



# TECHNICAL REPORT

## M2M ENABLEMENT IN INTELLIGENT TRANSPORT SYSTEMS

TEC-TR-S&D-M2M-003-01  
M2M AUTOMOTIVE WORKING GROUP



TELECOMMUNICATION ENGINEERING CENTRE  
DEPARTMENT OF TELECOMMUNICATIONS  
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रवि शंकर प्रसाद  
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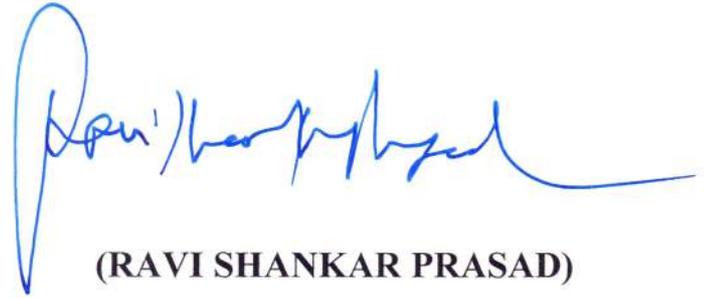
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### Message

I am glad to note that Telecommunication Engineering Centre is bringing out Technical Reports on M2M enablement in Transport, Health, Power and Safety & Surveillance sectors and a Report on M2M Gateway & Architecture.

M2M communications is going to change the way the humans live and control their surrounding as well as various social and economic sectors operate. It is expected to improve the efficiency of various sectors such as Automotive, Health, Power and Safety & Surveillance etc. by transmitting the information electronically and automation of information processing. It will help in providing quality services to our citizens.

I am confident that the Technical Reports will help in developing specifications/ standards to be used in India and opportunity of manufacturing wide variety of devices and other products in India. I congratulate TEC and all concerned for this commendable work which is very timely, and wish them success in all their endeavors.



(RAVI SHANKAR PRASAD)

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**08<sup>th</sup> May 2015**

## **Message**

I am extremely happy to note that Telecommunication Engineering Centre (TEC) is bringing out Technical Reports regarding M2M enablement in Intelligent Transport System, Health, Power, Security and Surveillance and a Technical Report on Gateway an Architecture of M2M communications.

2. While Government started the work of developing roadmap for M2M communications in India, TEC at the same time initiated the work of identifying technical requirements of Automotive, Health, Power, Safety and Surveillance sectors. As there has been active participation from stakeholder of each sector, the reports have taken into account the ground level status and requirement for M2M enablement.

3. India has to make strides in making its various sectors smart for which quick adoption of M2M is the necessary. These reports will help stakeholders in development and finalization of sectors specific plans for adoption of M2M.

4. I appreciate the efforts put in by Telecommunication Engineering Centre in bringing out these reports. I wish them success in all their endeavours.

**(Rakesh Garg)**  
**Secretary(Telecom)**



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## Message

I am happy to note that Telecommunication Engineering Centre (TEC) is bringing out technical reports regarding M2M enablement in Intelligent Transport System, Health, Power, Security and Surveillance and a report of Gateway an Architecture of M2M communications. We are aware that adoption of M2M communication will inter-alia, lead to enhancement in the efficiency of various sectors of society and economy.

Need for improvement in efficiency in various socio-economic sectors has been felt for a long time and some efforts in this direction have also been made whereby M2M based systems have been deployed. However, the solutions which have been implemented are generally based on propriety platforms. However, to achieve smart processes and functioning in all the sectors, interoperability of devices/ platforms/ applications is necessary which entails adoption of open standards.

The technical reports of TEC are a good step in this direction and will certainly help various stakeholders to take preparatory steps in their respective sectors for future adoption of M2M communications.

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## Message

I am pleased to note that Telecommunication Engineering Centre (TEC) is bringing out Technical Reports regarding M2M enablement in Intelligent Transport System, Health, Power, Security and Surveillance and a report on Gateway & Architecture of M2M communications.

TEC has taken timely action to take up the work of study and preparation of the Technical Reports in the Automotive, Health, Power, Safety and Surveillance sectors. The Reports have been prepared to be released along with the National M2M roadmap by virtue of relentless efforts of TEC and its Working Groups consisting of stake holders.

M2M communication is an opportunity for India not only to keep pace with the world but also to march ahead in development of specifications of new products consisting of Devices, Gateways and Platforms meeting the Indian requirements, though of course, in sync with the standards.

I appreciate the efforts of Telecommunication Engineering Centre specially its S&D Division and all the Working Groups for bringing out these technical reports in a very timely manner. I wish them success in all their endeavours.

  
(A.K. Bhargava)

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## FOREWORD

Telecommunication Engineering Centre (TEC) is an organ of Department of Telecommunications (DoT). It provides technical support to DoT. TEC develops technical specifications of products for use in telecom networks. It carries out technology studies and proactively takes up development of specifications based on such studies. Development of specifications is a transparent process with active participation of stakeholders. Certification of telecom products is also one of its activities.

M2M Communication is an area which has rapidly attracted attention of world over, primarily due to its enormous potential in bringing about fundamental changes in the delivery and use of services in almost all sectors of economy and society and the quality of human life.

M2M systems have been in use for some time past, e.g. in automotive sector. However, the use of technology/devices/application is generally proprietary in nature as standards have started involving in the recent past. We are aware that variety of social and economic activities are interdependent and in today's digital world, it is possible to link them through networks and applications to achieve enhancement in efficiency and development of new services. This is possible only when there is interoperability among devices/networks/applications. This requires standardization and development of harmonized specifications.

Towards achieving this objective, TEC in consultation with stake holders from government, industry, standards bodies and sector users, took up study of four sectors to begin with namely Automotive, Health, Power, Safety and surveillance. Four working groups (WG), one for each were formed with the participation from stakeholders as mentioned above. As it is also necessary to work out architecture for M2M domain and also service delivery models, Gateway and Architecture WG was also formed. All the groups have overwhelming participation. Chairmen, Rapporteurs & Co-rapporteurs have been elected by the WGs themselves. Joint Working Group is chaired by Sr. Deputy Director General and Head TEC.

These groups have carried out use case studies and analysis for respective sectors. Beginning the year 2014, these groups have worked relentlessly. This can be gauged from the fact that there were about 50 conference calls and four Face to Face (F2F) meetings combined of all groups and lot of many interactions within the groups. Services and Development (S&D) Division of TEC coordinated and managed the entire activity of formation of working groups, holding meetings, preparation of the reports etc.

The reports contain use cases in the sectors & their technical analysis, key challenges in implementation and the way forward. Suggestions for way forward those have emerged, require action by various stake holders as well as by TEC and the Working Groups. TEC and the Working Groups will continue further work and it is planned to bring out next release of Technical Report after further study as early as possible.

I express my sincere thanks to all the Chairmen, Rapporteurs and Co-rapporteurs and members of the Working Groups as well as the participating stakeholders as organization and as persons whose enthusiastic support and untiring efforts have made it possible to bring out these detailed reports.

Ultimate aim is to identify the areas for development of standards, harmonize Indian standards with international standards and development of product specifications ensuring interoperability. India being a big market for M2M, there is enormous potential of manufacturing devices and networking products for M2M in India. Let us all join hands to become part of the 'Make in India' programme of the Government of India.

I hope that the report will provide guidance to the stakeholders to plan standardized deployments in the concerned sectors. I also hope that the stake holders will provide their continued support to TEC to carry out further work in M2M domain. We will be enriched in our work through valuable suggestions from any quarter.



(A.K.Mittal)

**Sr. Deputy Director General & Head  
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## Executive Summary

Transportation is backbone of any nation and is considered as major factor that further fuels economic growth. However, there are serious concerns on the negative impact of transportation on human health and environment. Three main concerns dominate when we think of innovation in transportation, namely reduction in commutation time, in accidents and in emissions.

Over the past decades, computer system and advance communication technology has highly developed and raised hope that ICT can benefit motor vehicle transport by introducing of ITS. ITS encompasses a wide range of technologies that address concerns related to transportation.

The rapidly increasing vehicle population in India puts a heavy demand on traffic management in metropolitan cities and other towns. Intelligent Transportation System is an established route to address this and minimize traffic problems.

This document of Telecom Engineering Centre describes M2M enablement in Intelligent Transport System. It introduces the subject with brief illustration of M2M communication and its framework for Intelligent Transport System.

The report has identified 35 use cases in Intelligent Transport System e.g. eCall, Fleet Management, Ambulance, Public Safety, Pollution under Control Check Automation etc.

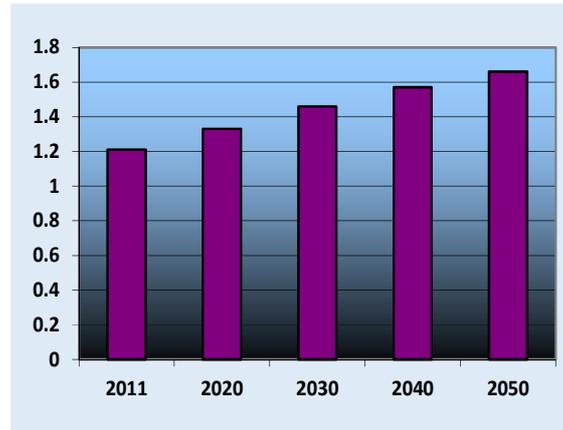
The report identifies key challenges: lack of standards and ITS architecture, KYC norms, indigenous manufacturing etc. Standards will allow for a level playing field for all participants and also for customers.

The report suggests way forward wherein action points on various aspects such as collaborative efforts, promotion of entrepreneurship, lack of national data sharing standards and data policy etc. have been brought out.

With a robust IT and telecom infrastructure in place, India stands to gain from the use of ITS to alleviate urban transport issues. Use of such technologies can be vehicular or infrastructural. As the Indian economy progresses and urbanization in India increases, use of ITS and its importance will increase proportionately. The unique ecosystem and diverse challenges creates plenty of room for R&D for creation of suitable technologies in India.

# 1 Introduction

Transport is an important part of India's economy. Since the economic liberalisation of the 1990s, infrastructure development has progressed rapidly; today there are a variety of modes of transportation i.e. by land, water and air. Since Population of India is rapidly growing from last few decades so it is demand of hour is to find out more sophisticated means of transportation.

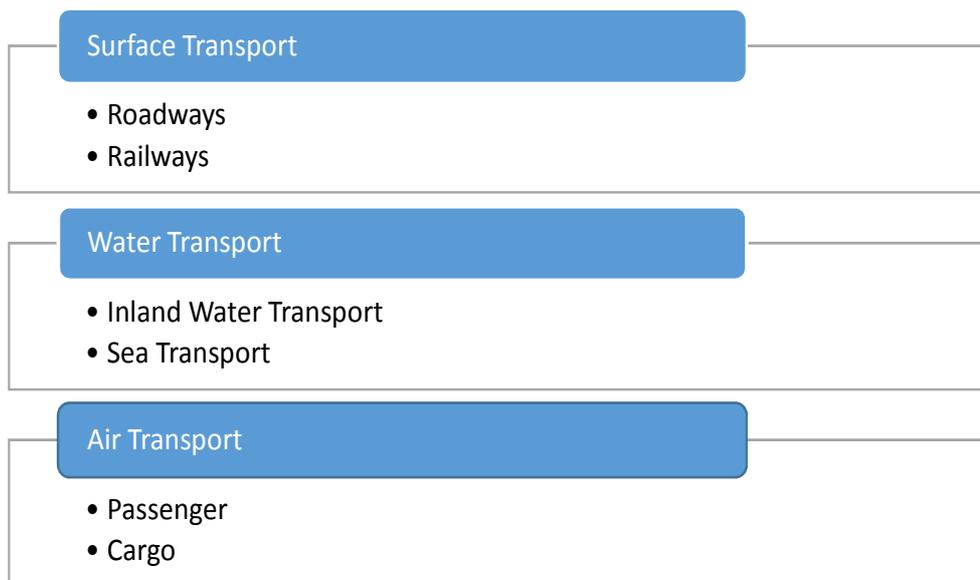


**FIGURE 1: POPULATION GROWTH OF INDIA**

Public transport remains the primary mode of transport for majority of the population, and India's public transport systems are among the most widely used transportation system in the

world. India's rail network is the fourth longest and the most heavily used system in the world, transporting 8,224 million passengers and over 969 million tonnes of freight annually, as of 2012.

There are various medium for transportation as classified below:

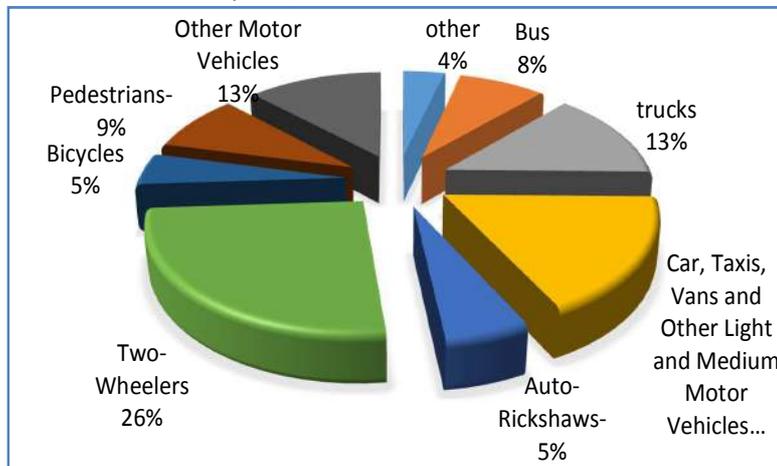


**FIGURE 2: TYPES OF TRANSPORT MEDIUM**

## 1.1 Surface Transport

### 1.1.1 Roadways

Road Transport is one of the most important modes of transport, originating from ancient civilizations. Gradually it became more and more popular means of transport. Road Transport is further subdivided into Vehicular Transport (Cars, Trucks, Buses, Lorries, Autoricksaws, two-wheelers, Bullock Carts,



Tongas, Tumtums, and Hand Carts etc.) and Non-vehicular Transport (Pedestrians and Animals) Indian transport industry has seen an exponential growth in the last decade. Currently, it is estimated that India is home to more than 140 million vehicles, which is also a cause of some major challenges, which India is facing. Figure 3 shows the

**FIGURE 3: TYPES OF ACCIDENT ON INDIAN ROADS**  
categories of commuters who get killed in road accident in India.

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*Transport Sector contributes to about 6% of GDP whereas road transportation has share more than 75%. Roads carry almost 90% of the country's passenger traffic and 65% of its freight. Total Road Length 4.32 million km.*

*Source: - Presentation of CSIR on Issues related to Toll Road in India*

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### 1.1.2 Railways

Railways have been the pioneer of modern mechanical transport. It has brought the greatest revolution in transport. It accelerated commercial and industrial development of various countries. Until the introduction of Motor Transport, Railway had the monopoly as the Land Transport. In India, it is the principal means of transport. It carries over 80 per cent of goods traffic and over 70 per cent of passenger traffic. It spreads for more than 60000 kilometres across the country.

## 1.2 Road network in India

A good road network is a critical infrastructure requirement for rapid growth. It provides connectivity to remote areas; provides accessibility to markets, schools, and hospitals; and opens up backward regions for trade and investment. Roads also play an important role as connecting channel among airports, railway stations, and ports.

India has one of the largest road networks in the world, of 33.14 lakh km, consisting of

- National highways (NHs)
- State highways (SHs)
- District roads (MDRs)
- RRs that include other district roads and village roads.

NHs with a length of 92851 km comprises to only 2.0% of the road network, but carries 40% of the road-based traffic. SHs with a length of about 1,37,000 km and MDRs with a length of 3,00,000 km together constitute the secondary system of road transportation, contributing significantly to the development of the rural economy and industrial growth of the country. The secondary system also carries about 40% of the total road traffic, although it constitutes about 13% of the total road length. RRs, once adequately developed and maintained, hold the potential to provide rural connectivity vital for generating higher agricultural incomes and productive employment opportunities besides promoting access to economic and social services.

TABLE 1: DETAILS OF INDIAN ROADS

S. No.	Category of Road	Length in Km.
1	Total road network	48.65 lakhs
2	National Highways	92,851
3	State Highways	1,38,489
4	Major District Road, Rural road & Urban road	46.34 lakhs

In India, there are various means of public transport. Below is the description of the some transport options.

### 1.2.1 Mass Transit System

Mass transit system refers to public shared transportation, such as trains, buses, ferries etc. that can commute a larger number of passengers from origin to destination on a no-reserved basis and in lesser time.

Rapid transit is an important form of mass transit such as subways and surface light rail systems, designed for commuting inter-city or intra-city. Mass transit may be based on fixed route system such as subway trains, metros or non-fixed route system such as buses. It is potentially more economical, eco-friendly and less time consuming. In addition, it is the most competent way of reducing the ever-growing traffic congestion of the developing cities.

Here are some basic example of Mass Transit System like Bus Rapid Transit (BRT), metro rails and monorails, which are being built in different cities to encourage the use of public transport.



FIGURE 4: TYPES OF TRANSPORT MEDIUM

Major reason for non-adoption of mass transit over private transport is the unorganized last mile transport and intermediate public transport.

### 1.2.2 Intermediate Public Transport

Unreliable last mile connectivity affects the overall quality and usage of mass transit system. While efforts are being carried out to enhance mass public transport. There is a need to introduce new models of regulation and reforms that can be adopted for a more efficient and safer system that enables the rickshaw and other para-transit carriers to have an optimal role in the transport mix.

In India, public transport to the last mile remains a challenge to commuters due to the following reasons.

- Last mile accessibility
- Security
- Convenience and comfort
- Long journey time
- Non-integrated mass transit systems
- Non-regulated expense (approx. 40% of total travel cost)

### 1.2.3 Private Transport

Private Transport is transportation mode which is generally not used by general public as vehicle is owned by individuals such as cars, motorcycle, scooters etc.

TABLE 2: PUBLIC TRANSPORT V/S PRIVATE TRANSPORT

Parameter	Public Transport	Private Transport
Travel Cost	Low	High
Convenience	Low	High
Pollution & Emissions	Low	High
Comfort	Low	High
Capacity	High	Low



FIGURE 5: SPACE TAKEN BY PRIVATE VS PUBLIC TRANSPORT

#### 1.2.4 Goods/ Freight transport system

Unbelievable high time to transport good, unexpected delay caused due to road toll, and amount of fuel wasted, is a major roadblock towards achieving the vision of “Make in India”.

Recent studies shows that India faces a loss of Rs. 600bn (\$10.8bn) a year due to congestion, slow speed of freight and waiting time at toll plazas.

## 2 What is M2M Communication?

It refers to the technologies that allow wired / wireless system to communicate with the devices of same ability. M2M uses a device (sensor, meter etc.) to capture an 'event' (motion, video, location, speed etc.), which is relayed through a network (wireless, wired or hybrid) to an application (software program), that translates the captured event into meaningful information. A conceptual picture of which is shown below:

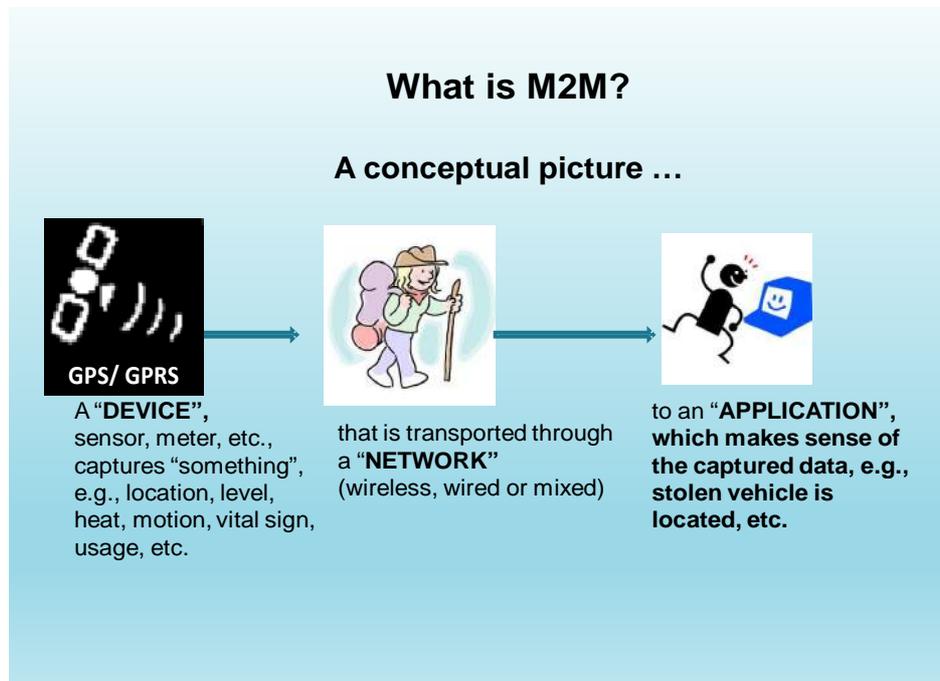


FIGURE 6: CONCEPTUAL PICTURE OF M2M

The enabling technologies for IoT are sensor networks, RFID, M2M, mobile Internet, wired & wireless communication network, semantic data integration, semantic search, IPv4 / IPv6, etc. In wireless communication Wi-Fi, ZigBee, 6LoWPAN, Bluetooth technology may be used for short range connectivity of devices / devices to the gateway and GSM 2G/ 3G/ 4G or WiMAX for connecting M2M gateway to server.

IPv4 addresses are going to exhaust. Standardization and adoption of IPv6 in telecom and ICT organizations will provide an opportunity of having billions of devices which can be IP enabled and seamlessly addressable through mobile or wired broadband connections.

M2M is a subset of IoT. IoT is a more encompassing phenomenon because it also includes *Human-to-Machine communication* (H2M). With IoT, the communication is extended via Internet among all the things that surround us.

Various sectors such as Power, Automotive, Health, Safety & Surveillance and Agriculture etc. may be transformed and revolutionized by using M2M / IoT.

### 3 Need of M2M Communication in Transport Sector

Due to rapid increment of number of vehicles with respect to existing infrastructure and slow rate of development in infrastructure sector recent studies show that India faces

- a loss of Rs. 600bn (\$10.8bn) a year due to congestion, slow speed of freight and waiting time at toll plazas,
- an average Indian spends about 90 minutes a day travelling in major cities, with an average speed of 5km/hr on some major roads,
- in India, around 5 lakhs road accidents happen, causing a loss of around \$20 billion, with 6 lakhs people injured and 1.5 lakhs killed,
- every year, nearly 36,000 vehicles are stolen, which amount to Rs. 115 crore with only about 14,500 getting traced, often in un-roadworthy conditions, with many components missing,
- vehicles are the major contributor to AIR pollution.

M2M Communication can leverage sensor ecosystem, communication modules, network channel, real-time processing, big data and cloud computing to optimize emergency services and save lives, reduce congestion on roads and generate revenue, provide road safety to commuters and to monitor and regulate driving behaviour, manage traffic by optimizing route.

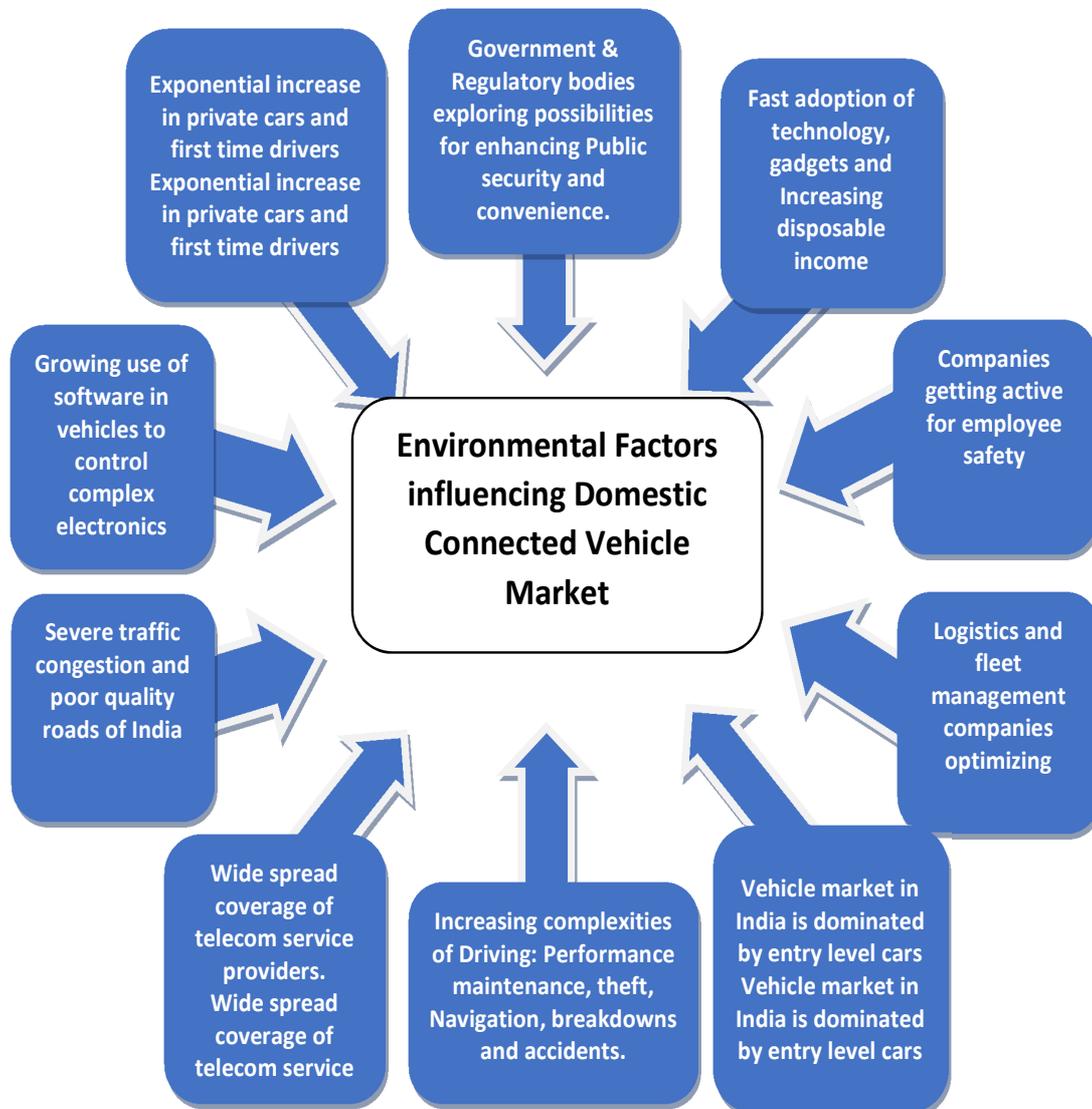
Furthermore, M2M adoption results in enhancing convenience to use public transport, connecting para transit and mass transit modes, monitoring and managing personal car, enabling vehicle manufacturers to provide VAS to consumers, creating Vehicle to Vehicle and Vehicle to Infrastructure communication systems, monitoring and reducing traffic violations, enabling parking assistance and road tolling.

Below are the benefits, which can be realized by using M2M/IoT technologies in transportation system and the way they can be measured.

- **Safety:** Measures include reduction in overall number of accidents, and its severity, injury, and fatality rates. Surrogate measures include monitoring vehicle speed, or accounting to the number of violations of traffic safety laws.
- **Mobility:** Measures include the amount of delay (in units of time) and the reduction of travel time.
- **Capacity/Throughput:** It is measured by the maximum number of persons or vehicles that can commute per hour at a point. It will increase making optimum utilization of resources.
- **Customer Satisfaction:** Measures related to satisfaction include time and convenience of travel through various modes, mode choices and quality of service as well as volume of complaints and suggestions.
- **Productivity:** Measures include operational efficiencies and cost savings.
- **Energy and Environment:** Measures of effectiveness include changes in emission levels and energy consumption. Specific measures for fuel use and emission levels include emission levels (kilograms or tons of pollutants for carbon monoxide (CO), oxides of nitrogen (NOx), hydrocarbons (HC) and volatile organic compounds (VOC); fuel use (litres or gallons); and fuel economy.
- Indirectly it will increase national GDP.
- Reduce delay caused by traffic and toll collection,
- Reduce crime; make travel safe, secure and convenient.
- Improve efficiency.

### 3.1 Ecosystem & Environmental Factors

The ecological dissimilarity of India makes its challenges and requirements unique, and interesting to resolve. All use cases gets influenced by ecosystem & environmental factors shown in the figure below.



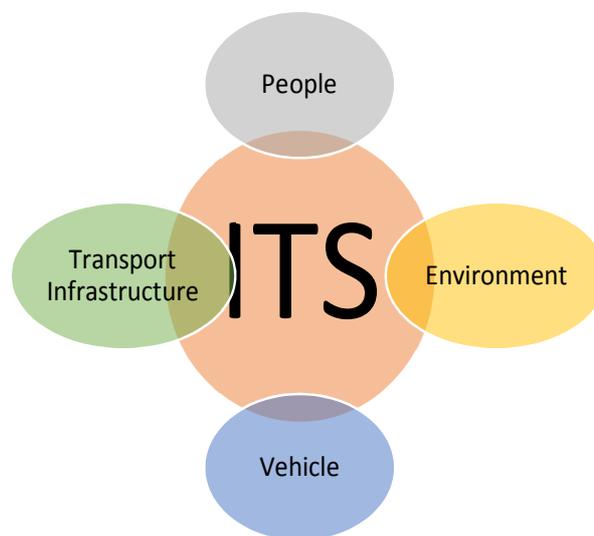
**FIGURE 1: ECOSYSTEM & ENVIRONMENTAL FACTORS**

## 4 Conceptual Description of M2M Communication in ITS

### Broad overviews of ITS

ITS enables elements within the transport system such as commuters, vehicles, roads, traffic lights, message signs to become intelligent, embedding them with microchips and sensors, empowering them to communicate with each other.

- People: Commuters & planners via smart phone or computers.
- Environment: Forces of nature, Incidents (Accidents, traffic jams, road conditions etc.)
- Vehicles: Personal & public vehicles through after-market device or embedded modules.
- Transport infrastructure: Petrol pumps, bus stands, traffic signals, digital signage, cameras & streetlights.



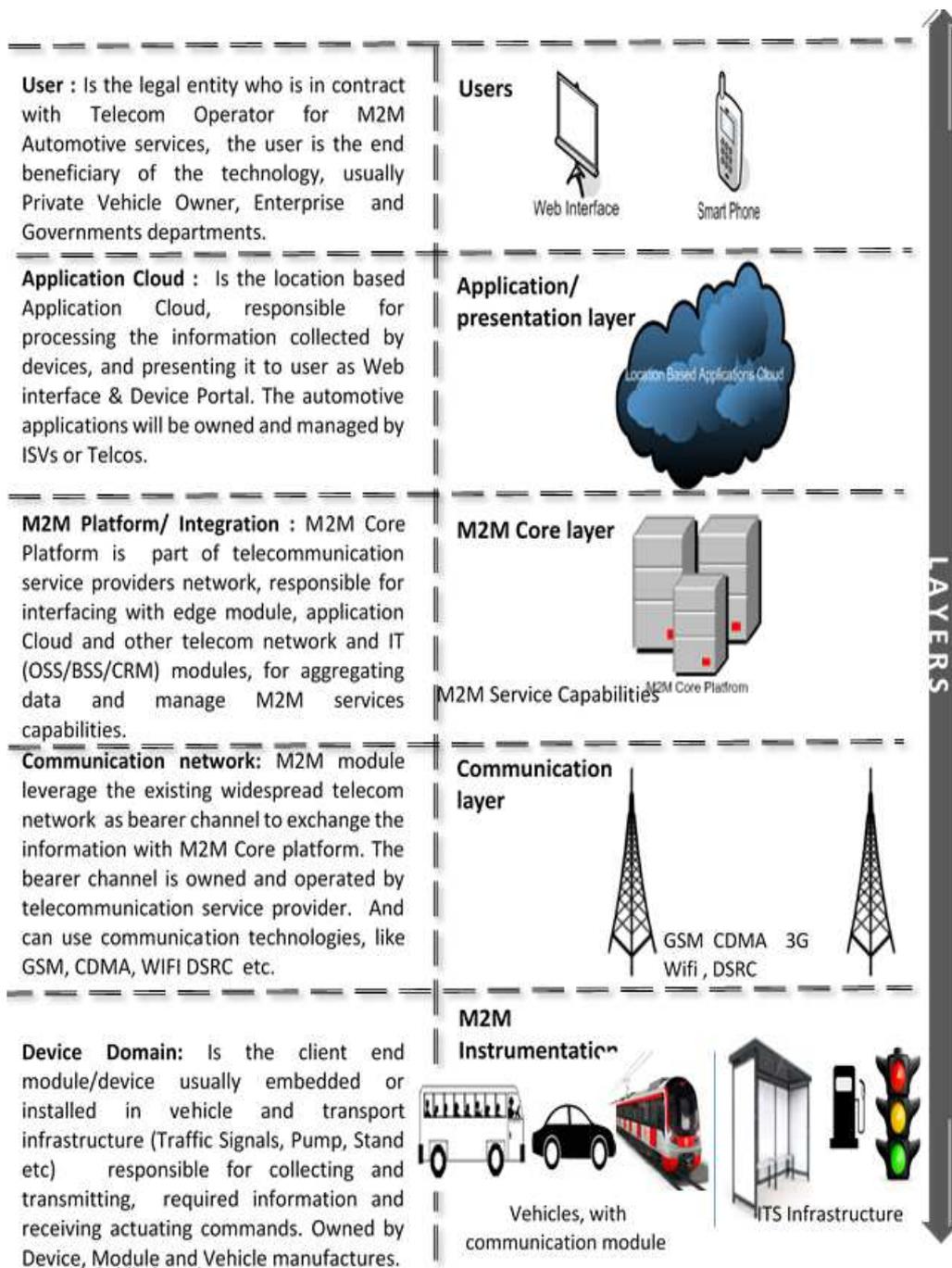
**FIGURE 8: BROAD OVERVIEW OF ITS SYSTEM**

The Intelligent Transport System will use following system:-

1. Telecommunication systems
  - a. Public access mobile radio networks (GSM, UMTS, etc.)
  - b. Private mobile networks and network services dedicated to road transport operators (PMR/PAMR, DSRC, co-operative driving, vehicle to vehicle and vehicle to infrastructure technologies).
2. Automatic Identification Systems (AIS)
  - a. Radio frequency identification (RFID); Smart cards; Video identification technology
3. Automatic Vehicle Location Systems (AVLS)
  - a. GPS based; Cellular networks; Systems based on automatic identification devices, in case of fixed routes.
4. Traffic data collection and automatic classification systems
  - a. Video, microwave, magnetic detection
5. Electronic Data Interchange (EDI)

6. Cartographic databases and Geographic Information Systems (GIS). (GIS related information kindly refer to para 4.5).

### 4.1 Layers of Intelligent Transport



**FIGURE 9: LAYERS OF INTELLIGENT TRANSPORT SYSTEM**

### 4.2 Different Types of Connected Cars

On Board Diagnostic (OBD) refers to a vehicle’s self-diagnostics & reporting capability. OBD systems give access to status of the various vehicle subsystems.

#### 4.2.1 Non OBD

Its contents include non-OBD (On board diagnostic) M2M module with GPS sensor, RFID reader and surveillance camera externally fitted into the vehicle. The device has both short and long-range wireless connectivity. As Indian market is dominated by entry-level vehicles, this solution caters to the immediate demand of track and trace requirements in the Indian market. Vehicles have standard way to connect with the device without warranty getting void

#### 4.2.2 OBD II

This will cater to the premium vehicles segment compliant with OBDII Standards. The solution will provide remote diagnostic and performance features in addition to the basic track and trace feature.

#### 4.2.3 Embedded

The solution is for new Vehicles embedded with factory fitted M2M module. Driven by vehicle OEMs/manufacturers, the robust solution will cater to all connected vehicle use cases.

### 4.3 Connected Car Components

Apart from the following components required for the connectivity and communication between vehicles are microcontroller, computing/ data storage hardware components and power management components.

#### 4.3.1 Sensors & Accessories

These include GPS module, fuel sensors, temperature sensors, door sensors, IP cameras, RFID/Smart card reader, accelerometer, display, speakers, and panic button and relay to control ignition.

#### 4.3.2 Wireless Communication Module

- Short range includes vehicle-to-vehicle and vehicle-to-infrastructure (DSRC, Bluetooth, Wi-Fi, and vehicular radar).
- Long range includes GSM/CDMA/3G/Satellite.
- Other components include

#### 4.3.3 SIM

The normal SIM card is not suitable for harsh conditions of vehicles like vibrations, temperature, and humidity. GSMA has created specifications for embedded M2M SIM, for remote Over-the-Air (OTA) provisioning, hermetically sealed or installed in hazardous or remote locations. It can withstand temperature variation for automotive grade temperature range of -40 degree to +125 degree Celsius. Embedded SIM technology offers big opportunities for auto manufacturers as the lifecycle of an eSIM is, on averages, 10-15 years. International standards for eSIM have evolved.

### 4.4 Communication Technology of ITS

#### 4.4.1 Wireless WAN

Wireless WAN is a wide area network in which separate areas of coverage or cells are connected to provide service to a large geographic area. WWAN is supported on mobile networks. There are three families of WWAN technologies, GSM/UMTS, CDMA 1x/CDMA2000, LTE and WiMAX. WWANs typically incorporate encryption and authentication for secure communication.

#### 4.4.2 Vehicle to Infrastructure

Intelligent Transport System describes communication between Vehicle-to-Infrastructure. The infrastructure could be as follows:

- Road side beacons
- Traffic signals
- Toll collections centres
- Petrol pumps and charging centres (for electric vehicles)
- Digital signage
- Safety applications like red light violation, over-loading or crossing speed limit

One of the primary objectives of V2I is to mitigate vehicle accidents, enable safety applications not otherwise secured through Vehicle-to-Vehicle communications. With advancements in battery-operated cars, charging stations would be an additional utility in petrol pumps with the vehicle being intelligent enough to monitor fuel levels and indicate to users of charging station in the vicinity. RFID, DSRC, GPRS and GPS are technologies used in all above applications/use cases. Roadside beacon and traffic signals can manage congestion and diversions during peak traffic time. Digital signage can be used to highlight safety messages to on-road vehicles.

#### **4.4.3 Vehicle to Vehicle**

It provides connected vehicles to communicate with each other. The communication is over Dedicated Short Range Communications (DSRC). DSRC provides a fast secure and reliable connectivity. V2V communication provides enhanced awareness to users on roads where natural limitations impair communication. Connected vehicles provide enhanced awareness at a competitive cost over existing on-board sensor systems available today in some vehicles. It forewarns of possible hazards, alert situations on the road, possible diversions, zones, which the user enters which may have restrictions. Research is continuing on the possible user alerts once the vehicle gets the message of possible hazards. It could be placed as LED on the vehicle dashboard or as haptics/vibrator on the driver seat to warn the user to draw attention. The user can get real-time information on traffic congestion, accidents and arrival of support and substitute commuting modes like taxis and cabs, which can assist further in smoother commute.

#### **4.4.4 Dedicated Short Range Communication**

It is a high speed, low latency and short- range communication, which is gaining popularity in the design of connected vehicles. FCC has allocated 75 MHz spectrum in the 5.9 GHz band<sup>1</sup>, European Telecommunications Standards Institute (ETSI) has identified 30 MHz of spectrum in the 5.9 GHz band for ITS. It operates in extreme vehicle speed condition and is immune to extreme weather conditions. Its design can tolerate multi-path transmissions, typical to roadway environments supporting vehicle-to-vehicle and vehicle-to-infrastructure communication.

#### **4.4.5 Wire line to connect stationary Infrastructure**

The connectivity of fixed infrastructure services is mostly on the wire line networks, as they are fixed and reliable. The infrastructure can also serve as hub for connectivity of vehicle.

#### **4.4.6 After-market Black Box-to-vehicle**

Electronic communication devices are usually not fitted by OEMs at the manufacturing lines. An after-market V2V communication device provides advisories and warnings to the driver of a vehicle similar to those provided by an OEM-installed V2V device. Aftermarket V2V devices can be installed from the open market by automobile technicians, at vehicle dealerships, and at authorized dealers. Some aftermarket V2V devices such as cell phones with apps are portable, standalone units need to be installed close to the engine system for desired results.

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<sup>1</sup><http://jwcn.eurasipjournals.com/content/pdf/1687-1499-2014-49.pdf>

## 4.5 GIS for Indian Geography

A Geographic Information System or GIS is a computer system that allows you to map, model, query, and analyse large quantities of data within a single database according to their location. GIS gives you the power to:

- create maps
- integrate information
- visualize scenarios
- present powerful ideas, and
- develop effective solutions

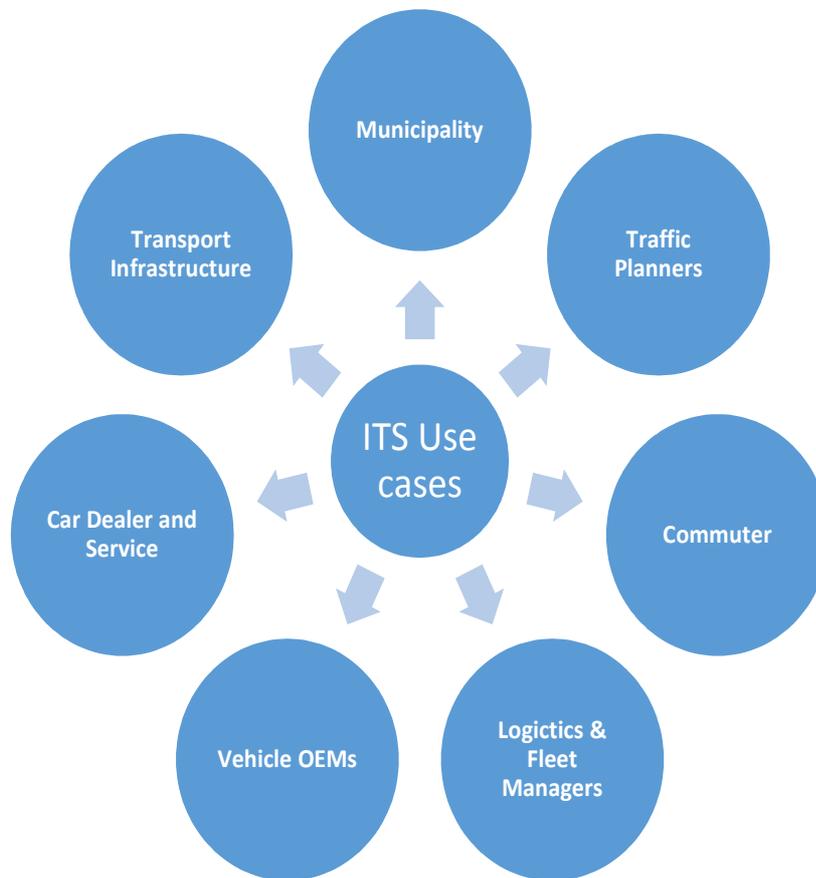
Below figure depicts the GIS stakeholders:



FIGURE 10: GIS STAKEHOLDERS

## 5 Use Cases

Some of the use cases for ITS are illustrated in figure below



**FIGURE 11: ITS USE CASES**

### 5.1 Municipality

#### 5.1.1 Public Safety

This is a very important use case category, which will enhance the public security and emergency management system in India. A typical call flow has been shown figure 12. M2M technology will enable police emergency VAN to respond to citizen's panic calls efficiently and will reduce the response time. The framework can enable officials to manage and monitor the incident remotely.

Typical Call Flow

- a) A citizen calls the assigned emergency control room number from the incident location.
- b) Control Room Application interacts with ITS platform to report the incident with mobile number of the caller.
- c) ITS platform sends the location query request to operators GMLC.
- d) GMLC uses network based ECID technology to locate the caller's Location.
- e) The system identifies the closest Fire Brigade and Ambulance to the incident location.
- f) It sends the relief to the incident location

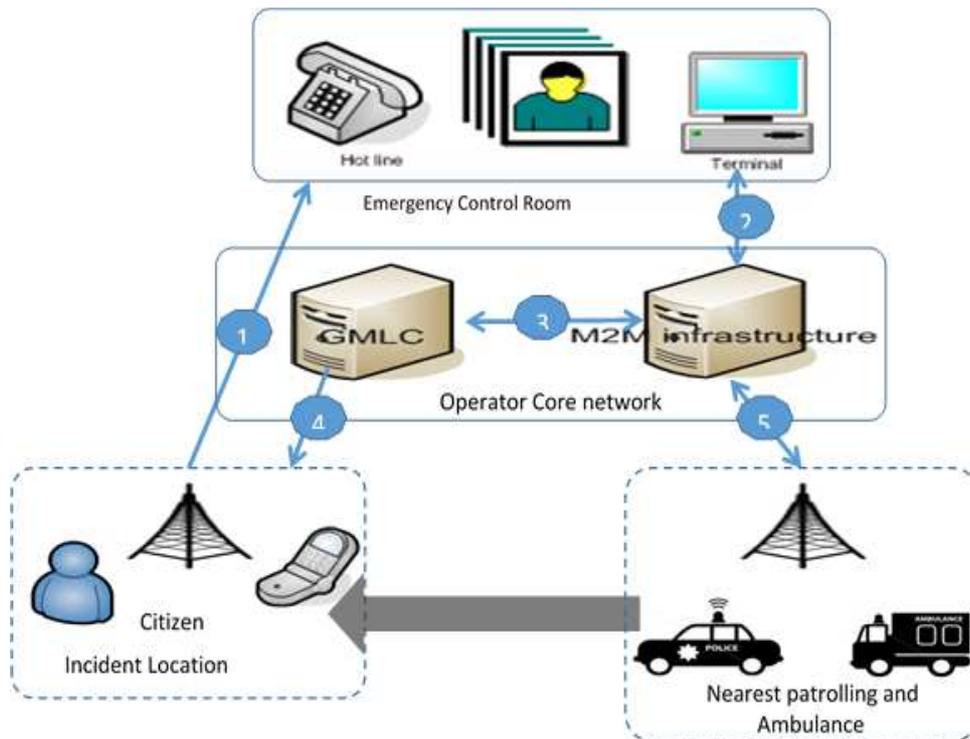


FIGURE 12: eCALL TYPICAL CALL FLOW

### 5.1.2 Utilities Vehicle Management

This is related to monitoring and managing the utility vehicles of municipalities like, garbage trucks, motor sweepers, compactors, tippers, dumper placers, water tankers etc. The system can help us to track movement, create schedules, plan daily route, and receive alerts. It will have all basic features of VTS for fleet management. Additional RFID Reader will be used to identify the Waste Collection Bins / Area Water Tanks or water facility etc.

### 5.1.3 Emergency Response System

In cases of emergencies police or para-military forces or even in worst situation armed forces need to take charge. Fire Brigade and lifeguards also take charge in certain conditions. Coordination of the Teams and Fleet management is very vital to handle such situations. Such a system has to be trustworthy, and should not be dependent on public communication channels alone. Moreover, it should be able to use GSM, CDMA, Satellite, or any other dedicated channel for critical communications.

### 5.1.4 Waste Collection Management

This deals with optimizing the waste collection management by connecting utilities vehicles with VTS device, by geo tagging the waste bins and by using RFIDs and other sensors. The overall waste collection system components will include.

- i. Garbage truck tracking
- ii. Time prediction and route designing
- iii. Communication with vehicle
- iv. Worker tracking
- v. Bin tracking and weighing
- vi. Real time data transmission
- vii. Control centre requirements.

### 5.1.5 Ambulance

There are three aspects of Ambulance Fleet Management,

1. To locate the nearest ambulance when any patient requisitions for it. For this purpose, basic fleet management features of VTS may be sufficient.
2. Secondly, the hospital gets an alert when the Ambulance reaches certain distance from the respective hospital. This time can be utilized by the hospital to get ready to receive the patient. This will include the arrangements for stretcher, wheel chair and/or the para- medical staff at the hospital. This can be done by utilizing Geo Fencing feature which is part of the basic feature of VTS.
3. Third and the most vital requirement is that the treatment of the patient should start immediately on his arrival at the hospital. If possible, treatment or possible preventive measures can be started in the ambulance itself.

Normally, when patient reaches hospital some time is consumed in registration process, getting personal details and details of the problem, allergies, medical history of the patient and in some case of his family also. Patient's vital data covering blood pressure, pulse rate, glucose level etc. depending on the medical problem is also required to be observed and noted. All these activities if completed in the ambulance itself, while the patient is being moved to the hospital, can save the precious initial time. This can be achieved by making the ambulance equipped with the tele-treatment facilities, equipping the ambulance with laptop, camera, video / communication means (3G/LTE etc), making available medical instruments for blood pressure measurement, pulse rate measurement, ECG machine etc. and trained para medical staff to use these equipment and for completing the registration process and initial information recording. The telemedicine set up will get this information simultaneously conveyed to the hospital system and getting the expert advice for giving any required first aid.

### 5.1.6 Pollution under Control Check Automation

This use case describes an automated process for PUC testing, completely eliminating human element (to prevent fraud certificates). PUC Certificate will be electronically readable (example QR code of vehicle registration number and PUC certificate validity date). This can be linked to supply of fuel by fuel station.

Fuel stations will be able to "validate" the electronic PUC certificate through a machine (RFID reader or QR code reader) before dispensing fuel. The validation result should be printed on the fuel bill and in the fuel station records (as evidence of PUC validation).

## 5.2 Traffic Planners

### 5.2.1 Traffic Management System

Traffic management system integrates various subsystems (CCTV, GPS data, vehicle detection, messaging, digital signage etc.) into a coherent single interface that provides real time data on traffic status and predicts traffic congestions for more efficient planning and operations. Dynamic traffic control systems, freeway operations management system, incident response systems, etc. respond in real time to changing conditions.

### 5.2.2 Over Speed Monitoring

It uses Electronic Vehicle Speed Display units as Vehicle infrastructure units. These units have to be programmed with speed limits by Central Traffic management system based on the type of road, location of Road and traffic condition.

Infrastructure unit determines traffic condition based on density of vehicles on road and pass on the density information to Central Traffic management system to determine the speed limit to be configured for that display board.

Vehicle reads the speed information from such Display Boards using V2I communication and alerts the driver when he/she is over speeding. Hence, the driver is cautious about his behaviour, resulting in less traffic violations.

### 5.2.3 Real-Time Passenger Information Systems (RTPIS)

ITS are gaining recognition in India. The automatic real-time passenger information system has the potential of making the public transport system an attractive alternative for city-dwellers, thereby contributing to fewer private vehicles on the road, leading to lower congestion levels and less pollution.

Novel features may include

- i. A route creator utility, which automatically creates new routes from scratch when a bus is driven along the new route,
- ii. Voice tagging of stops and points of interest along any route,
- iii. Web-based applications for passengers, providing useful information like a snapshot of present bus locations on the streets,
- iv. Web-based analysis tools for the transport authority, providing information useful for fleet management, like number of trips undertaken by a specific bus.

### 5.2.4 Automatic Passenger Counting

For dynamic traffic management, it is important to get rapid feedback from the network and to understand the entire transit system. Increasing demands on public transport put pressure on transit

agencies to improve their operations and services. New information technology such as ITS can be used to meet higher demands on public transport. One ITS technology with the potential to improve operations and services within public transport is the Automatic Passenger Counting (APC) system. The APC system counts passengers alighting and boarding a vehicle, and can be used to get knowledge about the passengers' journey [2]. With this knowledge, it may be possible to understand the demands and make adjustments for the future.

#### **5.2.5 CCTV Junction Surveillance**

- 1) End-to-end solution for CCTV Junction Surveillance within the same Traffic Command Control Centre
- 2) Real time streaming video from junctions and strategic locations enables effective traffic & incident management from remote Traffic Command Control Centre
- 3) Allows operators to directly observe the traffic conditions at all junctions, verify incidents and congestion conditions
- 4) Multiple choices for IP based PTZ/Fixed Cameras with 36X zoom facility that enable capture of minute details from junction
- 5) Crime prevention and deterrence

### **5.3 Commuter – End User**

#### **5.3.1 Intelligent Transit Trip Planner and Real Time Route Information**

The Personal car user will receive travel related information to assist decision making on route, estimated travel time, and avoid congestion. This can be enabled by providing different information using various technologies such as

- 1) GPS enabled in vehicle navigation system.
- 2) Dynamic digital signage for real time communication of information on traffic congestions, bottle necks, accidents and alternate route information during road closure and maintenance.
- 3) Digital heat map with traffic congestion related information in color-coding.

The public transport user will be able to use his smart phone to check availability, plan their transit, make booking and pay using electronic mode.

### **5.4 Fleet Managers**

#### **5.4.1 Fleet Tracking, Start / Stop Management**

This use case will enable radio taxi operators to automate their operational process. All the CABs operating in the field will be embedded or fitted with a M2M gateway device, which would continuously transmitting the location, status, alerts, driver behaviour. Call Centre Agent can track any CAB through the GUI and allocate the CAB to the nearest customer. Value Added Services like maintenance management, Driver behaviour, Security feature for passengers (panic button), in vehicle surveillance etc.

This use case will enable transportation fleet enterprises to manage their operations more efficiently. The High Value Asset (fleet) will be connected with a GPS + GSM/CDMA module, and will transmit location information on a predefined time or on request. The application will utilize the data transmitted by the device to derive maintenance schedule, route optimization, distance travelled, speed, driving behaviour, fleet efficiency.

#### **5.4.2 Fleet Management by Logistics Company**

Besides all the Basic functionalities of VTS Stated above which are used by the Logistics companies, fuel is important cost component, which needs monitoring. This is achieved by using Fuel sensor or by tapping data going to the fuel gauge of the vehicle.

#### **5.4.3 Captive Railway Wagons**

Many organizations own Railway wagons and use them for transporting their products. Tracking of such wagons is very important, as there is no electricity in the wagon, the battery backup becomes most important and should last the journey which could be more than 15 days.

#### **5.4.4 Fleet Management of Vehicles Carrying Perishable Products**

Companies using such vehicles use all basic functionalities of VTS being used by logistics Companies. In addition, they require Temperature Sensors to monitor the temperature to be maintained. Door Sensors can be used to monitor and control that the door is opened only when essential to prevent energy loss.

#### **5.4.5 Heavy Machinery Fleet Management**

Basic features of the VTS for Fleet Management are generally sufficient for such fleet (Cranes, dozers etc.). Camera can provide better appreciation of the surroundings. These equipments, if OBD-II compliant, can provide vital information related to performance and maintenance of the equipment. This is very important for the finance companies to keep track of the location and health of the vehicle

#### **5.4.6 Employee Commutation Safety**

This service will enable companies operating in BPO/ITES/IT sector to automate their CAB Management service for employees and ensure their safety. All the CAB operating for a specific company will be tracked along with the employees on board. Companies will be able to manage and monitor their employee commutation policies.

#### **5.4.7 School Bus Management System**

This use case will ensure safety of children travelling by school's owned transport services. The users of this solution would be school administrators, parents of the students who would track and trace the school bus on real time, receive alerts and notifications. The device installed in the vehicle should be equipped with GPS for locations tracking, RFID for identifying the students and staff on boarded.

### **5.5 Original Equipment Manufacturer (OEM)**

Technology enables the vehicle manufactures to provide VAS services and create new stream of revenue. OEM can provide services such as stolen vehicle tracking and location based anti-theft applications. The OEMs can even monitor on field performance of the product after launch.

### **5.6 Car Dealer and Service**

#### **5.6.1 Vehicle Diagnostic & Maintenance Report**

For all OBD II complaint vehicles the service centres can provide maintenance report to the consumer and check the health of the vehicle to take preventive actions. The device will be able to send data related to health of the vehicle, like oil temperature, coolant temperature, oil level etc.

### 5.6.2 Road Side Breakdown Assistance

The system monitors the critical parameters of the vehicle and in case of any fault; it can locate the nearest roadside assistance centre. Send an alert to the centre with vehicles issue report along with location, this will help the service centre to respond effectively and immediately.

### 5.6.3 ECO Driving

OBD enabled M2M device mounted on the automobiles check the fuel emission (SO<sub>2</sub>, NO<sub>2</sub>, etc.) while on drive and can send an alert to the service station in case if the emissions are alarming. In addition, this information would be stored on cloud to give a consolidated automobile-health view to the service centre once the automobile goes for servicing

## 5.7 Infrastructure / Safety

### 5.7.1 Smart Parking

Smart parking helps one of the biggest problems on driving in urban areas; finding empty parking spaces and controlling illegal parking. This implies M2M technologies aims rightness/safety as well as convenience.

It involves using low-cost sensors, real-time data collection, and mobile-phone-enabled automated payment systems that allow people to reserve parking in advance or very accurately predict where they will likely find a spot. When deployed as a system, smart parking thus reduces car emissions in urban centres by reducing the need for people to needlessly circle city blocks searching for parking. It also permits cities to carefully manage their parking supply.

### 5.7.2 Road Toll Collection

This use case will enable private car/fleet owners to decide the most economical toll route and pay the charges automatically through online payment gateway. Using RFID tags telematics box on vehicles, automated road toll collection can be computed.

Congestion charging is very effective in high-density geography, this will help optimizing the scarce infrastructure and earn additional revenue. Based on real-time traffic congestion differential charging may be applied at different time frames.

### 5.7.3 Smart Signals

This use case is about adjusting the signal timing and priority based upon the priority of the vehicle like ambulances etc. and provides framework to monitor and control over speeding and traffic violation centrally.

TSP is a special operational strategy that allows transit vehicles to adjust signal-timing plans on their respective routes when travelling on signalized roadways. Ultimately, deployment of this technology is directed toward the reduction of delay on these routes and the improvement of schedule reliability.

Smart signals also include Congestion signalling on the driver dashboard. This can be useful for congestion control at any place dynamically as well as regulate traffic flow during any contingency.

### 5.7.4 Smart Roads

Municipalities around the world spend millions of dollars to maintain and repair their roadways. Despite this investment, very few people are happy with the quality of the roads where they live or work. The reason is that bad roads damage vehicles. They are sometimes hazardous to drivers and pedestrians, and, at the very least, are annoying to drive or bike on. In India bad roads is a severe

problem and considering that goods roads are essential for fast development of India's economy, road condition monitoring becomes an important use case.

In India municipal budgets are generally constrained, determining which roads need fixing becomes even more challenging. In addition, informing drivers of hazardous road conditions especially at night or when lighting is poor would be a useful feature for navigation systems. Wireless Sensor Network is a cost-effective and scalable option for reducing infrastructure maintenance costs and increasing safety on the road. We can install wireless sensors in vehicles, mainly taxis and buses since these are the vehicles which remain on road most of the times and daily covers huge area of road network and hence can provide more suitable information regarding the status of roads in the city. Municipalities can use this data to determine which roads are in serious bad condition and needs immediate repair or rebuilding.

#### 5.7.5 Traffic Signal Violation Monitoring

This use case requires RF Transmitter to be used at each of the Traffic Signal to identify traffic violation. Vehicle must have a unit to detect the RF signal on violation and notify the same to speeding/reckless driver. A unit software is required to keep the count of the same and once a predefined limit is approaching, should inform the driver about the legal preceding if continued in the similar fashion. Once the limit is reached, the system will pass the vehicle information to Central Traffic Management System along with the reason for logging a complaint. Moreover, such a system must be tamper proof so that the driver is not able to misuse the same.

Central Traffic Management System to device the necessary action thereafter.

Challenges of this use case are:

- i. RF Transmitter at each Signal
- ii. Central Traffic Management Centre for devising the speed limit
- iii. Traffic Density Calculation

#### 5.7.6 Automated Challan Issuance

The surveillance cameras installed at the signals would have the Number Plate recognition algorithm hosted on the server. Once an automobile violates the traffic rules, the surveillance cameras would take the image of the number plate and send it to the central location. At the command and control centre, the Video Analytics Platform would identify the car registration number from the image sent and would then map it to the National Car Registration Database. It should be borne in mind that there could be multi-lingual number that can be embossed on the plate. The video analytics platform should convert the captured car registration number in unicode and then compare with the pool. Once identified, the driver is issued a ticket against his/her name through a SMS on his registered number and the ticket number is stored on the cloud for future reference.

#### 5.7.7 Push Advertising in Public Transport

Location Based Advertising on integrated displays in public transport systems has great potential. The Passengers are normally bored when they ride with a public transport system (metro, bus, tram etc.) so they are open to general interest information and location based advertising (push approach).

Therefore, they will receive messages during their ride. Mostly, they get value-added information e.g. about various events, special activities, opening hours of museums, timetables, delays, city-activities etc.

Example: When the public transport system passes an electronics store, on the display of the high resolution screen special offers and saving of the store are displayed. [6] At the next exit, you have

the chance to get out of the public transport system and go directly to the store to check the service/product and buy it directly.

## 5.8 Logistics

### 5.8.1 Asset / Cargo Tracking

This use case requires a battery powered portable devices, which can track the current location of the asset/cargo. On demand or periodically the device can upload its location, which would be helpful in tracking the same. This can be used for tracking wild animals in sanctuaries, domestic animals at large farms, children's, pets and disabled people.

This service will enable Logistic companies to track their valuable assets movement, manage schedule and customer expectation. The asset will be connected to thin client GPS device with GSM/CDMA module, which will transmit current locations periodically or on request. Due to small packet size both SMS and Packet core would be used as bearer channel.

### 5.8.2 Condition Check – Large-Sized Construction Machines

Large-sized construction machines are continuously operated for long hours. Once they break down, it takes substantial cost to repair them. Besides, since repairing a large-sized construction machine takes much time, it significantly affects the machine activity rate. Therefore, construction machines, especially large ones, are required to be free of down time and capable of planned operation without interruption. In order to secure such machines, it is necessary to early detect any symptoms of machine trouble by physical examination, etc. and have the maintenance personnel take suitable measures without delay

### 5.8.3 Order Fulfilment and Route Optimizations

Assigning tasks online to work force, define beat routes. Moreover, track daily movement with regards to the schedule and route as well as monitor progress.

### 5.8.4 Usage Based Insurance

User Based Insurance and PAY as You Drive opportunities and how the industry is leveraging technology to maximize return on investment through M2M telematics. As many insurers and consumers now know, telematics technology has changed. Offering a vast range of benefits, telematics can help insurers grow their businesses, know and support their customers, and deliver a more profitable future.

Its features include:

1. Real-time feedback on driver behaviour
2. Vehicle diagnostics
3. Parental monitoring of teen driving
4. Increased fuel efficiency
5. Fewer claims and lower costs
6. Better risk mitigation
7. Stolen-vehicle tracking
8. Decrease response time

## 6 ITS Initiatives in India

### 6.1 Pilots & Deployments

#### 6.1.1 JNNRUM (Jawaharlal Nehru National Urban Renewal Mission)

Basic Block Diagram of OBITS (On Bus Intelligent Transport System) with key features:-

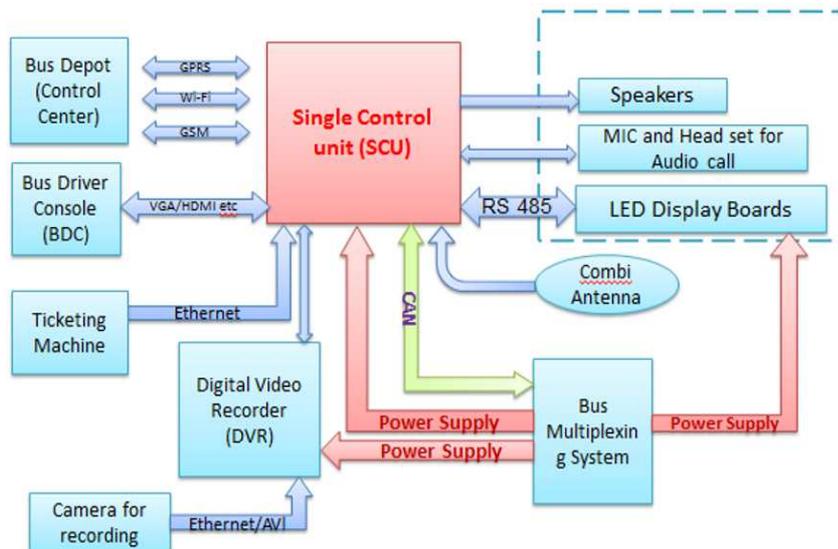


FIGURE 13: BLOCK DIAGRAM OF OBITS

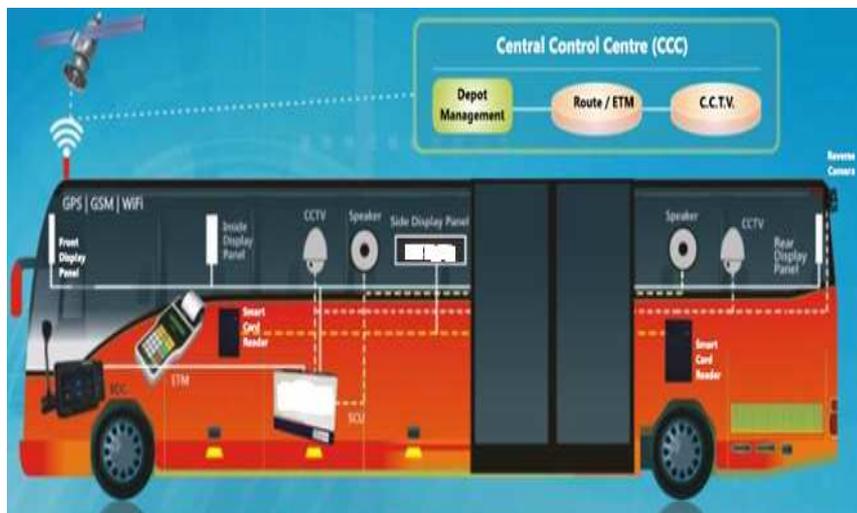


FIGURE 14: BUS WITH DEVICES

Features of JNNURM deployments are

- Automatic Vehicle Location (AVL)
- Passenger Information System (PIS)

- Synchronization with Bus Depot
- Continuous/ Schedule based Security Camera Recording on activation of predefined features
- Emergency Two way Voice Call
- Rear View Camera Display on Enabling Reverse Gear
- GPS Based Navigation and 3G wireless communication
- Supports Communication protocols like CAN 2.0, RS 232, Ethernet and USB
- Vehicle Health Monitoring and Diagnostics (VHMD)
- Vehicle Tracking System/ Navigation System
- Electronic Toll Collection (ETC) RFID Tag
- Speed Limiters
- Immobilizers
- Collision warning
- Adaptive cruise control

### 6.1.2 Electronic Toll Collection

Delhi-Mumbai highway – 350 tolls are to be enabled with ETC, Gol mandates installation of RFID tags on the medium and heavy motor vehicles.

#### 6.1.2.1 Automatic Fare Collection Systems (AFCS)

- i. Implemented in Metro systems and Ahmedabad Bus Rapid Transit (BRT)
- ii. Bids underway in various BRT systems

#### 6.1.2.2 Location Technologies

- i. GPS based tracking for public transport fleet in operation in all major cities,
- ii. CBSE, Oil companies, BPOs mandating VTS fitment on vehicles.

#### 6.1.2.3 Intelligent Signalling

- i. Implemented in Ahmedabad, Delhi & Mumbai

### 6.1.3 Research and Development

There are many R&D initiative on the subject of ITS, and certainly we might know what traffic applications are needed for Indian roads. We might design and implement sensing technologies needed to handle those applications for Indian chaotic traffic. We might build robust, low-cost communication models to gather data from sensors and disseminate information to commuters. But unless we test our solutions in the field in medium to large scales, we will never come to know about practical issues. Building collaboration with the public sector is an absolute necessity for this domain to created sustainable output.

And there is a need to get all R&D efforts aligned, some of the projects being undertaken for R&D on ITS are detailed below.

#### 6.1.3.1 Some ITS research Projects

Below table has mentioned some research projects on ITS sector.

TABLE 3: SOME ITS RESEARCH PROJECTS

S. No.	Sub Project/ ITS Technology	Likely End Users	Assigned Agency
1.	Wireless Traffic Control System	Traffic police and local authorities	CDAC
2.	Second Generation Area Traffic Control System ( CoSiCoSt- II)	Medium and large cities deploying ATCS	CDAC
3.	Real Time Traffic Counting & Monitoring System	Traffic Planners and development authorities	CDAC
4.	Red Light Violation Detection System	Traffic police	CDAC

### 6.1.3.2 Centre of Excellence in Urban Transport

Centre of Excellence in Urban Transport is an initiative for the Ministry of Urban Development, GoI for solving urban transport's most pressing problems and challenges.

TABLE 4: CENTRE OF EXCELLENCE IN URBAN TRANSPORTATION

S. No.	Sub Project/ ITS Technology	Likely End Users
1.	Evaluation of traffic data collection techniques for Indian conditions	General public and traffic planners
2.	Bus arrival time prediction under Indian Traffic Conditions	General public and traffic planners
3.	Dynamic Network Modeling under Mixed-Traffic	Traffic Planners and development authorities
4.	Comprehensive Transportation Planning for the Selected Zones in Bangalore City	Town planners & local authorities
5.	Tools for Transportation Planning	Traffic & Town planners
6.	Development of Activity based Models for Forecasting of Travel Demand	General public and traffic planners
7.	Urban Speed Management	Traffic police

### 6.1.3.3 DIMTS

Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd. is an equal equity joint venture of Government of NCT of Delhi and IDFC Foundation with a focus on urban transportation.

TABLE 5: DIMTS PROJECTS

S. No.	Sub Project/ ITS Technology
1.	Wireless Traffic Signal Controller (Wi-TraC)
2.	Red Light-Stop Line Violation & Detection System (RLSVDS)
3.	CCTV Junction Surveillance
4.	Variable Message Sign (VMS)
5.	Video Incident Detection
6.	Control and Command Centre

## 7 Communication Technologies and Standards in ITS

There is a need to examine global standards with Indian context in view for implementation of eCall. It is noted that Working Group 15 of the CEN TC274 has written a set of standards regarding eCall. Compliance with these standards is required in the General Approach of the Council.

- EN 16062 - eCall high level application requirements (HLAP) defines the high level application protocols to facilitate eCalls using mobile networks.
- EN 16072 - Pan-European eCall operating requirements specifies the generic operational requirements and intrinsic procedures for the provision of an eCall service that allows to transfer an emergency message and to establish a voice channel between IVS and PSAP.
- EN 16102 - eCall - Operating requirements for third party support covers the same scope for but for third party services in order to allow service providers to offer services handling eCalls.
- EN 15722 - eCall minimum set of data (MSD) specifies the content and format of the data to be transferred by the IVS to the PSAP during an eCall.
- CEN/TS 16454 - eCall end to end conformance testing sets out test procedures that allow different actors in the eCall chain (vehicle/IVS, MNO, PSAP, TPSP) to claim conformance to all above listed EN eCall standards without being able to control the behavior of other actor.

The following ETSI standards have been referenced in the various eCall related documents:

- ETSI TS 102 164 (Version 1.3.1)
- ETSI TS 121 133 (Release 8 or later)
- ETSI TS 122 003 (Release 8 or later)
- ETSI TS 122 011 (Release 8 or later)
- ETSI TS 122 071 (Release 8 or later)
- ETSI TS 122 101 (Release 8)
- ETSI TS 124 008 (Release 8 or later)
- ETSI TS 124 123 (Release 8 or later)
- ETSI TS 126 267 (Release 8 or later)
- ETSI TS 126 268 (Release 8 or later)
- ETSI TS 126 269 (Release 8 or later)
- ETSI TS 127 007 (Release 8 or later)
- ETSI TS 151 010 (Release 8 or later)
- ETSI EN 301 511
- ETSI EN 301 908

Standards around the communication technology domain which need to be considered within the above ITS services domain

- ISO 21212:2008 Intelligent transport systems -- Communications access for land mobiles (CALM) -- 2G Cellular systems
- ISO 21213:2008 Intelligent transport systems -- Communications access for land mobiles (CALM) -- 3G Cellular systems
- ISO/DIS 21214 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Infra-red systems
- ISO 21214:2006 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Infra-red systems
- ISO 21215:2010 Intelligent transport systems -- Communications access for land mobiles (CALM) -- M5

- ISO 21216:2012 Intelligent transport systems -- Communication access for land mobiles (CALM) -- Millimetre wave air interface
- ISO/NP 21217 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Architecture
- ISO 21217:2010 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Architecture
- ISO/DIS 21218 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Access technology support
- ISO 21218:2008 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Medium service access points.
- ISO/IEC FDIS 14813 -1 :2013 (E) – Intelligent Transport System
- ISO /TR 14813-4: 2008 (E) – Intelligent Transport System
- ISO/ TR 14813 – 3: 2008 (E) – Intelligent Transport System
- ISO/ TR 14813 – 6: 2009 (E) – Intelligent Transport System

## 8 Key Challenges

- Uncoordinated approach: There is need for enhanced the co-ordination between all the stakeholders. It will help if all the initiatives are brought under single ITS roadmap.
- Lack of standards and ITS architecture: India does not have an ITS architecture or an ITS roadmap for the industry to prepare and follow. Standards will allow for a level playing field for all participants and also for customers
- After market device: There is no provision of connecting after-market device to vehicles without violating the warranty of the vehicle. Today vehicles do not come with standard interface to connect the devices. So while connecting the devices the warranty gets void.
- KYC: KYC norms for the SIM being used in ITS Devices (GPS/ GPRS etc.) need to be different than the KYC norms for SIM being used for mobile phone. Currently, there is no mechanism to ensure vehicle ownership transfer is in sync the device SIM connection, which needs to be addressed.
- Indigenous manufacturing: All modern vehicles are equipped with multiple sensors, which are presently not manufactured in India and are imported.

## 9 Way Forward

- Collaborative efforts: All stakeholders should join the larger ecosystem, and work toward single national objective. This will ensure wide acceptability of the technology and economies of scale. The stakeholders include:
  - Vehicle OEMs, Municipalities, Security Agencies (police), hospitals;
  - Associations : Car Manufactures, Associations : Society of Indian Automobile Manufacturers (SIAM), Automotive Research Association of India (ARAI) ;
  - Ministry of Road Transport and Highways, Ministry of Urban Development etc.



**FIGURE 14:**  
**COLLABORATIVE EFFORT**

It will be helpful if a centralised Nodal Agency is formed which will cater all end to end solutions for Intelligent Transport Systems and coordinate with all concerned departments, stakeholders etc. for various implementations.

- Promoting Entrepreneurship: In India there is an abundance of start-ups and SMEs with dedicated focus on M2M/IoT. As M2M domain has huge potential for India, there is need to create policies to help them in incubation stage. Any incentive for R &D and IPR for manufacturers/developers may also be discussed for policy initiatives in the matter. There is a potential to manufacture the ITS components in India. This will also result in growth of ITS in India.
- Study of Embedded SIM: - There is need to study the use of embedded SIM simultaneously in all environments and harmonise the different approaches and move towards embedded SIM. Embedded SIMs can be built into devices which then can be remotely and securely set up for an M2M solution.
- Dedicated Spectrum for Transportation: - There is need to study spectrum requirements for R&D and technology adoption for advanced technologies such as Radar based collision detection, V2I etc. and identify existing spectrum allocation and additional spectrum allocation requirements
- Role & Responsibility of Working Group: -ITS technologies for India cannot be entirely modelled on the existing successful ITS deployment of other countries as the ecosystem in India is different. The working group in TEC may focus on creating ecosystem for Indian geography and standardization of protocols/technologies for ITS.
- Lack of National Data Aggregator and Archive: There is need of a National Archival for ITS data, on which common applications can ride. The data being received on the server of the authorities can further be used not only for real time location but also for speed control by getting speed alerts and issuing speed violation challans based on the speed limits prescribed for various roads. The data can also be used for checking and controlling driving behavior / pattern. Further this will be useful for checking the road permit requirements for various states. Even load being carried by these vehicles can be regulated by adding load cells / sensors to the GPS devices.

- Lack of National Data sharing standards and data policy: There is need to create standards for sharing of data being generated by various ITS initiatives. The authorities can share this data and this can be available to multiple users/applications and also for planning and optimizing the transport infrastructure. A framework needs to be created for developers to use this data for various applications like congestion maps, accident hotspots etc.

## 10 References

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- <http://www.its.dot.gov/>

# 11 Annexure 1

## 1. Use Case Analysis

This chapter explains:

### 1.0 Use Case Analysis

#### 2. Title

UC automotive road safety in vehicle emergency call system.

#### 3. Objective

This use case deals with providing an infrastructure and corresponding process/infrastructure to auto-call an emergency number in case of an untoward situation.

#### 4. Background

##### a. Current Practice

One of the existing implementation can be seen in Ford's Ecosports. The system is a vehicle-based, no-cost, non-subscription call-for-help system that delivers a voice message directly to the emergency operator, indicating that a vehicle has been involved in an accident in which the airbags have been deployed, or fuel pump shuts-off opening up the line for hands-free communication.

The emergency assist system works via Ford's synchronise system, which is a voice-activated, hands-free communications and entertainment package for mobile phones and digital media players that allow the driver to make and receive calls and play music.

The system uses the driver's own mobile phone via Bluetooth and activates the moment the driver enters the car. In the event of an accident, the system uses its hands-free phone capabilities to connect the driver directly with India's emergency service number 108.

Before initiating the emergency call, the system will provide a 10 second window to allow the driver or passenger to decide whether to cancel the call. If not cancelled within 10 seconds, system continues with the emergency call.

The call flow is as follows:

- 1) In event of an accident, the vehicle location is determined by GPS.
- 2) Sync announces in the cabin that it is placing an emergency call.
- 3) Dials 108 emergency number for all emergency services.
- 4) Automatically plays a message, which informs the operator that a crash has occurred in a Ford vehicle and the location of that vehicle using the most appropriate language.
- 5) System confirms that the emergency assistance call has been initiated.
- 6) The user can cancel the call anytime by pressing hang-up.

##### b. Need for the Use Case

Every year the number of vehicle accidents and death injuries are increasing exponentially. Had it been that a quality support service is deployed at the accident site in time, number of such tragedies could be avoided.

Some of the factors affecting the quality service are as follows:

- 1) Delayed alerts at the emergency centre.
- 2) Delayed arrival of emergency services at the accident scene.
- 3) Insufficient information during rescue.
- 4) Inefficient traffic management.

This requires an automated system in the vehicle that can detect and react in case of an accident or any untoward incident.

## 5. Description

eCall system is an In-Vehicle Call system, which opens the line for communication over GSM in case of an accident. eCall System to be positioned in the Vehicular Network.

An accident can be identified based on airbags deployment or triggering of fuel pump shut-off.

All necessary information required for roadside assistance in time is sent over SMS through the established communication to the Emergency Service Provider. This includes the following:

- 1) Geo-coordinates
- 2) Vehicle model
- 3) Vehicle diagnostics info for crash impact

Before the communication is established, Vehicle Identification Number and Vehicle Diagnostics information is read from vehicular network using OBD protocol. Geo-coordinates are read using the embedded GPS module.

A voice call is also placed for the driver to provide additional data to service provider. However, voice call is hung-up after certain timeout if the driver's condition is critical.

eCall System also publishes the accident information over V2V network to nearby vehicles and to nearby infrastructure units over the V2I network using short-range communication protocols.

Emergency service provider receives data from the vehicle over GSM network. Emergency service provider to have an intelligent system to analyse received data and then determine type of service to be deployed at the accident site. System automatically places a call to the service provider such as ambulance, fire station, car service centre and shares vehicle data.

Service vehicle to deploy an intelligent system, which communicates the accident information to nearby infrastructure units, which further forwards the data to infrastructure unit in the near vicinity until closer to accident spot.

Infrastructure units could be signal lights, which receive such data to make way for the service vehicle to reach the accident spot in time, thereby resulting in timely deployment of service vehicle at the accident spot.

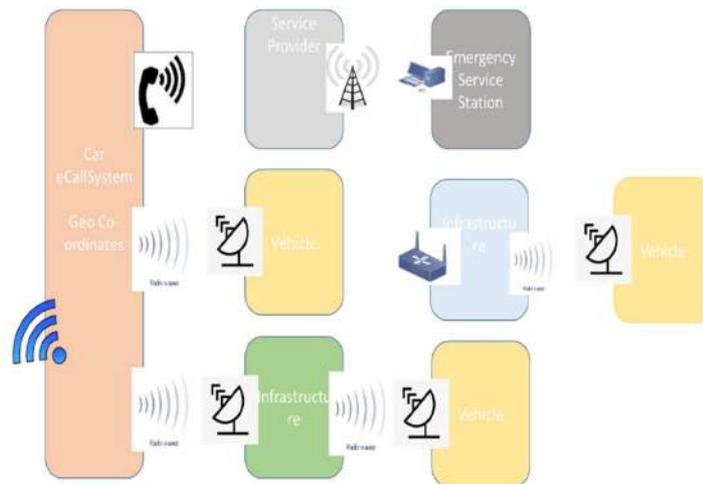
### a. Actors

eCall system is an in-vehicle call system, which opens the line for communication over GSM in case of an accident. eCall system positioned in the vehicular network.

**TABLE 6: ACTORS' DESCRIPTION**

Actor Name	Actor Type (person, organization, device, system)	Role Description
eCall System	Device	Device responsible for initiating the rescue operation
Service Provider	System	System responsible for 1. deploying the necessary services at the site of accident 2. Arrive at best route for the service vehicle 3. to Communicate the accident details to all the traffic signals to make way for service vehicles
V2V Communication Unit	Device	Device responsible for vehicle to vehicle communication
V2I Communication Unit	Device	Device responsible for vehicle to Infrastructure communication
Service Vehicle	System	Vehicle carrying the necessary equipment to

**b. Contextual Illustration**



**FIGURE 15: eCALL SYSTEM TEXTUAL DESCRIPTION**

**c. Pre-requisites**

The infrastructure through a person or service is expected to route and receive emergency calls. A system is expected to be in place to act on emergency calls.

**d. Triggers**

Any vehicle accident or an untoward accident may activate the vehicle emergency call system.

**6. Scenario**

**a. Generally Applicable Scenario**

One of the existing implementation is Ford’s implementation in its SUV Ecosport.

Some of the challenges anticipated are:

- 1) Information is sent as SMS for the service provider to identify nearest emergency service that needs to be deployed at the incident promptly.
- 2) If in a situation to speak, the driver can provide additional information for better assistance.
- 3) Communication over Vehicle-to-Vehicle (V2V) network is established to communicate accident information with approaching vehicles in the vicinity to avoid secondary accidents and traffic congestion if on highways.
- 4) Approaching vehicle to alert the driver about such an incident and further communicate the same to other vehicles in the vicinity.
- 5) V2I network can also be planned to have information flow over a wider range to cover more vehicles.
- 6) Emergency service providers to identify emergency services that need to be deployed based on received data.
- 7) Emergency service providers to arrive at best route for the service vehicle to reach depending on time of day promptly.
- 8) Emergency service provider to communicate the same to all traffic signals in the route to make way for service vehicles through the city

## b. Process Flow Diagram

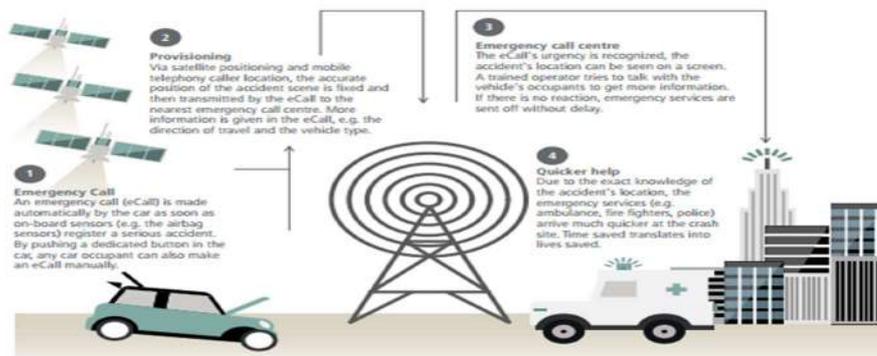


FIGURE 16: PROCESS FLOW DIAGRAM

## 7. Information Exchange

### a. eCall System

- Vehicle identifier tag is the Vehicle Identification Number.
- Vehicle diagnostics information is the OBD data.
- Vehicle geo co-ordinates are the longitude, and latitude details.

### b. Service Provider

- Emergency types are fire service, car service, ambulance, and police.
- Vehicle data, includes all of the above vehicle diagnostics information, which constitutes OBD data.

### c. V2V Communication Unit

- Vehicle location is longitude and latitude details.

**d. V2I Communication Unit**

- Vehicle location is longitude and latitude details.

**e. Service Vehicle**

- Vehicle location is the vehicle's data.

**8. Architectural Considerations****a. Generally Applicable Scenario**

The applicable scenario generally describes organizational requirements, quality, performance, security requirements, user interface requirements, and deployment infrastructure needs. Several use cases in a domain/sub-domain can have same architectural requirements.

**b. Interface Requirements**

Following are the interface requirements:

- 1) eCall system should be able to receive GPS data from GPS.
- 2) eCall system should be able to send data over GSM module.
- 3) eCall system should be able to send data over Short Range communication interface to approaching vehicle or infrastructure module in the vicinity.
- 4) Service provider shall be able to receive data over GSM.
- 5) Service vehicle shall be able to forward the data to nearby infrastructure unit.

**c. Performance Criteria**

- Vehicle data as described above is transmitted at the instance of accident from eCall system to the service provider.
- Ideally data to reach the service provider with minimum delay to service the situation promptly.
- About 100 bytes of data which includes geo co-ordinates, VIN and OBD Data to be transmitted from vehicle over GSM network at the time of accident to service provider.
- Service provider to dispatch this information to service vehicle with the problem description upon receiving data from the vehicle at the crash site.
- V2V and V2I system to send vehicle data over vehicular network (DSRC) at the time of accident.
- Vehicle data transfer is of highest priority and is the only data transmitted at the time of accident. In case of network failure, vehicle data sent over SMS will be buffered at the network provider end, and be made available to the end unit as soon as it reconnects the network.

**d. User Interface**

A Graphical User Interface based application will be required at the service provider end and at the service vehicle to view the vehicle data. No such user interface is required at the eCall system itself.

**e. Communication Infrastructure**

eCall system shall use GSM network and V2V network for communication with the outside world.

**f. Deployment Considerations**

eCall system to be deployed in the region of car which is very less likely to be damaged in the event of an accident. Device should be to extremely rugged/heat resistant to withstand an accident impact. Ruggedness and durability should be similar to that of a black box in aeroplanes.

#### g. Geographical Considerations

Infrastructure units are placed few hundred meters apart from each other.

#### h. Security

There are no security threats with eCall system as no critical data is transmitted.

#### i. Startup Shutdown Process

eCall system to be battery powered. Once the system is up and running, device will be in sleep state until an accident event occurs, thereby preventing battery from draining during normal operation of the vehicle.

#### j. Data Management

Data rate, payload size, frequency of communication, synchronous or asynchronous session types, request-, request-acknowledge-, handshake-request-, response types, and broadcast constitute data management in addition to data integrity and payload sizes.

### 9. Potential Market Growth

#### a. Growth Forecast

Safety systems in cars will be key growth drivers for the Indian automotive electronics market in the next few years as it attains Compounded Annual Growth Rate (CAGR) of 21.8% as per research estimates.

Accelerating growth in embedded, in-car Telematics over the next 15 years will lead to cars representing over 5% of all connected devices by 2025, compared with just 0.1% today. The automotive embedded Telematics market will grow at a CAGR of 24.6% over the next 15 years to reach €20 billion by 2025.

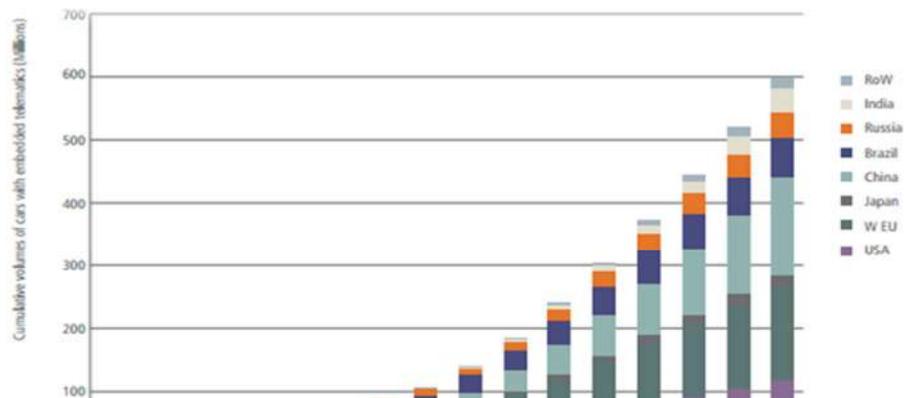


FIGURE 17: POTENTIAL GROWTH

## 10. Challenges

Some of the challenges anticipated are as follows:

- 1) No single Indian emergency service provider.
- 2) Interoperability of different emergency service provider.
- 3) Detection of fraudulent calls.
- 4) Detection of false alarms.
- 5) Backup procedure to make the call in case of primary call system fails.

## 11. Available Global Standards

Safety systems in cars will be key growth drivers for the Indian automotive electronics market the next few years, as it attains a CAGR of 21.8 per cent as per research estimates.

Working Group 15 of the CEN TC274 has written standards on eCall. Compliance with these standards is required in the general approach of the council.

- 1) EN 16062 - eCall High Level Application requirements (HLAP) defines the high level application protocols to facilitate eCalls using mobile networks.
- 2) EN 16072 - Pan-European eCall operating requirements specifies the generic operational requirements and intrinsic procedures for the provision of an eCall service that allows transfer of emergency messages and to establish a voice channel between IVS and PSAP.
- 3) EN 16102 - eCall - Operating requirements for third party support covers the same scope for but for third party services in order to allow service providers to offer services handling eCalls.
- 4) EN 15722 - eCall minimum set of data (MSD) specifies the content and format of the data to be transferred by the IVS to the PSAP during an eCall.
- 5) CEN/TS 16454 - eCall end-to-end conformance testing sets out test procedures that allow different actors in the eCall chain (vehicle/IVS, MNO, PSAP, TPSP) to claim conformance to all above listed EN eCall standards.

## 12. ETSI Standards

The following ETSI standards have been referenced in the various eCall related documents:

- ETSI TS 102 164 (Version 1.3.1)
- ETSI TS 121 133 (Release 8 or later)
- ETSI TS 122 003 (Release 8 or later)
- ETSI TS 122 011 (Release 8 or later)
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- ETSI TS 126 269 (Release 8 or later)
- ETSI TS 127 007 (Release 8 or later)
- ETSI TS 151 010 (Release 8 or later)
- ETSI EN 301 511
- ETSI EN 301 9

## 12 Abbreviations

Abbreviation	Full Name
ARAI	Automotive Research Association of India
AES	Advance Encryption Standard
CDMA	Code Division Multiple Access
CAGR	Compounded Annual Growth Rate
CAN	Car Area Network
CCTV	Closed Circuit Television
DES	Data Encryption Standard
DIMTS	Delhi Integrated Multi-Modal Transport System
EOBR	Electronic On-Board Recorder
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
GPS	Global Positioning System
HLAP	High Level Application Requirements
IOT	Internet of Things
ITS	Intelligent Transport System
MDS	Minimum Data Set
M2M	Machine to Machine
OBD	On-Board Diagnostics
OTA	Over the Air
RFID	Radio Frequency Identification
RLSVDS	Red Light-Stop Line Violation & Detection System
RSA	Short for the surnames of its designers Ron Rivest, Adi Shamir and Leonard Adleman
SIAM	Society of Indian Automobile Manufacturers
SIM	Subscriber Identification Module
V2V	Vehicle to Vehicle
V2I	Vehicle to Infrastructure
VMS	Variable Message Sign
VTS	Vehicle Tracking System
Wi-Trac	Wireless Traffic Signal Controller



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DEPARTMENT OF TELECOMMUNICATIONS  
MINISTRY OF COMMUNICATIONS & INFORMATION TECHNOLOGY  
GOVERNMENT OF INDIA