Association of State Road Transport Undertakings

# Expression of Interest (EoI)
for Implementation of Vehicle Tracking (GPS), Surveillance System (CCTV & Panic Button) in State Road Transport Buses.

ASRTU Bhawan,
Plot No.4-A, PSP Block, Pocket- 14, Sector-8, Dwarka, New Delhi – 110077

## 1. INTRODUCTION

Association of State Road Transport Undertakings (ASRTU) represents 62 Public Sector Bus Transport Organizations (STUs) in India for their common aims & objectives related to public bus transport system. Its member STUs own nearly 1.5 lakh buses and purchase spares worth about Rs.2500 crores a year. ASRTU also invites National Competitive Bids and concludes Rate Contracts (RCs) for automobile spares and accessories in common use with all the STUs.

ASRTU's policy is to encourage quality and competition, hence inviting tenders from OE suppliers exclusively.

### AIM OF THE DOCUMENT

**The purpose of this document is to short-list bidders who are interested and potential to implement Vehicle Tracking (GPS), Surveillance System (CCTV & Panic Button) in State Road Transport Buses.**

### 1.2 EOI ISSUING AUTHORITY

This Expression of Interest (EoI) is issued by the Association of State Road Transport Undertakings (ASRTU), intended to short-list a firm. ASRTU's decision with regard to the short-listing of bidders through this EoI shall be final and the ASRTU reserves the right to reject any or all the bids without assigning any reason.

| | | |
|---|---|---|
| Name of officer | : | Secretary, Standing Committee (Supplies & Contracts) |
| Name of Section | : | Rate Contract |
| Postal Address | : | ASRTU Bhawan, Plot No. 4-A, PSP Block, Pocket-14, Sector-8, Dwarka<br>New Delhi-110077 (INDIA) |
| Telephone Number | : | 011-43294294, 25361640, 25361641 |
| Facsimile Number | : | 011-43294242, 25361642 |
| During office hours | : | 9:30 Hours to 18:00 Hours on all working days from Monday to Friday. |
| Email | : | asrtu@del2.vsnl.net.in |
| Website | : | http:/www.asrtu.org |

### Proposed System

The basic idea for implementing Vehicle Tracking (GPS), Surveillance System (CCTV & Panic Button) in State Road Transport Buses is to insure women safety in the Buses. The State Transport Undertakings can track their buses, record the video footage with the installed surveillance system and to provide Panic button facility in case of emergency.

Scope of the work

- **The proposed solution of Vehicle Tracking (GPS), Surveillance System (CCTV & Panic Button) in State Road Transport Buses must be in accordance with the specifications published by Ministry of Road Transport & Highways with respect to GPS devices, CCTV devices and Emergency button.**

- The system must have admin console and it must facilitate different dashboards for different users for all the stakeholders.

- The solution will generate different kind of MIS reports as finalized by the competent authority.

- The solution must provide the audit trail, so that, every recorded activities of passengers can be tracked and monitored for future action.

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- The solution must be scalable and compatible to with SRTU's existing System.
- Training is to be provided to SRTU's staff about the functioning of system. It also includes the proper technology sharing, training in detail to install the system including software and hardware training.

Selection Criteria

The firm has to submit the proposal along with attached Proforma A, the selected firms will be called for demonstration and technical screening and subsequently asked to bid.

1. The prime bidder should be a registered company under Indian Companies Act or consortium of companies (Not exceeding two members including prime bidder).
2. The firm should at least 2 similar project experience.
3. The firm should have an average annual financial turnover of at least 1 crores in last 3 financial years.
4. The firm should demonstrate that they have enough capacity (including personnel) in handling such kind of projects.
5. Submit two years annual report and 3 years audited financial statements (year 2013-14, year 2014-15, year 2015-16).
6. The firm should have reputed financial rating through a rating agency like ICRA.

General Information:

a) **The detailed specifications for GPS devices, CCTV devices and Emergency button which was published by the Ministry Road and Transport & Highways can be downloaded from ASRTU website**

b) The EOI DOCUMENTS can be seen in the ASRTU web site www.asrtu.org

c) EOI initiation date is on 26.08.2016. Last date for submission of EOI documents is on 15.09.2016 @ 04.00 p.m. at ASRTU Bhawan, Plot No.4-A, PSP Block, Pocket- 14, Sector-8, Dwarka, New Delhi – 110077. Superscribe on the envelop “Expression of Interest (EoI) for Implementation of Vehicle Tracking (GPS), Surveillance System (CCTV & Panic Button) in State Road Transport Buses.”

d) ASRTU reserves the right to cancel the EOI at anytime without assigning any reasons.

e) Wherever efficiencies are specified certificates given by authorized third party are to be enclosed to that effect.

f) Any correspondence should be made in the name of the Executive Director, ASRTU, New Delhi.

Annexure-I

Proforma ‘A’

Please furnish the particulars with proof.

| S.No. | Particulars | |
|---|---|---|
| 1. | Name of the Company | |
| 2. | Registered Address with Phone, Fax & Email id | |
| 3. | Contact person with Name, Designation, Mobile No. & email Id details. | |
| 4. | Year of Incorporation with Certificate details | |
| 5. | Name, address and details of consortium if any | |
| 6. | Experience in similar projects (furnish evidence) | |

| | | |
|---|---|---|
| | | |
| 7. | Name of the customers | |
| 8. | Details of qualified professionals for implementation of the solutions ( furnish evidence) | |
| 11. | Turnover of preceding 3 years, furnish Yearwise | |
| 12 | Details of Present working Technologies | |
| 12. | Whether having ISO/ Six Sigma or any certificate, furnish copy | |
| 16. | Any other additional requirement related to the above mentioned project. | |
| 17. | Remarks if any | |

The information mentioned herein above proforma is true and correct and we hereby undertake to accept all the obligations and responsibilities of EoI.

Place :

Date :

Signature of authorized* Signatory with stamp

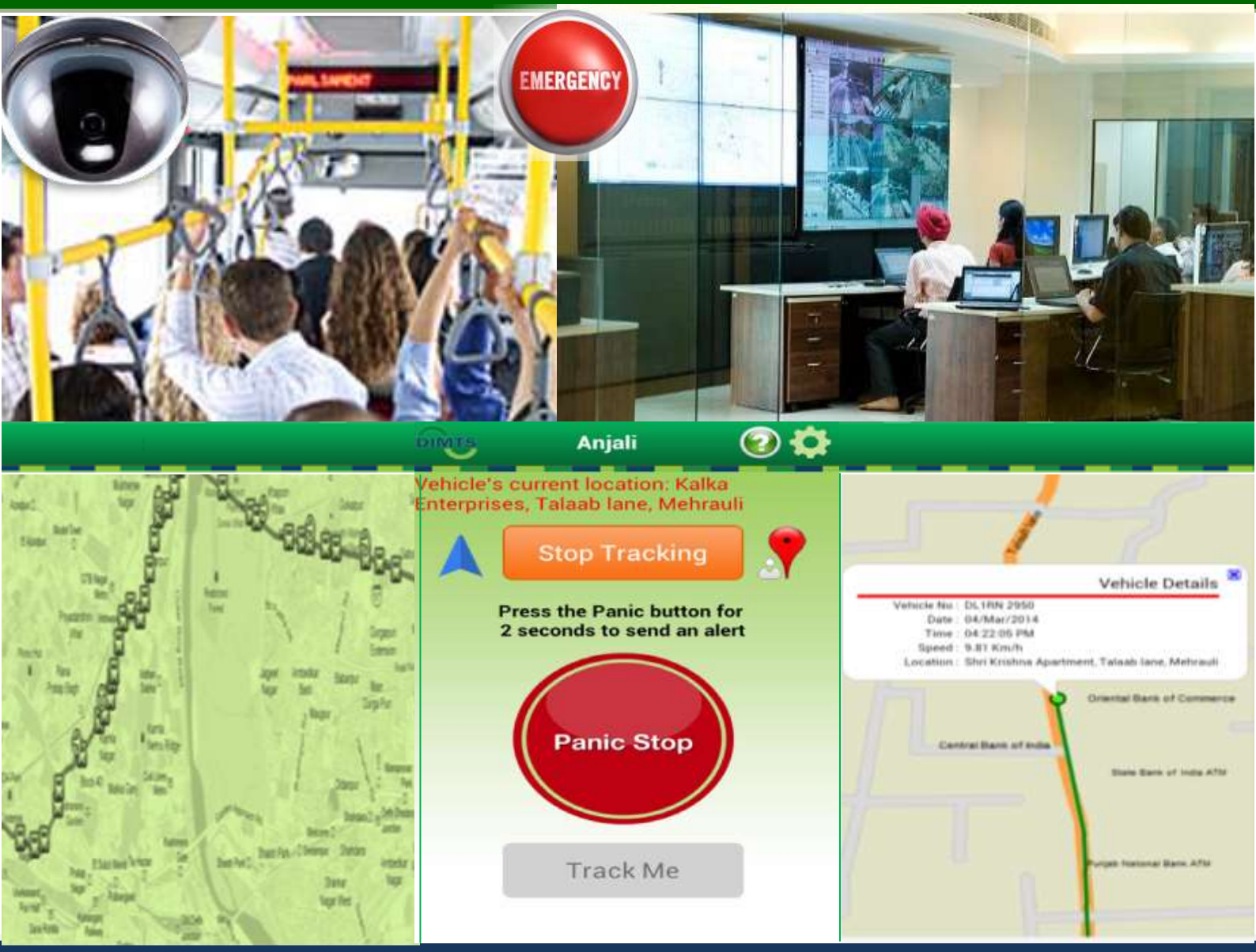
Name of the authorized person of the Company

Designation:

सत्यमेव जयते

**MINISTRY OF ROAD TRANSPORT AND HIGHWAYS**
**GOVERNMENT OF INDIA**

## Detailed Specification Document For Vehicle Tracking Devices (GPS)




# NATIONAL LEVEL VEHICLE SECURITY AND TRACKING SYSTEM

March 2015

# NATIONAL LEVEL VEHICLE SECURITY AND TRACKING SYSTEM

## Detailed Specification Document for Vehicle Tracking Devices (GPS)

**04th March 2015**

**Prepared by**

**Delhi Integrated Multi-Modal Transit System Limited**

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# Abbreviations

| Acronym | Definition/Description |
|---|---|
| ASCII | American Standard Code for Information Interchange |
| BMTC | Bangalore Metropolitan Transport Corporation |
| CCTV | Closed Circuit Television |
| CDMA | Code Division Multiple Access |
| CEP | Circular Error Probability |
| DOP | Dilution of Precision |
| DTC | Delhi Transport Corporation |
| DRMS | Distance Root Mean Square |
| GIS | Geographical Information System |
| GGSN | GPRS Gateway Service Node |
| GNSS | Global Navigation Satellite System |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning System |
| GoI | Government of India |
| GSM | Global System for Mobile |
| GPS | Global Positioning System |
| HDOP | Horizontal Dilution of Precision |
| HRTC | Himachal Road Transport Corporation |
| IMEI | International Mobile Equipment Identity |
| IMSI | International Mobile Subscriber Identity |
| I/O | Input / Output |
| IP | Ingress Protection |
| IRNSS | Indian Regional Navigation Satellite System |
| KSRTC | Karnataka State Road Transport Corporation |
| LAC | Location Area Code |
| LCD | Liquid Crystal Display |
| LNA | Low Noise Amplifier |
| MoF | Ministry of Finance, GoI |
| MoRTH | Ministry of Road Transport and Highways, GoI |
| NMR | Network Measurement Report |
| PDOP | Positional Dilution of Precision |
| PIN | Personal Identification Number |
| PSV | Public Service Vehicle |
| PUK | Personal Unblocking Code |
| RF | Radio Frequency |
| RSSI | Received Signal Strength Indicator |
| SEP | Spherical Error Probability |
| SI | System Integrator |

| Acronym | Definition/Description |
|---|---|
| SIM | Subscriber Identification Module |
| SV | Satellite Vehicle |
| TAR | Technology Analysis Report |
| TTFF | Time To First Fix |
| VTD | Vehicle Tracking Device |

# 1.0 INTRODUCTION

## 1.1 Project Background

The Ministry of Finance (MoF), Government of India (GoI) has set up a dedicated fund called the "Nirbhaya Fund" for implementation of initiatives aimed at enhancing the safety and security for women in the country. The proposals formulated by various Ministries/Departments aimed at enhancing the safety and security of women in the country are proposed to be funded through the Nirbhaya Fund.

The Ministry of Road Transport and Highways (MoRTH), Government of India has proposed to implement a scheme for Security for Women in Public Road Transport in the Country which is envisaged to be funded from the Nirbhaya Fund. The said MoRTH proposal has received in-principle approval from the Ministry of Finance (MoF), Government of India (GoI). The scheme to set up the National Level Vehicle Security and Tracking System has the following components proposed:

- A National Backend Data Centre
- City Command and Control Centre in 32 cities in India having population of more than one million. The architecture can be up-scaled to include more towns.
- Installation of Vehicle Tracking Device (VTD)/CCTV/Emergency buttons in notified public transport vehicles (On-Board Devices) in the above cities.

## 1.2 Report Context

MoRTH has engaged Delhi Integrated Multi Modal Transit System Limited (DIMTS) to support MoRTH in formulating and implementing the scheme “Security for Women in Public Road Transport in the Country”. As a part of this engagement, this detailed specification document for Vehicle Tracking Device, which would be required to be installed in vehicles under this scheme, has been prepared for MoRTH.

## 1.3 Report Structure

Chapter 1.0 provides an Introduction to the project, report context and structure.

Chapter 2.0 covers the detailed specifications of the vehicle tracking devices along with tracking device specifications used in different organizations.

Chapter 3.0 covers the Communication Protocol recommended for the vehicle tracking devices to interface with the backend.

Chapter 4.0 covers the recommended Test Parameters for the vehicle tracking devices.

Chapter 5.0 covers the listing of references used in preparing this report.

# 2.0 VEHICLE TRACKING DEVICE

## 2.1 Overview

Vehicle Tracking Device uses the Global Navigation Satellite System (GNSS) to determine and record the precise location of a vehicle at regular intervals. The location data so determined can be stored within the device, and/or can be transmitted to the backend using a wireless communication modem built in the device. As discussed in Technology Analysis Report (TAR) for the scheme, the Table 2-1 shows the types of on-board devices that would need to be installed in the vehicles covered under scheme.

**Table 2-1: On-board Device Types**

| Device Type | Device Description | Applicable for Vehicles |
|---|---|---|
| Type 1 | CCTV system with in-built tracking system and emergency button system | 23 passengers and above (excl. driver) |
| Type 2 | CCTV system with in-built emergency button system | 23 passengers and above (excl. driver) |
| Type 3 | Vehicle tracking device with in-built emergency button system | Can be used in all vehicles |
| Type 4 | Vehicle tracking device with in-built emergency button system and fare meter | Auto rickshaws and Taxis |

The vehicle tracking devices will be installed in all categories of vehicles covered under the scheme. The Type 1 devices are integrated devices with CCTV system, in-built vehicle tracking system and emergency button system. The detailed specifications for Type 1 and Type 2 devices have been covered in a separate document prepared for these devices. This document provides detailed technical specifications for Type 3 and Type 4 tracking devices. Separate specifications have been provided for these devices in respect of the parameters and elements where there is difference in requirements. For the remaining parameters and elements, a common set of specifications are applicable for both Types 3 and Type 4 vehicle tracking devices.

The vehicle tracking device primarily consists of the following elements:

- Locating Module: To determine the location of a vehicle
- Communication Module: To transfer location and other data from the device to the backend
- Storage, Other Systems and Interfaces

The above components have been described in the sections that follow.

## 2.2 Locating Module

Locating Module, also known as Global Navigation Satellite System (GNSS) receiver, is the main component of vehicle tracking device that determines its location on the surface of earth typically using satellite based positioning system called GNSS.

The GNSS comprises a set of dedicated satellites which continuously transmit signals that are received by the locating module. Locating module in the Vehicle tracking device typically uses one or more of the GNSS. The locating module, through a process of trilateration on the basis of signals received from minimum 3 satellites, identifies its geographic location coordinates which is then used to identify the location of the vehicle on which the vehicle tracking device is installed. For a 2-dimension fix of location, a minimum of 3 satellites are required and for a 3-dimension fix, a minimum of 4 satellites would be required.

As detailed in the Technology Analysis Report (TAR) for the scheme, it is recommended that locating module *must* use any one or more of the operational GNSS (GPS, GLONASS). It is further recommended that location module to support Indian Regional Navigation Satellite System/GAGAN. Also it is recommended that locating module *may* use any one or more of the other operational augmentation systems.

The important locating module parameters have been detailed in the sub-sections that follow:

### 2.2.1 Channels

The number of channels in a locating module denotes the parallel channels available for the module to search for and connect to GNSS signals. The more the number of channels, the faster is the time to fix and better is the accuracy even when one satellite moves out of range. Refer Table 2-2 for the number of channels used for vehicle tracking devices in different organizations.

**Table 2-2: Number of Channels**

| Sl.No. | Name of Organization | Year | Number of Channels |
|---|---|---|---|
| 1 | Bangalore Metropolitan Transport Corporation (BMTC) | Mar. 2012 | Parallel GPS Receiver – Minimum 20 channels |
| 2 | Delhi (Delhi Transport Corporation (DTC)+ Cluster Buses) | Sep. 2009 | The minimum specification for Parallel GPS Receiver: 20 channels or more. The supplied device supports 50 channels. |
| 3 | Himachal Road Transport Corporation (HRTC) | Dec. 2013 | Parallel GPS Receiver, Minimum 16 channels |
| 4 | Karnataka State Road Transport Corporation (KSRTC) | Nov. 2013 | Parallel GPS Receiver, Minimum 16 channels |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | 42 channels |

**Recommendation:** It is recommended to use GPS or GLONASS or both receiver module with a minimum of 32 acquisition channels and minimum of 18 tracking channels. It should support GAGAN introduced in India by ISRO. The devices should also support Indian Regional Navigation Satellite System (IRNSS).

### 2.2.2 Sensitivity

Sensitivity refers to the minimum signal strength level at which locating module can successfully perform a location fix. A GNSS locating module has two different sensitivity levels – acquisition sensitivity and tracking sensitivity.

**A. Acquisition Sensitivity**

Acquisition Sensitivity refers to the minimum signal level at which the receiver is able to successfully perform a Cold Start. During the signal acquisition process the signal level must be higher than that during the tracking process because the time synchronization is not known to the locating module.

**B. Tracking Sensitivity**

Tracking Sensitivity refers to the minimum signal level at which the locating module receiver is able to maintain a location fix. This is generally a much lower signal level than the acquisition sensitivity level.

Table 2-3 contains the Locating Module sensitivity values used for vehicle tracking devices in different organizations.

**Table 2-3: Sensitivity Values used for Tracking Devices**

| Sl. No. | Name of Organization | Year | Sensitivity |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | • Acquisition sensitivity (-)160 dBm<br>• Tracking Sensitivity (-)160 dBm |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | • Acquisition sensitivity: better than (-)148 dBm<br>• Tracking Sensitivity better than (-)155 dBm |
| 3 | HRTC | Dec. 2013 | • Minimum (-)158 dBm Acquisition without external assistance |
| 4 | KSRTC | Nov. 2013 | • Minimum (-)158 dBm Acquisition without external assistance |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | • Tracking Sensitivity (-)160 dBm |

**Recommendation**: It is recommended that the tracking sensitivity be -165 dBm or better and acquisition sensitivity better than -160 dBm.

### 2.2.3 Accuracy

The accuracy of a locating module refers to the degree of closeness the location readings are to the actual position of the receiver on the ground. Typically the accuracy is expressed as Circular Error Probability (CEP) or Spherical Error Probability (SEP) or Distance Root Mean Square (DRMS).

The following are the common parameters based on which the tracking device accuracy can be specified:

**A. Circular Error Probable (CEP)**

Device accuracy specified as CEP relates only to the horizontal plane. CEP is defined as the radius of a circle centered on the true value that contains 50% of the actual GPS measurements. A locating module with 10 meter CEP accuracy will be within 10 meters of the true position 50% of the time.

**B. Spherical Error Probability (SEP)**

Tracking device accuracies specified as SEP refer to both horizontal and vertical planes. A locating module with 8 metre SEP accuracy would be within 8 metres of its actual position 50% of the time.

**C. DRMS (Distance Root Mean Square also called RMS, 1Sigma)**

This is computed as square root of the average of the squared horizontal position errors with 65% probability. The position expressed has the probability of being within a circle with radius with 65% probability. A locating module with 6 metre DRMS accuracy would be within 6 metres of its actual position 65% of the time.

**D. 2DRMS**

This is computed as square root of the average of the squared horizontal position errors with 95% probability. The position expressed has the probability of being within a circle with radius with 95% probability. A locating module with 8 metre 2DRMS accuracy would be within 8 metres of its actual position 95% of the time.

Table 2-4 provides details regarding the locating module accuracy specifications used for tracking devices by different organizations.

**Table 2-4: Tracking Device: Accuracy Values**

| Sl. No. | Name of Organization | Year | Accuracy |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | 5 M CEP Positional Accuracy |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | Less than 10 m Positional Accuracy, (2dRMS confidence level higher than 95%) or 3m CEP |
| 3 | HRTC | Dec. 2013 | Accuracy Horizontal <6 meters (50%) |

| Sl. No. | Name of Organization | Year | Accuracy |
|---|---|---|---|
| 4 | KSRTC | Nov. 2013 | Accuracy Horizontal <6 meters (50%) |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Horizontal Position Accuracy 2.5 meter |

**Recommendation:** It is recommended that accuracy of vehicle tracking device should be better than 6 m 2DRMS (on ground) or 2.5 m CEP (on ground).

### 2.2.4 Dilution of Precision

Precision is the degree of proximity of the location data to their mean value. The relative position of satellites affects the accuracy of location calculation by the locating module. Location coordinates computed when the satellites are clustered together suffer from dilution of precision (DOP), a factor that multiplies the associated errors. The DOP for an ideal satellites constellation arrangement equals close to 1, which does not magnify the underlying errors.

Locating modules provide several measures of DOP viz. Horizontal Dilution of Precision (HDOP) and Vertical Dilution of Precision (VDOP). The combination of these two components of the three-dimensional position is called PDOP - Position Dilution of Precision. Table 2-5 defines the meaning of various DOP values.

**Table 2-5: DOP Values and Description**

| DOP Value | Rating | Description |
|---|---|---|
| 1 | Ideal | This is the highest possible confidence level to be used for applications demanding the highest possible precision at all times. |
| 1-2 | Excellent | At this level, positional measurements are considered accurate enough to meet all but the most sensitive applications. |
| 2-5 | Good | Represents a level that marks the minimum appropriate for making business decisions. Positional measurements could be used to make reliable in-route navigation suggestions to the user. |
| 5-10 | Moderate | Positional measurements could be used for calculations, but the fix quality could still be improved. A more open view of the sky is recommended. |
| 10-20 | Fair | Represents a low confidence level. Positional measurements should be discarded or used only to indicate a very rough estimate of the current location. |
| >20 | Poor | At this level, measurements are inaccurate by as much as 300 meters with a 6 meter accurate device (50 DOP × 6 meters) and should be discarded. |

*Source*: http://www.radio-electronics.com/info/satellite/gps/accuracy-errors-precision.php

**Recommendation:** It is recommended that the locating module send the DOP values to the backend which is provided for in Chapter 3.0 containing communication protocol.

### 2.2.5 Time to First Fix - TTFF (Hot Start / Warm Start / Cold Start)

Time to First Fix (TTFF) describes the time required for a tracking device to acquire adequate satellite signals and related data (almanac and ephemeris data) to compute location.

For tracking device to determine its location, two types of data are needed by the device: almanac and the ephemeris. These data are continuously transmitted by the GNSS satellites and the locating module of the tracking device collects and stores these data. The almanac data contains satellite status and orbit information and allows the locating module to determine which satellites are visible. Ephemeris data is collected from each satellite that contains precision corrections to the almanac data and is required to compute accurate position of the satellite. It is typically updated every 2 hours and is valid for about 3-6 hours.

TTFF depends on the mode of start of the device: Hot Start, Warm Start or Cold Start with cold start having the longest TTFF. These have been described below:

**Cold Start Mode:** If the tracking device has not been used for a long time or has moved a few hundred kilometres, usually it takes time to get the first location fix. This is termed as cold start as the device does not have current almanac, ephemeris, initial position or time.

Table 2-6 provides the details regarding TTFF specifications in Cold Start Mode used by different organizations.

**Table 2-6: TTFF in Cold Start Mode**

| Sl. No. | Name of Organization | Year | Cold Start Mode |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | < 60s |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | < 60s |
| 3 | HRTC | Dec. 2013 | Not specified |
| 4 | KSRTC | Nov. 2013 | Not specified |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | 30 Sec, Open Sky |

**Warm Start Mode:** Under this mode, the device has current almanac, initial position, and time which are valid. However, ephemeris data is either invalid or only partially valid.

Table 2-7 provides the details regarding TTFF in Warm Start Mode used by different organizations.

**Table 2-7: TTFF in Warm Start Mode**

| Sl. No. | Name of Organization | Year | Warm Start Mode |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | < 50s |

| Sl. No. | Name of Organization | Year | Warm Start Mode |
|---|---|---|---|
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | < 40s |
| 3 | HRTC | Dec. 2013 | Not specified |
| 4 | KSRTC | Nov. 2013 | Not specified |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Not specified |

**Hot Start Mode:** Under this mode, the device acquires the location fix faster as it has current almanac, initial position, time and ephemeris data which are all valid.

Table 2-8 provides the details regarding TTFF specifications in Hot Start Mode used by different organizations.

**Table 2-8: TTFF in Hot Start Mode**

| Sl. No. | Name of Organization | Year | Hot Start Mode |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | < 5s |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | < 10s |
| 3 | HRTC | Dec. 2013 | Not specified |
| 4 | KSRTC | Nov. 2013 | Not specified |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Hot Start: 1 sec, Open Sky |

**Recommendation:** It is recommended that acquisition time be as follows:

| Cold Start | Warm Start | Hot Start |
|---|---|---|
| Less than 40 sec, Open Sky | Less than 20 sec, Open sky | Less than 5 sec, Open Sky |

### 2.2.6 Antennae

Tracking devices require an antenna to capture the satellite signals and transmit to the device. Antenna could be external or be embedded within the device. The external antenna is used generally in a situation where the location of tracking device is such that it does not have sufficient view of the sky or the device has metal enclosure. High sensitivity vehicle tracking devices with internal antenna are able to work with limited view of the sky as well. Table 2-9 provides details regarding the tracking device antennae used by different organizations.

**Table 2-9: Tracking Device Antennae**

| Sl.No. | Name of Organization | Year | Antennae |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | Built In Active antenna |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | Built In Active antenna |
| 3 | HRTC | Dec. 2013 | Built In Active antenna |
| 4 | KSRTC | Nov. 2013 | Suitable Antenna for |

| Sl.No. | Name of Organization | Year | Antennae |
|---|---|---|---|
| | | | efficient operation with provisions for stable mounting |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Active GPS Antenna |

**Recommendation:** It is suggested that the device with built-in active antenna should be used in the Type 3 and Type 4 vehicle tracking devices.

## 2.3 Communication Module

The vehicle tracking device would have a communication module to connect to the backend system and send the captured location data as per the configured protocol. The communication module would rely upon and use cellular wireless communication network that is available in the geographic area to transmit the data to the backend.

**Key Recommendations:** The following are recommended:

- In view of the project requirements and the quantum of data transfer anticipated, 2G services would be adequate for the tracking devices under the project.
- 2G communication module would be adequate for tracking device on a standalone basis.

The detailed specifications for the communication module are covered in sub-sections below.

### 2.3.1 Wireless Network

General Packet Radio Service (GPRS) is widely used for transmitting data over Global System for Mobile (GSM) (2G) network. Table 2-10 provides details regarding the supported wireless network and related specifications used by different organizations.

**Table 2-10: GPRS/GSM Specifications**

| Sl. No. | Name of Organization | Year | GPRS/GSM |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | • Multi Slot GPRS<br>• GPRS class 10 , EDGE (e-GPRS) Multi-slot class 10<br>• Supports all modes – SMS, Voice, Data, GPRS, TCP/IP |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | • Multi Slot GPRS<br>• GPRS class 10 or Above<br>• Should support SMS, Voice, Data, GPRS, TCP/IP |
| 3 | HRTC | Dec. 2013 | • GSM: Normal MS-SMS data<br>• GPRS: Type B class 10 |
| 4 | KSRTC | Nov. 2013 | • GSM: Normal MS-SMS data |

| Sl. No. | Name of Organization | Year | GPRS/GSM |
|---|---|---|---|
| | | | • GPRS Type B class 10 |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | • GSM/GPRS or Higher Modem – Transmitting power Class 4 (2W) at GSM 850 and EGSM 900 Class 1 (1W) at DCS 1800 and PCS 1900 with IMEI |

**Recommendation:** It is recommended that Multi Slot GPRS class 10 (or above) communication module be used in the tracking devices under the project. The module should support SMS, Voice and Data.

### 2.3.2 Frequency Band

A multi-band communication module (such as dual-band, tri-band, quad-band and penta-band module) supports communication over multiple radio frequency bands.

A quad-band module typically supports four frequency bands: 850 and 1900 MHz, mostly used in the Americas (ITU region 2), and the 900 and 1800 MHz bands used elsewhere (also in India).

Table 2-11 provides details regarding for Frequency Band related specifications used by different organizations.

**Table 2-11: Frequency Band Used by Different Organizations**

| Sl. No. | Name of Organization | Year | Frequency Band |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | In- Built GPRS module / Modem (Dual Band) |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | In- Built Triband GPRS module / Modem |
| 3 | HRTC | Dec. 2013 | Frequency: 900/1800/1900 (dual band) Class 4 (2W) at 900 MHz (EGSM) Class 1 (1W) at 1800 MHz |
| 4 | KSRTC | Nov. 2013 | Frequency as per allowed bandwidth and frequency for operations in India |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Quad-band GSM/GPRS Modem or higher, Downlink max. Speed 85.6 kbps and Uplink max. speed 42.8 kbps<br>Transmitting power Class 4 (2W) at GSM 850 and EGSM 900 Class 1 (1W) at DCS 1800 and PCS 1900 with IMEI |

**Recommendation:** It is recommended to have Quad-band GSM/GPRS Modem supporting all 2G and 3G frequency bands in India.

### 2.3.3 Subscriber Identity Module (SIM)

Currently in India, the SIM cards used in mobile phones are generally utilized in the tracking devices. However SIM cards specially designed for the M2M (Machine to Machine) applications and automotive environment are also available in the Indian market.

The features required for automotive environment which are critical to this application are as follows:

- Survive the automotive operational requirement such as vibration, temperature, and humidity
- Long life span

Table 2-12 shows the SIM types for M2M applications and their typical features.

**Table 2-12: SIM Types and Features**

| Sl. No. | Parameter | SIM M2M Plastic  | SIM M2M Robust Plastic  | M2M Industrial SIM  |
|---|---|---|---|---|
| 1 | Operating Conditions | • Standard Environmental Conditions<br>• Standard Electrical Conditions | • Standard Environmental Conditions<br>• Extreme Electrical Conditions<br>– Longer Usage life-Span<br>– Intensive Use | • Extreme Environmental Conditions<br>– Temperature<br>– Shock<br>– Humidity<br>– Corrosion<br>• Extreme Electrical Conditions<br>– Longer Usage Life Span<br>– Intensive Use |
| 2 | Temperature Range | -25$^0$ C to 85$^0$ C | -25$^0$ C to 85$^0$ C | -40$^0$ C to 85$^0$ C |
| 3 | Erase and Write Cycles | 500k E/W cycles | • High stress memory supports > 2M E/W cycles per file<br>• Outside of HSM 500k E/W cycles | • High stress memory supports > 2M E/W cycles per file<br>• Outside of HSM 500k E/W cycles |
| 4 | Data Retention | >2 Years | >10 Years | >10 Years |
| 5 | Designed Lifetime | 2 Years + | 10 Years + for electrical | 10 Years + at -40$^0$ C to 85$^0$ C |

**Recommendation**: It is recommended to use SIM M2M Plastic or M2M Standard Industrial SIM or Robust Plastic SIM and the device should support this requirement.

### 2.3.4 Network Measurement Report (NMR)

The GPRS / GSM module of the device should be capable of capturing and sending serving Cell ID as well as the neighbouring Cell IDs, where the device is located. The Cell ID should come along with the LAC (Location Area Code) and RSSI (Received Signal Strength Indicator) field to indicate the GSM network parameter. This data would help in providing a limited tracking even if the location fix is lost.

**Recommendation**: It is recommended that the devices send to backend the serving Cell ID and neighbouring Cell IDs along with LAC and the RSSI value as per the protocol set out in Chapter 3.0 of this report.

### 2.3.5 Connection Type

The device should communicate with the backend in TCP/IP connection mode. Device may also have application level acknowledgement from the backend to check against any error.

At the device end, priority would always be given for the live packet. In case any history packets are to be sent, then device would send the history packets during the intervening period between 2 live packets.

The SMS mode of data transmission as backup would be followed, in case of emergency state (if the device is in emergency state) wherein the device would send data to the backend as per the protocol set out in Chapter 3.0 of this report.

## 2.4 Storage, Other Systems and Interfaces

### 2.4.1 Storage

The vehicle tracking devices need to have sufficient memory to operate in offline mode with no loss of data. Typically the tracking devices have memory to store data for about 5,000-20,000 logs. Table 2-13 contains the details regarding tracking device storage capacity used by different organizations.

**Table 2-13: Device Storage**

| Sl. No. | Name of Organization | Year | Storage |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | 20,000 logs |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | 20,000 logs (Location data) |
| 3 | HRTC | Dec. 2013 | Not specified |
| 4 | KSRTC | Nov. 2013 | 5000 way points |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Not specified |

**Recommendation:** It is suggested that the device should have capability to store a minimum of 40,000 location data.

### 2.4.2 Geofencing

Geofencing is a tool that supports creation of virtual perimeter or barrier around a physical geographical area. This together with the location tracking application supports monitoring of vehicles having tracking devices enter or exit an established geo-fenced area and provides administrators with alerts when there's a change in status.

Table 2-14 contains details regarding the Geofencing related provisions used for tracking devices by different organizations.

**Table 2-14: Geofencing Parameters**

| Sl. No. | Name of Organization | Year | Geofencing |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | 20,000 logs |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | 150 route Geofences |
| 3 | HRTC | Dec. 2013 | Not specified |
| 4 | KSRTC | Nov. 2013 | Not specified |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Not specified |

**Recommendation:** It is recommended that Type 3 and Type 4 devices should have facility to store minimum 3,000 geofence points and should also have the facility to update route Geo-fence master in the device over the air. Geofence can be a circular area or polygon area. Device should also support creation of minimum 200 routes (a route consists of a sequence of geofence points). One route in general can be of 150 distinct geofence points. Device should have enough memory to store 3,000 geofence points. However device will compare a maximum of 150 geofences at a time as these 3,000 geofence points will be stored as route wise.

**Device Geofence Downloading Mechanism (As an example)**

- Server will send a command to indicate the start of route downloading process with start character, device IMEI, total number of routes, route numbers to be downloaded, and end character.
- Device will send an acknowledgement and ask server to send route definitions having route number, number of geofence points of route, geofence latitude, longitude, radius and geofence ID. Maximum 5 routes definition would be sent at a time.
- Device should save these routes on its flash memory and be able to select the particular route when receiving command from server. Device would search only geofence points of the selected route/area.

Note: All the commands and their definitions for route downloading mechanism would need to be provided for each tracking device.

### 2.4.3 Encryption and Error Checking

Encryption technology can be used for data security and validity. Although GPRS is a secure licensed channel however encryption is needed in data network when packet leaves the GPRS Gateway Service Node (GGSN). Encryption can be undertaken using an 8 bit Ex-OR or CRC-16, but the details must be available so that location update (LU) data received at backend can be decrypted and compared to determine, if the LU got tempered or not while in transmission.

The encryption and error checking is a desired feature in the tracking device to protect against error in data during transmission. Appropriate encryption mechanism is required from the device.

### 2.4.4 Firmware Updates/ Configuration Over the Air (OTA)

The device should support firmware updates/upgrades and configuration of the device parameters over the air. The configuration should be possible over both GPRS as well as over SMS through secure mechanism. The details of device parameters that are to be configured are detailed in Chapter 3.0 containing communication protocol.

Table 2-15 contains firmware update and device parameter configuration related provisions used by different organizations.

**Table 2-15: Firmware Update / Device Configuration Specification**

| Sl. No. | Name of Organization | Year | Firmware Update |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | Software upgradeable / configurable over the air. |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | Facility to update route geofence master in the device over the air.<br>Remote administration and firmware update over the air. |
| 3 | HRTC | Dec. 2013 | Over the Air Download of firmware as well as configuration parameters |
| 4 | KSRTC | Nov. 2013 | Over the Air Download of firmware as well as configuration parameters |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Not specified |

**Recommendation:** It is recommended that the device should support both firmware updates/upgrades as well as device parameter configuration over the air. The configuration of parameters should be possible both over GPRS as well as over SMS channel through secure mechanism.

### 2.4.5 Tracking Device Health Monitoring Parameters

The device should send status of health parameters at configured interval and this should also be configurable over the air. It should be possible for the health parameters to be fetched on demand via command as set out in protocol in Chapter 3.0.

### 2.4.6 Ports and Sensors

Vehicle tracking devices are required to be connected to external devices for data exchange and to enable this, they need to be provided with suitable interfaces.

**A. Rx/Tx:** Typically referred as a serial port.

- Rx: Receive Line
- Tx: Transport Line

**B. Digital / Analog Input**

These port will be used for interfacing the sensor / equipment such as emergency button, sensors etc.

**C. Debugging Port**

This port will be used for connecting external device for updating firmware, downloading logs etc.

Table 2-16 provides details related to Ports and Sensors specifications used by different organizations for the vehicle tracking devices.

**Table 2-16: Ports and Sensors Specification**

| Sl. No. | Name of Organization | Year | Ports and Sensors |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | Either USB or RS232. 8 or more digital Inputs, 4 or more digital outputs |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | Two number RS232 ports, with 8 or more digital Inputs, 4 or more digital outputs (For Relays, sirens etc.), 1 or more analog inputs (For analog inputs like fuel, temperature etc. |
| 3 | HRTC | Dec. 2013 | RS232 |
| 4 | KSRTC | Nov. 2013 | Not specified |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | RS232 |

**Recommendation:** Table 2-17 shows the details of recommended ports in the vehicle tracking devices.

Table 2-17: Recommended Ports for Tracking Devices

| External I/O | Device Type 3 | Device Type 4 |
|---|---|---|
| Transmit Line, Receive Line | 2 TX, 2 RX | 1 TX, 1 RX |
| Input / Output (I/O) | 4 Digital Input, 2 Analog Input | 2 Digital Input, 1 Analog Input |
| Debugging Port | 1 | 1 |

The above TX and RX lines can be used as USB, Mini USB or RS232 etc.

### 2.4.7 Emergency Button

The emergency button will be used to raise an alert in case of any emergency in the vehicle. Commuters can press emergency button installed in the public transport vehicle to alert the authorities. Table 2-18 contains provisions related to emergency button used by different organizations.

Table 2-18: Emergency Button Specifications

| Sl. No. | Name of Organization | Year | Emergency Button |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | Not specified |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | Not specified |
| 3 | HRTC | Dec. 2013 | Emergency messages from the vehicles by generating alarms |
| 4 | KSRTC | Nov. 2013 | Emergency button provided in the Vehicle Tracking and Monitoring System (VTMS) Unit |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Buttons for emergency alerts and SOS messages |

**Recommendation:** Table 2-19 shows the recommended number and location of emergency buttons for Type 3 and Type 4 devices.

Table 2-19: Emergency Button Requirement

| Device Type | In-built in the device | External |
|---|---|---|
| Type 3 | 1 | Up to 7 |
| Type 4 | 1 | 1 |

### 2.4.8 Vibration Parameters

The vehicle tracking devices will be subjected to high degree of vibration during vehicle operation. As vibration leads to mechanical failure, the tracking devices will need to be designed and tested to work in such environment. Refer Table 2-20 for vibration related specifications used by different organizations.

**Table 2-20: Vibration Related Specifications**

| Sl. No. | Name of Organization | Year | Vibration Specifications |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | Vibration to meet SAE standards |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | Dust, temperature, vibration and Water Splash resistant |
| 3 | HRTC | Dec. 2013 | Vibration to meet SAE standards |
| 4 | KSRTC | Nov. 2013 | Vibration to meet SAE standards |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | Not specified |

**Recommendation:** It is recommended that device should conform to and meet the testing requirements outlined in Chapter 4.0.

### 2.4.9 Environmental Variables

Table 2-21 contains the specifications used by different organizations for various environmental parameters.

**Table 2-21: Environmental Parameters Specifications**

| Sl. No. | Name of Organization | Year | Environmental Parameters Specifications |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | • Temperature range; -10° C to 60 °C<br>• Humidity Level: 5% to 95% non-condensing |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | • Temperature range ; -10° C to 85 °C<br>• Humidity Level: 5% to 95% non-condensing |
| 3 | HRTC | Dec. 2013 | • Temperature Operating -20°C to +70°C<br>• Humidity 5% to 95% RH non-condensing at +40°C |
| 4 | KSRTC | Nov. 2013 | • Temperature Operating -20°C to +70°C<br>• Humidity 5% to 95% RH non-condensing at +40°C |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | • Operating Temperature : -25 to 80 degree Celsius (without LCD), -20 to 70 degree Celsius (with LCD) |

**Recommendation:** It is recommended that the device be able to operate in temperature range from -20° C to 85° C (Type 3) and -20° C to 70° C (Type 4). It is further recommended that the device be able to operate under Humidity ranges from 5% to 95% RH non-condensing.

### 2.4.10 Ingress Protection (IP)

The vehicle tracking devices must be able to work in dusty environment that are typically encountered by the public transport vehicles where these would be installed. IP rating (IS/IEG 60529) is used for specifying the environmental protection characteristics of the tracking device. The IP rating is composed of two digits, the first referring to the protection against solid objects and the second against liquids. The higher the number, the better would be the protection offered.

**A. First Digit**

| | |
|---|---|
| 0 | No protection (Sometimes X) |
| 1 | Protected against solid objects up to 50 $mm^3$ |
| 2 | Protected against solid objects up to 12 $mm^3$ |
| 3 | Protected against solid objects up to 2.5 $mm^3$ |
| 4 | Protected against solid objects up to 1 $mm^3$ |
| 5 | Protected against dust, limited ingress (no harmful deposit) |
| 6 | **Totally protected against dust** |

**B. Second Digit**

| | |
|---|---|
| 0 | No protection (Sometimes X) |
| 1 | Protection against vertically falling drops of water (e.g. condensation) |
| 2 | Protection against direct sprays of water up to 15 degrees from vertical |
| 3 | Protection against direct sprays of water up to 60 degrees from vertical |
| 4 | Protection against water sprayed from all directions - limited ingress permitted |
| 5 | **Protected against low pressure jets of water from all directions - limited ingress permitted** |
| 6 | Protected against low pressure jets of water, limited ingress permitted (e.g. ship deck) |
| 7 | Protected against the effect of immersion between 15cm and 1m |
| 8 | Protected against long periods of immersion under pressure |

Table 2-22 contains details of the IP ratings used by different organizations for the tracking devices.

**Table 2-22: IP Rating of Tracking Devices**

| Sl. No. | Name of Organization | Year | Ingress Protection |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | • Dust, temperature, vibration and Water Splash resistant<br>• IP 65 rated or equivalent |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | • Dust, temperature, vibration and Water Splash resistant |

| Sl. No. | Name of Organization | Year | Ingress Protection |
|---|---|---|---|
| | | | • IP 65 rated or equivalent |
| 3 | HRTC | Dec. 2013 | • IP 65 or equivalent |
| 4 | KSRTC | Nov. 2013 | • Vibration and shock resistant, heat resistant, dust resistant and water / rain splash resistant and shall be tamper proof<br>• IP 65 or equivalent |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | • Heat, dust proof, UV resistant and sea water resistant.<br>• IP 65 |

**Recommendation**: It is recommended that the tracking device be at least IP 65 rated.

### 2.4.11 Power Supply

The tracking devices will be installed on the vehicles where power supply voltage from vehicle battery widely varies (12V, 24V etc.) and also the power supply is not as stable as that in case of fixed locations, especially during engine start-up and braking when the voltage can fall to 9V or less. Typically electronic devices are very sensitive to power surges and spikes, and equipment may fail if they do not receive stable power supply. The devices will need to have a resilient power supply unit that can withstand such fluctuations and the devices also need to have power backup so that they continue to function for some duration when the vehicle battery is not functional or is disconnected from the devices. Refer Table 2-23 for power supply related specifications used by different organizations for tracking devices.

**Table 2-23: Power Supply Specifications of Tracking Devices**

| Sl. No. | Name of Organization | Year | Power Supply |
|---|---|---|---|
| 1 | BMTC | Mar. 2012 | • Input voltage range 8-30 Volts<br>• Active mode Peak <= 1.0 A<br>• Active mode Avg <= 200 mA; Intelligent power management system 4 hours or more of Battery Back Up<br>• Sleep Mode <= 25 mA |
| 2 | Delhi (DTC+ Cluster Buses) | Sep. 2009 | • Primary Power: Vehicle Battery 12/24 volts<br>• Battery Life: 8 hours normal life |
| 3 | HRTC | Dec. 2013 | • Primary Power: Vehicle Battery 12/24 volts<br>• Battery Life: Mandatory 8 hours normal operation |
| 4 | KSRTC | Nov. 2013 | • Operating Voltage: 8V – 32V<br>• Operating current: @24V , Ideal |

| Sl. No. | Name of Organization | Year | Power Supply |
|---|---|---|---|
| | | | Mode: 80m, GPRS or higher trans/rec: - 160 mA<br>• Battery Reverse: Integrated Protection |
| 5 | Municipal Corporation of Greater Mumbai | 2014 | • Input voltage range 8-30 Volts<br>• Active mode Peak < 1.0 A<br>• Active mode Avg < 200 mA<br>• Sleep Mode < 25 mA<br>• Battery Backup: 4 hours or more in active mode |

**Recommendation:** Table 2-24 shows the details of the recommended power supply related specification.

**Table 2-24: Recommended Power Supply Related Specifications**

| Input Voltage Range | Active Mode Peak | Active Mode Avg. | Sleep Mode | Battery Backup |
|---|---|---|---|---|
| 8-32 Volts | < 1.0 A | Avg. < 120 mA | < 25 mA | Minimum of 4 hours or more in active mode. |

There must be a protection mechanism to protect device from sudden surges in voltage and current.

## 2.5 Recommended Technical Specifications for Vehicle Tracking Devices

Table 2-25 presents the detailed specifications of Type 3 and Type 4 devices. As has been explained earlier, Type 3 devices are vehicle tracking devices with in-built emergency button system. Type 4 devices are vehicle tracking devices with in-built emergency button system and fare meter.

**Table 2-25: Minimum Specifications for Type 3 and Type 4 Vehicle Tracking Devices**

| Sl. No. | Specification | Type 3 | Type 4 |
|---|---|---|---|
| **General Features** | | | |
| 1. | GPS or GLONASS or both (Location, speed, heading, time stamp) data polling and sending frequency capability of less than or equal to 10 sec. The devices should also support Indian Regional Navigation Satellite System (IRNSS) | ✓ | ✓ |
| 2. | Vehicle tracking device to support GAGAN, the Indian SBAS (Satellite Based Augmentation System) | ✓ | ✓ |
| 3. | Location on demand on GPRS/SMS | ✓ | ✓ |

| Sl. No. | Specification | Type 3 | Type 4 |
|---|---|---|---|
| 4. | Memory to store min 40,000 positional log | ✓ | ✓ |
| 5. | Configurable backup SMS facility in case of GPRS failure | ✓ | ✓ |
| 6. | Capability to send serving and adjacent cell ID as well as network measurement report (NMR) | ✓ | ✓ |
| **GPS Module Specification** | | | |
| 1. | Parallel GPS or GLONASS or both receiver module with 32 (minimum) acquisition channels and 18 minimum tracking channel. The devices should also support Indian Regional Navigation Satellite System (IRNSS) | ✓ | ✓ |
| 2. | Vehicle tracking device to support GAGAN, the Indian SBAS (Satellite Based Augmentation System) | ✓ | ✓ |
| 3. | Acquisition sensitivity: better than (-)160 dBm | ✓ | ✓ |
| 4. | Tracking sensitivity better than (-)165 dBm | ✓ | ✓ |
| 5. | Accuracy of Less than 6m Positional Accuracy 2DRMS (on ground) or 2.5 m CEP (on ground) | ✓ | ✓ |
| 6. | Hot start: <5s | ✓ | ✓ |
| 7. | Warm start: < 20s | ✓ | ✓ |
| 8. | Cold start: <40s | ✓ | ✓ |
| 9. | Outputs as per NMEA 0183 | ✓ | ✓ |
| 10. | WGS-84 compliant | ✓ | ✓ |
| 11. | A-GPS | ✓ | ✓ |
| **GPRS** | | | |
| 1. | In - Built Quad-band GPRS module/Modem | ✓ | ✓ |
| 2. | Multi Slot GPRS | ✓ | ✓ |
| 3. | GPRS class 10 or above | ✓ | ✓ |
| 4. | Should support all – SMS, Voice, Data, GPRS, TCP/IP | ✓ | ✓ |
| **Power Characteristics** | | | |
| 1. | Input voltage range 8 – 32 volts | ✓ | ✓ |
| 2. | Active mode peak current < 1.0 A | ✓ | × |
| 3. | Active mode Avg < 120 mA | ✓ | × |
| 4. | Sleep mode < 25 mA | ✓ | × |
| 5. | Battery backup of minimum of 4 hours in active mode | ✓ | ✓ |
| **Environmental Variables** | | | |
| 1. | Temperature range ; -20° C to 85° C (Type 3), -20° C to 70° C (Type 4) | ✓ | ✓ |
| 2. | Humidity Level: 5% to 95% non-condensing | ✓ | ✓ |

| Sl. No. | Specification | Type 3 | Type 4 |
|---|---|---|---|
| 3. | Dust, temperature, vibration and water splash resistant | ✓ | ✓ |
| 4. | IP 65 rated or better. Tamper proof | ✓ | × |
| 5. | Automotive grade unit with components and manufacturing process as required for automotive use. | ✓ | × |
| **Antennae** | | | |
| 1. | Should have internal GPRS antenna | ✓ | ✓ |
| 2. | Should have internal GPS antenna | ✓ | ✓ |
| **Port/Sensors (External I/O)** | | | |
| 1. | Transmit Line, Receive Line | ✓ | ✓ |
| a. | 2 TX, 2 RX | ✓ | × |
| b. | 1 TX, 1 RX | × | ✓ |
| 2. | I/O | ✓ | ✓ |
| a. | 4 Digital Input, 2 Analog Input | ✓ | × |
| b. | 2 Digital Input, 1 Analog Input | × | ✓ |
| 3. | Emergency Button I/o | ✓ | ✓ |
| 4. | Debugging Port (1) | ✓ | ✓ |
| **Geofencing** | | | |
| 1. | Device should store minimum 3000 geofence points. One route in general can be of 150 distinct geofence points. | ✓ | ✓ |
| 2. | Facility to update route Geo-fence master in the device over the air | ✓ | ✓ |
| **Other Features** | | | |
| 1. | Emergency button | ✓ | ✓ |
| 2. | Processor: 32 bit, 400MHz or above | ✓ | ✓ |
| 3. | Device should be capable of sending a packet to 2 different IPs simultaneously. | ✓ | ✓ |
| 4. | Status LED's to indicate Power, GPS, emergency function, and GPRS status. | ✓ | ✓ |
| 5. | Over the Air Download of firmware as well as configuration of parameters. | ✓ | ✓ |
| 6. | Remote administration and firmware update over the air. | ✓ | ✓ |
| 7. | Integration with Fare Meter for Cab as well as Auto Rickshaw | × | ✓ |
| 8. | Printer<br>(i) Font : 12 x 24<br>(ii) Print Width : 2 Inch minimum<br>(iii) Print Speed : 60mm/sec<br>(iv) Print : English , Alphanumeric characters<br>(v) Resolution : 8 dots/mm<br>(vi) Print receipt should have the following | × | ✓ |

| Sl. No. | Specification | Type 3 | Type 4 |
|---|---|---|---|
| | fields:<br>a) Vehicle Number<br>b) Start Time<br>c) End Time<br>d) Trip details<br>e) Trip Distance<br>f) Waiting Time<br>g) Night Time flag / Charge | | |
| 9. | LCD Display (Minimum 4 lines x 20 character per line, backlit) | × | ✓ |
| 10. | Switches/Buttons Mechanism<br>(i) Trip Start (Mandatory and integrated with the meter start)<br>(ii) Trip End (Mandatory and integrated with the end of meter)<br>(iii) Waiting (Visual Display)<br>(iv) Emergency button to trigger the alert message.<br>(v) Print button to get the bill printed. | × | ✓ |

# 3.0 COMMUNICATION PROTOCOL

## 3.1 Frame Format – Type 3 Devices (GPS Standalone)

Table 3-1 contains the listing of fields that the Type 3 vehicle tracking devices would be required to send to the backend. Such devices will be installed in the non-metered vehicles such as buses, grameen sewa etc. The first 3 fields (Start character, Header for SI and Vendor ID, who had supplied the device) must be fixed in position as well as format (Header part of frame). Rest all other fields are required to be present in the location data sent by the devices to the backend, but can be in any sequence or with any separator between fields. The data value can be either in American Standard Code for Information Interchange (ASCII) or in HEX format.

Device must transmit the Login message whenever it establishes its connectivity with Server with the specified fields. Login Message will carry below following information:

- $DeviceName –Vehicle number where the device was installed
- $IMEI –15 Digit IMEI number
- $Firmware – Version of the firmware used in the hardware
- $Protocol -Version of the frame format protocol.
- $LastValidLocation – Last location info saved at the device.

**Example:**

- $Msg.Server.Login
- $DeviceName=DL3CBM9821
- $IMEI=123456789012345
- $Firmware=1.0.0
- $Protocol =1.0.1
- $LastValidLocation=$1,220714,050656,28.758963,N,77.6277844,E,25*

**Table 3-1: Data Frame Format for Type 3 Devices**

| Field | Description | Sample Data |
|---|---|---|
| Start Character | $ | $ |
| Header | The header of the packet/ identifier | |
| Vendor ID | Vendor identification header | |
| Firmware Version | Version details of the Firmware used in EX.1.0.0 | 1.0.0 |
| Packet Type | Specify the packet type –<br><br>NR = Normal<br>EA = Emergency Alert<br>TA = Tamper Alert<br>HP = Health Packet | Depending upon the context, every frame from tracking device must carry a qualification code. This helps to determine the state in which vehicle is at that time. |

| Field | Description | Sample Data |
|---|---|---|
| | IN = Ignition On<br>IF = Ignition Off<br>BD = Battery Disconnect<br>BR = Battery Reconnect<br>BL = Battery Low<br>GE = Geofence Entry / Bus Stop entry<br>GX = Geofence Exit / Bus Stop Exit<br>DI = Depot/Parking In shed<br>DO = Depot/Parking Out shed | |
| Packet Status | L=Live or H= History | L |
| IMEI | Identified of the sending unit. 15 digit standard unique IMEI no. | 123456789012345 |
| Vehicle Reg. No | Mapped vehicle registration number | DL1PC9821 |
| GPS Fix | 1 = GPS fix OR 0 = GPS invalid | 1 |
| Date | Date value as per GPS date time per GPS date time (ddmmyy) | 220714 |
| Time | Time value as per GPS date time in UTC format (hhmmss) | 050656 |
| Latitude | Latitude value in decimal degrees (up to not less than 6 places) | 28.758963 |
| Latitude Dir | Latitude Direction. Example N=North, S= South | N |
| Longitude | Longitude value in decimal degrees (up to not less than 6 places). | 77.6277844 |
| Longitude Dir | Longitude Direction.<br>Example E=East, W= West | W |
| Speed | Speed in km/hr (Upto One Decimal Value) | 25.1 |
| Heading | Course over ground in degrees | 310.56 |
| No of Satellites | Number of satellites used for fix (minimum 5 satellites in vision, to have the fix) | 8 |
| Altitude | Altitude of the device in meters | 183.5 |
| PDOP | Positional dilution of precision | |
| HDOP | Horizontal dilution of precision | |
| Distance | Distance Travelled in Meters (Between Current and the Previous packet) | 100 |
| ODO | Total Distance Travelled in Km (from activation of unit to till last packet) Upto One Decimal | 25.8 |
| Min Speed | Minimum Speed travelled by vehicle between last and the current packet in Km/h (Upto One decimal value) | 2.0 |
| Avg. Speed | Average Speed between last and the current packet in Km/h (Upto One decimal value) | 5.0 |
| Max Speed | Maximum Speed travelled by vehicle | 10.5 |

| Field | Description | Sample Data |
|---|---|---|
| | between last and the current packet in Km/h (Upto One decimal value) | |
| Network Operator Name | Name of Network Operator | INA Airtel |
| Ignition | 1= Ignition On , 0 = Ignition Off | 1 |
| Main Power Status | 0 = Vehicle Battery Disconnected<br>1= Vehicle Battery Reconnected | 1 |
| Main Input Voltage | Indicator showing source voltage in Volts.(Upto One Decimal Value) | 12.5 |
| Internal Battery Voltage | Indicator for Level of battery charge remaining. (Upto One Decimal Value) | 4.2 |
| Emergency Status | 1= On , 0 = Off | 0 |
| Tamper Alert | C = Cover Closed, O = Cover Open | C |
| GSM Signal Strength | Value Ranging from 0 – 31 | 25 |
| MCC | Mobile Country Code | 404 |
| MNC | Mobile Network Code | 10 |
| LAC | Location Area Code | 00D6 |
| Cell ID | GSM Cell ID | CFBD |
| NMR (neighboring Cell ID) | Neighbouring 4 cell ID along with their LAC | |
| Digital Input Status | 4 external digital input status (Status of Input 1 to Input 3 (0=Off; 1=On)) | 000 |
| Digital Output Status | 2 external digital output status (0=Off; 1=On) | 01 |
| Geofence Stop ID | Identify the particular stop, Default = 0 | U001 |
| Frame Number | Sequence Number of the messages (000001 to 999999) | 000005 |
| Checksum | Insures No error in transmission (optimal) | 16 |
| End Character | Indicated End of the frame | * |

**Recommendation**: It is recommended that the tracking device support minimum fields as mentioned above. Individual devices can give more fields than the ones listed above.

The tracking device should be able to support different frequency of sending the data frames, in following states:

- Ignition OFF
- Emergency (Emergency state would supersede every other state)
- Ignition ON

## 3.2 Frame Format – Type 4 Devices (Tracking Device with EFM)

Table 3-2 contains the listing of fields that the Type 4 vehicle tracking devices (with electronic fare meter) would be required to send to the backend. Such devices will be installed in the vehicles that charge fare as computed by the fare meter such as Auto rickshaws or Taxis. Such devices would be required to send certain additional data to the backend as compared to the Type 3 vehicle tracking device (without fare meter) covered in the earlier section.

It is the first 3 fields (Start character, Header for SI and Vendor ID, who had supplied the device) which must be fixed in position as well as format (Header part of frame). Rest all other fields are required to be present in the location data sent by the devices to the backend, but can be in any sequence or with any separator between fields. The data value can be either in American Standard Code for Information Interchange (ASCII) or in HEX format.

**Table 3-2: Data Frame Format for Type 4 Devices**

| Field | Description | Sample Data |
|---|---|---|
| Start Character | $ | $ |
| Header | The header of the packet/ identifier | |
| Vendor ID | Vendor identification header | |
| Firmware Version | Version details of the Firmware used in EX.1.0.0 | 1.0.0 |
| Packet Type | Specify the packet type –<br><br>NR = Normal<br>EA = Emergency Alert<br>TA = Tamper Alert<br>HP = Health Packet<br>IN = Ignition On<br>IF = Ignition Off<br>BD = Battery Disconnect<br>BR = Battery Reconnect<br>BL = Battery Low<br>GE = Geofence Entry / Bus Stop entry<br>GX = Geofence Exit / Bus Stop Exit<br>DI = Depot/Parking In shed<br>DO = Depot/Parking Out shed<br>TS = Trip Start<br>TE = Trip End | NR |
| Packet Status | L=Live or H= History | L |
| IMEI | Identified of the sending unit. 15 digit standard unique IMEI no. | 123456789012345 |
| Vehicle Reg. No | Mapped vehicle registration number | DL1PC9821 |
| GPS Fix | 1 = GPS fix OR 0 = GPS invalid | 1 |
| Date | Date value as per GPS date time (ddmmyy) | 220714 |

| Field | Description | Sample Data |
|---|---|---|
| Time | Time value as per GPS date time in UTC format (hhmmss) | 050656 |
| Latitude | Latitude value in decimal degrees (with minimum 6 decimal places) | 28.758963 |
| Latitude Dir. | Latitude Direction.<br>Example N=North, S= South | N |
| Longitude | Longitude value in decimal degrees (with minimum 6 decimal places) | 77.6277844 |
| Longitude Dir. | Longitude Direction.<br>Example E=East, W= West | W |
| Speed | Speed in km/hr. (Upto One Decimal Value) | 25.1 |
| Heading | Course over ground in degrees | 310.56 |
| No of Satellites | Number of satellites used for fix | 8 |
| Altitude | Altitude of the device in meters | 183.5 |
| PDOP | Positional dilution of precision (Upto 2 digit) | 2 |
| HDOP | Horizontal dilution of precision (Upto 2 digit) | 3 |
| Distance | Distance Travelled in Meters (Between Current and the Previous packet) | 100 |
| ODO | Total Distance Travelled in Km (from activation of unit to till last packet) .(Upto One Decimal Value) | 25.8 |
| Min Speed | Minimum Speed travelled by vehicle between last and the current packet in Km/h (Upto One decimal value) | 2.0 |
| Avg Speed | Average Speed between last and the current packet in Km/h (Upto One decimal value) | 5.0 |
| Max Speed | Maximum Speed travelled by vehicle between last and the current packet in Km/h (Upto One decimal value) | 10.5 |
| Network Operator Name | Name of Network Operator | INA Airtel |
| Ignition | 1= Ignition On , 0 = Ignition Off | 1 |
| Main Power Status | 0 = Vehicle Battery Disconnected<br>1= Vehicle Battery Reconnected | 1 |
| Main Input Voltage | Indicator showing source voltage in Volts .(Upto One Decimal Value) | 12.5 |
| Internal Battery Voltage | Indicator for Level of battery charge remaining. (Upto One Decimal Value) | 4.2 |
| Emergency Status | 1= On , 0 = Off | 0 |
| Tamper Alert | C = Cover Closed ,<br>O = Cover Open | C |

| Field | Description | Sample Data |
|---|---|---|
| GSM Signal Strength | Value Ranging from 0 – 31 | 25 |
| MCC | Mobile Country Code | 404 |
| MNC | Mobile Network Code | 10 |
| LAC | Location Area Code | 00D6 |
| Cell ID | GSM Cell ID | CFBD |
| NMR (neighboring Cell ID) | Neighbouring 4 cell ID along with their LAC | |
| Digital Input Status | 4 external digital input status (Status of Input 1 to Input 3 (0=Off; 1=On) | 000 |
| Digital Output Status | 2 external digital output status (0=Off; 1=On) | 01 |
| Vehicle Status | H = Hired ,<br>A = Available ,<br>R = Retired / Off Duty | H |
| Trip Start | Trip start time integrated with meter switch | 050620 |
| Trip End | Trip End time integrated with meter switch | 053020 |
| Trip ID | Unique ID for each trip | 06 |
| Trip Duration | Duration of the Trip in minutes | 30 |
| Trip Distance | Km's covered during the Trip in Km .(Upto One Decimal Value) | 18.5 |
| Trip Fare | Total amount payable for the trip .(Upto One Decimal Value) | 56.0 |
| Geofence Stop ID | Identify the particular stop, Default = 0 | U001 |
| Frame Number | Sequence Number of the messages (000001 to 999999) | 000005 |
| Checksum | Insures No error in transmission (optional) | 16 |
| End Character | Indicated End of the frame | * |

**Recommendation**: It is recommended that the Type 4 tracking devices support minimum fields as mentioned above. Individual devices can send more data fields than the ones listed above.

The Type 4 device should be able to support different frequency of sending the data frames, in the following states:

- Ignition OFF
- Emergency (Emergency state would supersede every other state)
- Ignition ON
- Trip ON state

## 3.3 Alerts from Devices

Table 3-3 contains the listing of alerts that need to come from the tracking devices. These alerts are applicable for both live packets as well as the history packets.

**Table 3-3: Alerts Supported for the Devices for Vehicle Tracking**

| Sl. No. | Message | Type 3 | Type 4 | Remarks |
|---|---|---|---|---|
| 1 | Location Update | ✓ | ✓ | Default message coming from each device |
| 2 | Location Update (history) | ✓ | ✓ | Would be sent, if GPRS is not available at the time of sending the message |
| 3 | Alert – Disconnect from main battery | ✓ | ✓ | If device is disconnected from vehicle battery and running on its internal battery |
| 4 | Alert – Low battery | ✓ | ✓ | If device internal battery had fallen below a defined threshold, indicating that device need to get a recharge |
| 5 | Alert – Low battery removed | ✓ | ✓ | Indicate that vehicle internal battery is charged again |
| 6 | Alert – Connect back to main battery | ✓ | ✓ | Indicate that vehicle is connected back to main battery |
| 7 | Alert – Ignition ON | ✓ | ✓ | Indicates that Vehicle has started (ignition ON) |
| 8 | Alert – Ignition OFF | ✓ | ✓ | Indicates that Vehicle has stopped (ignition OFF) |
| 9 | Alert – SIM removed or tampered | ✓ | ✓ | Message would be generated indicating SIM is removed or tampered |
| 10 | Alert – SIM inserted or tampered | ✓ | ✓ | Message would be generated indicating SIM is inserted or tampered |
| 11 | Alert – GPS box opened | ✓ | ✓ | Message would be generated indicating GPS box opened |
| 12 | Alert – Emergency state ON | ✓ | ✓ | When any of the emergency button is pressed by any passenger. System should also provide location of emergency button which is pressed. |
| 13 | Alert – emergency State OFF | ✓ | ✓ | When emergency state of vehicle is removed |

| Sl. No. | Message | Type 3 | Type 4 | Remarks |
|---|---|---|---|---|
| 14 | Trip Start | X | ✓ | Only for hired mode vehicle, when Fare meter is 'Down' |
| 15 | Trip End | X | ✓ | Only for hired vehicle, when fare meter is 'Up' |
| 16 | Alert – Geofence Entry | ✓ | ✓ | Triggered when geofence entry happened |
| 17 | Alert – Geofence exit | ✓ | ✓ | Triggered when geofence exit happened. |
| 18 | Over the air parameter change | ✓ | ✓ | Should support the change of configuration parameters from backend by sending a command |
| 19 | Over the air change of tariff fare | X | ✓ | Changing of fare parameters, night time rates, waiting period rate, minimum fixed rate. |

## 3.4 Configuration of Device Parameters Over the Air (OTA)

The device parameters as shown in Table 3-4 should be configurable over the air (through SMS or GPRS) for the Type 3 and Type 4 devices.

Configurable commands must involve the following features:

- SET: For setting the parameters.
- GET: For enquiring regarding the parameters such as mobile number, gsm strength, vehicle number and other important parameters.
- CLR: For clearing certain commands, alarms, alerts etc.

**Table 3-4: Configurable Parameters for Type 3 and Type 4 Devices**

| Sl. No. | Parameter Description | Type 3 | Type 4 |
|---|---|---|---|
| 1 | Change of the APN | Y | Y |
| 2 | Change of IP and port number | Y | Y |
| 3 | Setting of the Primary or Secondary IP | Y | Y |
| 4 | Configuring the Vehicle registration number | Y | Y |
| 5 | Configuring the frequency of data transmission in Ignition ON / OFF, Emergency state | Y | Y |
| 6 | Configuring the time duration for Emergency state | Y | Y |
| 7 | Configuring the frequency of data update in Trip ON | | Y |
| 8 | Capability to reset the device | Y | Y |

| Sl. No. | Parameter Description | Type 3 | Type 4 |
|---|---|---|---|
| 9 | Capability to create a geo fence, or increasing the number of geo fences which can be configured | Y | Y |
| 10 | Command to get the IMEI of the device | Y | Y |

## 3.5 SMS Fall back

The SMS mode of data transmission as backup would be followed, in case of emergency state (if the device is in emergency state) since SMS has the limitation of sending only 160 characters, so LU (location update) message, to be send in SMS, would have following fields: IMEI, Lat, Direction, Long, Direction, GPS fix, speed, Cell ID, LAC, Date, Time.

## 3.6 Tracking Device Health Monitoring Parameters

The device should send status of health parameters at configurable interval and this threshold value should also be configurable over the air. It should be possible for health parameters to be fetched on demand via command as set out in Table 3-5.

**Table 3-5: Health Packet Frame Format**

| Sl. No. | Field | Description | Type 3 | Type 4 |
|---|---|---|---|---|
| 1 | Start Character | $ | ✓ | ✓ |
| 2 | Header | The header of the packet/ identifier | ✓ | ✓ |
| 3 | Vendor ID | Vendor identification header | ✓ | ✓ |
| 4 | Firmware Version | Version details of the Firmware used in EX.1.0.0 | ✓ | ✓ |
| 5 | IMEI | Identified of the sending unit. 15 digit standard unique IMEI no. | ✓ | ✓ |
| 6 | Battery percentage | Indicates the internal battery percentage | ✓ | ✓ |
| 7 | Low battery threshold value | Indicates value on which low battery alert generated | ✓ | ✓ |
| 8 | Memory percentage | Indicates flash memory used | ✓ | ✓ |
| 9 | Data update rate when ignition ON | Indicates Packet frequency on ignition ON | ✓ | ✓ |
| 10 | Data update rate when ignition OFF | Indicates Packet frequency on ignition OFF | ✓ | ✓ |
| 11 | Digital I/o status | Inputs connected to the | ✓ | ✓ |

| Sl. No. | Field | Description | Type 3 | Type 4 |
|---|---|---|---|---|
| | | device. | | |
| 12 | Analog I/o status | Analog input status | ✓ | ✓ |
| | EFM LED working | LED health status | X | ✓ |
| | Printer Working | Printer status | X | ✓ |
| | Printer paper present or not | Optional, to be made available if possible | X | ✓ |
| 13 | End character | * | ✓ | ✓ |

# 4.0 TRACKING DEVICE TESTING

## 4.1 Introduction

The vehicle tracking devices are expected to work in a challenging automotive environment of dust, vibration, heat etc. The following sections provide the details of recommended key tests that the device models need to be subjected to in order to get assurance on their performance characteristics. The final set of tests and related details would be provided as part of the device empanelment document.

## 4.2 Functional Testing

Functional testing will be carried out to assess the performance of the tracking device on important functional aspects as below:

### A. Location Accuracy Test

Location accuracy signifies the ability of tracking device to accomplish a location data relative to the true position. The various types of location accuracy tests to be performed on the device are as follows:

i. ***Relative Location Accuracy test*** compares the variation between multiple location data obtained by the device under the cold/warm/hot start mode while the device remains at the same location.

***Acceptance Criteria:*** 2.5 m CEP or 6 m 2DRMS

ii. ***Absolute Location Accuracy test*** compares the location data obtained by the device under cold/warm/hot mode while the device remains at the same location with known true position.

***Acceptance Criteria:*** 2.5 m CEP or 6 m 2DRMS

iii. ***Moving or Dynamic Location Accuracy test*** compares the variation between the location data obtained by the device with the true positions at multiple locations along a test path.

***Acceptance Criteria:*** 2.5 m CEP or 6 m 2DRMS

### B. Cold-Start Time to First Fix (TTFF) Test

This test is used to determine the time taken for first fix during a cold start of the device. The device in this test is placed into a cold start state. The time it takes for the device to determine its first good location fix is recorded. The cold start test is performed several times and the results are averaged.

***Acceptance Criteria:*** Should be less than 40 seconds

### C. Warm-Start Time to First Fix Test

This test is used to determine the time taken for first fix during a warm start of the device. In this test the device is started in warm start mode and time taken by

device to determine the first valid location fix is recorded. This is done several times and results are averaged.

***Acceptance Criteria:*** The warm start TTFF should be less than 20 seconds.

**D. Hot-Start Time to First Fix Test**

This test is used to determine the time taken for first fix during a hot start of the device. In this test the device is started in Hot start mode and time taken by device to determine the first valid location fix is recorded. This test is performed several times and results are averaged.

***Acceptance Criteria:*** The hot start TTFF should be less than 5 seconds.

**E. Acquisition Sensitivity Test**

Acquisition sensitivity refers to the minimum signal level at which the device is able to successfully perform a cold start TTFF. The acquisition sensitivity test is a simulated signal test. A device cold start is performed, and the time to acquisition is measured. Signal levels are then progressively decreased until the device can no longer acquire the location. This signal strength is recorded.

***Acceptance Criteria:*** The acquisition sensitivity should be better than (-)160 dBm.

**F. Tracking Sensitivity Test**

Tracking sensitivity refers to the minimum signal level at which the device is able to successfully maintain the location fix. The acquisition sensitivity test is a simulated signal test.

The device under this test is locked on to the simulator's output frequency and the simulator power output is lowered until the lock is lost. Multiple repetition of the test with different satellite geometries ensures that an accurate average measure is recorded.

***Acceptance Criteria:*** The tracking sensitivity should be better than (-)165 dBm.

**G. Interference Testing**

Interference is a common problem affecting GNSS based devices. Interference can come from various sources such as intentional jamming/spoofing etc.

Interference testing is a type of test, in which Cold Start/Hot Start test are performed with device exposed to interfering signals and the performance os recorded.

***Acceptance Criteria:*** The Interference should not result in any degradation of the Cold Start/Hot Start TTFF times. In addition, it should not result in any degradation of the absolute location accuracy required and the same should be 2.5 m CEP or 6 m 2DRMS.

**H. Multipath Testing**

This test is a simulated frequency test conducted to determine the effect of multipath signals. The signal from a single satellite is simulated to arrive at the device via two or more paths. One path is typically a direct path, and other paths are typically a reflection of the same signal from building or structure.

***Acceptance Criteria:*** The multipath should not result in any degradation of the Cold Start/Hot Start TTFF times. In addition, it should not result in any degradation of the absolute location accuracy required and the same should be 2.5 m CEP or 6 m 2DRMS.

## 4.3 Performance and Durability Testing

The devices will need to be tested for performance in the challenging vehicle environments of vibration, dust, fluctuating power supply etc.

### 4.3.1 Vibration Test

The devices in vehicles are subjected to a harsh environment in terms of vibrations and that too for extended period of time. Two tests are recommended based on the nature of application environment.

**Shock**: Shock test is performed to provide a degree of confidence that the device can physically and functionally withstand the relatively infrequent, non-repetitive shocks encountered in transportation environments. This test provides an assessment of the effect of the shocks on the performance of the device. The test shall be performed as per MIL-STD-810 F Method 516.5 or equivalent.

***Acceptance Criteria***: Device after the shock test shall meet the the requirements of functional tests.

**Vibration**: This test is performed to check that the device the device can physically and functionally withstand the vibration exposures in the life cycle typically encountered in a vehicular environment. The test shall be performed as per MIL-STD-810F Method 514.5 or equivalent.

***Acceptance Criteria***: Device after the vibration test shall meet the the requirements of functional tests.

### 4.3.2 Ingress Protection (IP)

The vehicle tracking devices must be able to work in dusty environment that are typically encountered by the public transport vehicles where these would be installed. IP rating (IS/IEG 60529) is used for specifying the environmental protection characteristics of the tracking device. The device will be tested for dust and water ingress according to IP 65 test specification.

- ***Acceptance Criteria***: The device should be IP 65 compliant or better.

### 4.3.3 EMI /EMC

The Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) tests are performed to assess whether the device performs its intended functions in the electromagnetic environment to which it would be exposed. Further, the device should not generate electromagnetic disturbances that may influence other equipment in the vicinity.

Note: In case the device is 'e' marked as per The Automotive Electromagnetic Compatibility Directive (AEMCD) and a detailed test report is submitted (which includes above tests), no fresh testing would be required.

***Acceptance Criteria***: The device should meet the EMI/EMC requirements as per AIS 004 (Part 3) or equivalent.

### 4.3.4 Power Rating and Parameters Testing

Table 4-1 shows the power rating and applicable parameters:

**Table 4-1: Power Rating and Its Parameters**

| Rated Power | Type 3 Device | Type 4 Device |
|---|---|---|
| Idle Current Consumption | <120 mA | <300 mA |

### 4.3.5 Battery Backup Test

Battery backup is the amount of time that the device battery can support sending the data without being connected to the power source.

This test will be performed by disconnecting the input charging voltage to the device. On disconnecting the external supply, battery would use its charge capacity to send data through GPRS. Time duration between external power disconnect to the last data packet time denotes the battery backup time.

- ***Acceptance Criteria***: Device should be able to work in active mode for a period of 4 hours or more.

### 4.3.6 High voltage/ Current Test

The device shall operate under the automotive environment of fluctuating voltage and high current. The test shall be carried out as per ISO 7637 to assess the device performance under such conditions.

- ***Acceptance Criteria***: The device should be able to withstand the simulated test volt and current levels to which it will be exposed during the test without degradation in performance.

### 4.3.7 Reverse Polarity Protection without Fuse

The device must fulfil the functional requirements after being subjected to reverse polarity based on the input voltage rating of the device.

- ***Acceptance Criteria***: Device shall meet the requirements of functional tests, after the reverse polarity test.

### 4.3.8 Test for Wiring Harness

Flammability Test: The wiring harness used in the device should be tested for flammability as per IS 2465.

Electrical Properties: The wiring harness used in the device should be tested for electrical properties as per AIS 028.

## 4.4 Environmental Test

The following testing should be carried out as part of environmental testing:

### 4.4.1 High Temperature Test

The high temperature test is used to evaluate effects of high temperature conditions on safety, integrity, and performance of the device. The test shall be carried out in accordance with Indian Standard IS: 9000 (Part 3/Sec 5) or MIL-STD-810 F Method 501.4. The device shall be subjected to the high temperature test conditions as per device specification of + 85°C/ + 70°C, as applicable.

- ***Acceptance Criteria***: Device during and after the high temperature test shall meet the requirements of functional tests.

### 4.4.2 Cold Test

The temperature testing is used to evaluate effects of low temperature conditions during storage and operation affect device safety, integrity and performance. The test shall be carried out in accordance with Indian Standard (IS): 9000 (Part 2/Sec 4) or MIL-STD-810 F Method 502.4. The device shall be subjected to low temperature conditions as per device specification of (-)20°C.

- ***Acceptance Criteria***: Device during and after the cold test shall meet the the requirements of functional tests.

### 4.4.3 Damp Heat Test

The temperature and humidity conditions change based on geographical locations and time. The purpose of this test is to determine the effects of a warm, humid atmosphere on the device performance. The device should be tested according to IS 9000 (Part 5/Sec 2) or MIL-STD-810F Method 507.4 as per the device specification of 95% Humidity.

- ***Acceptance Criteria***: Device during and after the test shall meet the requirements of functional tests.

### 4.4.4 Temperature Shock:

Temperature shock test is carried out to determine if the device can withstand sudden changes in the temperature of the surrounding atmosphere without

experiencing physical damage or deterioration in performance. The device shall be tested as per MIL-STD-810 F Method 503.4 or equivalent.

- ***Acceptance Criteria***: Device after the test shall meet the requirements of functional tests.

### 4.4.5 Salt Spray Test

The salt spray test is conducted to check corrosion resistance of device. Salt spray test is an accelerated corrosion test that produces a corrosive attack on the device sample. The device shall be tested as per AIS: 012/ IS10250.

- ***Acceptance Criteria***: Device after the test shall meet the requirements of functional tests.

## 4.5 Protocol Testing

Protocol is a set of rules to be followed by the device while sending data to the backend. The protocol comprises data update rate, number of fields, start character, end character, alert type etc. (Table 4-2)

Protocol testing involves checking the compliance of data sets received by the backend against the protocol both with respect to the data fields as well the format. It is expected that the data coming to a central server should be exactly as required under the protocol.

**Table 4-2: Protocol Testing Validation Process**

| Field | Description | Validation Process |
|---|---|---|
| Start Character | $ | |
| Header | The header of the packet/ identifier | |
| Vendor ID | Vendor identification header | |
| Firmware Version | Version details of the Firmware used in EX.1.0.0 | |
| Packet Type | Specify the packet type –<br><br>NR = Normal<br>EA = Emergency Alert<br>TA = Tamper Alert<br>HP = Health Packet<br>IN = Ignition On<br>IF = Ignition Off<br>BD = Battery Disconnect<br>BR = Battery Reconnect<br>BL = Battery Low<br>GE = Geofence Entry / Bus Stop entry<br>GX = Geofence Exit / Bus Stop Exit<br>DI = Depot In shed<br>DO = Depot Out shed<br>TS = Trip Start<br>TE = Trip End | To be demonstrated by manufacturer/ supplier and to be tested. |

| Field | Description | Validation Process |
|---|---|---|
| Packet Status | L=Live or H= History | To be tested. |
| IMEI | Identified of the sending unit. 15 digit standard unique IMEI no. | To be tested. |
| Vehicle Reg. No | Mapped vehicle registration number | To be tested. |
| GPS Fix | 1 = GPS fix OR 0 = GPS invalid | To be tested. |
| Date | Date value as per GPS date time (ddmmyy) | To be tested. |
| Time | Time value as per GPS date time in UTC format (hhmmss) | To be tested. |
| Latitude | Latitude value in decimal degrees (with minimum 6 decimal places) | To be tested. |
| Latitude Dir. | Latitude Direction.<br>Example N=North, S= South | To be tested. |
| Longitude | Longitude value in decimal degrees (with minimum 6 decimal places) | To be tested. |
| Longitude Dir. | Longitude Direction.<br>Example E=East, W= West | To be tested. |
| Speed | Speed in km/hr | To be tested. |
| Heading | Course over ground in degrees | To be tested. |
| No of Satellites | Number of satellites used for fix | To be tested. |
| Altitude | Altitude of the device in meters | To be tested. |
| PDOP | Positional dilution of precision | To be tested. |
| Distance | Distance Travelled in Meters (Between Current and the Previous packet) | To be tested. |
| ODO | Total Distance Travelled in Km (from activation of unit to till last packet) | To be demonstrated by manufacturer/ supplier and to be tested. |
| Min Speed | Minimum Speed travelled by vehicle between last and the current packet in Km/h (in decimal value) | To be demonstrated by manufacturer/ supplier and to be tested. |
| Avg. Speed | Average Speed between last and the current packet in Km/h (in decimal value) | To be demonstrated by manufacturer/ supplier and to be tested. |
| Max Speed | Maximum Speed travelled by vehicle between last and the current packet in Km/h (in decimal value) | To be demonstrated by manufacturer/ supplier and to be tested. |
| Network Operator Name | Name of Network Operator. | To be tested. |
| Ignition | 1= Ign On , 0 = Ign Off | To be demonstrated by manufacturer/ supplier and to be tested. |
| Main Power Status | 0 = Vehicle Battery Disconnected<br>1= Vehicle Battery Reconnected | To be demonstrated by manufacturer/ supplier and to be tested. |
| Main Input Voltage | Indicator showing source voltage in Volts. | To be demonstrated by manufacturer/ supplier and |

| Field | Description | Validation Process |
|---|---|---|
| | | to be tested. |
| Internal Battery Voltage | Indicator for Level of battery charge remaining | To be demonstrated by manufacturer/ supplier and to be tested by SI or empanelment authority. |
| Emergency Status | 1= On , 0 = Off | To be demonstrated by manufacturer/ supplier and to be tested. |
| Tamper Alert | C = Cover Closed , O = Cover Open | To be demonstrated by manufacturer/ supplier and to be tested. |
| GSM Signal Strength | Value Ranging from 0 – 31 | To be tested. |
| MCC | Mobile Country Code | To be tested. |
| MNC | Mobile Network Code | To be tested. |
| LAC | Location Area Code | To be tested. |
| Cell ID | GSM Cell ID | To be tested. |
| NMR (neighboring Cell ID) | Neighbouring 4 cell ID along with their LAC | To be tested. |
| Digital Input Status | 4 external digital input status (Status of Input 1 to Input 3 (0=Off; 1=On)) | To be demonstrated by manufacturer/ supplier and to be tested. |
| Digital Output Status | 2 external digital output status (0=Off; 1=On) | To be demonstrated by manufacturer/ supplier and to be tested. |
| Vehicle Status | H = Hired ,<br>A = Available ,<br>R = Retired / Off Duty | To be demonstrated by manufacturer/ supplier and to be tested. |
| Trip Start | Trip start time integrated with meter switch | To be demonstrated by manufacturer/ supplier and to be tested. |
| Trip End | Trip End time integrated with meter switch | To be demonstrated by manufacturer/ supplier and to be tested. |
| Trip ID | Unique ID for each trip | To be tested. |
| Trip Duration | Duration of the Trip in minutes | To be tested. |
| Trip Distance | Km's covered during the Trip in Km | To be demonstrated by manufacturer/ supplier and to be tested. |
| Trip Fare | Total amount payable for the trip | To be tested. |
| Geofence Stop ID | Identify the particular stop,<br>Default = 0 | To be tested. |
| Frame Number | Sequence Number of the messages (000001 to 999999) | To be tested. |
| Checksum | Insures No error in transmission (optional) | To be tested. |

| Field | Description | Validation Process |
|---|---|---|
| End Character | Indicated End of the frame | * |

The following tests would be performed along with the protocol testing of the device:

**A. Memory Storage**

The device should support 40000 or more positional logs. This is a functional test and the device will be simulated to be in non –GPRS coverage area and the logs will be maintained. The capacity of logging will be checked by monitoring the logs on the device.

**B. Geofencing**

The device should support over 3000 geofences as per the device specification.

# 5.0 REFERENCES

The following is a list of documents that have been used in the preparation of this report.

- MoRTH approval note on the project
- MoRTH scheme for the project
- Concept Report for the Project
- Technology Analysis Report for the Project
- Urban Bus Specifications – II, Ministry of Urban Development, Government of India (MoUD)
- Tender documents: Delhi Transport Corporation (DTC), Bangalore Metropolitan Transport Corporation (BMTC), Himachal Road Transport Corporation (HRTC), Karnataka State Road Transport Corporation (KSRTC), Municipal Corporation of Greater Mumbai.

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MINISTRY OF ROAD TRANSPORT AND HIGHWAYS
GOVERNMENT OF INDIA

## Detailed Specifications Document For CCTV Devices



# NATIONAL LEVEL VEHICLE SECURITY AND TRACKING SYSTEM

March 2015

# NATIONAL LEVEL VEHICLE SECURITY AND TRACKING SYSTEM

# DETAILED SPECIFICATIONS DOCUMENT FOR CCTV DEVICES

**4th March 2015**

**Prepared by**

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# Abbreviations

| Acronym | Definition/Description |
|---|---|
| AGC | Auto Gain Control |
| AGPS | Assisted Global Positioning System |
| AIS | Automotive Industry Standards |
| APN | Access Point Name |
| ASCII | American Standard Code for Information Interchange |
| ATW | Auto Tracking White Balance |
| BLC | Back Light Compensation |
| BMTC | Bangalore Metropolitan Transport Corporation |
| C | Celsius |
| CCD | Charge Coupled Device |
| CCTV | Closed Circuit Television |
| CDMA | Code Division Multiple Access |
| CEP | Circular Error Probability |
| CIF | Common Intermediate Format |
| CMOS | Complementary Metal Oxide Semi-conductor |
| DIMTS | Delhi Integrated Multi-Modal Transit System Limited |
| DRMS | Distance Root Mean Square |
| DTC | Delhi Transport Corporation |
| DVR | Digital Video Recorder |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| FPS | Frames Per Second |
| GB | Giga Byte |
| GoI | Government of India |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning System |
| GSM | Global System for Mobile Communications |
| HDD | Hard Disk Drive |
| HTTP | Hypertext Transfer Protocol |
| Hz | Hertz |
| IMEI | International Mobile Equipment Identity |
| IP | Internet Protocol |
| IP | Ingress Protection |
| IR | Infrared |
| LAC | Location Area Code |

| Acronym | Definition/Description |
|---|---|
| LAN | Local Area Network |
| LED | Light Emitting Diode |
| mDVR | Mobile Digital Video Recorder |
| M-JPEG | Motion - Joint Photographic Experts Group |
| mNVR | Mobile Network Video Recorder |
| MoF | Ministry of Finance, GoI |
| MoRTH | Ministry of Road Transport and Highways, GoI |
| MoUD | Ministry of Urban Development, GoI |
| MPEG | Moving Picture Experts Group |
| NC | Normally Close |
| NMR | Network Management Report |
| NO | Normally Open |
| NTSC | National Television System Committee |
| NVR | Network Video Recorder |
| ONVIF | Open Network Video Interface Forum |
| OSD | On Screen Display |
| PAL | Phase Alternating Line |
| PMPML | Pune Mahanagar Parivahan Mandal Ltd. |
| PoE | Power-over-Ethernet |
| RH | Relative Humidity |
| RSSI | Received Signal Strength Indicator |
| RTC | Real Time Clock |
| SATA | Serial Advanced Technology Attachment |
| SIM | Subscriber identity module |
| SMS | Short Message Service |
| SSD | Solid State Drive |
| TB | Terra Byte |
| TCP | Transmission Control Protocol |
| TTFF | Time To First Fix |
| TVL | Television Lines |
| URL | Universal Resource Locator |
| USB | Universal Serial Bus |
| WDR | Wide Dynamic Range |

# 1.0 INTRODUCTION

## 1.1 Project Background

The Ministry of Finance (MoF), Government of India (GoI) has set up a dedicated fund called the "Nirbhaya Fund" for implementation of initiatives aimed at enhancing the safety and security for women in the country. The proposals formulated by various Ministries/Departments aimed at enhancing the safety and security of women in the country are proposed to be funded through the Nirbhaya Fund, being administered by Ministry of Finance.

The Ministry of Road Transport and Highways (MoRTH), Government of India has proposed to implement a scheme for Security for Women in Public Road Transport in the Country which is envisaged to be funded from the Nirbhaya Fund. The said MoRTH proposal has been approved by the Government of India. The scheme to set up the National Level Vehicle Security and Tracking System has the following components proposed:

- A National Backend Data Centre
- City Command and Control Centre in 32 cities in India having population of more than one million. The architecture can be up-scaled to include more towns.
- Installation of GPS, Emergency buttons and CCTV (in buses only) in specified public transport vehicles in the above cities.

## 1.2 Report Context

MoRTH has engaged Delhi Integrated Multi Modal Transit System Limited (DIMTS) to support MoRTH in formulating and implementing the scheme “Security for Women in Public Road Transport in the Country”. As a part of this engagement, this detailed specification document for CCTV On-Board Devices, which would be required to be installed in vehicles under this scheme, has been prepared for MoRTH

## 1.3 Report Structure

Chapter 1.0 provides the project background, report context and structure.

Chapter 2.0 outlines the types of various CCTV Devices, categorization of CCTV Devices based on technology and vehicle size and various components of CCTV devices.

Chapter 3.0 covers the details regarding the Analog CCTV Devices including Analog CCTV Cameras, Mobile Digital Video Recorders and Emergency Buttons.

Chapter 4.0 covers the details regarding the IP CCTV Devices including IP CCTV Cameras, Mobile Network Video Recorders and Emergency Buttons.

Chapter 5.0 provides details of recommended communication protocol between CCTV On-board Devices and backend server including data from CCTV Devices to the backend and data from backend to CCTV Devices.

Chapter 6.0 covers the details of testing recommended for various CCTV On-board Devices.

Chapter 7.0 provides a listing of references used in preparing this report.

# 2.0 CCTV ON-BOARD DEVICES – TYPES AND COMPONENTS

## 2.1 Overview

The National Level Vehicle Security and Tracking System envisages installation of vehicle tracking device, CCTV system and emergency buttons in passenger road transport vehicles, as per the details provided in Table 2-1.

**Table 2-1: On-board Devices Types**

| Device Type | Device Description | Applicable for Vehicles |
|---|---|---|
| Type 1 | CCTV system with in-built tracking system and emergency button system | 23 passengers and above (excl. driver) |
| Type 2 | CCTV system with in-built emergency button system | 23 passengers and above (excl. driver) |
| Type 3 | Vehicle tracking device with in-built emergency button system | Can be used in all vehicles |
| Type 4 | Vehicle tracking device with in-built emergency button system and fare meter | Auto rickshaws and Taxis |

As per the above details, vehicle tracking device and emergency buttons will be installed in all passenger road transport vehicles whereas CCTV system will be installed in vehicles having seating capacity for 23 or above passengers (excluding driver).

The detailed specifications and other related aspects for Type 1 and Type 2 devices are covered in this document. The specifications and other related aspects for Type 3 and Type 4 devices have been dealt in a separate document titled 'Detailed Specifications Document for Vehicle Tracking Device' prepared for the Scheme.

In case of Type 1 CCTV System device, which has in-built vehicle tracking system, the vehicle tracking requirements will be governed by the specifications as mentioned in the aforesaid document.

In cases where Type 2 CCTV System device is opted, a separate Vehicle Tracking Device will be required to be fitted in the vehicle to meet the tracking related requirements of the Scheme. In this case, the emergency buttons in the vehicle will be part of the CCTV System devices but they will integrate with Vehicle Tracking Device also, in order to provide input to the Vehicle Tracking Device in case of pressing of any of the emergency button to enable the Vehicle Tracking Device to send the alert information to the backend. Other than the above, the CCTV System devices (cameras or DVR/NVR) will not be integrated with the Vehicle Tracking Device in the vehicle. The feeds from vehicle Tracking Device related to vehicle location and emergency alert will be integrated with the feeds from the CCTV System related to images and health status of CCTV System devices in the backend, based on vehicle registration number.

There will be a number of options for CCTV On-board devices depending upon the technology and size of vehicle. Different configurations of the CCTV System devices and categorisation of devices based on technology and size of the vehicle are explained in the following sections.

## 2.2 Categorisation of CCTV On-Board Devices Based on Technology

There are following two types of CCTV Systems based on underlying technology of transfer of images from camera to external recorder:

- Analog CCTV System
- IP CCTV System

In the Analog CCTV System, the images are transferred from analog cameras to a video recorder in analog form, whereas in IP CCTV System, the images are transferred from IP cameras to a video recorder in digital form. This report covers both Analog as well as IP CCTV Systems, so that both options are available.

## 2.3 Categorisation of CCTV On-Board Devices Based on Vehicle Size

The number of CCTV cameras in different types of buses will depend upon the following factors:

- Number of doors
- Length of the bus
- Seating layout and interior design of the bus

The guiding principles for the number of cameras and their layout in buses will be as follows:

- All the passenger doors of the bus should be adequately covered by CCTV cameras in a way that image of each passenger boarding the bus is captured.
- The overall length of the bus is suitably covered by CCTV cameras in a way that any incident happening in the bus is adequately covered.

Based on the above guiding principles, the number of CCTV cameras in buses up to 12 meter length (midi buses and standard buses) will be up to 4, whereas in larger capacity buses (double-decker buses and articulated buses), the number of cameras in a bus will be more than 4.

Based on the number of cameras viz. up to four cameras or more than four cameras, there will be following two types of video recorders in the buses:

- Video recorders with 4 video channels
- Video recorders with 8 video channels

The detailed specifications for both types of video recorders are detailed in the later chapters. Separate specifications have been provided for these devices in respect of the parameters and elements where there is difference in requirements. For the

remaining parameters and elements, a common set of specifications are applicable for both type of video recorders.

## 2.4 Components of CCTV System

The on-board CCTV System will comprise various devices such as video recorder with or without in-built vehicle tracking module, CCTV cameras and emergency buttons. The specifications of these devices will vary depending upon the type of CCTV System device and technology of CCTV System. Different devices which will become part of the CCTV System are listed in Table 2-2.

**Table 2-2: Components of CCTV System**

| Device Type | Analog CCTV System | IP CCTV System |
|---|---|---|
| Type 1 | • Mobile Digital Video Recorder (mDVR) with in-built Vehicle Tracking Module<br>• Analog CCTV Cameras<br>• Emergency Buttons | • Mobile Network Video Recorder (mNVR) with in-built Vehicle Tracking Module<br>• IP CCTV Cameras<br>• Emergency Buttons |
| Type 2 | • Mobile Digital Video Recorder (mDVR)<br>• Analog CCTV Cameras<br>• Emergency Buttons | • Mobile Network Video Recorder (mNVR)<br>• IP CCTV Cameras<br>• Emergency Buttons |

The detailed specifications and features of the above devices are explained in the subsequent chapters of the document.

# 3.0 ANALOG CCTV ON-BOARD DEVICES

## 3.1 Overview

The Analog CCTV system will comprise the following devices:

- Analog CCTV Cameras
- Mobile Digital Video Recorder (mDVR)
- Emergency Buttons

The detailed specifications of the above devices are provided in subsequent sections in this chapter.

## 3.2 Analog CCTV Cameras

### 3.2.1 Focal Length

The focal length of the lens of the CCTV camera is one of the most important parameters to determine the field of view of the camera. Focal length of lens of the CCTV camera directly impacts the angle of view of the CCTV camera. Focal length of the lens of the camera is measured in mm. Short focal length cameras have wide angles of view and long focal lengths cameras have narrow angles of view.

The focal length of the CCTV camera can be fixed or variable. In case of variable focal length cameras, the focal length can be varied manually in case of Vari-focal CCTV cameras or it can be varied electrically in case of Zoom cameras. The variable focal length cameras are used mostly in case of PTZ (pan, tilt, zoom) cameras, where large area is required to be monitored through a single camera, often in real-time.

The focal length for fixed CCTV cameras generally varies from 2.8 mm to 100 mm. The common focal lengths for fixed CCTV cameras are 2.8 mm, 3.6 mm, 6 mm, 10 mm, 16 mm etc. For a typical 1/3” CCD, a CCTV camera with lens of 3.6 mm focal length will have about 72 degree horizontal field of view, whereas a CCTV camera with lens of 16 mm focal length will have only about 15 degree horizontal field of view. It is important to use an optimum focal length of the lens for CCTV camera to meet the desired objectives.

The focal length of CCTV camera lens specified by various organizations for surveillance projects in their buses are given in Table 3-1.

**Table 3-1: Lens Focal Length Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | Lens |
|---|---|---|---|
| 1 | Haryana Roadways (Gurgaon and Faridabad) | Oct 2014 | Fixed Lens 3.6 mm |
| 2 | Delhi Transport Corporation | Jan 2014 | 3.6 mm |

| Sl. No. | Name of Organization | Year | Lens |
|---|---|---|---|
| | (DTC) | | |
| 3 | Urban Bus Specifications - II, (JnNURM), Ministry of Urban Development (MoUD) | May 2013 | Fixed Lens 3.6 mm |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 3.6 mm (2.8 mm, 6 mm optional) |
| 5 | Bangalore Municipal Transport Corporation (BMTC), Bangalore | Mar 2013 | Fixed Lens 3.6 mm |

Analog CCTV cameras with fixed lens with focal length of 3.6 mm are recommended for the current project.

### 3.2.2 Resolution

In case of Analog cameras, the image resolution is measured in terms of TV Lines or TVL, which denotes the horizontal resolution of the image. The resolution of Analog cameras mostly varies between 420 and 700 TV Lines. TVL is defined as the maximum number of alternating light and dark lines that can be resolved. A resolution of 400 TVL means that 200 distinct dark lines and 200 distinct white lines can be counted over a horizontal span equal to the height of the picture. The higher the number of TV Lines, more is the resolution of the camera image.

The CCTV camera resolutions specified by various organizations for surveillance projects in their buses are given in Table 3-2.

**Table 3-2: CCTV Camera Resolution Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV Camera Resolution |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | 520 TVL |
| 2 | Delhi Transport Corporation | Jan 2014 | 600 TVL |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | 420 TVL |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 420 TVL |
| 5 | BMTC, Bangalore | Mar 2013 | 420 TVL |

CCTV cameras with resolution of 600 TV Lines are recommended for the current project.

### 3.2.3 Video Format

There are mainly two video format standards used in the Analog CCTV cameras namely PAL and NTSC. There is another standard named SECAM which is used in

very few countries in the world. NTSC stands for National Television Standards Committee and is the colour video signal television standard comprising 525 lines, 60Hz. PAL stands for Phase Alternate Line which is the colour video signal television standard working on 625 lines, 50Hz. The difference between the two standards is mainly due to different electrical power systems in use in different countries. NTSC is used In the United States where 60 Hz electric power is used, most of the South American countries and a few other countries whereas PAL is used in most of other countries, including India, where 50 Hz electric power is used.

Most of the Analog CCTV cameras and DVRs support both NTSC and PAL standards. The video standard specified by various organizations for surveillance projects in their buses are given in Table 3-3.

**Table 3-3: Video Standards Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV System Video Standard |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | PAL |
| 2 | Delhi Transport Corporation | Jan 2014 | PAL/NTSC |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | PAL |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | PAL/NTSC |
| 5 | BMTC, Bangalore | Mar 2013 | PAL |

CCTV cameras supporting PAL video format are recommended for the current project.

### 3.2.4 Image Sensor

Image sensors are placed after the lens of the camera. The light passes through the lens and falls on the image sensor. The picture elements (pixel) on the sensor collect the light and convert it into analog voltage, which is further converted into digital signal through a separate analog to digital convertor. There are two types of image sensors namely CMOS (Complementary Metal Oxide Semi-conductor) and CCD (Charge Coupled Device). CCD sensors give good quality images in a wide range of light conditions, whereas CMOS sensors are not able to perform well in low light conditions. The analog cameras typically use CCD sensors. The CCD sensors come in different sizes such as $^{2}/_{3}$", ½", $^{1}/_{3}$", ¼", etc. The size of the CCD sensors along with focal length has an impact on the field of view of the camera. The CCTV cameras with smaller CCDs have narrower field of view whereas those with bigger CCDs have wider field of view.

The image sensor specified by various organizations for surveillance projects in their buses are given in Table 3-4.

**Table 3-4: Image Sensor Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | Image Sensor Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | 1/3" CCD |
| 2 | Delhi Transport Corporation | Jan 2014 | 1/3" CCD |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | 1/3" CCD |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 1/3" CCD |
| 5 | BMTC, Bangalore | Mar 2013 | 1/3" CCD |

CCTV cameras with 1/3" CCD image sensor are recommended for the current project.

### 3.2.5 Minimum Illumination

Minimum illumination is a parameter to measure the sensitivity of a camera to be able to capture useable images in low light conditions.

The minimum illumination specified by various organizations for surveillance projects in their buses are given in Table 3-5.

**Table 3-5: Minimum Illumination Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | Minimum Illumination Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Not specified |
| 2 | Delhi Transport Corporation | Jan 2014 | 0.01 lux |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 0.1 lux at F1.2 |
| 5 | BMTC, Bangalore | Mar 2013 | 0.0 lux at F1.2 |

CCTV cameras with minimum illumination of 0.01 lux at F1.2 are recommended for the current project.

### 3.2.6 Colour/Monochrome

CCTV Cameras are available in colour, monochrome or cameras that have the ability to switch between colour and monochrome. The CCTV cameras that switch between colour and monochrome are also called day/night CCTV cameras and are intended for environments of low lighting at various times. At zero or very low ambient light, the cameras can switch to monochrome to be able to capture images, with the help of built-in Infrared light.

It is thus recommended to have a Day/Night colour camera which can switch between colour and monochrome as per the intensity of light like day time or night time.

### 3.2.7 Infrared Capability

The CCTV cameras which are required to work in day as well as night including conditions with zero ambient light have lenses that are capable of viewing in Infrared (IR) light in addition to the ambient light. Since the buses shall be plying at the day time as well as during the night time, the camera should be capable of effectively capturing images in bright light as well as low light intensities. A CCTV camera can have Infrared LEDs mounted on its housing to provide Infrared light to be able to capture images. The range of Infrared LEDs or IR Distance is the distance of the illumination made by the Infrared LEDs to enable the camera to capture images.

The infrared capability of CCTV cameras specified by various organizations for surveillance projects in their buses are given in Table 3-6.

**Table 3-6: Infrared Capability Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | Infrared Capability Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Yes, IR Distance of 10 meters |
| 2 | Delhi Transport Corporation | Jan 2014 | Yes, IR Distance of 10 meters |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Yes, IR Distance of 10 meters |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | Yes, Approx 10 to 20 meters |
| 5 | BMTC, Bangalore | Mar 2013 | Yes, IR Distance of 10 meters |

CCTV cameras with built-in Infrared LEDs with a range of minimum 10 meters are recommended for the current project.

### 3.2.8 CCTV Camera Ruggedness

The CCTV cameras will be installed in buses and will be subject to vibrations and shocks. Also, the CCTV cameras will be prone to vandalism and tampering attempts. Accordingly, the CCTV camera should be suitably protected against vibration, shocks and vandalism.

The features for protection against vibration, shocks and vandalism for CCTV cameras specified by various organizations for surveillance projects in their buses are given in Table 3-6.

**Table 3-7: CCTV Camera Ruggedness Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV Camera Ruggedness Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Vandal Proof |
| 2 | Delhi Transport Corporation | Jan 2014 | Vandal Proof |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | Impact Protection – IEC60068-2-75 test, Eh, 50J; EN50102, up to IK10 |
| 5 | BMTC, Bangalore | Mar 2013 | Rugged |

CCTV cameras with rugged, vandal proof housing are recommended for the current project.

### 3.2.9 IP Rating

An Ingress Protection (IP) rating is used to specify the environmental protection of enclosures of equipment. The IP rating number is composed of two digits, the first digit refers to the protection against solid objects and the second digit signifies protection against water. The higher is the number, the better is the protection offered by the equipment against ingress of solid objects/ water. Different IP ratings and the corresponding protection levels, as prescribed in IS/IEC 60529 standards are given in Table 3-8.

**Table 3-8: IP Rating Numbers and Corresponding Protection Levels**

| First Digit | Protection Level | Second Digit | Protection Level |
|---|---|---|---|
| 0 | No protection | 0 | No protection |
| 1 | Protected against solid objects of 50 mm diameter and greater | 1 | Protection against vertically falling drops of water |
| 2 | Protected against solid objects of 12.5 mm diameter and greater | 2 | Protection against vertically falling drops of water when enclosure is tilted up to 15 degree |
| 3 | Protected against solid objects of 2.5 mm diameter and greater | 3 | Protection against water spray at any angle up to 60 degree from the vertical |
| 4 | Protected against solid objects of 1 mm diameter and greater | 4 | Protection against water splashing from any direction |
| 5 | Protected against dust, limited ingress (no harmful | 5 | Protected against low pressure jets of water from all directions |

| First Digit | Protection Level | Second Digit | Protection Level |
|---|---|---|---|
| | deposit) | | |
| 6 | Totally protected against dust | 6 | Protected against high pressure jets of water |
| | | 7 | Protected against the effect of temporary immersion up to 1m |
| | | 8 | Protected against long periods of immersion beyond 1m |

The ingress protection rating specified by various organizations for CCTV cameras for surveillance projects in their buses are given in Table 3-9.

**Table 3-9: CCTV Camera IP Rating Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV Camera IP Rating Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | IP66 |
| 2 | Delhi Transport Corporation | Jan 2014 | IP65/IP66 |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | IP66 |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | IP66 |
| 5 | BMTC, Bangalore | Mar 2013 | IP66 |

CCTV cameras with IP Rating of IP66 are recommended for the current project.

### 3.2.10 Operating Temperature

The CCTV cameras are required to work in varying temperature conditions. So, the CCTV cameras should be able to perform in a wide range of temperature.

The operating temperature range for CCTV cameras specified by various organizations for surveillance projects in their buses are given in Table 3-10.

**Table 3-10: Operating Temperature Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV Camera Operating Temperature Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | 0 to 65 degree C |
| 2 | Delhi Transport Corporation | Jan 2014 | -10 to 60 degree C |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), | Apr 2013 | -10 to 60 degree C |

| Sl. No. | Name of Organization | Year | CCTV Camera Operating Temperature Specifications |
|---|---|---|---|
| | Pune | | |
| 5 | BMTC, Bangalore | Mar 2013 | 0 to 45 degree C |

CCTV cameras with operating temperature range of -10 to 60 degree C are recommended for the current project.

### 3.2.11 Humidity

Humidity is a highly varying parameter in India and the CCTV cameras need to function in a wide range of humidity levels. The humidity levels for CCTV cameras specified by various organizations for surveillance projects in their buses are given in Table 3-11.

**Table 3-11: CCTV Camera Humidity Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV Camera Humidity Specifications |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Upto 90% RH |
| 2 | Delhi Transport Corporation | Jan 2014 | 0% to 95% RH |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 90% or less (non-condensing) |
| 5 | BMTC, Bangalore | Mar 2013 | Not specified |

CCTV cameras with humidity levels of 0% to 95% are recommended for the current project.

### 3.2.12 Audio

CCTV Cameras can have the option for recording of audio in addition to the images. The feature to capture audio with the images in the CCTV cameras can be of great help in investigating any incident and also can serve as important piece of evidence against the culprits.

Though, the organizations as mentioned above have not specified audio capture as part of their CCTV systems, it is recommended to have CCTV cameras to capture audio along with the images, for the current project. The CCTV cameras can have built-in microphones or there can be a separate microphone installed in proximity to CCTV camera to capture audio.

### 3.2.13 Input Power

The CCTV cameras in a vehicle can draw electric power from the DVR to which they are connected. It is recommended that the CCTV cameras in the vehicle draw power

from the DVR and in view of this, there shall not be any separate direct power provisioning for the cameras.

### 3.2.14 Image Enhancement Features

CCTV cameras have to work in different light conditions, which include low light, bright light and different combinations of white and colour lights. CCTV cameras can have automatic controls to manage such varying conditions to enhance the image quality. These features are explained below:

**White Balance**

In order to represent white and different colours in the image properly, the CCTV cameras use a feature called white balance. The CCTV cameras with Automatic White Balance automatically adjusts the colour temperature of the camera image with reference to the best-match white colour available in the image, so that white and other colours appear as natural as possible. Some cameras use an advance technique called Auto-tracking White Balance (ATW) in which, the camera maintains a fixed reference of white balance built into its settings, so that the camera will be able to display the correct colours even if there is no white in the scene.

**Gain Control**

In case of low light conditions, the camera images can become practically useless due to grains and noise in the image. To tackle this problem, cameras can have a feature called Automatic Gain Control (AGC). The AGC function provides clear image in low light condition with the help of an amplifier which is used to boost the video signal in low light to increase the camera's sensitivity.

**Backlight Compensation**

In case, bright light falls on the camera from some source such as through window, CCTV camera reduces the exposure which causes a dark image of the object of interest. In such cases, due to large amount of background light, it becomes practically impossible to see any details of the objects. In order to resolve this issue, the CCTV cameras use a mechanism called Back Light Compensation (BLC), which improves the exposure of the objects that are in front of the bright light source. The image with BLC is much clearer than that without BLC. However, the BLC has a limitation of making the background also brighter. Another mechanism called Wide Dynamic Range (WDR) which, instead of brightening the entire image, brightens the dark parts and darkens the bright parts of the image. WDR is able to give better image quality than BLC.

Various image quality enhancement features specified by various organizations for surveillance projects in their buses are given in Table 3-12.

**Table 3-12: CCTV Camera Image Quality Features by Different Organizations**

| Sl. No. | Name of Organization | Year | CCTV Camera Image Quality Features |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Automatic Backlight Compensation |
| 2 | Delhi Transport Corporation | Jan 2014 | Auto Backlight Compensation<br>Auto White Balance<br>Auto Gain Control |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Automatic Backlight Compensation |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | Backlight Compensation |
| 5 | BMTC, Bangalore | Mar 2013 | Automatic Backlight Compensation<br>Auto White Balance<br>Auto Gain Control |

CCTV cameras with the following features are recommended for the current project:

- Wide Dynamic Range (WDR) & Auto Backlight Compensation (BLC)
- Auto-tracking White Balance (ATW)
- Automatic Gain Control (AGC)

### 3.2.15 Motion Detection

Motion Detection is an electronic method of detecting a change in the field of view of a camera. It is achieved by storing one frame of the image and then comparing the next frame with the stored frame to find out, if there has been a change. Motion detection can be used to initiate some action such as starting recording of images in case there is some change in the camera's field of view.

It is recommended that the CCTV cameras for the project should support Motion Detection, so that during night time, the recording can be restricted to the times when there is some happening in the vehicle, as per the specified configuration.

### 3.2.16 Analog Camera Specifications

A summary of recommended specifications for Analog CCTV Camera including those suggested in the above sub-sections as well as other parameters is given in Table 3-13 below:

**Table 3-13: Recommended Specifications of Analog CCTV Camera**

| Sl. No. | Parameter | Recommended Minimum Specification |
|---|---|---|
| 1 | Type | Analog, Colour camera |

| Sl. No. | Parameter | Recommended Minimum Specification |
|---|---|---|
| 2 | Video Format | PAL |
| 3 | Lens | Fixed, 3.6 mm |
| 4 | Camera Resolution | 600 TV Lines, 752 (H) x 582 (V) |
| 5 | Image Sensor | 1/3" CCD |
| 6 | Minimum Illumination | 0.01 Lux at F1.2 with IR Off<br>0.0 Lux with IR On |
| 7 | Shutter Time | 1/50 sec to 1/100,000 sec |
| 8 | Infrared Capability | Built-in Infrared LEDs with range of minimum 10 meters<br>Auto Day/Night |
| 9 | Camera Ruggedness | Rugged, vibration, shock and tamper proof housing<br>Vibration resistance as per EN 60068 or equivalent<br>Shock resistance as per EN 60068 or equivalent |
| 10 | IP Rating | IP66 |
| 11 | Operating Temperature | -10 to 60 degree Celsius |
| 12 | Operating Humidity | 0% to 95% RH |
| 13 | Audio | Built-in Microphone or separate microphone |
| 14 | Image Enhancement | • Auto-tracking White Balance (ATW)<br>• Automatic Gain Control<br>• Wide Dynamic Range (WDR) and Automatic Backlight Compensation (BLC) |
| 15 | Input Power | Power from mDVR |
| 16 | Motion Detection | Automatic Motion Detection |

## 3.3 Mobile Digital Video Recorder

### 3.3.1 Video Input Channels

Video input channel is the number of camera inputs the recorder is capable of handling. A recorder with 4 video channels input can handle simultaneous connectivity with 4 CCTV cameras.

The numbers of video input channels specified by various organizations for surveillance projects in their buses are given in Table 3-14.

**Table 3-14: Video Input Channels Specifications by Different Organizations**

| Sl. No. | Name of Organization | Year | Number of Video Input Channels |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | 4 Channels |

| Sl. No. | Name of Organization | Year | Number of Video Input Channels |
|---|---|---|---|
| 2 | Delhi Transport Corporation | Jan 2014 | 4 Channels |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | 4 Channels |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 4 Channels |
| 5 | BMTC, Bangalore | Mar 2013 | 4 Channels |

The mobile DVR with minimum 4 video input channels is recommended for midi and standard buses for the current project. In case of articulated or double-decker buses with more than 4 CCTV cameras, the mobile DVR with 8 video input channels is recommended.

### 3.3.2 Video Compression

A video compression standard (codec) is designed to compress and uncompress digital video in order to reduce the amount of bandwidth required to transmit the video over a wireless link and to store the video on a storage medium.

The common codecs used in video compression are Motion JPEG or M-JPEG (Joint Photographic Experts Group), MPEG-4 (Moving Picture Experts Group) and H.264. In addition to the above codecs, H.265 (also known as High Efficiency Video Coding or HEVC) is a new standard for video compression that can deliver better performance than previously available standards including H.264. However, most of the currently available mDVRs do not support H.265 standard. The H.264 codec is most efficient of the standards currently supported by mDVRs and records high quality videos while reducing storage space of the Hard Disk Drive (HDD) by a considerable extent. Most mDVRs on the market provide H.264 codec to compress videos.

The support for various video compression standards specified by various organizations for surveillance projects in their buses are given in Table 3-15.

**Table 3-15: Video Compression Standards Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Video Compression Standards Supported |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | H.264 |
| 2 | Delhi Transport Corporation | Jan 2014 | MPEG-4, H.264 |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | H.264 |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | H.264, MPEG-4, MJPEG |
| 5 | BMTC, Bangalore | Mar 2013 | Not specified |

For the current project, the mobile DVR with support for H.264, MPEG-4 and M-JPEG is recommended. Once the H.265 video compression standard becomes commonly available, the future mDVRs will also be required to support the same.

### 3.3.3 Frame Rate

Frame Rate or Frames per Second (FPS) represents the number of pictures that can be captured into the video stream for all the video inputs received from CCTV cameras connected to the mDVR. Certain DVRs are capable of streaming the video at dual rate i.e. one video stream at higher frame rate for local storage and second video stream at a lower frame rate for transmission to remote server.

The video frame rates specified by various organizations for surveillance projects in their buses are given in Table 3-16.

**Table 3-16: Video Frame Rate Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Video Frame Rate |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | 2CIF (352x288) 25 fps each for four channels<br>D1 (704x576) 25 fps for one channel<br>D1 (704x576) 12 fps each for four channels |
| 2 | Delhi Transport Corporation | Jan 2014 | 25 fps |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | CIF (352x288) 25 fps each for four channels<br>D1 (704x576) 25 fps for one channel<br>D1 (704x576) 12 fps each for four channels |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 100/120 fps at D1<br>Dual stream, configurable |
| 5 | BMTC, Bangalore | Mar 2013 | CIF (352x288) 25 fps each for four channels<br>D1 (704x576) 12 fps each for four channels |

For the current project for midi and standard buses, the mobile DVR with support for 25 fps at 4CIF (704x576) resolution for all channels i.e. cumulative 100 fps at 4CIF (704x576) resolution is recommended. For articulated or double-decker buses with more than 4 CCTV cameras, the mobile DVR with support for 25 fps at 4CIF (704x576) resolution for all channels i.e. cumulative 200 fps at 4CIF (704x576) resolution is recommended. In both the cases, the mDVR should support dual streaming, each video stream configurable at different frame rates and resolution.

### 3.3.4 Audio

The mobile DVR can have one or more audio input channels to record audio captured by microphones either built-in the CCTV camera or separately installed. Availability of audio can greatly help in resolving security incidences in buses by providing vital clues/evidences.

The audio channels specified by various organizations for surveillance projects in their buses are given in Table 3-17.

**Table 3-17: Audio Channels Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Audio Channels in mDVR |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Not specified |
| 2 | Delhi Transport Corporation | Jan 2014 | 1 Channel |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Number of Channels not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 4 Channels<br>G.711 |
| 5 | BMTC, Bangalore | Mar 2013 | Not specified |

For the current project, it has been recommended to have audio recording with one microphone each built in the camera or placed along with cameras inside the bus. The mDVR shall, therefore, have a feature to support four channels of audio. The mDVR shall support G.711 and G.726 audio compression standards. For bigger buses (articulated and double-decker buses) with more than 4 CCTV cameras, the mobile DVRs with 8 audio channels are recommended.

### 3.3.5 Storage

The storage media supported by mobile DVR is very important from the point of view of capacity, security and safety of video storage in the mDVR. Currently the available modes of video recording media inside the recorder are Secure Digital (SD) Cards, Solid State Disks (SSD) and Serial Advanced Technology Attachment (SATA) Hard Disk Drives (HDD). Secure Digital (SD) Cards and Solid State Disks do not have moving parts but the SATA Hard Disks have moving parts. The mDVR would be mounted on the buses and shall be subject to vibrations and shocks, making the storage media susceptible to damage or corruption of data. Thus, the mDVR should have adequate measures to protect the storage media from damage or corruption due to vibrations and shocks.

In addition to the type of storage, capacity is another important parameter of storage in mDVR. The mDVR should have adequate storage capacity to be able to store the data for the desired period. In case of recording by 4 cameras for a continuous period of 20 hours per day with video compression on H.264 on 4CIF quality at the rate of

25 frames per second and a video retention period of 7 days, the mDVR shall require a storage capacity of about 452 GB including 7 days audio storage.

The type of storage and its capacity specified by various organizations for mDVRs for surveillance projects in their buses are given in Table 3-18.

**Table 3-18: Storage Type/Capacity Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Storage Type and Capacity in mDVR |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Type: Not specified<br>Capacity: 30 days for total 2 channels in 2CIF mode, 20 hours per day |
| 2 | Delhi Transport Corporation | Jan 2014 | Type: Not specified<br>Capacity: 7 days (24x7 recording) |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Type: Hard Disk / SD Card<br>Capacity: 48 hours (for total 4 channels) recording of images and voice in CIF mode |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | Type: Not specified<br>Capacity: 7 days video |
| 5 | BMTC, Bangalore | Mar 2013 | Type: Compact Flash (CF) Card<br>Capacity: 48 hours recording in CIF |

The mDVRs with Solid State Disk or SATA Hard Disk Drive (with special mounting arrangements for vibration and shock prevention, such as anti-vibration pads) with a storage capacity of 500 GB are recommended for midi and standard buses for the current project. For articulated or double-decker buses with more than 4 CCTV cameras, the mobile DVRs with 1 TB capacity Solid State Disk or SATA Hard Disk Drive (with special mounting arrangements for vibration and shock prevention, such as anti-vibration pads) are recommended.

### 3.3.6 Network Interfaces

The mobile digital video recorder needs to have network/communication interfaces to enable data transfer with external devices. The stored video and health check updates will be required to be transferred from the mDVR to external system, whereas the firmware and configuration parameters will be required to be transferred to the mDVR. The mDVR can have various network interfaces such as Ethernet (RJ45), Wireless LAN (Wi-Fi) and 2G/3G.

Various network/communication interfaces specified by various organizations for mDVRs for surveillance projects in their buses are given in Table 3-19.

**Table 3-19: Network Interfaces Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Network Interfaces in mDVR |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Not Specified |
| 2 | Delhi Transport Corporation | Jan 2014 | LAN, 2G/3G/CDMA/GSM enabled, Wi-Fi |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Wireless LAN with backhaul |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | LAN |
| 5 | BMTC, Bangalore | Mar 2013 | Not Specified |

The currently used 2G and 3G telecom frequency bands in India are given in Table 3-20.

**Table 3-20: Telecom Frequency Bands in India**

| Sl. No. | Telecom Network | Frequency Bands |
|---|---|---|
| 1 | 2G Telecom Network | 900 MHz, 1800 MHz |
| 2 | 3G Telecom Network | 2100 MHz |

It is recommended that the mDVRs for the current project should have Ethernet (RJ45) and Wireless LAN (Wi-Fi) interfaces. In addition, the mDVR also should have inbuilt 3G communication module capable of working on 2G connectivity, supporting 900 MHz, 1800 MHz and 2100 MHz frequency bands.

### 3.3.7 Subscriber Identity Module (SIM)

Based on the environment of usage, the subscriber identity module (SIM) can be of different types such as general purpose plastic SIM or Machine to Machine (M2M) SIM. The M2M SIMs are further categorised as M2M Plastic SIM, M2M Robust Plastic SIM and M2M Industrial SIM, depending upon their environmental robustness, data retention capability and life span. The key features of different types of M2M SIMs are described in Table 3-21.

**Table 3-21: M2M SIM Types and Features**

| Sl. No. | Parameter | SIM M2M Plastic | SIM M2M Robust Plastic | M2M Industrial SIM |
|---|---|---|---|---|
| 1 | Operating Conditions | • Standard Environmental Conditions<br>• Standard Electrical Conditions | • Standard Environmental Conditions<br>• Extreme Electrical Conditions<br>○ Longer Usage | • Extreme Environmental Conditions<br>○ Temperature<br>○ Shock<br>○ Humidity<br>○ Corrosion |

| Sl. No. | Parameter | SIM M2M Plastic | SIM M2M Robust Plastic | M2M Industrial SIM |
|---|---|---|---|---|
| | | | life-Span<br>○ Intensive Use | • Extreme Electrical Conditions<br>○ Longer Usage Life Span<br>○ Intensive Use |
| 2 | Temperature Range | -25$^0$ C to 85$^0$ C | -25$^0$ C to 85$^0$ C | -40$^0$ C to 85$^0$ C |
| 3 | Erase and Write Cycles | 500k E/W cycles | • High stress memory supports > 2M E/W cycles per file<br>• Outside of HSM 500k E/W cycles | • High stress memory supports > 2M E/W cycles per file<br>• Outside of HSM 500k E/W cycles |
| 4 | Data Retention | >2 Years | >10 Years | >10 Years |
| 5 | Designed Lifetime | 2 Years + | 10 Years + for electrical | 10 Years + at -40$^0$ C to 85$^0$ C |

It is recommended to use M2M Plastic or M2M Robust Plastic or M2M Industrial SIM in the mDVR and the mDVR should support the use of all of these types of SIMs.

### 3.3.8 Input Power

The mDVR in the bus shall draw power from the vehicle battery. As there are different types of models and manufacturers of buses, the battery inputs to the recorder could be different. Moreover, the bus power shall be subject to spikes at the time of starting the ignition of the bus. The mDVR should be able to work on a wide range of input power and also be capable of withstanding spikes in power.

The input power specified by various organizations for mDVRs for surveillance projects in their buses are given in Table 3-22.

**Table 3-22: mDVR Input Power Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Input Power to mDVR |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Will work on bus battery, 24 Volts |
| 2 | Delhi Transport Corporation | Jan 2014 | 8 to 36 Volts |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | 12 Volt |
| 5 | BMTC, Bangalore | Mar 2013 | Not specified |

It is recommended that the mDVRs for the current project should work on input power of 8 to 32 volts.

### 3.3.9 Environmental Conditions

The mDVR should be able to operate in the wide range of environmental conditions i.e. temperature and humidity levels likely to be experienced in buses in various cities in India.

The environmental parameters specified by various organizations for mDVRs for surveillance projects in their buses are given in Table 3-23.

**Table 3-23: Environmental Parameters Specified by Different Organizations**

| Sl. No. | Name of Organization | Year | Environmental Parameters for mDVR |
|---|---|---|---|
| 1 | Haryana Roadways | Oct 2014 | Temp: 0 to 55 degree C<br>Humidity: Not specified |
| 2 | Delhi Transport Corporation | Jan 2014 | Temp: -10 to 60 degree C<br>Humidity: 0% to 95% |
| 3 | Urban Bus Specifications - II, MoUD | May 2013 | Temp: Not specified<br>Humidity: Not specified |
| 4 | Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), Pune | Apr 2013 | Temp: -20 to 60 degree C<br>Humidity: Up to 85% RH, non-condensing |
| 5 | BMTC, Bangalore | Mar 2013 | Temp: -21 to 56 degree C<br>Humidity: Not specified |

It is recommended that the mDVRs for the current project should work on a temperature range of -10 to 60 degree Celsius and humidity levels of 0% to 95% RH, non-condensing.

### 3.3.10 mDVR Specifications

A summary of recommended specifications of mDVR including those suggested in above sub-sections as well as other parameters is given in Table 3-24.

**Table 3-24: Recommended Specifications of mDVR**

| Sl. No. | Parameter | Recommended Minimum Specification | |
|---|---|---|---|
| | | mDVR for Midi and Standard Buses having up to 4 CCTV cameras | mDVR for bigger Buses having up to 8 CCTV cameras |
| 1 | Video Format | PAL | |
| 2 | Number of Video Inputs | 4 channels | 8 channels |
| 3 | Number of Video Outputs | 1 | |
| 4 | Number of Audio Inputs | 4 channels | 8 channels |

| Sl. No. | Parameter | Recommended Minimum Specification | |
|---|---|---|---|
| | | mDVR for Midi and Standard Buses having up to 4 CCTV cameras | mDVR for bigger Buses having up to 8 CCTV cameras |
| 5 | Number of Audio Outputs | 1 | |
| 6 | Video Compression Standards Supported | H.264, MPEG-4 and M-JPEG | |
| 7 | Audio Compression Standards Supported | G.711 and G.726 | |
| 8 | Number of streams | Dual streams, both streams independently configurable for each camera resolution and frame rate | |
| 9 | Recording Resolutions | 4CIF/2CIF/CIF/QCIF (can be set independently for each channel, for both streams) | |
| 10 | Video Frame Recording Rate | 1 to 25 fps for all channels at 4CIF (total 100 fps at 4CIF) – resolution and frame rate can be set independently for each camera, for both streams | 1 to 25 fps for all channels at 4CIF (total 200 fps at 4CIF) – resolution and frame rate can be set independently for each camera, for both streams |
| 11 | Alarm Sensors | Minimum 4 inputs (NO/NC, configurable)<br>2 outputs | |
| 12 | Storage | 500 GB, 2.5” SATA Hard Disk Drive or Solid State Drive with suitable anti-vibration mechanism<br>Desirable: Solid State Drive<br>Hard Disk to be pluggable and easily removable, secure and protected by lock | 1 TB, 2.5” SATA Hard Disk Drive or Solid State Drive with suitable anti-vibration mechanism<br>Desirable: Solid State Drive<br>Hard Disk to be pluggable and easily removable, secure and protected by lock |
| 13 | Recording Modes | Normal, Schedule based, Alarm triggered, Motion detection | |
| 14 | Event Based Recording and Tagging | Pre-recording – 1 to 15 minutes<br>Post-recording – 1 to 60 minutes | |
| 15 | Shut Down Delay | Configurable shut down delay after ignition off – 5 min to 4 hours | |
| 16 | Power Input | 8 to 32 volts, spike/surge protection | |
| 17 | Power output | Regulated power to CCTV cameras and microphones | |
| 18 | Working Temperature | -10 to 60 degree Celsius | |
| 19 | Working Humidity | 0% to 95% relative humidity non-condensing | |
| 20 | Network/Communication | LAN – 1 RJ45 interface | |

| Sl. No. | Parameter | Recommended Minimum Specification | |
|---|---|---|---|
| | | mDVR for Midi and Standard Buses having up to 4 CCTV cameras | mDVR for bigger Buses having up to 8 CCTV cameras |
| | Interfaces | Wi-Fi – 802.11/b/g/n<br>Built-in 3G module, supporting both 2G and 3G (at least 900, 1800 and 2100 MHz frequency bands), Support for SMS, Voice, Data, GPRS, TCP/IP | |
| 21 | External Interfaces | 1 RS232<br>1 USB 2.0<br>1 SIM slot (Capable of using M2M Plastic, M2M Robust Plastic SIM and M2M Industrial SIM) | |
| 22 | Image quality | 1 to 5 (configurable) | |
| 23 | Watermark | Tamper-proof Watermark | |
| 24 | Configurable Video Overwriting | Video over-writing to be configurable to support:<br>• Cyclic overwriting (oldest recording to be overwritten)<br>• Event tagged recording not to be overwritten for a longer period (7 to 30 days, configurable) | |
| 25 | Connections | All input and output connections to be vibration/shock resistant and locking<br>Desirable: Aviation Connectors | |
| 26 | LED Indicators | Power, Recording, 3G/ GPRS Network | Power, Recording, 3G/ GPRS Network, GPS |
| 27 | Vibration resistance | EN 60068 or equivalent | |
| 28 | Shock resistance | EN 60068 or equivalent | |
| 29 | Health Parameters over 2G/ 3G/ SMS | Capable of sending health parameters (cameras not-functioning, cameras tamper, HDD/SSD error, HDD/SSD full) at specified frequency to the server<br>Capable of detecting failure, error or tamper of cameras or any component and sending alert to server | |
| 30 | Over-the-air Update/ Upgrade | Over-the-air update of configuration parameters of mDVR and cameras, as specified in protocol document<br>Over-the-air upgrade of firmware | |
| 31 | Motion Detection | Configurable sensitivity levels<br>Motion Detection zones to be configurable independently for each camera | |
| 32 | RTC | Built-in RTC, drift not more than 10 seconds at any time | |
| 33 | Data Download | mDVR should provide video and audio download facility for the desired date/time and duration. It should be possible to connect a laptop to mDVR through network cable on RJ45 port and open | |

| Sl. No. | Parameter | Recommended Minimum Specification | |
|---|---|---|---|
| | | mDVR for Midi and Standard Buses having up to 4 CCTV cameras | mDVR for bigger Buses having up to 8 CCTV cameras |
| | | mDVR's user interface in a standard browser using a standard URL such as http://dvr (or any other text specified by MoRTH) without having to configure the laptop's network settings.<br>After entering user-id and password (specified by MoRTH), it will be possible to search, view, select and download video clips of desired duration and date/time in standard formats such as .avi or .mpg. It will not be possible to delete any video or change configuration settings using this set of user-id and password. | |
| 34 | Data Transfer on 3G and 2G | In case the vehicle moves to an area where 3G coverage is not present, the mDVR will automatically shift to GPRS (2G) connectivity to send the health status data. Also, in such case, on press of an emergency button, the mDVR will automatically shift to a lower frame rate and resolution (both configurable) and send the video from cameras to the backend server over GPRS (2G). | |

The above specifications for mDVR will be applicable for both Type 1 and Type 2 devices. However, the mDVR which are part of Type 1 device will also have to meet vehicle tracking related specifications as listed in sub-section 3.3.11.

### 3.3.11 Additional Specifications for Type 1 mDVR

The mDVRs which will be part of Type 1 device (CCTV system with in-built tracking system and emergency button system) will have a built-in locating module which will provide vehicle tracking related functionalities. Various parameters that are important for vehicle tracking device have been examined in another document titled 'Detailed Specifications Document for Vehicle Tracking Device' prepared as part of the project documentation. As such these parameters are not being explained in this document and only a summary of recommended specifications of mDVR related to vehicle tracking functionalities is provided in Table 3-25.

**Table 3-25: Additional Specifications for Type 1 mDVR**

| Sl.No. | Paramter | Recommended Minimum Specification |
|---|---|---|
| 1 | Location Module | Parallel GPS or GLONASS or both receiver module with 32 (minimum) acquisition channels & 18 minimum tracking channel.<br>The devices should also support Indian Regional Navigation Satellite System (IRNSS). The device should also support GAGAN, the Indian SBAS (Satellite Based |

| Sl.No. | Paramter | Recommended Minimum Specification |
|---|---|---|
| | | Augmentation System).<br>Location, speed, heading, timestamp data polling and sending frequency capability of less than or equal to 10 sec |
| 2 | Location on demand | On 3G/GPRS/SMS<br>Configurable backup SMS facility in case of 3G/ GPRS failure |
| 3 | Memory | Memory to store minimum 40,000 positional logs |
| 4 | Acquisition sensitivity | Better than (-)160 dBm |
| 5 | Tracking sensitivity | Better than (-)165 dBm |
| 6 | Accuracy | Less than 6 meter Positional Accuracy 2DRMS (on ground) or 2.5 meter CEP (on ground) |
| 7 | Hot start | < 5 sec |
| 8 | Warm start | < 20 sec |
| 9 | Cold start | < 40 sec |
| 10 | Outputs | As per NMEA 0183 |
| 11 | WGS-84 compliant | Yes |
| 12 | A-GPS | Yes |
| 13 | Geo-fence capability | Device should store minimum 3000 geo-fence points. One route in general can be of 150 distinct geo-fence points. |
| 14 | Cell ID and Network Measurement Report | Capability to send serving and adjacent cell ID as well as network measurement report (NMR) |
| 15 | Over the Air Capability | Download of firmware as well as configuration parameters<br>Remote administration and firmware update over the air<br>Facility to update route Geo-fence master in the device over the air<br>Device should be capable of sending a packet to 2 different IP's simultaneously |

The following specifications which have been recommended for Type 3 Device (Vehicle tracking device with in-built emergency button system) and Type 4 Device (Vehicle tracking device with in-built emergency button system and fare meter) are not being recommended for Type 1 mDVR as the same are not technically feasible and prevalent in the available mDVRs:

- Internal battery backup of minimum 4 hours
- Internal GPS antenna
- Internal GPRS antenna

## 3.4 Emergency Buttons

### 3.4.1 Overview of Emergency Buttons

Several Emergency Buttons will be required to be installed in the bus within easy reach of the passengers. One Emergency Button will be installed within reach of the driver also, so that the driver can also raise alert in case of an emergency situation in the bus. On pressing of any Emergency Button in the bus, the mDVR and Vehicle Tracking Device (if a separate unit) will get the signal. On receipt of the signal from the Emergency Button, the mDVR and Vehicle tracking device will initiate the following actions:

- Send the emergency alert to the backend system, as part of the bus location data.
- Start sending the images from the cameras to the backend at a specified frequency. The mDVR will continue sending the images to the backend for a specified duration.
- Tag the video recording of cameras for a specified duration before and after the press of Emergency Button with emergency event. The video recording tagged with emergency event will not get overwritten and deleted for a specified number of days.

**Figure 3-1: Emergency Button on a Bus**

### 3.4.2 Recommendations

The recommendations in respect of Emergency Buttons are given below:

- The number of Emergency Buttons and their positioning in different types of buses will be decided based on the length, seating and interior layout of the buses. One Emergency Button will be installed within easy reach of the driver. Other Emergency Buttons will be installed on both sides of the bus in such a way that the distance between two buttons is not more than 3 meters.
- The Emergency Buttons will be connected to both, the mDVR and the Vehicle Tracking Device (if a separate device) in a manner such that in case of press of any Emergency Button, both mDVR and the Vehicle Tracking Device get the alert signal.

- The Emergency Buttons will be ‘Normally Closed’ (NC) type. The form factor of Emergency Buttons will be such that the button is easy to press in the case of an emergency, and simultaneously also minimizes the possibility of accidental or unintended press thereby causing a false alert.

# 4.0 IP CCTV ON-BOARD DEVICES

## 4.1 Overview

The IP CCTV On-Board Devices will comprise the following devices:

- IP CCTV Cameras
- Mobile Network Video Recorder (mNVR)
- Emergency Buttons

Certain specifications of IP CCTV On-Board Devices which have been listed in section 4.2.9 will be same as that of Analog CCTV On-Board Devices analysed in previous chapter. The specifications of IP CCTV On-Board Devices, which are different than Analog CCTV On-Board Devices, are analysed in the following sections.

## 4.2 IP CCTV Cameras

### 4.2.1 Image Sensor

Unlike analog CCTV Cameras which use CCD sensors only, the IP Cameras can use both CCD as well as CMOS sensors. The CCD sensors are better at capturing images in low light conditions, but CMOS sensors have better speed of processing and lower costs.

It is recommended to use $^1/_3$" Progressive Scan CMOS sensors or $^1/_3$" CCD sensors for the IP cameras.

### 4.2.2 Resolution

In case of Analog CCTV cameras, the resolution is limited to about 0.4 megapixels, whereas IP cameras can have higher resolutions of several megapixels. The higher resolution camera offer more details in the image captured, but the size of image increases manifold, thus impacting storage and bandwidth requirements.

It is recommended that the IP cameras should have minimum 0.4 megapixel resolution, as in the case of Analog cameras.

### 4.2.3 Interface

The IP cameras can have an Ethernet interface for connection to the mNVR. Thus it is recommended that the IP CCTV cameras in the bus shall have 1 RJ45, 10/100 M Ethernet interface for connection to the mNVR.

### 4.2.4 Input Power

The CCTV cameras in the bus shall draw power from the mNVR and there shall not be any separate power provisioning for the cameras. As the IP Cameras have RJ-45 Ports to connect to the network, the Power-over-Ethernet (PoE) can be used to

supply power to CCTV cameras from mNVR, eliminating the need for extra power cable.

Thus, it is recommended that the IP cameras shall draw power from mNVR through Power-over-Ethernet.

### 4.2.5 Video Compression

In case of IP cameras, the camera itself processes and encodes the video. For the current project, the IP cameras with support for H.264, MPEG-4 and M-JPEG video compression are recommended. Once the H.265 video compression standard becomes commonly available, the future IP cameras will also be required to support the same.

### 4.2.6 Frame Rate

Frame Rate or Frames per Second (FPS) indicates the number of pictures that can be captured into the video stream. The IP cameras should be able to support frame rate of up to 25 frame per seconds for all resolutions.

### 4.2.7 ONVIF Compliance

ONVIF (Open Network Video Interface Forum) is a global open standard for interface of IP surveillance products. ONVIF helps in standardization of communication between IP based video devices and achieving inter-operability between them. It is recommended that the IP cameras should be ONVIF Profile S compliant.

### 4.2.8 Audio Compression

In case of IP cameras, the audio is compressed by the IP camera, before sending it to the mNVR. The IP cameras should support G.711 and G.726 audio compression standards.

### 4.2.9 IP Camera Specifications

A summary of recommended specifications of IP CCTV cameras including those which are same as that of Analog cameras as well as those suggested in above sub-sections is given in Table 4-1.

**Table 4-1: Recommended Specifications of IP CCTV Camera**

| Sl. No. | Parameter | Recommended Minimum Specification |
|---|---|---|
| 1 | Type | IP, Colour camera |
| 2 | Lens | Fixed, 3.6 mm |
| 3 | Camera Resolution | Minimum 0.4 megapixels, 800 x 600 pixels |
| 4 | Image Sensor | 1/3" CCD or 1/3" progressive scan CMOS |
| 5 | Video Compression | H.264, MPEG-4, M-JPEG |
| 6 | Audio Compression | G.711, G.726 |
| 7 | Frame Rate | 1 to 25 fps for different resolution |

| Sl. No. | Parameter | Recommended Minimum Specification |
|---|---|---|
| 8 | Minimum Illumination | 0.01 Lux at F1.2 with IR Off<br>0.0 Lux with IR On |
| 9 | Shutter Time | 1/50 sec to 1/100,000 sec |
| 10 | Infrared Capability | Built-in Infrared LEDs with range of minimum 10 meters<br>Auto Day/Night |
| 11 | Camera Ruggedness | Rugged, Vibration and shock proof housing<br>Vibration resistance as per EN 60068 or equivalent<br>Shock resistance as per EN 60068 or equivalent |
| 12 | IP Rating | IP66 |
| 13 | Operating Temperature | -10 to 60 degree Celsius |
| 14 | Operating Humidity | 0% to 95% RH |
| 15 | Audio | Built-in Microphone or separate microphone |
| 16 | Image Enhancement | • Auto-tracking White Balance (ATW)<br>• Automatic Gain Control<br>• Wide Dynamic Range (WDR) and Automatic Backlight Compensation (BLC) |
| 17 | Input Power | Power from mNVR through Power-over-Ethernet (PoE) |
| 18 | Motion Detection | Automatic Motion Detection |
| 19 | Interface | RJ45 10/100 M Ethernet |
| 20 | ONVIF compliance | ONVIF Profile S compliant |

## 4.3 Mobile Network Video Recorder

### 4.3.1 Power-over-Ethernet (PoE)

Mobile Network Video Recorders are capable of supporting Power-over-Ethernet (PoE) which means providing power to IP cameras through the Ethernet cable along with communication of data. It is recommended that the mobile NVR for midi and standard buses with up to 4 CCTV cameras should have integrated PoE switch that meets the peak power requirement for 4 CCTV cameras with infrared ON. In case of articulated or double-decker buses with more than 4 CCTV cameras, the mobile NVR should have integrated PoE switch that meets the peak power requirement for 8 CCTV cameras with infrared ON.

### 4.3.2 mNVR Specifications

A summary of recommended specifications of Mobile Network Video Recorder including those which are same as that of mDVR as well as those suggested in above sub-section is given in Table 4-2.

**Table 4-2: Recommended Specifications of mNVR**

| Sl. No. | Parameter | Recommended Minimum Specifications | |
|---|---|---|---|
| | | mNVR for Midi and Standard Buses having up to 4 CCTV cameras | mNVR for bigger Buses having up to 8 CCTV cameras |
| 1 | Number of Video Inputs | 4 channels | 8 channels |
| 2 | Number of Video Outputs | 1 | |
| 3 | Number of Audio Inputs | 4 channels | 8 channels |
| 4 | Number of Audio Outputs | 1 | |
| 5 | Video Compression Standards Supported | H.264, MPEG-4 and M-JPEG | |
| 6 | Audio Compression Standards Supported | G.711 and G.726 | |
| 7 | Number of streams | Dual streams, both streams independently configurable for each camera resolution and frame rate | |
| 8 | Recording Resolutions | Equivalent to 4CIF/2CIF/CIF/QCIF (can be set independently for each channel, for both streams) | |
| 9 | Video Frame Recording Rate | 1 to 25 fps for all channels at 4CIF equivalent (total 100 fps at 4CIF equivalent) – resolution and frame rate can be set independently for each camera, for both streams | 1 to 25 fps for all channels at 4CIF equivalent (total 200 fps at 4CIF equivalent) – resolution and frame rate can be set independently for each camera, for both streams |
| 10 | Alarm Sensors | Minimum 4 inputs (NO/NC)<br>2 outputs | |
| 11 | Storage | 500 GB, 2.5” SATA Hard Disk Drive or Solid State Drive with suitable anti-vibration mechanism<br>Desirable: Solid State Drive<br>Hard Disk to be pluggable and easily removable, secure and protected by lock | 1 TB, 2.5” SATA Hard Disk Drive or Solid State Drive with suitable anti-vibration mechanism<br>Desirable: Solid State Drive<br>Hard Disk to be pluggable and easily removable, secure and protected by lock |
| 12 | Recording Modes | Normal, Schedule based, Alarm triggered, Motion detection | |
| 13 | Event Based Recording and Tagging | Pre-recording – 1 to 15 minutes<br>Post-recording – 1 to 60 minutes | |
| 14 | Shut Down Delay | Configurable shut down delay after ignition off – 5 min to 4 hours | |
| 15 | Power Input | 8 to 32 volts, spike/surge protection | |

| Sl. No. | Parameter | Recommended Minimum Specifications | |
|---|---|---|---|
| | | mNVR for Midi and Standard Buses having up to 4 CCTV cameras | mNVR for bigger Buses having up to 8 CCTV cameras |
| 16 | Power-on-Ethernet | Integrated PoE switch supporting peak power requirement for 4 CCTV cameras with infrared on | Integrated PoE switch supporting peak power requirement for 8 CCTV cameras with infrared on |
| 17 | Working Temperature | -10 to 60 degree Celsius | |
| 18 | Working Humidity | 0% to 95% relative humidity non-condensing | |
| 19 | Network/Communication Interfaces | LAN – 1 RJ45 interface (in addition to the camera ports)<br>Wi-Fi – 802.11/b/g/n<br>Built-in 3G module, supporting both 2G and 3G (at least 900, 1800 and 2100 MHz frequency bands), Support for SMS, Voice, Data, GPRS, TCP/IP | |
| 20 | ONVIF compliance | ONVIF Profile S compliant | |
| 21 | External Interfaces | 1 RS232<br>1 USB 2.0<br>1 SIM slot (Capable of using M2M Plastic or M2M Robust Plastic SIM and M2M Industrial SIM) | |
| 22 | Image quality | 1 to 5 (configurable) | |
| 23 | Watermark | Tamper-proof Watermark | |
| 24 | Configurable Video Overwriting | Video over-writing to be configurable to support:<br>• Cyclic overwriting (oldest recording to be overwritten)<br>• Alarm linked recording not overwritten | |
| 25 | Connections | All input and output connections to be vibration/shock resistant and locking<br>Desirable: Aviation Connectors | |
| 26 | LED Indicators | Power, Recording, Network | |
| 27 | Vibration resistance | EN 60068 or equivalent | |
| 28 | Shock resistance | EN 60068 or equivalent | |
| 29 | Health Parameters over 3G/ 2G/ SMS | Capable of sending health parameters (cameras not-functioning, cameras tamper, HDD/SSD error, HDD/SSD full) at specified frequency to the server<br>Capable of detecting failure, error or tamper of cameras or any component and sending alert to server | |
| 30 | Over-the-air Update/ Upgrade | Over-the-air update of configuration parameters of mNVR and cameras<br>Over-the-air upgrade of firmware | |
| 31 | Motion Detection | Configurable sensitivity levels<br>Motion Detection zones to be configurable | |

| Sl. No. | Parameter | Recommended Minimum Specifications | |
|---|---|---|---|
| | | mNVR for Midi and Standard Buses having up to 4 CCTV cameras | mNVR for bigger Buses having up to 8 CCTV cameras |
| | | independently for each camera | |
| 32 | RTC | Built-in RTC, drift not more than 10 seconds | |
| 33 | Data Download | mNVR should provide video and audio download facility for the desired date/time and duration. It should be possible to connect a laptop to mNVR through network cable on RJ45 port and open mNVR's user interface in a standard browser using a standard URL such as http://dvr (or any other text specified by MoRTH) without having to configure the laptop's network settings.<br>After entering user-id and password (specified by MoRTH), it will be possible to search, view, select and download video clips of desired duration and date/time in standard formats such as .avi or .mpg. It will not be possible to delete any video or change configuration settings using this set of user-id and password. | |
| 34 | Data Transfer on 3G and 2G | In case the vehicle moves to an area where 3G coverage is not present, the mNVR will automatically shift to GPRS (2G) connectivity to send the health status data. Also, in such case, on press of an emergency button, the mNVR will automatically shift to a lower frame rate and resolution (both configurable) and send the video from cameras to the backend server over GPRS (2G). | |

The above specifications for mNVR will be applicable for both Type 1 and Type 2 devices. However, the mNVR which are part of Type 1 device will also have to meet vehicle tracking related specifications as listed in sub-section 4.3.3.

### 4.3.3 Additional Specifications for Type 1 mNVR

The mNVRs which will be part of Type 1 device (CCTV system with in-built tracking system and emergency button system) will have a built-in locating module which will provide vehicle tracking related functionalities. Various parameters that are important for vehicle tracking device have been examined in another document titled 'Detailed Specifications Document for Vehicle Tracking Device' prepared as part of the project documentation. As such these parameters are not being explained in this document and only a summary of recommended specifications of mNVR related to vehicle tracking functionalities is provided in Table 4-3.

**Table 4-3: Additional Specifications for Type 1 mNVR**

| Sl.No. | Paramter | Recommended Minimum Specification |
|---|---|---|
| 1 | Location Module | Parallel GPS or GLONASS or both receiver module with 32 (minimum) acquisition |

| Sl.No. | Paramter | Recommended Minimum Specification |
|---|---|---|
| | | channels & 18 minimum tracking channel<br>The devices should also support Indian Regional Navigation Satellite System (IRNSS). The device should also support GAGAN, the Indian SBAS (Satellite Based Augmentation System).<br>Location, speed, heading, timestamp data polling and sending frequency capability of less than or equal to 10 sec |
| 2 | Location on demand | On 3G/GPRS/SMS<br>Configurable backup SMS facility in case of 3G/ GPRS failure |
| 3 | Memory | Memory to store minimum 40000 positional logs |
| 4 | Acquisition sensitivity | Better than (-)160 dBm |
| 5 | Tracking sensitivity | Better than (-)165 dBm |
| 6 | Accuracy | Better than 6 meter Positional Accuracy 2DRMS (on ground) or 2.5 meter CEP (on ground) |
| 7 | Hot start | < 5 sec |
| 8 | Warm start | < 20 sec |
| 9 | Cold start | < 40 sec |
| 10 | Outputs | As per NMEA 0183 |
| 11 | WGS-84 compliant | Yes |
| 12 | A-GPS | Yes |
| 13 | Geo-fence capability | Device should store minimum 3000 geo-fence points. One route in general can be of 150 distinct geo-fence points. |
| 14 | Cell ID and Network Measurement Report | Capability to send serving and adjacent cell ID as well as network measurement report (NMR) |
| 15 | Over the Air Capability | Download of firmware as well as configuration parameters<br>Remote administration and firmware update over the air<br>Facility to update route Geo-fence master in the device over the air<br>Device should be capable of sending a packet to 2 different IPs simultaneously |

The following specifications which have been recommended for Type 3 Device (Vehicle tracking device with in-built emergency button system) and Type 4 Device (Vehicle tracking device with in-built emergency button system and fare meter) are

not being recommended for Type 1 mNVR as the same are not technically feasible and prevalent in available mNVRs:

- Internal battery backup of minimum 4 hours
- Internal GPS antenna
- Internal GPRS antenna

## 4.4 Emergency Buttons

The requirements and recommendations for the Emergency Buttons for IP CCTV Camera system will be same as listed in previous chapter in section 3.4.

# 5.0 COMMUNICATION PROTOCOL

## 5.1 Overview

The CCTV devices will communicate with the backend server for sending data to the backend server as well as to receive data from the backend server. The data that will be sent by the two types of the CCTV Devices (Type 1 – CCTV system with in-built tracking system and Emergency buttons and Type 2 - CCTV system with Emergency buttons) is listed in Table 5-1.

**Table 5-1: Data Sent to Server by Different Types of CCTV Devices**

| Sl. No. | Data | Type 1 Device | Type 2 Device | Remarks |
|---|---|---|---|---|
| 1 | Image data | ✓ | ✓ | Only in case of press of Emergency Button |
| 2 | Tracking data | ✓ | | |
| 3 | Health status data | ✓ | ✓ | |
| 4 | Emergency Alert data | ✓ | ✓ | |

In addition to the data that will be sent by the On-board CCTV Devices to the backend, the latter will also be required to send certain data to the On-board CCTV Devices. This data will not be required to be sent on a pre-specified frequency, but will be sent on need-basis.

In order to prevent unauthorised access to the On-board CCTV Devices, they will communicate over-the-air with pre-defined IP addresses (configurable) only.

The data to be sent by the backend to the On-board Devices will comprise:

- Configuration Parameters Update
- Firmware Upgrade

The data communication related requirements are analysed in the following sections.

## 5.2 Data from CCTV Devices to Backend Server

### 5.2.1 Image Data in case of Emergency

In case of press of any Emergency Button, the video recorder (mDVR or mNVR) will get the input regarding the Emergency Alert. The video recorder will start sending the images to the backend at a specified frequency and resolution (both configurable parameters). The video recorder will keep on sending the images to the backend for a specified duration (configurable parameter).

The following metadata will also be sent with the images:

- Vehicle Registration Number (Can be configured as video recorder's identifier)
- Camera Identifier
- Date and Time
- Location coordinates (In case of Type 1 device)

### 5.2.2 Data on Request

It will be possible to poll a video recorder (mDVR or mNVR) from the backend and download live or recorded video and/or audio data from the video recorder. It will be possible to search and select the video and/or audio clip to be downloaded, based on date and time.

### 5.2.3 Tracking Data (applicable only for Type 1 device)

The tracking data will be sent by Type 1 device only. In case a vehicle is fitted with Type 2 device, the tracking data will be sent separately by the tracking device.

The tracking data will be sent at specified frequency (configurable parameter). The frequency can be different for different situations, such as ignition on/off, normal situation or Emergency situation etc.

In case of an Emergency event triggered by press of Emergency button, the tracking data will have higher priority than image data and health status data.

The first 3 fields of the tracking data (Start character, Header for the device manufacturer and Vendor ID, who had supplied the device) must be fixed in position as well as format (header part of frame). Rest all other fields are required to be present in the tracking data sent by the device to the backend, which can be in any sequence or with any separator between fields. The data value can be either in American Standard Code for Information Interchange (ASCII) format or in HEX format.

Device must transmit the login message whenever it establishes its connectivity with backend server, as per the fields provided in Table 5-2.

**Table 5-2: Login Message Format for Tracking Data for Type 1 Device**

| Sl. No. | Field | Description | Sample Data |
|---|---|---|---|
| 1 | $Msg.Server.Login | Stat of Message | |
| 2 | $DeviceName | Vehicle number where the device was installed | DL3CBM9821 |
| 3 | $IMEI | 15 Digit IMEI number | 123456789012345 |
| 4 | $Firmware | Version of the firmware used in the hardware | 1.0.0 |
| 5 | $Protocol | Version of the frame format protocol | 1.0.1 |
| 6 | $LastValidLocation | Last location info saved at the device | $1,220714,050656,28.758963,N,77.6277844,E,25 |

The tracking data message will carry information in the format as provided in Table 5-3.

**Table 5-3: Tracking Data Format for Type 1 Device**

| Sl. No. | Field | Description | Sample Data |
|---|---|---|---|
| 1 | Start Character | $ | $ |
| 2 | Header | The header of the packet/ identifier | |
| 3 | Vendor ID | Vendor identification header | |
| 4 | Firmware Version | Version details of the Firmware used in EX.1.0.0 | 1.0.0 |
| 5 | Packet Type | Specify the packet type –<br>NR = Normal<br>EA = Emergency Alert<br>TA = Tamper Alert<br>HP = Health Packet<br>IN = Ignition On<br>IF = Ignition Off<br>BD = Battery Disconnect<br>BR = Battery Reconnect<br>BL = Battery Low<br>GE = Geofence Entry / Bus Stop entry<br>GX = Geofence Exit / Bus Stop Exit<br>DI = Depot In shed<br>DO = Depot Out shed | Depending upon the context, every frame from tracking device must carry a qualification code. This helps to determine the state in which vehicle is at that time. |
| 6 | Packet Status | L=Live or H= History | L |
| 7 | IMEI | Identified of the sending unit. 15 digit standard unique IMEI no. | 123456789012345 |
| 8 | Vehicle Registration No | Mapped vehicle registration number | DL1PC9821 |
| 9 | Location Module Fix | 1 = Location Module fix OR 0 = Location Module invalid | 1 |
| 10 | Date | Date value as per location module date time (ddmmyy format) | 220714 |
| 11 | Time | Time value as per location module date time in UTC format (hhmmss format) | 050656 |
| 12 | Latitude | Latitude value in decimal degrees (up to not less than 6 places) | 28.758963 |
| 13 | Latitude Dir | Latitude Direction (N=North, S= | N |

| Sl. No. | Field | Description | Sample Data |
|---|---|---|---|
| | | South) | |
| 14 | Longitude | Longitude value in decimal degrees (up to not less than 6 places). | 77.6277844 |
| 15 | Longitude Dir | Longitude Direction (E=East, W= West) | W |
| 16 | Speed | Speed in km/hr (Upto one decimal value) | 25.1 |
| 17 | Heading | Course over ground in degrees | 310.56 |
| 18 | No of Satellites | Number of satellites used for fix (minimum 5 satellites in vision, to have the fix) | 8 |
| 19 | Altitude | Altitude of the device in meters | 183.5 |
| 20 | PDOP | Positional dilution of precision | 3 |
| 21 | HDOP | Horizontal dilution of precision | 2 |
| 22 | Distance | Distance Travelled in Meters (Between Current and the Previous packet) | 100 |
| 23 | ODO | Total Distance Travelled in Km (from activation of unit to till last packet) Upto one decimal value | 25.8 |
| 24 | Min Speed | Minimum Speed travelled by vehicle between last and the current packet in Km/h (Upto one decimal value) | 2.0 |
| 25 | Avg. Speed | Average Speed between last and the current packet in Km/h (Upto one decimal value) | 5.0 |
| 26 | Max Speed | Maximum Speed travelled by vehicle between last and the current packet in Km/h (Upto one decimal value) | 10.5 |
| 27 | Network Operator Name | Name of Network Operator | XYZ |
| 28 | Ignition | 1= Ignition On , 0 = Ignition Off | 1 |
| 29 | Main Power Status | 0 = Vehicle Battery Disconnected<br>1= Vehicle Battery Reconnected | 1 |
| 30 | Main Input Voltage | Indicator showing source voltage in Volts.(Upto one decimal value) | 12.5 |
| 31 | Emergency Status | 1= On , 0 = Off | 0 |
| 32 | Tamper Alert | C = Cover Closed, O = Cover | C |

| Sl. No. | Field | Description | Sample Data |
|---|---|---|---|
| | | Open | |
| 33 | GSM Signal Strength | Value Ranging from 0 – 31 | 25 |
| 34 | MCC | Mobile Country Code | 404 |
| 35 | MNC | Mobile Network Code | 10 |
| 36 | LAC | Location Area Code | 00D6 |
| 37 | Cell ID | GSM Cell ID | CFBD |
| 38 | NMR (neighboring Cell ID) | Neighbouring 4 cell ID along with their LAC | |
| 39 | Digital Input Status | 4 external digital input status (Status of Input 1 to Input 3 (0=Off; 1=On)) | 000 |
| 40 | Digital Output Status | 2 external digital output status (0=Off; 1=On) | 01 |
| 41 | Geo-fence Stop ID | Identify the particular stop, Default = 0 | U001 |
| 42 | Frame Number | Sequence Number of the messages (000001 to 999999) | 000005 |
| 43 | Checksum | Insures No error in transmission (optimal) | 16 |
| 44 | End Character | Indicated End of the frame | * |

It is recommended that the Type 1 Device should support minimum fields as mentioned above with respect to tracking data. Different devices can provide more fields than specified above. The Type 1 Device should be able to support different frequency of sending the tracking data, in following states:

- Ignition OFF
- Emergency (Emergency state would supersede every other state)
- Ignition ON

### 5.2.4 Health Status Data

The CCTV system device will send the health status data to the backend at specified frequency (configurable parameter). The health status data will comprise the data elements as listed in Table 5-4.

**Table 5-4 : CCTV System Health Status Parameters**

| Sl. No. | Data Element | Remarks |
|---|---|---|
| 1 | mDVR ID | |
| 2 | mDVR Name | |
| 3 | Manufacturer's ID | Unique Identifier for Manufacturer |
| 4 | Date and Time of Health Status | |

| Sl. No. | Data Element | Remarks |
|---|---|---|
| 5 | Device Primary IP | |
| 6 | Device Secondary IP | |
| 7 | Firmware Version | |
| 8 | Protocol Version | |
| 9 | IMEI Number | IMEI number of device |
| 10 | HDD 1 Status | Whether HDD is functioning properly or has any error |
| 11 | HDD 1 Memory Status | Whether memory has exceeded the specified threshold |
| 12 | HDD 2 Status | Whether HDD is functioning properly or has any error |
| 13 | HDD 2 Memory Status | Whether memory has exceeded the specified threshold |
| 14 | Camera 1 Recording Status | |
| 15 | Camera 2 Recording Status | |
| 16 | Camera 3 Recording Status | |
| 17 | Camera 4 Recording Status | |
| 18 | Camera 5 Recording Status | |
| 19 | Camera 6 Recording Status | |
| 20 | Camera 7 Recording Status | |
| 21 | Camera 8 Recording Status | |
| 22 | Microphone 1 Recording Status | |
| 23 | Microphone 2 Recording Status | |
| 24 | Microphone 3 Recording Status | |
| 25 | Microphone 4 Recording Status | |
| 26 | Microphone 5 Recording Status | |
| 27 | Microphone 6 Recording Status | |
| 28 | Microphone 7 Recording Status | |
| 29 | Microphone 8 Recording Status | |
| 30 | Ignition Status | Whether Ignition is ON or OFF |
| 31 | Emergency Buttons Status | |

It will be possible to configure the mDVR to send an image at CIF resolution from each camera on the vehicle to the backend along with the health status. The images will be accompanied with the metadata, as listed in the sub-section 5.2.1 above.

### 5.2.5 Alert Data

In case of press of any Emergency Button, the mDVR will get the input regarding the Emergency Alert. The mDVR will immediately send the Emergency Alert data to the backend. The Emergency Alert data will be prioritised above all other type of data scheduled to be sent by the device to the backend. In addition, the mDVR will also send alert data in case of specified events like SIM card ignition on, ignition off, SIM

card removed, etc. A list of such alerts that CCTV Device will send to the backend server is provided in Table 5-5:

**Table 5-5: Alerts Supported for the CCTV Device**

| Sl. No. | Message | Remarks |
|---|---|---|
| 1 | Alert – Ignition ON | Indicates that Vehicle has started (ignition ON) |
| 2 | Alert – Ignition OFF | Indicates that Vehicle has stopped (ignition OFF) |
| 3 | Alert – SIM removed or tampered | Message would be generated indicating SIM is removed or tampered |
| 4 | Alert – SIM inserted or tamper removed | Message would be generated indicating SIM is inserted or tamper is removed |
| 5 | Alert – Device enclosure opened | |
| 6 | Alert – Emergency state ON | When any of the emergency buttons is pressed by any passenger. System should also provide location of emergency button which is pressed. |

In addition to the above alerts, certain additional alert messages will be sent by Type 1 CCTV Device to the backend, as provided in Table 5-6:

**Table 5-6: Additional Alerts Supported for the Type 1 CCTV Device**

| Sl. No. | Message | Remarks |
|---|---|---|
| 1 | Alert – Geo-fence Entry | Applicable for Vehicles which are authorized to run on a defined route or within a geographic area only.<br>Triggered when vehicle enters a geo-fence |
| 2 | Alert – Geo-fence Exit | Applicable for Vehicles which are authorized to run on a defined route or within a geographic area only.<br>Triggered when vehicle exits a geo-fence |

## 5.3 Data to be Sent by Backend to CCTV Devices

### 5.3.1 Configuration Parameters Update

There may be a requirement to change the configuration parameters of various CCTV System Devices from the back-end. The list of such configuration parameters of CCTV cameras and mDVR (or mNVR) that could be changed from the backend is provided in Table 5-7.

**Table 5-7 : CCTV Devices Configuration Parameters**

| Sl. No. | Configuration Parameter | Remarks |
|---|---|---|
| 1 | Camera Main Stream Video Resolution | Main Stream will be for local recording |

| Sl. No. | Configuration Parameter | Remarks |
|---|---|---|
| 2 | Camera Main Stream Image Quality | |
| 3 | Camera Main Stream Bitrate | |
| 4 | Camera Main Stream Bitrate Type | |
| 5 | Camera Main Stream Max Bitrate | |
| 6 | Camera Main Stream Frame Rate | |
| 7 | Camera Main Stream I Frame Interval | |
| 8 | Camera Sub Stream Video Resolution | Camera Sub Stream will be for transmission to backend in case of press of Emergency Button |
| 9 | Camera Sub Stream Image Quality | |
| 10 | Camera Sub Stream Bitrate | |
| 11 | Camera Sub Stream Bitrate Type | |
| 12 | Camera Sub Stream Max Bitrate | |
| 13 | Camera Sub Stream Frame Rate | |
| 14 | Camera Sub Stream I Frame Interval | |
| 15 | Camera Video Recording Enable/ Disable | |
| 16 | Camera Audio Recording Enable/ Disable | |
| 17 | Camera Name for display | |
| 18 | Camera Name Display X-coordinate | |
| 19 | Camera Name Display Y-coordinate | |
| 20 | Camera OSD Date Format | Camera On Screen Display |
| 21 | Camera OSD X-coordinate | |
| 22 | Camera OSD Y-coordinate | |
| 23 | Camera OSD Type | Transparent, Non-transparent, Flashing, Non-Flashing |
| 24 | Camera Schedule based Recording – On/Off | In case of Camera Schedule based Recording – Off, it will be All-day recording |
| 25 | Camera Record Schedule – WeekDay; Start Time; End Time | In case of Camera Schedule based Recording On only<br>Can be different for different days of week |
| 26 | Camera Video Expired Time (Number of Days) | Time for keeping the recording in local storage.<br>Recording will be permanent (will be overwritten on cyclic basis), in case, Camera Video Expired Time is set as 0. |
| 27 | Camera Record based on Motion Detection – On/Off | |

| Sl. No. | Configuration Parameter | Remarks |
|---|---|---|
| 28 | Camera Record based on Motion Detection – Sensitivity | |
| 29 | Camera Record based on Motion Detection – Area for Motion Detection | |
| 30 | Camera Pre-record Time for Event Trigger | |
| 31 | Camera Post-record Time for Event Trigger | |
| 32 | Camera Text Overlay – Text | |
| 33 | Camera Text Overlay – X-coordinate | |
| 34 | Camera Text Overlay – Y-coordinate | |
| 35 | mDVR Clock Time | To set the mDVR clock time |
| 36 | mDVR Post Ignition-Off Duration | |
| 37 | Get mDVR Firmware Version | |
| 38 | Get mDVR Protocol Version | |
| 39 | Get mDVR MAC Address | |
| 40 | Get mDVR Primary IP Address | |
| 41 | Set mDVR Primary IP Address | |
| 42 | Get mDVR Secondary IP Address | |
| 43 | Set mDVR Secondary IP Address | |
| 44 | Set Port Number | |
| 45 | Configure Vehicle Registration Number | |
| 46 | Change APN | |
| 47 | Configure time duration for Emergency state | |
| 48 | Get IMEI number of mDVR | |
| 49 | Reboot/Reset mDVR | |

The above parameters will be applicable for both Analog CCTV System as well as IP CCTV System. In case of IP CCTV System, mDVR will be read as mNVR.

It will be possible to set the parameters at Sl. 1 to 34, separately for each camera, based on Camera-ID.

In addition to the configuration parameters listed in Table 5-7 above, certain additional parameters can be configured for Type 1 mDVR or mNVR, as provided in Table 5-8.

**Table 5-8: Additional Configuration Parameters for Type 1 CCTV Devices**

| Sl. No. | Configuration Parameter | Remarks |
|---|---|---|
| 1 | Set frequency of vehicle tracking data transmission in Ignition ON state | Set or modify polling rate of vehicle tracking data when vehicle ignition is 'ON' |

| Sl. No. | Configuration Parameter | Remarks |
|---|---|---|
| 2 | Set frequency of vehicle tracking data transmission in Ignition OFF state | Set or modify polling rate of vehicle tracking data when vehicle ignition is 'OFF' |
| 3 | Set frequency of vehicle tracking data transmission in Emergency state | |
| 4 | Create Geo-fence | |
| 5 | Delete Geo-fence | |
| 6 | Increase the number of geo-fences | |

For each Configuration update message, the mDVR (or mNVR in case of IP CCTV System) will return a success message on successful update.

### 5.3.2 CCTV Devices Firmware Upgrade

There may be a requirement to upgrade the firmware of the CCTV Devices (mDVR or mNVR) for enhancement of any functionality or removal of any error. It will be possible to upgrade the firmware of the CCTV Devices from the backend over-the-air. This will also include any upgrade of protocol of communication between CCTV Devices and backend. For upgrade of CCTV Device firmware, the backend will first get the current firmware version of the CCTV Device using command 'Get mDVR Firmware Version' (or Get mNVR Firmware Version). In case, the firmware version is not matching the latest firmware version and needs to be upgraded, the backend will send a message to the mDVR or mNVR, as the case may be, with the new firmware file.

For each firmware version upgrade message, the mDVR (or mNVR in case of IP CCTV System) will return a success message on successful upgrade.

## 5.4 SMS Fall back

In case, the mDVR or mNVR is in emergency mode (i.e. within a specified duration of pressing of Emergency Button), the device will shift to the SMS mode in case both 3G and GPRS connectivity are not available. In such case, the device will send the Alert message, health status data and tracking data (in case of Type 1 device) through SMS mode. Since SMS has the limitation of sending only 160 characters, so the tracking data to be sent in one SMS will have fields - IMEI, Latitude, Direction, Longitude, Direction, location fix, speed, Cell ID, LAC, Date and Time.

# 6.0 CCTV DEVICES TESTING

## 6.1 Introduction

The CCTV devices are expected to work in a challenging automotive environment of dust, vibration, heat etc. The following sections provide the details of recommended key tests that the device models need to be subjected to in order to get assurance on their performance characteristics. The final set of tests and related details would be provided as part of the device empanelment document.

## 6.2 Functional Testing

Functional testing will be carried out to assess the performance of the CCTV devices on important functional aspects as below:

### 6.2.1 Image Quality Test

***Applicable for***: Analog and IP Cameras

The CCTV devices in vehicles are subjected to a wide range of light condition such as bright light, low light, etc. The CCTV cameras will be tested for image quality in varying light conditions including bright light at a spot, overall bright light, low light and in no light with IR on.

***Acceptance Criteria***: The images captured by the camera in different light conditions should be clear without any blur or haziness.

### 6.2.2 Camera Resolution Test

***Applicable for***: Analog and IP Cameras

The CCTV cameras will be tested for meeting the camera resolution specification. The analog camera will be tested for meeting the requirement of 600 TV Lines, 752 (H) x 582 (V) resolution. The IP camera will be tested for meeting the requirement of 0.4 megapixels, 800 x 600 pixels.

***Acceptance Criteria***: The camera resolution meets the prescribed specification.

### 6.2.3 Camera IR Test

***Applicable for***: Analog and IP Cameras

The Infrared capability of CCTV cameras is used to capture images in low light or no-light conditions. The cameras will be tested for their IR capability. The cameras should be able to switch on the IR and shift to monochrome image capture automatically in case of insufficient light conditions. The camera should automatically switch off the IR and shift back to colour image capture, in case light conditions improve.

With IR on, the camera should be able to capture clear image for objects up to 10 meters range.

***Acceptance Criteria***: The camera switches IR on and off automatically and capture clear images for objects up to the specified IR range.

### 6.2.4 IP Camera Video Compression Support

***Applicable for***: IP Cameras

The IP CCTV cameras should support H.264, MPEG-4 and M-JPEG video compression standards. The IP CCTV cameras will be tested for supporting all these compression standards. The future IP CCTV cameras which support H.265 video compression standard, will be tested for this also.

***Acceptance Criteria***: The IP CCTV camera should support H.264, MPEG-4 and M-JPEG video compression standards. The future IP CCTV cameras should support H.265 video compression standard also.

### 6.2.5 IP Camera Frame Rate

***Applicable for***: IP Cameras

The IP CCTV cameras should be able to capture images in varying frame rate ranging from 1 fps to 25 fps for all resolutions supported by the camera. The capability of camera to capture images at different frame rates will be tested at different resolutions (equivalent to QCIF, CIF and 4CIF).

***Acceptance Criteria***: The IP CCTV camera should be able to capture images at varying frame rates ranging from 1 to 25 fps at all supported resolutions.

### 6.2.6 IP Camera Audio Compression Support

***Applicable for***: IP Cameras

The IP CCTV cameras should support G.711 and G.726 audio compression standards. The IP CCTV cameras will be tested for supporting both these compression standards.

***Acceptance Criteria***: The IP CCTV camera should support G.711 and G.726 audio compression standards.

### 6.2.7 mDVR/mNVR Video Compression Support

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should support H.264, MPEG-4 and M-JPEG video compression standards. The video recorder will be tested for supporting all these compression standards. The future mDVR and mNVR which support H.265 video compression standard, will be tested for this also.

***Acceptance Criteria***: The video recorder should support H.264, MPEG-4 and M-JPEG video compression standards. The future video recorders should support H.265 standard also.

### 6.2.8 mDVR/mNVR Audio Compression Support

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should support G.711 and G.726 audio compression standards. The video recorder will be tested for supporting all these compression standards.

***Acceptance Criteria***: The video recorder should support G.711 and G.726 audio compression standards.

### 6.2.9 mDVR/mNVR Recording Resolution

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should be capable of recording video at different resolutions which would be configurable individually for each channel. The video recorder will be tested for recording of video at different resolutions individually for each channel.

***Acceptance Criteria***: The video recorder should be capable of recording video at 4CIF, 2CIF, CIF and QCIF resolutions (equivalent for mNVR) set individually for different channels.

### 6.2.10 mDVR/mNVR Dual Stream Capability Testing

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should be capable of capturing video in dual stream mode in which both streams can be configured separately for each camera resolution and frame rate. The video stream at high resolution and frame rate is used for recording in local storage whereas the other stream at lower resolution and frame rate can be transmitted to backend server over-the-air, if required. The video recorder will be tested for recording of video in dual stream at different camera resolutions and frame rates set individually for each stream.

***Acceptance Criteria***: The video recorder should be capable of recording video in dual stream, each stream at different camera resolution and frame rate.

### 6.2.11 mDVR/mNVR Recording Modes Testing

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should be capable of initiating and stopping recording in the following modes:

- Normal mode – the video recorder records continuously.
- Schedule based – the video recorder records as per the specified schedule. The schedule can be configured for different time spans for different week days.
- Alarm triggered – the recorder starts recording in case an alarm is triggered and continues the same for a pre-specified duration.
- Motion detection – the recorder starts recording on detection of motion in the pre-specified detection zone and continues the same for a pre-specified duration.
- Event based pre and post recording – in case of an event or alarm, the recorder tags the recording for a specified duration preceding and post event. The durations for tagging of recording pre and post event can be configured separately in the range of 1 to 15 minutes and 1 to 60 minutes respectively, both

in the steps of 1 minute.

- Shut down delay after ignition off – the recorder shuts down after a specified duration after the vehicle ignition is switched off. The shut-down delay duration can be configured in the range of 5 minutes to 4 hours.

The video recorder will be tested for each of the above configurations for different values of the parameters in the steps of 5 minutes, covering the entire range specified for the parameter.

***Acceptance Criteria***: The video recorder should be capable of recording in each of the above modes for the entire range of values specified for different modes.

### 6.2.12 mDVR/mNVR Video Overwriting Testing

***Applicable for***: mDVR and mNVR

The mDVR and mNVR will have limited storage capacity to store the video. So, the video recorder should be capable of overwriting the old video on FIFO (first in first out) basis. Also, the event tagged video recording should not be overwritten for a configurable period. The video recorder will be tested for capability of overwriting old video on FIFO basis and to retain the event tagged video for a period configurable between 7 to 30 days.

***Acceptance Criteria***: The video recorder should be capable of overwriting the old video when the storage capacity is about to exhaust. The video recorder should be able to retain the event tagged video for a configurable period in the range of 7 to 30 days.

### 6.2.13 mDVR/mNVR Data Download Testing

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should support downloading of data (video and audio files) from its local storage to an external device such as a laptop. It should be possible to connect the external device to the video recorder through network cable on RJ45 port and open its user interface in a standard browser using a standard URL such as http://dvr (or any other text specified by MoRTH) without having to configure the laptop's network settings.

After entering user-id and password (specified by MoRTH), it will be possible to search, view, select and download video clips of desired duration and date/time in standard formats such as .avi or .mpg. It will not be possible to delete any video or change configuration settings using this set of user-id and password. There will be a separate set of user-id and password for setting/modifying configuration parameters of the mDVR and mNVR.

The video recorder will be tested for download of video and audio data from its local memory, as per the above process. Also, it will not be possible for the user to delete any video or change any configuration settings.

***Acceptance Criteria***: The video recorder should support the capability of downloading video and audio data as per the above process.

### 6.2.14 mDVR/mNVR Data Communication Testing

***Applicable for***: mDVR and mNVR

The mDVR and mNVR should support data transfer to backend server on both 3G as well as 2G connectivity. In case the vehicle moves to an area where 3G coverage is not present, the video recorder should automatically shift to GPRS (2G) connectivity to send the health status data. Also, in such case, on press of an emergency button, the video recorder should automatically shift to a lower frame rate and resolution (both configurable) and send the video from cameras to the backend server over GPRS (2G).

The video recorder will be tested for data transfer on both 3G and 2G and automatically shift from one connectivity to the other. The video recorder will also be tested for the capability to shift to a lower frame rate and resolution (configurable) and send the video from cameras to the backend server over GPRS (2G).

***Acceptance Criteria***: The video recorder should support data transfer on both 3G and GPRS (2G) and automatically shift to lower frame rate and resolution when 3G is not available for video transfer to backend.

### 6.2.15 mNVR Power-over-Ethernet (PoE) Test

***Applicable for***: mNVR

mNVRs will be required to provide power to cameras over Ethernet. The mNVR will be tested for its capability to provide power to all the cameras connected to it through PoE, in varying power requirement conditions such as camera IRs switched on or switched off.

***Acceptance Criteria***: The mNVR should be able to provide power to all the cameras connected to it over PoE for all the power requirement conditions of the cameras.

### 6.2.16 IP Camera and mNVR ONVIF Compliance Testing

***Applicable for***: IP Cameras and mNVR

The IP CCTV cameras and mNVR should be ONVIF Profile S compliant to ensure integration of IP CCTV equipment from different suppliers. The IP CCTV cameras and mNVR will be tested for compliance to ONVIF Profile S standards.

***Acceptance Criteria***: The IP CCTV camera and mNVR should be compliant to ONVIF Profile S standards.

## 6.3 Performance and Durability Testing

The CCTV devices (cameras and video recorders) will need to be tested for performance in the challenging vehicle environments of vibration, dust, fluctuating power supply etc.

### 6.3.1 Shock and Vibration Test

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

The CCTV devices (cameras and video recorders) in vehicles are subjected to a harsh environment in terms of shocks and vibrations and that too for extended period of time. Two tests are recommended based on the nature of application environment.

**Shock**: Shock test is performed to provide a degree of confidence that the device can physically and functionally withstand the relatively infrequent, non-repetitive shocks encountered in transportation environments. This test provides an assessment of the effect of the shocks on the performance of the device. The test shall be performed as per relevant parts of EN 60068 standard or equivalent.

***Acceptance Criteria***: Device after the shock test shall meet the the requirements of functional tests.

**Vibration**: This test is performed to check that the device can physically and functionally withstand the vibration exposures in the life cycle typically encountered in a vehicular environment. The test shall be performed as per relevant parts of EN 60068 standard or equivalent.

***Acceptance Criteria***: Device after the vibration test shall meet the the requirements of functional tests.

### 6.3.2 Ingress Protection (IP)

***Applicable for***: Analog and IP cameras

The CCTV cameras must be able to work in dusty environment that are typically encountered by the public transport vehicles where these would be installed. IP rating (IS/IEC 60529) is used for specifying the environmental protection characteristics of the CCTV cameras. The cameras will be tested for dust and water ingress according to IP 66 test specification.

***Acceptance Criteria***: The camera should be IP66 compliant or better.

### 6.3.3 EMI /EMC

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

The Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) tests are performed to assess whether a CCTV device (camera or video recorder) performs its intended functions in the electromagnetic environment to which it would be exposed. Further, the device should not generate electromagnetic disturbances that may influence other equipment in the vicinity.

Note: In case the device is ‘e’ marked as per The Automotive Electromagnetic Compatibility Directive (AEMCD) and a detailed test report is submitted (which includes above tests), no fresh testing would be required.

***Acceptance Criteria***: The device should meet the EMI/EMC requirements as per AIS 004 (Part 3) or equivalent.

### 6.3.4 High voltage/ Current Test

***Applicable for***: mDVR and mNVR

The video recorder shall operate under the automotive environment of fluctuating voltage and high current. The test shall be carried out as per ISO 7637 to assess the device performance under such conditions.

***Acceptance Criteria***: The device should be able to withstand the simulated test volt and current levels to which it will be exposed during the test without degradation in performance.

### 6.3.5 Reverse Polarity Protection without Fuse

***Applicable for***: mDVR and mNVR

The video recorder must fulfil the functional requirements after being subjected to reverse polarity based on the input voltage rating of the device.

***Acceptance Criteria***: Device shall meet the requirements of functional tests, after the reverse polarity test.

### 6.3.6 Test for Wiring Harness

***Applicable for***: All wiring for Analog cameras, IP cameras, mDVR and mNVR

Flammability Test: The wiring harness used in the device should be tested for flammability as per IS 2465.

Electrical Properties: The wiring harness used in the device should be tested for electrical properties as per AIS 028.

## 6.4 Environmental Test

The following testing should be carried out as part of environmental testing:

### 6.4.1 High Temperature Test

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

The high temperature test is used to evaluate effects of high temperature conditions on safety, integrity, and performance of the CCTV devices (cameras and video recorders). The test shall be carried out in accordance with Indian Standard IS: 9000 (Part 3/Sec 5) or EN60068 or MIL-STD-810 F Method 501.4 or equivalent. The device shall be subjected to the high temperature test conditions as per device specification.

***Acceptance Criteria***: Device during and after the high temperature test shall meet the requirements of functional tests.

### 6.4.2 Cold Test

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

The temperature testing is used to evaluate effects of low temperature conditions during storage and operation affect safety, integrity and performance on the CCTV devices (cameras and video recorders). The test shall be carried out in accordance with Indian Standard (IS): 9000 (Part 2/Sec 4) or EN60068 or MIL-STD-810 F

Method 502.4 or equivalent. The device shall be subjected to low temperature conditions as per device specification.

***Acceptance Criteria***: Device during and after the cold test shall meet the the requirements of functional tests.

### 6.4.3 Damp Heat Test

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

The temperature and humidity conditions change based on geographical locations and time. The purpose of this test is to determine the effects of a warm, humid atmosphere on the CCTV devices (cameras and video recorders) performance. The device should be tested according to IS 9000 (Part 5/Sec 2) or MIL-STD-810F Method 507.4 as per the device specification of 95% Humidity.

***Acceptance Criteria***: Device during and after the test shall meet the requirements of functional tests.

### 6.4.4 Temperature Shock

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

Temperature shock test is carried out to determine if the CCTV devices (cameras and video recorders) can withstand sudden changes in the temperature of the surrounding environment without experiencing physical damage or deterioration in performance. The device shall be tested as per relevant parts of EN 60068 standard or equivalent.

***Acceptance Criteria***: Device after the test shall meet the requirements of functional tests.

### 6.4.5 Salt Spray Test

***Applicable for***: Analog cameras, IP cameras, mDVR and mNVR

The salt spray test is conducted to check corrosion resistance of CCTV devices (cameras and video recorders). Salt spray test is an accelerated corrosion test that produces a corrosive attack on the device sample. The device shall be tested as per AIS: 012/ IS10250.

***Acceptance Criteria***: Device after the test shall meet the requirements of functional tests.

## 6.5 Protocol Testing

Protocol is a set of rules to be followed by the device while sending data to the backend. The protocol comprises data update rate, number of fields, start character, end character, alert type etc. as detailed in chapter 5.0.

Protocol testing involves checking the compliance of data sets received by the backend against the protocol both with respect to the data fields as well the format. It is expected that the data coming to a central server should be exactly as required under the protocol.

The following testing will be performed as part of the protocol testing:

- The capability of the video recorder to send various types of data messages to the server in the protocol specified for the corresponding message.
- The capability of the video recorder to receive and correctly interpret messages from the server with respect to configuration update.
- The capability of the video recorder to upgrade its firmware over-the-air on receipt of the same from server.

## 6.6 Additional Testing for Type 1 mDVR and mNVR

The following additional testing will be carried out for Type 1 mDVR and mNVR with respect to vehicle tracking related features.

- Location Accuracy Test
- Cold Start Time to First Fix (TTFF) Test
- Warm Start Time to First Fix Test
- Hot Start Time to First Fix Test
- Acquisition Sensitivity Test
- Tracking Sensitivity Test
- Interference Testing
- Multipath Testing
- Protocol Testing with respect to tracking data
- Memory Storage Test
- Geofencing Test

The details and acceptance criteria for the above tests is provided in the document titled ‘Detailed Specifications Document for Vehicle Tracking Device’ prepared as part of the scheme.

## 7.0 REFERENCES

The following is a list of documents that have been referred to in the preparation of this report.


- MoRTH approval note on the project
- MoRTH scheme for the project
- Concept Report for the project
- Technology Analysis Report for the project
- Urban Bus Specifications – II, Ministry of Urban Development, Government of India (MoUD)
- CCTV Related Tender Documents: Delhi Transport Corporation (DTC), Bangalore Metropolitan Transport Corporation (BMTC), Haryana Roadways (HR), Pune Mahanagar Parivahan Mahamandal Ltd. (PMPML)

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