



भारतीय राष्ट्रीय राजमार्ग प्राधिकरण

(सड़क परिवहन और राजमार्ग मंत्रालय)

National Highways Authority of India

(Ministry of Road Transport and Highways)

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No.11041/218/2007-Admn

Date : 15.09.2016

Policy Matter - Technical (214/2016)

[Decision taken on file No. NHAI/13043/01/2016/HAM of Electronics (HAM) Division]

Sub.: Implementation of Advance Traffic Management System (ATMS) on developed sections of National Highways with NHAI - Standard ATMS Provisions.

Existing provisions under BOT/ OMT Concessions prescribe ATMS in the projects where traffic is more than 40,000 PCUs/day. Further, the system requirements are not adequately defined in the Manuals (Specifications and Standards)/ Schedule-D. The ATMS implemented so far is non-integrated/ stand-alone systems resulting into different set-up of ATMS components with inadequate Items/BOQ which is insufficient to serve the desired purpose of "Intelligent Transport Systems" meant to deliver tangible service to address the road safety.

2. NHAI has prepared one standard document addressing Functional and Technical Specifications of ATMS Solution comprising essential components & sub-components. A copy of the standard document is enclosed. The primary focus of the system prescribed under this document is:

- (i) Proactive detection of potential incidents likely to lead to road accidents, e.g. contraflows, stopped vehicles and caution to the approaching traffic vulnerable to possible accidents.
- (ii) Context sensitive checklist based incidents and accident management system procedure to ensure standardized response across all stretches.
- (iii) Establishment of corridor control centre (ATMS Control Centre) typically located at fee plaza complex. A single control centre to typically handle one project stretch depending upon factors such as tolling length etc. within the scope.
- (iv) CCTV Surveillance and provide enforcement assistance.
- (v) Provision of Service Level Parameters to measure effectiveness of ATMS after it is implemented on a project stretch.
- (vi) Mobile App to provide interface between control centre and road user for timely dissemination of key information.

3. NHAI has taken the following decisions:


- (i) The standard document enclosed shall be incorporated in RFPs (Specifications and Standards) of all future projects, where ATMS is considered. The criteria to go for ATMS in the projects is also modified, i.e., ATMS is to be prescribed for all roads of NHAI being put to tolling, i.e., even if traffic is less than 40,000 PCUs/ day, ATMS will be implemented on all 4-lane and above highways.

Contd.....P/2

(ii) In case of existing BOT/ OMT Projects where provision of ATMS exists, RO may obtain consent of Concessionaire within 15 days either to allow Electronics Division to procure ATMS Service Provider (or) Concessionaire through their existing service provider shall commit and undertake immediately the upgradation of their existing ATMS as per enclosed standard document of ATMS maximum within 6 months. In order to decide the cost sharing formula, RO may also obtain from the Concessionaire the details of cost of ATMS incurred by him as also recurring/ O&M cost of ATMS. The consent and the details may be forwarded to Sh. Deepak Saxena, GM (Electronics).

(iii) In case of BOT/ OMT Projects not having provision of ATMS and in case of Public Funded Projects (NHAI Toll Plazas), Electronics (HAM) Division will procure the Service Provider for ATMS and implement ATMS (cost to be borne NHAI) at the cost of NHAI, by selecting the reaches/ sections in the order of level of traffic, with priority to reaches near Delhi first.

Encl.: Standard Document of ATMS


(A.K. Sadhu)
CGM (Coord)

To

All officers and employees of HQ/ROs/PIUs/CMUs/Site Offices.



National Highways Authority of India
G-5&6, Sector-10, Dwarka, New Delhi - 110075

Advanced Traffic Management System (ATMS) on NHs

Functional & Technical Specifications of ATMS Components / Sub-Components



Highway Automation and Management Division

August 2016

Document Control Status

Document Amendment Record			
Version	Date	Prepared By	Brief Record of Change
June 2016	05-05-2016	M/s CDM Smith INC. (Formerly Wilbur Smith Associates) having its registered office at No.8, Second Floor, 80 Feet Road, RT Nagar, Bangalore - 560032, Karnataka, India	Part of a set of documents prepared under consultancy project on Road Safety Zone (RSZ) Concept on East-West Corridor NH-25 (27) under Road Safety Component of ADB Loan 2029-IND.
August 2016	02-08.2016	NHAI	Addition of: (i) Travel time estimate system (ii) Disaster Management framework (iii) Addition of requirement on external connectivity. Improvements in Technical Requirements of CCTV, Mobile Radio Communication System..

ACRONYMS and ABBREVIATIONS

APTS	Automatic Power Transfer Switch
ATMS	Advanced Traffic Management System
BIS	Bureau of Indian Standards
BS	British Standard
CIF	Common Interface Format
CCTV	Closed Circuit Television
DLP	Defects Liability Period
DM	Disaster Management
DDMA	District Disaster Management Authority
ECB	Emergency Call Box
ERT	Emergency Road side Telephone
EN	European Standard
FAT	Factory Acceptance Tests
FPS	Frames Per Second
GUI	Graphical User Interface
HDPE	High-density polyethylene
HVAC	Heating Ventilation and Air conditioning
IRC	Indian Roads Congress
ITM	Integrated Traffic Management
ITS	Intelligent Transport Systems
ITU-T	Telecommunication Standardization Sector of the International Telecommunication Union
JPEG	Joint Photographic Experts Group
LAN	Local Area Network
MET	Meteorological Data Systems
MoRTH	Ministry of Road Transport and Highways
MTBF	Mean Time between Failures
MTTR	Mean Time to Repair
NAS	Network-Attached Storage
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Force
NHAI	National Highways Authority of India
NMS	Network Management System
NVR	Network Video Recorder
OF	Optic Fibre
OFC	Optic Fibre Cable
O&M	Operation and Maintenance
PIJF	Polythene Insulated Jelly-filled
PTZ	Pan, Tilt, Zoom
SAT	Site Acceptance Tests
SDMA	State Disaster Management Authority

SIT	System Integration Tests
Solar PV	Solar Photo voltaic
SWB	Static Weighbridge
TEC	Telecommunication Engineering centre of the Government of India
UPS	Uninterruptible Power Supply
VMS	Variable Message Signs
WAN	Wide Area Network
WIM	Weigh-in-motion
WPC	Wireless Planning Council

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Chapter 1 INTRODUCTION

This document is a part of a set of documents to facilitate NHAI for implementation of the Advanced Traffic Management System on National Highways. Government of India, Ministry of Road Transport and particularly, NHAI have taken the initiative to provide guidelines for ATMS implementation in the past and the references can be found in **IRC:SP:87-2013** (Manual of Specification and Standards for Six-laning of Highways through PPP), **IRC:SP:84-2014** (Manual of Specification and Standards for Four-laning of Highways through PPP), and MoRTH manual prescribing Specification for Road and Bridge Works (5th Revision) etc. As these references focused broadly on road infrastructure development, this document is focused mainly on implementation of comprehensive and integrated Advanced Traffic Management System (ATMS) on National Highways.

1.1 Purpose of this Document

The Purpose of this document is to identify the essential components / sub-components that should necessarily be included in such a project and provide detailed functional requirements and standards to be adhered to by such components / sub-components to ensure achievement of desired safety, reliability, availability and environmental requirements.

The Functional and Technical specifications prescribed in this document are the minimum/benchmark requirements individually and collectively to be fulfilled by various ATMS equipment and systems. However, to encourage adoption of best practices with upcoming improved technologies in the field of Intelligent Transport System (ITS) with the passage of time, the implementing agency shall ensure to offer latest and most relevant technical solutions.

1.2 Scope of Document

Broadly, the ATMS implementation shall cover design, supply, installation, commissioning and operation and maintenance of Advanced Traffic Management Systems (which is one of the components of Intelligent Transport System – ITS). The system would include out-door equipment including emergency call boxes, variable message sign systems, vehicle actuated speed system, meteorological data system, close circuit TV camera (CCTV) system, traffic counting and classification system, mobile radio communication system and transmission system. The indoor equipment would comprise a large display board, central computer (with Network Management System – NMS), CCTV monitor system, call centre system or management of emergency call boxes housed in a control centre with uninterrupted power supply. Any new technology, meeting the requirements specified in these specifications should not be excluded. The systems shall meet following objectives:

- Smooth and uninterrupted traffic flow
- Enhance road safety
- Real time information and guidance to users
- Emergency assistance round the clock
- Alerts for abnormal road and weather conditions
- Reduced journey time and inconvenience

Keeping in view the above objective, ATMS shall inter-alia provide the following facilities to various stake holders.

Highway Users	<ul style="list-style-type: none"> ➤ Make emergency calls to Control Centre in case of accidents, breakdown, fire and ambulance. ➤ Receive alerts / alarms messages about unusual condition on the road.
Traffic Managers	<ul style="list-style-type: none"> ➤ Data / information for efficient and effective handling of traffic ➤ Control systems to configure / change variable message sign from control centre ➤ Information regarding location of any accident, incoming calls, help required and messages to be passed to third parties (other stake holders) ➤ Mobilize, monitor and guide the movement of ambulances, cranes and patrolling vehicles with Information regarding traffic congestion, speed and weather conditions.
Regional Level Control Centre and Master Control Centre for NHAI, HQ	<ul style="list-style-type: none"> ➤ Provision of reviewing live feed and / or recorded archives of CCTV video footage as well as voice messages ➤ Live audio Patch-up with the highway stretch manager and / or ambulance facility and Trauma Care Centre ➤ Help assessment of traffic position at specific location on NHs for authority to take adequate action thereupon. ➤ Live feed of the GIS map-based monitoring facility of the entire highway stretch including all details related to incident management. ➤ Active monitoring of performance (by sampling) of ATMS System Service Provider ➤ Comparison of similar data between two or more selected ATMS enabled stretches and Video conferencing with one or more ATMS control centres. ➤ Continuous learning to improve process, suitability of technology, optimal choice of devices / equipment for continuous enhancement of NHAI's road safety mission.

A typical ATMS implementation shall comprise of at least the systems / sub-systems depicted in the table below and meet the applicable latest versions of the international/national standards, included therein:

S. No.	Subsystem	Items	Designed to conform	Certified to Standard
1	Video Surveillance System (CCTV)	CCTV Fixed Camera	PAL, BS EN 62676-1-2, ONVIF specifications profile S & profile G, BS EN 62676-2-2, BS EN 62676-2-3	EN 61000, IEC 60068-2-27, EN 60529(IP66)
		CCTV PTZ Camera		
		Video Encoder		
		Road-side Housing and Support Structure	BS EN 12767	EN 60529 (IP56)
2	Video Incident Detection System(VIDS)	Video Camera	PAL, BS EN 62676-1-2, BS EN 62676-2-2, BS EN 62676-2-3	EN 61000, IEC 60068-2-27, EN 60529 (IP66)
		Road-side Housing & Support Structure	BS EN 12767	EN 60529 (IP56)

S. No.	Subsystem	Items	Designed to conform	Certified to Standard
3	Vehicle Actuated Speed Display	Display	EN 12966	EN 60529(IP 56)
		Support Structure	BS EN 12767	
4	Emergency Road Side Telephone System	Phone System		
		Road side Housing and Support Structure	EN 60529 (IP65), BS EN 12767	
5	Variable Message Signs (VMS) [Fixed and Portable]	Display		EN 12966 EN 60529 (IP56)
		Road side Housing and Support Structure	BS EN 12767	EN 60529 (IP56)
6	Meteorological Data System (MET)		MoRTH – Specifications for Road & Bridge works: 5 th Revision	
7	Weigh-in-Motion system			OIML R 134-1
8	Automatic Traffic Counter cum Classifier (ATCC)		MoRTH – Specifications for Road & Bridge works : 5 th Revision	
9	Network / Communication Infrastructure	Cable		TEC Approved
		Protocol	IEEE 802.x, RS 485, RS 422	
10	Mobile Radio Communication System		ETSI DMR tier 3 / ETSI DPMR Mode 3/ NXDN Trunking	
11	ATMS Control Centre		EN 50132-7, Relevant NTCIP standards, IEC 12207	

NOTE: Other relevant standards and codes required to be adhered to by the service provider are listed in Chapter 16 of this document. A suggested guideline for placement of various ITS devices and subsystems is detailed in Appendix – A of this document.

1.3 Documents Layout and Contents

This document details the technical specifications for the design, supply, installation, commissioning and maintenance requirements for a comprehensive and integrated Advanced Traffic Management System (ATMS) for National Highways in India. This document describes each type of ATMS equipment under the following headings:

1. Scope
2. Equipment Function
3. Functional Requirements
4. Technical Requirements
5. Environmental Requirements
6. Testing
7. Installation Requirements
8. Maintenance Requirements
9. Operational Requirements

The first section of the document details the general provisions for ATMS equipment, with the following sections providing details for each type of equipment listed in section 1.3. Where details specified within the specific equipment sections overlap with those of the General Provision for ATMS, the specific equipment section shall take precedence.

1.4 Scope of Work

Briefly, the ATMS components to be deployed shall inter alia include:

- (a) Video Surveillance System (CCTV PTZ Dome / Fixed Camera)
- (b) Video Incident Detection System
- (c) Vehicle Actuated Radar Speed Displays
- (d) Emergency Roadside Telephones
- (e) Fixed / Portable Variable Message Sign
- (f) Meteorological System
- (g) Portable Weigh in Motion
- (h) Automatic Traffic Counter cum Classifier
- (i) Travel Time Estimation System
- (j) The ATMS Control Centre including the equipment (hardware, software, and local networking)
- (k) Communications System utilizing Optic fiber, point-to-point wireless links, GSM/GPRS and Wi-Fi Communications linked to ATMS Control Centre.
- (l) Power supplies for field equipment: working on Mains power supported with back-up (largely on renewable energy) to facilitate 24 X 7 operation and for the ATMS Control Centre working on Mains power supported by UPS and Diesel generator set of adequate capacities, to facilitate 24 x 7 operation.
- (m) Disaster Management Support System.

1.4.1 The essential feature of the proposed ATMS is the presence of an integrated Traffic Management and Rescue Console. The Traffic management and rescue console, under the leadership of the ATMS Control Centre, is intended to introduce an automated check-list based approach to ensure an integrated and efficient service delivery to the various stakeholders to prevent accidents and in case the accident does happen, then timely coordinated action in rescuing accident victims and early restoration of traffic.

1.4.2 Services shall be governed through Service Level Requirements (SLR) mentioned in Appendix-B to this document. Service Level Requirements basically prescribe identified key performance standards and minimum benchmark to be achieved by the Service Provider in service delivery.

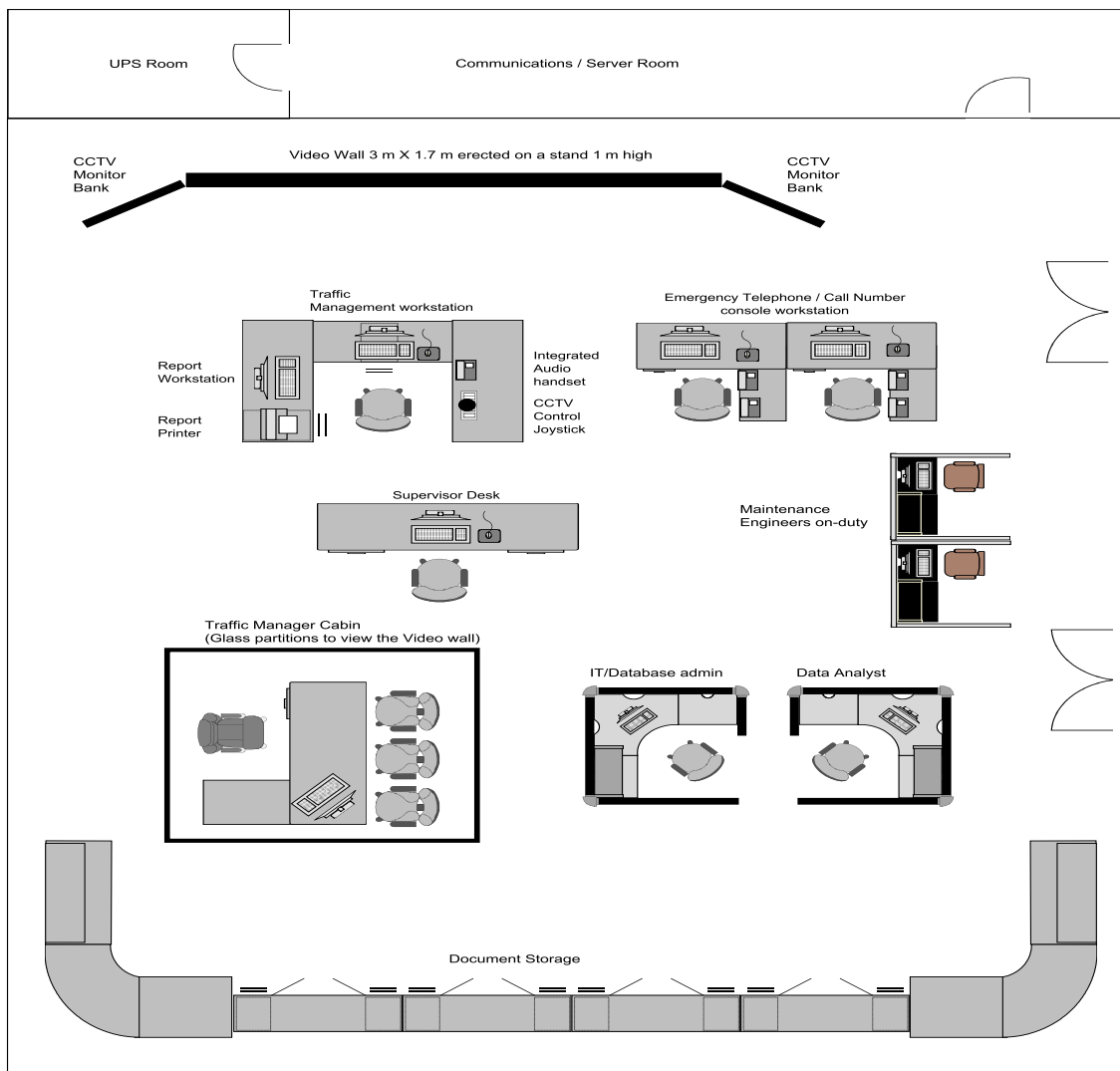
1.4.3 Service Provider shall be responsible to deliver complete turnkey solution of ATMS and entire responsibility for system design, testing, civil and electrical works including cabling / conduit, electrical power requirement including provision of uninterrupted power supply (UPS) of adequate capacity shall vest with the service provider.

1.4.4 ATMS Control Centre: The most crucial and important part off the project shall be establishing the ATMS Control Centre that will accommodate and operate the entire ITS systems. The Figure shown below provides an indicative layout of the ATMS Control Centre facility that will accommodate and operate the ATMS systems to facilitate operations such as:

- (a) Emergency Response System: call logging (Emergency wayside phones) and incident management on the Integrated, visual console and audio communication station;

- (b) Data analysis and reporting systems;
- (c) Traffic Management system logging vehicle speed & flow data;
- (d) Operational procedures;
- (e) Emergency events and incident reporting database.

1.4.5 It is proposed that the ATMS Control Centre facility be established in a building on the highway approximately midway of the corridor within the ROW where feasible. Rescue & Patrol vehicles shall be located at more than one strategic location along the highway to ensure an adequately rapid response during rescue and traffic management. A possible choice could be to situate it with the Traffic Aid Post and Medical Aid Post that the Concessionaire is required to provide within Article 17 & 18 of the Concession Agreement. Where as in case of public funded projects the Service Provider shall prepare at least three alternative proposals of ATMS Control Centre and submit to NHAI for approval. Priority be given to choose a location which is within RoW and is in close vicinity to infrastructure (BTS/Exchange) of any telecom service provider so that network connectivity from ATMS Control Centre may easily be ensured.



Concept Layout of ATMS Control

1.4.6 Service Providers Responsibility/Obligations

The Service Provider agrees and undertakes to fulfil the minimum service requirements/ obligations prescribed under Appendix B to this document. Broadly, these shall *inter-alia* include

- 1.4.6.1 Setting up of an integrated ATMS solution including ATMS Control Centre as per requirements including all related civil and mechanical works on the highway.
- 1.4.6.2 Coordinate with respective agencies for obtaining the necessary approvals before commencing works. System installation shall be done with minimal disruption to on-going operations.
- 1.4.6.3 Strictly comply with the prescribed timelines and technical specifications.
- 1.4.6.4 Operating the ATMS to meet the Service Level Requirements (SLR) prescribed.
- 1.4.6.5 Performing system maintenance to ensure adhering to the requirements for system maintenance.
- 1.4.6.6 Ensure ATMS architecture is capable of remote monitoring. NHAI would monitor the service performed and / or status of traffic / highway administration including handling of incidence by highway patrol through real time access of ATMS Control Centre of the Service Provider through NHAI's Regional Control Centre and / or Master Control Centre in New Delhi / NCR. Service Provider shall provide on-line access to the control centre for NHAI and/or NHAI's representative meeting the prescribed provisions. NHAI may prescribe Electronic Data Interchange (EDI) Protocol for real time access to ATMS data and Service Provider will be bound to follow such EDI protocol.
- 1.4.6.7 The service provider shall be responsible to comply with all statutory requirements concerning the subject matter viz. compliance to Labour Laws, Tax(es), employee insurance etc. and indemnify NHAI and its employees or representative against any such claims.
- 1.4.6.8 The service provider shall be responsible for arrangement and provision of all sources of electrical power and communication for setting up the ATMS and providing the required services in compliance of SLR.
- 1.4.6.9 The Service Provider shall suitably interface their ATMS system with the 24X7 National Highways Helpline (1033) to meet the service level requirements.
- 1.4.6.10 Reporting Requirements: Providing monthly performance reports related to operations and maintenance of the project. Report formats will be developed in consultation with NHAI and shall include all parameters considered under SLR.

1.4.7 Technical Resources / Personnel

- 1.4.7.1 The service provider shall form a multi-disciplinary team for undertaking this assignment. The agency shall be fully responsible to deploy its resources / personnel whose qualifications and experience fully commensurate with the task/responsibilities assigned and to achieve the objectives under the. The Personnel deployed should be experienced enough and should have proficiency in the requisite techniques / skills so as to provide practical, realistic and actionable

service. Indicative minimum staffing and qualifications requirements for ATMS Control Centre and the process flow is attached to this document (Appendix C).

1.4.7.2 Removal and/or Replacement of Personnel

If NHAI (i) finds that any of the Personnel has committed serious misconduct or has been charged with having committed a criminal action, or (ii) has reasonable cause to be dissatisfied with the performance of any of the Personnel, then the service provider shall, at the NHAI's written request, forthwith provide as a replacement a person with qualifications and experience acceptable to NHAI.

1.4.7.3 Performance standards:

The service provider shall undertake to perform the services with the highest standards of professional and ethical competence and integrity. Keeping in view the sensitivity involved, the personnel deployed should maintain confidentiality / integrity at all times and work in a professional manner to protect the interest of NHAI. The firm shall promptly replace any personnel assigned under this contract that NHAI considers unsatisfactory.

Chapter 2

GENERAL PROVISIONS FOR ATMS EQUIPMENTS

2.1 Overview

2.1.1 Purpose

This section describes the general requirements for the design, supply, installation, commissioning and maintenance of ATMS systems.

2.2 Non-Functional Requirements

2.2.1 Performance

1. Each equipment specification contained in this document details the specific performance requirements pertaining to that specification.
2. All ATMS equipment shall work 24 hours a day on all days of the year.

2.2.2 Reliability

1. Each type of ATMS equipment shall be designed to operate continuously for a period of time as specified in the relevant section of this document, when used in the ATMS project environment.
2. Generally, each item of ATMS equipment shall have a Mean-Time-to-Repair (MTTR) (time to full normal operation following a failure) specified under required service levels in the associated Service Level Agreement contract. Equipment failure and MTTR metrics will be monitored and recorded through an exclusive, computerized ATMS Asset Management system to be set up by the service provider that shall be continuously maintained for audit by NHAI or its authorized representative.

2.2.3 Maintenance

Routine and preventative maintenance procedures shall be provided for all ATMS equipment to ensure that the equipment continues to work within the prescribed service levels.

2.2.4 Environmental

1. All ATMS equipment must maintain full functionality and continue to operate within the limits of this specification when subjected to the working environment of the project.
2. All equipment shall function and perform as per the specification, or better, in ambient temperatures ranging from -10°C to 55°C and in 95% relative humidity non-condensing.

2.2.5 Documentation

The ATMS Service Provider shall be adequately prepared with necessary documentation for effective operations and maintenance. Towards this, all ATMS Equipment shall be supplied and used with technical documentation comprising such manuals and handbooks accompanied by maps, plans, drawings, diagrams, specifications, computer programs, flow diagrams, coding lists, library programs, and all such information as may be necessary for the Service Provider to effectively operate and maintain the system.

1. The documentation shall be provided under the following general headings and indicative contents (which are not necessarily exhaustive) as may be appropriate to the equipment being supplied;
 - a) Hardware details:
 - i) *Basic technical data, type nos., ratings, product codes, etc.*
 - ii) *Details of energy usage at defined load states*
 - iii) *Technical description*
 - iv) *Warnings and restrictions*
 - v) *Drawing lists, parts lists*
 - vi) *Module identification codes*
 - vii) *Mass and overall size of each type-numbered item*
 - viii) *Packaging material details.*
 - b) software manuals:
 - i) *Data, descriptions and details.*
 - c) Drawings - mechanical and structural:
 - i) *General arrangements*
 - ii) *Principal detail drawings.*
 - d) Drawings - electrical and electronic:
 - i) *System schematics, circuit and wiring diagrams.*
 - e) Installation instructions:
 - i) *Comprehensive instructions (including drawings for site assembly) for correct installation and connection of all parts of the Equipment, to be retained for reference purposes*
 - ii) *Instructions relating to each item of equipment likely to be installed separately.*
 - f) Commissioning instructions:
 - i) *Set-up details of addresses, operating parameters, control ranges and limits, etc.*
 - ii) *Commissioning procedures and tests.*
 - g) Operating instructions:
 - i) *Procedures for normal operation.*

- h) Maintenance instructions:
 - i) *Details of routine maintenance*
 - ii) *Cleaning instructions*
 - iii) *Trouble-shooting and fault-finding charts.*
 - iv) *Maintenance information cards or booklets.*
 - i) Product 'End of Life' Plan:
 - i) *Instructions for dismantling the equipment without causing damage*
 - ii) *Details of re-usable/recyclable components and materials and the coding system used to identify them,*
 - iii) *Details of any precious metals*
 - iv) *Details of any hazardous substances, heavy metals or other pollutants with instructions on their safe handling and disposal.*
3. Documentation shall be produced in accordance with the standard as required by the NHAI or NHAI's representative and shall be approved by the NHAI or NHAI's representative before the system is accepted.
 4. Documentation shall use SI units in accordance with ISO 80000-1.
 5. Detailed design drawings and structural calculations for each type of pole, gantry or structure (including foundations) used to mount ATMS equipment shall be submitted to the NHAI and/or the NHAI's nominated representative for approval after due certification by a Licensed Structural Engineer. The design calculations shall be carried out in accordance with relevant MoRTH/IRC standards where applicable.
 6. The drawings shall show materials specification and finishes for each item of equipment proposed for use. All weld types and sizes shall be identified on the design and construction drawings.
 7. Power schematic diagrams for all ATMS installations shall be submitted to the NHAI and/or the NHAI's nominated representative for approval.
 8. Telecommunications schematic diagram shall be submitted to the NHAI and/or the NHAI's nominated representative for approval. The telecommunications diagram shall include all systems, subsystems and components, including connections to modems, devices and the telecommunications access and backbone network.
 9. As-built record drawings shall include longitude and latitude data accurate to within two (2) metres for each of the ATMS equipment and infrastructure installed.
 10. Documentation should be organized so that unnecessary repetition is avoided. Topics likely to be frequently referenced by the service provider (e.g. operating and maintenance instructions) should be given prominence. As it is recognized that the volume of the documentation and drawings to be provided will vary considerably with the complexity of the equipment being supplied (ranging from one ring binder to several volumes), the NHAI or NHAI's representative

should be consulted for its agreement on the presentation and layout of the documents to be provided.

11. Documents and drawings should be maintained at site as well as provided to NHAI on CD-ROM in Adobe Acrobat (.pdf) file text recognition format (i.e. converted to pdf from the source program rather than scanned) using the version current at the time of supply. A minimum of two sets shall be provided. The disks shall be virus checked and fully marked up / labelled prior to dispatch to the NHAI.
12. The NHAI or NHAI's representative may additionally require two sets of final documents and drawings in full size paper form for record purposes, which shall be provided on a due confirmation from the NHAI or NHAI's representative.
13. When paper copies of text documentation are to be maintained at site and / or provided to NHAI, they shall be in A4 format bound into durable binders. The manner in which drawings in paper form are bound may vary with their size and should be agreed with the NHAI or NHAI's representative prior to delivery.
14. Installation instructions to be included in the package of any item of equipment likely to be installed separately or in conjunction with the ATMS equipment, shall be in the form of a leaflet or similar. It shall have sufficient information (with diagrams) for the item concerned to be correctly installed in position and connected, and describe any necessary set-up procedure.
15. Maintenance information cards or booklets, one set of which is to be secured within each equipment enclosure or cabinet shall be encapsulated in a durable weatherproof format. They shall show the general layout of equipment and component modules and references in schematic form, and set-up addresses for on-site replacement of component modules.
16. The format and extent of electronic media and/or hardcopy presentation of technical shall be agreed with NHAI / NHAI's representative before final versions are produced.

2.2.6 Submittals

1. All ATMS equipment shall, as a minimum, meet all the requirements listed in these specifications. Future technological advances may allow for ATMS equipment to be provided that exceed the minimum requirements in these Specifications.
2. Systems and subsystems that minimize the possibility that failure of any single component or module will cause total system failure shall be provided. Failure of one component or module shall not cause the failure of any other component or module.
3. Product data, design and construction drawings for all of the components shall be submitted to the NHAI and/or the NHAI's nominated representative for approval.

4. Heat-load calculation sheets, accompanied by related manufacturer's data sheets to support justification of proposed cooling systems shall be submitted to the NHAI and/or the NHAI's nominated representative for approval. Power consumption calculations to support proposed power distribution type and size shall also be submitted.

2.2.7 Quality Assurance

1. The ATMS equipment provider shall have in place a quality system complying with ISO 9001, for the activities of design, development and production of the ATMS equipment to be supplied unless otherwise agreed by the NHAI or NHAI's nominated representative. The quality system shall cover each and every location where such activities are undertaken.
2. The NHAI or NHAI's nominated representative may audit the potential supplier's quality system and test facilities before approving use of the proposed supplier. NHAI reserves the right for the same.
3. The following requirements must also be considered:
 - a) The design and installation of Electrical Installations shall comply with the requirements of the Bureau of Indian Standards.
 - b) The service provider shall be required to provide, at their own expense, samples of the proposed equipment and all associated approvals, test reports and schedules to verify that the equipment meets all of the NHAI's requirements.

2.2.8 Field-Access & On-line remote Access during the Contract period

1. Field-Access: All the equipment of the ATMS system shall provide access for data extraction and control (where applicable) in a secure manner from a local laptop computer. The access shall be either in the form of a wired connection via a standard interface like TCP/IP (in the form of an Ethernet connection), RS 232, RS 485 or a wireless connection like Bluetooth or Wireless Lan. It shall be further possible in a secure manner to view and transfer such accessed data on to the appropriate ATMS server database to 'make-good' any data loss that may have occurred during normal operations. Such an operation of data extraction and transfer to the ATMS server database shall be automatically detected and logged into the system as an event for causing a system alert and appropriately included in the event report.
2. The service provider shall use an appropriate GUI supported software (s) for the performing the above data access, control and transfer to the ATMS database.
3. The systems commissioned by the Service Provider shall provide, during the entire period of the Contract, adequate remote on-line access (via-internet) to the NHAI and / or NHAI's representative for on-line evaluation of the functioning of each equipment / sub-system, including all field equipment. The Service Provider shall also provide the NHAI a suitable tool for the same. In the case of PTZ CCTV Cameras, this tool shall also support the facility of observing real-time images from each camera by remote operation of the Pan-Tilt-Zoom facility. NHAI reserves the right to include the results of any such examination by NHAI and / or its representative in the achieved service levels for the period under evaluation.
4. For the purpose of enabling the above on-line access facility, each of the equipment / sub-systems shall be Internet Protocol (IP) based supporting the Simple Network Management Protocol (SNMP).
5. The above tool shall also include a feature by which the NHAI and / or NHAI's representative can generate detailed performance, operation and maintenance reports without the need for any support / intervention from the Service provider's personnel.

2.3 Functional Requirements

2.3.1 Power Supply

1. The field equipment shall have the locally available mains power supply (from the electricity utility) as the primary source and supported with a relevant Renewable energy - based power supply and / or generator back up to ensure 24 x7 operation.
2. The ATMS Control Centre shall have the locally available mains power supply (from the electricity utility) as the primary source and supported with a UPS and generator back up to ensure 24 x 7 operation.

3. Except where detailed in specific sections below, all ATMS equipment shall be powered from either
 - a) A single phase 230Vac 50Hz supply.
 - b) A three phase 440Vac 50Hz supply.
4. ATMS enclosures shall include a power distribution subsystem for supplying power supply to each component within the enclosure and related / inter-connected ATMS equipment. The circuit breakers shall be properly sized according to the expected loads of the ATMS equipment and to meet relevant electrical code requirements.
5. All electrical equipment and cabling shall be provided in accordance with relevant BIS standards. In case there no relevant BIS standard exists the BS 7671 standard shall be applicable.
6. The power distribution panel shall be directly fed by the main circuit breaker at the electrical point of service. The power distribution assembly shall include an interface and connection to the UPS (where provided). The power assembly shall be connected to the earthing system.
7. The enclosure shall be earthed in accordance with the relevant BIS regulations.
8. The enclosure shall include a 230Vac 15 Amps 3-pin dual socket power outlet conforming to BIS standard.
9. The power sockets shall be installed in accordance with relevant BIS standard.
10. A Multi-stage Transient Voltage Surge Suppressor (TVSS) shall be provided for each external cable (related to power supply, signal, data or any other), connection which is terminated at any item of exposed external equipment, or routed through an outdoor area. The TVSS shall be rated in accordance with BIS requirements.
11. The TVSS shall be capable of handling minimum 30KA fault current. Provision shall be made for protection of earthing and the shield/armour of coaxial cables and TVSS for each signal conductor.
12. The TVSS shall not only clamp the voltage, it shall also divert the fault currents to ground. If a TVSS is destructively tripped, there shall be a clear visual indication that the ATMS equipment is no longer protected and the TVSS needs a reset or replacement.
13. ATMS equipment shall automatically regain full operational functionality when related electrical power supply is restored, without the need for manual intervention.

2.3.2 Uninterruptible Power Supply (UPS) Subsystems

1. The worst-case power-load data shall be used to design the electrical conductor sizes. These shall be submitted to the NHAI and/or the NHAI's representative for approval.
2. A UPS shall be provided wherever required. The UPS shall meet the requirements of relevant standards of BIS.

3. Unless otherwise stated in the design drawings and/or specifications, UPS with a minimum of four (4) hour backup shall be provided for all ATMS equipment and telecommunications device locations.
4. An Automatic Power Transfer Switch (APTS) shall be provided inside the ATMS ground mounted enclosure which transfers power from one of the external sources to the electrical distribution system. The APTS shall monitor the status of the primary power source and transfer the power connection to the secondary power source when primary power source fails or suffers degradation. The APTS shall be provided with means to operate in manual mode.
5. The APTS must be able to transfer the connection with the internal power system, from the primary power source, to the secondary power source, within 1 mains power cycle (less than 20ms).
6. Additional equipment necessary to eliminate the delay in the transfer of power sources which may cause the ATMS equipment to reboot shall be provided.
7. Each external power supply line shall be terminated at the APTS.

2.3.3 Earthing

All earthing of ATMS equipment shall comply with BIS regulations.

2.3.4 Telecommunications

The field equipment shall be connected to the ATMS Control Centre via an optic fibre network using suitable interfaces. Refer to section 12 within this document for details of telecommunications and networks.

2.4 Hardware Design Requirements

2.4.1 Mechanical and Housing Requirements

Non-Ground Mounted Equipment

1. ATMS equipment not contained in a ground mounted equipment enclosure will have specific housing requirements depending on location, weather conditions and vibration from road vehicles.
2. The housing shall be structurally rigid. Mounting accessories such as nuts, bolts, studs, locks, washers etc. shall be of corrosion resistant stainless steel. The whole assembly shall withstand vehicular fumes without degradation for its entire service life.
3. Housing design shall be conducive to easy maintenance.
4. Housing shall secure the housed equipment, from tampering and theft. Means shall be provided to raise an alarm in the control room in case of tampering.
5. Cable entries to connect the signal, power and control wires to the encased equipment shall be provided and the housing shall meet IP65 to the minimum (unless otherwise specified for a particular ATMS equipment under the relevant section of this document).
6. Housing shall have adequate space to accommodate cable overages normally provisioned for future re-connection.
7. Forced air cooling within the housing shall be provided if installation situation demands.
8. Viewing window in case of camera housings shall not introduce distortions or artefacts on the image.
9. Suitable arrangements to prevent misting within the housing shall be provided where ever necessary.
10. Further details are included in sections relevant to each type of ATMS equipment.

2.4.2 Ground Mounted Equipment Enclosures and Poles

2.4.2.1 Ground mounted enclosures and mounting arrangements

1. The ground mounted enclosure shall house telecommunications equipment, power and other related equipment necessary for the operation of ATMS equipment.
2. The equipment must continue to work within its normal operating parameters in this environment, regardless of location.

3. The ground mounted enclosure shall be weather resistant and conform to BIS requirements with an ingress rating of IP65, as a minimum. Where the ground mounted enclosure needs to be penetrated, such as to facilitate installation of cables, provisions must be made to the penetration(s) in order to maintain the enclosure rating.
4. The enclosure shall include a secure locking mechanism to make it tamper-proof. Further there shall be a provision to generate automatically an electronic signal on any attempted tampering that can be used to generate an audio-visual alarm at the control centre.
5. Each enclosure door shall be equipped with an adjustable doorstop to hold the door open.
6. Warning labels shall be provided for all electrical panels in accordance with BIS or BS 7671. Asset identification information shall be provided on the outside of the enclosure and shall be weather resistant.
7. All Internal connectors, components and wire terminations installed in the enclosure shall be labelled in accordance with the design drawings
8. Racks and shelves shall be provided in the enclosure to mount equipment as needed, including telecommunications devices and power assemblies. The rack shall comply with: BIS requirements (or approved equivalent international standard).
9. The rack shelves shall be capable of sustaining a constant 10 kg load. For all enclosures utilizing telecommunications services from a telecommunications network provider, a nominal mounting space of 200mm x 300mm x 75mm shall be provided for interface modules used by the service provider. The enclosure shall provide an additional fused or breaker protected, UPS-powered receptacle for related power requirement.
10. The ground mounted enclosure shall include an LED lighting fixture, minimum rating 5 watts, complete with lens or shield and high-efficiency LED lamp driver.
11. Ground mounted enclosures shall be mounted on a concrete foundation of the concrete class and dimensions shown in the detailed project design drawings. A cabinet riser shall be included when the cabinet is located below grade to protect against water incursion.
12. All mounting arrangements for ATMS equipment shall also comply with the requirements of that equipment as detailed in this specification.
13. The foundation and the foundation bolts for Ground mounted enclosures, tilt and fixed poles etc. shall be fabricated using a suitable (site specific grade of steel) material. The assembly shall be galvanized to a minimum coating thickness of 100 microns.
14. Galvanized Nuts, locknuts, locking pins washers etc. shall be supplied as a part of the foundation.
15. Fixing templates with a placement accuracy of at least +/- 1mm shall be provided to allow for the correct orientation and installation of the steel foundation on to the concrete base.

16. The strength of the foundation assembly shall be suitable to hold the Enclosure/Pole while withstanding weather conditions of the site for a period of at least 25 years.

2.4.2.2 Poles

1. The poles shall be designed to offer a stable platform for the imaging equipment to operate. Each pole and its associated hardware shall be fabricated using material appropriate for its installation site.
2. Nominal mounting height may be assumed as 12 meters. However, some situations may warrant different heights.

2.4.2.2.1 Tilt Pole

1. The poles shall be designed to offer a stable platform for the imaging equipment to operate. Each pole and its associated hardware shall be fabricated using material appropriate for its installation site (GI, marine grade SS, powder coated steel or enamel painted etc.)
2. Poles shall incorporate a mid-hinge tilt arrangement with a suitable counter weight to ensure a balanced tilt. The structural design shall conform to relevant standards and shall be certified by a statutory authority for structural integrity and maximum allowable vibration (typically caused by wind forces and other external stimuli) to ensure a stable image at full optical zoom of the camera mounted on it.
3. The design shall be tapering gradually over the whole length with the minimum cross section at the top.
4. The design shall be base plate mounted with a matching foundation.
5. The poles shall be supplied with a mounting template, rag foundation bolts and other associated installation hardware.
6. An access door at the bottom of the pole shall be provided at a typical height of 0.5 meters from the base for the termination panel. The typical door dimensions shall be 125mm wide by 500 mm high.
7. The design of the pole and hinge arrangement shall be such that the mounted equipment does not touch the base of the pole or ground when lowered.
8. Suitable eyelets, anchors, pulleys, etc. shall be incorporated in the pole design to allow for ease of raising the pole and to regulate the speed of lowering.
9. The design shall incorporate secure latching systems at the hinges to hold the two sections rigidly. There shall also be a provision to pad-lock the two sections to prevent unauthorized people from lowering the pole.
10. The base plate shall be designed to allow underground appropriate plastic /Galvanized Iron conduits to enter the base of the pole.
11. There shall be a tapered hole located not more than 150 mm from the top on the side of the pole to accept conduit fittings to route cables to the mounted imaging system components.

12. The assembly shall be of stainless steel/galvanized /Enamel Painted/powder-coated to an appropriate minimum coating thickness.
13. Deflection due to wind shall not exceed 0.1 degrees at a wind speed of at least 28m/s with the equipment mounted on the pole.
14. Suitably sized powder coated terminal box and terminal block assembly shall be provided and be treated as a part of the fixed pole. It shall be installed on the pole near the bottom end and the joint, cable entry/exit points (or glands) shall be sealed using a water proof sealant to avoid water ingress into the box or the pole base.

2.4.2.2.2 Fixed Pole

1. Fixed poles shall be used to mount flashing traffic lights and cameras in some of the locations.
2. Fixed pole cross section shall either be circular with a typical outer diameter of 150 mm or square cross section.
3. The joint(s) shall be seam welded.
4. The fully fabricated pole column shall be of stainless steel/galvanized /Enamel Painted/powder-coated to an appropriate minimum coating thickness.
5. The poles shall incorporate suitably designed holes on the sides to allow for electrical cables to enter or exit the pole undamaged.
6. The bottom portion of the pole shall be treated for corrosion resistance in accordance to the installation site.
7. The structural design shall conform to relevant standards and shall be certified by a statutory authority for structural integrity and maximum allowable vibration (typically caused by Wind forces and other external stimuli) to ensure a stable image at full optical zoom of the camera mounted on it.
8. Deflection due to wind shall not exceed 0.1 degrees at a wind speed of at least 28m/s with the equipment mounted on the pole.
9. Suitably sized powder coated terminal box and terminal block assembly shall be provided and be treated as a part of the fixed pole. It shall be installed on the pole near the bottom end and the joint, cable entry/exit points (or glands) shall be sealed using a water proof sealant to avoid water ingress into the box or the pole base.

2.4.3 Heating, Ventilation and Air Conditioning (HVAC) Subsystem

1. Where required, the ground mounted enclosure shall include an air conditioning system. The air conditioning system can be either passive or active. The design shall be submitted to the NHAI or NHAI's representative for approval.
2. Where a cooling system involving air conditioner or other heat-exchanger is used, the cooling system shall be mounted next to or on the exterior of the

ATMS enclosure. Where the enclosure needs to be penetrated, such as to facilitate installation of pipes for coolant supply and return lines, provisions shall be made to the penetration(s) in order to maintain the enclosure rating.

2.4.4 Installation

1. The ground mounted enclosure shall be installed according to appropriate good engineering practices. All internal components and UPS (if required) shall be securely mounted.
2. For ground mounted enclosure installation, UV-resistant caulking material shall be applied along the joints of the enclosure. For mounting under a camera lowering system, the enclosure shall be positioned away from the space directly below related camera.
3. Provisions shall be made for all ducts (i.e. power, telecommunications, etc.), in accordance with the design drawings and/or specifications, that will facilitate the connection between the enclosure and the ATMS equipment.
4. Where cables enter the ground mounted enclosure, they shall be fixed and secured against movement and to relieve stress on the cable termination. All penetrations to the enclosure shall be sealed with silicone sealant to impede entry of gas, dust and water.
5. All wires/cables within the enclosure shall be secured and labeled. Earth wires from all electrical devices, including surge suppressors, shall be terminated directly to the dedicated earth terminal in the enclosure. Earth conductors shall not be daisy-chained from device to device.
6. All conductors carrying electricity at 60Vac or higher shall be segregated from all telecommunications, signal conductors and conductor carrying electricity lower than 60Vac. A minimum of 75mm shall be provided between these two conductor groups. Where conductors belonging to these two groups need to cross each other at distances closer than 75mm, the installer must ensure the conductors are at a 90 degree angle (perpendicular) to each other.
7. Each wire shall be identified on both ends of the wire with heat shrink, thermal transfer tube type wire markers in English. Adhesive labels are not acceptable. The wire markers shall be white with black lettering. Hand marking of the label is not acceptable.

2.5 Testing and Training

2.5.1 General Testing

Any test facility commissioned to carry out environmental, electromagnetic compatibility or optical performance tests or safety testing of telecommunications equipment shall have adequate accreditation meeting a relevant BIS standard or ISO standard or set up by a relevant government agency as a central facility.

1. Quality systems relating to the design, development, testing, supply and maintenance of software shall implement the guidance of ISO 9000-3.

2. The Service provider shall operate an Environmental Management System complying with the requirements of ISO 14001.
3. Any certification or accreditation necessary to comply with this specification shall have validity current at the time the Contract is placed and be maintained valid throughout the period of the Contract. Evidence of this certification or accreditation shall be provided.
4. The ATMS service provider shall be responsible for any testing and/or certification of equipment needed to meet or demonstrate compliance with statutory or regulatory instruments and requirements.
5. The ATMS equipment shall provide reasonable access and facilities for the NHAI or the NHAI's nominated representative to audit the operation of its quality systems and test facilities as deemed necessary by the NHAI or the NHAI's nominated representative.
6. The ATMS service provider shall accept all responsibility for the satisfactory quality, design and workmanship of the ATMS equipment being supplied and every part of the system and equipment whether manufactured by or supplied to the ATMS service provider by supply chain partners and whether specified or approved by name or not.
7. Documentation detailing the proposed schedule of tests to be undertaken at each stage of the test process for all ATMS equipment shall be provided. As a minimum, the tests shall include Factory Acceptance Tests (FAT), Site Acceptance Tests (SAT) and System Integration Tests (SIT). All costs for such tests shall be borne by the service provider.
8. All test equipment shall have a valid calibration certification.
9. The acceptance of each stage of testing does not imply that testing is complete at that stage. If problems are found at a later date or stage of testing, it may be necessary to return to an earlier stage of testing after repairs have been made to the system. If at a later stage of testing, an item of equipment is replaced, repaired, or significantly modified, the equipment shall be retested to the level necessary to isolate any problem and establish a course of action to remedy the situation.
10. Test procedures, checklists, test forms and data summary sheets shall be provided for each item. The proposed test procedures shall include a description of the test topics, applicable pass/fail metrics, planned test method and planned test instruments and tools. The NHAI and/or the NHAI's nominated representative shall be notified of the date, time and place of each test, as a minimum at least 28 calendar days prior to the date the test is planned to be conducted. The tests shall be conducted in the presence of the NHAI and/or the NHAI's nominated representative unless specifically authorized in writing by NHAI otherwise.
11. The NHAI and/or the NHAI's nominated representative shall sign the trial test documents as proof of a successful trial test for each item of ATMS equipment

and ancillary components. If the test trial is unsuccessful, the NHAI and/or the NHAI's nominated representative shall be given minimum seven (7) full business days' prior notification before rescheduling another test trial.

12. ATMS Equipment that fails to conform to the requirements of any test will be considered defective and the equipment will be rejected by the NHAI and/or the NHAI's nominated representative. In the event a defect is determined, it shall be determined whether it is limited to a specific unit or could be potential problems in all such units. Equipment rejected because of problems limited to the specific unit may be offered again for retest provided all issues of non-compliance have been corrected and re-tested and evidence thereof submitted to the NHAI and/or the NHAI's nominated representative. The evidence thereof shall include as a minimum a technical report detailing the investigation that has been undertaken to determine the cause of the failure. The report shall detail, as a minimum, the symptoms, cause and what action was required to remedy the failure. This report, shall be submitted and approved by the NHAI and/or the NHAI's nominated representative prior to a new test date being scheduled.
13. In the event that the ATMS equipment malfunctions during the test period, the NHAI and/or the NHAI's nominated representative may declare a defect and require replacement of all equipment at no additional cost. When a defect is declared, the test and test period shall be restarted from the beginning for that specific ATMS equipment.
14. If ATMS equipment has been modified or replaced as a result of a defect, a report shall be prepared and delivered to the NHAI and/or the NHAI's nominated representative for acceptance. The report shall describe the nature of the failure and the corrective action(s) taken. If a failure pattern, as defined by the NHAI and/or the NHAI's nominated representative, develops, the NHAI and/or the NHAI's nominated representative may direct that design and construction modifications be made to all similar units without additional cost to the NHAI. In the case of problems common to many units, all units shall be modified at no additional cost to the NHAI.
15. See relevant subsections below for a detailed description of each type of testing and what it involves.

2.5.2 Factory Acceptance Test (FAT)

1. The Factory Acceptance Test (FAT) shall be undertaken to ensure the ATMS equipment has been completed to the required functionality, safety and quality and meets all the contractual specifications.
2. The FAT shall be undertaken before shipping to site to ensure the equipment has been completed (constructed, programmed and pre-commissioned) to the required quality and is fully operational. This will include equipment

- assembled to its final deliverable state either inside or outside the ATMS project.
3. The FAT shall be undertaken on the equipment due to be shipped to the site to fulfil their operational requirement and not on an alternative product.
 4. The factory acceptance test is used to:
 - a) Provide proof of functionality, quality and integrity with a comprehensive checking process against the product specifications
 - b) Verify all-important documents (manuals, instructions, plans, drawings) to ensure they accurately reflect the requirements and the equipment operation
 - c) Ensure that the equipment performs as expected under the testable range of foreseeable conditions, including misuse and errors.
 5. The FAT may be witnessed by the NHAI or the NHAI's nominated representative.
 6. Each FAT shall be specific to the product being tested but shall include the following as a minimum;
 - a) Pre-inspection testing and inspection
 - b) Pre-configuration of settings and software
 - c) Preparation of a test register
 - d) Review of drawings and documentation
 - e) Adequate testing of functionality
 - f) Interface testing
 - g) Full communications testing
 - h) Full cycle of powering up, logging on, logging off and powering down.
 7. In the event of a test failing for any reason, the equipment provider must undertake an analysis of the fault. If the fault is considered to be irresolvable, then an exception shall be logged in the test register. At the end of the FAT, the completed tests should be evaluated with the test team including any test failures that occurred. An evaluation meeting shall agree on the nature of any faults encountered and discussing if the FAT should be continued.
 8. One of the following actions shall be taken dependent on the extent of the fault:
 - a) The FAT can be completed if the faults are minor, and the system shall be considered acceptable, subject to the fault being fixed before system commissioning at site. A FAT shall also be repeated on a new version of the system incorporating a fix for the fault.
 - b) Testing faults resulting from test procedure error or operator error shall be repeated. The test may be repeated immediately if the error is detected at the time of the FAT.
 - c) Major faults during the FAT shall lead to abandoning the FAT and rescheduling it for a later date pending the fault being resolved appropriately by the equipment provider.
 - d) The FAT tests specified shall be repeated for the SAT.

2.5.3 Site Acceptance Tests (SAT)

1. A Site Acceptance Test (SAT) shall be undertaken at each ATMS equipment location to verify that it meets the requirements described in the detailed project design specifications.
2. Following the installation of equipment, but prior to the connection with other ATMS systems and subsystems, a SAT shall be conducted on each piece of equipment and witnessed by the NHAI and/or the NHAI's nominated representative.
3. The test shall exercise all standalone (non-network) functional operations of the ATMS equipment and ancillary components installed and shall demonstrate conformance with the requirements described in the detailed project design specifications, relevant standards and manufacturer specifications.
4. The quality of equipment and its installation shall be judged and verified to ensure compliance to relevant standards outlining operational safety, Ingress protection, Surge/ lightning protection and Radio interference.
5. Equipment installation shall be inspected to confirm compliance to equipment manufacturer's installation good practice recommendations.
6. The ATMS equipment provider shall ensure that the required testing equipment, including a portable computer and test software is provided for the SAT.
7. If any ATMS equipment or ancillary component fails to pass its SAT more than twice, it shall be replaced with new ATMS equipment or ancillary component of same make and model and the entire SAT shall be repeated until proven successful.
8. The SAT shall be conducted for each and every piece of ATMS equipment and ancillary components.
9. Time extensions shall not be granted to perform the SAT due to any failures. Failures during the SAT shall be resolved at no additional cost to the NHAI.

2.5.4 System Integration Tests (SIT)

1. The SIT shall also incorporate the network-manageable portions of the ATMS system including the ATMS system interface to the Regional and Main Control centres. The SIT shall begin after earlier stages of testing have been successfully completed (i.e. FAT and SAT) and accepted by the NHAI and/or the NHAI's nominated representative. When possible, the SIT shall be conducted during the harshest environment period deemed for that particular equipment. The duration of the SIT will be agreed with the NHAI or the NHAI's nominated representative prior to starting.
2. In the event of a system, subsystem, ATMS equipment, or ancillary component failure, with the exception of consumable items such as fuses, the Project shall be shut down for purposes of testing and correcting identified deficiencies

(System Shutdown). System Shutdown is defined as any condition which, due to work performed by the Service provider, results in the Project, or any system, subsystem, ATMS equipment, or ancillary component thereof to cease operation.

3. The SIT shall be re-started after the identified deficiency has been corrected.
4. If the total number of System Shutdowns exceeds three (3) due to the same system or subsystem, ATMS equipment, or ancillary component;
 - a) The system, subsystem, ATMS equipment, or ancillary component shall be removed and replaced with a new and unused unit.
 - b) All applicable FAT and SAT, as deemed necessary by the NHAI and/or the NHAI's nominated representative shall be performed and the SIT shall be restarted upon written approval from the NHAI and/or the NHAI's nominated representative.
5. Time extensions shall not be granted to perform the SIT due to any failures. Failures during the SIT shall be rectified at no additional cost to the NHAI.
6. Upon the successful completion of the SIT and all the required submittals, testing, training, and documentation have been successfully submitted to and approved by the NHAI and/or the NHAI's nominated representative, the NHAI and/or the NHAI's nominated representative shall provide written notice of Final Acceptance.
7. The notice of Final Acceptance implies that the system is ready for commercial operation subject to adequate training provided to the Operations and Maintenance personnel (Ref section 2.5.7).

2.5.5 Defects Liability Period (DLP)

1. Any minor defects in the system identified by the NHAI and / or the NHAI's nominated representative and provided to the Service provider in the form of a written notice during the Final Acceptance (Ref 2.5.4 above) shall be rectified during the Defects Liability Period. The above defects list shall also include any defects that surface during the DLP which shall also be rectified by the Service provider during the defined DLP itself.
2. Suitable tests for confirming the rectification of defects shall be performed by the Service provider to the satisfaction of the NHAI and/or NHAI's representative.
3. The DLP shall be in force for a period of 6 (Six) months succeeding the notice of Final Acceptance.

2.5.6 Integration

1. Integration activities of the ATMS project shall be coordinated and undertaken such that all systems, subsystems, ATMS equipment and ancillary components are integrated with the ATMS Control Centre hardware and in accordance with the detailed project design specifications.

2. All integration activities shall be coordinated with the NHAI and/or the NHAI's nominated representative prior to commencement of any integration activities and shall be agreed in accordance with the project program.
3. Integration activities shall include the telecommunication nodes (i.e. Managed Ethernet Switches) with the existing and/or proposed fibre optic Ethernet telecommunications network for the design and connectivity of the ATMS Project.
4. All ATMS equipment shall be managed and operated by the ATMS Control Centre. The ATMS equipment shall be integrated as identified in the design drawings and/or specifications, into the ATMS Control Centre.

2.5.7 Training

1. Training shall be provided for the operation and maintenance of all the ATMS equipment and ancillary components.
2. Certification by the NHAI and / or the NHAI's representatives is mandatory for the Service provider to begin commercial operations of the system.
3. Training shall be designed to familiarize the Service provider's own Operations & Maintenance personnel and NHAI's representatives with the design, installation, operation and maintenance of the ATMS equipment and the overall system. The training shall also cover functionality, theory of operation, calibration, testing, performance and operating parameters.
4. A single organized training shall be conducted by the Service provider. A complete course outline and summary of the experience and qualifications of the instructors shall be submitted to the NHAI and/or the NHAI's nominated representative for approval prior to commencement of training. Training sessions may be combined and/or shortened with the agreement of the NHAI. The training will be conducted at a location agreed with the NHAI.
5. The training materials shall be provided in English. The training materials shall include as a minimum:
 - a. Course outline
 - b. A Microsoft Office PowerPoint presentation showing detailed subject material
 - c. Operation and maintenance manuals in both electronic and paper format
 - d. Test equipment and tools
 - e. Any other required information.
6. Training shall also include the imparting of practical 'hands-on' experience to the trainees during each training session.
7. At the end of each training session, a test shall be conducted on the trainees to gauge their learning and the effectiveness of the training.
8. If, at any time during a training course, the NHAI and/or the NHAI's nominated representative determine that the course is not being presented in an effective manner, the training session shall be suspended. The Service provider shall make the necessary changes to the course, resubmit the required training materials for approval and reschedule the training course.

2.6 System Operation and Maintenance

1. The Service provider shall perform System Operation and Maintenance (O&M) (after Final Acceptance of the system) meeting the requirements contained in the Terms of Reference.
2. The Service provider shall deploy adequate number of trained personnel at site and at their back office to ensure that the above requirements are met. The Service provider shall submit, to the NHAI, reports as required on their Operation and Maintenance.

2.7 Computer Software Requirements

These requirements include those that are required to ensure adequate availability & sustainability of the ATMS software during the contract period.

1. The software for the system shall be designed and developed for adequate scalability of existing system functionality, addition of new functionality and easy maintainability. The medium used for storage and loading of programs shall be suitable for the way they are likely to be handled and stored and shall not require closely controlled environmental conditions.
2. The software development methodology used should ensure the development of modular software.
3. The ATMS service provider shall ensure that the development environment is adequately maintained during the contract period to ensure adequate support for the maintenance of the software under use and further additions/modifications to its functionality as may be required.
4. All documentation, diagrams (including software schematics or automated tool output) and specifications, shall be produced to recognize Standards and, apart from where other standards are agreed, shall use conventions, symbols and terminology defined in the appropriate European or International standards.
5. There shall be at least two sets of all source programs held on the agreed medium. For reasons of security one set shall be kept remote from the other(s) and regularly updated as changes are made. By agreement the NHAI or the NHAI's nominated representative may hold one set.
6. The ATMS service provider shall hold at least two sets of all operational programs including, where appropriate, site-specific data and programs held in appropriate media..
7. All programs being deployed shall be clearly identified and include the appropriate issue details and date.
8. The documentation held at site shall be fully annotated with issue number, date and section reference and shall include the following:
 - a) A concise description of the overall function of the software.
 - b) Details of the computer hardware of the system, upon which the software is installed and any proprietary software products used, including databases, operating systems and their version/issue status.

- c) A complete list of all modules in the software with their functional description and interaction with other modules. .
- d) Clear operating instructions.

2.8 Information Security

1. Providers of ATMS system are required to ensure that the system being provided operates in a secure manner. The solutions offered shall be in accordance with Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011 published vide Government of India Notification No. G.S.R. 313(E) dated 11th April, 2011.
2. The Service provider is expected to have familiarity with ISO 27001 or procure the necessary expertise in developing and delivering solutions in line with information system security best practice.

Chapter 3

Video Surveillance System (CCTV)

3.1 Scope

This specification lays down the general, functional and technical requirement of the Closed Circuit Television (CCTV) System to be used as a sub-system of ATMS implementation. CCTV shall include fixed cameras and PTZ cameras.

3.2 Function

1. The system monitors vehicular and other road related activity along the highway stretch.
2. CCTV system is required to ensure effective surveillance of the target road section and related surrounding areas and generate a tamperproof record for post event analysis.

3.3 Functional Requirements

1. The System shall provide an online display of video images. It shall be possible to use monitors with latest display technology or similar display devices located in ATMS Control Centre.
2. Proposed CCTV system shall follow an open standard and follow an IP based network centric architecture to provide a high-speed system implementation for best performance.
3. System shall use video signals from various types of CCD colour cameras installed at road locations, process them for viewing on workstations/monitors at ATMS Control Centre and simultaneously record all the cameras.
4. Video Footages should have been compressed using H.264 (MPEG 4 part 10/AVC) standard prior to recording.
5. System shall use either IP cameras or analog CCD cameras with external encoder. Analog CCD cameras should connect to a Hardware encoder through a cable and the combination shall support minimum dual streams. The hardware encoder used shall be capable of producing streams at 25 FPS for each connected camera. If the camera is IP based, it should be UTP ready. The compressed video shall be streamed over the IP network.
6. Encoders shall have less than 200 ms of latency and shall support dual stream–H.264 (MPEG 4 part 10/AVC).
7. The recording resolution and frame rate for each camera shall be user programmable.
8. Surveillance CCTV cameras shall operate on 230 V, 50 Hz single-phase power supply. If the camera or connected accessory operates on a different voltage or frequency, necessary conversion/correction device shall be supplied along with the camera.

9. Encoders shall be POE compliant and connected to Layer 2 or Layer 3 switch as per system design using UTP CAT 6 Cable or fibre optic cable and the required connectors as per standards.
10. The encoder shall be built on embedded processor, preferably with its own RTOS and should convert Analog Composite/S-Video input into good quality digital stream on real time basis. It shall be able to transmit as Unicast /Multicast IP packet with low latency (less than 200 m.sec) for live viewing as well as for recording.
11. The video resolution should be configurable between the camera's maximum resolution (D1 or better) @ 25fps to CIF @ 25 fps or at lower frame rate per camera at the discretion of the user.
12. The encoder should generate H.264 (MPEG-4 part 10/AVC) video stream Compliant with ISO/IEC 14496-10 standard. The encoder should be interchangeable with any standard encoder of any other make, which generates H.264 (MPEG-4 part 10/AVC) video stream Compliant with ISO/IEC 14496-10 standard.
13. PTZ cameras shall support the feature of pre-programmed tours for easy customization to cover specific points of interest in a predetermined pattern.

3.4 Technical Requirements

1. The rated resolution should be sufficient to view the target area in acceptable detail for all cameras. Vehicle characteristics such as colour, shape and vehicle class shall be discernible from a distance of 1000 meters from the camera (at full optical zoom).
2. All cameras shall have a minimum sensitivity of 0.02 lux for colour images at a shutter speed of 1/15.
3. AGC and Auto iris combination shall provide a light range adaptation of 10000:1 or better.
4. All cameras should be rated for outdoor use.
5. All cameras shall have day-night IR filter for brilliant daytime colour and excellent night vision under low light.
6. Ability to communicate using a choice of technologies (Wired ether-net, WIFI, OFC etc.) to allow for system scalability and smooth integration, as the communication infrastructure is changed or upgraded.
7. PTZ cameras shall allow for 360 degree pan, 2 to 92 degree tilt and at least 35x optical zoom to provide for coverage of a wide target area and yet maintain the required image detail. All PTZ cameras shall have Closed loop speed control with Integral pan / tilt motor drive to enable smooth, precise pan-tilt for fine control and accurate tracking, even at high zoom levels.
8. All cameras shall have Flat glass window with internal heater for better optical performance in rainy, humid environments.
9. All cameras housing should be waterproof, weather-sealed and corrosion resistant.

10. It shall be ensured that the Camera mounted on the pole provides an adequately stable image up to wind speeds of 200 km / h such that a vehicle's make and model can be clearly identified on the control room display, at full zoom. Such a stable image shall also be ensured when vibrations are encountered during the passage of heavy vehicles close to the CCTV pole

11. **CCTV Fixed Cameras** shall comply with the following Physical and electrical specifications:

- | | |
|-----------------------|---|
| a) Image Sensor | 1/4" CCD Minimum |
| b) Active Pixels | 752(H)x582(V) minimum |
| c) TV line Resolution | 480 Lines or better |
| d) Sensitivity | 0.02 lux (B/W), less than 0.2 lux (Colour) or better |
| e) Focus | Fixed/Manual |
| f) Signal to Noise | > 46 dB |
| g) AGC | Automatic |
| h) White Balance | Automatic |
| i) Electronic Shutter | Auto/Manual, 1/3~1/10000s |
| j) Scanning Format | PAL |
| k) Video Output | VBS 0.7V minimum 4000mcd or Ethernet 10/100 Base-T |
| l) Housing | IP66 or better. |
| m) Power | 230V, 50 Hz domestic supply |
| n) Protection | Class – D for data/signal lines and class B for power |

12. **CCTV PTZ Cameras** shall comply with the following Physical and electrical specifications:

- | | |
|-----------------------|--|
| a) Image Sensor | 1/3" CCD or better |
| b) Active Pixels | 1280(H) x960 (V) or better |
| c) Resolution | 720p or better matching the Active Pixels of the Camera offered by the bidder to meet 3.4 (12.b) above,,D1,CIF |
| d) Sensitivity | 0.005 lux (B/W), less than 0.06 lux (Colour) or better |
| e) Focus | 3.5mm to 129mm or better |
| f) Optical Zoom | 35x or better |
| g) Signal to Noise | > 54 dB |
| h) AGC | Automatic |
| i) White Balance | Automatic |
| j) Electronic Shutter | Auto/Manual, 1/1 ~ 1/30,000s |
| k) Iris Control | Automatic |
| l) Scanning Format | PAL |
| m) Video Output | Ethernet 10/100 Base-T |
| n) Pan Range | 0 to 360 degrees, Auto flip at 180 degrees. |
| o) Pan Speed | variable 0.2 degrees per sec. to 80 degrees per sec. |
| p) Tilt Range | +10 to -92 degrees |
| q) Tilt Speed | variable 0.2 degrees per sec. to 40 degrees per sec. |
| r) Pre-set Positions | 255 minimum. |
| s) Housing | IP66 or better. |
| t) Power | 230V, 50 Hz domestic supply |
| u) Protection | Class – D for data/signal lines and class B for power |

13. Encoders shall comply with the following Physical and electrical specifications:

- | | |
|-------------------------------|---|
| a) Format | PAL Colour, B/W, Composite, 25fps, 2:1 interlaced |
| b) Resolution | To match the Active Pixels offered by the bidder for each type of camera to meet requirement 3.4 (11.b) & 3.4 (12.b) above, D1, 4 CIF 704 x 576, 2 CIF, CIF, QCIF. |
| c) Frame Rate | 25 fps (PAL) and lower |
| d) Encoding | H.264 (MPEG-4 Part 10/AVC) Compliant with ISO/ IEC 14496 -10 Standard |
| e) Video Parameters | Brightness, contrast, hue, sharpness & sizing selectable |
| f) Video Latency | Less than 200 milli Seconds |
| g) Connectors | BNC for Composite Video input, suitable connectors for Power, Alarm in, and Alarm out, RJ-45 for Ethernet 10/100 Base-T output shall comply with the following Physical and electrical specifications |
| I. IP Address | :Static IP Address or as per System requirement. |
| II. H-264 (MPEG4-Part 10/AVC) | :Compliant with ISO / IEC14496 -10 |
| III. IP Packets | :Unicast and Multicast |
| IV. Iris Control | :Automatic |
| V. Housing | :IP66 or better (if separate from camera). |
| VI. Power | :any, as long as it links to 230V, 50 Hz domestic supply. |
| VII. Protection | :Class – D for data/signal lines and class B for power |

3.5 Environmental Specifications

1. Cameras & connected outdoor equipment shall be suitable to work from -10°C to 55°C with Relative Humidity up to 95% non-condensing. If any additional equipment(s) is/are needed to achieve this range, it shall be supplied along with the camera/outdoor equipment.
2. Camera housing shall be of IP 66 or better rating.

3.6 Testing

Since each CCTV installation is different, it would be the responsibility of the manufacturer/Service provider to demonstrate the viability of his solution with a previous work of a similar capability or a pilot on the proposed ATMS site.

3.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site (or from a renewable energy power supply rated for a nominal voltage of 12V DC, where ever applicable).
2. Location of CCTV Cameras shall be within the ATMS stretch as verified by NHAI's representative.

3.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
2. The Service provider shall undertake to support/maintain and (or) provide spare parts till equipment reaches end of life, which shall not be less than contract period from the date of supply.

3.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the CCTV systems shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 4

Video Incident Detection System (VIDS) - CCTV Based Video Analytics

4.1 Scope

This specification lays down the general, functional and technical requirement of the CCTV based VIDS to be used as a sub-system of ATMS implementation, for automatic detection of incidents and generation of local visual alerts. It also includes the associated visual alerts in the form of flashing lights which are connected to and activated by the VIDS. The system offered shall have the capability to also operate in low light conditions normally experienced during night. In very poor visibility conditions such as during winter fog/smog, the system shall detect the condition of poor visibility and generate visual alerts. Further it shall raise an alarm if signal/image quality is too poor to reliably process.

4.2 Function

The VIDS, essentially consisting of a fixed CCTV camera and an attached (& co-located) Video Image processing unit, shall perform remote incident detection at designated spots on the highway section and immediately provide local warning to nearby travelers / road-users on detection of relevant incidents. It shall also communicate such detected incidents to the ATMS Control Centre for storage, analysis & reporting.

4.3 Functional Requirements

1. The system shall include pole / gantry-mounted colour CCTV Cameras connected to co-located Video Image processing modules that can detect incidents based on video analytics and trigger alarms on detection. The above equipment shall be suitably gantry or pole mounted. The entire video detection system shall consist of the following:
 - a) Video Image processing unit(s)
 - b) Video camera(s) with IR filter, enclosure, and sunshield
 - c) Camera Lens
 - d) Pole/gantry mounted flashing warning lights
 - e) Surge Suppressor
 - f) All other necessary equipment for operation
2. The Cameras shall be mounted at a height of at least 15 m above the road surface level.
3. The system shall automatically detect the following incidents using video analytics:
 - a) Vehicles travelling in the wrong directions (e.g. Contraflow, i.e., a direction that is the reverse of or across the allowed direction of traffic flow)
 - b) Stalled Vehicles
 - c) Queuing up of vehicles
 - d) Large material dropped/lying on the road

e) Poor visibility due to fog / smoke / dust

A detailed list of incidents is included under section 4.3.2.1 of this document.

4. The incidents, as determined and programmed by the user shall be automatically detected in real-time and alarms generated.
5. These systems shall be installed at highway locations such as vulnerable merger points of Service road with the main carriageway, blind corners / turns on the main carriageway and road junctions.
6. The system shall be able to detect both approaching and receding traffic in multiple traffic lanes. A single camera shall be capable of detecting a maximum of 8 lanes.
7. On detection of an incident the system shall activate flashing lights locally to warn road users.
8. Simultaneously the detected incidents shall be communicated to the ATMS Control Centre via the OFC link.
9. It shall also be possible to view on-line and record at the ATMS Control Centre, the video images from these CCTV cameras belonging the VIDS.
10. Gantry/Pole mounted flashing lights of 300mm diameter with a visibility of at least 500m shall be used for local warning.
11. There shall be at least two such warning lights each mounted typically at a distance of 100meters and 200meters before the incidence monitoring point when seen from the direction of travel. The above distances shall be suitably optimized during detailed engineering.
12. The lights shall be powered by a local solar PV based power supply and shall be inter-connected with the incident detection system either by cable or by wireless (GSM-based).
13. During periods of poor visibility, as detected by the VIDS, the lights shall go into a flashing mode until visibility improves to a level for adequate incident detection.
14. The above lights shall stop flashing either on the event of the disappearance of the detected incident(s) or on the occurrence of a reset from the control room.
15. It shall be possible for a supervisory computer in the ATMS control centre to view images in real time as they occur.
16. Alarms related to detected incidents shall be also be enunciated on the above supervisory computer at the ATMS Control centre and shall be audio-visual.

4.3.1 Video Image Processing Unit

1. The Video Image Processing Unit shall combine indoor / outdoor traffic flow monitoring and automatic incident detection all in one single board.
2. The system offered shall be modular and multi-functional.
3. The boards shall fit directly into racks without an interface box. The boards shall have input ports to monitor a minimum of four (4) separate cameras.
4. The incident detecting video image processing shall be done on a dedicated PCB and the alarms / messages shall be sent to the flashing lights and the ATMS

server immediately. Use of auxiliary PCB's connected through ribbon cables etc. is not recommended and may not be acceptable.

5. The Video Image processing unit coupled to the camera shall have the capacity to detect the presence of vehicles in at least 100 detection zones within the field of view of the image sensor.
6. This unit shall have the ability to compensate for camera movements under adverse weather and traffic conditions.

4.3.2 Incident Detection

1. The system shall provide
 - a) Measurement of traffic flow speed between 0 -150 Km/ Hr. for up to 8 lanes
 - b) Detection of vehicles coming from the direction opposite to the allowed direction of travel and vehicles traveling in a direction that is across the allowed direction of travel.
 - c) Automatic detection of five types of traffic flow: normal, dense, delayed, congested and stop & go.
 - d) Total number of detection zones in an image should be at least 100.
 - e) Detection of stationary vehicles within 10 sec
 - f) Monitoring zone occupancy of the detection area
 - g) Detection of deceleration
 - h) Detection of fog / smoke.
 - i) Detection of a fallen object
 - j) Alarms for following events
 - (1) Queue
 - (2) Stop
 - (3) Reverse Direction and direction across the road
 - (4) Movement and collection of people
 - (5) Speed Drop
 - (6) Fog / smoke
 - (7) Video Signal absent
 - (8) Error
2. It shall be possible to define an output for each alarm. It shall also be possible to have remote monitoring and the ability to remotely change configurations of the image processing boards. The field electronic modules shall save images in case of alarm and send them to a server in the ATMS Control Centre. Such an image sequence shall consist of number of images with the pre-incident information and number of images with the post –historical incident information. In addition to the above it shall also provide following alarms:
 - a) Video quality bad / low
 - b) No video signal
 - c) Communication problem
3. In the event of communication problem with the central server the alarms shall be saved on the local field electronic module. The memory shall be adequate to store up to a minimum of 255 alarms.

4. The central server shall clean the data on the local module once the details are transferred on to the server.
5. This Video Image Processor-Incident Monitor shall combine traffic incident detection and traffic flow monitoring in one single field electronic module.
6. It shall be possible to define up to 16 stop zones per video image distributed over detection groups (one group can contain one or more zones). There shall be facility during set-up to program following alarm levels
 - a) Stopped vehicle
 - b) Image quality
 - c) Smoke
7. There shall be facility during set-up, for alarms to be enabled or disabled for a specific type of traffic flow (e.g. no stopped vehicle alarms during queue conditions).

4.3.3 Flow Monitoring

1. The system shall:
 - a) Define up to 8 speed zones per video image.
 - b) Monitor traffic flow speed from 0 to 150 km/hr for up to 8 lanes.
 - c) Have facility for speed zone to be made direction sensitive.
 - d) Monitor zone occupancy of the detection area.
 - e) Automatically distinguish between minimum 5 types of traffic flow (levels of service) based on flow speed and zone occupancy.
 - f) Detect wrong-direction vehicles & sudden speed variations within seconds.
2. The data and events from different video image processing boards shall be transferred and stored on to a server in the ATMS Control Centre..
3. The data shall be stored on to a relational data base and can be accessed locally or via a network
4. The real time data shall also be made available on to a TCP/IP socket for NHAI applications & other systems to monitor and control traffic if need be.
5. The system shall be based on NHAI-server architecture. It shall be possible to operate both on the same PC or on different PC's connected on LAN.
6. In distributed architecture the server shall perform the function of polling the detectors / video image processing boards, storage of traffic data, alarm events and alarm image sequences in the data base. It shall provide for real-time connection for the NHAI's using TCP/IP connectivity.
7. The NHAI's (Traffic Management Terminal) shall access the database using standard Network connectivity to view the historical traffic flow and incidents.
8. The operating system shall support a Relational Database for storage of traffic data & events and a reporting tool for reports generation.
9. The software shall have the facility to program the individual video image processing boards in remote configuration. The same shall be done using the drop down menu.
10. The entire network configuration shall be displayed on the screen and the video image processing cards shall be selectable for programming / modification.

4.4 Technical Requirements

Performance of CCTV based video incident detection system:

Incident type	% Accuracy	Time to detect
Stopped vehicles	>=95%	10 sec.
Queue	>=99.5	2 sec
Wrong direction (Contra-flow)	>=95%	<1 sec

4.5 Video Camera

- 1) The unit shall be a high resolution, 1/3 image format CCD camera, designed for professional video surveillance systems. Incorporating the latest in CCD technology, the video camera shall provide detailed video without lag, image retention, or geometric distortion.
- 2) The camera shall have great low light sensitivity, electronic shutter, automatic gain control and back –light compensation to enable camera to operate in wide range of lighting conditions. The camera shall be compatible with infrared illuminators and shall support both direct drive and video drive auto-iris lenses.
- 3) The Camera shall have the following specification:
 - a) Rated input voltage 230 VAC, 50 Hertz
 - b) Imager Interline transfer CCD 1/3" format
 - c) Sync. System Internal with Crystal External with Mains synchronization
 - d) Active picture elements 1920 X 1080 Active Pixels
 - e) Signal to noise ratio >50 dB minimum
 - f) Minimum Illumination 0.15 Lux (F1.2 , AGC On) at 50 IRE
 - g) Electronic Shutter Manual: 1/50 to 1/10000 sec, 8 selections possible.
Automatic : AES 1/50 TO 1/100000 Sec.
 - h) Back Light 6 Zones
Compensation
 - i) Camera Text in Picture 16 Character title anywhere on screen.
 - j) Encoding for integration H.264 (MPEG-4 Part 10(AVC)
with the ATMS control
Centre

Note: The bidder may also offer a CCTV Camera system with a built-in Video analytics feature meeting the requirements.

4.6 Housing

This shall be an aluminium enclosure designed for outdoor CCD camera installations and shall meet the following minimum requirements:

- | | |
|--------------------------|--|
| a) Camera mounting | Removable cradle assembly |
| b) Cable entry | Through liquid-tight fittings that will accept cable. |
| c) Finish | Off-white semi-gloss polyurethane |
| d) Construction | Extruded aluminium housing, Aluminium rear-end cap, Aluminium front cap with glass faceplate, and aluminium cradle, a sunshield to be included |
| e) Window | 5 mm thick, with a Thermostat controlled window |
| f) Heater/defogger strip | |
| g) Rated input voltage | 230 VAC 50 Hz |
| h) Output voltage, | 24 VAC 50 Hz |
| i) Nominal power | 30 Watts |

Dome cameras shall be housed in an enclosure suitable for outdoor camera installations and shall meet the following minimum requirements:

- | | |
|--|--|
| a) Camera mounting | Vandal-proof wall/pole/corner/hanging mount as per site requirement |
| b) Cable entry | IP66 compliant cable pass-through |
| c) Finish | Off-white semi-gloss |
| d) Construction | Aluminium or engineering plastic with optically clear UV protected polycarbonate dome. |
| e) 24*7 fan assisted thermostatically controlled Heater/defogger/forced air cooler | |
| f) Rated input voltage | 230 VAC 50 Hz |
| g) Output voltage | 24/12 V AC/DC as required by the camera and zoom components |
| h) Nominal power | 50 watts |

4.7 Environmental Requirements

1. Cameras & connected outdoor equipment shall be suitable to work from -10°C to 55°C with RH up to 95% non-condensing. If any additional equipment(s) is/are needed to achieve this range, it shall be supplied along with the outdoor equipment.
2. Equipment housing shall be of IP 66 or better rating.

4.8 Testing

Since each installation is different, it would be the responsibility of the Service provider to demonstrate the viability of his solution with a previous work of a similar capability or a pilot on the proposed project site.

4.9 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site (or from a renewable energy power supply rated for a nominal voltage of 12V DC, where ever applicable).
2. Location of CCTV based VIDS shall be within the project highway stretch.

4.10 Maintenance Requirements

1. The equipment supplied shall remain operable for the contract period from the date of commissioning.
2. The Service provider shall undertake to support/maintain the equipment till the completion of the contract period.

4.11 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the CCTV-based VIDS shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 5

Vehicle Actuated Speed Display

5.1 Scope

This specification lays down the general, functional and technical requirement of the Radar Vehicle Actuated Speed Display complemented by a data-logging CCTV Camera to be used as a sub-system of ATMS implementation. The speed display shall include mounting fixtures and the anchoring mechanisms for the same. These speed displays shall be installed to warn road users of over speeding and thereby acting as a deterrent. They shall also have the capability to collect and relay real time data for subsequent analysis in the ATMS Control Centre.

5.2 Function

The speed display shall provide textual or graphical warning to the vehicles exceeding the preset speed limit. It shall further capture an image of the over-speeding (i.e. the speed exceeding the preset limit) vehicle.

5.3 Functional Requirements

1. The system shall perform during day and night as well as in adverse weather conditions.
2. It shall have built in diagnostic functions to quickly assess the validity of speed calibration.
3. It shall adjust display intensity automatically to suit the ambient light conditions.
4. It shall be modular in construction for ease of maintenance.
5. It shall display numeric speed data as well as graphical (standard IRC road warning sign)(preferably) / textual warning.
6. Measurement:
 - a. Speed range : 1 km/h to 200 km/h
 - b. Maximum Measuring errors: Up to 100 km/h $\rightarrow \pm 3$ km/h, Above 100 km/h $\rightarrow \pm 5$ km/h
 - c. Minimum Monitored section length : 500 m
7. It shall have the facility to log vehicle data (Speed & vehicle image)of over-speeding vehicles and transfer them to the ATMS control centre.

5.4 Technical Requirements

1. The speed display shall be formed using individual modules.
2. Speed display must be constructed using corrosion resistant panel with LED pixels in row: column matrix.
3. Scanning/Multiplexing ratio shall be 1/8 or better.

4. The LED Cluster shall consist of individual LED's rated for out-door use.
5. Shall support an industry standard communication interface such as TCP/IP on copper, Wi-Fi, and/or fibre optic to help setting the preset speed and retrieve log data.
6. Shall maintain time stamped record (speed and vehicle image) of each case of over speeding in a log file that can be retrieved over the connected network or using a locally connected laptop.
7. It shall optionally be possible to configure the display to send real time violation event record (speed, vehicle image and time stamp) over the connected network while recording the same.
8. It shall be possible to control the brightness of displays automatically using built-in light sensors.
9. All PCB's shall be of FR4 material, 1.6mm thick and LED matrix PCB shall be 2.4mm thick. PCBs shall be of the quality suitable for use in environment conditions specified.
10. The equipment shall allow local diagnostics via laptop connected to its communication port.
11. Fault diagnostics shall be provided to include the following as a minimum:
 - a) Camera Failure
 - b) Radar Failure
12. The equipment shall comply with the following Physical and electrical specifications:

Function	Specification
Display size in inches	15 high x 8 width per digit or character
Viewing Angle	15 to 30 degrees
Color and Wavelength (nm)	Red (625), Amber (590), Green(525)
Luminous Intensity	7500 candela per meter square.
Power Feed	230V AC @ 50Hz, with Battery backup and preferably solar chargeable
Mounting	Fixed over existing gantry or a separately erected pole
Humidity	0 to 95% Non-Condensing
Operating Temperature (Ambient)	-10°C to 55°C
Construction	Weatherproof outdoor non sealed ventilated
Communication	Ethernet on Copper, Fibre, Radio (3G/GPRS, blue-tooth and Wi-Fi)
Protocol	TCP/IP, NTCIP, SNMP
Data-logging camera	Resolution 680 TVL, sensitivity 0.03 lux@F1.2 (Colour) and 0.01 to 0.0001 adjustable @F1.2
Operation	Software for VAS display sign configuration and log file retrieval.

5.5 Environmental Specifications

The VAS shall meet the following climatic and environmental requirements:

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3
3	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2
9.	Vibration test	TEC (IPT 1001A revised)

5.6 Testing

The equipment shall be tested for functional requirements as below:

1. Speed limit shall be programmed using the provided software over the network or through a locally connected laptop terminal, as the case may be.
2. Brightness of pixels, ambient light sensor, radar accuracy and false positives.

5.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site or from on-board solar chargeable batteries.
2. Solar panels (if supported) shall be installed on the same fixture as the display (pole or gantry)
3. Location of speed display shall be within the project highway stretch.

5.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
2. The Service Provider shall undertake to support/maintain the equipment till the completion of the contract period.

5.9 Operational Requirements

1. The software supplied to configure and retrieve logs shall export data that would integrate with ATMS unified database located in the ATMS Control Centre.

Chapter 6

Emergency Roadside Telephone System

6.1 Scope

This specification lays down the general, functional and technical requirement of the Emergency Roadside Telephone (also referred to as Emergency Call Box) to be used as a sub-system of ATMS implementation. The term “Emergency Roadside Telephone” or the term “Phone” covers the phone instrument, mounting hardware, pole or any other mounting structure along with grouting, the charging stations, secondary power source such as the batteries, and the solar modules in case the units are solar charged.

6.2 Function

Emergency Roadside telephones are to be used by the road users to make emergency calls to the local ATMS Control Centre to report incidents such as accidents and /or other emergency situations on the highway requiring immediate help / intervention.

6.3 Functional Requirements

1. Suitable for working on a Fibre Optic / dedicated copper transmission/ wireless network as per requirement.
2. Built-in speaker and microphone for hands-free operation.
3. Clearly labelled and distinctly identifiable “activate” button to initiate communication.
4. Audio and visual indication of communication status such as call placed, call acknowledged at the control centre, call in progress, or call on hold.
5. Multiple numbers shall be programmed (at least three) into the device so that incidents of line busy are minimized.
6. The unit shall dial each number in sequence automatically till the line is connected or call is cancelled by the road user.
7. Shall provide a means to record the message in case all the lines are busy.
8. Provision to operate the phones in case of primary power failure. Battery backed power source shall be used and preferably, it shall be solar charged.
9. The ERT Phones shall operate in duplex mode.
10. The ERT Phones shall have the front facia suitable for rugged outdoor use.
11. The ERT phone shall be designed to provide the following operation related functions:
 - 11.1 The user will push the call button to initiate a call from the phone.
 - 11.2 The calling user shall hear a ring tone if the call is successfully initiated. Alternatively if the line is busy, a busy tone accompanied by a voice message

both in English, Hindi & Local language shall sound. When the system is not functioning a suitable message shall sound along with a distinctive tone that is other than the ring tone or the busy tone.

- 11.3 The phone units shall have self –diagnostics to test themselves for correct operation. Any malfunction detected shall be reported to the control room system immediately along with the nature of the fault.
- 11.4 A scheduled test of all phone units shall be performed at regular intervals for correct operation of speaker and microphone.
12. The ERT system shall have automated start-up ability in the event of power outage and restoration.
13. All Alarms, results of self-diagnostics tests and data related to the ERT system shall be logged to a central database. Attempted damage as detected by the anti-tampering sensor shall be recorded separately for quick access.

6.4 Technical Requirements

1. Echo cancellation should be implemented in the phone.
2. The design should consist of a single PCB and minimal serviceable parts.
3. To prevent vandalism it is essential that the components and PCB shall not be usable as a regular phone even after modification.
4. The phones shall be remotely configurable using software at the control centre.
5. The phones shall also be locally configurable using a laptop and provided software.
6. The phones shall remain operable up to a noise level of 95dB
7. If using cables, there should be at least 20% spare capacity to replace faulty pairs without laying additional cables.
8. Configuration, Diagnostics and other communications shall not interfere with the voice communications. These signals and their significant harmonics should be beyond the audible range.
9. Protection from ESD and lightning should meet or exceed class – D for data lines and class – B for power lines.
10. Remote fault diagnostics shall be provided to include the following minimum:
 - a) Power Failure/low/high voltage at Phone site
 - b) Voice data transmission/reception/communication failure detection.
 - c) Correct operation of speaker and microphone.
 - d) Crosstalk detection.
 - e) Storage battery condition information.
11. The ERT phone shall have a front panel locking arrangement which shall require a special tool / key to access the door.
12. In the event of any tampering (e.g. door open condition) the Emergency Roadside telephone shall generate an automatic electronic signal that can be detected and displayed (in the form of an audio-visual alarm) at the ATMS Control Centre.

6.5 Environmental Specifications

1. The housing shall be fibre-reinforced plastic sporting a prominent colour that can be easily recognized by road users.
2. The housing shall meet or exceed IP65 standards of water ingress protection.
3. Operating Temperature -10°C to $+55^{\circ}\text{C}$
4. Relative Humidity: Up to 95 % (Non-Condensing)
5. The electronic subassemblies shall be certified to meet or exceed the following specifications:

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3
3	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2
9.	Vibration test	TEC (IPT 1001A revised)

6.6 Testing

The equipment shall be tested for functional requirements as below:

1. Earth continuity
2. Insulation resistance
3. Call from phone to operator - Ringing tone
4. Check for the speech path
5. Check for hold tone
6. Check for busy message
7. Check for call back facility from operator station to phone
8. Check for phone test facility from operator station
9. Check for Programming of ECB address
10. Check for Tamper alarm

6.7 Installation Requirements

1. Zones of Telecommunication black spots shall be identified on the project highway for locating the Emergency Roadside Telephones(ERTs)..
2. On longer (> 2 km) stretches suffering from telecommunication blackspots, ERTs shall be installed at intervals of 2 Km (+/- 100m) on both sides of the highway such that a distance of 1km (+/- 50m) is the maximum one has to travel to reach the nearest available ERT..
3. Power shall be obtained from Solar PV charged on-board batteries rated to operate the phone for a minimum of 3 days in the absence of adequate solar radiation..
4. Solar panels and chargers (if applicable and supplied) are to be installed in accordance with the site requirements.

5. The ERT phone shall be installed 2 meters away from the edge of the hard shoulder. It shall be mounted on a metal pole with a base that shall be grouted over a 1 m X 1 m X 0.3 m concrete platform provided with a handrail (with a suitable access opening) for protecting the user from vehicular collision. Further the direction of the ERT phone shall be such that the user can have a clear view of the arriving traffic during access and use of the phone. Further a minimum length of 10 meters of crash barrier shall be installed for protecting the ERT phone location from arriving traffic.
6. Illuminated guide signage shall be placed approximately 50 metres and 10 meters on either side of the phone.
7. Suitable mounting fixtures such as poles and other suitable/related equipment shall be supplied and installed by the service provider..

6.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
2. The Service provider shall undertake to support/maintain the equipment till the completion of the Contract period.

6.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the facility shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 7

Variable Message Sign (VMS)

7.1 Scope

This specification lays down the general, functional and technical requirement of the Variable Message Signs (VMS) to be used as a sub-system of ATMS implementation. VMS shall include both Fixed and Portable variable message signs including the Gantry (for Fixed VMS) and the trailer & anchoring mechanisms (for the Portable VMS).

7.2 Function

The VMS shall provide road users advance information of road conditions ahead and shall be controlled from the local ATMS Control centre. VMS system is one of the important and effective tool to manage traffic in response to road incidents, special events and construction or maintenance activities on the road. When drivers are to be warned of an incident, advised to opt for an alternate route, guided to reach a specific location or clear a lane as a response to an incident, the message posted should be appropriate and precise. The messages and the procedure for displaying them should be such that the information is grasped by a driver whose primary focus is driving his vehicle while ensuring his and his co-passenger's safety.

VMS boards envisaged are of 3 types: (i) Full VMS, (ii) Compact VMS and (iii) Portable VMS. The main function of a full VMS (located at the entries to the highway and typically before major junctions leading to alternate routes) is to display highway status and travel guidance information while the Compact VMS's main function is to warn vehicles of traffic congestion in the cities / villages immediately ahead. The Portable VMS (toll be temporarily commissioned near the incident location) will be used to warn road users of road works and incidents that affect traffic flow. Portable VMS shall be mounted at the back of mobile vehicle to show the sign of 'men at work' and / or speed limits in the construction zone and / or traffic lane restrictions. These shall be powered by solar energy and / or battery.

Under no circumstances shall VMS be used for advertising of any kind. It would be in a blank mode when traffic, roadway, environment or pavement conditions or public service announcements do not warrant the display of message or messages.

7.3 Functional Requirements

1. A VMS message should be effective. To ensure effective messages, the message themselves:
 - a) Shall fulfil a purpose
 - b) Shall command a short-span but definite attention.
 - c) Shall convey Information that is unambiguous and simple to comprehend.
 - d) Shall aim to elicit a definite and desired response from the driver
 - e) Shall be displayed early enough to provide adequate time to respond to the event.

2. The display procedure shall be such that:
 - a) The message accuracy is authenticated.
 - b) Relevance of the message is maintained by continually monitoring the incident and updating the display.
 - c) Avoid stating the obvious.
 - d) Credibility of the information is maintained and ensured.
3. Should have procedures to post alter, and delete messages interactively to ensure message relevance and credibility.
4. Should have an intuitive user interface for the operator to learn, operate and manage the system.
5. Should be modular in construction for ease of maintenance.
6. The VMS should have sufficient graphics capability to display multi-lingual messages (English, Hindi and the local language that will be specified by NHAI) and standard IRC road signs.
7. The modules shall be field replaceable.
8. The system design shall be such so as the display is legible from a distance of at least 250 metres.

7.4 Technical Requirements

1. The display board shall be formed using individual modules.
2. Display panel must contain a corrosion resistant panel with LED pixels in row: column matrix (Full Matrix display).
3. Scanning/Multiplexing ratio shall be 1/8 or better.
4. The LED Cluster shall consist of individual LED rated for out-door use.
5. Failure of one Text row shall not affect the Other Rows. It shall also be possible to query the status of each row to determine its health and configuration status.
6. Shall use Unicode to display messages in English, Hindi and a selected local language.
7. Shall have built in test and monitoring facilities to ensure data integrity of the messages.
8. Shall adjust display intensity automatically based on ambient light conditions to ensure readability at all times.
9. The display background should be non-reflective and the display should be U.V. resistant. Shall support multiple industry standard communication interfaces, minimum being RS-422, TCP/IP on copper, Wi-Fi, and optionally fibre optic.
10. Shall support at least the NTCIP and any one of defined and documented communication protocol(s) such as NMCS2, MESSAGE CONTROL, TR2070D, Version 2 or other equivalent international protocol.
11. It shall be possible to control the brightness of displays automatically using built-in light sensors or remotely through the provided VMS control software.
12. All PCB's shall be of FR4 material, 1.6mm thick and LED matrix PCB shall be 2.4mm thick. PCBs shall be of the quality suitable for use in environment conditions specified.

13. The controller shall allow local diagnostics via laptop connected to its communication port.

14. The equipment shall comply with the following specifications:

- | | |
|----------------------------------|---|
| a) Length(minimum) | 1650 +/- 100 mm for Portable VMS |
| b) Height (minimum) | 1000 +/- 100mm for Portable VMS |
| c) Length (minimum) | 2400 +/- 100mm for Compact Fixed VMS |
| d) Height (minimum) | 1500 +/- 100mm for Compact Fixed VMS |
| e) Length (minimum) | 5000 +/- 200 mm for Full Fixed VMS |
| f) Height (minimum) | 1800 +/- 200 mm for Full Fixed VMS |
| g) Depth (minimum) | 200 mm (for all types) |
| h) Number of Display Lines | Minimum 2 for Portable and Compact types & 3 for the Full VMS |
| i) Pixel Format | Minimum 144 x 16 per line |
| j) Pixel Pitch | Maximum 15mm |
| k) Pixel Size | 11.7mm x 11.7 mm |
| l) LEDs per Pixel | minimum 4 |
| m) Contrast Ratio | >30:1 perpendicular to the board face
>10:1 at an angle of +70° to perpendicular |
| n) Minimum Character Height | as per IRC SP 85 |
| o) Language | English, Hindi + 1 Regional Language |
| p) Number of faces (sides) | 1 |
| q) Colour and Wavelength (nm) | Red (625), Amber (590), Green (525) |
| r) Luminous Intensity (each LED) | minimum 4000 mcd |
| s) Memory | Capable of storing minimum 10 frames |
| t) Interface Standard | RS422 and RS485 interfaces with Ethernet compatibility |
| u) Housing | Powder coated housing (IP 55 or better) |
| v) Mounting | a) On Gantry for Full Fixed VMS b) On Gantry / Pole for Compact |
| w) Mounting Height | Fixed VMS and C) Vehicle Mounting for Portable VMS.
a) Minimum clearance of 5.5. m from road surface for Gantry mounted Fixed VMS b) 3.5 m from display centre to ground for pole mounted Fixed VMS, c) Suitably mounted on vehicle for clear viewing by arriving traffic. |

15. Fault diagnostics shall be provided to include the following as a minimum:

- Power Failure at VMS
- Processor PCB Failure
- Display line Failure
- Incoming data reception/communication error detection.
- Temperature within the enclosure information.

7.5 Environmental Specifications

The VMS shall meet the following climatic and environmental requirements:

- Operating temperature: -10 °C to + 55 °C
- Relative Humidity: Up to 95 % (non-condensing)

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3

3	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI Procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2
9.	Vibration test	TEC (IPT 1001A revised)

7.6 Testing

The equipment shall be tested for functional requirements as below:

1. Messages shall be displayed using the central software & local terminal
2. Fault conditions shall be simulated. Messages / fault logs shall be checked for :
 - a. Text Row Fault
 - b. Communication failure
 - c. Power failure
 - d. Brightness of Pixels
 - e. Rear Door open

7.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains / UPS/ Diesel Generator Set provided on site or from on-board lead-acid automobile batteries rated for a nominal voltage of 12V DC (for mobile VMS). If powered from an UPS the source of charging shall be preferably a renewable energy source (e.g. Solar PV, wind etc)
2. Fixed VMS shall be mounted on a sturdy and aesthetically pleasing gantry structure whereby the vertical clearance of at least 5.5m is available from the road.
3. Safety barriers shall be provided at gantry support column(s) for their protection and for safety of road users.
4. The structure on which the VMS is mounted shall be sturdy and capable of bearing wind loads up to 200 kmph.
5. The concrete pedestal for support column should be flushed with ground but in no case should protrude more than 1.5m.
6. Minimum distance of VMS on expressways should be 1.5 km prior to decision point and that for National Highways it should be 1 km. The signs should be visible from a distance of 250m. It should not be located on a curve and on a highway sections having grade exceeding 4 percent.

7.8 Maintenance Requirements

1. The VMS and its sub-systems shall test/diagnose on a regular basis as well on request & log event of any problem for each individual equipment, Such problems shall be automatically flagged at the ATMS control centre and also logged in the ATMS server .

2. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
3. The Service provider shall undertake to support/maintain till the completion of the Contract period.

7.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the VMS shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre.

Chapter 8

Weigh in Motion (Portable)

8.1 Scope

This specification lays down the general, functional and technical requirement of the portable Weigh in Motion (WIM) System to be used as a sub-system of ATMS implementation. The Weigh in Motion systems shall include the standard mounting fixtures and the anchoring mechanism.

8.2 Function

The system shall use portable weigh-pads to log, monitor and enforce vehicle load criteria to prevent damage to road and bridge assets. There shall be a suitable camera to capture the image of offending vehicle and its registration number so as to transfer this image information along with the weight information to the enforcement agency.

8.2 Functional Requirements

1. Shall be modular in construction for ease of deployment and maintenance.
2. Shall easily be configurable for use as an axle by axle static weigh bridge shall be sturdy enough to support static weighing of overloaded vehicles.
3. Shall come with a low profile weigh pads, leading and trailing ramps as standard accessories.
4. Weigh pads shall preferably connect to the rest of the weighing system wirelessly.
5. Shall support a local internal vehicle database to instantly classify the weighed vehicle as overload.
6. Shall support vehicle classification and indicate breach of length as well as weight overshoots.
7. In case of breach of any criterion, details of the vehicle shall be transmitted over the network in real time. The details shall include the vehicle weight, Classification, overshoot information, and image of the vehicle with registration number clearly visible.
8. Shall support and facilitate export of violation data (vehicle image(s), vehicle type, violation type such as overload, length overshoot etc.) along with the image of both, the vehicle and its registration plate to enforcement department.
9. Shall interface with a printer to provide an on-the-spot printout of the current transaction.

8.3 Technical Requirements

1. The whole unit shall be battery powered for ease of portability.
2. Shall support local diagnostics in the firmware to aid detect configuration/reconnection errors and field repairs.
3. Shall be protected from water ingress and operate reliably in wet road surfaces.
4. Shall optionally operate on 230V 50 Hz Mains supply in addition to battery.
5. Shall come with a bright clear display rated for outdoor use.
6. Shall have lightweight aluminium alloy weigh pads for ease of portability and installation.
7. Shall come with a suitable trolley/trailer/packing and dismantling arrangements and tools for efficient portability.
8. Shall conform to or exceed the following electrical and mechanical parameters:

Accuracy in WIM mode	±2%
Accuracy in SWB mode	±0.5%
Weigh Range	20000Kg per pad (40000Kg per axle)
Permissible vehicle speed for WIM mode	5 Kmph or more
Allowed speed variance	±5%
Classification accuracy	> 98%
Communication option	RS232/RS485/Ethernet/Wireless
Weigh pad to main unit communication	Wireless (preferred)/Wired
Power	Battery and domestic mains
Battery life	5 days minimum
Weigh pad ingress protection	IP66 or better
Weigh pad weight	< 30 Kg
Weigh pad profile height	< 40 mm

8.4 Environmental Requirements

The WIM system shall meet the following climatic and environmental requirements:

- a) Operating ambient Temperature : -20 to + 55 Deg C (Road surface temperature can be substantially higher)
- b) Up to 95 % (Non-condensing) (The road surface can be wet)

SN	TEST	REFERENCE
1.	Change of temp test	IS 9000 Part XIV Sect. II
2.	Dry heat test	IEC-571; IS: 9000 Part-III Sect 3
3.	Cold test	IS 9000 Part II Sect. III
4.	Damp heat test (Cyclic)	IS9000 Part V Sect. 2 Variant 1
5.	Damp heat test (Steady state storage)	IS9000 Part IV
6.	Salt mist test	IS9000 Part XI procedure 3
7.	Dust test	IS 9000 Part XII
8.	Bump test	IS 9000 Part VII, Sec. 2
9.	Vibration test	TEC (IPT 1001A revised)

8.5 Testing

The equipment shall be tested for functional requirements as below:

1. Tolerance to speed of travel (in WIM Mode), Weight accuracy in both mode and classification accuracy shall be tested by trial run of different classes of vehicles.
2. WIM unit shall be configured and trial data shall be collected and analyzed using the provided software over the network or through a locally connected laptop terminal, as the case may be.
3. Real time data transfer shall be tested by running a vehicle known to breach any of the preset parameters and capturing the real time data.
4. The system model shall be approved by the Weight and measures department of Government Of India and duly calibrated before use.

8.6 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site or from on-board solar PV chargeable batteries.
2. Location shall be chosen to ensure trolleys and other packing accessories of the WIM have a place to park and do not block or obstruct any of the highway lanes.
3. Weigh pads shall be located on firm rigid surface to extend the life of the pads and to ensure maximum measurement accuracy.

8.7 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of commissioning.
2. The service provider shall undertake to support/maintain the equipment till the completion of the contract period.

Chapter 9

Meteorological Data System (MET)

9.1 Scope

This specification lays down the general, functional and technical requirement of the Meteorological Data System (MET) to be used as a sub-system of ATMS implementation. The MET system shall include sensors, the data logger and the interface with the ATMS Control Centre.

The Meteorological Data System shall consist of wind sensors for monitoring wind speed and direction, visibility sensors for detection of visibility changes resulting from fog or dust storm, atmospheric sensors to measure air temperature and humidity and road condition sensor to read road surface temperature.

9.2 Function

The MET system is required to measure and acquire weather parameters likely to affect safe travel on the highway and communicate it on-line to the ATMS Control Centre for use in Traffic Management.

9.3 Functional Requirements

1. The MET system shall be installed at the ATMS Control Centre
2. The MET system shall include the following sensors that are pole-mounted (except the Road-surface temperature sensor):
 - a) Ambient temperature
 - b) Road-surface temperature
 - c) Relative humidity
 - d) Precipitation (sensing)
 - e) Wind Velocity
 - f) Visibility
3. Weather parameter values, using the above sensors, shall be acquired by a suitably co-located data logger (pole-mounted) which in turn shall communicate on-line the measured parameter values to the ATMS Control Centre. The data acquisition and update rate shall be programmable from 1 sec to 1 hour in the data logger related to each of the above sensors.
4. The data logger shall have adequate battery-backed memory to store, at a minimum, the last 72 hours of data storage at the highest update rate. Further it shall be possible to download the stored data, in an off-line mode, to a modern data storage device like an USB 'pen drive'.
5. It shall be possible to remotely set, from the ATMS Control Centre, the above data update rate related to each of the sensors.
6. The data logger and the sensor may normally draw power from the ATMS Control Centre power supply system but shall be independent power supply-

wise by employing a Solar PV based backup power supply unit. Thus the MET system shall function un-interrupted even in the case of any power supply failure at the ATMS Control Centre.

9.4 Technical Requirements

1. The data logger shall be connected to the ATMS Control Centre via TCP / IP data link for both data acquisition as well as for setting up of parameters
2. The MET System shall be compact, rugged in design and shall be easy to maintain.
3. All sensor housings shall be made of anodized Aluminium or Stainless Steel
4. Air Temperature Sensor
 - a) Range : -30°C to +60°C
 - b) Sensing Element : Should provide a linear output for the entire temperature range
 - c) Resolution : 0.1% of range
 - d) Accuracy : +/-0.1% of range
 - e) e) Radiation Screen to be used
5. Relative Humidity Sensor
 - a) Range : 0- 100%
 - b) Minimum Accuracy : +/- 2% RH
 - c) Resolution : 0.1%
 - d) Sensor Mechanism : The sensor shall be adequately protected against dust/pollution and shall provide a linear output voltage for 0 –100% humidity
 - e) Radiation Screen to be used
6. Visibility Sensor
 - a) Range : 10 to 1000m
 - b) Wavelength : 880nm
 - c) Sensor Type : Infrared sensor, source & detector
 - d) Accuracy : 15%
7. Wind Direction Sensor
 - a) Threshold Speed : Less than 0.3 m/s
 - b) Accuracy : Better than +/-5%
 - c) Damping ratio : 0.7
 - d) Sensing mechanism : Compass magnetically coupled to Vane
8. Wind Speed Sensor
 - a) Range : Up to 79 m/s
 - b) Threshold speed : Less than 0.3m/s
 - c) Accuracy : +/-2% or +/- 2m/s whichever is better?
 - d) Output Signals : Average Wind / Average Gust
9. Road Condition Sensor
 - a) Temp. Sensor Range : -10°C to +75°C
 - b) Resolution : 0.1°C
 - c) Accuracy : +/-0.2°C
10. Precipitation Sensor
 - a) Output : ON/OFF

9.5 Environmental Specifications

1. Pole mounted sensors, in general, shall be suitable to work from -10°C to +60°C with RH up to 95% non-condensing. However the specific parameters of the environmental specifications of the devices used to measure the same parameter shall be suitably higher than the range they measure.
2. The housing shall be suitable for a 24 X 7 outdoor installation

9.6 Testing

It would be the responsibility of the Service provider to demonstrate the viability of the MET system with a previous work of a similar capability or a pilot on the proposed ATMS site.

9.7 Installation Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site. However there shall be independent Solar PV-based power supply (preferably pole-mounted) to enable the MET system function un-interrupted even in the case of any power supply failure at the ATMS Control Centre.
2. The MET system shall be installed at the ATMS Control Centre.

9.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least the contract period from the date of supply/Installation.
2. The Service provider shall undertake to support the equipment till the completion of the Contract period.

9.9 Operational Requirements

The software supplied and installed at the ATMS Control Centre to operate the MET system shall be able to integrate with/Export data to the ATMS unified database located in ATMS Control Centre.

Chapter 10

Automatic Traffic Counter-cum-Classifier

10.1 Scope

This system shall be provided at different locations on the highway for identifying and recording all types of vehicles on the highway for effective monitoring and data collection at ATMS Control Centre. This information shall then be utilized along with other measured and analysed data to inform the road user regarding the current traffic conditions using various means like the Variable Message Signs and Mobile Apps. Also, the information recorded shall be utilized for performing statistical analysis. Besides, the system shall be capable of classifying any other vehicle category as per user needs. Vehicle classification should be user selectable based on length of vehicle and / or detuning of the loop inductivity. The system shall be robust and be capable of operating with minimum maintenance. The system shall interface with the ATMS/ATMS Software for central monitoring. The indicative classification of common vehicles in India, based on wheel base, is as given below:

■	Type of Vehicle	Probable /Range of Wheel Base (mm)
(1)	Two Wheelers (Motorised) Scooters, Mopeds, Motor Cycle	0-1350
(2)	Three Wheelers (Auto/Tempo)	1400-1800
(3)	Four Wheelers Cars, Jeeps, Vans, Etc.	1801-2675
(4)	Light Motor Vehicles	2690-3400
(5)	Trucks/Buses	3401-5600
(6)	Multi Axle Vehicles	5000-18000

Vehicle Classification should be user selectable based on length of vehicle and number of axles. The system shall have the capability of accommodating multiple installations through installation of detectors / sensors which can be left permanently in place and connected as required to the recording device when traffic counts are made at that particular location. It shall also be capable of taking inputs from portable sensors and should be modular in design. The system shall have capability of interfacing with data integrators for central monitoring. It shall have suitable interface for transmitting information from ATCC System to the ATMS Control Centre.

10.2 Functional & Technical Requirements

10.2.1 Sensors

The sensors should be a combination of piezo-electric sensors and inductive loops, enabling counting / classification of up to 4-lane traffic (expandable to at least 8-lane traffic) with user set time periods.

10.2.2 Electronics

Vehicle counting / classification interval shall be programmable from one minute to 1440 minutes (24 hours) and system should accept user programmable recording intervals to count and classify during a 24 hour period. The system should be able to count and classify vehicle by each lane.

10.2.3 Data Collection

The system shall be capable of sending data to ATMS/ATMS Software which shall enable the ATMS/ATMS Software to classify the vehicles, detect average speed per lane, vehicle occupancy and headway as a minimum. Data collection shall be by via an IP connection. The system shall be capable of recording, for later analysis, on an individual vehicle basis, time/date, speed, direction. Number of axles, axle spacing, and site identification.

10.2.4 Data Storage

The system should be able to record and store vehicle data for a period of at least two weeks with daily traffic volumes of up to 10,000 vehicles.

10.2.5 Operating Language

English language shall be the acceptable language for all communication and operational purposes.

10.2.6 System Accuracy

The accuracy of the system in recording speeds and headways/ gaps shall be as per following table:

System Accuracy Requirements

Parameter	Accuracy	Conditions
Average Speed	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph and the vehicles conform to normal highway driving behaviour.
Average Headway	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle head-ways are between 1 and 10 seconds and the vehicles conform to normal highway driving behaviour.
Flows	5 percent	There are at least 100 vehicles of each category in group and vehicles conform to normal highway driving behaviour.
Vehicle classification	5 percent	Out of a group of 100 vehicles, conforming to normal highway driving behaviour, at least 95 shall be accurately classified as per the classification scheme provided under section 10.1. of this document.
Occupancy	10 percent	There are at least 25 vehicles in the group, individual vehicle speeds are between 10 kmph and 195 kmph, individual vehicle headway are between 1 and 10 seconds and the vehicles conform to normal highway driving behaviour.

Note:

(a) There shall be no double count in case of lane crossover / straddling. Anti-coincidence technique shall be used to avoid such incidents of single vehicle passing through two lanes. The ATCC controller shall however send the raw data as well as the processed information, wherever anti coincidence is utilized.

(b) The vehicle count shall not be missed even when multiple vehicles cross different lanes at simultaneous instances.

10.2.7 Data Retrieval

The system should have the capability of data retrieval, direct data transfer through a serial link to computer, Leased line/ GSM/CDMA.

10.2.8 Software

Software and manuals to analyze the data from output of vehicle counts, classifications speeds and headways shall be provided. Capability of graphic/tabular presentation of analyzed data shall also be offered.

10.2.9 Mode of Operation

This will be user programmable up to at least 12 speed and 15 vehicles class bins, of vehicles operating in India (user specified). System capability in this regard may be indicated. Counter shall also bin simultaneously in speed, axle and count or any combination of the three.

10.2.10 Capability

The system shall have capability of recording vehicle counting and classification, speed, headway at set interval of 1-10 minutes.

10.2.11 Calibration

The ATCC system shall be calibrated by the service provider during system commissioning and subsequently during the contract period at regular intervals of time such that the system accuracy, as defined above, is always maintained.

10.2.12 Self-Diagnostics

The ATCC and its sub-system should test/diagnose on a regular basis, as well on request, log event of any problem for each individual field unit and its associated unit in the ATMS database. All alarm/data conditions shall also be logged to the ATMS database.

Chapter 11

Mobile Radio Communication System

11.1 Scope

Mobile Radio Communication system should be capable of providing wireless communication between ATMS Control Centre and Vehicle Mounted Units & Handheld units for Emergency response as well as routine Operations & Maintenance activities for the Highway.

The Mobile Radio Communication system should have Vehicle mounted units fitted on ambulances, Cranes and Patrolling Vehicles for facilitating instant communication even when these are on the move across the highway. In addition handheld radio units will also be required for Maintenance activities on the highway. The vehicle mounted & handheld units shall communicate with the ATMS Control Centre as well as amongst themselves. The ATMS Control Centre besides having base/repeater Stations and Control equipment should have a provision for a voice logger to be attached with it for recording all communication

11.2 General Requirements

The Mobile Radio communication system should be designed/engineered and implemented in such a way so as to have 99% of the highway area covered with coverage reliability of a minimum 95%. The system should provide crystal clear, static free communication even for vehicles moving at high speeds. The system should be based on a state of the art Digital technology. Ability of the system to operate in mixed (analog and Digital) mode, though not mandatory shall be desirable for reasons of additional flexibility. The System should be modular in design to aid quick diagnosis and efficient onsite maintenance. The systems shall neither induce radio interference to affect functioning of other telecom equipment in proximity, nor be susceptible to interference from adjacent mounted radio equipment. Each unit shall be uniquely addressable, and preferably, be ESN validated. Mobile Radio base station unit installed at the ATMS control center shall seamlessly integrate with the co-located Emergency Response integrated audio communication unit.

11.3 Technical Requirements

All components used in the assembly of equipment shall be of industrial grade specification. The equipment shall conform to ETS European standards and shall be suitably protected through shielding/grounding against external EMI/ESI Interference, and shall be immune to RFI, ESD and lightning. Detailed technical requirements of the Base unit (Repeater and base station) as well as the field unit (Hand held and vehicle mounted) of the Mobile radio system are as under:

Repeater/Fixed Base Station

1. The Base unit shall include a controller for switching and control function.
2. The Base unit shall connect to other repeaters if need be.
3. The Base unit shall have call logging and airtime accumulation facility.
4. The Base unit shall be configurable through the installed software on a locally connected computer or over a TCP/IP link.
5. The system shall have capability to interface with the Public Switched Telephone Network (PSTN) for enabling remote access as well as Mobile/Handheld to telephone calls and vice versa.
6. It shall not be possible to program the repeaters without a hardware security lock.

Handheld/Vehicle Mounted Radio

1. The field unit shall have an alphanumeric display..
2. The Vehicle mounted radio shall support integration of GPS.
3. It shall not be possible to program the radios without software security key.
4. The radios shall have a Data Messaging Capability and shall have facility to receive and send pre-defined status messages (at least 12 Character Messages).
5. The radios shall have the facility to store at least 24 addresses.
6. At least 16 status messages shall be selectable in the radio for sending to the other radios.
7. The caller shall be identifiable through display of the PTT ID (of the radio sending the message) on the display of the radio receiving the message.
8. The radios shall have the capability to receive Short Messages (at least 40 Characters) from a Control centre.
9. The radios shall have enough memory to store minimum 6 received Status messages along with the sender's ID and 2 nos. Short Messages received along with the sender's ID.

The system shall satisfy the following functional requirements:

1. The radio shall support a broadcast call or a group call or an Individual Call.
2. It shall be possible to establish an ATMS to field unit link, field unit to ATMS link or field unit to field unit link for communication, as the need arises.
3. The mobile radio system shall be integrated via the Fiber optic communication system (e.g. Inter-tower communication).
4. The system shall have the facilities for waiting calls, holds calls and transfer calls.
5. Call queuing shall be supported in case all communication paths/ channels are busy.
6. Shall support multiple priority levels with pre-emption
7. Field unit to field unit calls shall auto-terminate if either of the party hangs up or the ATMS control centre initiates a call to one of the parties or the conversation exceeds 5 minutes.
8. Late entry feature
9. It shall be possible to bridge the regular PSTN network to the mobile radio network in case of emergencies.
10. Base unit installed at the ATMS control center shall be capable of processing at least 3 calls simultaneously.
11. In case of emergency, it shall be possible to exchange quick, short status/alarm messages.
12. The system shall have suitable voting system to select the better signal at base stations as well as mobile units.
13. Selection, positioning, planning and installation of equipment shall ensure that a localized failure does not collapse the entire communication. Redundant paths shall ensure near total coverage even in such cases.

14. The system shall use frequencies to be obtained by the ATMS Service Provider from WPC in the complete stretch as per scope.
15. The system shall be protected against any damage due to power supply fluctuations, transients and surges.
16. Frequency & Power output Specifications

Sr. No.	Items	UHF	800 MHz
1	Frequency band	400-430 MHz or	806-825 MHz Base Station RX
		450-480 MHz or 480-512 MHz	851-870 MHz Base Station TX
2	Power Output		
2.a	Maximum power output of Base station/Repeater with Power amplifier	100 Watt	80 Watt
2.b	Mobile	30 Watt	5-15 Watt
2.c	Hand held terminal	5 Watt	3 Watt
3	Adjacent channel spacing	12.5 KHz/25 KHz (Analogue) 6.25 KHz/12.5 KHz (Digital)	12.5 KHz/25 KHz (Analogue) 6.25 KHz/12.5 KHz (Digital)
4	Duplex spacing	10 MHz	45 MHz

Chapter 12

Travel time Estimation system

12.1 Scope

This specification lays down the general, functional & technical requirements of the Travel Time Estimation system(TTES).

12.2 Function

The Travel Time Measurement System (TTES) is used to estimate the travel time over a highway segment between any two defined locations. The TTES employs RFID transceivers at such defined locations to identify vehicles by reading the RFID FASTag or any valid 18000-6C RFID tag (e.g. the OEM tags on many new vehicles) affixed on their windshields. The travel time estimation algorithm that executes on an exclusive server networked with the above transceivers, looks for the matching of tag numbers (the Tag-ID) read at the source (start location) of the segment with tag numbers read at the destination (end location) of the segment. A statistical estimate of the travel time between the two locations is arrived at based on the calculated time difference between the reads at these two locations for several matching tags.

In the case of the ATMS system the TTES will be used to determine the estimated time to cross a Toll Plaza located within the project highway with an option to extend it later to include various segments within the highway. For estimating the toll plaza crossing time, RFID transceivers shall be installed at around 500 m on either side of the toll plaza at suitable locations.

As the FASTag affixed vehicles travel through the ETC lanes their time to cross the toll plaza will be, on an average, significantly lower than those vehicles with RFID Tags that do not belong to the FASTag program and which can thus be presumed to have passed through the cash lanes. Thus the estimation algorithm will typically find two distributions (e.g. Gaussian) of the time required to cross the plaza, with the distribution with the lower mean time corresponding to those of the vehicles passing through the ETC lanes and the distribution with the higher mean time corresponding to those of the vehicles passing through cash lanes.

12.3 System Configuration

The system shall comprise

- a) RFID transceivers suitably mounted on gantries at locations on the highway that are designated / defined as either a source or destination of a highway segment for which the travel time is to be estimated.
- b) Power supply system for the above
- c) TTES server located at the ATMS control room
- d) Communication interface system that can network the above RFID transceivers with the TTES server via the ATMS Network Infrastructure for Data Communication described under Chapter 13 of this document.

12.4 General Requirements

- 1) The TTES system shall have the capability to estimate two times to cross a plaza i.e. one related to vehicles passing through ETC lanes and the other related to vehicles passing through cash lanes.
- 2) The TTES system shall function independent of the ETC system installed in the Toll Plaza.
- 3) The TTES system shall operate 24 X 7 and periodically make available the toll plaza crossing times to the NHAI ATMS cloud via the ATMS Server and the ATMS system's external connectivity.

12.5 Functional Requirements

- i. RFID transceivers (with a suitable antenna configuration) shall be located around 500 m on both sides of the Toll Plaza, in both directions to read the 18000-6C RFID Tag affixed on the Vehicle windshield. These Tags may either be part of the FASTag program or belonging to the set of OEM RFID tags affixed to new vehicles in India.
- ii. The RFID transceiver shall read only the Tag-ID from the tag and it is the Tag-ID that shall be stored as the vehicle reference within the TTES system.
- iii. Each RFID transceiver (with its suitable antenna configuration) shall be able to detect RFID tags in a free-flow mode of traffic i.e. traffic that is not confined to a lane.
- iv. The read Tag-IDs shall be suitably buffered in the transceiver, if required, and sent to the TTES server for the purpose of estimation of the Toll Plaza crossing times.
- v. The reading of Tag-IDs by all transceivers shall be time synchronized such that read sequence of a Tag by successive transceivers is maintained along with the accurate time stamps of the reading.
- vi. The system shall employ a suitable statistical algorithm to estimate the mean toll plaza crossing times for ETC lanes and Cash lanes separately. This algorithm shall reside and execute in the TTES server which is networked with the RFID transceivers via the ATMS Network Infrastructure for Data Communication. The TTES server shall be located in the ATMS control centre.
- vii. The estimation shall be performed every 15 minutes as a default, but time period between two estimations shall also be settable.
- viii. The times thus estimated shall be periodically sent to the ATMS server for storage in the ATMS database and for updating the NHAI ATMS cloud via the ATMS system's external connectivity.

- ix. The system shall provide at the minimum the following reports.
- a) Direction-wise Toll Plaza mean crossing times over a 15 minute period for a 24 hour period starting from 00.00 hours of a calendar day for the ETC lane and the cash lane categories.
 - b) Hourly, daily, weekly, monthly and yearly average values of the toll plaza crossing times.
 - c) Comparison reports between toll plaza crossing times at two points of time e.g. 09:00 hours on 1 Jan 2017 and 09:00 hours on 1 Jan 2018.

The service provider shall also arrange to generate and provide any other report (including statistical reports) that can be generated from the data available in the TTES server and the ATMS system.

12.6 Technical Requirements

- (1) RFID transceiver shall have an anti-collision function, to read multiple RFID tags at the same time.
- (2) Channel Switching should be done within 5 milliseconds.
- (3) RFID transceiver shall be capable of reading the tag of moving vehicle with speed of up to 120 km/h.
- (4) RFID transceiver and Antenna shall support up to 4 radio channels.
- (5) The RFID channel switching shall be customizable with an application from the Control room.
- (6) The RFID Transceiver shall possess a read accuracy of at least 95 % i.e. it shall be able to read at least 95 % of the 18000-6C RFID tags affixed on vehicles' windshields, passing under it.
- (7) All the tags shall be stored in the transceiver's internal memory before sending on the network.
- (8) Power supply
 - a) For the RFID Transceivers a suitably backed-up power supply for 24 X 7 operation shall be provided.
 - b) The TTES server shall be powered from the UPS-backed up power supply available at the ATMS control centre.

(9) Specifications

a) RFID Antenna and Reader

Item	Specification
Method	Passive Type
Radio Interface	
Air Interface Protocols:	ISO 18000-6C (EPC Class 1 Gen 2). Shall also support the future Gen2 V2 version
Frequency	865-867 MHz (specified in India)
Power Output	+10 to +30 dBm (EIRP 1W / port)
Interference Rejection:	Dense interrogator Mode
CONNECTIVITY:	
Communications:	10/100 BaseT Ethernet (RJ45); and Serial
Antenna Ports:	Integrated for Single lane Operation
ENVIRONMENTAL:	
Operating Temp.:	-40 to +65C (Ambient)
Storage Temp.:	-40 to + 85C
Humidity:	95% non condensing
Sealing:	IP67 independently Protected for Outdoor Usage
HARDWARE AND SOFTWARE:	
Weight	Up to 3.5kg
Housing	IP67
Operating System:	Smart OS / Linux Debian/ equivalent
Firmware Upgrade:	Web based and remote firmware management functions
Network Services:	DHCP, HHT PS, FTPS, SSH, HHT P, FTP, Telnet, SNMP and NTP, WS Discovery IP addressing Static and Dynamic
REGULATORY:	
WPC:	Equipment type approval.
OPERATIONAL & PERFORMANCE:	
Design:	Designed to be kept always ON (Transmitting)

Note: The transceiver shall support connection to up to 4 antennas

b) TTES server

Description	Remarks
Chassis	2 U Rack Mountable
CPU	Two numbers of latest generation Intel 2600 v3 Quad Core processor 3.0 Ghz, 10 MB Cache
Memory	64 GB RAM using 16GB Module scalable to at least upto 512GB, using DDR4 DIMM (RDIMM) memory modules. Should be capable of identifying and reporting whether genuine OEM memory is installed for system reliability
Memory Protection	Advanced ECC with multi-bit error protection and memory online spare mode
HDD Bays	2* 1.2 TB 10K RPM 12G drives SAS Enterprise level Hard disk and max 8 HDD support
Optical drive Bay	One optical drive DVD-RW
Controller	Server should have RAID controller with 2GB battery backed write cache (onboard or in a PCI Express slot)
Networking features	Server should support networking cards with below features: 1Gb 4-port network adaptor supporting advanced features
Interfaces	
	Micro SD slot – 1
	USB 3.0 support With Up to 3 total: 2 rear, 1 internal, USB 2.0 x 1 (front)

Bus Slots	Five PCI-Express 3.0 slots, atleast One x16 and Four x8 slots
Power Supply	Redundant 800W Gold hot plug Power Supplies
Fans	Redundant hot-plug system fans
Graphics	Integrated video standard with 16MB of Video RAM
	1280 x 1024 (32 bpp)
	1920 x 1200 (16 bpp)
Industry Standard Compliance	ACPI 2.0 Compliant
	PCIe 3.0 Compliant
	PXE Support
	WOL Support
	Microsoft® Logo certifications
	USB 3.0 Support
	ASHRAE A3/A4
Embedded system management	UEFI (Unified Extensible Firmware Interface Forum)
	Should support monitoring ongoing management, service alerting, reporting and remote management with embedded Gigabit out of band management port
	Server should support configuring and booting securely with industry standard Unified Extensible Firmware
	System should support RESTful API integration
Security	System management should support provisioning servers by discovering and deploying 1 to few servers with Intelligent Provisioning
	Power-on password
	Serial interface control
	Administrator's password
	UEFI
Operating Systems and Virtualization Software Support	TPM 1.2
	Microsoft Windows Server
	Red Hat Enterprise Linux (RHEL)
	SUSE Linux Enterprise Server (SLES)
	Oracle Solaris
Provisioning	VMware
	Essential tools, drivers, agents to setup, deploy and maintain the server should be embedded inside the server. There should be a built -in Update manager that can update firmware of system by connecting online.
Remote Management	System remote management should support browser based graphical remote console along with Virtual Power button, remote boot using USB/CD/DVD Drive. It should be capable of offering upgrade of software and patches from a remote client using Media/image/folder; It should support server power capping and historical reporting and should have support for multifactor authentication.
	Server should have dedicated 1Gbps remote management port. Remote management port should have 2GB NAND for user access. NAND flash should be used for keeping system logs and downloading firmware from OEM website or internal repository
	System Remote management licenses offer smart remote functionality without compromise. The license includes the full integrated remote console, virtual keyboard, video, and mouse (KVM), multi-user collaboration, console record and replay, and GUIbased and scripted virtual media and virtual folders. You can also activate the enhanced security and power management functionality.
Warranty	Server should have 05 years 24 hours a day, seven days a week for assistance on resolving issues. Hardware onsite response within four hours if needed; collaborative software included in this Care Pack service provides troubleshooting assistance on industry leading software running on this server.
Operating System	Require this server with MS Windows 2012 Std 64Bit Operating System
Fiber Channel Host Bus	Dual 16GB single port PCIe Fibre Channel Host Bus Adapter

12.7 Installation Requirements

- (1) The RFID Transceivers and the antennas shall be mounted on suitable gantries located around 500 m away from the toll plaza on either side.
- (2) The TTES server shall be rack mounted in the ATMS control centre.

Chapter 13 Network Infrastructure for Data Communication

13.1 Scope

This Specification lays down the general, functional and technical requirements of Communication infrastructure to be used as a sub-system of the ATMS implementation.

13.2 Function

This system provides connectivity between ATMS Control Centre and outdoor equipment such as Emergency Roadside Phones, Variable Message Signs, Mobile and fixed CCTV cameras, Speed Displays, ATCC, Mobile Weigh in motion Stations, etc.

It also provides the external data connectivity required between the ATMS control centre and the NHAI ATMS Cloud as well as between the ATMS control centre and the NHAI ATMS Master & relevant Regional Control Centres.

13.3 System Configuration

1. The system shall comprise:

- a) Cable System
- b) Interface System
- c) Optical Fibre Transmission System
- d) Power Supply System

Note: As part of optimization of the communication system high-capacity point-to-point wireless links may be included to support the Optical Fibre cable-based communication system. However such a wireless link shall never form a segment of the main Optical Fibre backbone. The communication backbone shall always be realised via optical fibre. The wireless link can however be included as a direct link from a device like a CCTV Camera to an appropriate node (including the end nodes) of the Optical Fibre backbone. Such an approach may be utilised to connect road-side equipment to the ATMS control centre that may be otherwise difficult to do so via only the optical fibre link. However NHAI may approve and accept such wireless links, proposed by the service provider, as part of the ATMS system network infrastructure only after the successful carrying out of proof-of-concept tests by the Service provider. The costs for such proof-of-concept tests shall be entirely born by the service provider.

2. Cable System: The system shall comprise:

- a) Backbone OFC cables
- b) Auxiliary OFC Cables linking access points to the back bone and road side equipment to access points
- c) Polythene insulated jelly filled outside plant Cat5e/Cat6 copper cable (PIJF OSP cable) linking various roadside copper based equipment to access points
- d) Coaxial cables.

3. Interface System: The system shall comprise:

- a) Sensor interface equipment
- b) Optical fibre cable interface equipment

- c) Control Centre interface equipment
- 4. **OFC Transmission System:** The system shall comprise:
 - a) Optical line terminals
 - b) Interface Cards
 - c) Network management
- 5. **Power Supply System:** The system shall comprise:
 - a) 12/24V/48V DC power supply systems as per design requirements at various locations.
 - b) 230 V AC, 50Hz power feed as per requirements at various locations.
 - c) Solar PV –based power supplies for 230 V AC, 12/24 V DC as per requirements at various locations.
 - d) UPS, batteries and battery chargers, solar panels and chargers (if applicable) at Control Centre.

13.4 General Requirements

1. The cable system along with interface equipment shall work satisfactorily under adverse conditions like storm, etc.
2. The jointing and other accessories shall be suitably housed and be of compact and rugged design with suitable accessibility for ease of maintenance.
3. The individual sub-systems shall perform their assigned functions and in no way affect or influence adversely the performance of adjacent or associated sub- systems.
4. The backbone Fibre cable for safety and reliability shall be kept independent of other communication and power cables – such as
 - a) Other OFC Cables used for interconnecting the field equipment to the back bone / main control centre, copper cable etc.
 - b) Cables that carry power to the various ATMS field Devices.

13.5 Functional Requirements

1. PIJF OSP CAT5e/CAT6 Cable System
 - a) Road side equipment such as Emergency Roadside Phones, Speed display, VMS Displays or other equipment shall be connected through the PIJF Cable and terminated at an Ethernet switch in the nearest Access point
 - b) The PIJF Cable used shall electrically comply with Cat5e or Cat6 (preferred) standards.
 - c) Suitable punch-down lightning and surge protectors shall be used at prior to terminating cables at both ends.
2. Optical Fibre Cable
 - a) The backbone of cable system shall interconnect ATMS Control Centre with access points situated at suitable distances from the ATMS Control Centre. Other access points shall link to the backbone via auxiliary OF cables from these locations.
 - b) The OF Cable System shall carry signals from all outdoor equipment such as Emergency Roadside Phones, Variable Message Signs, ATCC Portable and fixed CCTV cameras, Speed Displays, through the network equipment at the access points to the Control Centre.

- c) The OF Cable system shall interconnect all the access points to the ATMS Control Centre and also if required with associated network devices for signal transmission without any impairment.
 - d) The backbone communication OF Cable system shall not be broken anywhere in between to link access points or road side equipment. This cable shall be terminated only at the designated access points and the ATMS Control Centre. It shall not be allowed to interface any other sub-systems in the field to this cable or any spare cores in the cable directly or through branching.
 - e) The separate and independent OF Cable system shall be used for the transmission of video signals, data signals from the equipment locations to access points where the copper cable has limitations for transmission of signals.
 - f) The OF cable shall provide for dedicated spare fibres to cater to any future need that may arise.
3. Co-axial Cable System
- a) The Co-axial Cable System shall provide immediate interface to carry signals from analog CCTV Cameras (if used) to the encoders situated at the nearest access point.
 - b) The OF Cable shall also be used with transmitters and receivers if the distance is large and high quality signal transmission and reception is not possible using co-axial system.
 - c) The signals shall, without any impairment, be routed to the ATMS Control Centre via the equipment at the access point, auxiliary OFC and the backbone OF cable.
4. Interface System
- a) The Interface System shall cover the PIJF Cable, Co-axial Cable and OF Cable System & transmit and process the composite signals to achieve the desired reliability/availability requirements.
 - b) The Interface sub-systems shall be capable of handling the composite audio, video and data signals at various interface levels and process them.
 - c) The Interface sub-systems shall be designed optimally at various levels i.e. from the individual sub-systems level to integrator through to the Control Centre.
5. Power Supply System
- a) The Power Supply System shall support the requirements of individual sub-systems.
 - b) The Power Supply System proposed for individual sub-systems shall take into account the overall availability/reliability requirements.
 - c) The Power Supply System design shall take into consideration local power availability, temperature and other climatic variations, and easy maintainability.

13.6 Technical Requirements

- 1. PIJF OSP Cable
 - a) The Cable shall be Cat6 manufactured by reputed manufacturers such as Lucent, Amp etc.
 - b) The PIJF Cables shall be laid in suitable trenches with protection against corrosion, inadvertent cutting, flooding, rodents and termites.
- 2. OF Cable

- a) The Back bone OF Cable shall have a fibre count of minimum 12 fibres. This cable shall not be used for any other connectivity.
 - b) The cable used for short-haul connectivity between outdoor equipment & Access points, access point to backbone etc. shall have fibre count as per the design requirements (4 cores, 6 cores, 12 cores, 24 cores, etc.). These shall be based on the location of equipment along the highway.
 - c) The fibre size, stranding, filling and associated technical and testing details shall also, as a minimum, comply with the TEC specifications approved by Department of Telecommunications, Govt. of India.
 - d) Methodology for cable laying, installation, splicing and protection measures shall be described in detail by the Service Provider for approval of NHAI and shall conform to standard industry practices.
3. Co-axial Cable System
- a) The Co-axial Cable System shall connect the cameras with the Control Centre via the access points. It shall have capability to interface with the OF Cable network for signal transmission.
 - b) The Co-axial Cable System shall conform to relevant ITU-T standards for signal transmission and protocols.
4. Interface System: The Interface System shall broadly operate at the levels as described below:
- a) Way side (Emergency) phone to access point via PIJF Copper Cable.
 - b) VMS Signs to Access point via copper Cat 6 patch cord or OF Cable.
 - c) CCTV System to ATMS Control Centre via Co-axial to encoder (if required) and further via OF Cable.
 - d) Integration with the NMS equipment at different levels for monitoring, logging and control of individual sub-systems.
 - e) Interfaces at appropriate system and sub-system levels shall follow the protocols and standards of RS232, RS485, RS422 and ITU-T, IEEE, ITU- R or other approved international standards for transmission and networking of voice, video and data signals. These shall be as per the detailed specification in the tender elsewhere.
5. Power Supply System
- a) The power supply arrangement at individual sub-system level shall be designed for their optimum and reliable operation.
 - b) The design shall take care of availability of local utility power and necessary backup to achieve the desired performance objectives.
 - c) Video Cameras and Variable Message Signs located on the roadside in particular shall be supplied backup power supply for operating in all types of weather conditions.
 - d) Diesel Generators and UPS (Solar PV-based or otherwise) as required shall be included as part of the system design as per the need for sub-systems/ Control Centre. Design calculations to establish the capacity of these subsystems shall be furnished by the Service Provider.
 - e) The power supply design shall take care of voltage and frequency fluctuations and redundancy to achieve the required system performance.
 - f) Suitable lightning protection and earthing shall be provided to guard against system malfunction.

13.7 Cable Laying and Installation

1. The cable laying, installation, termination and wiring shall follow standard international practices. The Service Provider shall be solely responsible for the proper execution of the work.
2. Cable Laying
 - a) The Service Provider shall submit a cable route plan with distribution chart for the indoor and outdoor requirements.
 - b) Excavation of cable trench shall be done in all kinds of soil to a minimum depth of 1.65m from the ground below the central median of the highway and to a width of not less than 0.3m and also provide proper protection as required by NHAH while crossing power cables, pipe lines etc. The bottom of trench shall be levelled and got rid of any sharp material.
 - c) The cables shall be laid as far as possible on one side of the road. The Service Provider shall restore the road surface, diversion and other modifications as a result of the trenching to the original state after completion of this work. Wherever required depth is not achievable additional protection shall be provided in consultation with NHAH and with prior written approval of the NHAH and / or NHAH's representative.
 - d) The optical fibre cables shall be laid in permanently lubricated HDPE ducts of appropriate dimension with protection against moisture ingress, termites and rodents.
 - e) The OF cable and the PIJF cable shall be laid in the same trench. There shall be two or more ducts laid in the trench as per the requirement..
 - f) Whenever power cables are to be laid in the trench along with other cables, brick separation of at least 5 bricks/per metre length-wise shall be provided.
 - g) Right of way will be provided by NHAH.
 - h) The trenching and cable laying activities shall cause minimum disruption to the traffic flow on the highway. The material, cable drums and the manpower used shall not inhibit the flow of vehicles in any manner.
 - i) The excavation of trenches shall be done only in lengths that can be handled in a single day. The trenches shall not be left uncovered overnight.
 - j) The trenching and cable laying shall take into account likely diversions on bridges, toll plazas, built-up area, ERT (Emergency Road Side Telephone) pedestals, etc.
 - k) The cable laid along the bridges shall be suitably protected (via GI conduits) and clamped.
 - l) Adequate extra length shall be left at the end of the cables to meet future exigencies.
 - m) Cable across the road from the backbone of OF/PIJF cable for ERT's and other sub-systems along the route shall be laid in ducts below the bed using trenchless ducts through horizontal direction drilling. The procedure shall be deployed after written approval of the NHAH and / or NHAH's representative.
 - n) These shall be laid on one side of the highway. Crossings and cuts on the highway shall be provided with trenchless excavation. Suitable route markers every 500 metres shall be provided. Suitable no. of patch panels, joint boxes, termination boxes, pigtailed and patch cords, etc. shall be provided.

- o) Waste material such as unused ducts, cable cut-pieces, and other debris shall be cleaned and suitably disposed as per the relevant recycling and disposal standards by the Service provider.
- p) The service provider shall provide adequate perforated cable trays and/or cable supports as per industry best practices.
- q) All cables shall be numbered with ferules in accordance with the universal cable numbering system.
- r) All cables shall be ISI marked, fire retardant low smoke type and shall be terminated with proper lugs and joints as per best industry practices.

13.8 External data connectivity to the NHAI ATMS Cloud and the NHAI ATMS Master & Regional Control Centres

A suitable leased-line (wired or wireless) supporting a minimum 8 Mbps data link shall be provided by the service provider for the purpose of connection to the NHAI ATMS Cloud and the NHAI ATMS Master & relevant Regional Control Centres. Such a link shall make the ATMS system directly on-line accessible to the above NHAI facilities and shall provide the following information:

- 1) Video images & required data strings to the NHAI ATMS Cloud at pre-programmed intervals and on demand.
- 2) Providing streaming video data, streaming audio data and data strings on demand from the NHAI Master & relevant Regional Control Centres.

Further this link shall also fully support the on-line access of the ATMS system by NHAI / NHAI's representative as described in Clause 2.2.8.3 of this document.

Chapter 14

ATMS Control Centre with ATMS Software

14.1 Scope

This Specification lays down the general, functional and technical requirement of the ATMS Control Centre. .

The Control Centre shall accommodate following equipment and software:

- (i) Central Computer Server (with integrated ATMS Software including the traffic Management and Rescue module, integrated audio communication unit & support for relevant Mobile smartphone applications)
- (ii) Emergency call management system equipment and software
- (iii) Integrated Traffic Management (ITM) console consisting of mainly the ITM Workstation, the Integrated audio communication unit and further integrated with the
 1. Large Display Board based on the Video-wall
 2. CCTV Console,
 3. VIDS console and
 4. other equipment
- (iv) ATMS software
- (v) Mobile radio operator and configuration equipment and software
- (vi) Backbone communication equipment and Network Management System for the same
- (vii) Printer
- (viii) Uninterrupted Power Supply with supply system and back up
- (ix) Mains Power supply system and Diesel Generator set equipment.

14.2 Function & Architecture

ATMS Control Centre would be the facility from where all the activities of the ATMS would be controlled. ATMS Control Centre would primarily comprise of the in-door portion of CCTV, VMS, and other support systems. All the aforementioned sub-systems shall preferably reside in a dedicated permanent structure with adequate floor area to house the required man power and equipment. Where ever such a permanent floor/building/structure cannot be made available, the ATMS Control Centre shall be housed in temporary portable cabins.

A schematic of the ATMS control centre system is shown in figure 1 below:

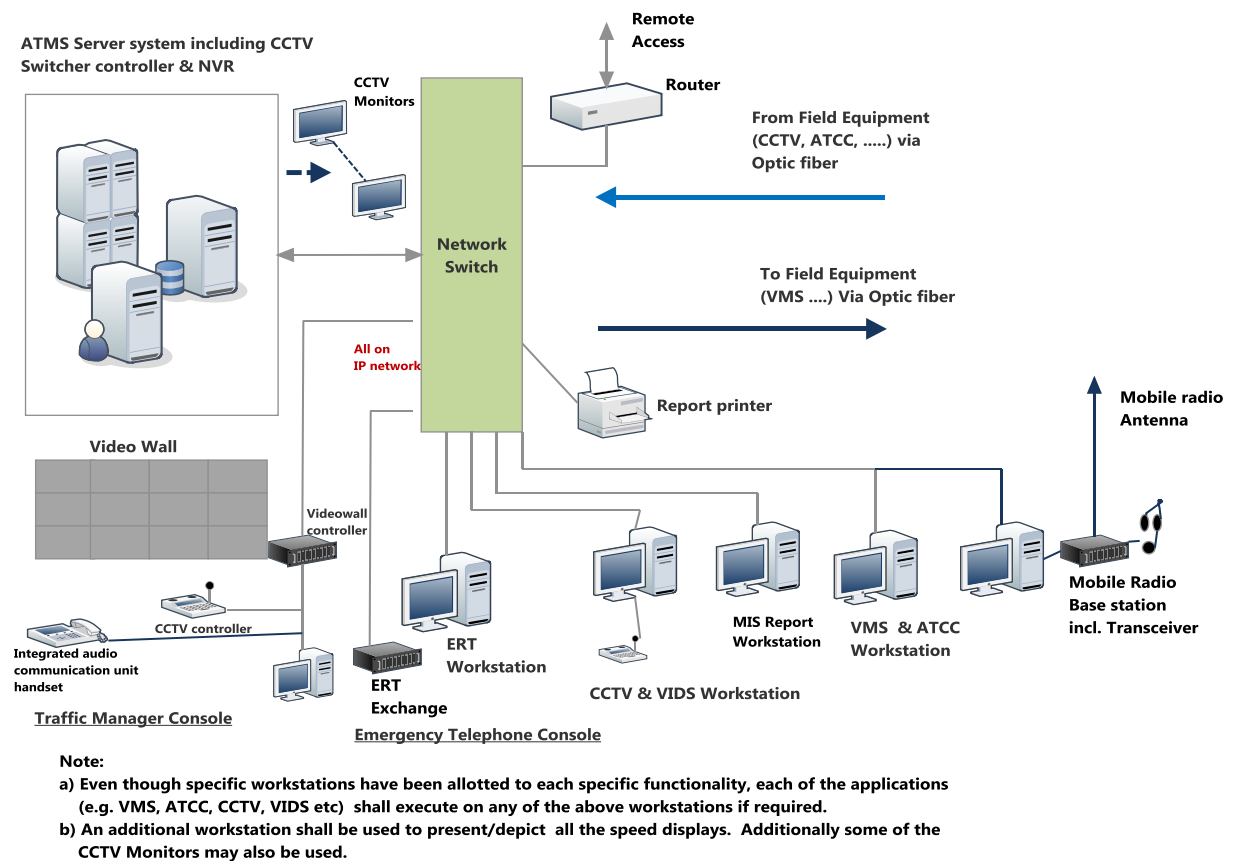


Fig 1 ATMS Control Centre system

14.3 Functional Requirements

Since the ATMS Control Centre houses the in-door functional components of all the installed ATMS sub-systems(CCTV, VIDS, ATCC, MET, VMS...), the following subsections describe the functional requirements including a brief specification for the temporary portable cabin.

14.3.1 General

1. Each sub-system shall be expandable to account for increase or decrease in field installed devices. Minimum $\pm 25\%$ spare capacity (rounded off to the nearest higher whole number) should be ensured.
2. All the supplied equipment shall operate on 230 V, 50 Hz single -phase power supply. Power for all the equipment will be regulated using on-line UPS with minimum 30 minutes or more back up. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device(s) for such requirement shall be supplied along with the equipment.
3. All the control equipment e.g. file servers, database servers, NVR/CCTV CAMERA SERVER, Video Analytics NAS/Raid backup device, decoders, networking equipment etc. shall be provided in standard Racks.
4. System shall have provision of WAN connectivity for remote monitoring.
5. Online backup should be maintained to protect against storage failure.

6. The system provider shall provide all technical details regarding data formats, communication protocols, packet formats, etc. to NHAI.
7. All sub-system software modules shall be available in all the workstations, so that, with minimum intervention of System Maintenance, one user-group can perform their operations on a different workstation. However, for security reasons, only the functionality based on the expected user-group who is utilizing the workstation for day-to-day operation shall be available for immediate use.
8. All Sub-systems shall generate and report alerts when a pre-defined event occurs.
 - (a) **Safety related alerts / reports:** Further all the software modules of the sub-systems installed (CCTV, VMS, Speed display, Roadside Communication etc.) shall deliver safety-centric reports (e.g. fatal collisions in a given stretch, violation of regulation etc.), enforcement-centric (number of tickets issued, comparison of violations on monthly basis etc.);
 - (b) **Equipment related alerts / reports:** Failed packets, number of repairs carried out on field devices, down time on account of major faults etc..
 - (c) All sub-system (e.g. CCTV, VMS, ATCC, VIDS, VAS etc) related alerts & events shall also be communicated to the Traffic Management console for display on the Video wall / Traffic management console workstation.
 - (d) Further each sub-system shall also accept commands / messages from the Traffic Management console for ensuring the achievement of an Integrated ATMS system.
9. The system shall provide detailed reports related to the System Operations (including the actions of various stakeholders during Incident Management) and operations. The format for the same shall be finalized by the service provider in consultation with NHAI and / or the NHAI's authorized representative. Maintenance reports, at the minimum, shall include the current operational status of each equipment, actual events of down-times of each equipment, actual events of Mean time to Repair of each equipment and actual events of Meantime between failure of each equipment and the preventive & repair maintenance log.
10. The system shall also provide a method to log and report road highway incidents. Data used for logging and reporting shall be 'picked-up' automatically from the road-side / field equipment and other sensors as applicable.
11. Further the system shall provide a facility of generating user-formatted reports that can, for example, bring together the occurrence of highway incidents, values of various sensors and the operational status of various equipment on a common time line / scale.

12. System Security

- a) It shall be possible to control / restrict all functions / sub-functions (can be menus, submenus, buttons to perform specific operation), etc. available in

each module based on the user group in general and in certain special user groups viz., Project Manager / Administrator, the control shall be possible at the user level.

- b) The Access control shall have 3 levels of access, Read, Write, and Modify. It shall be possible that any user / user group can be assigned none / all from the above levels for a specific function.
- c) All the manual override options shall be considered separate functions and it shall be possible to disable these functionalities by simply not allowing access to these functions for any user/ user group.
- d) Detailed list of Access rights shall be evolved during detailed engineering .
- e) At the end of session, the operator logs out from the application and the log out shall be recorded in the database.
- f) It shall not be possible for a different user to open a separate instance of the application without the current user logout in the same workstation.
- g) It shall be possible to exit the application only with Administrator authentication including username and password.

14.3.2 CCTV & VIDS

1. There shall be a Supervisory Monitoring & Control System with Digital Video Surveillance Control Software to manage all the video surveillance devices.
2. The Supervisory Monitoring and Control System shall consist of at least a Camera Switcher controller, Joystick, Camera server, NVR, adequate number CCTV monitors & a workstation (CCTV & VIDS workstation). The system shall be able to provide streaming video images to the video Wall and / or the above monitors and / or workstation.
3. The supervisory monitoring and control software should be capable enough to display and manage the entire surveillance system. It shall support a variety of devices such as cameras (PTZ, Fixed & VIDS), video encoders, video decoders, PTZ controller, NVR, NAS boxes/Raid backup device etc.
4. The manufacturer of the CCTV Switcher Controller /NVR /Camera Server shall be
 - a) A well-known and established company worldwide in the field of Information Technology.
 - b) Has established and appointed representative or authorized agency near project location.
 - c) Capable of providing adequate after-sales service and support on 24X7 basis.
5. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage VMS, WIM, Speed Display, and Roadside Communication etc.
6. The software shall store configuration of encoders / decoders and cameras. There shall be options to generate reports of stored device configuration.
7. The system should support intelligent video motion detection to track objects, learn the scene and adapt to a changing outdoor environment. Environmental

changes such as rain, hail, wind, swaying trees and gradual light changes should have minimum effect on the settings.

8. The control software should provide for alarms and alarm log. Alarm settings need to be individually configurable for each alarm and each camera prerecord duration. The duration shall be selectable from a list of values ranging between 2 seconds or less to 5 minutes or more. There shall be provision to achieve, print and display the log using device filter, device group filter and/or a time window.
9. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of camera a user can view and control.
10. The administrator should be able to place users in a hierarchy. The higher priority user should inherit the rights of a lower priority user automatically when he is taking overriding control of cameras, which are already being controlled by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.
11. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.
12. For monitoring purposes, a Video wall shall be setup with suitable mounting arrangements, as described in section 13.3.2.1. Facility for viewing and controlling all the cameras at various other locations e.g on CCTV monitors (supporting HDMI, RGB & IP-based), as required, shall be provided in addition.
13. The Area under surveillance shall be monitored and controlled from ATMS Control Centre through workstations and Joystick controllers with the help of Digital Video Surveillance Workstation Frontend Software as part of the Supervisory monitoring and control system Software..
14. The Workstation Frontend Software should also be working on a browser based system for remote users to allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.
15. The software should Support flexible 1/2/4 Windows Split screen display mode or scroll mode on the PC monitor or on preview monitor as per requirement.
16. The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and colour balance of camera, Selection of pre-sets, Video tour selection etc.
17. The user shall have the facility to request for view or control of any camera outside his rights for a reservation period. Control of camera is released after the reservation period (Request enhanced control rights for a short duration).
18. ATMS Control Centre may have one or more Operators simultaneously controlling the installed field video hardware.
19. The recording resolution and frame rate for each camera shall be user programmable.
20. Recording modes such as continuous, manual, or programmed date-time-duration modes, camera, group of camera-wise. All modes may individually be disabled or enabled using scheduled configuration. It should also be possible to

search and replay the recorded images on date, time basis as well as camera basis. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

21. The NVR / CAMERA SERVER can be an embedded-type or server-based. However the NVR /CAMERA SERVER software shall run on off-the-shelf available servers (Camera server & Database server). Each NVR / Camera Server shall be able to handle 36 or more cameras.
22. Network Video Recorder shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable.
23. System should ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.
24. System shall provide sufficient storage of all the camera recordings for a period of 30 days or more @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras (extended capacity of cameras i.e. present capacity + 25%).
25. System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired. The recording shall support audit trail feature.
26. All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.
27. Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.
28. Facility of Camera recording in CIF, 2CIF, 4 CIF as well as in any combination i.e. any camera can be recorded in any quality – Selective or Group of cameras must be available in the system.
29. Video shall be compressed using MPEG-4 or better standard and streamed over the IP network. Once on the network, video can be viewed on a Control room workstation or on analog monitor using a hardware decoder (MPEG-4/compatible standard Receiver) and shall be recorded on NVR/CAMERA SERVER and shall be backed up on NAS/RAID Backup device.
30. System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.
31. The offered system shall have facility to retrieve/export/ backup (on CD, DVD or Blu-ray recorders) the desired portion of clipping (from a desired date/time to another desired date/time) through the search functionality of the application software. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc. Log of any such activity should be maintained by the system for audit purposes.

32. Redundancy/Fail-over feature is required i.e. in case of failure of an NVR/CAMERA SERVER the relevant cameras shall automatically switch over to the redundant NVR/CAMERA SERVER.
33. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
34. Video stream from individual cameras shall be recorded on respective NVR/Camera Server &, subsequently, archived to NAS box/RAID backup device. System shall have provision to automatically over-write the new information after the period of 30/31 days
35. The Necessary script/algorithm for the above must be available in the Application.
36. All the workstations in LAN should be provided with software to view and control the cameras, encoders and retrieve the recorded video images from the NVR/CAMERA SERVER/NAS/Raid backup device seamlessly.
37. VIDS
 - a) It shall be possible to switch and view video streaming images on-line from all VIDS cameras on the CCTV monitors and Videowall and the CCTV , VIDS workstation
 - b) The supervisory software (executing on the VIDS Supervisory computer) shall determine the following parameters related to traffic flow monitoring :
 - (i) Traffic volume(No of vehicles detected during the time interval);
 - (ii) Occupancy (Lane occupancy measure in percentage of time);
 - (iii) Vehicle classification, Flow rate (vehicle per hour per lane);
 - (iv) Headway (Average time interval between two vehicles);
 - (v) Speed, Level of Service;
 - (vi) Space occupancy &
 - (vii) Traffic Density from both the ATCC and the VIDS data captured from the respective field equipment.
 - c) The allowed errors on count and detection shall be $\leq 4\%$ under normal weather conditions and $\leq 7\%$ under adverse weather conditions (shadows, fog, rain).
 - d) The allowed error on speed detection will be $\leq 4\%$.

14.3.2.1 Video Wall (large display board)

1. The video wall shall typically be a matrix of 3x3 but the controller shall be capable and flexible enough to accommodate varied different monitor matrix geometries as dictated by space availability or constraints.
2. The typical video wall display size shall be 35" x 46" to 54" x 72".
3. Video wall controller shall be capable of capturing and displaying video information from different sources such as DVI, DisplayPort, VGA, IP streaming etc.
4. The monitors used in constructing wall display matrix shall have bezel edge sizes less than 6 mm.
5. The video wall shall be an integrated package of control room display management and configuration software, display controller capable of handling at least 48 monitors, and the required number of slim bezel monitors.
6. The video wall system shall support hot-plugging and redundancy.

7. Video wall controller shall support auto calibration and auto colour balancing.
8. Mounting arrangements for individual monitors within the wall matrix shall be designed to allow for easy replacement and hot plugging.
9. The manufacturer of the Video wall shall be
 - a) A well-known and established company worldwide
 - b) Have an established and appointed representative or authorized agency in project location.
 - c) Capable of providing after-sales service and support on 24X7 basis adequately.
10. The target image on the Video wall shall be freely resizable and re-positionable on any part of the Screen.
11. The Video Wall shall be capable of accommodating multiple displays in multiple rows and columns behaving as single logical screen.

14.3.3 VMS

1. There shall be a Control System with Variable Message Sign Control Software to manage all the VMS Boards within the installation.
2. The software should be capable of managing at least 65530 hierarchically grouped VMS display boards. It should support VMS boards of varying sizes.
3. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage CCTV, WIM, Speed Display, and Roadside Communication, apart from the Traffic Management module (where applicable) etc.
4. The software shall store configuration (VMS ID, its actual location, brightness levels, horizontal pixel size, number of lines supported, Regional Language supported etc.) of each VMS that it controls. There shall be options to generate reports of stored device configuration.
5. The system should support adaptive display brightness to adjust readability to the changing outdoor environment.
6. The control software should support some form of CRC¹ on display data and control command packets for device error reporting.
7. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of VMS a user can control.
8. The administrator should be able to place users in a hierarchy. The higher priority user should inherit the rights of a lower priority user automatically when he is taking overriding control of VMSs, which are already being controlled by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.
9. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.

¹ Cyclic Redundancy Check

10. ATMS Control Centre will have a workstation for VMS operation. Facility for controlling all the VMSs at various other locations, as required, shall be provided.
11. The VMS to be controlled shall be accessed from ATMS Control Centre through workstations with the help of VMS Control Workstation Frontend Software. Further the above software shall also accept messages for display from the Traffic Management console programmed on GUI interfaces provided by this software.
12. As the VMSs can be configured to display messages in a chosen regional language, the software should be able to control VMS configured for any regional language.
13. The user shall have the facility to request control of any VMS outside his rights for a reservation period. Control of VMS is released after the reservation period (Request enhanced control rights for a short duration).
14. ATMS Control Centre may have one or more Operators simultaneously controlling the installed VMSs.
15. As stated earlier, all data and command packets shall have a suitable CRC attached to them. All packets sent would be acknowledged by a response packet from the respective display with its own CRC.
16. The response packets from VMSs shall include status (command executed or not) as well as error codes to indicate the nature of error.
17. The system should support multicast (broadcast to a predefined group of displays) and broadcast. Multicast or broadcast packets shall have no response packets from VMSs.
18. A single message may be shown as a static sign or a group of messages may be shown in a round robin fashion till a new set of messages are not relayed to a particular VMS.
19. The time duration for which a message is displayed while in round robin mode will be programmable from 1 second to 255 seconds.
20. VMS and the associated software shall support the following text animations:
 - a) Scroll right to left
 - b) Flashing (For example, this would be to attract attention to speed limits)
 - c) Typing
 - d) Curtain top to bottom
 - e) Curtain bottom to top
 - f) Replace left to right
 - g) Replace right to left
 - h) Text without any effect (for example, this would be default for most text)
21. The use of text effects shall be strictly a policy of NHAI road safety experts dictated by situation and hence, should not be a fixed global parameter. It shall be dynamically assignable and remain valid for a text string for the current instance alone.
22. It shall be possible to send ten strings in round robin mode.

23. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
24. A sub-module of the VMS software called the Mobile Application Service and Relay (MASeR) shall manage the updating and relay of critical incidence information such as incidence location, diversion information, and directions for the driver to follow to all the registered road users.
25. Using the same VMS-MASeR software module, it shall be possible to manage request services such as route planning and guidance, request for current co-ordinates, weather and traffic status, approximate travel time, average vehicle speed etc. to registered road users.

14.3.4 ATMS software

- a) The ATMS software integrates the field equipment like CCTV cameras, VIDS, ATCC, MET & VMS with the Integrated Traffic Management (ITM) console to ensure the availability of an effective system for Traffic monitoring & incident / accident management
- b) The ATMS software shall be based on a modern architecture and shall optimally execute on the ITM workstation and the ATMS server to ensure that
 - i. The system response are instantaneous to support effective Traffic Management (i.e. Traffic monitoring and incident / accident management) actions on the ITM workstation.
 - ii. No information (data, video stream & audio stream) from any source is lost. Further all such information is made available on the Integrated Traffic Terminal, with no delay, precisely at the time they are required.
 - iii. Effective integration with the CCTV system, VIDS system, VMS system, MET system and other relevant ATMS equipment is carried out in a seamless manner with no disruption of / disturbance to the Traffic management function (i.e. Traffic monitoring and incident / accident management). For such integration, standard interfaces (e.g. NTCIP) shall be used wherever available.
 - iv. All information (Data, video and audio streams) collected from various sources shall be archived in the ATMS server for quick retrieval by authorized personnel. However the performance of the ATMS software in terms of response times shall not be affected during such a retrieval process.
- c) The ATMS software shall be a modular system comprising of at least the following modules:
 - A. Data acquisition module for acquiring data, video streams and audio streams from field equipment
 - B. Highway Traffic Monitoring module
 - C. Incident / Accident Management Module
 - D. Integrated audio communication module
 - E. Report generation module
 - F. System Administration module

- G. Communication module for authorized access by external systems (e.g. NHAI's Regional control centre & the Main control centre)

A. Data Acquisition module

- i. The Data Acquisition enables the acquiring of data from the various field equipment in the form of data strings, video streams and audio streams. Examples include
- Data strings from VID system, MET system, ATCC system, WIM system, VAS system
 - Data strings of Date and Time and details of events (e.g. the time an Emergency Call was attended to on the 1033 telephone line or on the ERT phone system), alarms and faults related to any part of the system.
 - Video Streams from CCTV Camera, VID Camera
 - Audio Streams related to conversations on the 1033 Emergency Telephone , Road-side Emergency Telephone
- ii. The module allows the user to configure the acquisition conditions as follows:
- At regular intervals of time with the interval being user specified (e.g. from the MET data logger, ATCC system)
 - On the occurrence of Traffic related events in the field (e.g. data from the VID system, instances of calls from Emergency Telephones)
 - On demand (e.g. Video stream from a CCTV Camera)
 - On the occurrence of system related events like equipment failure and restoration, user login / logout
- iii. The above information thus acquired shall be stored in the ATMS server using an established database package like Oracle or MS SQL.

B. Highway Traffic Management module

- i. This module shall support effective Traffic monitoring on the highway. The targeted road section or the entire stretch shall be depicted on the Large display (video wall) and ITM workstation, in the form of animated screens including Graphic User interfaces specified under Clause 816.1 to 816.17 of Specifications for Road and Bridge Works of MoRT&H. The depiction shall include locations of all ATMS field devices on a GIS map with the ability to display alongside the current information (e.g. CCTV video Images, VMS messages, Met data) relevant for each field device, either permanently or on selecting the device with a mouse. The details of the project-specific composition of the GUI will be finalized during the project execution phase between the Service Provider and NHAI (or its authorized representative).
- ii. The module shall display the events, alarms & faults acquired by the system (Traffic related and system related) on a window at the bottom of the ITM / Video Wall(Large display screen), with the window size in terms of the number of events displayed being user configurable. Further the system shall

provide a feature for the user to acknowledge such events and the subsequent display of the same.

- iii. In addition to the above, the module shall also display the related event (where relevant e.g. a road-side emergency telephone call, VIDs event) on the GIS map using suitable animated icons. The animation shall contextually change when the event has been acknowledged and when the condition causing the event has disappeared.

C. Incident / Accident Management module

This module shall support Incident / Accident Management by:

- i. Allowing the Traffic Management console operator to locate and mark (with a mouse) an accident / incident on the GIS map of the highway and initiate the Incident management actions.
- ii. Displaying a contextual on-line checklist for the operator to follow in sequence. Further the clicking on each item of the checklist shall automatically activate the related ATMS equipment to aid in the management viz., i) seamless audio connection for the Traffic Management console operator, via the integrated audio communication unit, irrespective of the communication media (Mobile radio, Mobile phone/landline, road-side Emergency telephone), to the ambulance, Trauma Care Centres, Patrol & other O&M vehicles ii) automatic Pan, Tilt and Zoom of the nearby camera to view the accident iii) Bringing on the VMS -wise message edit screen (by interfacing with the VMS Control software ref: Section 13.3.3) to create and dispatch messages to VMS boards and mobile apps of registered road users). The checklist itself shall be derived from the relevant Traffic Management and rescue procedures captured either in the Operation (O&M) manual of the highway or based on world-class best practices.
- iii. Logging the time-stamp of the operator operating each element of the checklist to aid in 'post-facto' analysis of the operator's performance towards establishing his /her efficiency and further training needs.
- iv. Automatically performing pre-defined actions related to each of the above elements (e.g. Identification of the accident spot on the road shall control the nearby CCTV cameras to 'look' in the direction of the accident spot)
- v. Aiding on-line tracking (via GPS) of the various O&M vehicles like the Ambulance, Tow-vehicle and the Patrol vehicle supported with dynamic display of information like shortest route, travel time to the accident spot, Trauma Care Centre etc.
- vi. Providing a user-programmable facility, as an aid, for the automatic generation of VMS messages depending on incidents based on e.g. information measured by the MET sensors and sensors installed on the highway (e.g. the generation of a Visibility Alert signal in the event of

visibility going below 1 km). This module shall alert the operator on generating the message which shall then be deployed on the operator's approval.

- vii. The detailed workflow of this module involving various checklists, shall be finalized between the service provider and NHAI during the project execution phase.

D. Integrated audio communication module

This module shall interface with and control the integrated audio communication unit to aid the operator seamlessly communicate with various stakeholders via a host of communication media like telephone landlines, mobile telephony, mobile wireless etc.

E. Report generation module

- i. This module shall generate periodic as well as on-demand statistical reports using data received from WIM, Automatic Traffic counter cum Classifier and MET sensors for traffic planning and management, as well as traffic forecasting. There shall also be a provision to generate reports to aid planning and strategizing enforcement.
- ii. The module shall provide a range of reports on demand including those
 - related to the acquired data,
 - VMS messages edited and sent,
 - Equipment availability,
 - System related events including those related to
 - System malfunction and restoration
 - User login – logout
 - VIDS events detected
 - Mobile App messages received
 - Traffic flow volume(No of vehicles detected during the time interval), Occupancy (Lane occupancy measure in percentage of time), Vehicle classification, Flow rate (vehicle per hour per lane), Headway(Average time interval between two vehicles), Speed, Level of Service, Space occupancy & Traffic Density from both the ATCC and the VIDS data captured from the respective field equipment.
- iii. The module shall further provide detailed performance reports on all aspects ranging from detection of incidents, through the field Operations team (Patrol vehicles, Break-down cranes and Ambulances) actions, Traffic Management Console operator and other ATMS Control Centre operator actions. Automatic system generated reports supporting the service provider's claim of meeting the service level requirements with respect to operations, shall also be provided.
Detailed formats of each report shall be finalised by the Service Provider in consultation with NHAI.

F. System Administration module

This module shall essentially enable the definition and maintenance of user accounts.

G. Communication module

This module will manage authorized access to the ATMS system by

1. Authorized NHAI personnel / representatives
2. Other authorized NHAI systems like the Regional office Control Centre ATMS system and the Main Control centre ATMS system
3. Any other system authorized by NHAI

Based on requests from the above entities the communication module shall provide the following information to the requesting entity:

- i. Video Streams (Live and Archived)
- ii. Audio streams (Live and Archived)
- iii. Data strings and Data elements (Live and Archived)

The standard data exchange protocols for the above will be shared by NHAI with the Service Provider.

14.3.5 Integrated Audio Communication Unit

The Integrated Audio communication unit enables the Traffic Manager / operator to communicate with all stakeholders in a seamless manner irrespective of the medium of communications. Using a hardware like a digital telephone exchange that supports software control, this unit allows the Traffic manager wearing a headset with a microphone (or a handset) to seamlessly communicate with the stakeholders in traffic operations using various audio communication media like Mobile wireless radios, Mobile (GSM) telephones, Telephone landlines as well as the road-side Emergency Telephone. The communication is initiated on selection of a context sensitive checklist element or by selection of suitable icons on the ITM workstation screen during the Traffic monitoring or accident / incident management. This unit shall support communication between the Traffic manager and a single stake holder or a group of stakeholders. As a back-up option this unit shall also enable such communication via physical push-buttons located on the unit.

14.3.6 Interface with Mobile Phone Apps

1. **App for Road Users:** The ATMS control centre system shall seamlessly interface with NHAI's provided mobile apps (for the popular Mobile Operating Systems like iOS®, Android® and Microsoft Windows® and based on the state-of-the-art technologies) to support the following functions.
 - a) Support Journey planning by providing dynamic and up to date location-wise information on congestion, incidents, weather conditions and other useful information for the section of the highway planned for the road-user's journey.
 - b) Enable the road-user to report incidents via the app using drop-down menus, supporting images captured by the Phone camera and the position

- of the road-user as detected by the on-board GPS or in the absence of which, as entered by the road-user.
- c) Enable the road-user to report an incident by calling or by messaging using the position of the road-user as detected by the on-board GPS or in the absence of which, as entered by the road-user.
 - d) Send Pop-up messages to the road-user related to the traffic on the highway thus performing the function of an on-board VMS.
 - e) Send pop-up messages to the App Users indicating that he/ she was over speeding at ... date,time, & place.
2. **App for Enforcement Agencies:** The system shall also include a software module that sends Incident messages to the police on their mobile-phones (App published by the Service provider) for traffic enforcement including information like the type of incident, location and related images. The details of this information shall be picked-up from the ATMS Control Centre database and road-user inputs if any and relevant.
3. **App for Highway Traffic / Route Patrol Agencies:** Further the above module shall also generate and send incident and system status messages to the Traffic Manager and other senior management personnel of the O&M team on their mobile phones (App published by the Service provider).

14.3.7 Emergency Telephone console

1. There shall be a Control System with a Control Software to receive all Emergency Communication from the NHAI 24 X 7 National Highways helpline and the Emergency Road-side telephones (shortcode '1033').
2. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage CCTV, VMS, WIM, and Speed Display, apart from the Traffic Management module (where applicable) etc.
3. The software shall store configuration Emergency Roadside Telephone ID, Location on the highway stretch etc.) of each Emergency Roadside Telephone it controls. There shall be options to generate reports of stored device configuration.
4. The system shall record all calls on to a dedicated server with adequate indexing to retrieve the same on a later date.
5. The help desk will be manned by call managers / operators. The administrator should be able to create, add, edit & delete users (call managers/ operators). He should be able to administer access rights of the entire highway or a section thereof to the call manager.
6. The administrator should be able to place call managers in a hierarchy. The higher priority manager should inherit the rights of a lower priority manager automatically when he is taking overriding control of Emergency Roadside Phones, which are already being controlled by a lower priority manager. There should be minimum 3 hierarchical levels of security for providing user level log in.

7. The system shall provide activity log (audit trail) with user id, time stamp, and action performed, etc.
8. The system shall perform communication health check (link quality check) on all the connected field communication devices and report errors if any on the administrator console.
9. ATMS Control Centre shall have dedicated workstations for Call management. For monitoring purposes, Video monitors shall be setup and would show the location of originating and on-hold calls clearly on relevant map sections of the highway using Roadside communication Frontend Software.
10. The Roadside Communication Frontend Software shall allow disconnection/termination of the call by call manager only after the call is answered.
11. The user shall have the facility to request for control of any section of highway outside his rights for a reservation period. Control of the said section is released after the reservation period (Request enhanced control rights for a short duration).
12. ATMS Control Centre may have one or more Operators simultaneously logged in to the Roadside communication software to manage their respective sections of the highway.
13. Each workstation and the associated software should allow up to nine calls to be maintained on hold while the current call is being serviced.
14. Call manager/operator logoff shall be allowed only when no call is in progress or on hold.
15. System should ensure that once recorded, the audio cannot be altered; ensuring the audit trail is intact for evidence purposes.
16. System shall provide sufficient storage of all call recordings for a period of 30 days or more.
17. The call manager/operator shall have the facility to call back any Emergency Roadside Telephone.
18. The call manager/ operator shall also have the facility to patch any call from the Emergency Telephone to an external telephone line (fixed and mobile), local intercom at the ATMS Control Centre and the local mobile radio network
19. The call manager/operator shall have the facility to initiate communication health check on any device within his section of the highway.
20. It shall be possible to switch calls. That is, if a call # 1 is in progress, the call manager can open any other call that is in hold status. Call # 1 shall go hold status.
21. The offered system shall have facility to retrieve/export/ backup (on CD, DVD or Blu-ray recorders) the desired portion of call record (from a desired date/time to another desired date/time) through the search functionality of the application software.
22. It shall be possible to archive old call records and logs on CD, DVD, Blu-ray recorders, or RAID backup devices. Log of any such activity should be maintained by the system for audit purposes.

23. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.
24. All the workstations shall be provided with software to play recordings, archive and manage calls. However, managers would require sufficient access rights to use play and archive modules.

14.3.8 Speed Display

1. There shall be Software to acquire and manage data from all the Speed Displays within the installation.
2. The software should be capable of managing any number of Speed displays.
3. The software shall operate on open architecture and integrate/ co-exist with other subsystem software that are installed to manage CCTV, VMS, WIM, and Roadside Communication, apart from the Traffic Management module (where applicable) etc.
4. The software shall store configuration (Current Preset Speed limit, Maximum configurable speed limit, etc.) of each Speed Display in the installation. There shall be options to generate reports of stored device configuration.
5. The administrator should be able to create, add, edit & delete users. He should be able to administer access rights to system resources and functionality as well as access permissions to a list of Speed Displays a user can access.
6. The administrator should be able to place users in a hierarchy. The higher priority user should inherit the rights of a lower priority user automatically when he is taking overriding access rights of Speed displays, which are already being accessed by a lower priority user. There should be minimum 3 hierarchical levels of security for providing user level log in.
7. The system shall provide User activity log (audit trail) with user id, time stamp, and action performed, etc.
8. The software shall receive and process packets of real time online data arriving from all the Speed Displays if such a feature is supported by the speed display.
9. The Speed Displays shall be accessed by ATMS Control Centre operators through workstations with the help of Speed Display Control Workstation Frontend Software.
10. The user shall have the facility to request access rights of any Speed Display outside his rights for a reservation period. Access right of Speed display is released after the reservation period (Request enhanced control rights for a short duration).
11. ATMS Control Centre may have one or more Operators simultaneously accessing the installed Speed displays.
12. The Speed Display Software shall have options to check configuration information, remote diagnostics, data/violation record download etc.
13. Database Server shall keep track of all configurations, error data, configuration events, usage events and error events.

14.3.9 Communication medium and Infrastructure

1. The communication medium and cabling depends primarily on bandwidth requirement, which in turn is driven by the following three major factors:
 - a) Equipment type
 - b) installation topology and
 - c) Volume (Quantity) of equipment.
2. Since factors a, b, and to some extent c is dependent on vendor solution, a prescriptive specification may be counterproductive. However as a general guideline the following is expected as a bare minimum.
 - a) ATMS Control Centre Internal Cabling – combination of Multimode FO and cat-5E or cat-6 Ethernet
 - b) CCTV – Single mode FO backbone or dedicated point to point RF links (where FO is not possible) with single mode FO, Cat-5e/Cat-6 or copper coaxial links between switches, camera, encoders etc.
 - c) VMS, Speed display and WIM – Low volume traffic can share backbone and switch ports with CCTV. Switch to device may be FO, Cat-5e/Cat-6 or copper coaxial/Twisted pair links. In case the equipment communicates through RS – 485 or RS – 422, suitable Ethernet to 485/422 converters need to be provided.

14.3.10 Container Office Cabin

1. It shall be a modular and Pre-fabricated for use as ATMS control centre on site where no concrete building is made available on RoW by NHAI.
2. While being light in weight, it shall possess a high structural strength.
3. It shall be spacious enough to house all the ATMS Control Centre equipment (including the Video wall) as well as the operations and maintenance personnel considering the required seating area (as per ergonomic requirements) for each person and appropriate furniture required. Further it shall be possible to ensure the optimal viewing distance for the video wall size required as per specifications provided in the F&T specifications document.
4. It shall provide adequate space for a conference room (with projection facility) to seat minimum 10 persons. There shall further be provision to include two cabins within the facility for use by senior personnel.
5. It shall be provided with appropriate Fire detection, alarm and Fire extinguishing systems.
6. It shall be provided with a suitable access control system.
7. It shall provide adequate Toilet / washroom facilities for the personnel and visitors.
8. The Power supply equipment (generator, UPS etc.) may be housed in an adjacent cabin suitable for the same.

14.4 Key Hardware Technical Specifications

Detailed minimum technical specifications of the key ATMS Control Centre hardware components are as under:

1. NAS Storage:

CPU	Latest Intel Processor with fastest speed available in the market
On-board Memory	8 GB RAM
Number of HDDs Supported	12x 2.5" or 3.5" SATA 6Gb/s, 3Gb/s hot swappable
HD Drive	As per system requirement
Host Interface	2x 4Gbps Fibre, 2x 1Gbps Copper and 2x 6Gbps SAS Ports
RAID Support	RAID levels 0, 1, 5, 5+, 6, 6+
Network Adapter	Dual-port 10GbE network expansion card
Network Transport Protocols	TCP/IP
Network File Protocols	CIFS, NFS, HTTP/HTTPS, FTP, NTP, SNMP, SMTP, DHCP and DNS
Drive Status /Space Monitoring	Supported
OS	MS Windows or Linux with on-site support
Power supply	Hot pluggable Redundant Power Supply

2. Workstation:

CPU	Latest Intel Processor with fastest speed available in the market
Mother Board	Intel Original Mother Board
Memory	4 GB DDR RAM
Hard Drives	1 TB
Video Card	2 Nos hardware accelerated for connecting 2 monitors
RAID	Supported
Network Adapter	Integrated 10/100/1000 Base –T
Sound Card	Built-in
Disk writer	CD, DVD and Blu Ray
Monitor/Keyboard/Mouse	21" LED TFT/Multimedia/Optical
OS	MS Windows OS Latest version at the time of tender
Anti-Virus Software	Latest software at the time of tender

3. Camera/File/Database Server

On-board CPU	Latest Intel Processor with fastest speed available in the market
Memory	16 GB RAM
Hard Drives	4 TB with RAID 5 Support (As per requirement in case of camera server)

Disk writer	CD, DVD and Blu Ray
Network Adapter	2x Intel Gigabit ET Dual Port NIC
Video Card	Hardware accelerated
Monitor/Keyboard/Mouse	21" LED TFT/Multimedia/Optical
OS	MS Windows or Linux Latest version at the time of tender
Anti-Virus Software	Latest software at the time of tender

4. NVR

Channels Supported	48
CPU	Latest Intel Processor with fastest speed available in the market
Flash	512Mb (DOM)
LED Indicators	Status, LAN, eSATA, 10GbE
LCD Display	Supported
Number of HDDs Supported	8 x 3.5-inch SATA ; SATA 6Gb/s (backward compatible with SATA 3GB/s)
HDD Max Capacity	32 TB
HD Drive	As per system requirement
Hot Swap	Supported
RAID Support	RAID levels 0, 1, 5, 5+, 6, 6+
Gigabit LAN port	4
Recording Modes	Continuous, Scheduled, Manual, Alarm
Pre-event and Post event Recording	Up to 300 seconds pre and post
Audio recording	Supported
Maximum Resolution Supported	Full HD 1080P (HDMI/VGA output)
Drive Status /Space Monitoring	Supported
OS	MS Windows or Embedded Linux with on-site support
Power supply	Hot pluggable Redundant Power Supply

5. Video Wall Controller

Processor	Intel core-i7 @ 3.4GHz or better
Memory	16GB or More
Hard Disk	2 x 500GB or more in RAID-1 supporting hot-plug and redundant
Ethernet	2 or more Gigabit Ethernet ports
Resolution	Support up to 32768 x 32768 pixel desktop
Graphic card(s)	Multichannel (4 or more) cards 2560 x 16008 @ 60Hz on DisplayPort and 1920 x 1200 @ 60 Hz on DVI
Video Inputs	DVI, DisplayPort, composite, RGB analog, IP Streaming
Input Standards supported	PAL, NTSC, VGA, MPEG2, MPEG4, H.264, MJPG, V2D
Power supply	Dual 230V @ 50 Hz input redundant hot-swap compatible.
Form factor	19" Rack mount
OS	MS Windows or Linux with on-site support

14.5 Environmental Specifications

All the control equipment shall be suitable for operation from 0°C to 45°C and relative humidity up to 80 % non-condensing.

14.6 Testing

1. Functionality testing of all the subsystems
2. Verification/Inspection of servers, switches and other hardware.

14.7 Installation and Power Requirements

1. Power shall be obtained from 230V 50 Hz mains provided on site supported by a minimum 10 kVA (typical) 3 phase UPS of a standard approved make and a 25 kVA 3 phase Diesel Generator set of a standard approved make These power back up systems shall provide power of adequate quality and durability to the system in order to meet the service level requirements.
2. Cabling shall be as per standard structured cabling norms.
3. All Server racks to be backed up by suitably rated exclusive on-line UPS of adequate capacity with a backup time of 1 hour or more. The UPS shall be of a standard approved make.

14.8 Maintenance Requirements

1. The equipment supplied shall remain operable for at least 10 years from the date of supply/Installation.

2. The supplier/Service provider shall undertake to support/maintain and (or) provide spare parts till equipment reaches end of life, which shall not be less than 10 years from the date of supply.

14.9 Operational Requirements

Functional software modules supplied and installed at the ATMS Control Centre to handle different operations like CCTV, VMS etc. shall be able to integrate with/Export data to and import data from the ATMS unified database located in ATMS Control Centre servers.

Chapter 15 Other Relevant Standards and Codes

15.1 Standards

Equipment and equipment installation shall comply with the latest revision of the applicable Bureau of Indian Standards (BIS). Where no BIS exists for any aspect of equipment manufacture, supply, installation, identification, protection, testing or operation, then the relevant IEC or ISO standard shall apply. CEN or CENELEC standards shall apply where no BIS, ISO or IEC standards exist.

With respect to the above some of the specific standards / Code of Practices include the latest versions of the following:

Sl No	Standard	Relevant to
1	IRC SP 85	For Variable / Changeable message signs
2	IS / IEC 61508	Functional safety
3	IS 14700, CENELEC EN 50081-1: CENELEC EN 50082-1:	EMC compatibility/ EMC Emission compliance/ EMC Immunity
4	BIS 732 or BS 7671	Electrical wiring installation (BIS 732) or Wiring Regulations (BS 7671)
5	IS 2309	Lightning protection
6	IS 3043	Electrical Earthing
7	IS 5216	Safety procedures and practices in Electrical works
8	IS 7689	Control of undesirable static electricity
9	IS 694, IS 1554	PVC Insulated Cables
10	EN 61280-4-1	Fibre-Optic field test related
11	IS 14927	Cable Trunking & Ducting systems
16	EN 50173	Generic/structured cabling
17	IEC 60529	Degrees of Protection provided by Enclosures
18	IS 9000 Part XIV Sect. II	Change of temperature test
19	IEC-571; IS: 9000 Part-III Sect 3	Dry heat test
20	IS 9000 Part II Sect. III	Cold test
21	IS9000 Part V Sect. 2 Variant 1	Damp heat test (Cyclic)
22	IS9000 Part IV	Damp heat test (Steady state storage)
23	IS9000 Part XI procedure 3	Salt mist test
24	IS 9000 Part XII	Dust test

Sl No	Standard	Relevant to
25	IS 9000 Part VII, Sec. 2	Bump test
27	BS1363	240V Power Outlet
28	IEEE C62.41 CLASS A or BS EN 62305	Surge Protection
29	IEC 60297 or DIN 41494	Mounting Racks and Shelves
30	ISO 14001	Environment Management System

Chapter 16 Use of ATMS during Disaster Management

16.1 Introduction

A disaster may be defined as an incident that:

- a) Directly affects life and/or health of many people,
- b) Adversely affects the environment resulting in an altered environment proving to be detrimental to human wellbeing
- c) Damages material assets on a large scale.

Disasters may broadly be of three types:

- a) Natural disasters such as floods, earthquakes etc.
- b) Human systems failures such as a dam collapse, building collapse and more importantly those related to Chemical, Biological, Radiological and Nuclear (CBRN) emergencies.
- c) Conflict based disasters such as war, terrorism etc.

As the consequences of a disaster invariably are on a larger scale, the standard tools and operating procedures for managing emergencies at facilities like hospitals, highways etc. may turn out to be inadequate. Thus quickly allocating additional resources commensurate with the scale of the event and establishing procedures to enable its coordinated use by services and agencies of different disciplines would assume paramount importance in disaster management.

A very important goal of a good Disaster Management (DM) strategy is to ensure sustainable mobility during disaster events, as only this in turn can ensure the realization of important goals of saving lives and reducing economic damage. Thus the relevance of a highway in Disaster Management arises from this context i.e. as an invaluable lifeline for evacuation of those affected by a disaster and for reaching relief supplies to the affected areas. Further highways themselves are vulnerable to disasters in the form of floods, earthquakes etc. Any disaster that befalls a human settlement also affects the highway(s) connecting it to the rest of the world.

The highway ATMS with its capability to 'sense and capture' the conditions on the highway and its environment, its ability to support structured decision making and implementation, as well as its versatile road-user communication via on-road equipment and mobile devices, becomes a valuable tool to strongly enable the highway's role as the core lifeline.

16.2 Disaster management framework in India

The National Disaster Management Authority (NDMA) is the apex agency having the responsibility for laying down policies, plans and guidelines for Disaster Management and coordinating their enforcement and implementation for ensuring timely and effective response to disasters. The above guidelines assist the Central Ministries, Departments and States to formulate their respective DM plans to be subsequently approved by the NDMA. The National Executive Committee (NEC) playing the role of the executive committee of the NDMA, the State Disaster Management Authority (SDMA), the District Disaster Management Authority (DDMA), the National Disaster Response Force (NDRF) and the National Institute of Disaster Management are the associated institutions that play important roles in disaster management in India.

16.3 Phases in Disaster Management

The phases include Mitigation, Preparedness, Response and Recovery. During the Mitigation phase, although not time critical, it is important that all related organizations get interconnected with adequate data / information transfer. During the preparedness phase, which is however time-critical, the warning data regarding the disaster is shared among the above organizations. The response phase requires the establishment of critical on-line communication between the organizations and the affected public for achieving quick response to the disaster events. The recovery phase, again not time critical, involves the sharing of large amount of data between organizations for the acts of reconstruction, lessons learnt etc.

16.3 Highway management agency's perceived role vis-à-vis the Disaster Management framework

It can be seen that the Highway Management Agency has to play the role of an organization actively involved in all phases of the Disaster Management listed above. Specifically, among the above institutions related to Disaster Management in India, the DDMA (under the leadership of the District Collector / District Magistrate) acts as the planning, coordinating and implementing body for DM at the District level and takes all necessary measures for the purposes of disaster management in accordance with the guidelines laid down by the NDMA and SDMA. Thus it logically follows that it is with the DDMA and its associated institutions each highway management agency has to interact with to derive and play its coordinated part in disaster management. Further the highway management agency should actively support the NDRF with adequate information (visual and other) when actively engaged in responding to a disaster situation.

With the DDMA a three phase interaction is required. In the initial planning phase the specific role of the highway management agency in DM is evolved along with the checklists required to be included in the ATMS for implementation during DM. The second phase includes the on-line sharing of highway status and other important information collected by ATMS. The third phase, after the DM phase is concluded, is an interaction to evaluate performance and generate lessons learnt to help enhancement of the checklists.

A schematic of the envisaged interaction is shown in figure 1 below.

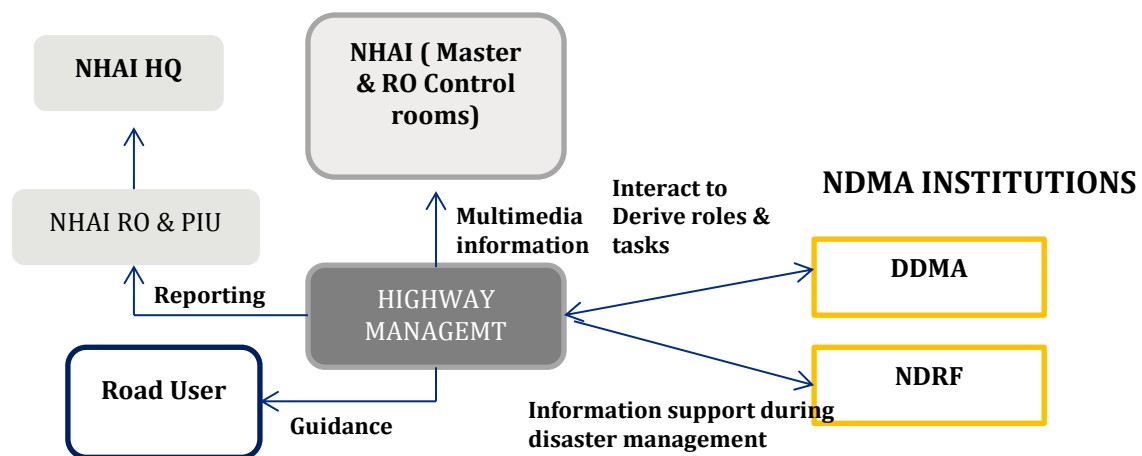


Figure 1 Envisaged interaction of Highway Management for DM

16.4 Role of ATMS during Disaster Management

The ATMS is the single most important tool for use by the highway management agency during disaster management. Table 1.0 below lists out the services that can be provided by the ATMS.

S. No	Beneficiary	ATMS service	Delivery Media
1	Road User	a) Highway status information including i) Flooding and potential flooding of highway locations, bridges ii) Traffic Status / congestion on various sections of the highway and other highways / roads connecting to it. iii) Estimated Travel times iv) Highway ride quality v) Adverse weather conditions vi) Alternate roads open / closed status vii) Law & order issues on specific locations	a) Variable Message Signs b) NHAI Mobile App
2	Road User	Specifics of above information in the form of Question / Answers	Support via the National highway Emergency help line
3	NDRF	a) Road status as above including Estimated travel times b) Best routes to reach affected areas	a) Specific NHAI Mobile App b) Via direct audio communication with the ATMS Control Centre c) Via visit to the ATMS Control Centre to examine the highway status and discuss plan of action(s).

Table 1.0 Services provided by the ATMS for Disaster Management

16.5 Enhancement of ATMS for Disaster Management

In order to play an effective role during DM the ATMS shall be enhanced at least with the following facilities.

- Satellite telephone at the ATMS Control Centre to communicate with the NDRF and related agencies. This is expected to be provided by NDMA.
- Establishing a temporary Satellite data link at the ATMS control centre to transfer data on-line to the NHAI RO and Master control rooms in case of failure of the existing data link (e.g. MPLS) at the control centre.
- Portable high bandwidth (Microwave) wireless communication equipment to re-establish data links where the Fibre optic connectivity has failed (due to physical cable damage) due to flooding / earthquake etc.
- Establishment of an automatic software driven checklist for disaster management as part of the Incident management module of the ATMS software. The checklist shall be generated for the highway in consultation with the DDMA for various types of disasters.

Appendix – A

GUIDELINES / RATIONALE FOR LOCATING - ATMS DEVICE / SYSTEM

S. No	ITS Device / System	User Need / Application	Rationale for Equipment location
1	PTZ CCTV Camera	To monitor traffic conditions (Day & Night) on the highway including junctions with considerable traffic, populated village town sections / road junctions and vulnerable sections of the highway	Range of 1 km on the highway (i.e. 1 km on either side).
2	Fixed CCTV Camera with video analytics and supported with local warning lights	To monitor (Day and Night) and warn road users on the main carriageway about dangerous traffic conditions (e.g. Contraflow, stopped traffic at Service road merger points, blind turns on the main carriageway & junctions with considerable traffic]	Detection range from Camera location: 200 m (Day and night) Provision of warning with flashing lights: 100 m before the area of detection 200 m before the area of detection to warn arriving vehicles
3	Fixed CCTV Cameras	At road junctions to monitor traffic flow and aid in traffic flow measurement (Day & Night)	To be located such that detection range is 200 m or less
4	VMS Displays (Full)	To inform/warn/guide road users at start of highway stretch & important junctions on highway conditions for travel planning	At major entries to the highway stretch Before major junctions on the main carriageway that can lead to alternate routes to the highway Minimum visible distance on the highway: 250 m Message languages: Hindi, English & Local language
5	VMS Displays (Compact)	To warn road users before each village/ town on congestion and travel speeds	Before each 'large' village/ town on the highway with a potential for traffic congestion. Minimum visible distance on the highway : 250 mm Message languages : Hindi, English & Local Language
6	VMS (Portable)	To provide local guidance to road users at locations of traffic incidents & road works	Temporarily deployed before locations related to road works and incidents affecting traffic movement. Minimum visible distance on the highway : 250 mm Message languages : Hindi, English & Local Language

S. No	ITS Device / System	User Need / Application	Rationale for Equipment location
7	Emergency Roadside Telephone	To enable a caller from the highway to provide urgent messages on Accidents/ Incidents and road congestion for supporting the Emergency response System	Zones experiencing telecom blackspots along highway need be identified to be provided with ERT. On long highway stretches (> 2 km) suffering from telecom blackspots, ERT to be located at every 2 Km on both sides of the highway stretch.
8	Meteorological System	To obtain abnormal weather conditions for communication to road users	A single system at the ATMS Control Centre for highways where the entire highway is located on a similar terrain and with similar weather conditions. More systems depending on the changing terrain and varying weather conditions.
9	Vehicle Actuated Speed detection and warning system	To warn road users on over speeding	System can be located suitably depending on the chosen detection location (e.g. at the entry of every village)
10	Mobile Communication System	To support the O&M team in traffic management and system maintenance	Mobile wireless towers (towers for the main base station and repeater stations) to be appropriately designed and quantities arrived at depending mainly on the highway terrain. Handsets with relevant members of the O&M team along with Portable/Mobile wireless sets on O&M vehicles
11	Weigh-in-motion	Portable system(s)	Typically to be located at entries to the highway and at chosen locations close to where heavy loads are likely to be carried (e.g. near manufacturing industries) to implement periodic / surprise checks
12	Automatic Traffic cum Classifier system	Identification and recording of vehicular movement on highway for effective monitoring and data collection.	Capable of accommodating multiple installations through installation of detectors / sensors left permanently in place and connected with recording device. Typical location to be decided judiciously taking due care of traffic diversion / merger on the project highway.
13	ATMS Control Centre	Using a suitable electronic and IT system (hardware and software) integrated with the ATMS field equipment, it	Typically at 1 location per 120 km for a highway

S. No	ITS Device / System	User Need / Application	Rationale for Equipment location
		supports centralized Monitoring of highway stretch, receiving emergency calls and active management of accidents including providing system aided guidance and supervision of rescue and traffic Management activities	
14	Travel Time Estimation System	To estimate the toll plaza crossing times by reading the vehicle-affixed RFID tags before and after the Toll Plaza	RFID Transceivers located 500 m before and after the toll plaza, in either direction.

Appendix B

SERVICE LEVEL REQUIREMENT (SLR)

1. Service Levels Requirements and Penalties

The service Provider shall be responsible to ensure

- (a) 24x7 operation of the system by deploying competent personnel to perform actions / operations as specified under the Service Level Requirements.
- (b) 24x7 uninterrupted availability of the complete ATMS along with other systems, subsystems, peripherals, components commissioned under ToR. In order to achieve this, the service provider shall provide adequate preventive and repair maintenance services. Indicative Service Level Requirements for maintenance are prescribed in this document.

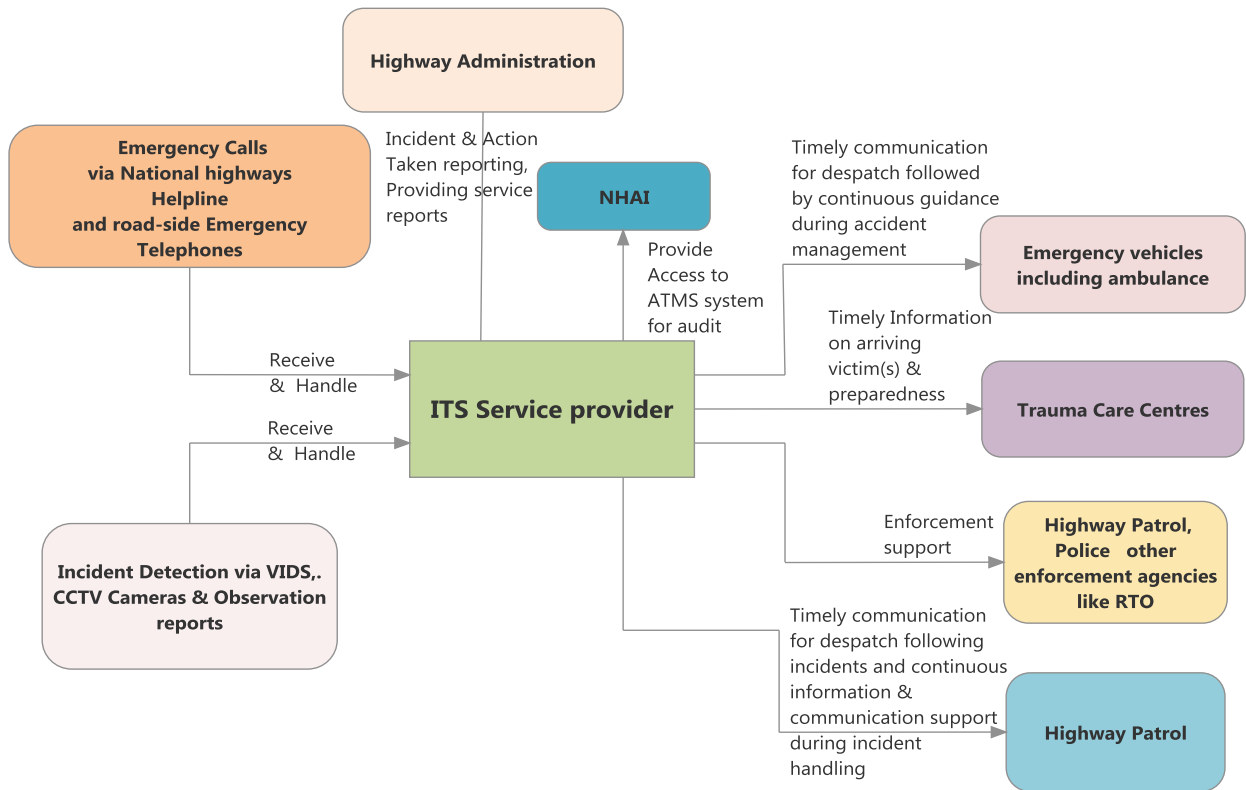
2. Service Level Requirements for ATMS Systems Operations

The service level requirements with respect to operations shall, include minimum following elements:

- (a) Routine monitoring of the project highway stretch from the ATMS Control Centre:
 - i) Structured and Systematic visual monitoring of the entire highway using PTZ CCTV Cameras.
 - ii) Manning the Emergency Telephone console to receive and respond to emergency calls without fail.
 - iii) Traffic Monitoring on various stretches of the highway, based on measured data available from the Video Incident Detection Systems and Automatic Traffic Counter and Classifier Systems.
 - iv) Monitoring of system status including the status of individual equipment and sub- systems and alerting the maintenance team in case of any failure(s).
 - v) Monitoring of movement of vehicles mandated for incident management on the project highway (Ambulance, route patrol, tow-away cranes) via GPS vehicle tracking and CCTV.
 - vi) Communication with the Highway Patrolling Team whenever necessary.
- (b) Accident / incident management from the ATMS Control Centre, using the Traffic Management Console:
 - i) Appropriate evaluation (based on information available via ATMS) and initiation of prompt actions to enable the optimal (most logical and rapid) movement of ambulances(s), Patrol vehicles, break-down crane(s) to the accident site.
 - ii) Efficient performance of incident management actions and monitoring based on the automatic system related checklist –based tool provided in the Traffic Management and rescue module on the Traffic management console.
- (c) Performing periodic mock trials of rescue and incident management (at least once in a month) to maintain the efficiency and effectiveness of the operations team.
- (d) The Service Provider shall provide a monthly report of the system performance.

Note:

- (a) The vehicles such as Ambulance, Route Patrol and Tow-away cranes fitted with VTS shall belong to the agency responsible for operations and management of the project highway stretch.
- (b) The ATMS Service Provider shall work closely with operations team to facilitate it deliver its mandated services as well as monitoring their performance.

**ATMS SERVICE PROVIDER's MAIN OPERATIONAL FUNCTIONS AND
INTERACTION WITH OTHER STAKEHOLDERS****Operational functions**

1. Routine monitoring of Highway Traffic to detect abnormal traffic and incidents
2. Receiving Emergency Calls via road-side Emergency Telephones and 24X7 National highways help line
3. Management of Incidents received via the Video Incident Detection Systems & reports from agencies like Highway patrol and others (e.g. damage to road, chemical spilling on road etc)
4. Accident Management on the Traffic Management console including
 - Accident evaluation & timely communication for Despatch of Emergency vehicles and Highway patrol vehicles
 - Selection of and timely communication to selected trauma care centre(s)
 - Timely Communication to Road Users via on-road(VMS) and personal devices (Mobile Apps) to the road users on the accident and related traffic guidance
 - Continuous monitoring of progress of Emergency vehicles
 - * Progress of Ambulance(s) towards trauma care centre(s)
 - * Progress of vehicles involved in Traffic Normalization
 - Providing relevant information to all stakeholders when required and on demand including information for enforcement with evidence like captured video and data
 - Reporting to Highway Administration and NHAI
 - Time and place of accident
 - Time of communication to Emergency Vehicles
 - Time of victim(s) reached to the trauma care centre(s)
 - Time of traffic normalization
 - Adequately meeting Service levels

The service level requirements with respect to operations are captured in table below:

Service Level Requirements (SLRs) with respect to ATMS Operations

S. No.	Requirement	Deliverable & Metric	Remarks
1	Receive and handle Emergency Calls		
	24x7 monitoring and handling of Emergency calls received from road-side Emergency telephones or from the 24x7 National Highways helpline	Daily shift-wise logs accounting for handling ALL calls arriving at the Control centre and monitoring of time taken to resolve / address the issues.	Automatic ATMS system Generated report on calls arrived and calls handled.
2	Routine monitoring of the status of Highway traffic		
	24x7 monitoring from the ATMS Control Centre using personnel stipulated in the Process document	Daily shift-wise activity logs, accounting for 24 x 7 x 365 hours of operation for a typical year	Automatic ATMS system generated report
3	Accident / Incident / Traffic Management		
	Response to incidents (e.g. Emergency calls received at the ATMS Control Centre) within stipulated time and enabling of all actions for optimal rescue and traffic normalization, including the rapid deployment of vehicles (ambulances, breakdown cranes and Patrol vehicles)	a) Informing the ambulance within 3 minutes of receipt of Emergency Call reporting an accident. b) Informing the Selected Trauma Care Centre(s) within 5 minutes of receipt of Emergency Call reporting an accident. c) Sending the first set of appropriate announcement and guidance messages via VMS and Mobile apps (as applicable) to road users within 5 minutes of receipt of Emergency Call reporting an accident. d) Continuous monitoring of the progress of Emergency vehicles & capture of their time stamp of reaching site and reaching the trauma care centre (in case of an ambulance) with the victim. e) Providing inputs to the emergency vehicles (in terms of estimated travel times, optimal routes etc.) during their journey to the site and to the trauma care centre	Automatic ATMS system generated report & recorded audio files
4	Enforcement Support		
4.1	Provide evidence of overloading to the enforcement by way of detection through portable WIM	Provide evidence of overloading (when detected by the portable WIM)) including the following details: a) Location, Date and time stamp of overload detection b) Vehicle details in terms of vehicle class, number of axles, registration number, measured gross load and allowed gross load. c) An electronic visual Image of the vehicle d) The above to be provided by E-mail within 3 minute of the overload detection.	Automatic system generated log of action performed in the form of a report
4.2	Provide evidence of over speeding vehicle to the police for enforcement purposes	Provide evidence of over speeding (when detected by the speed camera) including the following details: a) Location, Date and time stamp of over speed detection b) Vehicle details in terms of vehicle class, registration number c) An electronic visual Image of the vehicle e) The above t be provided by E-mail within 3 minute of the over speed detection.	Automatic system generated log of action performed in the form of a report.

S. No.	Requirement	Deliverable & Metric	Remarks
4.3	Incidents detected by the Video Incident Detection System	Taking cognizance of incidents (after due validation) detected by the VIDS e.g. Illegal lane cutting and heavy vehicles in fast lane and provide immediate communication to relevant agencies (Police, Emergency vehicles etc.) for taking action. Provide evidence of incident to relevant agencies (Highway Patrol, Police) with Incident location, Date and time of detection of incident, type of incident, visual image, through suitable Mobile app within 3 minute of incident detection by VIDS.	Automatic system generated log of action performed, in the form of a report.
4.4	Detection of unsafe driving (over speeding, not driving in designated lanes, driving in wrong direction, wrong parking / stopped vehicle, over dimension, overloading.	Provide support with appropriate images and data captured by the ATMS system for enforcement to the appropriate agency like Highway Patrol and Police. Provide evidence with appropriate images / data support for enforcement including date and time of incident within 3 minutes of the reported incident.	Automatic system generated log of action performed, in the form of a report.
4.5	Detection of vehicles not permitted to use highways, animal on highways, vehicles damaging highways, spilling of hazardous materials on highways.	Same as above	Automatic system generated log of action performed, in the form of a report.
4.6	Detection of vandalism / damage to highway property / assets (road signs, lighting, crash barrier, median plantation, etc.	Same as above	Automatic system generated log of action performed, in the form of a report.
5	Real Time Access to ATMS Operations to NHAI's Control Centre at Regional Office / NCR		
	Keeping the system gateway open for NHAI remote access The system gateway shall be kept open 24 x 7 x 365 for NHAI to remotely access and assess the availability of individual system component of the ATMS	99.65 % of 24 X 7 X 365 hour annual System availability for NHAI remote access	Automatic System generated system availability report as measured by the Network Management System + Random remote access checks by NHAI

3. Service Level Requirements (SLR) – ATMS Systems Maintenance

The service level requirements with respect to system maintenance shall include minimum following elements:

- (i) **Scheduled/Routine Maintenance** – The service provider shall provide routine maintenance service on all equipment, system components, and ancillary equipment and ensure minimum required uptime for each system. The minimum required activities to be performed are given in this document.
- (ii) **Breakdown/Corrective Maintenance** – The service provider shall provide maintenance service in case of breakdown (i.e. repair) on all minor/ major systems, system components and ancillary equipment.
- (iii) **Software Upgrades** - From time to time service provider shall ensure installation of new versions of software used in the project.
- (iv) **Verify and perform System Calibration** - Calibration shall be performed at least once per year on relevant equipment.

- (v) **Software Support Service & Network Solution Service** – The service provider shall ensure Data Management, Software and Network Solution Support.
- (vi) **Technical Support** – The service provider shall provide the required engineering and technical support to the operations team as and when required.

The service level requirements with respect to maintenance are captured in Table below:

Service Level Requirements (SLRs) with respect to Maintenance

No.	ATMS Element	Quarterly Availability / Uptime	Maximum Down Time 3 Months Period	Maximum Mean Time To Recover (MTTR)
1	Individual Field Equipment or Individual ATMS Sub-System or ATMS Control Centre System or Network Infrastructure and Communication Systems	99.2 %	16 Hrs	4 Hrs

4. Data Retention, Back-up and Restore Operations

- (i) Data received from each ATMS equipment shall be retained for a period of one year.
- (ii) The backup devices and media as per current industry practice shall be provided.
- (iii) The Service provider shall ensure adequate security measure for safeguarding of ATMS data, by providing, off site Disaster Recovery or Data Storage mechanism.
- (iv) The service provider shall also be responsible to extract and provide data /information based on requirement of law Enforcement Agencies of Govt. of India/ State, on a case-to-case basis.

5. Spares

The service provider shall also maintain sufficient spares at each site to address and rectify any malfunctioning / defects leading to possibility of down time.

6. Statutory and Others

- (i) NHAI shall reserve the right to get the security / compliance audit of the ATMS done at any time through any agency appointed for the purpose and the service provide shall extend all support & cooperation for smooth conduct of said Audit.
- (ii) The Service Provider shall abide by all statutory guidelines and comply with rules/ regulations framed by NHAI and/or M/o Road Transport & Highways from time to time. It shall be responsibility of the service provider to incorporate such changes within the stipulated time frame into the ATMS.
- (iii) The Service Provider shall comply with the guidelines and/ or Specifications and Standards including the revisions thereof issued from time to time by M/o Road Transport & Highways Govt. of India / IRC. In absence of which, the system and equipment provided by the service provider shall meet relevant American or European/ British standards & specifications.

7. Miscellaneous

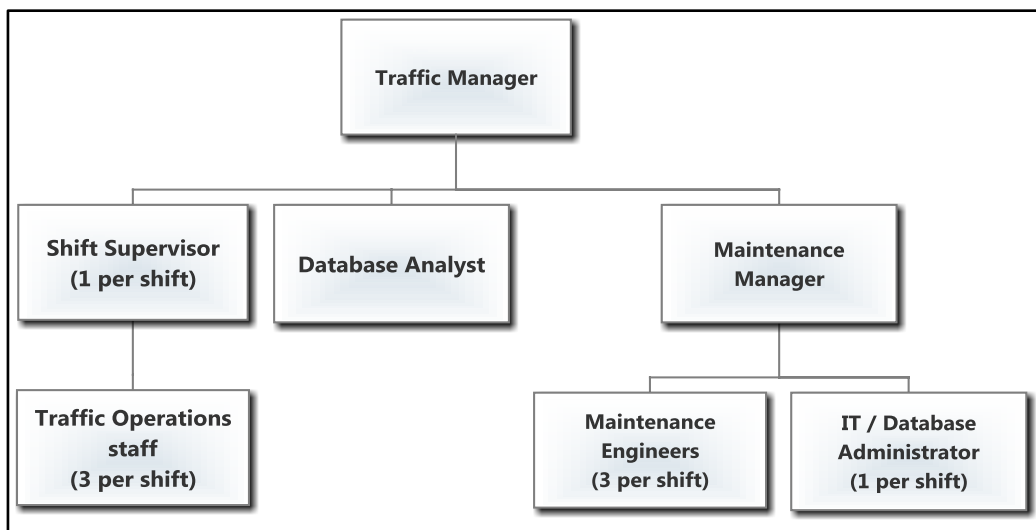
Providing services of comprehensive ATMS system at the designated site shall imply that if any civil work or electrical work is required to be undertaken for installation, testing and commissioning of any equipment under the project, the same shall also be the responsibility of the Service Provider.

Appendix C

1. ATMS Control Centre Organization and Staffing

1.1 The Organization

The organization for Operations and Maintenance (O&M) of ATMS on NHs is captured in figure below.

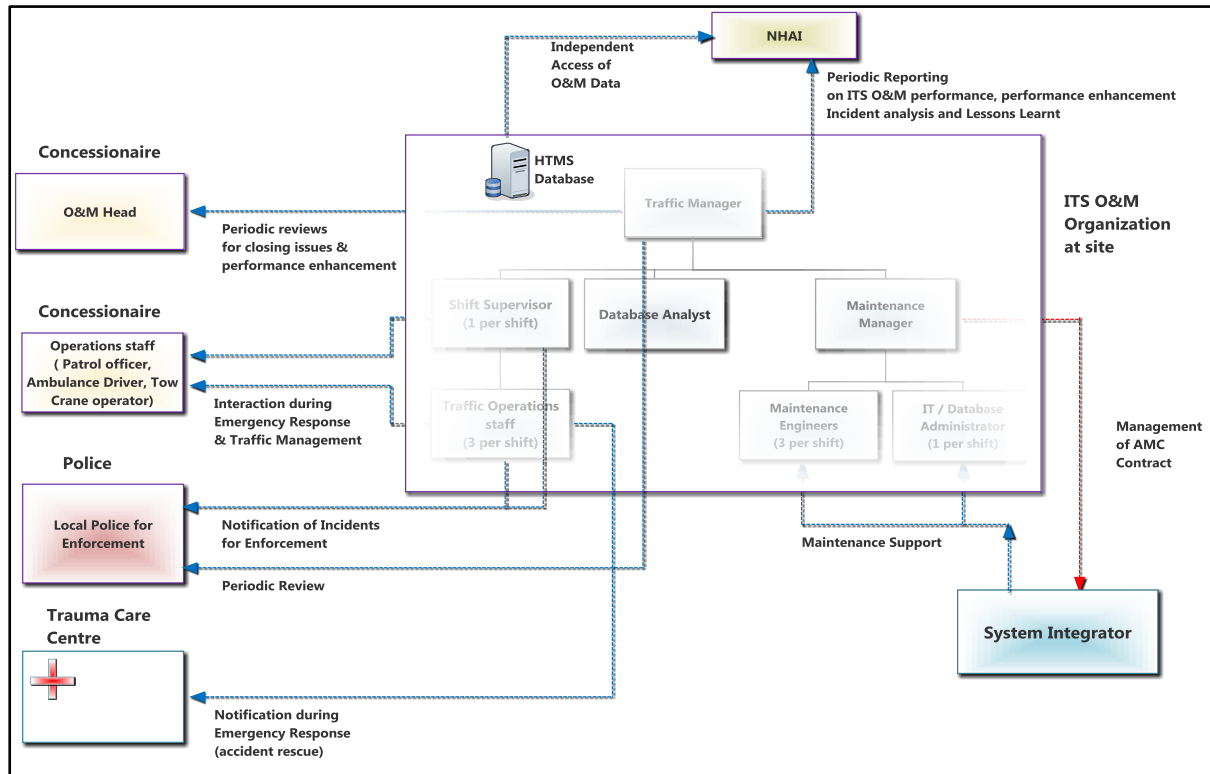


Minimum educational qualifications and experience of the ATMS Control Centre personnel is summarized below.

No	Role / Position	No of Personnel	Minimum Qualifications	
			Educational	Work Experience
1	Traffic manager	1	Engineering Graduate in Civil engineering with Traffic Management Elective	Minimum 5 year experience in managing Control room operations in Highway Traffic management
2	Shift Supervisor	3 (1 per shift)	Graduate (preferably Science)	Minimum 3 year experience in a similar position in Highway Traffic Management
3	Traffic Operations Staff	9 (3 per shift)	Graduate (preferably Science)	Minimum 2 year experience in a similar position in Highway Traffic Management.
4	Maintenance Manager	1	Engineering Graduate in Electronics	Minimum 5 years in maintenance management of similar systems
5	Maintenance Engineers	9 (3 per shift)	Diploma in Electronics and Certificate course in Network Management	Minimum 3 year experience in maintaining similar systems.
6	Database / IT admin	3 (1 per shift)	MCA with Graduate (preferably Science).	Minimum 3 year experience in maintaining Similar systems
7	Database analyst	1	MCA with Graduate (preferably Science) AND Certification in Database Management	Minimum 3 year experience in Database analysis

1.2 Stakeholder Interaction

Proposed interaction between members of the O&M organization and their interaction with the stakeholders is shown in figure below.



O&M Team – Stakeholder Interaction

2 Operations of the ATMS

2.1 Essential operations

The essential operations related to the proposed ATMS include a) routine monitoring of the highway and b) Managing accidents / incidents on the Traffic management and rescue console. They are required to be appropriately carried out by the Traffic Operator with suitable support from other staff.

2.2 Roles of members of the Operations team

2.2.1 Traffic Operator

a) Routine monitoring of the highway including

- i. Handling Emergency Calls on the Emergency Call console(s) for calls originating from roadside emergency telephones and those received from '1033' National Highways Incidence Management Helpline Number, making incident reports and alerting the Traffic operator manning the Traffic management and rescue console.
- ii. Traffic monitoring
 - a) Visual monitoring using CCTV cameras located along the highway.
 - b) Data evaluation of traffic flow measured by the Incident detection systems.
- iii. Monitoring of movement of utility vehicles (Ambulance, Patrol Vehicles and breakdown cranes) via GPS tracking, supported by CCTV monitoring.
- iv. Monitoring of the status of the ATMS system including the operational status of each ATMS system / subsystem (in the field and in the ATMS Control Centre). This also

includes receiving and recording any third-party (e.g. road user) complaints on system malfunction (e.g. VMS display).

- v. Monitoring the road maintenance works currently in progress and the deployment of suitable ATMS for road safety countermeasure. This will also include disseminate necessary precaution against road damage(s) and prone to potential accidents.
 - a) Suitably locating mobile VMS near maintenance sites
 - b) Selecting and enabling the sending of appropriate messages via VMS and Mobile apps
- vi. Logging of the above activities on a log book with adequate details including the Date and time, detailed system status including major / minor faults, if any.
- vii. Generation of following shift-wise reports
 - a) Incident report (e.g. those detected by the Incident detection system).
 - b) Emergency Call report with incident details.
 - c) Event report related to system status and system operation.
 - d) Traffic count report at specific locations.
 - e) Report of messages displayed on Variable Message Signs.
 - f) Weather status report.
 - g) Accident report including details of action taken in rescue of victims and traffic restoration.
 - h) Traffic movement report of Utility vehicles (Patrol vehicles, Ambulances and breakdown crane.
 - i) Asset status report including the status (whether present and the operational status) of all ATMS assets down to each equipment.
 - j) System performance report in terms of adequate quality and speed of response. This report shall integrate the status of individual equipment from the network management system.
 - k) Operations personnel Attendance report.

1.

b) Managing accidents / incidents:

- i) Operation of the Traffic management and rescue console and facilitate guidance to highway patrol perform their role on the ground.
- ii) Facilitate decision making based on the information provided by the ATMS system and adequate communication with the stakeholders participating in the rescue and traffic normalization. Communicate with the stakeholders by providing them with the necessary information (e.g. providing accident details to the police) in a timely manner and taking in essential information for effective decision.
- iii) Ensure that the rescue and traffic normalization actions are logically concluded.

2.2.2 Shift Supervisor

- a) Oversee and provide guidance to the Traffic operators in carrying out their functions.
- b) Interact with the stakeholders in a manner to support Traffic operators.

2.2.3 Database Analyst

This is essentially a supportive role and involves following:

- a) Perform analysis on 'Big Data' collected and stored in the ATMS database and provide insights on the highway's performance (Traffic volume, disruptions, accidents / incidents, Operational effectiveness, etc.) to the Traffic Manager.
- b) Generate and provide specific 'on-demand' analytical reports to the Traffic Manager for process improvement.

2.2.4 Traffic Manager

The Traffic manager oversees the complete operations at site.

The role mainly includes

- a) Monitoring the operational efficiency of the team.
2. This includes the analysis (based on system reports and direct observation) of the team's performance and determining the gaps for improvement.
- b) Improving Operational procedures based on the above analysis
- c) Planning and implementing training programs for the team based on the above analysis.
- d) Interaction with stakeholders
 - i) As a matter of support during routine operations and accident management
 - ii) For evaluating team performance and planning improvement strategies and actions for rescue, traffic normalization and traffic enforcement.
- e) Play the role of the administrative head at site.
- f) Reporting to the O&M top management on team performance

3. Maintenance

3.1 Maintenance Functions

The Maintenance function consists of the following activities

- 3.1.1 Scheduled/Routine Maintenance Service - This involves the provision of routine maintenance service on all systems, system components and ancillary equipment to meet the service level requirements.
- 3.1.2 Breakdown/Corrective Maintenance Service –This involves the provision of maintenance service in case of breakdown (i.e. repair) on all minor/ major systems, system components and ancillary equipment to meet service level requirements.
- 3.1.3 Software Upgrades – This involves the implementation of new versions of software released time to time by the system integrator.
- 3.1.4 Verify System Calibration - Calibration will be performed periodically and / or as per manufacturer's requirements on each relevant equipment.
- 3.1.5 Software Support Service & Network Solution Service – This involves Data management, Software And Network Solution Support Services;
- 3.1.6 Technical Support – This activity is to provide engineering and technical support as and when required;
- 3.1.7 Provide Spare Parts Supply and Management. It is important to hold, at any point of time, adequate spares to enable meeting the service level requirements.

3.2 Routine Maintenance Function

The objective of electronic equipment maintenance shall be to ensure reliability, to enhance its economic life and to improve its efficiency. Routine maintenance consists of a fixed set of checks, measurements, cleaning and calibration. These activities shall be based on Equipment Service Provider's specifications and general maintenance practices that include but not limited to:

- 3.2.1 Checking the condition of components, e.g. check connections for signs of deterioration.
- 3.2.2 Preparation of planned yearly/ monthly routine maintenance schedule.
- 3.2.3 Perform the maintenance works as per agreed schedule. Any Changes to the schedule shall be notified to NHAI by submitting the Change Routine Maintenance Schedule.
- 3.2.4 Provide timely information to the operations team on the planned maintenance work so that adequate advance communication can be provided to the road user and proper traffic guidance actions taken.
- 3.2.5 Check voltage levels: Power supply levels are crucial to the effective operation of electronic equipment. Borderline levels could lead to intermittent faults and damage to components.

- 3.2.6 Voltage level changes are caused by the deterioration of capacitors, transformers and semiconductor components.
- 3.2.7 Certain measurements can also be performed to check the status of elements of the system, i.e. Impedance and isolation tests.
- 3.2.8 Mechanical components need routine cleaning and lubrication to ensure their effective operation.
- 3.2.9 Preparation and submission of monthly performance report.
 - Summary of rectification of notified problems.
 - Maintenance schedule and actual date of maintenance works.
 - Records of communication on the occurrence of delay of routine maintenance and rectification works.
- 3.2.10 Rapid rectification of defects found during routine maintenance.
- 3.2.11 Necessary safety procedures / guidelines shall be followed during routine maintenance.

3.3 Data Management and Software Support Services (including software housekeeping)

This essentially includes

- (a) Continuous monitoring of the data and software performance at the field equipment, the communication system and the ATMS Control Centre system (e.g. Server) level to ensure data and software system stability at all times.
- (b) Immediate rectification of any problem and data recovery
- (c) Provide periodic housekeeping works on PC, Servers, Data, and Software related to the ATMS. They include inspection and update of related applications and operating system software.

3.4 Repair / Corrective Maintenance

This covers 24-Hours on site service to respond and rectify any fault on the ATMS reported by the Operations team or detected on own inspection, to meet the uptimes defined in the Service Level Requirements. The maintenance team will solve all issues and will provide corrective maintenance Services for all break down related to Data, PC, Servers, and Data Software Systems. The team will also manage all requests, questions, and enable off-site teams to trouble shoot via online links. The team will also support back and restore functions related to all ATMS equipment.

3.5 Roles of Members of the Maintenance Team

3.5.1 Maintenance Engineer

The maintenance engineers will be normally engaged in routine maintenance activity as per the maintenance schedule. However as a top priority they will switch over to corrective services in case of receipt of complaints about equipment failure / malfunction. A timely and quality work on routine maintenance will normally reduce the need for corrective services.

3.5.2 IT / Database Administrator

The Database administrator is responsible for data management and software support services taking the support of maintenance engineers wherever required.

3.5.3 Maintenance Manager

The maintenance manager is responsible for meeting the maintenance service level requirements. Her / His role specifically includes

- a) Monitoring the operational efficiency of the team with respect to meeting the service level requirements. This includes the analysis (based on system reports and direct observation) of the team's performance and determining the gaps for improvement.

- b) Improving maintenance procedures (including the spares holding policy) based on the above analysis
- c) Planning and implementing training programs for the team based on the above analysis.
- d) Interacting with stakeholders along with the Operations team in evolving better maintenance practices, optimal maintenance schedules and contribute towards improvements in operations.

3.5.4 Traffic Manager

- a) Play the role of the administrative head at site.
- b) Evaluate the performance of the maintenance manager and support her / his initiatives on process improvements and training.
- c) Reporting to the O&M top management on team performance.