engine.
iii. The business rules engine should be able to send and receive messages to other applications running within the CCCP suite as well as external systems like the surveillance system.
iv. The business rules engine shall be able to co-relate between different types of incidents or frequency of similar types of incidents.
v. The business rules engine shall be able to distinguish between “early warning or anticipation” type mode of operation and an “emergency or crisis” mode of operation.
vi. The CCCP shall provide capability for users with appropriate rights to define business rules.
vii. The CCCP shall provide capability to do a simulation run of a newly created/added business rule before it is activated.

9.10.8. Workflow - Technical Capabilities

The CCCP should have extensive workflow functionalities which can be used to develop SOPs, Cross functional workflows and integration of process across sub system as deem necessary.

i. Workflow and Incidents lifecycle system – this function should allow users to define and modify new workflows. The workflow could cut across multiple systems via the interfacing modules. Workflows for operational alerts and escalation should be triggered automatically without human intervention.
ii. Process designer - Intuitive visual tool that offers an integrated workflow process design and deployment tool for use by departments, developers community, technical architects, and ISVs without any restriction for X or Y axis for design interface. Graphical process designer must be 100% web based tool that enables BPM practitioners to define processes to achieve smart city objectives.
iii. Process Designer to enable a collaborative work environment that supports cross departmental communication.
iv. Audit trails maintained throughout the business process lifecycle from design and deployment to optimization, track and trace the actions of individuals for resource performance analytics and accountability.
v. Workflow approvals should have facility to approve from any smart device.
vi. Workflow function should provide facility to trigger a corrective action workflow and define the stakeholders for the same.
vii. Workflow system should be able to create, assign, track and report on the lifecycle of tasks during an incident.
viii. The workflow system should allow a specific task to be decomposed into sub-tasks.
ix. The workflow engine should be able to dynamic assignment of tasks based on roles, name, designation or any other attribute present in the resource database
x. The system should provide an easy to interpret management dashboard view of the progress of all tasks during an incident.
xi. The platform shall have cross functional workflows with the ability to communicate between People, devices and systems (ERP/ CMMS/ EAM/ Sub-systems etc).

xii. The workflow should be able to organise the visual representation of tasks into prioritized list, filtered list, as well as colour coded representation for ease of understanding.
xiii. The workflow should have Multi-level calendars for managing resource availability during the design time.
xiv. The workflow should able to use of alternate resources when a resource is not available to complete the teaks
xv. The workflow should able to do queue management for management of resources performing similar functions. Queue Management allows automatic, semi-automatic and manual modes of task dispatch. FIFO, LIFO, and Round-robin are some of the algorithms supported.
xvi. Escalation mechanisms to ensure tasks are never delayed
xvii. Multi-channel task notification set up at the design level
xviii. Assign a target completion date and time for the task, either directly or as a time-span from the task's creation.
xix. The criticality of task within workflow should be dynamically changed depending on the response SLA, for example, in case of delays in response to the task should change the task to high priority task.

9.10.9. Analytics and Reporting – Technical Capabilities

i. The analytics tool should be able to produce performance analysis and produce dashboard reports on performance.
ii. The CCCP should allow users to define benchmarks against performance parameters. Performance reports shall have the option to generate reports with or without benchmark comparison
iii. The CCCP should use analytics to create a view of hazards and prioritizes based on a severity and risk profile
iv. The CCCP shall be able to import data into its analytical tool.
v. CCCP should be capable of easily interfacing with any other external analytical tool that might be required in future to provide warning inputs to Smart City.
vi. The CCCP shall present a prioritized list of key actual incidents, and tasks requiring action.
vii. CCCP should be able to perform multi-dimensional analysis on incidents data. This should provide capability to do Trends Analysis.
viii. The CCCP should provide a clear reporting function following an incident for: Management dashboard reporting and Analysis of what went well and "lessons learnt"

9.10.10. CCCP Graphical User Interface (GUI)- Technical Capabilities

i. The CCCP should present information on standard Windows based workstations and terminals.
ii. The CCCP GUI shall be able to present management data such as dashboards, alarm and alerts, resource management information, incident information in color coded, clear, simple and unambiguous, logical format
iii. The color coding on the CCCP GUI shall represent the different status of a task or incident / alert.
iv. The GUI layout and arrangement of windows shall be user customizable.
v. Should able to present information and distinguish between an "early warning or anticipation" type set of data and "emergency or crisis" operating mode.

vi. The CCCP should be capable of presenting information in a browser based format such that it is accessible from any terminal with a web-browser. The supported browser should include, but not limited to, Internet Explorer, Chrome, Firefox and Safari
vii. The CCCP should be capable of showing still as well as video imagery.
viii. The CCCP information shall be capable of pushing onto other display devices such as the video wall of the City Management Centre.
ix. The CCCP should be capable of providing the following features for still and video imagery:
   (a) The system shall have a thumbnail gallery to display all imported images
   (b) The system shall be able to import pictures from still imagery cameras
   (c) The system shall be able to import pictures from local hard drives
   (d) The system shall be able to share the imported images with other users
   (e) The system shall time and date stamp any imported images
   (f) The system shall have the ability to view each still image full screen
   (g) The system shall have the ability to zoom in and out of a still image when viewed full screen
   (h) The system shall allow the image to be imported to the planning whiteboard module
   (i) The system shall enable users to add tags to images for easy search and retrieval later on
   (j) The system shall enable users to group and title images together for easy retrieval
   (k) The system shall be able to display video imagery
   (l) The system shall have a thumbnail gallery to display all video images
   (m) The system shall allow the video streams to be grouped and titled as per defined requirements.
x. The CCCP presentation layer shall have the capability of only refreshing those elements of the GUI that have changed state.

9.10.11. Integration Layer – Technical Capabilities

The CCCP should have robust integration capabilities of integration with existing and future platforms, IOT devices and application. The success and suitability of the platform also depends on the integration capabilities of the platform.

i. The CCCP should support various Information Technology Standards (like ESB, API Integration, Web Services), industrial protocols (like OPC UA, BCNET, Serial communication) and IOT (LoRA, MQTT, Stomp, AMQP etc) The layer should have capabilities to integrated with operational, IT systems and applications on real time basis and not on off line basis. CCCP should have built-in supervisory capabilities with ability to send control signals to the end systems in case of emergency and process overrides
ii. The CCCP platform shall include a broad range of Device Integration services for establishing the I/O interface to field devices such as RTU's, PLC's, IBMS etc systems. Similarly, it should seamlessly integrate with IOT devices/Sensors and applications.
iii. The CCCP should provide a comprehensive API or SDK (Software development kit) to allow interfacing and integration of 3rd party systems
iv. Bidder must demonstrate OPC connectivity for real time systems during POC & project for acquiring controls over subsystems like Water, Electrical, Street Lighting, Sewage etc. ESB Integration for such systems shall not be acceptable.

9.10.12. General System Development Functionality- Technical Capabilities

i. The CCCP platform Development Environment shall provide a mechanism to develop Application Object Templates.

ii. The CCCP Should provide SDK tools that help the City to produce new applications, and/or use solution APIs to enhance or manage existing solution.
iii. The CCCP system software shall include an object-oriented colour graphics display generator with full animation capabilities to provide users with a realistic and efficient visualization of the CCCP system process. It shall provide graphical capabilities to allow design of highly efficient user interface aimed at helping operators to easily achieve a state of situational awareness in relation to the process.

9.10.13. General System Display Functionality- Technical Capabilities

i. Shall have the facility to view and handle multiple alarms at one time
ii. Shall have the facility to view multiple video windows at one time. Operators shall be able to resize and move video windows.
iii. Shall have the facility to view windows in a single monitor or across multiple monitors
iv. Shall have the facility to access, display and manage incidents/alarms and related sensors data and information from subsystem based on priority and authority level.
v. Shall view and manage detailed response procedures and tasks
vi. Shall enable a single operator or multiple operators to monitor and control commands from connected subsystems, including all operational capabilities for detection, assessment, notification, entry control, and communications
vii. Shall provide the rapid annunciation and display of alarms to facilitate evaluation and assessment

9.10.14. GIS Display – Technical Capabilities

i. Shall view the environment fixed composite computer-generated (JPEG, BMP, AutoCAD, etc.) map
ii. Should allow user to view sensor and related name from the displayed map
iii. Should allow all resources, objects, sensors and elements on the map to be Geo-referenced such that they have a real-world coordinate.
iv. Should visually display a camera sensor with related camera orientation, camera range and camera field of view angle.
v. Should visually display an alarming sensor on map
vi. Should visually differentiate sensor alarm severities on map through different colour and icon identifiers
vii. Should immediately view alarm details (including description, video, etc.) and investigate the alarm from the map
viii. Should allow user to choose camera and other sensors from map to view live video and the data
ix. Should allow user to choose camera and take live video image snapshot and save to file from any camera
x. Should allow user to choose camera from map to move PTZ cameras
xi. Should allow user to choose camera to play, pause, stop, fast-forward, rewind, and play recorded video from preset time
xii. Should allow user to choose camera and take recorded video image snapshot and save to file or print from any live or recorded video
xiii. Should allow user to jump from one map to the next with a single click of a mouse with map links
xiv. Should allow map information “layers” to be displayed/hidden on items such as –

(a) Sensor names
(b) Sensors
(c) Sensor range (e,g. camera – orientation, range, field of view angle)
(d) Locations and zones
(e) Perimeter ranges
(f) Resource tracks
(g) Allow user to zoom in/out on different regions of map graphic

9.10.15. Asset Management – Technical Capabilities

CCCP should provide a comprehensive asset management or CMMS solution to manage critical assets like equipment and sensors of the smart city solutions. Asset management solution should be off-the-shelf module tightly integrated with CCCP. The objectively of this module is to ensure availability, maintainability and management of life cycle of smart city solution assets to ascertain the efficient functioning of the solution offered under this tender.

i. The system shall be able to define the complete model of the asset hierarchy.
ii. System should able to track the status of digitally connected assets on real time.
iii. The system should allow maintenance personnel can manage and plan incoming work requests as well as automatically generated work from preventive maintenance programs.
iv. Work orders assigned should be able to identify labour, materials, tools, drawings and subcontractor requirements, as well as safety information to support proactive maintenance activities.
v. The system should be able to create a library of standard, repeatable jobs with automatic work order generation
vi. The system should be able to build a detailed history of equipment information based on day to day maintenance activities. Failure history, including symptoms, the cause of failure and action taken can be easily reviewed and analyzed.
vii. The system should be able to provide indicators like as mean-time-between-failure and mean-time-to-repair
viii. The system should have the ability to track and manage asset Inventory
ix. The system should automate the reorder process by recognizing calculated safety stock levels, replenishment lead times and sophisticated “available-to-promise” logic based on expected receipts (open purchase orders) and issues.
x. The system should have the ability to establish multiple storerooms and locations, as well as flexible categorization capabilities, and allows the user-defined grouping of items for searching, analysing and reporting purposes.
xi. The system should provide the ability to uniquely identify and track repairable items and critical parts through serialization.
xii. The system should have an approval workflow to ensure auditable decision making.
xiii. The system should have integration with Geographic Information System (GIS) solution from ESRI or equivalent and provide geospatial view to store, edit, analyse, share, and display geographic information for informed decision making.

All the tracks which are explained in detail below need to be integrated with the CCCP for effective and efficient operation of Namchi Smart City.

9.11. C4 Integration Matrix

There need to be seamless integration with C4 as per the matrix given below for command, control and operations of Namchi Smart City.

Integration with	View	Control	Full Operations
E-Governance applications, City Portal , Mobile App (not in current scope of RFP)	Yes	Yes	Yes
City Surveillance	Yes	Yes	Should be Possible On Demand
Traffic Monitoring	Yes	Yes	Should be Possible On Demand
Municipal Vehicle Tracking and other vehicles (fire , etc.)	Yes	Yes	Yes
Bus Intelligent Transit System	Yes	Yes	Should be Possible On Demand
Smart Parking	Yes	Yes	Should be Possible On Demand
Other components Electrical SCADA, Water SCADA (provision to be made in future)	Yes	Yes	Should be Possible On Demand

NAMCHI SMART CITY LIMITED

10.Water

10.1. Ideation

As India continues to experience rapid urban expansion, public and private leaders at a national, state, and local level are looking into ways to better manage larger populations and unlock greater economic potential. Learning from previous national urbanization initiatives, the Smart Cities Mission promises to simultaneously improve the infrastructure and built environment in India's expanding cities while offering a new path to urban fiscal health. If successful, Indian cities will position themselves as clean, modern, and competitive places for years to come.

Several different reasons help explain this structural shift, especially since 1947 with India's independence. The rise of a more diversified economy, combined with a growing reliance on heavy industry, is one major factor. Similarly important are the 1991 economic reforms, helping to spread greater market activity and investment across country With a focus on service industries, India has also experienced a notable transition from rural and semi-urban areas to urbanized growth centers. Better infrastructure facilities and economic opportunities are constantly attracting more people into urban areas. In the reverse, rural areas struggle with economic distress, agricultural stagnation, and limited infrastructure development. However, many areas are urbanizing in an unplanned manner, and a large number of unrecognized slum communities have developed around the peripheries of major towns and cities.

India's growing tide of urbanization necessitates significant governance reforms to successfully manage such growth. Following a variety of reforms during the past few decades—including those included under prior national urbanization programs—many regions across India have assumed greater control over managing and financing their urban development. However, states and Urban Local Bodies (ULBs) can still vary widely in the amount of control they exercise in these matters and are continually exploring new ways to drive investments. The creation of new local units to manage

urban infrastructure—called Special Purpose Vehicles (SPVs)—offers the potential to guide more comprehensive planning efforts, but their long-term role must be more clearly defined.

Sikkim must focus on creating more customized solutions as part of its Smart Cities Mission, which should be shaped according to local infrastructure priorities and institutional capabilities. Essential infrastructure—including water and sanitation, but also newer technologies like mobile data-poses perhaps the most significant developmental gap in many Indian cities and should consequently be a top priority. Indian cities should also leverage their local economic strengths to develop priority industries and guide future development efforts, especially in sectors that offer higher wages and pathways to more durable growth. Projects to address these challenges must then be aligned with institutional capabilities. Given existing governance and financial challenges, Indian cities must scale their project sizes in light of practical considerations on the ground.

Sikkim must elevate the financial standing of its urban areas, making them more attractive destinations for future investment. Across all levels of government, particularly among different city agencies, Sikkim must ensure that dependable capital is available to meet economic goals in years to come. Increased private-sector engagement should be a paramount concern, which requires more active, coordinated leadership in project management, technical guidance, and risk mitigation. Should also actively investigate ways to boost activity within its municipal bond market, which can be a significant source of financial capital if it follows best practices in other leading markets such as the United States. In light of this economic context, we must conduct an investment gap analysis to estimate the level of investment needed to improve existing infrastructure and meet Smart City standards. Although every Indian Smart City will become smart in its own unique way, we also explore similarities with global peers to provide guidance for future infrastructure improvements through a detailed cluster analysis.

“Water” our most valued and Precious resource!

Water is important resource for all the livings in the earth. However, majority of the urban centers in the country and the developing countries are undergoing the water scarce situation which are either due to irrational distribution system or lack of pragmatic water management at different levels during the delivery from source to the last mile connections. .

As an overview, it’s seen that the distribution of water on the Earth’s surface is extremely uneven. Only 3% of water on the surface is fresh; the remaining 97% resides in the ocean. Of freshwater, 69% resides in glaciers, 30% underground, and less than 1% is located in lakes, rivers, and swamps. Looked at another way, only one percent of the water on the Earth’s surface is usable by humans, and 99% of the usable quantity is situated underground. Water requirement is increasing day by day as the population is increasing. Hence water management and distribution must be done efficiently.

The system needs to work on different parameters of water, like pressure, level and flow rate. Using these parameters water wastage, water leakage and water theft can be prevented. Automation plays the major role by which human errors are fully controlled. Earlier, the monitoring of the process was done by human resources, by whom huge errors used to occur, which in turn caused heavy losses. To reduce this loss, automation is developed using PLC and SCADA

The project is to be used for distributing the water equally to ensure everyone gets equal amount of water. It is also used to prevent the water theft during the distribution period. The proposed system should be fully automated by connecting it to the PLC & SCADA (Supervisory Control & Data Acquisition). Here human error and time will be drastically reduced. The water loss due to leakages, mankind laziness and operating error can be avoided. The main aim of this project is to rationalize water supply to consumers, understanding losses & taking corrective decisions also to build transparent, accountable and efficient water supply system. Thus, to develop a system in which we can analyze the different parameters like benchmark of water, water pressure and management by

comparing them with fixed benchmark. Also depending on the density of population, management of water pressure and flow readings needs to be attained.

10.2 Solution Requirements

MSI shall set up an Integrated Information Management System (IIMS) in the city operation centre for collation of data for overall water consumption at all Household Level and collection of data directly from the AMR bulk flow meters, pressure sensors, chlorine and turbidity monitoring at WTP by way of GSM/GPRS installed in various locations of the water distribution systems. The IIMS shall help the city to perform the following broad scope of work:

i. System study including existing infrastructure, operational requirements, process control & monitoring requirements to prepare procurement, implementation plan.
ii. Procurement, Installation & Commissioning of instruments (flow, pressure, level, Actuators, Analyzers, etc.) at WTP, Raw Water pumping stations, distribution network, etc.
iii. Deployment of networking infrastructure at all nodal points.
iv. Procurement, Installation & Commissioning of PLC/RTU for pumping stations, PLC control system for WTP.
v. Implementation of software components and its integration with PLC/RTU & field devices.
vi. Redundant SCADA software along with animated scalable graphics, data collections, Alarm generation, Analysis/alert displays.
vii. Historian server with Data Integration if any.
viii. Web based Dashboard and reporting system linked with SCADA and historian.
ix. Creating Dashboards as per stakeholder's requirement.
x. Energy Monitoring software, hook-up energy data thru RTU/PLC communication network, hook-up with SCADA /Historian to get pressure flow data for monitoring of pump efficiency.
xi. Preparing and deploying Mobile App with different screens as per stakeholder's requirement
xii. Implementation of Digitization of Operations, Inspection and Maintenance activities and logs, creating data entry system for remote locations.
xiii. Training required for the project, covering all the stakeholders
xiv. Operation & Maintenance of the Overall System Solution (Hardware, SCADA Software, Application Software and other Infrastructure) for 5Years.
xv. Commitment of support for spares and services for a period of 5 years from the date of implementation.
xvi. System administration and database administration of SCADA Software for 5 years.
xvii. Monitor and record the following:
    - Raw water Out flow at the Intake
    - Raw Water In Flow at the WTP.
    - Turbidity of the water at the WTP.
    - Clear Water Out Flow at the WTP.
    - pH content of clear water at the WTP.
    - Pure Water Out Flow at the Distribution Tank.
    - In flow at All GLSRs.
    - Out flow at all GLSR.
    - Pressure at the Critical Zone Points.

10.3. Objectives for Intelligent Water Supply & Monitoring Systems

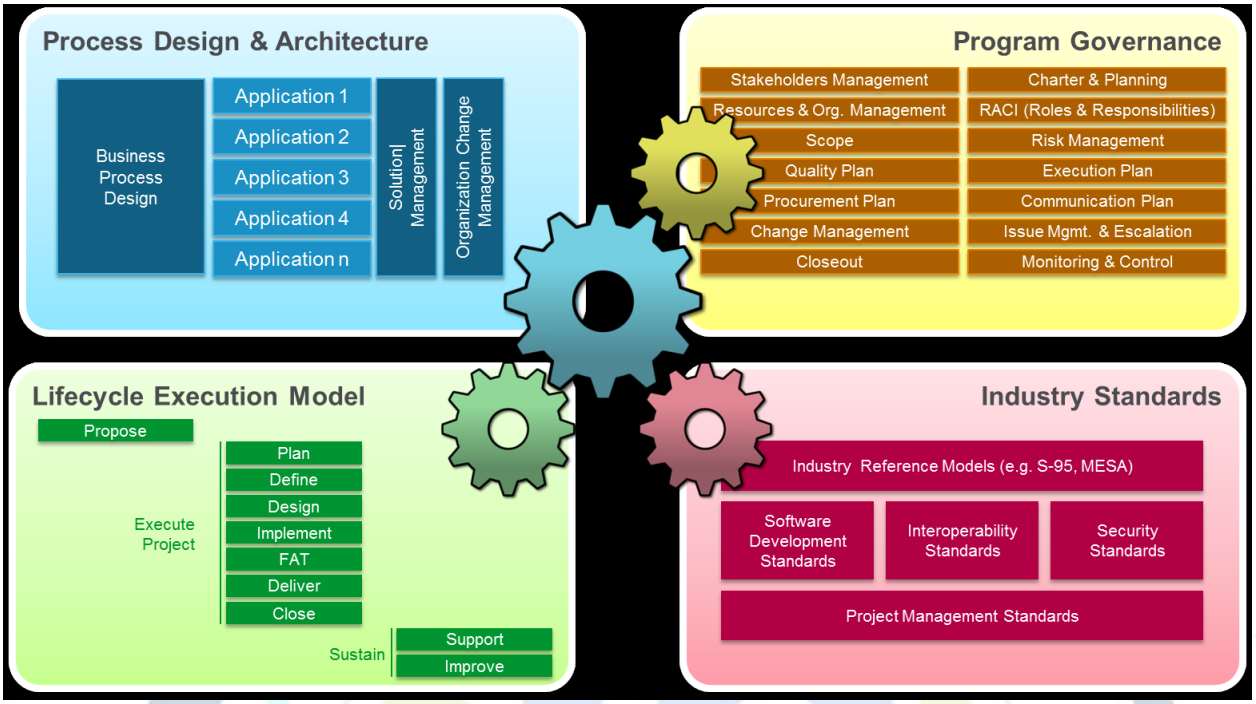
1. Provide required quantity and quality of water for 24x7 distribution scheme.

2. Real time Monitoring of
   (a) Water Network at each node for better utilization of resources.
   (b) To obtain real-time hydraulic data at central location.
   (c) Centralized data analysis.
   (d) Identifying root causes to non-compliance to equitable distribution.
   (e) Water quality right from raw water inlet at WTP to treated water distribution.
   (f) Efficiency of electrical pumps and other equipment used in pumping and treatment of water.
   (g) Identifying and minimizing leakages and NRW (Non-Revenue Water).
   (h) Provide alerts for deviation quality parameters and unwanted operational conditions.

These objectives can be achieved by the following:

1. Monitoring of water flow, level and pressure at each nodal point. (Nodal points is defined as location where water storage, pumping or treatment is done.)
2. Monitoring of Pump parameters i.e. discharge pressure, current, running hours etc.
3. Monitoring of Raw water quality at inlet of WTP. (pH and TSS-Total Suspended Solids).
4. Automation of Poly and Alum dosing based on raw water pH and TSS.
5. Automation of Filter-Bed backwash for better efficiency and water quality.
6. Monitoring flow and pressure of distribution network from WTP to GLSR/ESR.
7. Tracking of assets for its utilization, system generated preventive maintenance schedules, Logging of day-to-day maintenance activities.
8. Implementation of messaging system for sending production information to nodal agencies, provide alerts in case deviation of parameters.
9. Implementation of web based online dashboard and reporting system for monitoring of process parameters by authorized officials.

10.4. Program Management & Project Execution Model



10.5. System Study

Implementation agency has to conduct detailed study of system including following aspects,

- Operational requirements
- Operating Conditions for instruments
- Installation location and identification of tapping points if required
- Preparing execution plan considering required shutdown of process, alternate ways to keep process operational etc.
- Modifications, if required, in existing infrastructure to suite automation.

Detailed study report shall be submitted to respective authority with action plan and schedule. Report should also include detailed Bill of Quantities along with all accessories required for instrument installation; highlight any changes in bill of quantities or non-compliance of instrument with site conditions. BOQ shall consist of all offered hardware list with detailed specification, make/model and authorization documents for approval. MSI will also submit development plan for software application and Network integration plan.

10.3.Network Analysis

The water network management platform shall be able to perform feasibility studies and scenarios to evaluate the effect of:

- New residential areas
- New industrial sites
- Increased demands
- Maintenance and rehabilitation jobs
- Fluctuations in consumption

This is to design the network to meet future demand or to comply with regulations while improving service, and to avoid bottlenecks and optimize your investment.

A Hydraulic analysis shall allow you to quickly evaluate the effects of modeling changes. Dynamic network elements such as valves, pumps and reservoirs are color coded to reflect current operational status. Pressure prediction allows you to identify how to operate the network at exactly the necessary operating pressure. In this way, you will be able to reduce the effect of existing leaks.

Water Quality analysis shall allow you to quickly evaluate how various operating conditions influence water quality. Common water quality problems such as taste and odor can be tracked down using the age-of-water model.
Water Quality can be used to determine mean, true, and maximum water ages. You can also use the water quality module to track any pollutant in the system, and to separate the zones to avoid spreading of the pollutant.

Network Management – Real-time Application

1. The water network management system shall provide a better overview and improved operation by running the water network modeling tool in real-time mode.
2. By using live SCADA data the model shall be transformed from a planning tool to a decision-making tool, integrated in your day-to-day operations – with instant and clearly identified benefits and economic advantages.
3. The SCADA data shall be automatically loaded into the model, after having been preprocessed and validated to avoid flawed data or replacing faulty instrumentation with emulated values.
4. The real-time system shall be provided in a graphical user interface that is easy to operate by the operator, but that can also be configured in the same tool to run more complex scenarios requested by the engineer and planner.
5. The real-time system shall be able to combine historic view, real-time views and predictions in the same user interface – easily accessible.
6. The operator shall not be required to possess any in-depth knowledge of modeling to use the water management system. By scrolling back and forth on a simple button interface he shall be able to obtain the information he need such as pressure, flow and quality for any given point in time - in the past or in the future.
7. The model shall be fed with live information from the SCADA system as well as forecast information about weather conditions. This will enable the model to predict future consumption even during periods of quickly changing or extreme weather conditions.

8. Different variables, such as supply pressure, age of the water, amount of chemicals in the water or flow shall be displayed. Effects of interventions, such as opening or closing of valves shall be easily simulated, to reveal any disturbances in consumer supply.
9. The information shall be made available to the call center. Error conditions or temporary problems shall be evident. The call center shall be able to click on any node in the network to see measurements such as the water pressure at the specific location. Alarm set points for all parameters shall be pre-configurable.
10. The management system shall be fully integrated with SCADA and shall be prepared to send an alarm to SCADA if error conditions in the network are predicted.
11. The management system shall be visualized in a control room atmosphere with focus on simplicity and easy access to information – enabling everyone to obtain qualified information about the network – now and in the future.
12. In the main view it shall be possible to scroll in and out – visualizing what is relevant for the specific water utility; i.e. that GIS data suddenly materializes.
13. It shall be possible to generate VIEWS for each of the zones that the water utility wishes to focus on.
14. It shall be possible to pre-configure the themes the user wishes to see, whether it is related to:

- Pressure
- Flow
- Velocity
- Age
- Chlorine concentration
- Leakage as in Minimum Night Flow (MNF)
- Pipeline Leak Likelihood, Criticality & Replacement prioritization
- Other simulated parameters

10.3.1.Dashboard

The water network management system shall provide user configurable dashboard functionality for each user to present their preferred data or execute your pre-configured actions. Hence users can at a glance thy can verify if their network is working properly (such as looking at Key Performance Indicators - KPIs), or they can get direct access to the features and functions that they use on a regular basis.

10.3.2.Leakage Management

Application software for water network management system must assist utilities to perform leakage management at DMA level and inside DMA. The Nightline Measurement Method (NLM) considers measurements in a fixed time window during periods of minimum consumption, where leakages will make up the highest proportion of the total flow. User may do a preliminary identification of DMA with potentially high leakage levels by checking the NLM values from the fully configurable dashboard. User may further check the NLM trend for over a week and view the Net Flow into the zone for the same period.

Application software for water network management system must offer a standard International Water Association (IWA) Water Balance table that can be used for improved overview of the water distribution network status in any given flow control zone and to better assess the annual volume of real and apparent losses.

The Leak Likelihood theme in Application software should highlight area with potential high leakage and must help to further narrow down the search area for Active Leakage Control (ALC) activities.

Pipeline criticality analysis toolis built based on static and dynamic network attributes, such as pipe age, pipe material, average pressure, flow etc. Once an area for ALC is identified, work order can be issued to maintenance field crew via sms and email setting with inbuilt work order management tool.
Operator may also use the advanced pressure optimization tool to identify areas where there is a room for further pressure optimization. This can eliminate excess pressure in the DMA that can cause high leakages and water losses.
Relevant information obtained from the model can be shared across the water company by generating custom reports

10.4. SCADA Specifications (Centralized System)

10.4.1. Foreword

The purpose of this section is to provide the necessary description of SCADA (Supervisory Control and Data Acquisition) that will be a major component of automation solution.
This description will be used to qualify available products in terms of functionality, capability and other operating requirements. Ultimately allowing bidders to identify technology that match or exceed the desired capabilities.
This document is intended to be used to prescribe and answer SCADA solutions during the consultations.

10.4.2. General Considerations

System Servers shall perform centralized processing of the system information, including as a minimum, the following tasks:

1. Data Server to facilitate communications to the various controllers and devices in the system
2. Alarm Server to enable the monitoring, alerting, distribution and acknowledgement of alarms
3. Trend Server to enable the collection, storing and distribution of historical trends
4. Report Server for processing, storing and distribution of reports
5. It shall be possible to combine all of the System Server tasks onto a single workstation, or separate the functionality onto different workstations.
6. Additionally, each of these System Server tasks shall be capable of taking advantage of multi-CPU computers to load share across the CPUs and improve the overall performance of the system.
7. Each System Server task shall run independently such that a failure of one task does not negatively impact the operation of any other, and the failed task can be reset and recover without shutting down the system or the server in question.
8. Operator Stations shall contact the various server subsystems to acquire or write to data. Operator Stations shall act as clients for these tasks, rather than processing these items independently.
9. System Servers shall also be capable of acting as Operator Stations.
10. Configuration changes made to any server do not require a restart of unrelated servers.
11. Operator Stations and other clients do not require restarting when configuration changes are made, but are automatically updated as changes are deployed.
12. The system employs one or more Data Servers to read and write data to the controllers and other devices in the system using the System Network.
13. The Data Servers manage the reading and writing of data from the controllers and shall provide the data on request to any Operator Station in the system.

14. The Data Servers shall be able to read and write data when they are requested to by a client, or other server on the network, so as to reduce the traffic on the System Network and the processing load on the controller(s).
15. The Data Servers shall also have the option to read all data at predefined rate to allow for a background poll cycle.
16. Under healthy conditions communications shall be routed via the System Network to each controller in the system on behalf of all Operator Stations and only one Data Server will communicate directly with a given controller at any given time.
17. Requests for common data from multiple Operator Stations shall result in a single request to the controller.

10.4.3.Operator Displays

1. Graphic display pages shall be capable of a minimum of 1200 analogue tags, with updates of on average of two seconds (for all data to appear or change on the page).
2. Graphics pages shall support automatic resizing to match the screen resolution of the workstation or client, irrespective of the resolution the pages were developed in or configured for, and irrespective of whether vector or bitmap graphics are used on the page, without shutting down the system, without recompiling, and without having multiple copies of graphic pages for different resolutions.
3. The user shall be able to resize the window hosting the graphics page, and all components will be automatically resized to match the new window size.
4. The system shall support a screen resolution of up to 4000 x 4000 pixel resolution and shall support multiple monitors on the one workstation. This support shall include separate windows on each monitor, or a single window across multiple monitors.
5. The graphics system shall support full 32 bit (65 million) colors, and be capable of displaying images imported from 3rd party packages for use within the displays, including animating and color flooding the image.
6. It shall be possible to display other graphics pages by selecting screen targets, and to automatically display any screen based on the condition of a tag. e.g. automatically call a particular graphic display when an alarm occurs.
7. It shall be possible to configure keyboard macros on a per graphic basis or global keyboard macros that apply to all displays.
8. When multiple objects on a page are configured for flashing then all objects shall flash synchronously.
9. The system shall have the capability to provide pop-up windows for trends, loops, device status pages or any other graphical display purpose. To minimize operator confusion, pop-up windows shall be capable of being configured so that multiple copies of the same popup cannot be opened on the same workstation at the same time.
10. All full-size display pages shall include the page name, current time and date together with details of the last 3 alarms that have occurred.
11. Each display object shall support keyboard entry that will allow adjustment of any tag in the system. When an operator wants to enter a value, the object should be selected then the operator input shall be displayed as the input is typed (such as a tooltip adjacent to the object).The system shall check the value entered is in an approved range before action is taken

12. The system shall support full screen, live camera video images and video from disk (MPEG, AVI) concurrently with screen displays with no interruption to data collection. Refresh rates of display windows shall not be affected.
13. If communications to a particular I/O tag fails for any reason, then wherever that data is displayed the system shall post a visual indication that the tag is not valid.
14. The user shall be able to navigate around the graphics system utilizing a variety of navigation methods:
    i. Hot keys shall be available to provide quick links to specific graphics pages from the Windows keyboard.
    ii. Windows style navigation menus shall be provided allowing access to any configured page in the system from any other page.
    iii. The graphical displays shall be configured with “hot spots”, where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

10.4.4. Graphic Builder Software

1. The graphic builder shall be interactive and menu-driven, requiring no programming.
2. The software shall have the ability to directly import graphics and text from the following file formats:

BMP	JGE
DIB	JFI
DXF	JFF
DCX	PCD
EPS	PCX
GIF	PNG
IMG	RLE
JPG	TGA
JPEG	TIF

3. Imports using different color palettes and depths shall support both dithering and no dithering at the users discretion.
4. The graphics builder shall be capable of creating screens composed of both static and dynamic objects. To create these objects, the vendor shall provide sample screens and a set of standard shapes or symbols in a library at no charge. The developer shall be able to include these symbols by reference, or create new symbols/objects.
5. The graphics builder shall provide the following tools:

- Grid and guidelines (which can be displayed on screen) together with snap to grid and snap to guidelines to assist in aligning objects precisely.
- Horizontal and vertical alignment together with even spacing.
- Infinite layering with Send to Front/Back; Bring Forwards one Layer; Send Backwards one Layer.
- Bitmap editing including pixel drawing, image resizing, image cropping.
- Color swap from one color to another for a group of selected objects including colors within a bitmap.

5. Color swap shall also include swapping a range of colors such as all reds to all greens so that shaded objects can be color changed without redrawing or re-rendering.

6. Color adjustment including from one spectrum to another, as well as Lightness/Darkness and Saturation levels. Editing of nodes on poly lines that provides the addition or removal of nodes plus movement of nodes.
7. The graphics builder shall support a large number of "undo" and "redo" feature.
8. The graphics system shall support full 32 bit (65 million) colors, and supply a palette of 'favorite' colors for ease of development. It shall allow user defined flashing colors.
9. Display sizes shall be definable from 1x1 to 4000x4000 pixels, or any size combination within these limits.
10. Common static and dynamic objects shall be stored in libraries, and 'linked' such that changes to the master objects (including dynamic configuration changes),in the library are propagated to all instances of the object throughout the project without needing to access each object instance.
11. Pages shall be based on Templates, and 'linked' such that changes to the master template in the library are propagated to all pages throughout the project without needing to access each page.
12. Commonly used pages such as Alarm and Trend pages shall be included with the software and not require any development to use them at runtime.
13. The system must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make changes.
14. The Graphics Builder shall be able to modify all displays in the system including standard displays supplied with the software such as alarm, trend, startup, tag, reports and utilities displays.
15. The graphics builder software shall support the following dynamic objects as a minimum:

- freehand lines,
- straight lines,
- poly-lines,
- rectangles (including user-definable rounded corners),
- ellipses,
- pie slices,
- text,
- buttons (of the latest Win XP style),
- 3D Pipes and
- Bitmaps.

16. Dynamic objects shall have the following properties that shall modify the object according to the value of either a tag or an expression:

- Horizontal, Vertical and Rotational movement
- Up, Down, Left or Right Level Fill for both native and imported objects (such as 3D bitmaps)
- Gradient Level Fill
- On-Off, Multi-State, Integer, Threshold or Gradient Color Change
- Horizontal and Vertical Size
- Visibility
- Keyboard Input
- Touch (Mouse Up, Down, While Down)
- Horizontal and Vertical or Rotational Slider
- Security Access
- Disable
- Pop Up Tooltip

- Logging

17. It shall be possible to use the above properties concurrently.

18. Color change shall support all of the following types:

- On-Off: On Color and Off Color changes based on the result of an expression.
- Multi-State: A definable color shall display for each possible Boolean result of up to five conditions.
- Integer: A definable color shall display for each different integer value. Up to 255 different colors shall be definable
- Threshold: A definable color shall display based on multiple threshold expressions. For example, a fill color should change to red when the speed of a motor is greater than or equal to 4500 rpm and to white when less than or equal to 100 rpm, but remains gray for all speeds in between.
- Gradient: Color shall change through the spectrum according to the value of an analog tag. It shall be possible to define a starting and ending color.

19. It shall be possible to group together dynamic graphic objects and then apply dynamic properties to the group as a whole, rather than each individual object. Individual objects within the group shall continue to support their own unique properties independently of the group. For example, articulated equipment may have on/off status for individual components, but be required to move around the screen as a group. It shall be possible to edit individual object properties within a group without ungrouping them.

20. The system shall be an ActiveX container and allow for instantiation of ActiveX objects. It shall be possible for the system to interact with ActiveX objects in the following ways:

- Dynamically change properties of an ActiveX object via a Tag from a field device.
- Dynamically change properties from a supported high level language.
- ActiveX object to trigger actions in the system based on events in the ActiveX Object.
- ActiveX property values can be read by the system.
- It shall be possible to connect ActiveX properties to tags, allowing read/write between properties and tags without the need for scripts or code. ActiveX objects must have the same security as native graphics objects allowing ActiveX objects to be visible or hidden based on the privilege level of an operator.

10.5. Alarming

10.5.1. Alarm Display

1. With appropriate privileges, it shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.
2. The system shall provide multiple levels of alarm priority or category. The priority of an alarm shall be identifiable by the color and font settings of the alarm message on the screen.
3. Sound indication for each alarm category shall be configurable. This must be possible at each station. It shall be possible to have the alarm sound either by internal or external speaker
4. The software shall have a standard alarm display page that can be modified for the project. The standard alarm page shall have the facility for scrolling through multiple pages of alarms and for acknowledgment and disablement of individual alarms.
5. It shall be possible to display the following information for each alarm as it appears on an alarm display page:

- Alarm Tag Name
- Alarm Description
- Value of the Tag
- Trip limit
- Alarm Status - Disabled, Acknowledged, Unacknowledged
- Alarm Category
- Alarm Priority
- Time & Date in International Formats
- Privilege
- Category
- Operator Comments
- Value of any Tag or result of any calculation.

6. It shall be possible to display each alarm category in a different font and color (including flashing colors) dependent on whether the alarm is Active Unacknowledged, Active Acknowledged, Acknowledged Cleared, Unacknowledged Cleared or Disabled.
7. The alarm display shall support both proportional and fixed fonts with all alarm fields displayed in properly aligned columns.
8. It shall be possible to disable alarms on individual basis, by page, by alarm category, or for all alarms. When an alarm is disabled, the alarm will be displayed on a separate disabled alarms page so every user of the system can easily determine which alarms have been disabled.
9. The system shall allow for operator comments to be attached to any alarm when it is acknowledged or at a later time. These operator comments shall either be displayed with the alarm or displayed by clicking on the alarm.
10. It shall be possible to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error, or Disabled.
11. The alarm display shall have a mechanism for operators to dynamically define filtering of alarms by alarm tag, alarm name, alarm description, date/time range, state including sub-states for analogue alarms, type, area, category and priority. Additionally, up to 8 custom filters can be defined for each alarm during development and runtime, for fast access by operators.

10.5.2. Alarm Sorting

It shall be possible to sort (ascending and descending) active alarm displays by one or more alarm fields without grouping restrictions. Alarm fields that can be used for sorting include:

- Tag
- Name
- Category
- Priority
- Area
- Privilege
- State
- On Time
- Off Time
- Act Time.

10.5.3. Alarm Management

1. The system shall be capable of storing up to at least 5,000 alarm summary events in the native alarm archive, and retain them for at least 30 days, to recall through standard alarm display screens
2. The system shall support at least 10 categories of alarms, and up to 255 priorities of alarms.
3. Alarm events shall also be written to logging files and stored on a rolling file basis for archiving purposes.
4. At any station on the system it shall be possible to acknowledge alarms individually, by category or by page.
5. Built-in diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.
6. An alarm acknowledged on one Operator Station shall be shown as acknowledged on all client stations. Global acknowledgment of alarms from any station on the network shall be available without the need for special programming or scripting.
7. The system shall monitor analog tags, discrete tags, and calculated conditions to determine alarm conditions.
8. For alarm events (both digital and analogue) which are time-stamped by the field controller for increased accuracy, the system shall support using that timestamp for the event. The system shall support millisecond precision for this time-stamp.
9. When configured in a redundant architecture, the system shall automatically ensure that if the Primary Alarm Server fails, all alarm functions shall continue to operate normally and transparently to the clients. The system shall automatically generate a diagnostic alarm to indicate that the Primary or Standby has failed.
10. On restoration of a failed Server, the historical alarm history must synchronize between the Primary and Standby servers so that there are no mismatches in historical alarm history. No programming or scripting shall be required to achieve this synchronization.

10.6. Trending

10.6.1. Trend Display

1. Trend displays shall comprise line graphs with time on a linear, continuous horizontal or vertical axis and the trended value on the vertical or horizontal axis. Resolution of each graph shall be to within 0.1% of full scale. Where more than one tag is graphed, the graph of each tag and associated information shall be displayed in a different color.
2. Trend displays shall support both analogue and digital pens on the same graph. Trend pen assignments shall be user definable and retrievable in runtime to allow easy creation and management of favorite trend groups.
3. Each trend graph shall be capable of displaying up to 32 pens with adjustable time base to one second samples and reporting up to 10,000 points with user-specifiable time ranges, using the standard software. The graph shall be capable of viewing the entire archived trend history for a group of pens on a single display.
4. It shall be possible to trend multiple pens or multiple plots of the same pen over various time spans.
5. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independently of other pens displayed on a page.
6. The display shall include the capability to pan backward and forward within a selected time range to read the exact value of any displayed tag, by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired, with all information being displayed on average 1 second.
7. The trend display shall have a slide wire that can be moved over the page that will provide indication of the date, time and value at the intersection of the slide wire and the trend tags.
8. The trend display shall be dynamic, scrolling through time, with the capability to ‘replay’ or scroll through historical time as well as current time. There shall also be the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history. Pens on the same pane shall be able to be separated both in the time axis and the range axis.
9. The trend display shall provide "zoom" and "pan" facilities for both the trended tag range and the time axis range. The "zoom" facility shall allow an operator to compress or expand the axis range whilst the "pan" facility shall allow an operator to shift the origin of the axis. The system shall allow a user to define any zoom area by dragging a mouse across the trend.
10. The system shall provide Minimum, Maximum and Average summaries for all displayed analogue pens.
11. Trends which are acquired and stored by events, rather than periodically, shall be viewable both on a timeline, and by event number.
12. Each operator or login shall be able to access their own fully customized trend pages. These pages must be customizable online by each user in a drop and drag manner, or by using standard windows configuration popup features. Any setting available to be made in a configuration environment shall be available to the user to modify the trend graphs in runtime. As a minimum these include the pen color, pen scaling, background color, grid and Trend Tag assignments for each trend page.

10.6.2.System Specifications

1. The system shall support logging of all operator actions to disk, printer or screen.
2. The system shall be capable of logging the following information, User Name, Action, Time, Date, Value, and Comment in a user definable format.
3. The sequence of actions shall be viewable via an event viewer window within the system and also stored in an external open file format (such as txt, csv, dbf, sql) for later analysis.
4. The software shall be capable of logging historical trend information at configurable sample periods from 1 millisecond to 24 hours.
5. Trend data shall be stored in a circular file system with the number of files, the size of each file, the sample period, file location, privilege and area configurable for each Trend Tag. Storage file names and paths shall support file names up to 255 characters in length.

10.6.3.Historical Data

The SCADA system shall provide a built in data historian with the following facilities as standard features. These shall be provided without the addition of external software modules:

- Time-series relational database
- ODBC / SQL interface to historical (trend) data
- Historical data to be stored with time-stamp, point quality, alarm status
- Historic storage is to be based on configurable criteria including time between samples, alarm state change
- Compression capability

The historic data subsystem shall provide fixed and user configurable views of the historic data tables. These views are required to provide SQL pre-processing and present historic data in aggregate format.

The SCADA server shall provide Historian functions including the capability to validate historic data prior to exposing it externally to the SCADA system, selectable archiving rates, point-by-point storage compression regimes, annotation on history samples for tracking comments on operational conditions, modification of historic data for normalization and correction (tracks previous value and modifying user and is subject to user privilege), auditing of modified or annotated history.

10.6.4.Reports

1. The system shall have the capability to perform a trend print (not a screen print). The trend print function will print to the printer using objects, not bitmaps. The trend printout will include the engineering units and ranges for each trend, a trend grid and the time base for each trend. Each trend will be identified by a different line style (dotted, dashed, solid etc) on monochrome printers, and a different colour for colour printers.
2. When configured in a redundant architecture the trend collection and management shall be performed utilizing Primary and Standby Trend servers. Both will contain all trend information. If the Primary Trend Server fails then the Standby Trend Server will ensure all trend functions continue to operate. Clients will automatically retrieve data from the Standby Server. Upon restoration of the Primary, the Standby will automatically update the primary server such that there are no gaps in its historical trend archive. No operator involvement or scripting will be required.
3. The speed of this automatic update (backfill) shall be configurable to cater for low bandwidth networks.

4. Failure of the Standby Trend Server shall be monitored such that a failure at anytime will produce a diagnostic alarm.
5. The system shall perform all report generation, scheduling and management internally and will not require a third party package to perform these functions.
6. The system shall permit reports to be scheduled for a specific time of day, on a periodic basis, upon operator request, or event initiated (such as an alarm condition or end of batch).
7. The system shall support printing to the designated report printer or to log all reports to a disk file or database (SQL, ODBC, and DBF) or to a Web Server in a rich text file format such as HTML.
8. The system shall have the capability to display all reports on the screen, in user definable fonts and colours.
9. The system shall permit reports to be defined based on archived data. Single-point-in time reporting (online and historical) and time-range reporting are both essential, as is the ability to report on an unlimited number of tags in one report.
10. Reports shall support extensive calculations on both instantaneous and historical data, and any other data from the system.
11. Reports shall have the ability to write to any tag in the system during the execution of the report.

10.6.5. System Security & Access

1. Security shall be fully integrated into the system to allow access to any individual part of the system only to users with appropriate security levels. Security must be checked on the server side and passwords must be encrypted.
2. The system shall support a large number of users. For each user, it shall be possible to define a password and the privilege level(s) and areas that are available to that user. Passwords will be hidden both in the configuration and the runtime environment to ensure that other personnel cannot access another account.
3. The system shall support users that are defined in a Windows domain. Users will be able to be added, removed and granted access to existing roles via the Windows domain server without requiring changes to the system configuration. Authenticated Windows user credentials will be securely cached on the system client to allow the user to be able to login to the client in the event the domain controller is unavailable. The current Windows user will be able to be automatically logged in to the system at startup so that the user does not have to re-enter their credentials. The use of both internal system users and Windows users will be possible. The system will not require additional configuration to support Windows users, the setup of privilege levels will be common for both the internal system users and Windows users.
4. The software shall monitor the actions of the user currently logged on at each station, and automatically log the user out of the system after an adjustable time period. Logging out a user will not shut down the system; the system will revert to a view only security status.
5. It shall be possible to define a minimum of 8 privilege levels. The system will check to ensure that the user logged on has the correct privilege level for all functions. If the user does not have the correct privilege for a function or object the software will be able to display visual indication to the user such as shaded, hidden or popup message.
6. For each graphic object it shall be possible to assign it to a plant area, define its privilege level, define whether operator input is enabled or disabled, or whether the object will be visible or not based on the user's current privilege levels within the given plant area.

7. The system shall have a mechanism to restrict access to different areas of the plant for each individual user or group of users. It shall be possible to define a maximum of 255 different plant areas.
8. It shall be possible to prevent access to the operating system by unauthorized personnel.
9. It shall be possible to disable Windows "hot" keys such as Ctrl Esc, Ctrl Alt Del etc to prevent operator access to unauthorized software.

10.6.6.Web Clients

1. The system shall support full operator display functionality via an internet web browser without any loss of functionality. It shall not be necessary to export, compile or recreate graphics specifically for the Web Clients. Instead they shall operate from the same project configuration as the rest of the system, minimizing maintenance overheads and version control risks. The web browser version shall be fully functional in all aspects, with the exception that 3rd party items such as ActiveX objects may need to be loaded on the client PCs
2. Changes will be automatically uploaded to the Web Client only when the user accesses a display that has been modified so as to conserve bandwidth and optimize performance.
3. The Web Clients will operate in conjunction with firewalls and provide security to reduce the possibility of unauthorized access.
4. The vendor shall offer both Microsoft IIS and an alternative to facilitate its web browser solution.
5. It shall be possible to limit access to “view only” or provide full “read and write” access and web clients will provide identical functionality to an operator workstation on the LAN.
6. Assuming reasonable ISP performance, users accessing via the internet using a 56K modem access shall consistently obtain display refresh times on average of 1 to 5 seconds and page display times of on average less than 5 seconds.
7. If the resolution of the Web Client is lower than that of the Operator Station, the client shall have the ability to automatically rescale the application to fit within the client window
8. Systems that require third party thin client software to be loaded onto the Web Clients (such as MS Remote Desktop or Citrix) to achieve this functionality will not be accepted.

10.7.Process Historian

10.7.1.Foreword

The historian software should be a 100% pure Microsoft® SQL Server® historian and should be based on open, standard technologies. The Historian software should help the plant and IT personnel to optimize operational efficiency by providing a powerful, enterprise-wide reporting tool that collects, histories and delivers meaningful reporting data from multiple, disparate systems. By using the information provided by the Historian, one should be able to make more effective decisions toward optimizing operational performance.

The package comprising of historian and portal functionalities, should enable the user to accurately store data for long-term reporting while also giving the user the option of visualizing and accessing the information through the Historian portal, Microsoft Excel or Reporting Services.

10.7.2 Software Details

1. The software should improve production reporting and ad-hoc analysis by connecting, aggregating and presenting real-time information from multiple disparate systems throughout the enterprise, allowing corporate, IT, plant and production managers to make more informed and timely decisions.

2. The data store of the historian software should be an embedded Microsoft SQL Server. The historian should collect all changes in the process tag values, as well as alarm activity, from within each control system. Each change should be saved with a timestamp and an OPC quality stamp. Data should be acquired at user-definable rates, including sub-second data acquisition rates.
3. The historian should support redundant control system links. In the event that one link fails, the historian should request the data from the other link to the control system. In the event that the network link to the historian fails, the historian should backfill from the control system's trend and alarm systems to acquire data that it could not acquire in real time. Quality flags should be stored using the OPC status and sub-status definitions in conjunction with customized high-byte sub-statuses to accurately reflect the status of the SCADA system data at any point in time.
4. The historian should compress data by saving only changes in values. The data should be stored directly into tables in the SQL Server; so that the large number of applications that have SQL connectors can access the data and bring it into various applications. The historian should leverage the security of the SQL Server to enable the user to secure each table, view and function within the SQL Server. The user should be able to utilize Standard SQL audit tools to see if any unauthorized editing of databases has occurred.
5. The Historian should be able to acquire data from SCADA systems via OPC V2 and OPC V3 servers at sub-second retrieval rates.
6. The Historian should be provide easy configuration like simple drag-and-drop techniques for selecting data to be logged from SCADA systems, and a user-defined folder structure for organizing logged data. Customization of individual tag parameters should be provided through easy-to-use forms that identify aspects of the data to be logged
7. The Historian should offer web functionality. The Web Client should provide maintenance engineers with a fast way to analyze trend and event data and to compare real-time and historical data within one interface.
8. The historian should comprise a Microsoft Excel Client which provides engineers and operations managers with the calculation tools they need to model and analyze production. It should provide a high quality reporting system using Microsoft Reporting Services to build custom reports for any process application where data be presented graphically, with the ability to drill down for more detail into any results that may appear out of the ordinary.
9. The Historian software should connect to one or more plant control systems via OPC. The software should automatically import the tags, trends and alarms, making them available for immediate publication. It should support bidirectional data transfer allows data to be read from, or written to (with security privileges), plant control systems.
10. The historian software should support connections to both Microsoft SQL Server and Oracle databases. Once the database data source is created, it should automatically load the table structure. The software should be designed to handle both
11. Data archiving
12. Plant control system connections integrating plant floor data with existing third-party applications or ERP systems.
13. Operation of the software with Enterprise Edition of SQL Server 2008 R2 should also be supported, so that users wishing to use the Enterprise Edition can also benefit from data compression.
14. The software should use OPC HDA Server as standard protocol for freely connecting to manufacturing execution systems (MES) delivering a fully integrated solution allowing the

movement of information vertically from the factory floor throughout an enterprise with multi-vendor systems.

15. The software should support OPC DA Client, an industry standard protocol, for connectivity to any third-party SCADA system. The Historian software should provide direct access to tag alarm and trend information from within the SCADA systems. This data can be transferred to business applications or visualized within the Historian's Web and Excel Clients, enabling data from multiple SCADA systems to be compared and analyzed or histories to the historian for long term storage and greater analysis options.

10.7.3 Reports & Alarms

1. The historian software should use the graphical query builder and report generation capabilities of Microsoft Reporting Services to deliver drag-drop-and-click reporting of any data from the historian. The user should be able to schedule to run the reports based on an advanced scheduler. The functionality to send scheduled reports to managers by email or recorded in a file share should be provided. In either case, the user should be able to select to receive the report as HTML, PDF or an Excel spreadsheet.
2. Alarm management is a set of procedures, practices, tools and systems that jointly assist in making sure a plant's alarm system is effective throughout the life of the plant. The historian should provide pre-configured alarm rationalization reports based on the EEMUA (Engineering Equipment & Materials Users Association) 191 alarm management guidelines.
3. The historian software should contain ready-to-use energy reports that can facilitate energy consumption assessment and potential savings across the equipment level, production lines, an entire plant or multiple sites.
4. The package should contain an intuitive visualization tool that allows operators and process engineers to analyze the cause of process disturbances by bringing together trend and alarm data on a single integrated display. The user should be given complete flexibility with regards to the ways in which the pens can be displayed. For example, they can be overlaid or stacked or even moved to different panes to reduce clutter and make the display simpler and easier to read.
5. The Analysis tool should include features such as true Daylight Savings Time support, accuracy to millisecond resolution, and individual time axis per pen, customizable toolbars, rich printing and saving of display settings for easy recall.

10.7.4 Contingency Management - Pollutants

The water network management system on the basis in the real-time data can perform:

- A trace, performing a forward analysis of a situation from any given time
- A diagnostic trace, performing a backward analysis of a situation from any given time

The trace analysis shall be based on the real-time data, hence done on what has occurred. It is not needed to upload the model – it is ready for this analysis right away.

Production Planning

This system shall combine the knowledge about the water producers within the network with hydraulic constraints and water supply. Subsequently, the most economical way of operating the utility shall be identified leading to significant cost reductions.

Add on Modules for Advance Function

The water network management system shall be able to integrate advanced modules such as:

Transmission Line Leakage Detection System (LDS)

LDS allows near real-time identification of leaks and bursts on transmission networks and the estimation of the leak volume based on the mass balance methodology. To ensure that you will quickly detect new leaks in your network, the system shall provide a leak detection system integrated with the field flow meters and pressure sensors measurements. These data will be directly linked to the SCADA data. Zones with leaks are identified by the leak detection system, and an alarm shall be forwarded to the SCADA system to make sure that proper action is taken immediately.

Pressure optimization

The water network management system should be equipped with a pressure optimization that utilizes the real-time hydraulic model for set-point generation.

The Pressure optimization module shall consider the fluctuation of consumption in the net, and automatically provide the set-points for the pumps or pressure control valves ensuring a supply pressure that is 'just' good enough. The optimized pressure values can be sent back to SCADA/PLC/Loggers/PRV/VFD for an automated optimization.

The automatic Pressure optimization will help to reduce your Leakage level with approximately 10-15%, reducing your water loss, and associated cost of production and chemical treatment, but also reducing the pumping cost and subsequent CO2 emission.

Pump and reservoir optimization (generic)

In water distribution systems, the pumping costs often constitute the major part of the operating costs. In order to minimize the pumping costs a optional Pump and Reservoir Optimization module should be included.

The Pump and Reservoir Optimization module shall enable you to determine the optimal pumping schedule for a pipeline system for a given period (user defined), while taking the following points into account:

Demand schedules

- Storage capacities of reservoirs
- Power costs (unit costs may vary over time)
- Other operational costs, for instance costs for stopping and starting of pumps
- Capacity and availability of pumps and other equipment
- Pump efficiency and pumping curves
- These data may be retrieved from the SCADA system, via the real-time data interface, or they may be entered manually.
- The feedback to the system are flow set point or pressure set point for each pumping station that is sent back to the SCADA system automatically.

Additional Detailed Requirements

- Further detail requirements specification is divided into the following groups:
- System Architecture & Licensing
- Model Build & Maintenance
- Model & Scenario Configuration
- Offline Modeling
- Online Modeling

- Advanced Analysis and Optimization

Operating System

- The operating system (OS) must be capable of multitasking with up to 4 periodic tasks and more than 60 event or I/O tasks.
- The I/O and channels (counter, etc) of the various modules can be assigned to each task.
- The PLC RUN/STOP functions can be remotely controlled by setting the parameters of an input channel.
- It must be possible to assign a chosen physical input to prohibit any modification or downloading of the program.
- It must be possible to maintain the outputs or set them to fallback position when the PLC switches to STOP mode via channel by channel parameter entry.
- Execution of the warm and cold restart procedures is available by system bits which are accessible by the program and terminal.
- It must be possible to perform a functional update of the processor by simply downloading the firmware through the dedicated software or the programming software platform. However, it must also be possible to use a more recent version of the programming software without having to update the firmware of the processor.
- To help in debugging applications, it must be possible to set breakpoints and watch points in application so that customer can check all system and data when executing his application. System must also provide Step-by-Step running feature to execute all operations one by one in the application.
- Engineering tool must provide a trending tool embedded to display variables at a minimum of 1ms sampling rate.

NAMCHI SMART CITY LIMITED

Memory

1. The memory area must consist of an executable internal memory for the application which can be saved both in an internal Flash memory embedded, and in a Flash type removable memory card.
2. No battery supply is needed for non-volatile backup.
3. The most powerful processor in the range must provide up to 64 MB of integrated non-volatile memory to save whole application and data, even in redundant configurations.
4. Removable memory cartridge must provide up to 4 GB of memory capacity
5. Operating system running on this removable memory cartridge must insure a high level of reliability to be compliant with industrial constraints to support for example extraction of the cartridge during execution.
6. It must be possible to store the program, comments and symbols in the PLC to enable connection of the programming tool without having the application on it. The "empty terminal" functionality must be possible whichever IEC language is used. It must be also possible to use the memory extension to back up files (production data, recipes, etc)
7. It must be possible to secure access to application stored on the cartridge to prevent the run of application from any controller.

Cyber Security

1. The system must be compliant with IEC – 62443 standards.
2. The system MUST be Achilles level 2 certified.
3. The system must have passed successfully the CSPN test.
4. The system must be able to secure communication between PLC and engineering workstation providing authentication and integrity of data
5. The system must be able to secure communication between PLC and SCADA providing authentication and integrity of data
6. The system must be able to log any PAC security events into any SYSLOG database
7. The internal firmware of the CPU must be digitally signed and encrypted
8. The integrity of the firmware must be checked before any application download and at startup of the system
9. The integrity of the engineering software must be checked on demand.
10. The user must be able to disable the following Ethernet services: FTP/TFTP/HTTP/EIP/DHCP/BOOTP/SNMP
11. The system provides an access control list for each protocol and each connected IP address
12. Any modification of the operating mode of the system (Run / Stop / Program modifications)must be authenticated.

Distributed & Remote configurations

1. The communication functions of IP20 remote I/O modules must be independent of the input and output interface functions. It will therefore be possible to connect any module to the main field bus standards (multi-bus openness) including, amongst others:
   - Ethernet 10/100Mbps
   - Serial links
   - AS-i
2. System must also support in remote configuration expert modules, such as counting, and weighing functions.
3. System must support in same network a mix of synchronized and unsynchronized drops and equipment with PLC scan.

4. Connection to synchronized or unsynchronized drops must be provided through ring topology to insure quick recovery (<50ms) in case of one cable failure.
5. Supplier must provide an opened system where it must be possible to integrate third party device based on standard technologies.

11. Energy

Energy is defined as the ability to do work. **Energy** can be found in many things and can take different forms. Energy is a bit of a mystery. Most of the time we can't see it, yet it is everywhere around us. Revving car engines burn energy, hot cups of coffee hold energy, street lights that shine at night are using energy, sleeping dogs are using energy too—absolutely everything you can think of is using energy in one way or another. Energy is a magical substance that makes things happen. Everything in the world is either energy or matter ("stuff" around us) and even matter, when you really get down to it, is a kind of energy! One of the major objective of a Smart City is optimizing **energy** consumption, by creating **energy** efficient buildings, home appliances and electronic devices.

The energy we use in our daily lives falls into three broad categories: the food we eat to keep our bodies going, the energy we use in our homes, and the fuel we put in our vehicles. The food we eat comes from plants and animals, which our stomachs digest to make a sugary substance called glucose that blood transports around our bodies to power our muscles. All animals ultimately get their energy from plants, which are themselves powered by sunlight. Plants are like living solar panels that absorb the Sun's energy and convert it into food. The energy we use in our homes tends to be provided by coal, gas, and oil. These three "**fossil fuels**" are underground supplies of energy, created millions of years ago, that we drill, mine, or pipe to the surface to satisfy our energy needs today. Most of the energy we use in our vehicles also comes from oil. The trouble with fossil fuels is that we are using them much more quickly than we are creating them. Another problem is that burning fossil fuels creates a gas called carbon dioxide that is building up in Earth's atmosphere and causing a problem known as global warming (climate change).

We'll also need to be smarter in the way we use energy. By designing machines and appliances that do the same jobs but use less power, we can make the energy we have go much further. This is called **energy efficiency** (saving energy) and it's like a completely free way of making power.

11.1 Ideation

NAMCHI SMART CITY LIMITED

Electricity has made life very easy and thus its consumption is increasing day-by-day. In order to generate this electrical energy in its original form, a lot of natural resources are being used. Traditionally electricity was generated only from non-renewable energy resources but now renewable have come into picture. Although renewable are used for generation of electricity, the system and equipment needed to produce electricity from them are costly and thus can't be afforded by every common man. Hence this has led to the depletion of the natural resources. Therefore it is essential to switch to new and better options like smart grid, smart metering, and zero energy buildings that will help to reduce dependency on these reserves by reducing energy consumption and improving use of renewable energies. And in order to increase the efficiency of our power system Energy Management Systems (EMS) are essential. It is a comprehensive offering that combines energy and process optimization and, where appropriate, incorporates the solution into online advanced control and optimization strategies.

Energy management systems are used by power system operators to monitor power grid operating conditions and control grids in a reliable, secure, and economical fashion. An energy management system interfaces with the grid through a supervisory control and data acquisition (SCADA) system. The SCADA system transmits thousands of measurements at critical points of a power system in real time to the energy management system and command signals from the energy management system to field devices to take control actions. An energy management system integrates application software such as state estimation, contingency analysis, automatic generation control, and economic

dispatch. These applications typically operate the grid in a reactive (e.g., load following) or preventive (e.g., security constrained dispatch) fashion.

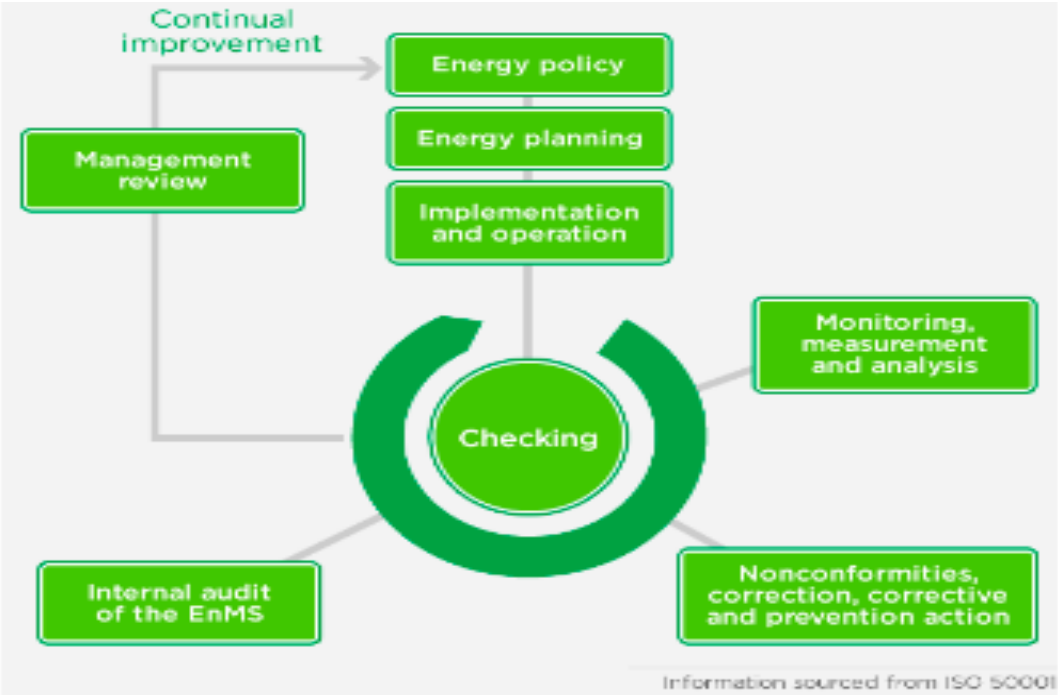


Figure 14: Basic Block Diagram of an Energy Management System

Electricity Act 2003 has been enacted and came into force from 15.06.2003. The objective is to introduce competition, protect consumer interests and provide power for all. The Act provides for National Electricity Policy, Rural Electrification, Open access in transmission, phased open access in distribution, mandatory SERCs, license free generation and distribution, power trading, mandatory metering and stringent penalties for theft of electricity. It is a comprehensive legislation replacing Electricity Act 1910, Electricity Supply Act 1948 and Electricity Regulatory Commission Act 1998. The Electricity Act, 2003 has been amended on two occasions by the Electricity (Amendment) Act, 2003 and the Electricity (Amendment) Act, 2007. The aim is to push the sector onto a trajectory of sound commercial growth and to enable the States and the Centre to move in harmony and coordination.

In an indication of growing appetite for electricity in India, the country's per capita electricity consumption has reached 1010 kilowatt-hour (kWh) in 2014-15, compared with 957 kWh in 2013-14 and 914.41 kWh in 2012-13, according to the Central Electricity Authority (CEA), India's apex power sector planning body.

However, at the Namchi Smart Cities context local legal framework covering the supply, distribution and realization of tariff of power units shall be applicable.

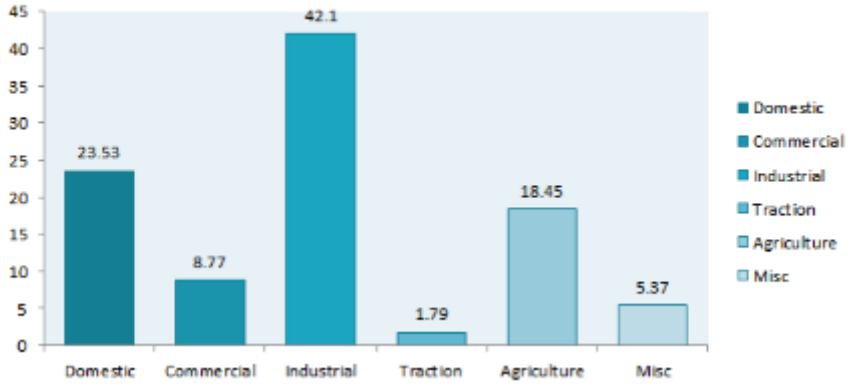


Figure 15: Percentage segmentation of electricity consumption as on March 2015

With rise in per capita consumption the average cost has also dramatically increased over the period of time. Increasing costs also results from increasing losses due to inefficiencies in managing the energy consumption. Utilities are operating under huge deficit and this may pose threat to their survival. Increasing tariff is one way of keeping a check on these deficits but a more efficient and sustainable system is needed to be developed to drive them out of losses.

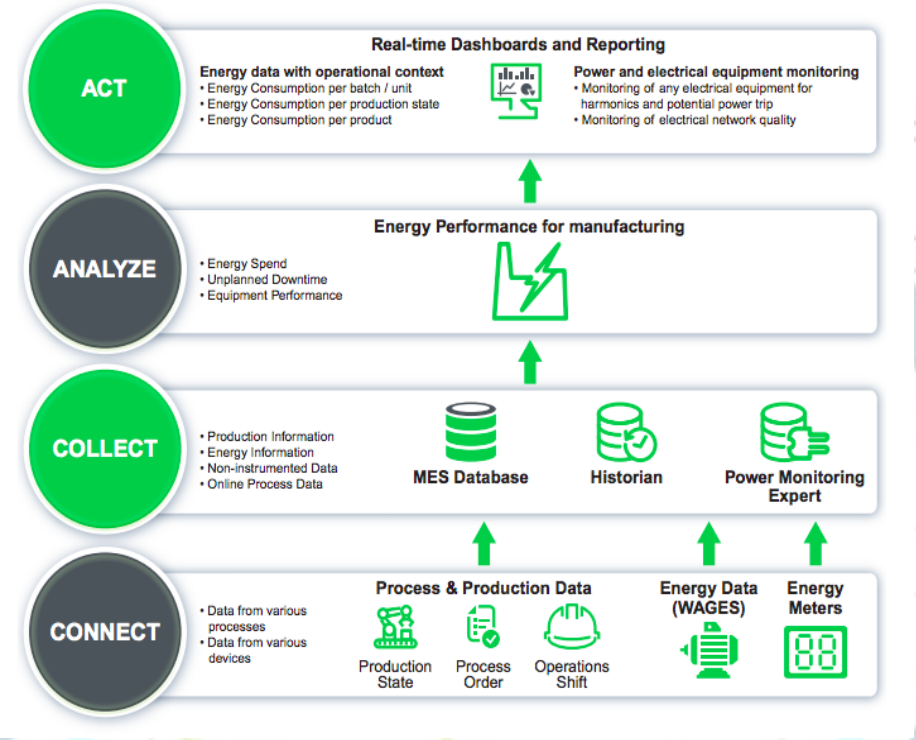
11.2. Solution Requirements

To integrate energy supply for Namchi City through Smart Electricity Meters and SCADA, This will be integrated with City Operations Center for command and control as and when implemented.

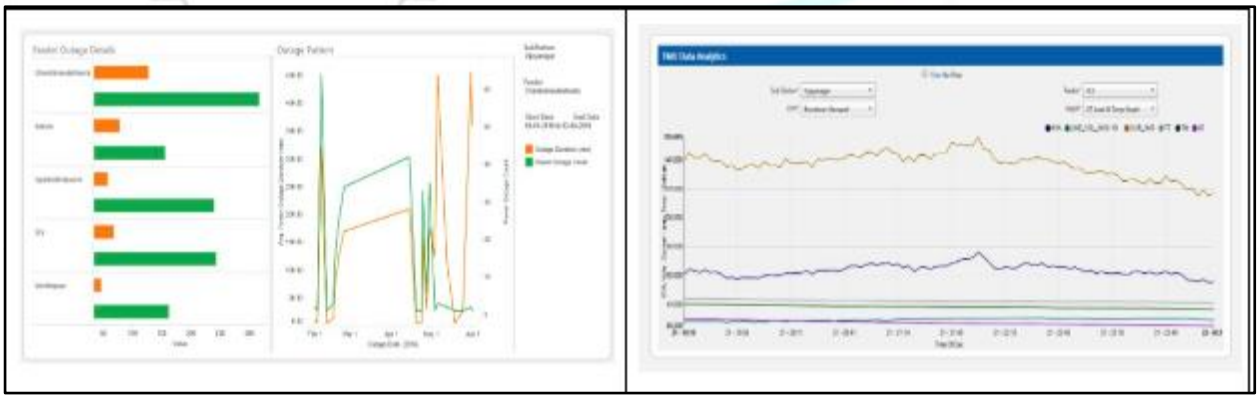
Provision for integration of CoC /C4 with future expansion of properties will be provided. The Smart Energy track Shall have Following Systems in the Smart Energy Transmission, Distribution and Smart Grid Management:

- Metering, Billing and Collection
- Meter Data Management System
- Meter Data Acquisition System
- Service connection, disconnection, dismantling and asset management

- Energy Audit
- GIS Mapping with differential GPS mapped assets on the network
- MIS and Web Self Service
- Centralized Grid Management and Assets Network
- Line-wise power calculations and estimates
- Power peak-load analysis and re-distribution
- Power harmonics and Power quality analysis
- Centralized monitoring from C4



Integration of smart UGD (SCADA) project with City Operations Centre for command and control as and when implemented provide the required facility to monitor, forecast and maintain continuous uniform power supply to all in the city. This integration will help in effective and efficient use of energy across usages.



11.3. Used Cases - Power

A. Automated Meter Reading
B. Advanced Metering Infrastructure
C. Electric Vehicles
D. Home Energy Management / Building Energy Management
E. Sub-station Automation and Distribution Automation

Sr No	Use Case Title	Brief Description
1	Automated Meter Reading	AMR is used extensively in RAPDRP for HT consumers, distribution transformers and feeders
2	Advanced Metering Infrastructure	Advanced Metering Infrastructure (AMI) is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customer premises equipment.
3	Electric Vehicles	eco-friendly and an efficient mode of transport, electric vehicles act as virtual power plants which can provide electricity to the grid, households and buildings during the peak hours.
4	Home Energy Management/Building Energy Management	Smart homes would offer monitoring and control of the electricity usage within the consumer Premises. Aggregators or energy management systems would form the core of home automation by providing a means to efficiently consume electricity.
5	Substation Automation and Distribution Automation	Modern substations should include 'smart' devices for monitoring and controlling the operation of transformers, circuit breakers, protective relays, capacitor banks, switches, voltage regulators, static VAR compensators, etc.

12. Intelligent Traffic Management System (ITMS)

12.1. Ideation

Road traffic congestion is a recurring problem worldwide. In India, a fast growing economy, the problem is acutely felt in almost all major cities. This is primarily because infrastructure growth is slow compared to growth in number of vehicles, due to space and cost constraints. Secondly, Indian traffic being non-lane based and chaotic is largely different from the western traffic. The difference can be understood fully only through experience, thus, Intelligent Transport Systems (ITS), used for efficient traffic management in developed countries, cannot be used as it is in India. ITS techniques have to undergo adaptation and innovation to suit the contrasting traffic characteristics of Indian roads. ITS in India, however, cannot be a mere replication of deployed and tested ITS in the developed countries. The non-lane based disorderly traffic with high heterogeneity of vehicles, need the existing techniques to be adapted to the Indian scenario, before they can be used.

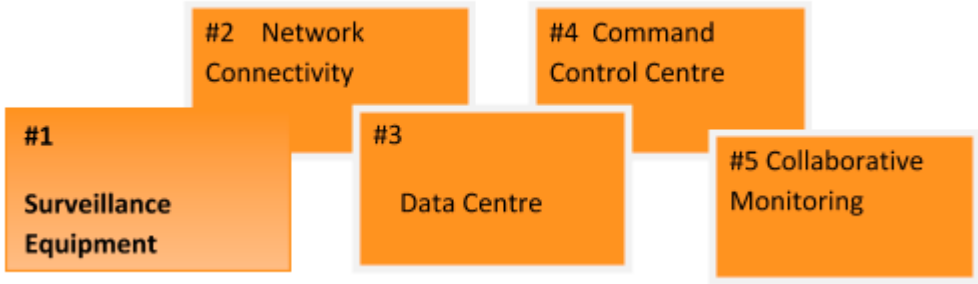
Intelligent Traffic Management System for Namchi Municipal Council can benefit from several possible ITMS applications. It can be RADAR based or Sensor based. Below is one set of application for Intelligent or Adaptive Traffic Management System

1. Intersection control - At intersections, deciding the total signal cycle and the split of green times among different flows, is one of the most basic traffic management applications.
2. Incident detection - Pinpointing locations of accidents or vehicle breakdown is important to handle the emergency situations.
   Vehicle classification – Knowing what kind of vehicles, and in what proportions, ply a certain road stretch, helps to choose appropriate road width and pavement materials.
3. Monitoring - Pollution and road quality monitoring are necessary for taking corrective measures.
4. Revenue collection - Toll taxes for infrastructure maintenance and fines for rule enforcement need to be collected.
5. Historical traffic data - Long term data helps to plan new infrastructure, calibrate traffic signal times, add public transport and so on.
6. Individual vehicle management - Getting information about parking places or estimates of carbon footprint, help owners of private vehicles.
7. Accident handling – Emergency services after accidents are a vital necessity.
8. Static Sensing, Mobile Sensing, Hybrid Sensing are some of the methodologies being currently used in India.
9. Static Sensing involves; Loops & Magnetic Sensors, Images & Videos, Acoustic Sensors & RF Sensors.
10. Mobile Sensing involves; GPS on public transport or Fleet vehicles & other specialized hardware.
11. Images & Videos involves CC Cameras/IP Cameras & HD Cameras.
12. RF Sensing involves RFID Tags on the vehicles & RFID readers placed at strategic locations to track movement & exact time of arrival & departure of vehicles.
13. The System shall provide interoperability of hardware, operating system, software, networking, printing, database connectivity, and reporting and communication protocols.
14. The system should cater to Traffic flow/Congestion, Traffic Volume estimation and statistical counts, Video Content Analytics requirement.
15. The system should improve reliability in journey times between various locations, so that citizens can experience an enhanced quality of road based transportation, through improving sustainability and efficiency in operation of the road network.
16. Reduction in traffic delays, optimized cycle times at intersection to regulate and maintain free flow of traffic to enhance the efficiency of the transport infrastructure.
17. The traffic services to the public can be improved through the user friendly presentation of various traffic related information in real time through sharing of all relevant data feeds for public consumption.
18. Implement traffic enforcement mechanism for traffic violation, checking and monitoring shall reduce the traffic related offences of Red Light violations.
19. Create a platform for sharing traffic information across the city- Mechanism to broadcast information regarding traffic, parking spaces and other incidents to police and citizens that hamper the traffic movements.
20. Information for Traffic rules & regulations, road safety, emergency service, details on traffic police-public interface, Challan notice information, and road safety measures on CSCL web portal.

21. Integrate e Challan system if already exists.
22. To Provide economic, adequate, punctual and efficient service to passengers by applying Information and communication technologies in the field of road transport including traffic, as well as for interfaces with other modes of transport.
23. To enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.
24. To simplify public transport use by improving efficiency in operational processes with real time information.
25. Simplifying public transport use by providing accurate real time information about services.

The proposed system should be an adaptive and predictive control system wherein we can use countdown timers. In the control system the timing proposed should be sent instantaneously to timers which should display live countdown timing. Apart from this, the system should be designed for heterogeneous traffic in which traffic count and occupancy is taken in to account. Where other system uses purely volume count and resulting in less optimized for Indian Conditions. Various other data like headway and average speed should also be used to correlate the traffic pattern and take decision. Signal coordination should be implemented with adaptive cycle time variation and use of countdown timers. Different days different plans and within a day different plan and timings should be configured day wise. The system can synchronize the corridor along with adaptive control system. It can vary cycle time along with the offset correction required for synchronization.

Solution Architecture:



12.2. Solution Requirements

The MSI shall be responsible for Supply, Installation, Implementation, Operation and Maintenance of the Intelligent Traffic Management System for a period of Five Years from the date of Go-Live of the respective phase independently. The standards should at-least comply with the published e-Governance standards, frameworks, policies and guidelines available at http://egovstandards.gov.in.

The indicative requirement for MSI is broadly categorized into the following:

Category	Scope of Work
Minimum surveillance infrastructure at field locations	MSI shall supply, install, implement & maintain : • Full HD/IP PAN-tilt-zoom cameras (PTZ). • Full HD/5MP IP fixed box cameras. • Full HD/IP dome cameras. • Panoramic cameras. • Pole, Junction Box, UPS, LAN switch, passive items & associated accessories. • Cameras to support ANPR. • Cameras to support RLVD. • Cameras to support ITMS • Data retention period of 90 days for regular camera data & 365 days for incidence or flagged data.
Network infrastructure	Between camera & aggregation point – Field location. Between aggregation points & Data Center. Between Data center & command control center/City operations center & viewing / monitoring center. Till the city network backbone is commissioned, the MSI will need to procure the necessary bandwidth as a service, in order to meet requirements which will be defined or as defined in the SLAs. The MSI will also need to migrate to the City network backbone within a month from the date the City network backbone is fully operational.
Surveillance system applications.	• Video management system (VMS). • Video Analytics (VA). • Red Light Violation Detection (RLVD) System. • Automatic Number Plate Recognition (ANPR) System. • High Speed Violation Detection System • Monitor and control traffic signals, including signaled pedestrian crossings. • Traffic signal optimization functionality. • Instant fault triggering to minimize the MTTR (Mean Time To Recover) • Increase MTBF(Mean Time Between Failure). • Reports generation which is either standard or customized. • Improve Journey Time Reliability. • Increased Traffic Signal Efficiency. • 24x7 monitoring and controlling. • Work independently and centrally controlled.

Video Feeds at few selected locations	MSI will be required to provision viewing of video feeds at selected KEY locations.
Training & Capacity building	Technical & functional training to the designated officials on a continuous basis.

12.2.1. Operator Workflow

A workflow shall be a sequence of operations an operator or administrator shall execute to complete an activity. The "flow" relates to a clearly defined timeline or sequence for executing the activity. The Monitoring UI shall be equipped with consistent workflows for various City wide elements like ALPR, RLVD & e Challan system.

12.2.2. User Workspace Customization

1. The user shall have full control over the user workspace through a variety of user selectable customization options. Administrators shall also be able to limit what users and operators can modify in their workspace through privileges.
2. Once customized, the user shall be able to save his or her workspace.
3. The user workspace shall be accessible by a specific user from any client application on the network.
4. Display tile patterns shall be customizable.
5. Event or alarm lists shall span anywhere from a portion of the screen up to the entire screen and shall be resizable by the user. The length of event or alarm lists shall be user defined. Scroll bars shall enable the user to navigate through lengthy lists of events and alarms.
6. Additional customization options include: show/hide window panes, show/hide menus/toolbars, show/hide overlaid information on video, resize different window panes, and choice of tile display pattern on a per task basis.
7. The Monitoring UI shall provide an interface to support the following tasks and activities common to Various systems
   (a) Monitoring the events from a live security system
   (b) Generating reports, including custom reports.
   (c) Monitoring and acknowledging alarms.
   (d) Creating and editing incidents and generating incident reports.
   (e) Displaying dynamic graphical maps and floor plans as well as executing actions from dynamic graphical maps and floor plans Unified with central Video Management System at Control Room.
8. The live video viewing capabilities of the Monitoring UI shall include:
   (a) The ability to display all cameras attached to the system both Public, Collaborative monitoring and Cloud based entities.
   (b) The ability to drag and drop a camera into a display tile for live viewing.
   (c) The ability to drag and drop a camera from a map into a display tile for live viewing.
   (d) Client viewer shall allow the operator to select one or more cameras icons on the site map using a camera selection tool.
   (e) Support for digital zoom on live camera video streams.

(f) The ability for audio communication with video units with audio input and output.
(g) The ability to control pan-tilt-zoom, iris, focus, and pre-sets.
(h) The ability to bookmark important events for later retrieval on any archiving camera and to uniquely name each bookmark in order to facilitate future searches.
(i) The ability to start/stop recording on any camera in the system that is configured to allow manual recording by clicking on a single button.
(j) The ability to take snapshots of live video and be able to save or print the snapshots.

9. The ability to browse through a list of all bookmarks created on the system and select any bookmarked event for viewing.

10. Tools for exporting video and a self-contained video player on various media such as USB keys, CD/DVD-ROM and Proposed Evidence management and Collaboration system. This video player shall be easy to use without training and shall still support reviewing video metadata.

11. Tools for exporting video sequences in standard video formats, such as AVI.

12. The ability to encrypt exported video files with industry standard encryption.

13. A tool building and exporting a set of videos into a single container. This tool shall allow the operator to build sequences of video to create a storyboard and allow the export of synchronous cameras.

14. Should be able to generate reports on number of working cameras.

15. System should not raise false alert for small movement of camera caused due to wind or for tree movement in the view

- Surrounding Camera View Feature: - Surrounding camera view feature shall allow the user to create surrounding track layout that includes neighbouring / surrounding cameras from map view using track creation tool.
- The user shall be able to delete the layout and set any created track layout as event pop up in future
- The camera associated with incoming event notification in the system shall be highlighted in the camera navigation tree with a blinking or different color for quick identification such that user shall be able to quickly identify which alarm is coming from which camera.
- Incidence Bookmarking: - This feature shall allow the user to select a video slot and tag/bookmark an incident to that video as the user witnesses it.
- The user shall be able to tag/bookmark incident to live as well as the archived video for any existing camera running in VMS system.

12.2.3. Investigation & Forensic Analysis

The solution shall provide the following process and investigation capabilities:

- **Bookmarking:** The solution shall allow the user to bookmark any Event clip for ready reference at any later point of time.
- **Critical event Tagging:** The solution shall allow the user to tag critical Event clips so that they do not get removed from the storage based on FIFO/Retention period settings. Video summarization: The VMS shall summarize activities in any given segment of video on demand, so that activities that happened during one hour of time can be viewed in less than 10 minutes.
- **Video Digging:** It should be possible to navigate across multiple camera views simultaneously in a systematic way. By a simple copy-paste operation, it should be able to synchronize replays for any two or more cameras. On spot investigation of activities in the scene, with orchestrated use of Sitemap, Message Window and Virtual Matrix, it should give real flavour of a truly intelligent IP-based video surveillance system. It should be able to follow movements of people, vehicles and other objects across multiple cameras in the archived video systematically and quickly, in a time synchronized fashion.

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 are to be part of implementation but not limited to:

- Detection and Recognize the pattern of demonstration and conflicts in crowd
- Detection and classification of human, animal and vehicle
- Safety: Detection and classification based on :
- Behavioral Biometric
- Identification through multiple behavior Parking violation
  Speeding vehicle
  Accident detection
  Loitering detection
- Person climbing barricade
  Person collapsing
  Person/Face recognition
  Gesture recognition: Identification through gesture change
- 'Vehicle of interest' tracking by colour, speed, number plate
- Helmet detection on two wheeler
- Unwanted/ abandoned vehicle detection
- Wrong way or illegal turn detection

- Environmental condition detection
- Air quality detection

12.3. Functional Requirement

12.3.1. Automatic Number Plate Recognition System (ANPR)

1. MSI shall provide Automatic Number Plate Recognition (ANPR) solution at the identified locations. The ANPR / RLVD application must be native to the VMS OEM.
2. ANPR cameras shall provide the image to the command control centre, where the ANPR server shall be located. The ANPR server shall aggregate the processed image using OCR software from the respective LPU for getting the registration number of the vehicle with the best possible accuracy. The system shall be able to detect, normalize and enhance the image of the number plate for detection of alphanumeric characters. System shall be able to identify stolen/ suspected vehicles by cross checking the numbers with vehicle database. ANPR software should closely unify with the VMS system for Video to No Plate Correlation.
3. The 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 the image captured shall be done in real time.
4. The proposed system / application should integrate with RLVD (Red Light Violation Detection) System.
5. ANPR Cameras, mounted at the traffic intersections and on identified mid blocks, the system shall help in identifying the vehicles that violate traffic regulations and helps in enforcement and maintenance of traffic discipline amongst the citizens. The application should be integrate with e-challan and support in generating challans to errant vehicle owners.
6. The ANPR application should have in-built capability to identify hot-list / suspect vehicles for ensuring law & order and increase operational efficiency of the police department.
7. The ANPR system should continuously record all footage in its field of view which is to be stored at a local processing unit (with an upload facility to central database in central Video Management System at Control Room).
8. The system processing should be in real time i.e. the recognition of license plate number should happen instantaneously.
9. The system should be able to process and read number plates of vehicles with speeds up to 120 km/h on all standard license plates.
10. ANPR Application should integrate with the RTO and VAHAN database to extract the registered details of the vehicles based on the captured number plate.
11. The application shall be designed to run on a standard PC-based platform with native failover options with no dependency on external application for Failover and Fallback.
12. Application SDK shall be available to support custom development for the platform.

12.3.2. Red Light Violation System (RLVD)

1. RLVD system shall detect and capture all the vehicles crossing the stop line when the signal state for the approach is red.
2. RLVD system shall be able to automatically detect the traffic signal state by directly interfacing with the traffic signal controller.
3. The RLVD solution should use an appropriate camera based non-intrusive vehicle detection system that will detect vehicles crossing the stop-line.
4. The system shall be capable of detecting and capturing multiple infracting vehicles simultaneously in different lanes on each approach at any point of time and shall display the site name, the approach name, the date and the timestamp on the violation image.
5. RLVD solution shall provide following functionalities together through different cameras:
   ● Automatic Number Plate Recognition (ANPR) Camera – To capture clear images of violating vehicles, with its focus on the number plate.
   ● Overview Camera – To capture multiple images of the vehicle and a short 10 second video of the violation in progress, clearly showing the vehicle crossing the stop line and the traffic signal light aspects for the approach.
6. The evidence image/video produced by the system should be wide enough to give the exact position of the infracting vehicles with respect to the stop line and clearly indicate color of the Traffic light at the instant of Infraction even if any other means is being used to report the color of the light.
7. RLVD system shall be equipped with external IR illuminators or with in-built IR illuminators, with the range as specified in the technical specifications, to capture violations during the night.
8. The RLVD system shall use open standards and protocols to the extent possible and declare the proprietary software wherever used.
9. The RLVD system shall be provided with UPS backup for a minimum of 1 hour.
10. RLVD system shall be equipped with a local processing unit (LPU) to generate and store violation data.
11. The LPU should be an industrial grade processing unit that is securely placed in an IP protected lockable cabinet. The access to the cabinet shall only be provided to authorize personnel of the competent authority.
12. The system should have secure access mechanism for validation of authorized personnel. The roles and rights of users should be defined in the system as per the requirements of the client. A log of all user activities should be maintained in the system.
13. A local RLVD client application shall run on the LPU, to process and store the violations. It shall constantly communicate with the central application at the control room and send violation data using FTP.
14. In the event that the connectivity to the control room fails due to connectivity issues, then all data pertaining to the infraction shall be stored in the LPU and transferred back once the connectivity is re-established. There shall also be a facility to physically transfer data onto a portable device whenever required. There should be a provision to store at a minimum violations over one week.
15. The LPU should automatically reset and restart in the event of a program freezing. The LPU shall restart on the press of a button and restart on a button press. However the system should start automatically after power failure.

16. The cameras shall be mounted on a cantilever pole with a minimum vertical clearance of 6 meters measured from the Road surface to the bottom of the pole and ensure no obstruction to vehicular traffic.
17. The pole shall be painted with one coat of primer and two coats of PU paint. The equipment including poles, mountings should have an aesthetic feel. The equipment should look “one” with the surroundings of the location and not look out of place.
18. RLVD server application shall communicate with the local client application and violation data should be fetched using FTP.
19. RLVD server application shall run the ANPR algorithm to identify number plates of violating vehicles from the captured images. The ANPR component of the system should be vendor independent, and the system should be able to support third-party ANPR engines on the backend server.
20. RLVD server application shall provide an option to manually verify the evidence for each violation event. This option shall display all the images and video captured for the violation in consideration along with the registration number generated using the ANPR engine.
21. RLVD server application shall provide an option to generate provisional challans for the violating vehicles after manual confirmation of number plates.
22. RLVD server application shall have an option to print challans.
23. RLVD server application shall provide an option to view all the previously generated challans and violation records.
24. RLVD server application shall be capable of integration with the RTO/VAHAN database to fetch vehicle details to generate the challans.
25. RLVD server shall also have housekeeping functionality using which approved users can customize or add any location along with the hardware and junction details.

12.3.3. Over Speed Detection System

1. The speed violation detection system detects the over speeding vehicles and generate an automatic e-Challan for the over-speeding violation. The below figure shows the speed violation detection system Installation.
2. The speed violation detection system captures speed of the vehicles which are passing through this system. The speed detection system detects speed of the vehicle and compares with the speed limit set in the configuration. If the actual speed of the vehicle is more than the speed limit, then it triggers the ANPR system to capture the number plate of the vehicle. Both the number plate and actual speed of the violated vehicle will be stored in the system. The system detects speed accuracy of 10% (+/-) of the actual vehicle speed.
3. The number plate deciphered are stored in the deciphered database. The number plate not deciphered by ANPR system are stored in the non-deciphered database. Later the non-deciphered number plate is manually further classified into soiled, broken and vernacular number plate.
4. All the deciphered number plate of violated vehicles e-Challans generated automatically. Non-deciphered number plate of violated vehicles e-Challans are generated manually.

12.3.4. E-Challan System

1. The successful bidder is required to develop a “e- Challan system” based on the laws/rules of Motor Vehicle Act of central/state government as well as per the format of Client department. The Challan generation module will be pre-integrated with the RLVD System. The Challan

generating system will generate and print Challans for all the RLVD events that are duly validated and checked by the operator.

2. Successful bidder is responsible for end-to-end designing, planning, supply, implementation, testing, commissioning and maintenance of entire e-Challan system.
3. It is envisaged that successful bidder will have to submit a detailed Functional Requirement document and software requirement specification covering each and every aspect of the system required to successfully run the system.
4. E-Challan system should be able to automatically generate e-challan based on the laws/rules of Motor Vehicle Act of central/state government for the violations detected by the surveillance system. It should also have a provision/interface for manual e- challan generation for violations captured through manual level investigation of video feeds and field level. Should the government make changes in laws pertaining to traffic management during the O&M period of the contract, the bidder will have to carry out such changes without any additional cost.
5. The management module of the e- Challan system shall be hosted at the central control room where challan generation and printing shall take place.
6. It should be integrated with the all the required databases/systems for auto generation of e-Challan like RTO system, VMS system, ITMS system and other required resources.
7. The successful bidder is required to submit the Standard Operating Processor system, documents, Frequently asked question along with all the patches and upgrades of the system.
8. Application development must be documented in detail and the code/script should be properly annotated with comments etc.
9. The system should be able to generate Management Information System reports based on the type/ Date /time/Location of offences, as may be required for the day to day activity.
10. The successful bidder shall integrate solution with applications such as Sarathi, Vahan, CCTNS etc. Bidder shall also publish API of challan information generated to be integrated by such other applications in to their databases.
11. e-Challan Management Software shall be open architecture software that shall integrate with Intelligent Traffic Management System applications suite offering efficient management of challans generated to penalize traffic violations like red light violation, stop line violation, speed violation, etc. Additionally, it shall also allows the operator to include other violations such as no helmet, triple riding, etc. as and when visually detected during the validation of challans.
12. Challan Traceability
    - Each challan shall be identified by unique identifier for future references.
    - Challan shall be tagged to issuing officers details
    - Challan shall have accurate date / time stamp

12.4. Use Cases: Intelligent Transport System

Sl. No	Use Case Title	Brief Description
1.	Use-cases related to Public Safety	This is a very important use case category, which will enhance the public security and emergency management system in India. A typical call flow has been shown figure 12. M2M technology will enable police emergency VAN to respond to citizen's panic calls efficiently and will reduce the response time.
2	Use-cases for Traffic Planners/Management	Traffic management system integrates various subsystems (CCTV, GPS data, vehicle detection, messaging, digital signage etc.) into a coherent single interface that provides real time data on traffic status and predicts traffic congestions for more efficient planning and operations. Dynamic traffic control systems, freeway operations management system, incident response systems, etc. respond in real time to changing conditions
3	Use case for Commuter	End user are the one who will utilise the benefits of Smart Cities. The ITS talks of electronics on personal vehicles such as GPS, V2V technologies
4	Use-cases related to Fleet Managers	Fleet Management is another use case that contributes to the Smart Cities and aid in reducing crimes
5	Use case for Original Equipment Manufacturers	OEM can provide services such as stolen vehicle tracking and location based anti-theft applications. The OEMs can even

		monitor on field performance of the product after launch. Technology enables the vehicle manufacturers to provide VAS services and create new stream of revenue.
6	Use case related to Smart Infrastructure	The Smart Infrastructure is important ingredient to have a successful Smart Cities. Some of the requirements of Smart Infrastructures are Smart Parking , Toll Collection , Smart Signals, Smart roads are some of the key contributors for this use-case

13. . City Surveillance

13.1. Ideation

The National Crime Records Bureau statistics of 2012 clearly reflect that there has been a tremendous increase (296.6% since 1953 and 2.6% over 2011) in cognizable offences such as rape, murder, kidnapping, etc. Cases of rape alone have increased nine times over the last 40 years, followed by while instances of kidnap and murder have increased by eight and 2.5 times respectively in the last 60 years. In spite of several security initiatives implemented by the government of India, there still have been events
that accentuate the need for immediate security strategies such as surveillance and analytics to enable a safe city environment and safeguard key public infrastructure.

The United Nations, through its Habitat Agenda on Human Settlements (Habitat II, 1996), which was adopted at the Istanbul Conference, initiated a series of approaches and strategies to effectively reduce and eradicate violence and crime within the cities. The aim of the UN-Habitat Safer Cities program is to reinforce personal safety and reduce fear by improving safety services and accountability to the community.

As India continues to experience rapid urban expansion, public and private leaders at a national, state, and local level are looking into ways to better manage larger populations and unlock greater economic potential. Launched under Prime Minister Narendra Modi in 2015, the “Smart Cities Mission” is an ambitious multiyear effort to boost economic development, technological innovation, and sustainable growth across 100 cities. Learning from previous national urbanization initiatives, the Smart Cities Mission promises to simultaneously improve the infrastructure and built environment in India’s expanding cities while offering a new path to urban fiscal health. If successful, Indian cities will position themselves as clean, modern, and competitive places for years to come.

First, India must focus on creating more customized solutions as part of its Smart Cities Mission, which should be shaped according to local infrastructure priorities and institutional capabilities.

Second, India must look to improve government capabilities at all levels to accelerate future urban development efforts. At the city level, for instance, ULBs must modernize their overall governance approach by further clarifying their functions and by shifting some of their responsibilities to SPVs or other administrative bodies, which may possess more specialized technical expertise and a more targeted mandate.

Third, India must elevate the financial standing of its urban areas, making them more attractive destinations for future investment. Across all levels of government, particularly among different city agencies, India must ensure that dependable capital is available to meet economic goals in years to

come. Increased private-sector engagement should be a paramount concern, which requires more active, coordinated leadership in project management, technical guidance, and risk mitigation.

Among the various urbanization initiatives, India's "Smart Cities Mission" garnered perhaps the most domestic and international attention. The objective of this initiative is to accelerate core infrastructure improvements in cities, provide a decent quality of life to citizens, offer a clean and sustainable environment, and readily apply "smart" solutions.7 With an "area-based" development approach

Protection of citizens and ensuring public safety is and will always be one of the top most priorities for any Government/Government agency. It requires highly advanced security solutions to enable any government agency to effectively control and nullify all security threats like terrorism, petty & organized crime, violence based on religion civil unrest and any other form of violence. CCTV video surveillance solution is one such system to ensure public safety through surveillance and monitoring its feed.

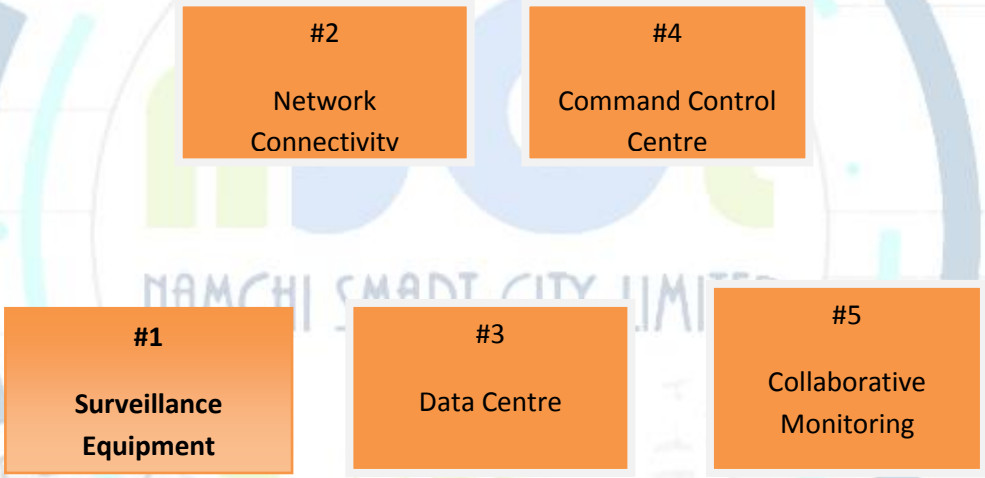
1. City surveillance should be able to cater to an effective monitoring system with appropriate management and decision support mechanisms.
2. City surveillance should ensure a pro-active 24/7 monitoring of PAN city which can capture video footages of major junctions and sensitive areas of the city of Namchi Municipal Council and project the feeds to the command and control centre with zero time lag and on a real time basis.
3. The prime surveillance equipment like High Definition Video Cameras along with its units must be located at proper locations where-in the area to be covered for video surveillance is 100% and the footage being captured is clear from all angles. Industry leading practices and Government security norms with respect to positioning and mounting the cameras, specifications of poles and junction boxes must be adhered to during the implementation stage.
4. City Surveillance System must ensure and provide a secure and safe environment for the citizens with intelligent and effective use of video analytics and integrated platform for all concerned department.
5. The surveillance System shall provide interoperability of hardware, operating system, software, networking, printing, database connectivity, reporting and communication protocols.
6. Appropriate branding/ color coding of junction boxes should be done, to warn mischief mongers against tampering with the equipment at the junction with the needful operational equipment. Cameras needs to be protected from the on field challenges of weather, physical damage and theft.
7. This City Surveillance software should have the capability to provide various alarms & triggers. The required analytics and related triggers should include Parking Violation, Wrong Direction, People loitering, Camera Tampering (In case this is an inherent feature of the camera, this may not be provided as a separate line item in VA), Unattended Object, Crowd detection, Traffic flow/Congestion, Traffic Volume estimation and statistical counts, Video Content Analytics Requirement, People tracking.
8. Video Management System must allow users to view a count of analytics events on the video pane while video is being displayed.
9. The city surveillance system must ensure real time and event base monitoring of the city, situation/ rule based alerts including early warnings for prevention and avoidance of unwanted incidents like riots, flooding, etc.
10. The system should have access to historic video data for investigative purposes.
11. Connect police and citizens through social media like Facebook and twitter to promote quick methods of interactions by using existing presence of citizens. The video surveillance system

is intended to effectively monitor all the critical operational areas of the locations & fully cover all the access points.

12. The video surveillance system is required to ensure effective security & surveillance of an area as well as create a tamper proof record for post event analysis. The surveillance system shall provide an on-line display of video images on monitors at local security control room & also at any other place as defined for large locations as per requirement. It should facilitate viewing of live and recorded images and controlling of all cameras by authorized users. All cameras should support for motion and tamper detection.

13.2. Components/Architecture

Safe city solutions incorporate a wide array of technology-driven sub-systems. Integration and interoperability of these sub-systems is fundamental in obtaining better intelligence from various sources and sensors. From CCTVs to crisis management centers, technology will enable law enforcement, emergency services and local decision-makers. This will help optimize their response to the expected as well as unexpected. The following are the components that form the basis of the safe city architecture.



13.3. Solution requirements

The MSI shall be responsible for Supply, Installation, Implementation and Operation & Maintenance of city Surveillance System for a period of Five Years from the date of Go Live of the respective phase independently. The standards should (a) at least comply with the published e-Governance standards, frameworks, policies and guidelines available on http://egovstandards.gov.in The indicative requirement for MSI is broadly categorized into following :

Category	Scope OF Work
Minimum Surveillance System infrastructure at field locations	Supply, Install, implement and maintain: Full HD IP Pan-tilt-zoom camera (PTZ) camera Full HD/5MP IP Fixed Box Camera. Full HD IP Dome Cameras. Panoramic View Cameras. Pole, Junction boxes, UPS, LAN switch, passive items, associated accessories etc..
	Cameras to support ANPR. Cameras to support Surveillance. Data retention period of 90 days for regular camera data. Data retention period for 365 days for flagged/incidence
Network Infrastructure.	Between camera & aggregation point – Field location. Between aggregation points & Data Center. Between Data center & command control center/City operations center & viewing / monitoring center. Till the city network backbone is commissioned, the MSI will need to procure the necessary bandwidth as a service, in order to meet requirements which will be defined or as defined in the SLAs. The MSI will also need to migrate to the City network backbone within a month from the date the City network backbone is fully operational.
Surveillance system applications.	Video management system (VMS). Video Analytics (VA).
Video Feeds at few selected locations.	MSI will be required to provision viewing of video feeds at selected KEY locations
Training & Capacity building	Technical & functional training to the designated officials on a continuous basis

13.4. Functional Specifications

13.4.1. Video Management System:

Video Management System (VMS) shall bring together physical security infrastructure, operations and shall use the IP network as the platform for managing the entire surveillance system.
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 could be easily managed and monitored. Scalable system shall permit viewing of video feed from 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 accept the feed from IP Camera installed at field locations. Server shall stream incoming video to a connected storage. VMS shall support video IP Bullet, PTZ / Dome cameras and any other camera that is ONVIF compliant.
CTV Architecture shall ensure even if the VMS and recording server fails still operator client in C4 shall be able to see live and Camera Playback.
VMS shall facilitate situational awareness of the on-ground condition at Integrated Command Control Centre or any other viewing 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 at a later time CSCL requires an integrated security solution that includes a command and control style operator console; a Linux/ RHEL/ Unix/Windows based Video Management Software (VMS) system, standard and high definition IP-based cameras, and system should meet the following requirements:

1. The VMS shall be based on a true open architecture that shall allow the use of nonproprietary workstation and server hardware, non-proprietary network infrastructure and non-proprietary storage. The software OEM should have its own development and/or customization centre in India so that customization as per user requirement can be done as and when required. The Software OEM with Indian Intellectual Property will be preferred due to highly sensitive security requirement.
2. The VMS shall integrate cameras using dedicated driver or using the industry standards ONVIF Profile S and Profile G.
3. The Security application shall offer a complete and scalable video surveillance solution which allows cameras to be added on a unit-by-unit basis. The database shall support more than 25000 cameras / IP endpoints in a single Hardware machine. VMS should support both Windows and Linux operating system on Server machine. It should support Windows or Linux OS on Client machine, independent of what operating system is there in the servers.
4. The Proposed VMS Solution Shall support native Failover with in application with no dependency on any external application for both hardware and application redundancy.
5. The Failover and Fallback management and recording Server shall be on hot standby, ready to take over during the primary management server fails. No manual action from the user shall be required.
6. The system shall support automatic failover for recording servers. The allocation of Cameras to recording servers shall be done automatically by the VMS in a load balanced manner. On failure or any particular Recording server, the cameras associated with the failed server should be automatically distributed across all the active servers without any human intervention. When the failed server becomes active, the cameras will be automatically allocated to the server again without any human intervention. There shall not be any need to deploy a

dedicated redundant server for this purpose. VMS shall support Failover against temporary disconnection of DBMS Service, without any loss of camera video. As soon as the DBMS service resumes, all data should automatically be stored to Database.

7. VMS should support open source DBMS, e.g., Postgre SQL, MySQL besides MS SQL.
8. The Application shall offer a plug and play type hardware discovery service with the following functionalities:
   a) Automatically discover Video surveillance units as they are attached to the network.
   b) Discover Surveillance units on different network segments, including the Internet, and across routers with or without network address translation (NAT) capabilities.
9. The Application shall have the capacity to configure the key frame interval (I-frame) in seconds or number of frames.
10. The Application shall allow multiple recording schedules to be assigned to a single camera.
11. The Application shall support Direct Multicast from Camera. For network topologies that restrict the Application from sending multicast UDP streams, the application shall redirect audio/video streams to active viewing clients on the network using multicast UDP.
12. The Application shall allow important video sequences to be protected against normal disk clean-up routines.
13. The application shall have the following options when protecting a video sequence: Until a specified date, for a specified number of days, indefinitely (until the protection is explicitly removed for evidence).
14. The application shall have the capacity to down-sample video streams for storage saving purposes. The down-sampling options available are the following:
    • For H.264, MPEG-4, and H.265, streams the down-sampling options are: all key frames, 1 fps, 2 sec./frame, 5 sec./frame, 10 sec./frame, 15 sec./frame, 30 sec./frame, 60 sec./frame, 120 sec./frame.
15. The application shall support edge recording capabilities with ability to playback the video recorded at different speeds and ability to offload the video recorded on the application server on schedule, on event, or manually to store it on the recording server.

13.4.2. Human Machine Interface (HMI)

2. The VMS shall allow the user the ability to define a homepage to be displayed in the local workstation.
3. The homepage shall include a specific layout of video panes and preselected cameras either in live or playback modes.
4. The DVMS shall enable the user to select switching to previously displayed views, where a view contains both the layout and the channels played on that layout.
5. The VMS shall allow the Camera to be searched by camera IP address or camera name in client camera tree.
6. The user shall be able to change the font size of Camera Navigation tree as required. The Monitoring UI shall fulfill the role of a Unified Security Interface that can monitor various Video, ALPR, and other system events and alarms, as well as view live and recorded video.
7. To enhance usability and operator efficiency, the Monitoring UI shall support the following UI concepts:
   (a) Dynamically adaptive interface that adjusts in real-time to what the operator is doing.
   (b) A dynamic dashboard loaded with entity-specific widgets (e.g. door and camera widgets).
   (c) Use of transparent overlays that can display multiple types of data in a seamless fashion.

(d) Consolidated and consistent workflows.
(e) Tile menus and quick commands easily accessible within every display tile of the user workspace.

7. Single click functionality for reporting and tracking. The Monitoring UI shall support both single-click reporting for various system elements. Single-click reporting or tracking shall create a new task with the selected entities to report on or to track.

13.4.3. Health Monitoring

1. Health monitoring module shall allow for continuous monitoring of the operational status and event-triggered alarms from servers, cameras and other devices.
2. The health monitoring module shall provide a real-time overview of alarm status or technical problems while allowing for immediate visual verification and troubleshooting.
3. Health monitoring modules should provide interface & navigational tools through the client including graphical view of the operational status & alarms from the servers, network cameras & other external devices including motion detectors & access control systems.
4. Intuitive navigation using a map based hierarchical structure with hyperlinks to other maps, servers & devices or through a tree view format.

13.4.4. Operator Workflows

A workflow shall be a sequence of operations an operator or administrator shall execute to complete an activity. The “flow” relates to a clearly defined timeline or sequence for executing the activity.

The Monitoring UI shall be equipped with consistent workflows for various City wide elements like ANPR, RLVD & e Challan system.

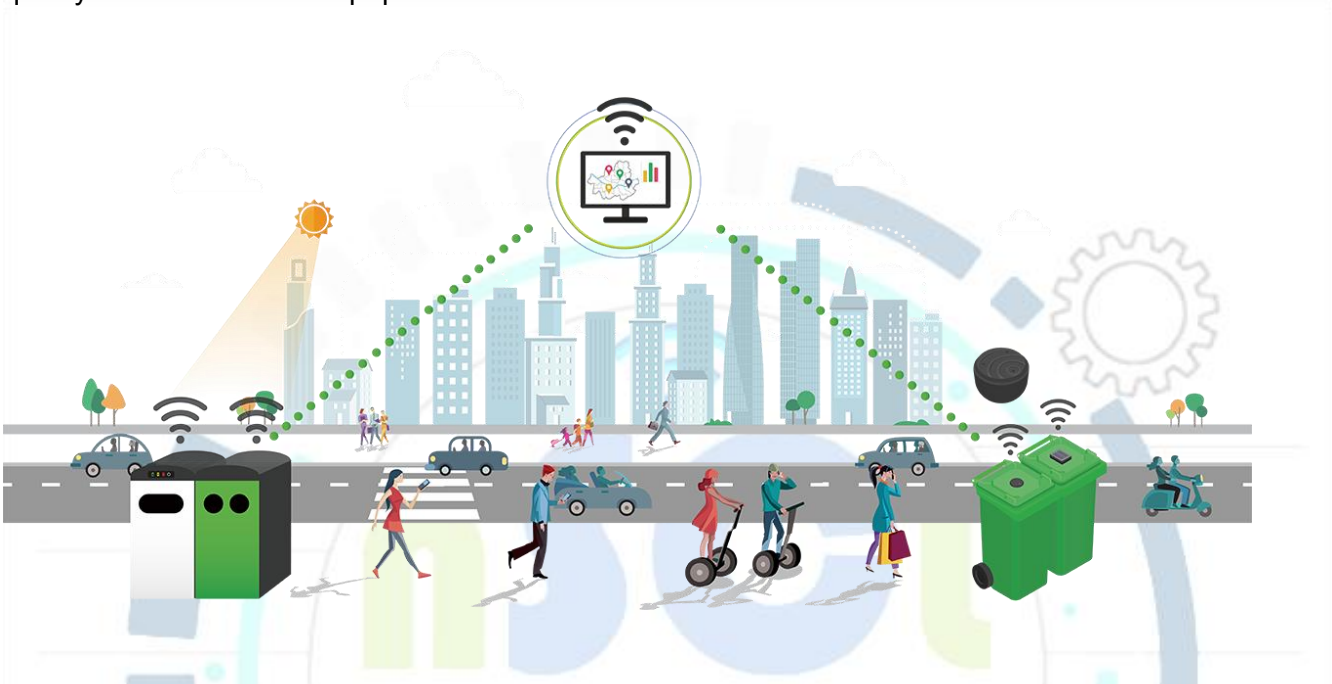
13.5. Use Cases - Surveillance

Sl. No	Use Case Title	Brief Description
1.	Vehicles with Video Surveillance & Video Tracking Systems	Video surveillance inside transport vehicles with vehicle tracking system
2	Women / Citizen Safety using smart phones / wearable devices	This use case describes specific handheld devices such as smart phone and/or wearable devices for personal safety, primarily for women. These handheld or wearable devices will generate alerts to a central control room during emergencies publishing GPS location data of the person
3	City-wide Video Surveillance Systems	City surveillance Cameras should be able to view traffic situations, accidents, and incidents with clarity along with other objects on road
4	Video Surveillance for Banks, ATMs, Jeweler Stores, and Similar Establishments	Surveillance is to prevent theft and unwanted intrusion, and sabotage during non-office hours and for internal security during office hours
5	Citizen Response Management System (CRMS)	Citizen Response Management System will be responsible for receiving emergency alerts, communicating with the user in distress and dispatching the patrolling vehicles, ambulances & fire brigade

14. Solid Waste Management (SWM)

14.1. Ideation

Under the “Swacch Bharat Mission” program, SWM or Solid Waste Management is now being encouraged, monitored and implemented very seriously on a National level to improve the “living quality index” of the urban population.



Solid waste management (SWM) has been a pertinent problem for Indian cities. The amount of solid waste that is produced daily goes beyond the institutional capacity of local governments to collect and dispose of efficiently, as revealed by several indicators.

Currently the Municipal Solid Waste (MSW) is one of the main urban lifestyle materials. The annual solid waste is about 1.3 billion tons, and it seems will rise to 4.3 billion tons by the year 2025, which will cover 50% of the general population worldwide. In addition, managing the waste collection process is one of the most complicated tasks in the urban habitat because, the amount of solid waste generated by residential and commercial-industrial sites are huge. Furthermore, the budget spent on the management of solid waste, which is equivalent to 50-70% is used for waste collection. Due to the high amount spent on collection, only a low amount is left for amelioration of the collection operation. The waste management cycle includes the generation of waste from industries, houses, markets etc.., from which the waste is thrown in the garbage bins or open places. This waste is further picked up by the municipal corporations to finally dump it in dumping areas and landfills. But due to lack of resources, ineffective groundwork, some waste is not collected which poses very serious health hazards to the citizens living in the surrounding environment. Proper cleaning intervals may provide a solution to this problem. But keeping a track of the status of the bin manually is a very difficult job. A smart waste monitoring and collection system is designed and developed to reduce the cost and the time of waste collection as well as to protect both public environment and public health and provide a safe and healthy life. Waste collection and monitoring by using new technologies such as Radio Frequency (RF), ultrasonic sensors, GSM/GPRS as well as Arduino, offer a new way to optimize the waste management systems. Recently, with expanding size of cities, the need for smart services arise such as smart and intelligent traffic, smart health care system, smart waste collection, smart

education, smart living, smart energy etc are more in focus. Many studies were carried out on the field of solid waste management, collection as well as monitoring. The importance of this impacts the environment and pollutants in the air, as well as create health related issues. Many researchers had given special guidance on different types of economical, technological and managerial challenges for the solid waste collection and management in developing countries. An application based on distributed sensor technology and geographic information system to be used in the monitoring of municipal solid waste has been proposed. Calculation of waste weight and volume, to be further used for optimizing routes of garbage collection vehicles and material density evaluation is the need of the hour. Another framework based on the integration of RFID and communication technologies such as GSM, GPRS, and GIS has been proposed. Theoretical framework and algorithm have been developed for successful hardware implementation. The information retrieved is stored for monitoring and management activities and a Graphical User Interface is presented for user interaction. Proposing a new architecture with the aim to improve the on-site handling and transfer optimization in the waste management process is of high importance. The system architecture is based on sensor nodes and makes use of Data Transfer Nodes (DTN) in order to provide a remote server to retrieve data measurements from the garbage bins. A remote monitoring solution has to be implemented, providing a user the possibility to interact with the system by using a web browser. Several activities with the aim to provide a Decision Support System have to be integrated to find solutions for resources organization problems linked to solid waste management.

A system is to be designed to monitor the solid waste bin condition on real time. The system architecture is to be designed using wireless sensor networks. A set of carefully chosen sensors are to be used to measure the status of the bins, ZigBee and GPRS are to be used as communication technologies. The physical architecture of the system must contain three levels such as smart bins, for the measurement and transmission of bin status, gateways for storing and forwarding bin data to server and control station for storing and analyzing the data.

Overall Objectives:

1. To implement a managerial solution for municipal waste collection operations to address lack of information about collecting time and area.
2. Lack of proper system for monitoring, tracking the vehicles that carry the waste.
3. Physical visit required to verify employee performance and weigh post station.
4. Transfer of Waste from Primary collection to secondary collection is done by vehicle transfer and improper coordination leads to missed trips and garbage piling up.
5. There is no quick response to urgent cases like truck accident, breakdown, long time idling etc.
6. To ensure efficient Solid Waste Management a GPS based Vehicle Tracking and Monitoring System (VTMS)

Specific Objectives:

1. Door to door collection tracking and monitoring system.
2. Door to door, waste tracking and monitoring: One of the primary objectives of the project is to track the locations of each household waste pickup and tipper vehicles movement.
3. Manage routes and vehicles dynamically through an automated system.
4. Do Route optimization which shall help in reduction of trip time, fuel saving and serving more locations.
5. Reduce the human intervention in monitoring process.
6. Keep history of vehicle routes, attended sites and other details.

7. Reporting of vehicles, garbage collected and other SWM details to higher authorities from any location at any time.
8. Monitor and track the activities of field staff force on daily basis.
9. Real time management of missed garbage collection points.
10. To ensure complete coverage of door to door and community collections.

14.2. Solution Requirements

1. MSI to provide End to End solution to procure, implement and provide support services and maintenance.
2. Implementation of "Door-to-Door collection monitoring system";
3. Supply and installation of RFID tags and readers.
4. Design and integrate Door-to-Door tracking and monitoring system.
5. MSI should provide Automatic Vehicle Locator solution to vehicles at primary (excluding pushcarts) and secondary collection points.
6. MSI should provide GPS based attendance management system to the staff.
7. SI should install Surveillance cameras at bulk waste generation points.
8. SI Shall provide an MIS System which shall be capable of recording the details of daily waste receipt, waste processed and waste disposed in terms of tonnage. The solution provided shall be automated by having a computerized weighbridge. The data shall be transmitted online to the CCC/CoC.
9. Integrating data feed from waste disposal site (data feed access would be provided by NSCL) like feeds from CCTV camera and Data from Weighbridge.
10. Sizing of Hardware, software and network devices required in the data Centers for using the Integrated SWM.
11. Supply & Installation of hardware (servers), software and network devices required in the data Centers for using the Integrated SWM.
12. Design, Development, Supply, Deployment & Implementation of Web Based Application software integrated with GPS, RFID devices, VTMS and complaint management modules.
13. Maintenance of RFID devices and after warranty period including the replacement of devices in cases of damage, new vehicle or any other change.
14. Maintenance of web based application for Integrated SWM., during and after warranty period.
15. Provide resources for support, maintain and administering the system.
16. Integration of ISWM with City Operation Centre.
17. Provide training to NSCL resources for operating the tracking system.
18. Obtain or create GIS mapping of households, commercial establishments, industries, Schools, Hospitals, Public Gardens, function Halls etc..

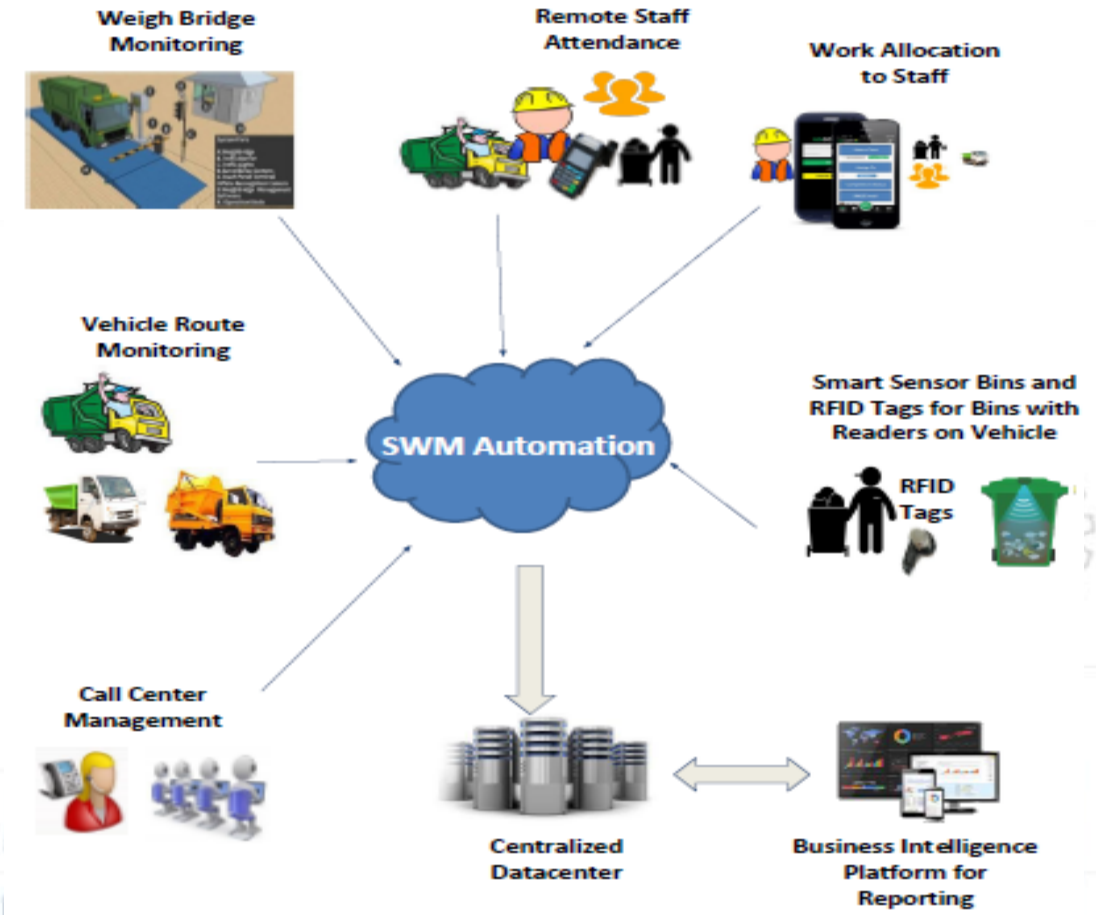
19. Provide training on the tracking system to the officials of NSCL.

Deployment Model and Solution architecture:

The solid waste management system is based on automatic information given by sensors installed on containers, trucks & temporary transit stations. Waste Management module collects all the data and processes it to obtain useful KPIs. Sikkim as a state has a different policy for waste collection that other states of India and hence the ecosystem consists of multiple stakeholders/components in the solution.

Solution Architecture

The deployment architecture of the entire solution is given as below.



NAMCHI SMART CITY LIMITED

14.3. Functional Specifications

14.3.1. Automated Vehicle Locator Management System

1. GPS tracking of the waste pick up vehicle for real time tracking.
2. System should help in coordination between primary and secondary collection vehicles for transferring dump.
3. Route Optimization will help in reduction of trip time, fuel saving and serving more locations.
4. System should ensure that complete coverage of door to door and community collections served by vehicles.
5. Record history of vehicle routes, attended sites and other details.
6. Monitoring & Reporting Application-reports of vehicles, garbage collection status, bin status etc.
7. Ensure complete coverage of door to door and community collections served by vehicles
8. Alert / Alarm management
   (a) Real time management of missed garbage transfer
   (b) Daily report of Door-Door Collection efficiency combined with complaints raised by Public.
9. Solution should be integrated into the GIS map provided by NSCL.

14.3.2. Mobile GPS based Staff Attendance Management System

GPS based device with RFID receiver shall enable Authority's field staff to register their attendance/presence throughout the day. The system shall periodically track the location (with time stamping)of the staff through their GPS based mobile device and shall map it in the system with the pre-defined area coordinates. The device shall feed the data through GPRS/GSM network to the city operation centre central application for reporting generation and alerts.

1. Provided to Staff who are doing activities like door-door collection via Pushcarts / Tricycle / street sweeping
2. Provide ability for the staff to update job completion reports along with pictures.
3. Pictures should be stored on historical mode in the GIS Map for a period of 1 week.
4. Solution should be integrated into the GIS map provided by NSCL.
5. Solution should be able to mark route attended by the staff along with the allocated route.

14.3.3 Mobile Application for Customers

MSI should develop a mobile application to be provided to the Public which will help them raise complaint for following:

1. Garbage Pile on the roads
2. Missed Garbage Collection at home / Industrial Area
3. Crowd sourcing application for complaint registration and grievances
4. Request for Garbage Collection

14.3.4 Unified Dashboard View for Solid Waste Management

1. A unified View should show the primary and secondary collection.
   (a) Included all vehicles tracked via AVL or Mobile based.
   (b) Collection Percentage achieved daily –co-relating with the final dumping processes
   (c) Correlation with the complaints raised / Area, along with photographic evidence
2. System should be capable of providing missed collection
3. System should be capable of marking areas where waste is generated or high to low basis
4. System should be capable of showing only a single selected process for a particular area
5. System should be capable of showing complaints raised by citizen tagged to a particular location.
6. System should be capable of showing CCTV footages from bulk waste generation points and inside the waste treatment plant on the GIS map
7. System should be capable of showing real time data from the load cell placed in the Waste Treatment Facility
8. Unified view should be capable of being integrated with other departments
9. 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 SI.

14.3.5 Infrastructure Requirements

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

(a) GPS Tracking System with all fittings & fixtures in all the vehicles
(b) GPS based mobile attendance management.
(c) CCTV Cameras at Waste Processing Site and at bulk waste generation points
(d) RFID tags at households
(e) RF tags on collection vehicles
(f) Automated Weighbridge

Type of Vehicle	
Auto Tipper (Primary Collection)	GPS Tracking System
Push Carts + Tricycle (Primary Collection)	Tracking via GPS Based Attendance System
Twin Dumpers (Secondary Collection)	GPS Tracking System
Tipper (Secondary Collection)	GPS Tracking System
Tractor (Secondary Collection)	GPS Tracking System
Staff Sweeping Roads	Tracking via GPS Based Attendance System

The solution that will be proved by the selected MSI will have the below mentioned indicative functional requirements. However detailed functional requirement will have to be prepared by the selected SIs after the award of the project by carrying out a details requirement gathering activity with NSCL and other line departments:

Functionality	Integration required with
Map Based Requirements	
Creating buffers along the emergency site, working site. Creating & sending alerts in case SUB's reached at particular level for vehicle movement, which can be shown on the map	GIS Vehicle Tracking System
Area Details	
Area information (Zone / Ward / Colony / Society) Population details Volume of the Solid waste which includes Wet & Dry waste (Recycled & Non Recycled) Resources required Collection procedure (i.e. Primary : House to House & Secondary : Community Bin to Garbage transport centre or mix)	GIS RFID
Garbage Collection Scheduling	
Assign SWM Vehicles to pick-up the Garbage. Category wise assignment like A: Highly in demand, B: Medium, C: Low Demand. Assignment of dynamic routes using the vehicle initial route and bins attended. Location-wise assignment of Sanitation Staff Scheduling of garbage collection and cleaning activities with the objective of maximizing citizen friendliness on the one hand and optimum use of resources on the other.	GIS GPS RFID
Primary / Secondary Garbage Collection Schedule	
Record the volume of garbage collected and disposed on a daily basis. Keeping certain Checks as per environmental regulations, like minimum frequency of lifting garbage etc.	GPS RFID
MIS	
Monitor the deployment of pickup trucks and personnel based on the schedule originally drawn. Info on the use of Transfer Stations. How much garbage received?	

Door to door collection, ward wise. Dashboard for all activities Reports of Ward Wise Weight Reports. Energy production report Any other custom report as per department	

15. Technical Specification

15.1 GPS/GSM Tracker

Sl No	Parameter	Minimum Specifications or Better
1	Weight	Should Be Lightweight.
2	Housing / Casing	Aluminium Or Fibre Case. No Plastic
3	Operational Temperature	-25 ~ 70
4	Storage Temperature	-40 ~ 80
5	Power Consumption	<1 W (60ma ~ 100ma)
6	Backup Power	24 Hrs Minimum.(In Ideal Mode) Built-In
7	Input Voltage	10 ~ 30v
8	Frequency	L1,1575.42 MHz
9	Protocol	Nmea 0183 V2.2
10	Channels	20
11	Flash	4mbit
12	Sensitivity	Tracking: -159dbm
13	Cold Start	42 seconds, Average
14	Warm Start	38 seconds, Average
15	Hot Start	1 Second, Average
16	Re-acquisition	0.1 Second, Average
17	Accuracy	Position: 10 meters, 2d Rms, 5 meters, 2d Rms,Waas.Enabled Velocity: 0.1 M/S. Time: 1us Synchronized To Gps Time
18	Frequency Bands	Sim 340 Quad-Band: Gsm 850,Egsm 900,Dcs 1800,Pcs 1900. The Band Can Be Set By At Command, And Default Band Is Egsm 900 And Dcs 1800 ,Compliant To Gsm Phase 2/2+
19	Temperature Range	Normal Operation: -20 To +55. Restricted Operation: -25 To -20 And +55 To +70. Storage Temperature -40 To +80.

20	Data GPRS	GPRS Data Downlink Transfer: Max. 85.6 Kbps. GPRS Data Uplink Transfer: Max. 42.8 Kbps. Coding Scheme: Cs-1, Cs-2, Cs-3 And Cs-4 Sim340 Supports Protocols PAP (Password Authentication Protocol) Usually Used For PPP Connections. Sim340 Integrates TCP/IP Protocol. Support Packet Switched Broadcast Control Channel (Pbcch) Csd Transmission Rates: 2.4, 4.8, 9.6, 14.4 Kbps, Non-Transparent Unstructured Supplementary Services Data (USSD) Support.
21	SMS	Mt, Mo, Cb, Text And Pdu Mode Sms Storage: Sim Card Support Transmission Of SMS Alternatively Over csd Or GPRS. User Can Choose Preferred Mode.
22	Sim Interface	Supported Sim Card: 1.8v ,3v
23	Two Serial Interfaces	Serial Port 1 Seven Lines On Serial Port Interface
24	Sim Application Toolkit	Supports Sat Class 3, GSM 11.14 Release 98.
25	Real Time Clock	Implemented
26	Timer Function	Programmable Via At Command
27	Firmware Upgrade	Firmware Upgradeable Over Serial Interface
28	Internal Battery Cum Charger	Li-Ion Battery With Minimum 08 Hrs Backup When Idle And 04 Hrs When Continuously Used. With Appropriate Charger To Be Charged From vehicle Battery
29	Certification	Minimum IP65 & ARAI Certification

15.2 RFID Tag and Reader

Sl No	Parameter	Minimum Specifications Or Better
1	Type	ABS, High Quality Engineering Fiber. UHF, Passive RFID Tag
2	Supported Transponders	ISO18000-6C EPC Class 1 GEN2
3	Frequency Range	ISM 865~928 MHz
4	Operation Mode	Fixed Frequency or FHSS Software Programmable.
5	Memory capacity	The tag should support ISO18000-6C protocol standard 2K Bits storage capacity, 1728 Bits (216 bytes) writable user area; MR6730B metal supports EPC C1 GEN2 (ISO 18000-6C), with 96 Bits writable EPC Code area, 512 Bits writable user area, and 32Bits password area, EPC 128 bit user 512 bit TID 96 bits.
6	Reading Rate	Software Programmable, Average Reading per 64Bits <10ms.
7	Tags material	Metal material with Fiber Housing
8	Reading Range	Be able to be calibrated.(to be kept as 2-4m max) based on the site visit.
SL No	Parameter	Minimum Specifications Or Better
9	Operation Temp	-35°C to 85°C.
10	IP Classification	IP 68
11	Weather	Heat, dust proof, UV resistant & sea water resistant.
12	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

15.3.4 RFID Reader Specifications

Sl No	Parameter	Minimum Specifications Or Better
1	Protocol	ISO18000-6C EPC GEN2. Configurable for mixed or single tag-type operation. Air interface software on IV7 is downloadable to add Gen 2 and Class 1 air interfaces and to "future-proof" the product as standards evolve and new features become available.
2	Frequency Range	Standard ISM 902 928MHz or 915 MHz (US FCC), 865 MHz (ETSI 302-208), and 869 MHz (ETSI 300-220)
3	Operation Mode	FHSS
4	RF Power	0~30 dBm, software adjustable
5	Reading Speed	Software Programmable Average Reading per 64Bits <6ms.
6	Reading Mode	Timing or Touch, Software Programmable (reading should be such that the reader does read two tags at a time)
7	Communication Mode with central server.	TCP/IP and GPRS or higher.
8	Data Input Port	Trigger input one time.
9	Reading Range	Max 12 m(able to calibrate)
10	Communication Interface	RS232
11	Accessories	Vehicle-mount DC power cable kit Antennas, and antenna cables.
12	Environmental Rating	IP65.
13	Humidity	10% - 90%g1g.
14	Shock and Vibration Protection	Withstands standard material handling vehicle environments. Meets or exceeds MIL STD 810F
15	Operating Temperature	-25°C to 55°C (-13°F to 131°F)

15.3. Pan Tilt and Zoom – based Cameras CCTV

Sl No	Parameter	Minimum Specifications Or Better
1	Video Compression	H.264 or better
2	Video Resolution	1920 X 1080
3	Frame rate	Min. 25 fps
4	Image Sensor	1/3" OR ¼" Progressive Scan CCD / CMOS.
5	Lens	Auto-focus, 4.7 – 84.6 mm (corresponding to 18x).
6	Minimum Illumination	Colour: 0.5 lux, B/W: 0.1 lux (at 30 IRE).
7	Day/Night Mode	Colour, Mono, Auto.
8	S/N Ratio	≥ 50dB.
9	PTZ	Pan: 360° endless/continuous, 0.2 to 300°/s (auto), 0.2 to 100°/s (Manual)

		Tilt: 90°, 0.2 to 100°/s (Auto), 0.2 to 40°/s (Manual) 18x optical zoom and 10x digital zoom 16 preset positions. Auto-Tracking; Pre-set tour.
10	Auto adjustment + Remote Control of Image settings	Colour, brightness, sharpness, contrast, white balance, exposure control, backlight compensation, Gain Control, Wide Dynamic Range.
11	Protocol	HTTP, HTTPS, FTP, RTSP, RTP, TCP, UDP, RTCP, DHCP,SNMP
12	Security	Password Protection, IP Address filtering, User Access Log, HTTPS encryption.
13	Operating conditions	0 to 50°C
14	Casing	NEMA 4X / IP-66 rated
15	Certification	UL / CE / FCC / EN
16	Auto Detection & Configuration	The camera should be automatically discovered and configured when connected to VMS or Network Switch, to set the right network parameters for the video stream on the network.
17	Activity detection	Camera should support User- definable alerts with configurable sensitivities and thresholds, email alert, and HTTP notifications. Camera should also support for IEEE 802.1X authentication.

15.4 Use Cases (SWM)

Integration of Solid Waste Management Services

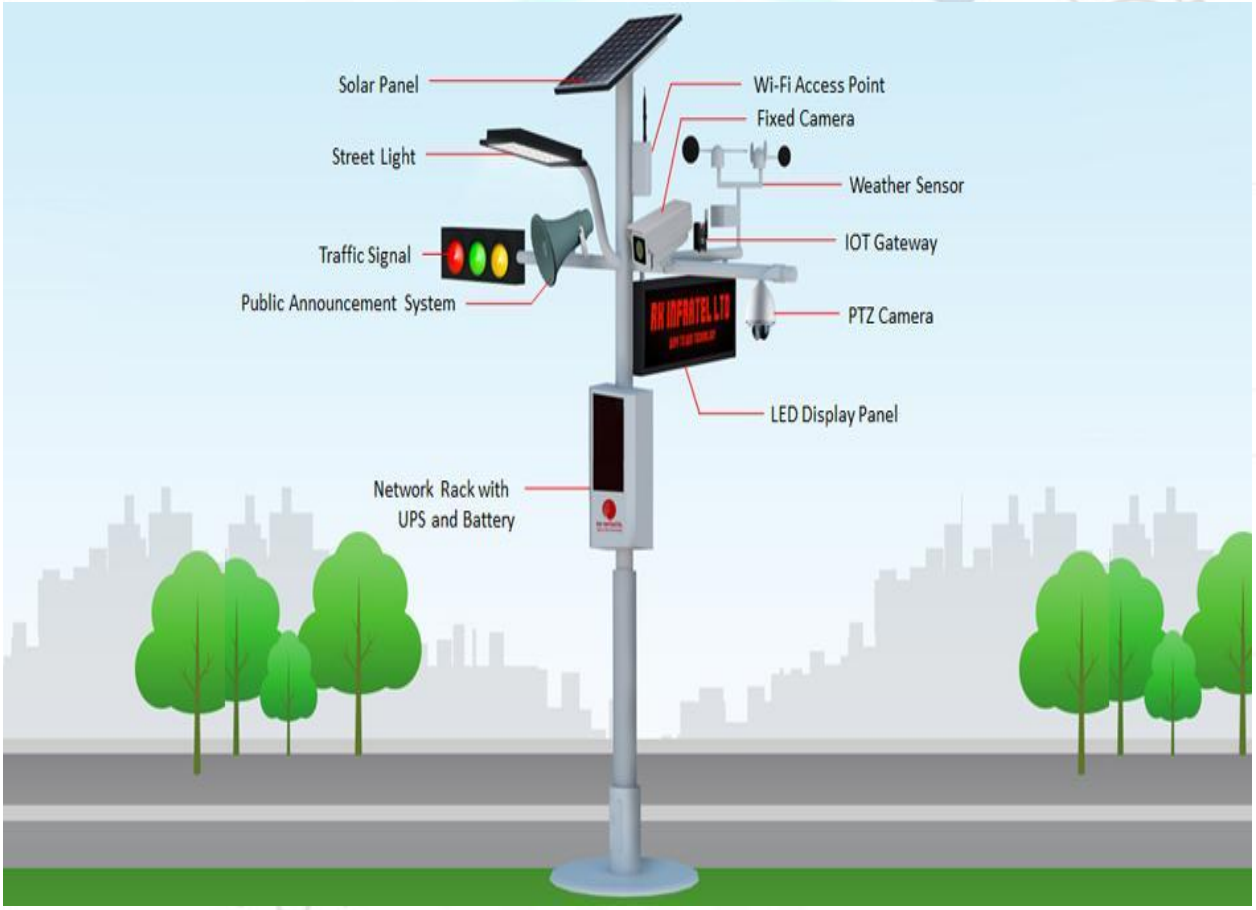
1. C4 will be required to integrate with the central application of Solid Waste management project
2. All the information received will also be required to be mapped on the GIS map.
3. All the information received from the command center shall also go into the Analytical layer which will help city in better planning and running of operations.
4. C4 should also be able to trigger the commands / alerts (if required) to the respective command center
5. C4 should have following features but not limited to :
6. View waste related grievances on the city map. The view should allow the facility to change the time scale from 1 hr. to 1 year, with daily, weekly, monthly, quarterly and yearly views available.
7. View the feeds received from E-governance system on the city map
8. View movement of Garbage pickup vehicles on the city map
9. View the feeds received from Solid Waste Management system on the city map.
10. Monitor real-time bin status zone and ward wise – Future requirement
11. View Reports generated by Solid Waste Management System
12. View Incidents reported on solid Waste Management System

16. Smart Pole with Environment Sensors

16.1 Ideation

A Smart Pole or Intelligent Pole will be an Integrated pole having the following components:

1. Environmental Sensors.
2. Public Address System.
3. Variable Messaging System
4. Digital Billboards
5. Panic Button.
6. CCTV Cameras.
7. Public Wi-Fi



In an endeavor to create a safe living city, the concept of an Intelligent Pole or Smart Pole will carry all the above components.

1. **Environmental Sensor**; To provide better air quality to the citizens and should be have the following capabilities :
   (a) They should be ruggedized enough to be deployed in open air areas on streets and parks.
   (b) They should be able to read and report at least the following parameters
      i. Temperature
      ii. Relative Humidity
      iii. Ambient Light

iv. Noise
v. CO
vi. NO2
vii. So2
viii. O3
ix. PM 2.5
x. PM 10
xi. UVa
xii. UVb
xiii. CO2

(c) Sensor should be able to communicate its data using wireless technology(GSM/WIFI

(d) Data should be collected in a software platform that allows third party software applications to read that data.Data Buffer Capacity up to 3 years

(e) Data Capture Frequency –30 seconds

(f) Li-Ion Battery Backup of 4 hours

(g) Aesthetic & Elegant Aerodynamic design

(h) Stabilization Time on power outages < 10 minutes

(i) LEDs on the enclosure for easy visual indications

(j) Software Solution

i. Solution to enable APIs for mobile & Web services
ii. APIs to provide
   - Status of Devices
   - NAQI Colour Scheme as per NAQI, India
iii. Lead pollutant contributing to NAQI
iv. Architecture to support computation of new parameters such as
   - Now Cast NAQI
   - Zonal Limits of pollutants if any
v. Data Analytics
   - Lead pollutants, trends & Source level apportionments
   - Integration and analysis of various northbound APIs including traffic / parking & Environment to derive insights.
vi. The sensor management platform should allow the configuration of the sensor to the network and also location details etc.

2. **Public Address System**; To ensure citizens and road users are periodically informed of safety norms & other information.
3. **Variable Messaging System (VMS)**; Communication to the public via sign boards has become important for displaying information. Information could range from
   - Bus Arrival / Departure
   - Traffic Blocks
   - Environment Sensors
   - Other general updates to the public
4. **Digital Billboards**; As a part of the beautification of certain specific locations, MSI will provide smart poles having digital billboards which could house telecom base stations of 2G/3G/4G

and WI-FI. It shall be possible to change the advertisements /Messages in these digital billboards from a centralized location. To provide visual information about various schemes or policies of the Government being implemented for the welfare of the citizens of Namchi Municipal Council.

5. **Panic Button**; In the event of Emergency, distress, citizens could reach the pre-defined support centre for getting support through panic buttons mounted on smart poles. Panic buttons to be strategically located, suitably sized and identified/clearly labelled for "Emergency". Once pressed will send a call to the nearest police station or Quick Response Team to assist citizens of Namchi Municipal Council.
6. **Public Wi-Fi**; To provide internet facility at public places to the citizens of Namchi Municipal Council by setting up Wi-Fi hotspots at Smart Bus Shelters and Intelligent Poles.

16.2 Solution Requirements

1. Environment Sensor: MSI would setup environmental sensors at all the poles and shall also integrate already existing air quality monitoring station APPCB if it exists.
2. PAS: SI should install PAS. Each junction point should have 2 Speakers and should confirm to the technical specifications mentioned in the document.
3. Digital Billboards: SI to consider poles and bus shelters in the City of Namchi Municipal Council for providing digital information panel.
4. Panic Buttons: The number of Panic Button will be mounted on intelligent poles or if not feasible to be installed separately in close vicinity to the smart pole.
5. CCTV camera: To be deployed on each intelligent pole.
6. VMS: To be deployed on each intelligent pole and bus shelters.
7. Wi-FI:

(a) The SI is responsible for setting up of Wi-Fi Hotspot including supply installation and O&M of all the required hardware and software as per the technical specification and scope of work.
(b) Detailed list of locations along with the no. of Access points at each location will be shared with the successful SI.
(c) System should support features such as user authentication, access etc. through OTP (One Time Password) on mobile no. & email. It should be capable to put a cap on the user session and amount of data consumed which shall be 200 mb/day, regulate bandwidth besides allowing users to buy in the extras usage access, if desired by NSCL.
(d) Thereby it shall be required to be integrated with SMS Gateway along with a payment gateway and centralized billing mechanism.
(e) The proposed solution should be inclusive of all the components like WLAN Controller, Authentication, Authorization and Accounting (AAA), RADIUS, SMS Gateway, Payment gateway.
(f) The proposed solution should be fully secured and as per WPC regulations/guidelines. SI is responsible for keeping log of users by storing minimum required information like Phone No, MAC & IP addresses, access time, duration, data consumed etc.

(g) The proposed solution should allow firmware/ patch upgrade and monitoring from a central location.

16.3 Functional Specifications

16.3.1 Environment Sensors

1. The MSI should ensure that the Environmental sensors cover 3 zones as per the Pollution Control Board of India norms. Namely, (a)Sensitive Zone, (b) Industrial zone & (c) Residential/commercial zone.
2. Smart environment sensors should gather data about pollution, ambient conditions (temperature and humidity), levels of gases in the city (pollution) and any other events on an hourly and subsequently daily basis. User should be able to set the schedules as per requirements. It is for information of citizens and administration to further take appropriate actions during the daily course / cause of any event.
3. The environment sensors should be having the following capabilities:
   (a) They should be ruggedized enough to be deployed in open air areas, on streets and parks.
   (b) They should be able to read and report at least the following parameters: Temperature, Humidity, Ambient Light, Sound, Pressure, CO, CO2, NO2, O3, SO2 and compulsorily PM 2.5 and PM 10 Noise and UV.
4. The analyzers must function properly in all conditions without any defect between 0 to 50 degrees C, ambient temperatures, 0 ambient dust levels. The data capture rate should not be less than 90%.
5. The manufacturer of the Equipment should assure technical support for the equipment for the duration as indicated in the scope.
6. Smart environment sensors will inform and enable citizens and administrators to keep a check on their endeavors which impact environment and enable the city to take remedial action if required. These environmental sensors can also be connected via 3G or 4G wireless network or Wi-Fi networks.
7. The data should be collected in a software platform that allows third party software applications to read that data. Various environment sensors shall sense the prevailing 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. It is preferred if the platform also includes intelligent analytical engines that makes information meaningful to all stakeholders and helps ease decision making.
8. Integration of environmental monitoring system with Variable messaging system to be displayed wherever possible.
9. The sensor management platform should allow the configuration of the sensor to the network and also location details etc.
10. The sensors should be able to be managed and calibrated remotely. This includes sensors being updated with calibration parameters, software upgrades. Sensors must also provide updates and detect faults with self-diagnosis functionality.

11. 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.
12. Any hardware failure should trigger alarm and generate an event that should be linked with the incident management system automatically and should be capable to schedule the automation of sending the failure report to the vendor.
13. The sensors provided should to 99% accurate and should be of industry standards.
14. 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.
15. Calibration system should be provided for the calibration of the air quality analyzers, data acquisition system.
16. The data collected should also be available on permitted mobile devices as necessary.
17. Real time or averaged data can be viewed quickly and easily client interface on the central computer.
18. It should have a feature for viewing instantaneous and historical data in the form of tables and graphs either locally or from a remote client.
19. Generation of reports for pollution load, wind etc should be available.
20. Alarm annunciation of analyzer/sensor in abnormal conditions in the control center so that appropriate action can be taken by authorities.
21. The environmental sensors should be visible as a layer in GIS Maps.
22. The data should be collected in a software platform that allows third party software applications to read that data. Various environment sensors shall sense the prevailing 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.
23. SI can also make use of the nearby Variable messaging displays wherever possible (need to be finalized post detailed survey of locations).
24. The sensor management platform should allow the configuration of the sensor to the network and location details etc.

16.3.2 Public Address System (PAS)

1. Public Address System (PA) should be capable of addressing citizen at specific locations from City Operation Center / CCC.
2. The proposed system shall contain an IP based announcing control connected to the City Operation Center / CCC.

3. Public Address system shall be used at intersections, public places, marketplaces or those critical locations as identified by SI during implementation, to make important announcements for the public.
4. 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 & Pen drives for public announcements.
5. The system shall contain an IP based amplifier and uses PoE (Power over Ethernet) 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 & keypad, Amplifier (Mixing & Booster).
6. PA system's master controller should have function keys for selecting the single location, group of locations or all locations, simple operation on broadcasting to any terminal or separated simple operation on broadcasting to any terminal or separated.
7. PA system's master controller should facilitate multiple MIC inputs and audio inputs.
8. SI shall describe in detail the design, operational and physical requirements of the proposed public announcement system to demonstrate compliance with all the specified requirements.

16.3.3 Variable Messaging System (VMS)

1. SI should setup VMS at identified locations. VMS would be used in two different verticals:
2. Passenger Information System at bus terminal.
3. Information System at smart polls.
4. SI should integrate VMS with the appropriate system to display the information.
5. Variable Message Sign Board (VMS) shall be installed at identified strategic locations. The locations would include traffic junctions, bus stops.
6. The VMS shall communicate information & guidance about traffic, diversions, bus arrival information etc. They shall also be used for showing emergency/ disaster related messages as and when required.
7. MSI shall describe in detail the design, operational and physical requirements of the proposed Variable Message Sign Boards to demonstrate compliance with all the specified requirements.
8. The VMS unit shall be able to communicate with the Command Control Centre system using GSM Data.
9. GSM data channel (GPRS) shall be used to send online messages and SMS channel shall be used to send configuration packets to configure the SIM.
10. Each unit shall be provided with a unique identification number and shall communicate with the Command Control Centre/CoC.

11. VMS shall be managed and operated from the Command Control Centre/CoC handled by a server where information in the form of data messages shall be fed in a manner to be displayed on a specific VMS installed at a particular location or across all locations.
12. Distance of view ability shall be finalized during the time of feasibility study.

16.3.4 Digital Billboard

NSCL will have rights for usage of advertisement display boards for a minimum of 20 minutes per hour per day. Further, NSCL may step in for displaying new/information for public convenience in case of any natural calamity, emergency etc.

16.3.5 Panic Button

SI will have to provide the Panic Button on Intelligent poles. These buttons will enable citizens to establish a two way audio (microphone and speaker) communication link with operation staff at City Operations Center (or other locations where control solutions is deployed) through a press of a button.

16.3.6 CCTV Cameras for Surveillance

MSI will be required to deploy CCTV Cameras on the Smart Poles for surveillance.

16.4 Technical Specification

16.4.1 Environment Sensor

Parameter	Minimum Specifications / Or Better
Communication	3G/4G
Measurement Principle	Device should be capable of measuring; Temperature Humidity Ambient Light Sound/Noise Co CO2 NO2 NOX
Measurement Range as per the PCB of India	NO2 upto 10 ppm CO upto 100 ppm SO2 upto 2000 ppm O3 upto 1000 ppb PM 2.5 0 to 250 micro gms / cu.m PM 10 0 to 450 micro gms / cu.m Weather Parameters: Temperature 0 to 100 Deg. C Relative Humidity upto 100% Light upto 10,000 Lux Noise 40 to 120 db(A) UVa upto 15 mW/ cm2 UVb upto 15 mW/ cm2 CO2 upto 5000 ppm
RainWater Measurement	Rainfall in millimeters (mm), both in quantity and intensity.
Repeatability	±0.5% Full Scale
Zero Drift	±1.0% FS max./week (±2.0% FS/week max. if range is less than 200 ppm) ±2.0% FS max./month for O3 meter
Span Drift	±2.0% FS max./week
Response Speed	30 seconds max. for 90% response from the analyzer inlet.
Integration	CCC with the Environmental Sensor Application Server.

16.4.2 Public Address System (PAS)

Parameter	Minimum Specifications/Or Better
PAS System	Should have the capability to control individual PAS i.e. to make

	announcement at select location or multiple locations PAS Should support both, Live and Recorded Inputs.
Speakers	Minimum 2 speakers to be used in different locations. Minimum 200 watts of Amplification
Connectivity	IP Based
Access Control	Access control mechanism would be also required to establish so that the usage (including sound volume) is regulated.
Integration	CCC
Battery	Internal Battery with different charging options (Solar / Mains)A 24V battery power supply for emergency backup, with automatic switchover.
Power	Automatic On/Off Operation
Casing	IP-65 rated for housing

16.4.3 Digital Billboard

No	Minimum Specifications/ or Better
1	Smart Billboard should be able to house small cell or limited macro main remote telecom sites and site build solution with space for all necessary equipment and functions that radio sites in mobile networks require. This should be self - contained, Multi-application intelligent site that is aesthetically unique and functionally viable.
2	Height of smart billboard should be of 9-10 metro height.
3	It should provide Space for telecom equipment, should be able to support 2G, 3G, LTE, Wi-Fi, 5G etc.
4	It should have ability to house power plant and battery
5	It should have provision for incoming power input cables and fiber connectivity
6	It can be Floor or Ground Mounted
7	It should be Vandal Proof
8	It should have display of minimum 60 inch.
9	It should be Aesthetical & Camouflaged finish with respect to environment.

NAMCHI SMART CITY LIMITED

16.4.4 Panic Button

Parameters	Minimum Specifications / Or Better
Construction	Cast Iron/Steel Foundation, Sturdy Body for equipment
Call Button	Waterproof Push Button, Visual Feedback for button press.
Speaker/Microphone	Waterproof and industrial grade equipment.
Connectivity	GSM/PSTN/Ethernet as per solution offered.
Sensors	Against tempering/Vandalism
Battery	Internal Battery with different charging options (Solar/Mains)
Power	Automatic on/off operation
Casing	IP-55 rated for housing
Operating Conditions	0° to 55°C. High quality digital trans receivers to be placed at certain locations determined by NSCL

16.4.5 Wi-fi Hotspots at Public Places

SL No	Minimum Specification / or Better
1	Must be compliant with IEEE CAPWAP or equivalent for controller-based WLANs.
2	Should have at least 2 x 10 Gigabit Ethernet interface.
3	Should support both centralized as well as distributed traffic forwarding architecture with L3 roaming support from day 1. Should have IPv6 ready from day one.
4	Controller should have hot-swappable redundant power supplies.
5	Controller should support minimum 20,000 users per chassis
6	WLAN Controller must be a dedicated hardware appliance which should support minimum of 1200 Access points in a single chassis. Proposed controller should support 1+1/N+1 redundancy from day one.
7	Should be rack-mountable. Required accessories for rack mounting to be provided.
8	WLC should support AVC functionality on local switching architecture.
9	WLC should support AC and DC powering options.
10	Should support minimum 4000 VLANs.
11	WLC should support L2 and L3 roaming for IPv4 and IPv6 clients.
12	WLC should support guest-access functionality for IPv6 clients.
13	Should support IEEE 802.1p priority tag.
14	Should ensure WLAN reliability by proactively determining and adjusting to changing RF conditions.
15	Should provide real-time radio power adjustments based on changing environmental conditions and signal coverage adjustments.
16	Should support automatic radio channel adjustments for intelligent channel switching and real-time interference detection.
17	Should support client load balancing to balance the number of clients across multiple APs to optimize AP and client throughput.
18	Should support policy based forwarding to classify data traffic based on ACLs.
19	Should support minimum 500 WLANs.
20	Should support dynamic VLAN assignment.
21	Should support Hotspot 2.0.
22	To deliver optimal bandwidth usage, reliable multicast must use single session between AP and Wireless Controller.
23	Must support coverage whole detection and correction that can be adjusted on a per WLAN basis.
24	Must support RF Management with 40 MHz and 80 MHz channels with 802.11n & 802.11ac

25	Should provide visibility to Network airtime in order to set the airtime policy enforcement
26	Must be able to restrict the number of logins per user.
27	Should support web-based authentication to provide a browser-based environment to authenticate clients that do not support the IEEE 802.1X supplicant.
28	Should support port-based and SSID-based IEEE 802.1X authentication.
29	Should support MAC authentication to provide simple authentication based on a user's MAC address.
30	WLC Should support Rogue AP detection, classification and standard WIPS signatures.
31	WLC should be able to exclude clients based on excessive/multiple authentication failure.
32	Shall support AES or TKIP encryption to secure the data integrity of wireless traffic.
33	Should support AP location-based user access to control the locations where a wireless user can access the network.
34	Should support Public Key Infrastructure (PKI) to control access.
35	Must be able to set a maximum per-user bandwidth limit on a per-SSID basis.
36	Should support SNMPv3, SSHv2 and SSL for secure management.
37	Should support encrypted mechanism to securely upload/download software image to and from Wireless controller.
38	Should provide visibility between a wired and wireless network using IEEE 802.1AB Link Layer Discovery Protocol (LLDP) and sFlow/equivalent.
39	Should support AP Plug and Play (PnP) deployment with zero-configuration capability.
40	Should support AP grouping to enable administrator to easily apply AP-based or radio based configurations to all the APs in the same group.
41	Should support selective firmware upgrade APs, typically to a group of APs minimize the impact of up-gradation.
42	Must Support the application visibility from Layer 4-7.
43	Should have a suitable serial console port.
44	Should meet Gartner Magic quadrants criteria for Wired and Wireless LAN Access Infrastructure specified in Vol.1

Outdoor AP (Wi-fi)

Sl No	Specification
1	Access Points proposed must be 802.11ac, Wave 2 compliant, include radios for both 2.4 GHz and 5 GHz.
2	Must have -88 dB or better Receiver Sensitivity.
3	Must support 2X2 multiple-input multiple-output (MIMO) with two spatial streams
4	Must support data rates up to 860 Mbps on 5Ghz radio.
5	Must support 80 MHz wide channels in 5 GHz.
6	Must support WAP enforce load-balance between 2.4Ghz and 5Ghz band.
7	Must support up to 28dbm or higher of transmit power
8	Access point should 802.11ac, Wave 2 802.11n and 802.11a/b/g Beam forming
9	Support Encrypted and authenticated connectivity between all backhaul components
10	Access point should have multiple wired uplink interfaces including 10/100/1000BASE-T Ethernet auto sensing (RJ-45) and a build-in SFP port
11	Wireless AP should support beam forming technology to improve downlink performance of all mobile devices, including one-, two-, and three-spatial-stream devices on 802.11ac without taking the inputs from client.
12	Wireless AP Should able to detect and classify non-Wi-Fi wireless transmissions.
13	Must incorporate radio resource management for power, channel, coverage hole detection and performance optimization
14	Access point shall support pole, wall and Cable strand mounting options.
15	The equipment shall support up to 100 MPH sustained winds & 165 MPH wind gusts.
16	The Access point shall be IP65 or above.
17	The Access point shall support operating temperature of -30 to 55°C
18	The Access point shall support Storage temperature of -50 to 70°C

19	802.11e and WMM
20	WiFi Alliance Certification for WMM and WMM power save
21	Must support QS and Video Call Admission Control capabilities.
22	Must support Spectrum analysis including @ 80 MHz
23	Same model AP that serves clients must be able to be dedicated to monitoring the RF environment.
24	Should support mesh capabilities for temporary connectivity in areas with no Ethernet cabling.
25	Must support 16 WLANs per AP for BSSID deployment flexibility.
26	Must support telnet and SSH login to APs directly for troubleshooting flexibility.

NSCL
NAMCHI SMART CITY LIMITED

16.4.6 CCTV Cameras Type 1 - 360° Panoramic Camera

Sl No	Camera Characteristics	Description
1	General Requirements	Multi-view layouts: 360° surround views and multi-region client dewarped views, with Digital PTZ functionality.
2	General Requirements	Camera should be based upon standard components and proven technology using open and published protocols. Device functionality can be extended by installing and running applications directly on the camera, for example SIP client, video analytics, audio analytics, etc.
3	Image Sensor	1/2.5″Progressive
4	Lens Specs	Focal length: 1.5mm, Maximum aperture: F2.8
5	Resolution	Active Pixels 1920(w) x 1920(h)
6	Minimum illumination	Color mode: 0.6 lux Black/White mode: 0.01 lux, 0 lux with illuminator active, The infrared illuminator should light an area up to 33 feet (10 meters) away
7	Day/Night	Automatic, Manual, Scheduled
8	Image Compression	H.264 and Motion JPEG
9	Frame Rate	25fps for PAL mode
10	Local Storage	32 GB
11	Streaming	Camera shall be able to setup and stream out two (2) stream profiles.
12	White Balance	Auto /Manual
13	Wide dynamic range	70 DB
14	Shutter Speed	1/5 second to 1/32,000 second
15	Ethernet	10/100/ Base-T (RJ45)
16	Field of view	180° horizontal, 180° vertical, 180° diagonal
17	Protocols	TCP/IP, DHCP, HTTP, HTTPS, NTP, RTP, RTSP, SMTP, SSL/TLS, SRTP, CDP, Bonjour, SNMP, and SSH

18	Power Supply	Max 23W consumed with a PoE+ (802.3at-compliant) source
19	Security	Security Password protection, IP address filtering
20	Miscellaneous	Housing IK10 and IP66-rated Detection of camera tampering and Detection of Motion should be possible using camera Should support edge based audio analytics. ONVIF 2.X' or 'S' compliant. Certifications: UL, EN, FCC, CE
21	Certifications Safety	UL 60950-1 second edition CSA22.2-No.60950-1 IEC/EN 60950-1 second edition
22	Certifications EMC-Requirements	CISPR22 Class B ICES-003 EN50121-4 EN50155 EN50130-4 EN55022 EN55024 EN61000-3-2/-3-3 VCCI Class B KN22 Class B KN24 CISPR 24 AS/NZS CISPR 22 FCC CFR Title 47 Part 15 Subpart B

16.4.7 CCTV Cameras Type 2 - Fixed Box Camera

Sl No	Camera Characteristics	Description
1	Requirement Overview	High-definition IP Box Camera for outdoor
2	Sensor Type	1/2.7" Progressive Scan CMOS with additional digital signal processor (DSP) to support complex applications such as real-time video analytics
3	Max Resolution	1920x1080 @ 30fps
4	Dynamic Range	69 db
5	Lens/Iris	3.1-8mm-P-Iris

6	Audio I/O	Camera supports full-duplex audio and options for half-duplex operation. Should support Audio compression G.711 A, Law, G.711 U, Law, G.726, Audio in x 1
7	Digital I/O	(3.5-mm miniature jack) Audio out x 1(3.5-mm miniature jack) DI x 1 DO x 1
8	Max Illumination	Color: 0.3 lux B/W: 0.05 lux
9	Day/Night	Automatic, manual, scheduled
10	Local Storage	Should support Micro SD - Min 32GB
11	Video Compression & Video Streaming	Single stream H.264 or MJPEG up to 1080p (1920 x 1080) @ 30 fps Dual stream H.264 and MJPEG ◦Primary stream programmable up to 1280 x 720 @ 30 fps ◦Secondary stream programmable up to 960 x 544 @15 fps
12	ONVIF	Should support for ONVIF 2.0 allows for standards based interoperability
13	POE and External Power	12V DC, 24V Ac and PoE-802.3af compliant (Class 3)
14	Power Consumption (in watts)	Max 10 Watt at DC
15	Supported Protocol	Dynamic Host Control Protocol (DHCP), Hypertext Transfer Protocol (HTTP), Secure HTTP (HTTPS), Network Time Protocol (NTP), Real-Time Transport Protocol (RTP), Real-Time Streaming Protocol (RTSP), Simple Mail Transfer Protocol (SMTP),

		Secure Sockets Layer/Transport Layer Security (SSL/TLS), TCP/IP, Secure Real-Time Transport Protocol (SRTP), Bonjour, Simple Network Management Protocol (SNMP), and Secure Shell (SSH) Protocol. Differentiated-services-code-point (DSCP) marking and class-of-service (CoS) marking
16	Operating Temperature	14° to 122°F (-10° to 50°C)
17	Certifications Safety	UL60950-1 2nd edition CSA22.2-No.60950-1 IEC/EN60950-1 2nd edition IEC/EN60825
18	Certifications EMC-Requirement	CISPR22 Class B ICES-003EN55022EN55024 EN61000-3-2/-3-3 Class A VCCI Class BKN22 Class B KN24
19	Auto Detection & Configuration	Camera should be automatically discovered and configured when connected to VMS or Network Switch, to set the right network parameters for the video stream on the network.

NAMCHI SMART CITY LIMITED

16.4.8 Video Analytics for IP Box Camera

The required software and licenses need to be provided by the SIas part of this project. Video Analytics Platform transforms video surveillance systems into pro-active and intelligent tools, unifying privacy, security and operational efficiency.

TYPE 1 - Direction Violation

- Analyze motion in a specified area and triggers alarms when any motion is detected in a defined direction
- Analyze area, object size and direction can be configured in a point-and-click interface
- Administrator should be able to define minimum object size should be relative to the reference object size.
- System should provide grid-based analysis (using cues at multiple scales for analytics)
- System should use feature-based tracking algorithms to detect and analyze motion
- System should provide option to enable privacy feature. (Privacy feature should be certified).
- Accurate detection for several objects moving in the prohibited direction
- Detect vehicles that travel in an incorrect direction on one way roads
- Visualization should be provided as an MPEG4 RTSP stream
- System should support most security management systems via API –using metadata in XML or JSON format

- System should support internal SSL in order to prevent tapping or any other kind of IP-based manipulation
- System should support built-in video recording and encryption options
  Certificate with asymmetric encryption: 3DES (+ 1024 bit RSA)
  Decryption with chip cards in combination with PIN codes (four-eye-principle) or by entering transaction codes
- System should support video formats in any resolution (from CIF to Full HD and more): H.265 / H.264 / MPEG-4 / MxPEG / H.263+ / M-JPEG / JPEG 2000
- System should support automatic check of hard disk and server status as well as connections to cameras and triggers events by email if any problem is detected.
- System should support self-contained analytics modules. Support any particular stream to be processed by several modules.

TYPE 2–BROKEN DOWN VEHICLE/PARKING VIOLATION ON ROADS

(1) Detect any new object in the scene by comparing the current image to a background model
(2) System should provide grid-based analysis (using cues at multiple scales for analytics)
(3) Ability to do foreground detection based on edge detection rather than color
(4) System should support detection zone and perspective (near & far object size) to be configured on screen
(5) System should support an unlimited number of detection areas (each with its own zone and settings)
(6) System should monitor object size: little fluctuations should be ignored. The alarm conditions should be defined by relative object size (min and max) and minimum dwell time
(7) System should provide option to enable privacy feature. (Privacy feature should be certified).
(8) Visualization should be provided as an MPEG4 RTSP stream
(9) System should support most security management systems via API –using metadata in XML or JSON format
(10) System should support internal SSL in order to prevent tapping or any other kind of IP-based manipulation
(11) System should support built-in video recording and encryption options
- Certificate with asymmetric encryption: 3DES (+ 1024 bit RSA)
- Decryption with chip cards in combination with PIN codes (four-eye-principle) or by entering transaction codes.

(12) System should support video formats in any resolution (from CIF to Full HD and more): H.265 / H.264 / MPEG-4 / MxPEG / H.263+ / M-JPEG / JPEG 2000.
(13) System should support automatic check of hard disk and server status as well as connections to cameras and triggers events by email if any problem is detected.
(14) System should support self-contained analytics modules. Support any particular stream to be processed by several modules.
    a. Use Cases
(15) Integration of Smart Pole
(16) C4 will be required to integrate with central application of Smart Street Lights system of receive required feeds from the same.
(17) C4 will be required to get information on various parameters but not limited to, status of working of the installed LED lights, count of ON, OFF, DIM, FAULTY LED lights, each phase

voltage, current, PF of each phase, Cumulative kWh and kVAh as well as other parameters etc..

(18) C4 will be required to get information on all incidents and faults. System should also have the provision for sending alerts to relevant official.

(19) All the information received will also be required to be mapped on the GIS map.

(20) All the information received from the Smart Light central application shall also go into the Analytical layer which will help city in better planning and running of operations.

(21) C4 should also be able to trigger the commands / alerts (if required) to the respective command center.

(22) The C4 should have capabilities to send the control single or ability to control the light functions like ON, OFF and DIM from the C4 platform.

(23) C4 will be required to get information on the status of working of the installed LED lights, as well as other sensors and other cameras.

(24) C4 will also get real-time video feed from the installed Smart Poles.

17. Intelligent Transport System (ITS)

17.1 Ideation

As part of Namchi Smart City initiatives we intend to make public transport efficient by introducing following components.

1. Fleet Management System Public Buses, Local and Main Line Taxis
2. PIS at Bus Shelters to display Schedule of buses, Local and Main Line Taxis
3. PIS, Billboards, WIFI for Smart Bus or Taxi Shelters
4. Geo Tagging of bus routes through RF readers on bus stops and RF tags & GPS devices on buses, Local and Main Line Taxis.

The proposed solution gives ability to track, record, and analyze how vehicles are performing in real time. These features will lead to improvements in 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 the bus, the route followed etc. will be used to provide the passengers waiting at the bus stops with the expected arrival time of the bus. The information will be displayed on boards installed at the bus stops, inside bus, websites, mobile apps etc. The system should also help in improving the efficiency of bus operation by generating various standard and exception reports.

17.2 Solution Requirements

1. SI shall install GPS based Automated Vehicle Locator System (AVLS) in Buses, Local and Main Line Taxis (City buses, Local and Main Line Taxis) connected with CoC
2. SI would install VMS at the bus shelters
3. SI should integrate the AVLS on the GIS maps provided by NSCL
4. SI should also provide a Mobile / Web Site based information to passengers about the real-time location of bus.

17.3 Functional Specifications

17.3.1 Vehicle Location System & Passenger Information System

1. 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.
2. Ability to receive SOS and alerts from moving / stranded buses, Local and Main Line Taxis en route
3. Facility to track defined vs. actual movement of vehicles, capture deviations if any.
4. Facility to view vehicle movement in a real-time mode on GIS maps provided by Belagavi Smart City Limited.
5. Ability to provide dynamic location specific information as the vehicle approaches bus stop/station for the benefit of passengers
6. 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
7. 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
8. Facility for providing current information location on demand
9. It should enable operational managers to create locations, routes, schedules Vehicle service alerts for service and maintenance
10. Provide daily Maintenance Schedule, pending Insurance and pending Pollution Check status.
11. Vehicle fleet summary dashboard – quick view on vehicle fleet performance based
12. on fuel Consumption, it should provide average fuel consumed per kilometer
13. 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

14. Register a bus on unscheduled route from backend on real time basis.

17.3.2 PIS at Taxi and Bus Queue Shelter (TBQS)

1. The information of the buses, Local and Main Line Taxis such as Route Number, Bus Number, Origin, Destination and Estimated Time of Arrival (ETA) & Estimated Time of Departure (ETD) will be displayed in both Telugu and English
2. The PIS information will also be made available via SMS / Mobile App / Website
3. Each BQS shall have two number of display terminals.
4. The SI shall be responsible for Supply, Installation and Insurance of PIS. All spares required for the smooth operation of the ITS system shall be maintained by the SI for the entire duration of the contract.
5. The Display unit will query the COC
6. The Bus Stop Display, which receives all such information, will display continuously until the next set of data is received.
7. Technical Specification of PIS Bus Shelter shall be as per VMS.

17.3.3 Mobile Application

1. Real-time bus tracking system (Support 3rd party application provider)
2. Complete information on bus routes and stops to commuters
3. Real-time ETA for a combination of bus route and stop
4. Real-time tracking for the bus on the map
5. Mobile Application for IOS, Android and Windows mobile devices
6. SI shall develop mobile apps which shall include a mobile application to help passengers to get information about the buses, Local and Main Line Taxis, search and view bus schedules on various routes and deliver ETA based on their real time location.
7. System shall show the timetable of the buses, Local and Main Line Taxis, fare structure etc.

17.4 Module Wise Functionality Requirements

Module: Multi Fleet System

Functionality	Public Transport Requirements Served
Information about all running and idle vehicle with following information: Driver Name, Contact Number, Speed, Current Location, Schedule time to reach next destination, No. of trips till now, Current trip number, No. of Delayed trips, Current trip status	Multi-fleet systems: All-in and simultaneous management of several fleets. The sharing of resources (communications system, control center and human management resources) creates beneficial economies of scale. A section which enables user 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 center staff and management team of Public Transport Authority to take proactive Decision to manage Transportation operations ina highly efficient manner. Application development and customization of screens, forms, reports and queries of data specifically include: Locating a particular bus in the fleet Auto pan facility for tracking a particular bus Sending online messages to an individual bus or group of buses, Local and Main Line Taxis selected on a map
Route wise vehicle information	
Violations / Alerts / Incidents	
Fleet Summary	
Tracking and Monitoring: Bus Status (Running, Stopped, Ignition Off) Running Speed Route Source & Destination Stoppages Visited Current Location Stoppages to Visit Bus Identity, Route Identity and Name	Integration of GPS with digitized map for tracking of vehicles on a real time basis including distress messaging between the vehicle and the control station. To monitor whether the buses, Local and Main Line Taxis are adhering to its scheduled route and time table throughout the route and identify if there are any deviation. Real time two way messaging between buses, Local and Main Line Taxis & Central Control Room. To monitor whether the buses, Local and Main Line Taxis halt at all the scheduled bus stops. 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 Tracking Bus Actual Transit against Scheduled Transit	
Current Location & Time	
Transit Diagram and ETA	

Module : Report & MIS

Functionality	Requirements
Different Analytical, Revenue Management and Alert reports (Through Data received from legacy Revenue Collection System)	Generation of exception reports like deviation from schedule route, timing, Missing Bus stops, Punctuality factor etc. based on captured vehicle data Calculation of the actual distance (in Kilometers) travelled by the vehicle, using the map Reports: Speed Log Stoppage Log Summary Report Day Wise Summary Report Vehicle Wise Performance Day Wise Performance Vehicle Wise Statistics: Monthly Performance Alerts: Fleet Summary Vehicle Status Speed Violation Real-time application data delivery for PIS
Speed Log	
Stoppage Log	
Summary Report Day Wise	
Summary Report Vehicle Wise	
Performance Day Wise, Week Wise, Monthly	
Performance Vehicle Wise	
Monthly Performance	
Calculation of the actual distance (in KM) travelled by the vehicle using the digitized map.	
Depot Report	
Deviation from schedule route or timing.	

17.5 General Functional Requirement of the proposed 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. Systems will 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 & deletion of equipment's, nodes, stations, user groups, users
   - Reports Access
   - Configurable messages
6. The system will 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. The software will 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.
   - The replay data will include location and headway adherence data.
   - The 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.
   - The system will be able to store a playback in a format that can be exported for viewing on any computer.
   - The system will allow the ability to use playback without exiting from the current AVL operational view.
8. The software will be accessed on workstations and CCC/CoC of all users identified by NSCL. All communications and AVL data will be stored in a manner that allows direct access by the software for at least 120 days and reporting data for 18 months live in the system. SI will provide Utilities to support archive and restore functions for older data.
   - The system will only be accessible by authorized persons, controlled using login and password protection. Single Sign On will be provided for all modules in CCC/CoC.
   - The 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. The system will allow selection of any time for the historical data. All data will be the property of NSCL and will be immediately available to NSCL.
10. The central system shall be delivered with a fully functioning Graphical User Interface.
11. The 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. The 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 SI 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, subsystems 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. The web-based system and all the equipment (on-board equipment, PIS displays in stations etc.) will all 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.
23. The 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. The central software will be scalable to accommodate for buses, Local and Main Line Taxis, bus-station/BQS/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 SI at the time of inception report.
27. The minimum scalability will be for 300 Buses, Local and Main Line Taxis, 100 PIS for BQS and Bus terminal. Authority will not pay any excess fees for increase in volume up to scalability.
28. The software will provide standard reports based on the AVL data. SI 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
29. 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. excel, etc. The SI shall provide the relational database layout including related fields, key fields and definitions for all fields in all tables in the database.
30. Any portion of the transactional database will be exportable in standard formats (such as comma separated variable (.CSV, xls, xlsx files etc.) for analysis in third party programs.
31. 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.
32. A data dictionary will be provided to Authority to facilitate development of custom reports.

33. SI 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.

17.6 Technical Specifications for AVL System

17.6.1 GPS/GSM Tracker

Parameter	Minimum Specifications or better
Weight	Should Be Lightweight.
Housing	Aluminium Or Fibre Case
Operational Temperature	-25 ~ 70
Storage Temperature	-40 ~ 80
Power Consumption	<1 W (60ma ~ 100ma)
Backup Power	24 Hrs Minimum.(In Ideal Mode)
Input Voltage	10 ~ 30v
Frequency	L1,1575.42 MHz
Protocol	Nmea 0183 V2.2
Channels	20
Flash	4mbit
Sensitivity	Tracking: -159dbm
Cold Start	42 seconds, Average
Warm Start	38 seconds, Average
Hot Start	1 Seconds, Average
Reacquisition	0.1 Seconds, Average
Accuracy	Position: 10 meters, 2d Rms,5 meters, 2d Rms, Waas Enabled Velocity: 0.1 M/S Time: 1us Synchronized To Gps Time
Frequency Bands	Sim 340 Quad-Band: Gsm 850,Egsm 900,Dcs 1800,Pcs 1900.The Band Can Be Set By At Command, And Default Band Is Egsm 900 And Dcs 1800 ,Compliant To GSM Phase 2/2+
Temperature Range	Normal Operation: -20 To +55 Restricted Operation: -25 To -20 And +55 To +70

	Storage Temperature -40 To +80
Data GPRS	GPRS Data Downlink Transfer: Max. 85.6 Kbps GPRS Data Uplink Transfer: Max. 42.8 Kbps Coding Scheme: Cs-1, Cs-2, Cs-3 And Cs-4 Sim340 Supports Protocols PAP(Password Authentication Protocol) Usually Used For PPP Connections. Sim340 Integrates TCP/IP Protocol. Support Packet Switched Broadcast Control Channel (Pbcch) Csd Transmission Rates: 2.4, 4.8, 9.6, 14.4 Kbps, Non-Transparent Unstructured Supplementary Services Data (Ussd) Support
SMS	Mt, Mo, Cb, Text And Pdu Mode SMS Storage: Sim Card Support Transmission Of SMS Alternatively Over Csd Or GPRS. User Can Choose Preferred Mode.
Sim Interface	Supported Sim Card: 1.8v ,3v
Two Serial Interfaces	Serial Port 1 Seven Lines On Serial Port Interface
Sim Application Toolkit	Supports Sat Class 3, GSM 11.14 Release 98
Real Time Clock	Implemented
Timer Function	Programmable Via At Command
Firmware Upgrade	Firmware Upgradeable Over Serial Interface
Internal Battery Cum Charger	Li-Ion Battery With Minimum 08 Hrs Backup When Idle And 04 Hrs When Continuously Used. With Appropriate Charger To Be Charged From Vehicle Battery
Certification	Minimum IP65 & ARAI Certification

17.6.2 Technical Specs for RFID Tag and Reader

UHF Passive RFID Tag Specifications:

Parameter	Specification
Type	ABS, High Quality Engineering Plastic
Supported Transponders	ISO18000-6C EPC Class 1 GEN2
Frequency Range	ISM 865~928 MHz
Operation Mode	Fixed Frequency or FHSS Software Programmable
Memory capacity	The tag should support ISO18000-6C protocol standard 2K Bits storage capacity, 1728 Bits (216 bytes) writable user area; MR6730B metal supports EPC C1 GEN2 (ISO 18000-6C), with 96 Bits writable EPC Code area, 512 Bits writable user area, and 32 Bits password area, EPC 128 bit user 512 bit TID 96 bits.
Reading Rate	Software Programmable, Average Reading per 64Bits <10ms
Tags material	Metal material
Reading Range	Should be able to be calibrated. (to be kept as 2-4m max) based on the site visit.
Operation Temp	-35°C to 85°C
IP Classification	IP 68
Weather	Heat, dust proof, UV resistant & sea water resistant.
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

17.6.3 RFID Reader Specifications

Parameter	Specification
Protocol	ISO18000-6C EPC GEN2 Configurable for mixed or single tag-type operation. Air interface software on IV7 is downloadable to add Gen 2 and Class 1 air interfaces and to “future-proof” the product as standards evolve and new features become available.
Frequency Range	Standard ISM 902 928MHz or 915 MHz (US FCC),865 MHz (ETSI 302-208), and 869 MHz (ETSI 300-220)
Operation Mode	FHSS
RF Power	0~30 dBm, software adjustable
Reading Speed	Software Programmable Average Reading per 64Bits <6ms
Reading Mode	Timing or Touch, Software Programmable (reading should be such that the reader does reads two tags at a time)
Communication Mode with central server	TCP/IP and GPRS or higher
Data Input Port	Trigger input one time
Reading Range	Max 12 m(able to calibrate)
Communication Interface	RS232
Accessories	Vehicle-mount DC power cable kit Antennas, and antenna cables
Environmental Rating	IP65
Humidity	10% -90%
Shock and Vibration Protection	Withstands standard material handling vehicle environments. Meets or exceeds MIL STD 810F
Operating Temperature	-25°C to 55°C (-13°F to 131°F)
Storage Temperature	-30°C to 75°C (-22°F to 167°F)
Humidity	10% to 90%
Power Supply	Vehicle DC power 12 to 60V, 4.5 A maximum

17.6.4 VMS

Parameter	Minimum Specifications or Better
Location	To be installed at Traffic Junctions / Bus Stops as identified and the text on sign must be readable even in broad daylight
Colour	True Colour
Brightness & Legibility	To be read even in broad daylight without any shade The displayed image shall not appear to flicker to the normal human eye >6000 cd/m2
Luminance Class	L-3 as per EN 12966
Contrast Ratio	R2-R3 as per EN 12966
Beam Width	B6+ : Viewing angle shall ensure message readability for citizens, motorists, pedestrians, etc. on the respective locations
Display Capability	Fully programmable, full color, full matrix, LED displays Alpha-numeric,Pictorials, Graphical & video
Display Language	To support both pictograms and multilingual (English, Telugu) Text
Display Front Panel	It shall utilize a front face that is smooth, flat, scratch-resistant, wipe-clean 100% anti-glare
Message Creation	Through both a Central Control Room Application and a local Laptop/Device loaded with relevant software
Language	Multilingual (Telugu/English/Hindi) and with options of multi fonts
Auto Dimming	Auto dimming adjusts to ambient light level.
In built Sensor	Photoelectric sensor
Storage capacity	60 GB
Display Area	Display size of VMD shall customized based on minimum viewing distance likely to be finalized in the feasibility stage

Number of Lines & Characters	The number of lines and characters can be customized as per the requirement (Min 3 Lines & 10 Characters)
Brightness & contrast	Controlled through software
Display Driving method	Direct current control driving circuit. Driver card of display applies Direct Current Technology
Display Style	Steady, flash, partial flash, right entry, left entry, top entry, bottom entry, canter spread, blank, and dimming
Connectivity	IP Based
Access Control	Access control mechanism would be also required to establish so that the usage is regulated.
Integration	Interface with GPRS/GSM Integration with management application in CCC
Battery	230 VAC + 15%, 50Hz, Single Phase (automatically restart in the event of an electricity supply failure) Batteries with solar charging options can also be recommended as back up
Power	Automatic On/Off Operation
Casing	Weatherproof Display for VMS IP-66 rated for housing all control equipment
Operating Conditions	0° to 55°C
Message Validity	If the controller is unable to connect to the server for the next message, it shall not display the old message, which has passed its expiry time. Instead it shall be programmed to display a default message

17.6.5 Application Software for VMS (Control Messaging Application at Data Center)

1. The Application System for Controlling Messaging for VMS shall:
2. Be deployable over multiple workstations.
3. Ensure that provision for feeding/updating the following information:
   i. VMS messages and information
   ii. Types of possible scenarios per VMS
   iii. Types of possible messages to be displayed on each VMS during various scenarios
4. Ensure that the normal operator is not able to publish any custom message and shall only display predefined sets of messages.
5. The application shall have an option for Supervisor (someone with appropriate authority) to bypass the control during certain situations and to write in free-text mode.
6. Ensure that operator can publish specific messages for managing traffic and general informative messages.
7. Allow an operator to seamlessly toggle between multiple VMS points at each workstation to send specific messages to specific locations.
8. Accommodate different access rights to various control unit functionalities depending on operator status and as agreed with the client.
9. Application should also have an automatic provision for displaying Bus Arrival and Departure Status where ever necessary, based on the smart transport application.

17.7 Use Cases

Intelligent Transport System (ITS)

1. C4 will be required to integrate with the ITS implemented.
2. C4 will be required to get information on various parameters but not limited to, real time location status of buses, Local and Main Line Taxis, Ticketing information, Scheduling and Dispatching system or daily information for dispatched and cancelled buses, Local and Main Line Taxis, route changes, Fare Schemes, Smart card details as well as other parameters etc..
3. All the information received from the application will also go into the Analytical layer which will help city in better planning and running of operations.
4. C4 will allow operator to initiate the SOP or workflow to manage the transport related incidences

18. E Governance

18.1 Ideation

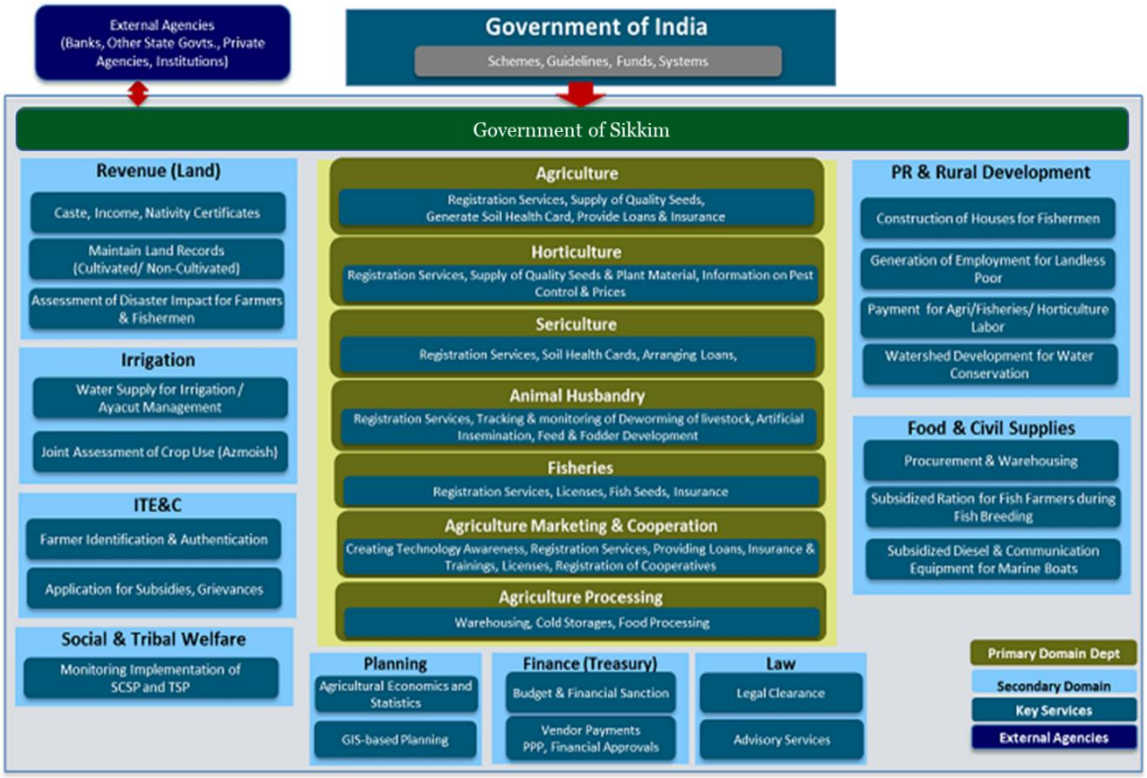
“Minimum Government, Maximum Governance” - that's PM Modi's mantra. Providing access to internet is one of PM Modi's pet projects. From online registrations, availability of forms to other important document work - everything has been made easier through online procedures. The pace of urbanization—demonstrated by growth per decade—has slowed compared with the initial years after independence, yet the current trends of 30 percent growth are likely to continue for some time. For example, according to the Twelfth Five Year Plan, nearly 600 million people will reside in urban areas by 2031. Moreover, it is expected that more than 200 million people will live in urban areas in fewer than 20 years. Another measure—the “Index of Urban Population”—provides an even better sense of this trend. Since independence, India’s urban population has sextupled, with the number of towns and urban agglomerations (similar in concept to metropolitan areas) almost doubling since 1951 alone. Notably, this growth in rural-urban migration is now much more widespread across the country, even though major metros such as Delhi, Mumbai, Chennai, and Kolkata were the primary centers of this activity in earlier decades. By comparison, a large number of “outgrowth areas” have recently emerged near existing cities, supporting additional migration from adjoining rural areas.

Several different reasons help explain this structural shift, especially since 1947 with India’s independence. The rise of a more diversified economy, combined with a growing reliance on heavy industry, is one major factor. Similarly important are the 1991 economic reforms, helping to spread greater market activity and investment across country. With a focus on service industries, India has also experienced a notable transition from rural and semi-urban areas to urbanized growth centers. Better infrastructure facilities and economic opportunities are constantly attracting more people into urban areas. In the reverse, rural areas struggle with economic distress, agricultural stagnation, and limited infrastructure development. However, many areas are urbanizing in an unplanned manner, and a large number of unrecognized slum communities have developed around the peripheries of major towns and cities.

By many indications, India only recognized the need for a systematic upgrade of urban spaces about a decade ago. On December 3, 2005, then Prime Minister Dr. Manmohan Singh launched JnNURM, a massive initiative to improve the quality of life and local infrastructure in India’s cities within seven years. With an estimated investment of $20 billion, JnNURM aimed to create economically efficient, productive, equitable, and responsive cities, covering more than 67 mission cities across the country and spreading growth in multiple regions. However, many projects had not been completed within the seven years, resulting in a two-year extension lasting until March 31, 2014.

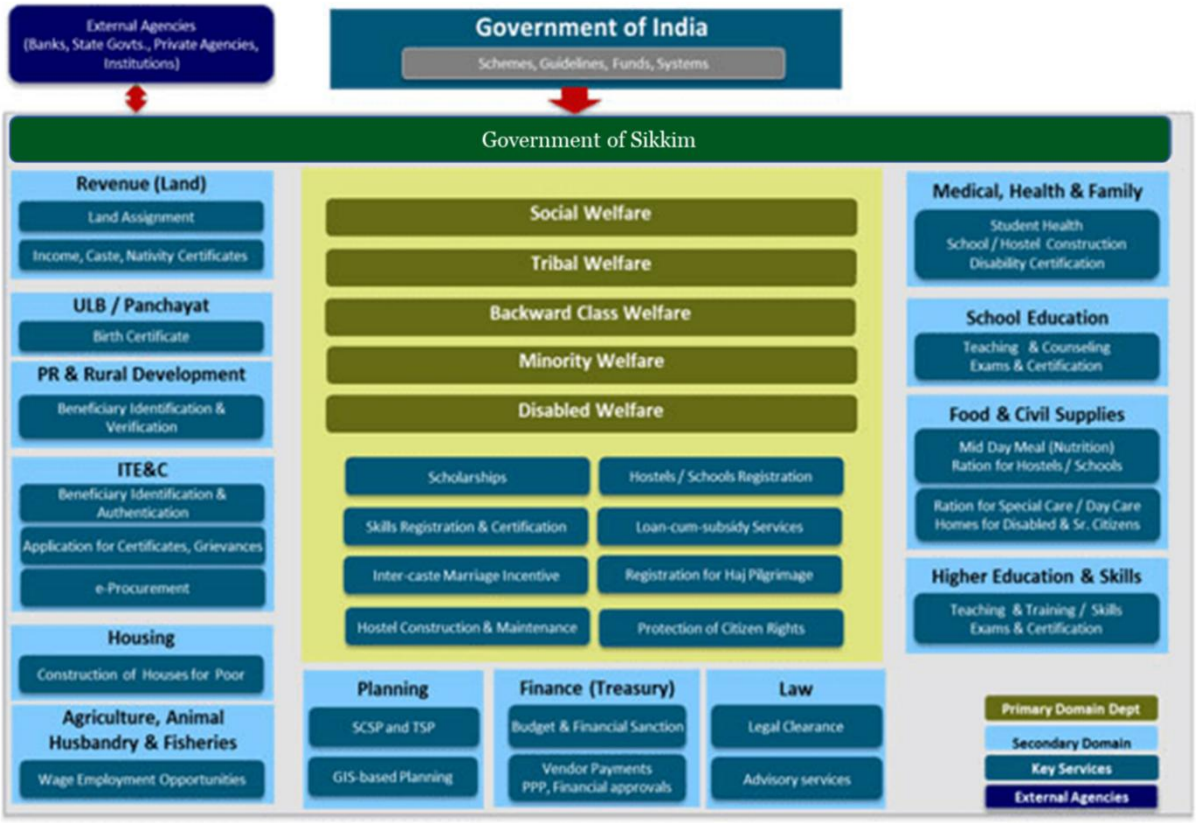
Mission:

Primary Sector



A. The broad focus areas under primary sector mission include making agriculture and allied activities profitable and sustainable, mitigate drought through water conservation, manage post-harvest activities effectively, enhance storage, processing and value addition capacity.
B. Primary sector departments and its sub-departments interact with other departments, within the state and also with departments under Government of India, external agencies such as banks, other state governments, private agencies and bilateral and multilateral funding institutions for discharging various functions and delivery of services.
C. Primary Sector mission launched by the Government will address Farm related issues like enhancing value addition from horticulture, livestock, fisheries and lack of bulk storage spaces including cold storages.
D. The focused areas under the Primary Sector would be: (1) Increasing productivity of the Primary Sector, (2) Mitigating the impact of droughts through water conservation and micro-irrigation, (3) Post harvest management to reduce wastage, (4) Establishment of processing , value addition capacity and supply chain for the identified crops.

Social Empowerment

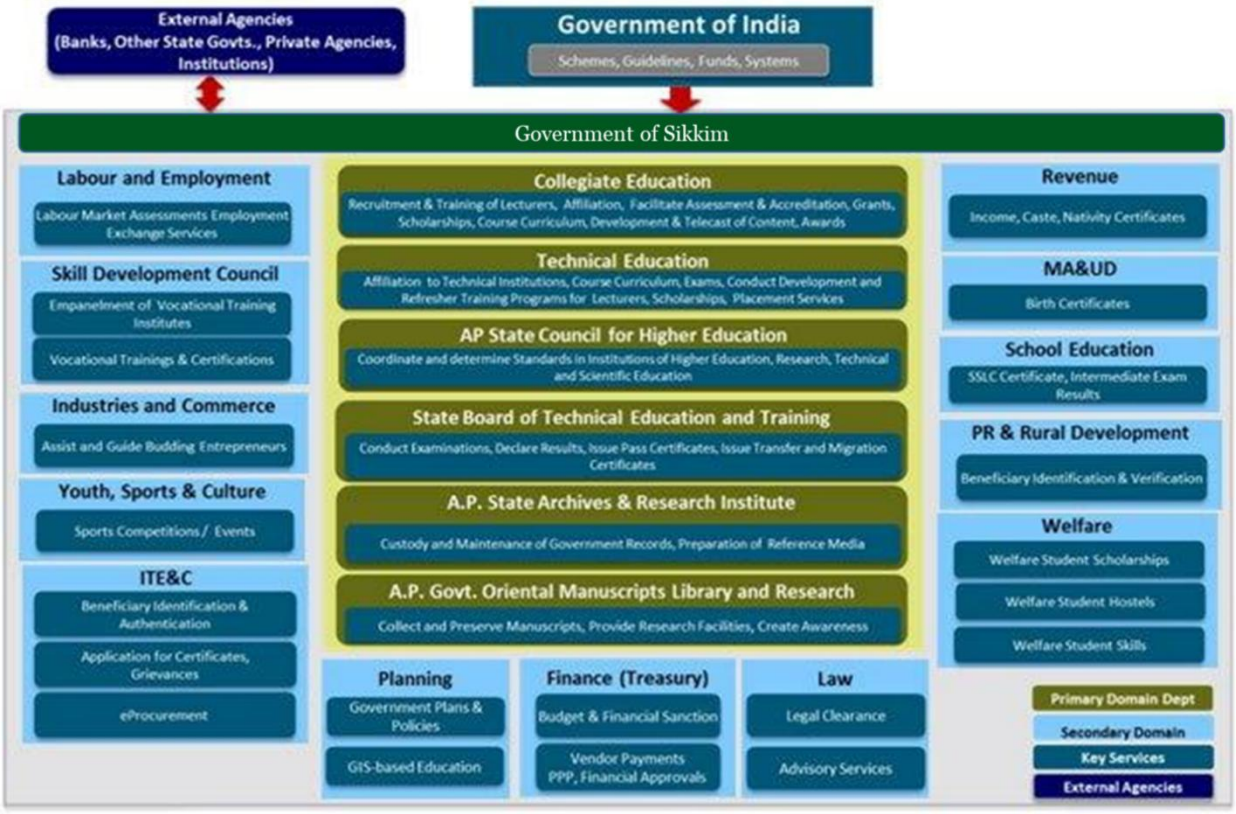


The state, with 67% literacy and with 60 % female literacy, is much below the National average literacy. Efforts are to be taken to compete with advanced states. Quality education is the need of the hour. Nearly 81 lakh children in the age group 5 to 16 will need quality education and smart learning methods much beyond the existing capacity of the system. Issues relating to drinking water and sanitation are to be addressed on priority.

This mission launched in the month of February 2015 focuses on the following;

i. Ensuring quality education, healthcare and nutrition to all the citizens to achieve Millennium Goals and other global indicators like Sustainable Development Goals being developed by the United Nations.
ii. Ensuring women empowerment and safety.
iii. Networking with organizations, which are innovative and have set-up models of good work.
iv. Ensuring specific focus on the disadvantaged sections of the society, especially the Scheduled Castes, Scheduled Tribes, Backward Classes, Minorities and Below Poverty Class (BPC) to ensure growth with equity.

Knowledge and Skills Mission



The Knowledge Mission will be guided by the Honorable Chief Minister's vision to transform Sikkim into an education and knowledge hub and develop institutions of higher learning that would conform to international standards and quality.

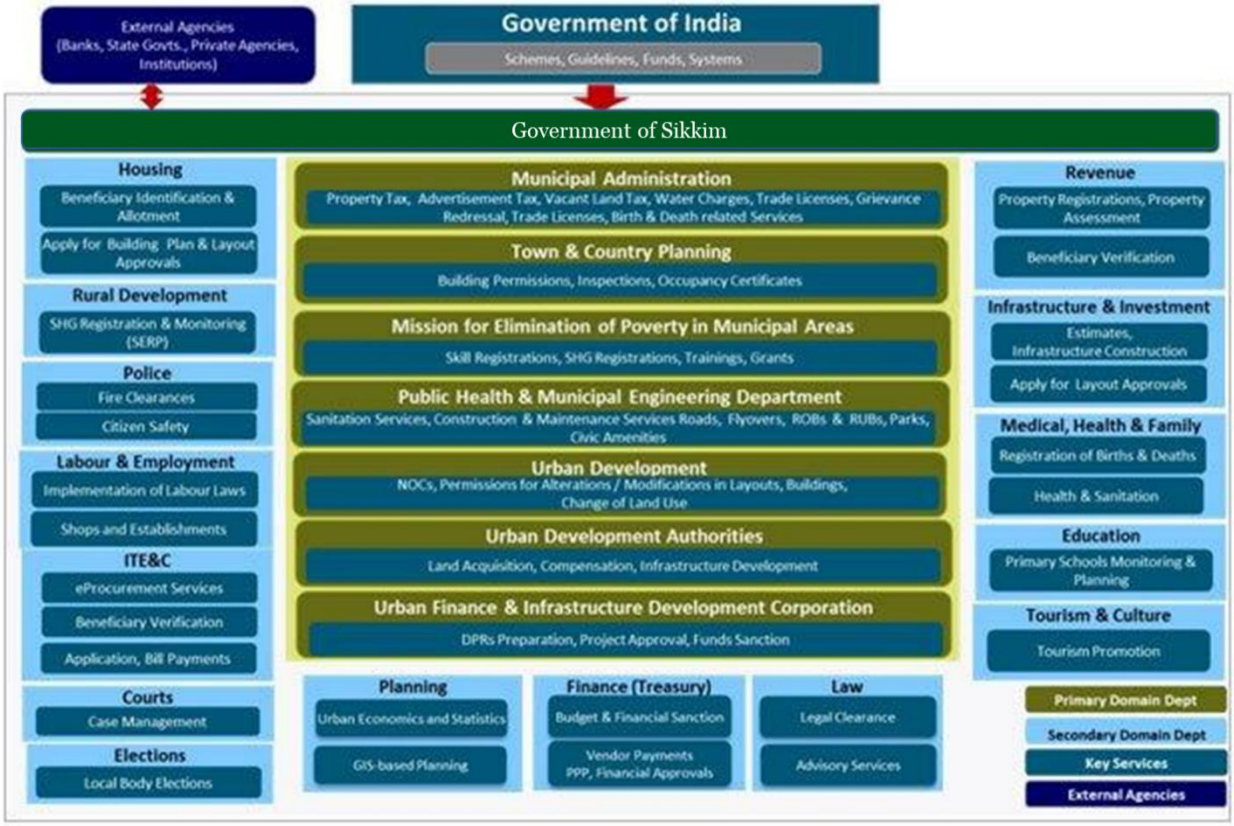
In this context, the Sikkim Knowledge Mission (Sik-KM) will streamline the efforts of the government towards creation of human capital and skill assets in a time bound manner with set targets and measurable outcomes Mission objectives.

The Sikkim Knowledge Mission will be built on the pillars of accessibility, affordability, partnerships and quality.

The Sikkim Knowledge Mission will have the following Key Objectives;

i. Improve the quality of education.
ii. Improve GER (Gross Enrolment Ratio),
iii. Address educational inequality between Rural and Urban areas.
iv. Invest in Faculty development.
v. Ensure youth employability.
vi. Align vocational training and educational targets with national and international best practices.
vii. Promote holistic student development.
viii. Promote Art, Humanities, Sports and extra-curricular development activities.
ix. Build institutional partnerships.
x. Develop support infrastructure for research and development.
xi. Encourage PPPs in higher education and industry collaborations.
xii. Streamline regulatory framework to provide a more conducive ecosystem for successful realization of Mission Objectives.

Urban Development Mission



Cities and towns as engines of growth and development, planned and balanced urbanization to accelerate growth and reduce poverty, urban renewal in a mission mode.

The key focus areas of departments under Urban Development mission include developing major cities and towns into Smart cities, which should act as engines of growth and development and lead to planned and balanced urbanization.

The mission lays special focus on improved transportation, housing and solid waste management, safety and security of citizens and poverty reduction.

Urban Development mission departments and sub-departments interact with other departments, within the State and also with line departments of Government of India, external agencies such as banks, other state governments, private agencies and development institutions for discharging various functions and delivery of e-Pragati services.

The Mission will Focus on the Following:

- Establishing 3 mega cities and 10 smart cities;
- Develop a roadmap for sustainable urban development by improving transportation, housing, expanding opportunities and living standards;
- Financial resource mobilization strategies for sustainable urban development;
- Solid waste management and treatment of wastewater;
- Pedestrian and cycling friendly clean and green urban spaces.

18.2 Solution Requirements

18.2.1 Integration with C4

Components of E-Governance / e-Pragati will be integrated using direct feeds, dashboards and sharing of alerts/ actionable inputs for integrate and view operations.

The State of Sikkim has already implemented various e-governance initiatives that shall be integrated and made available in the form of a dashboard in the CoC. The various modules are:

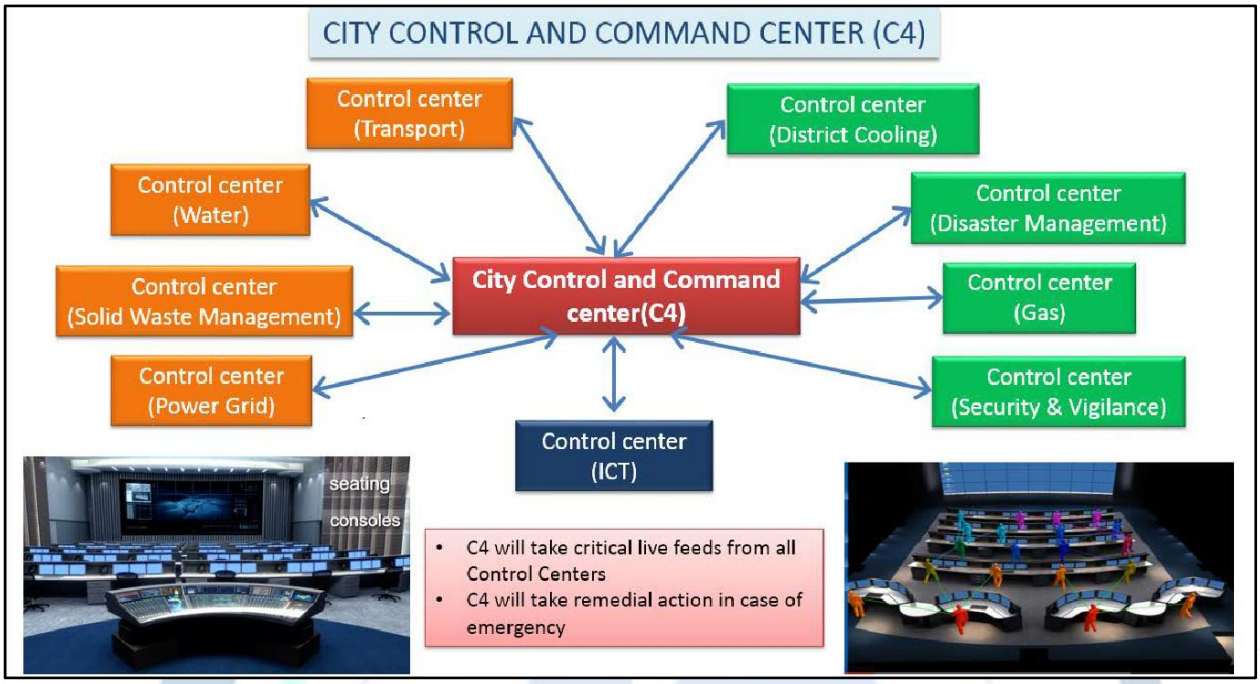
1. Geographical Information Systems.
2. Education Facilities
3. Smart Civic Amenities
4. Urban Planning System
5. Infrastructure Planning and Maintenance System
6. Asset Management System
7. Tax Management System
8. Estate Management
9. GIS Integration & 2D / 3D enabled Web GIS Interface with spatial analytics
10. Citizen centric services
11. Development Control Regulations (DCR)

Sl. No	Module	Sub-Modules
1	Urban Planning system	Master Plan of Capital City and Capital Region Zonal Development Plans and Zoning Regulations Infrastructure Master Plan Urban Extension Projects, Special Projects Policy Modifications and Notifications / Proposals Zone wise approved layout/Schemes/Projects Details of Approval of Layout / Scheme / Projects Land Assembly Layout Plans /Drawings Traffic and Transportation Roads module – create, update and maintain master plan roads Traffic Module – Input and update data on assets Bus route planning module Buildings Permissions Spatial tools for Impact assessment, parametric simulation of plans. 2D and 3D enabled spatial map viewers.
2	Infrastructure Management Module	Interface to create, update and maintain surface and underground infrastructure plans with all relevant attributes both spatial and non – spatial. 2D and 3D spatial viewing capabilities of the infrastructure plans with Open Standard formats. Impact analysis on the changes to the infrastructure plans with provision to view underground assets in 3D

		cross sectional views. Dashboard for progress tracking of infrastructure projects.
3	Asset Management Module	Asset Management Inventory Management Work Order Management Service Level Management (SLAs) Capital Projects Finance
4	Property Tax Management Module	Assess property tax for various plots that have been registered. Generate bulk demand notices and issue notices via email and SMS for registered users. Generate defaulters report, both textual and spatial thematic maps zone wise, block wise etc., Interface for online payment of taxes and Issue of tax certificates. Interface to update property usage type and modification of tax. Update and recording mutation of ownership in tax certificate. Interface to input signage assets, assess advertisement tax, management of signage leases and auctions. User collection fee module
5	Estate Management Module	To manage all survey related datasets and processes for cadastral, engineering and other surveys. Validation of survey datasets with respect to the standards prescribed by SOI. Make available survey datasets for other departments for their planning activities. Interface with land assignment application to store attributes of land; update plot data such as mutation, amalgamation and bifurcation of lands. Interface with economic development work to capture attributes on plots sold, leased to developers / investors. Parametric analysis of land demand and management of land bank. Create government housing related assets; allotment of housing for government officials, economically weaker sections. Input information pertaining to public buildings, assets and related attribute.
6	GIS Integration Module	Base Map Creation with all Topographical Map layers,

		Contours, Cadastral Maps Land Use Maps of Capital City and Capital Region Integration of Master Plan of Capital Region, Capital City, LPS Layouts and Final LPS Layouts with Lottery Data. API services to other Government Departments and 3rd party service providers.
7	Citizen Centric Services	Online Search for Master Plan of Capital City, Capital Region, LPS Layout and generation of Reports for Land Registrations Online application for Change of Land use Traffic advisory and Emergency services Provide location data analysis and geospatial information for the benefit of all citizens and the visiting population to meet their daily needs such as travel, leisure, information, tourism, during emergencies, etc. Adoption of features similar or equivalent to that of Singapore's one map. Record of objects / grievances and complaints Online payments, such as of property taxes
8	Development Control Management	Develop module to accept applications and CAD plans. Validate compliance with detailed zoning regulations. Validate compliance with detailed development control regulations. Approval of building permits based on compliance. Issue of completion certificates. Issue of notices for irregularities and violations against compliance. Accept layout permits. Validate layouts with zoning regulations. Approve layout permits. Interface with the land permit application to provide attributes and parameters associated with parcel of land under consideration; generate GIS ID and record data on system upon approval. GIS integration. MIS Reports.

City Command and Control Center



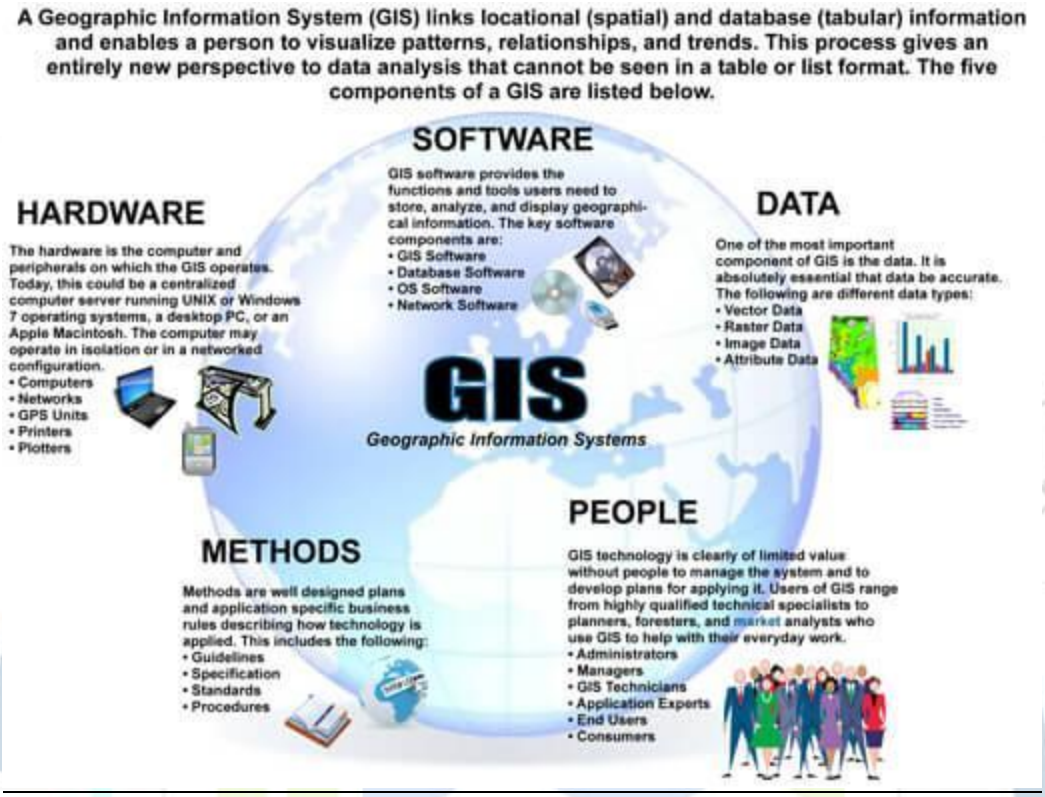
18.3 Use Cases

Integration of MCs, Call Centre & Municipal Services (Web Portal and Mobile Applications)

1. C4 will be required to integrate its helpdesk and system with Municipal Corporations call center, in case if there is some information or notification is to be sent to Municipal Corporations call canter for doing some action in the field regarding Municipal Corporation work.
2. All the information received from the command center will also go into the Analytical layer which will help city in better planning and running of operations.
3. C4 will be required to integrate with the backend system of SMC services which is SAP based system to monitor the performance of the application. Along with this C4 should be able to show the utilization by citizens of various sections of any mobile application in the form of a Dashboard.
4. C4 should be able to integrate with the existing ICT systems and edge / end / mobile devices of various Municipal Corporations departments such as Garden, General
5. Administration Department, Water Supply, Sewerage, Assessment and Collection (Property Tax, Shops and establishment), Fire (Fire Brigade Section), Transport of Heavy Vehicles and Maintenance (Workshop), Audit and License Issue to receive and send information.
6. C4 should be able to map the data received from various Municipal Corporations departments on its GIS Platform.
7. C4 will be required to send Municipal Corporations field agents alerts and notifications for any emergency / incidents / disaster in the city for doing required action. C4 system should also be able to get acknowledgement from the receivers.

11.19. Geographical Information System (GIS)

19.1 Ideation



Satellite images have many applications in agriculture, forestry, biodiversity conservation, regional planning, education, intelligence and warfare. Images can be in visible colours and in other spectra. There are also elevation maps, usually made by radar imaging. Interpretation and analysis of satellite imagery is conducted using software packages like ERDAS Imagine or ENVI. Some of the first image enhancement of satellite photos was conducted by the U.S. Government and its contractors. For example ESL Incorporated developed some of the earliest two dimensional Fourier transforms applied to address NASA photos as well as national security applications. Satellite imagery has also used in seismology and in deducing changes to land formation, water depth and sea bed, by colour caused by earthquakes, volcanoes, and tsunamis.

As urban areas are getting more crowded and falling increasingly short on future development potential, development of new self-sustaining cities are emerging as an alternate solution to these problems. Technology is at the heart of these new self-sustaining cities enabling automation and real-time integrated city monitoring and management through a network of sensors, cameras, wireless devices and data centers. Also referred to as smart cities, these new self-sustaining cities are a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas like economy, environment, energy efficiency, mobility, governance, people and living conditions.

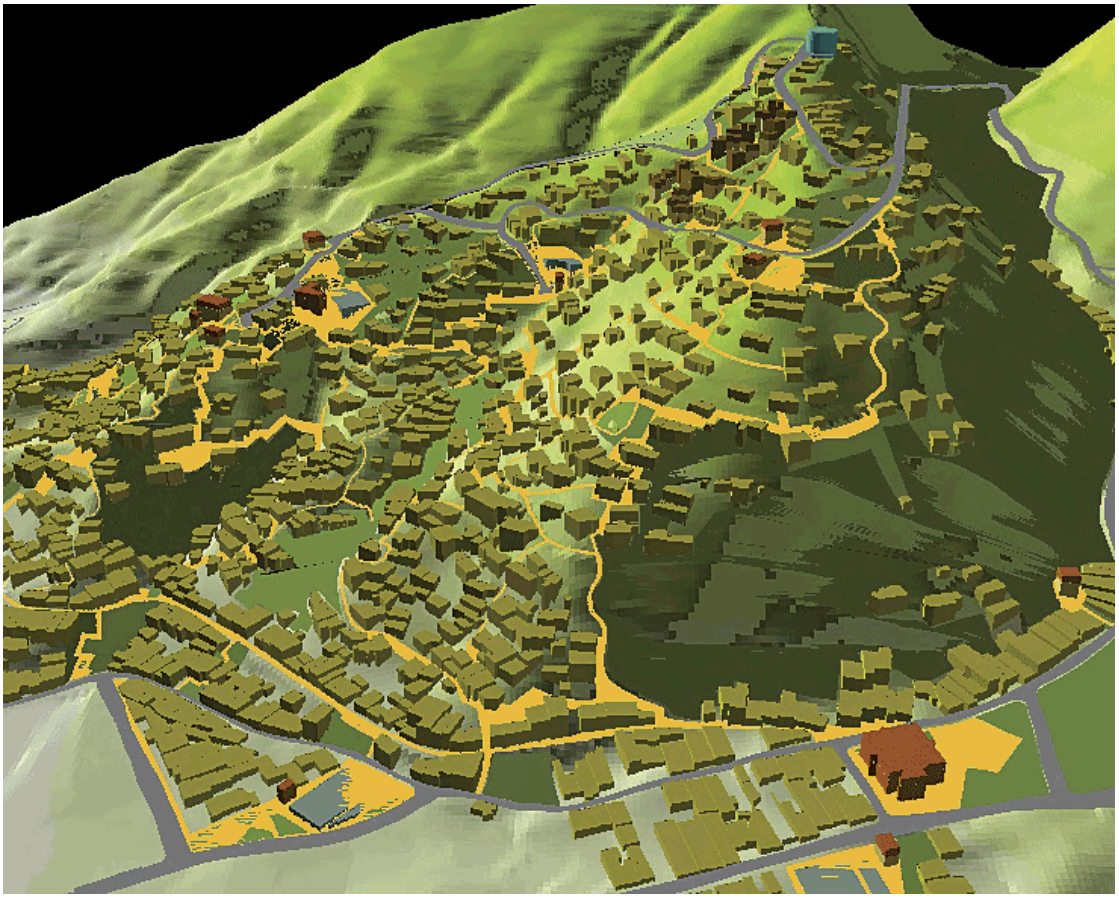
Smart cities, on one hand present a substantial growth opportunity in the coming years while on the other offers various challenges as well. Smart city projects are rather complex with residential and commercial spaces supported by an infrastructure backbone for power, roads, water, drainage and sewage i.e. a virtual living and breathing city. A critical success factor is a need for a common

technology platform to enable integration, coordination and synergistic functioning of different participants of the smart city ecosystem.

A centralized information system based on GIS (Geographical Information System) provides an IT framework which integrates not only every stakeholder but also every aspect of smart city processes – starting from conceptualization, planning, and development to maintenance.

GIS – A platform for smart cities:

A centralized information system based on GIS provides an IT framework for maintaining and deploying data and applications throughout every aspect of the city development life cycle.



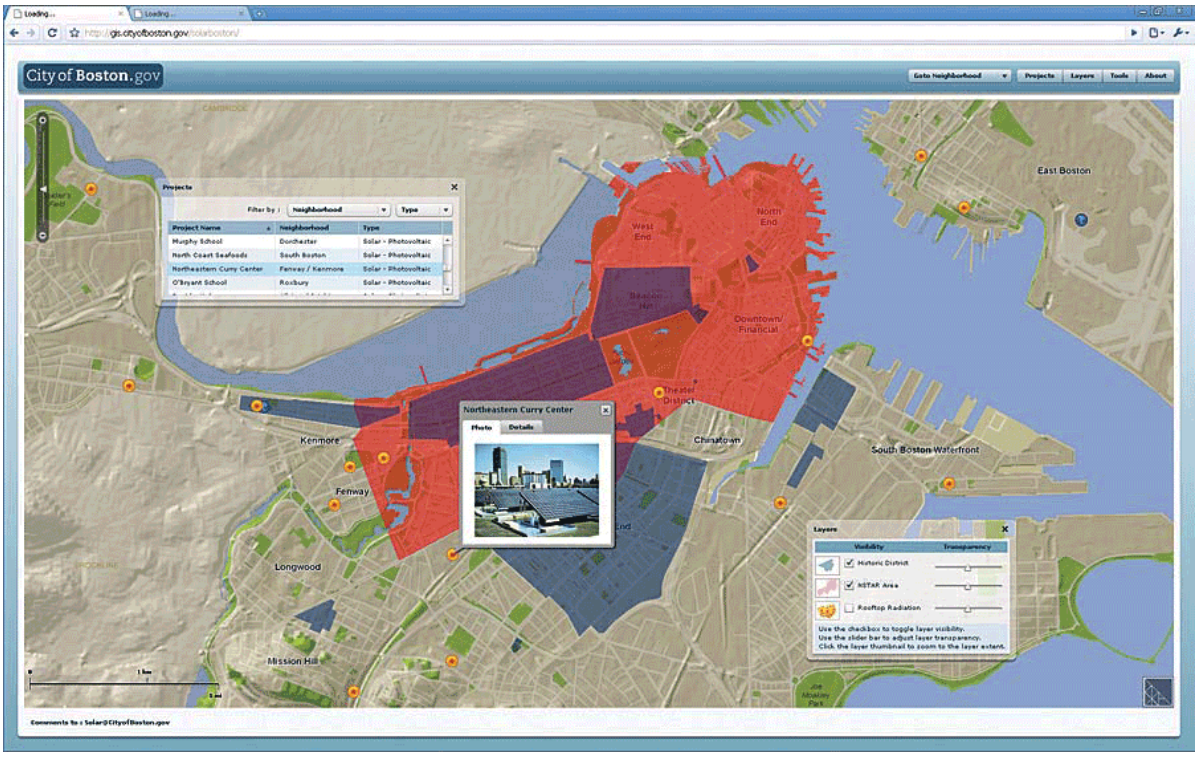
Acquire: Find the right sites for city development, view legal boundaries, arrive at right valuation of your existing / new sites.

Planning & Design: Identify deficiencies and determine optimal solutions. Integrate GIS with most design tools, including Computer Aided Design (CAD), Building Information Modeling (BIM) bringing greater analytics and cost-estimation capabilities to your infrastructure design process.

Construct: Integrate project and financial management software with GIS to better manage projects. GIS can provide a single point of entry for all construction-related documents and files.

Sell: Understand where and how to market city developments, attract buyers and tenants, and improve retention rates. Analyze demographics and market conditions to provide a more accurate picture of a property's suitability to needs.

Maintain: Easily manage disparate assets. Integrate your asset inventory with inspection history and work order management to maintain your critical investments in a cost-effective manner.



Sample image of the City of Boston

Site Selection & Land Acquisition:

GIS can combine and integrate different types of information to help making better decisions and also provides high quality visualization tools that can improve the understanding and enhance decision making capability w.r.t to site identification, valuation and finally selection. By analyzing location data – proximity to road network, fertility of soil, land use, soil bearing capacity, ground water depth, and vulnerability to disasters such as floods, earthquakes - the real estate organizations can arrive at the right property valuation. By analyzing, mapping, and modeling the merits of one site or location over another can be evaluated. In addition, this can also be used for arriving at appropriate market linked compensation to owners based on valuation parameters and in rehabilitation and resettlement planning.

Environmental / Legal Compliance:

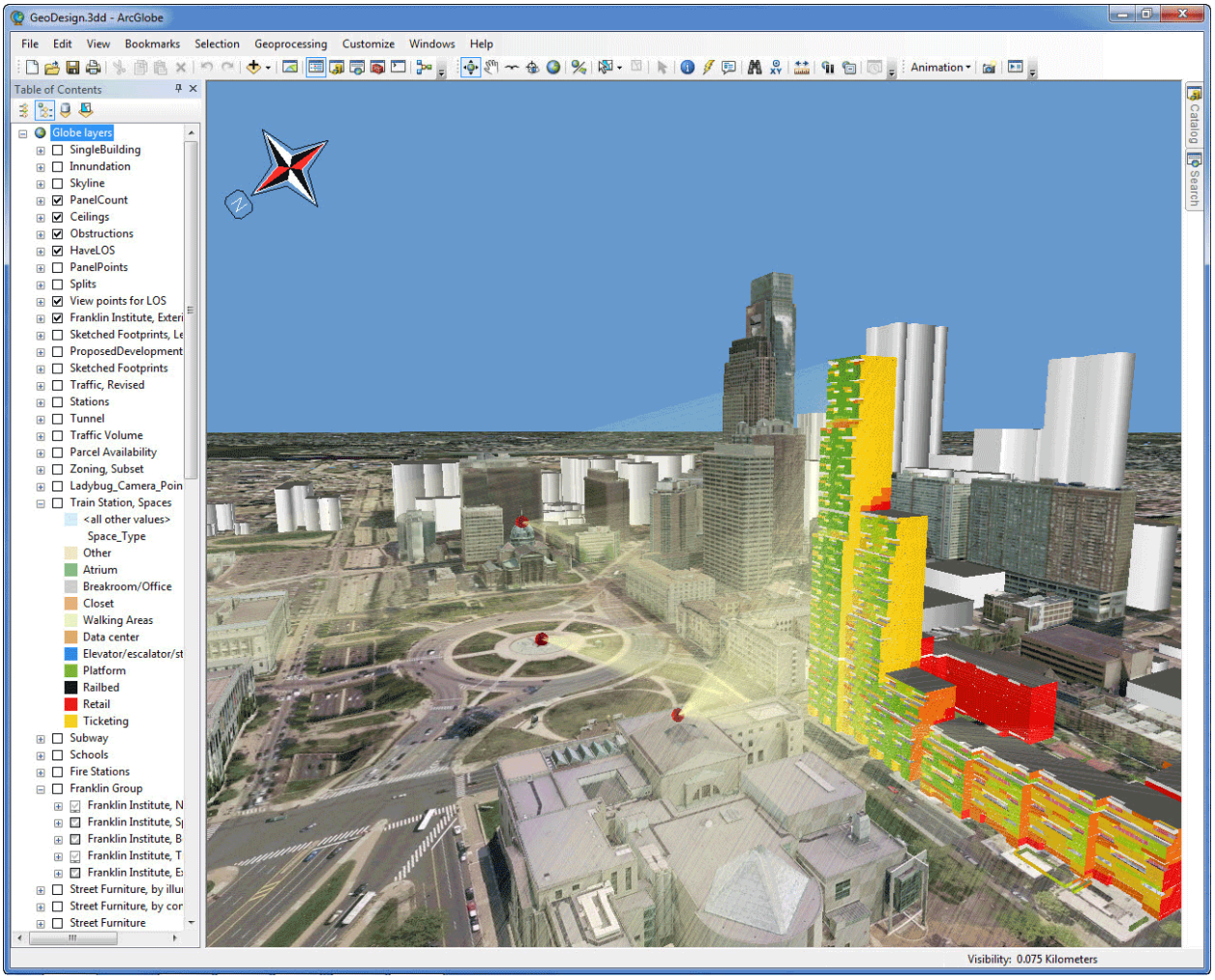
GIS makes meeting regulatory requirements less time consuming and easier to accomplish by providing a common platform for communication with regulators and public. The existing data can be directly connected to a compliance workflow ensuring adherence. Also, GIS-based graphical outputs can help in quickly generate reports that clearly demonstrate how compliance requirements and building bye-laws are being met.

Planning, Design & Visualization:

Geo-design will be the key framework for conceptualizing and planning for smart cities; it will assist at every stage from project conceptualizing to site-analysis, design specifications, stakeholder participation and collaboration, design creation, simulation and evaluation. GIS enables planners to integrate a variety of data from multiple sources like road, sewerage and drinking water and to perform spatial analyses and planning. Utilities can manage and map the location of millions of miles of overhead and underground circuits.

By integrating imagery, elevation, and environmental information with the CAD / BIM environment, engineers can continue working with familiar software while gaining access to important GIS data. Design files can be brought into a GIS and linked to financial software for better labor and materials and total project cost estimation. With these types of capabilities, GIS is an essential component of the engineering information systems of the future.

A 3D geographic information system can be used to create a realistic simulation of a project, environment, or critical situation.



GIS can help increase a facility's sustainability by reducing energy and water use, finding better waste disposal, and decreasing a building's carbon footprint. By managing information both inside and outside buildings down to the asset level, GIS can help in for example differentiating the environmental impact of development, planning and evaluating neighbor-hood patterns and design, estimate the "walkability" for LEED-ND projects based data on streets, pedestrian routes, bicycle routes, transit accessibility, building entrances, and a variety of other factors.

Construction & Project Management:

GIS, integrated with project management and financial software provides a comprehensive view of projects and their current status and helps in tracking performance. GIS helps organize all relevant project information, from soil data, and geotechnical studies to planning, environmental studies, engineering drawings, project maps, inventory and asset control.

Sales & Marketing:

With GIS, city developers can win over prospective businesses by creating informative sales tools and marketing reports that highlight the economic potential of a new location or future development. For residents, GIS helps in presenting a visual representation of all the information affecting the desirability and value of a property giving them a far more accurate picture of a property's suitability to their needs.

Facility Management (FM):

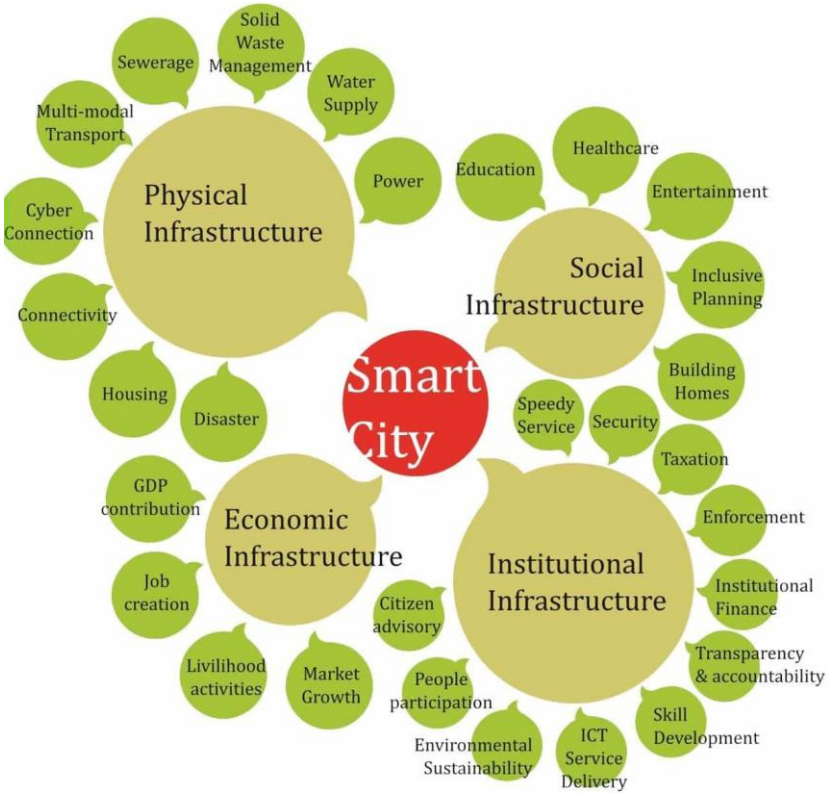
A GIS-based information system provides a powerful foundation for better facility management by generating integrated information that helps make better allocation decisions. GIS can integrate with and extend the current facilities management system. By importing and aggregating into a GIS the geometries and tabular data of the multiple BIM and/or CAD files required to accurately represent the built environment, the efficiencies and power of BIM can be leveraged, extended, and connected in geographic space to other relevant site, neighbor-hood, municipal, and regional data.

Operations & Reporting:

GIS can track and analyze assets over space and time and provide insight through visualization of information via maps and easy-to-understand reports. It supports creating an operations view that include maps, lists, charts, gauges, and more based on live geographic data defined in a web map or web service. Multiple operation views can be defined to meet the needs of stakeholders focusing on different aspects of the operation. With this ability to integrate disparate information sources into a common operational picture of all facilities, GIS provides greater power to control township operations and positively impact bottom line.

GIS can be used throughout the life cycle of a smart city – from site selection, design and construction to use and maintenance. GIS is an ideal technology that has the ability to scale across any expanse, from the individual asset within a building to a virtually global context tying all aspects of a Smart City planning and development.

19. Solution Requirements



1. Procurement and implementation of Licensed GIS application.
2. Development of portal for visualization of data.
3. Hosting of satellite data & existing Geospatial database on the portal.
4. Geospatial database creation. Update, Edit & Upload on the portal.
5. Training & capacity building of NSCL officials.
6. Development of GIS functionalities for query & analysis.
7. Development of modules & tools for Planning, Monitoring, Municipal & Civic services.
8. Integration of portal with the existing MIS of Land Management System.
9. Individual PAN CITY ICT track mapping as per the location list provided by NSCL including Geo-coordinates including ICT elements asset management.
10. Underground Power Duct Network Blueprint.
11. Underground ICT Duct Network Blueprint.
12. Underground Drain/Storm water Network.
13. Underground Water pipelines, Bulk Flow Meters, WTP, OHT & distribution network Blueprint.
14. Underground Natural Gas ducting network and distribution Network Blueprint.

MSI will develop all modules and sub-modules as mentioned below;

1. Functional Level:

- Development Functions; GIS based land & estate management module, Building permission module, Rehabilitation module.
- Municipal Functions; Utilities-Water & sewerage connection & Billing module.

2. Enterprise Level:

- HR system management module,
- Payroll,

3. Asset Management System Module

- Accounts & Finance management module.

4. Integration Level:

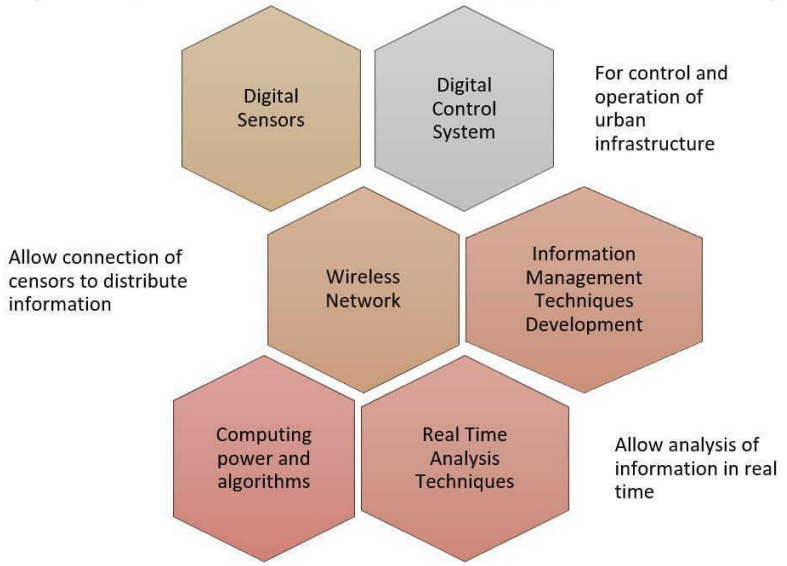
- E-district services (Birth, Death, Marriage Registrations, Shop license, Trade License etc..)
- City, Town & State Planning application,
- Integration with existing mailing solution,
- Integration with SMS gateway,
- Integration with Banks (for online payments),
- Integration with social media applications.

5. City Portal & Mobile Apps:

- Single Citizen Portal providing access to all solutions.
- Citizen collaboration & engagement platform.
- City Mobile App.

6. Pollution levels/Air Ambient/Quality.

19.1. GIS Applications



Existing database of existing land use plan in GIS facilitates site suitability analysis to arrive at a proposed land use that is efficient. Analysis is performed with help of GIS as a decision support system in monitoring changes in land use and its intensity over time in an urban area.

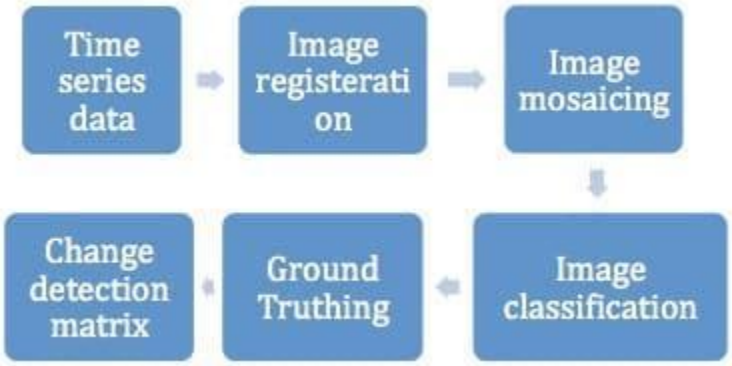
Detection and assessment of unauthorized settlements:
Emerging slums can be detected and tackled early through regular support from satellite images to observe the extent of encroachment. Redevelopment measures can be facilitated through the digitization of base map and attachment of associated information collected through household survey on GIS platform.

Managing Urban Sprawl:
Time series satellite images help in identification of underutilized lands within the city for redevelopment and provide information about land use conversions..and helps in monitoring horizontal spread of urban areas. Compact cities can be developed by integrating use of time series satellite images in city planning.

Identification & prediction of growth direction:
Time series data allows a comprehensive view of entire region and beyond, which can be used to stimulate and quantify impacts of specific policy inputs like IT Park, proposed transportation network etc.

Transportation Planning:
Satellite images provide base map of existing transportation corridors in different modes and facilitate the alignment of additional linkages to accommodate future development.

Urban Environment:
The platform helps to interpret characteristics and conditions of specific pollutants in air, water and land. This data can be used to assess the environmental impact of LUC.
Change Detection in urban areas using GIS:



Digital remote sensing data available through aerial photographs and satellite images are converted into useful information such as land cover maps. Overlay of collateral data like digital elevation models, soil and geology maps, block population statistics, separately residing in GIS are of great value in analysis of remotely sensed data.
Time series satellite images are reliable source of spatial information. Relevant features are digitized in vector format. Image classification and interpretation using time series images forms the basis for image detection. Images are registered using topo-sheets, ground control points with help of global positioning system. Region of interest lies in more than one scene. Different scenes need to be mosaic-tiled to obtain a seamless picture to obtain a uniform histogram of classification.

20. Smart Lighting

20.1 Ideation

Lighting for cities is expensive, with energy and maintenance costs accounting for approximately 40 percent of its budgets. In New York City, lighting uses approximately 295.5 million kWh, which costs $50 million a year for electricity alone. Transitioning to smart LED networks represents a tremendous opportunity for municipalities to not only save a substantial amount of money on energy and maintenance costs, but also become a smart city and offer the platforms to create opportunities for effective and productive engagement with its citizens, businesses, and visitors.

Intelligent LED street lighting networks are proving to be a transformational force in smart cities, providing an affordable option for cities to deploy an IoT platform that is delivering quantifiable results. Street lighting with controls can utilize time-based scheduling or even day-lighting to adjust dimming levels and achieve some energy savings. On the other hand, intelligent LED street lighting networks featuring embedded software, sensors, and microprocessor-based controllers capable of edge computing and data gathering offer digital capabilities that go well beyond traditional lighting controls. The power of these systems is magnified when deployed with a multitude of sensing devices and intelligent cameras utilizing smart algorithms. These systems are providing smart city operators and managers access to real-time awareness using dashboards and location-based intelligence.

35 million street lights light up India's roads. Various sources place the demand of electricity for these street lights between 20 to 40 percent of the energy produced in India. This sector faces multiple problems, such as:

Faulty lines with no maintenance of database

Theft and wastage.

Lighting control networks as conduits for IoT data flow in buildings and cities. Just a few years ago this would have sounded ridiculous, but the impact of IoT is transformational and has created an environment where we must approach things in new ways and operate without legacy burdens when evaluating solutions.

Lighting control systems have evolved in recent years to reflect the changing lighting needs of modern buildings, plants, infrastructure, and entertainment venues. Today's advanced lighting control systems can not only reduce energy costs, but also increase control, employee comfort, and productivity.

In addition, lower costs for data acquisition, edge-capable hardware, wireless technologies, and cloud-based management platforms have made intelligent lighting systems cost-effective for many small- to medium-size installations. A new generation of lighting innovators has created a paradigm shift within the industry, with lighting networks emerging as a logical option for IoT networks in buildings and cities.

NSCL
NAMCHI SMART CITY LIMITED

Multiple Benefits of Smart Lighting

The role of smart lighting solutions in the intelligent transformation of cities and buildings has gained momentum in the past years. This development will continue in the coming years based on increased connectivity and industrial internet of things (IIoT) solutions becoming a key element in most smart city strategies around the globe.

The opportunities that cities can seize with the installation of smart lighting solutions go far beyond value creation through energy (cost) and maintenance savings (which are huge considering that as much as 40 percent of a city's energy budget is consumed by street lighting and new efficient lighting can save up to 50% of these costs as a result of increased energy efficiency) or the improvement of the environmental impact.

Smart Lighting as a Backbone for IoT Applications:

The installation of smart lighting solutions can play a key role in a smart city strategy, in which street and other exterior lighting installations serve as backbone of a network in which services are delivered to the benefit of citizens, businesses and the city government.

Today, most cities that install new smart lighting or retrofit existing fixtures choose systems that already are equipped with sensor technology or that can be upgraded easily to utilize the advantages of IoT applications. Modern smart lighting products can help cities in monitoring the environment, to increase public- and traffic-safety, to upgrade connectivity as Wi-Fi hotspots or to deliver location-based services like smart parking and smart navigation.

20.2 Functional Requirements

At the most basic level, lighting controls provide elementary features such as remote on-off control, dimming, and scheduling functions. There is also a wide range of advanced functions that can be enabled by intelligent controls.

Energy monitoring and billing:

Accurate information on energy consumption is an important element in reducing energy costs. In addition, as street lighting becomes part of more complex electricity system, accurate and real-time information on energy usage becomes more important for optimization and grid management.
Performance monitoring: One of the most cited benefits of a networked street lighting system is the ability of a manager to remotely monitor outages. This eliminates time spent on nighttime patrols to identify malfunctioning lights and ensures that problems can be fixed in a timely manner.

Color controls:

Early LED lighting deployments were associated with a monotone, even harsh, light. But modern LEDs can be adjusted to select the color temperature of the white light provide by street lamps. For example, lighting may be adjusted for public safety purposes, to fit with special events, or for the different needs of retail or business districts. Recent developments in full color tuning permit even greater control of illumination, allowing an almost infinite range of color and temperature options.

Adaptive lighting:

Sensors that monitor local conditions can enable networked systems to adapt the brightness of street lighting as necessary. Linking light controls to traffic volumes, for example, can provide considerable energy savings. If no traffic is present or traffic volume is extremely light, then full brightness street lighting is not necessary. Similar motion detectors can enable lighting levels to match street activity. Weather sensors can also enable adaption to rain, snow, or other conditions. For example, lights may be turned up during rain showers and back down when the weather clears.

Emergency response:

Networked street lighting systems give city managers a number of features for dealing with public safety issues and emergencies, such as flashing lights in front of a house that emergency workers are attempting to find or brightening lights at an accident or crime scene. Other common applications include the use of adaptive light controls to provide warnings to drivers in school safety zones.
Please Note that many of these current and future applications benefit from designing in extra lighting power, so that if or when needed, lights can be brightened beyond normal levels.

20.3 Connectivity / Network Requirements

1. The development of multi-application networks for smart cities presents an immense opportunity to accelerate urban innovation. However, the plethora of networking options open to cities offers a confusing picture that makes future planning more difficult.
2. As cities look to deploy more sophisticated street lighting systems and to use the street lighting network as a platform for other applications, they face increasing complexity in the technology and investment choices they need to make. There are a large number of competing network technologies that can support street lighting networks. These solutions can be seen as a

spectrum of options, from relatively low cost and easily deployable solutions for basic services through to the most expensive, high performance systems suitable for the most demanding requirements.

3. Understanding the communication requirements for each possible smart city application provides a guide to which solutions are likely to fit a city's main requirements over the considered timeframe. One of the first distinctions is between the needs of basic and advanced lighting management. Each application has its own signature, the relative balance of priorities for speed, reliability, bandwidth, security, and cost, for example, and the tradeoffs that are possible across these attributes.
4. Monitoring applications: Applications such as air quality, noise monitoring, traffic, or pedestrian activity monitoring place relatively light demands on the network. The attraction of a smart city platform is to be able to deploy a wider range of sensors across more parts of the city to provide new data on the city environment. Ease of deployment, low operating costs, and breadth of coverage will be important considerations.
5. Operational systems: Applications such as smart parking, gunshot detection, or smart waste collection require reliable secure networks that can ensure accurate and timely information. Response times are important as part of overall message systems but medium or possibly medium-high in terms of network latency.
6. Critical systems: Controlling traffic lights, public safety cameras, and other critical operational equipment requires highly secure, reliable networks, often with significant bandwidth and low latency requirements. Such applications are typically supported by dedicated broadband networks.

Narrowband Options

Narrowband options, also known as low power wide area networking (LPWAN), the open LoRa WAN standard, ingenu's proprietary random phase multiple access (RPMA) technology, and two emerging cellular-based standards: narrowband-IoT (NB-IoT) and Long-Term Evolution (LTE)-Cat-M1.

The narrowband technologies are characterized by very low costs—radios cost $10 or less each, and service costs may be as low as just a few dollars per year. Battery life for these solutions is also long—10 or more years. LPWAN solutions also have good propagation for reaching underground or in-building locations, although this is not typically a need for smart lighting or city applications. Where basic street lighting control is the primary goal and frequent communications with devices is not necessary, a LPWAN technology may well do the job for years to come at a low price. But the ultra- and narrowband networks may not support a multitude of overlaid applications. Where cities are interested in a network that can support new applications over time (i.e., a more future-proof solution), a medium or broadband technology may be more appropriate.

Medium band Options:

Medium band options for smart lighting/city applications are widely available and offer significant flexibility to city managers at a relatively low cost. Each of the leading medium band networking options is described in more detail below.

PLC:

PLC technology is particularly interesting because it carries the signal over power lines that are already connected to most street lights. For that reason, outside of the United States and the United Kingdom, PLC has traditionally been the leading method of communicating with outdoor lights in a

networked system. Although this is changing, as RF mesh technology is now being deployed in various European smart city trials, PLC is still a significant network technology for lighting controls. Large numbers of lights run on dedicated power lines without the interruption of frequent substations. As a result, these power lines can be used as the backbone for networked communications. Segment controllers communicate over these lines to up to 200 light points, motion sensors, photocells, or other control equipment. Information is then transferred to a data center— usually over Transmission Control Protocol/Internet Protocol (TCP/IP). This approach reduces the total amount of wiring for a given project.

RF Mesh:
An RF mesh network forms a web-like network topology. Any node not in direct communication range of its target destination (a gateway or collector) will have its data relayed by another node in the mesh (e.g., another street light). A given data packet between a source and destination node may hop through many intervening nodes, extending the effective range of the network well beyond the range of any single transmitter or receiver.

Effective mesh networks are self-configuring and self-healing. They automatically determine which nodes are in range and reconfigure when the topology changes, such as when a node is added or removed or an obstacle between two nodes is added or removed. Virtually all the RF mesh technologies use unlicensed spectrum within the Industrial, Scientific, and Medical (ISM) frequency bands for their communications.

Any radio implementation in these bands must be able to tolerate interference from other ISM devices, be subject to various transmit power limits (generally less than 100 MW), and (in some cases) transmit duty-cycle limitations.
Evaluating the performance of the various RF mesh implementations is difficult given the range of options. The actual network performance of a mesh network depends on considerably more than the specified link speeds. Other factors include the actual topology of the network (the number of hops from the endpoint to the headend system), the number of nodes visible to other nodes, and the number of nodes per concentrator.

Given these factors, one of the issues with RF mesh networks is the lack of predictability of key throughput and latency performance characteristics. This is usually not an issue when RF mesh technology is used for basic smart lighting networks, but can be a concern when using the same mesh network for traffic light controls, for example.

Finally, the prevalence of unlicensed spectrum band use raises the question of how future IoT applications might affect the unlicensed spectrum bands in which they operate. Interference could also limit RF mesh networks in terms of their ability to perform some real-time applications. Increasing the density of the mesh may help alleviate some of these concerns—but at a higher cost. Nonetheless, the flexibility of the RF mesh architecture makes it attractive for early smart city applications, particularly street lighting and parking.

Hybrid PLC / Mesh:
While these networking technologies have traditionally operated independently of one another, more companies are working on using multiple types of control with a single system. These technologies enable flexibility to use wired and/or wireless links where it makes sense in each application. Wireless

can be particularly difficult in situations that require navigating tunnels, walls, and tall buildings. These hybrid solutions can offer more flexibility.

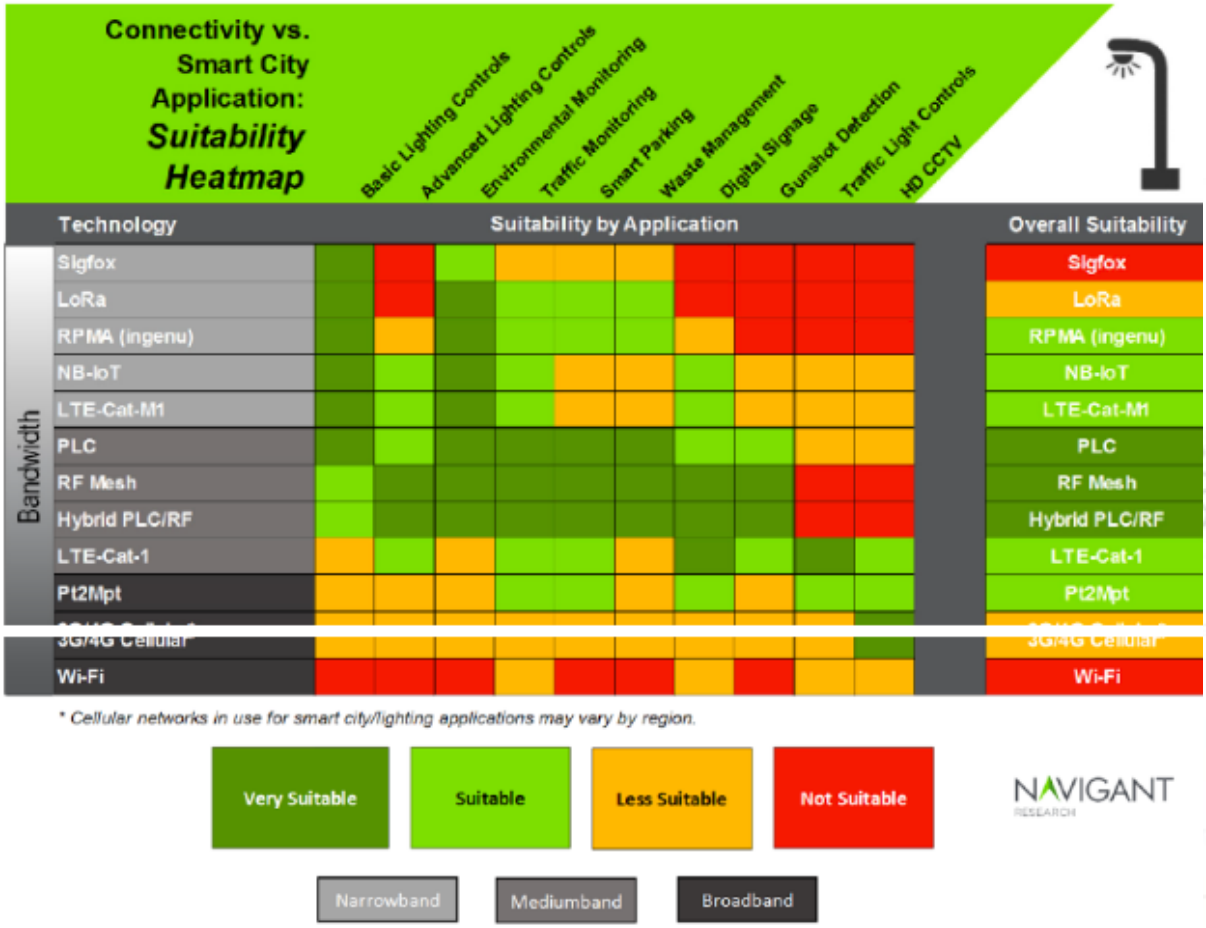
In April 2016, Echelon introduced an outdoor lighting control solution, the Lumewave Powerline-RF Gateway, that integrates power lines and wireless to enable lighting systems to mix and match connectivity options while still being managed through a single central management software. Echelon deployed such a system with the city of Bellingham, Washington, where 3,615 street lights are connected into a single network—86% wireless and 14% wired.

Broadband Options:
Greater bandwidth, such as that offered by traditional cellular networks, Wi-Fi, or point-to multipoint (Pt2Mpt) systems, offer greater flexibility and robustness in terms of the applications they may support—but typically come at a higher price than the narrow- and medium band options. The dominant broadband options for smart street lighting/city applications are described more fully below.

4G / 5G Cellular:
Cellular communications have grown in popularity for outdoor lighting applications thanks to nearly ubiquitous coverage globally and also to the fact that carriers have lowered pricing and begun to aggressively court the business. Because of low latency and higher bandwidth, 4G cellular technology can be a good choice when pairing smart lighting with other smart city applications. Depending on the specific technology, distance from the base station, and network congestion, data rates of 50 Mbps-100 Mbps (and even 1 Gbps promised for future versions) are possible, through 1 Mbps-5 Mbps speeds are routine today in most situations.
Enabling outdoor smart lighting and sensor data to use cellular data networks. The new cellular option enables a solution to implement LED lighting controls in residential, suburban, and other city areas that lack sufficient Wi-Fi coverage. The Core Node EX-C outdoor lighting control product will include capabilities such as scheduling, dimming, ambient light detection, and energy monitoring among other optional sensor features.

Point – To – Multi-point:
In a Pt2 Mpt network, multiple devices communicate through a central point. In this configuration, various nodes each send signals back to the centralized collection point. This approach is efficient, as only one data collection point is required for many nodes, and a failure at one node will not affect any others. However, if the hub fails, not all data from that central point will be sent to the master controller. That said, for some applications, a Pt2Mpt hub network will work well and may be less expensive and simpler to deploy than a mesh network. In addition, companies that use proprietary communication protocols and put an emphasis on network security seem to favor this type of system.

Suitability Heat-Map:



Recommendations And Best Practices:

1. Selecting street light solutions.
2. Connecting street lighting.
3. Understanding the potential of smart street lighting.
4. Clarity on local smart city priorities.
5. Setting Short, Medium and Long term objectives.
6. Smart Street Lighting as an asset.
7. Realize that the future is Hybrid.

Distinction Between Basic Lighting and Advanced Lighting:

Basic lighting: Controls such as on-off commands, dimming, and scheduling place little demand on the communication network—reliability and low cost are therefore the main requirements. Historically, a range of communication options have been used to provide these controls, including power line carrier (PLC), 2G cellular networks, and proprietary RF systems.

Advanced lighting: Management introduces a much broader range of control features, which require faster response and greater security (as a wider range of functions are accessible). There is also a presumption that additional features will be added over time, so the ability of the network to accommodate future upgrades is more important. Advanced lighting management also presumes the ability to integrate additional lighting (such as school zone flashers) or sensor controls with the network.

Smart City Platform applications with Smart Lighting:

Beyond the capabilities for advanced lighting controls, street lighting networks also have the potential to support a range of non-lighting applications as part of the broader deployment of Internet of Things (IoT) solutions for smart cities.

1. Environmental/air quality monitoring: Connected street lighting poles enable air quality and noise sensors to be easily deployed in specific locations or to provide citywide real-time monitoring capability.
2. Traffic monitoring: Traffic sensors connected to the street lighting can provide a more accurate and flexible monitoring of traffic and congestion levels.
3. Smart parking: Street lighting networks can provide the network infrastructure for parking sensors embedded in parking spaces or be used to mount video cameras that use vehicle detection software to provide occupancy information.
4. Gunshot detection and location: Gunshot detection systems can be deployed on lighting poles and use the network to transmit information on detected events to the operations center. Advanced systems can provide precise information on the specifics of the event, including the shooter's location and integrated video monitoring.

Other applications / Smart Elements which can benefit from Smart Lighting:

Traffic light controls: Traffic lighting that is adaptive to congestion levels, weather conditions, accidents, or other events can improve traffic flow, reducing travel times, fuel consumption, and pollution.

Smart waste management: Sensors in trash bins and dumpsters can provide data to optimize waste collection and identify problems from overfilling. Waste sensors can use dedicated networks or a common city network to relay data to the waste management team to help them plan collection routes.

Public messaging/digital signage: Public information networks now span a range of devices, including traffic and parking information panels, public information broadcasts, and dedicated kiosk services. Linking public information to real-time urban monitoring systems—like smart parking systems—provides more accurate and timely information. A common city network also allows public information to be relayed through a broader range of devices, including to smart phone or in-car systems.

High definition (HD) video surveillance: Many cities are using closed-circuit TV (CCTV) to provide video monitoring for traffic management and for public safety. The bandwidth requirements for HD video traditionally required a fixed broadband network—but high bandwidth wireless networks are increasingly capable of supporting such applications.

20.4 Use Cases

Case Study 1

White Bear Lake, Minnesota: Innovations in Lighting:

White Bear Lake is a suburb of about 23,000 residents located near Minneapolis-Saint Paul. It is home to two proof-of-concept projects in the town's Railroad Park focused on the benefits of white light tuning and the use of predictive weather controls for lighting. The white-tunable and connected LED lighting solution allows municipal managers to vary the color and intensity of the lighting in the park, as well as the wattage. This enables energy savings and for the lights to be dynamically adjusted to meet the needs of residents and visitors for special events hosted at Railroad Park. Cooler color temperatures enhance visibility and awareness whereas warmer color temperatures minimize disruption to sleep cycles and create more aesthetic public spaces. Tuning of the lights can be pre-scheduled or adapted dynamically in order to address particular situations (e.g., aid visibility for first responders and safety officers). The solution also addresses concerns raised by organizations such as the American Medical Association around the adverse effects of blue-white LEDs.

The second proof-of-concept utilizes Echelon's partnership with IBM to leverage IBM Watson's analytics capabilities for weather adaptive lighting. This solution enables dynamic responsiveness during challenging weather conditions such as heavy rainstorms, fog, blizzards, and dust storms. Weather adaptive lighting can also provide predictive inputs to lighting systems and a platform for creating public weather-related warning systems.

Case Study: 2

Northwestern United States: Integrating School Zone Beacons:

A city in Washington State is using its street lighting network to upgrade school flasher beacons, providing greater control and adaptability for its warning signals. This project, currently in the implementation phase, is a good example of how street lighting networks can be extended to support other innovative urban applications. Currently, the school's crossing beacons are supported and programmed over soon to be discontinued 2G cell networks, requiring cellular service for each sign. The signs are programmed based on the current school year and cannot support special events or holidays.

A single gateway solution is connected through wireless radio frequency (RF) controls and supports and communicates with the entire school network of flasher beacons. The solution allows the school to make changes to the flashing beacons dynamically, which ensures the lights are flashing during desired times and thus improves safety for the students. Remote scheduling and monitoring capabilities are greatly improved since specific schedules can be assigned to particular groups of beacons and the schedules can operate autonomously in the case of a loss in communications. Additionally, the flashing beacon solution can be expanded in the future to support the community's outdoor lighting network.