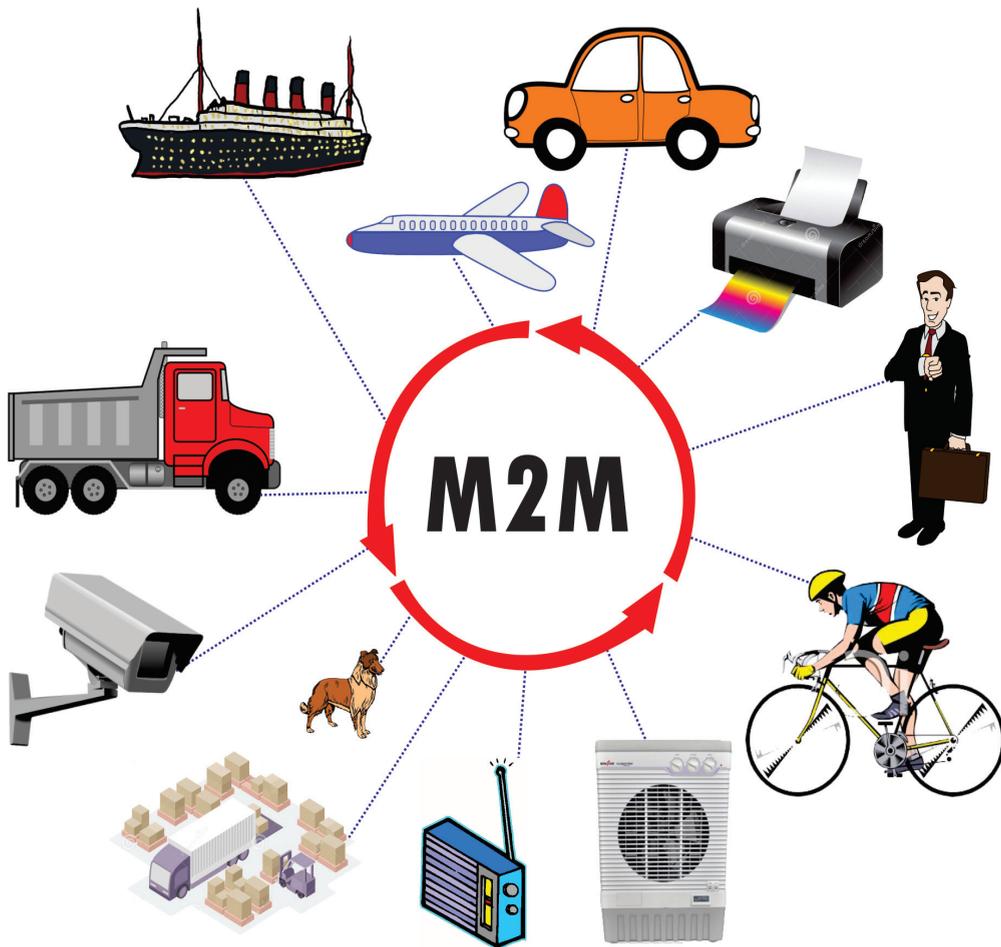




सत्यमेव जयते

# NATIONAL TELECOM M2M ROADMAP



**Government of India**  
**Ministry of Communications & Information Technology**  
**Department of Telecommunications**

# National Telecom M2M Roadmap

First Published: May 2015

## **Disclaimer**

This document is meant for circulation amongst all the stakeholders in the field of M2M/ IoT/ ICT. The information contained is mostly compiled from different sources and no claim is being made for being original. Every care has been taken to provide the correct and up to date information along with references thereof. However, neither DoT nor the authors shall be liable for any loss or damage whatsoever, including incidental or consequential loss or damage, arising out of, or in connection with any use of or reliance on the information in this document. In case of any doubt or query, readers are requested to refer to the detailed relevant documents.

रविशंकर प्रसाद  
RAVI SHANKAR PRASAD



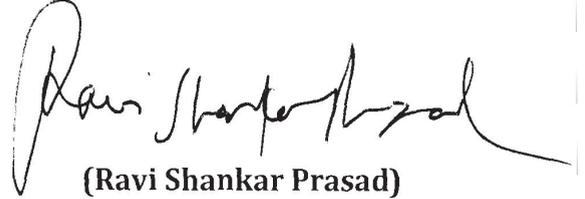
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भारत सरकार  
MINISTER  
COMMUNICATIONS AND IT  
GOVERNMENT OF INDIA

### MESSAGE

I am glad to note that Department of Telecommunications (DoT) is bringing out the '**National Telecom M2M Roadmap**'. Machine to Machine communications is one of the thrust areas of the department.

M2M communications is expected to revolutionize the performance of various sectors, businesses and services, by providing automation and intelligence to the end of devices, in a way that was never imagined. M2M communications can bring substantial tangible social and economic benefits by giving more efficient and effective services to the citizens in various sectors like Power, Transport, Healthcare, Security among various other sectors.

I am confident that this roadmap will provide guidance to all the stakeholders to nurture M2M communications, in our pursuit to provide citizen-centric services in this country, by use of technology. This roadmap will act as an enabler towards government vision of Digital India and Make in India. I congratulate all concerned for this commendable work, which is very timely, and wish them success in all their endeavours.

  
(Ravi Shankar Prasad)

राकेश गर्ग  
सचिव  
**RAKESH GARG**  
Secretary



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Ministry of Communications &  
Information Technology  
दूर संचार विभाग  
Department of Telecommunications

07 April, 2015

**MESSAGE**

I am extremely happy to note that Networks and Technologies (NT) Cell, DoT is bringing out the '**National Telecom M2M Roadmap**'. Machine to Machine communications is expected to play a vital role in bringing greater efficiency by reducing human interface in the communication between Machines and Computers in various sectors.

Machine to Machine communications along with ICT will play a critical role in bringing intelligence to the field level in various sectors and facilitate in transforming them to smart sectors, by reducing the human - machine interface. This will help in providing the best possible services to the citizens of this country.

I hope all the members of the M2M ecosystem will find this Roadmap most useful, and increase their efforts in the development and manufacturing of M2M based products and services in the country.

I appreciate the efforts of NT Cell, DoT for this commendable work, which is very timely. I wish them success in all their endeavors.

(RAKESH GARG)  
Secretary(Telecom)

आर एस शर्मा  
सचिव

**R S Sharma**  
Secretary



भारत सरकार  
संचार और सूचना प्रौद्योगिकी मंत्रालय  
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Government of India  
Ministry of Communications &  
Information Technology  
Department of Electronics &  
Information Technology (DeitY)

### *Message*

It is a matter of immense satisfaction that Networks and Technologies (NT) Cell, DoT is bringing out '**National Telecom M2M Roadmap**' to have a coordinated and holistic approach towards development of telecom networks and its related policies and standards in M2M.

Machine to Machine communication is going to play a major role and will contribute significantly towards Government Initiatives of Digital India and Make in India. The Roadmap will set a direction to boost development of M2M based products and services in India. It will facilitate in closely coordinated IT, Telecom and domain specific policies towards IoT deployments with diverse applications in various sectors to provide efficient citizen centric services.

I am confident that this Roadmap will be useful to all the stakeholders and will pave the way for open, scalable and interoperable IoT networks in country. I congratulate NT Cell, DoT for this commendable work and wish them success in all their endeavors.

New Delhi  
24<sup>th</sup> March, 2015

  
24/3  
(RS Sharma)



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### **Message Member (T)**

I am happy that Networks and Technologies (NT) Cell, DoT is bringing out this '**National Telecom M2M Roadmap**'. This is in line with the objectives of the department recognizing futuristic role of M2M to facilitate new technologies in furthering public welfare and enhanced customer choices through affordable access and efficient service delivery.

A number of initiatives are taken in India towards M2M service deployments in last few years but the approach has remained highly fragmented, and isolated in respective sectors. This Roadmap document endeavors to assimilate various M2M standards, outline policy and regulatory approaches and measures for increased M2M proliferation. It focusses on open, scalable and interoperable M2M deployments so that various components can be reused bringing efficiency and economy in overall deployments in the country.

I wish to convey my best wishes to NT Cell, DoT for this commendable work, in line with Industry requirements. I wish them success in their journey ahead.

(S.S. Sirohi)  
Member (T)  
15.04.2015.

**NARENDRA K. YADAV**  
Member (Services)  
&  
ex-officio Secy. to Govt. of India



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Dated: 9<sup>th</sup> April, 2015

## Message

I am glad to know that Networks & Technologies (NT) Cell, DoT is bringing out this 'National Telecom M2M Roadmap'. The document will serve the objectives of the department to develop new and upcoming technologies in the telecom sector.

M2M/ IoT are going to be next big thing at global level and a number of actions are happening across the world. M2M has tremendous potential to bridge the digital divide in the country. It will further put India in advantageous position as M2M technology can be used in upcoming infrastructure project leading towards state of the art deployments. Further M2M/ IoT based applications in sectors like Transport, Power, Utilities, Logistics, Health, Shipping, Smart City etc. have tremendous potential to bring sustainable value addition to the emerging scenario on continuous basis.

I am sure that this document will be found immensely useful by all stakeholders in their journey towards M2M. I wish to convey my best wishes to NT Cell, DoT for this commendable work, which is very timely and wish them success in their all efforts towards M2M proliferation in India.

(NARENDRA K. YADAV)

ऐनी मोराइस

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New Delhi-110 001



### Message

**Dated, April 9, 2015**

I am happy to learn that 'National Telecom M2M Roadmap' is being released by Networks and Technologies (NT) Cell, Department of Telecommunications. I hope that it will serve as a valuable source of knowledge for the stakeholders and facilitate large scale rollout of IoT/M2M based services in the country in line with the Government initiatives of Digital India and Make in India.

In today's communication age, technology has touched almost all fields of human activities. In order to achieve equitable development in a vast country like India, it is necessary to harness technology and bring out meaningful deployment to the remotest corner of the country. Standards based planned M2M deployment would go a long way in bridging the digital divide in India leading to socio-economic growth.

I congratulate NT Cell, DoT for this commendable work and wish them success in their further endeavors.

**(Annie Moraes)**  
**Member (Finance)**

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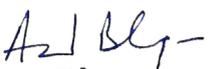
## Message

I am extremely pleased to know that Networks and Technologies (NT) Cell, DoT is bringing out the 'National Telecom M2M Roadmap' in line with the objectives of the department to develop the telecom sector.

Machine to Machine communication is the next big thing on the technology front and lot of development activities are happening across the world. It is heartening to note that this roadmap is comprehensively covering the M2M communication from concept to the practical use, with emphasis on the communication segment which is critical for M2M to succeed. The need for open standards and interoperability is of utmost importance to ensure that M2M devices proliferate in various sectors to provide efficient citizen centric services.

I am optimistic, that members of the M2M world will find this roadmap to be an useful guide, and will increase their momentum in faster rollout of standard based M2M solutions.

I appreciate the efforts of NT Cell, DoT for this laudable work, which is very timely. I wish them success in all their endeavors.

  
(A K Bhargava)

## **Foreword**

The Government has recognized importance of IT and initiated campaign of Digital India and Make in India. Success of these campaigns will ride on proliferation of M2M in India. Importance of M2M is also envisaged in the National Telecom Policy (NTP)-2012. This is due to the fact that M2M/ IoT will bring multi-fold devices connected on this network, improving the quality of life of common man and resulting in socio-economic growth of India. This is advantageous to India as smart devices capabilities can be used in Infrastructure projects making them efficient and opening immense opportunities.

The adoption of M2M based applications in areas like healthcare, tele-education, smart metering, smart grid, smart building, smart city etc. have enormous potential to boost the socio-economic development of the country. A good planning can bring India into advantageous position as lot many components can be shared whereby bringing economy in infrastructure development. Favorable policies and standards are one of the requirements to boost the M2M deployment.

It is against this backdrop that the 'National Telecom M2M Roadmap' is being released by DoT. The Policy and Regulatory guidelines have been formulated and firmed up after extensive discussions with all stakeholders including industry associations and Government organizations and adopting the pragmatic approach while incorporating the relevant viewpoints. Efforts have been made to incorporate all relevant inputs, material and experience gained during last one and half years since the activities were initiated. It is hoped that this document will prove to be an important milestone in the journey of M2M adoption and rollout of smart infrastructure and services in different sectors of the economy. I sincerely hope that with this initiative and the support of all stakeholders, the above aim envisaged in NTP-2012 will be timely achieved.

**(R M Agarwal)**  
**DDG (NT)**

## **Executive Summary**

Machine-to-Machine (M2M) communications represent tremendous opportunities, as roll-out becomes more widespread across various sectors. M2M can bring substantial and tangible social and economic benefits to consumers, businesses, citizens and governments. M2M is the basis for automated information interchange between machines and a control center for various industry verticals like Smart City, Smart Grid, Smart Water, Smart Transportation, Smart Health etc. Government of India has recognized the potential of M2M and emphasized the same in the National Telecom Policy 2012.

Traditionally, there have been two types of infrastructure: physical (buildings, roads, vehicles, transportation, power plants for example) and digital (IT and Communications infrastructure). There is a distinction between these two types of infrastructures – physical and digital, with both operating on separate fields. A convergence of the two coupled with smart management of the different infrastructures, could provide a multiplier effect and the same is the basis of M2M proliferation.

A number of initiatives are taken in India towards M2M services since the last few years but the approach has remained highly fragmented, and isolated in respective sectors. Through this document “National Telecom M2M Roadmap”, efforts are made to put together various standards, policy and regulatory requirements and approach for the industry on how to look forward for M2M. Globally Telecom Standards Development Organizations (TSDO’s) have taken lead in drafting M2M service frameworks and standards. Taking it ahead for India, this document focuses on communication aspects of M2M with emphasis on Interoperable standards, policies and regulations to suit Indian conditions across sectors, across the country.

Chapter 1 of this roadmap gives a brief introduction to M2M, its applications, opportunities and future of M2M. Chapter 3 covers the global scenario in regards to standards and regulations with reference to M2M, and initiatives taken by various countries for M2M growth and boosting their economy.

Chapter 2 dwells on the various communication technologies available for the last mile, related spectrum requirements, existing communication network availability for M2M use and broad outline to be followed while designing mega projects around M2M.

Chapter 4 provides the details of DoT activities towards policy formulation, standard development initiatives and actions to be taken in the future. The M2M specific policies are also defined in this chapter. Efforts have been made to keep the policies lightweight and in line with popular M2M business models so that M2M proliferation gets a boost.

Chapter 5 has focus on the government initiative of ‘Make in India’ and gives government approach in going forward with respect to creation of test bed facilities, product certification, Human Resource and Capacity Building, Center of Innovation, Pilots, Entrepreneurs and start-ups. Internet and Broadband growth in India is majorly using

imported devices. For IoT (Internet of Things) and M2M, the government of India wishes to have proliferation based on locally manufactured products and services and accordingly trying to put an eco-system in place. Chapter 7 provides the road ahead for the actions to be taken by the government in this regard.

Chapter 6 details how M2M can influence various sectors like Smart Cities, Automobile, Energy and utilities, tax compliance through fiscal registers by making POS online, Water Management, Health care, Agriculture, Safety and Surveillance, Supply Chain etc. and the sector wise application are covered in Annexure IV.

M2M, IoT (Internet of Things), IoE (Internet of Everything) are terms interchangeably being used in reference to Smart Infrastructure and services. Through this document efforts have been made to cover communication requirements for all such deployments.

M2M communication policy evolution will involve profound interactions with all M2M Eco System Partners including Academia, Industry, Chip Set Vendors, Service Providers, OEM's, Consultants, Solution Providers, Enterprises, National & International Standardization bodies and within the Government through Inter-Ministerial and center-State bodies. M2M will bring smartness in non-communicating products and services covering vast number of sectors, a number of them use minimal technology on date. For smooth adoption of same, close coordination and telecom expertise will be required. An Apex body for coordination among various sectors is proposed to take care of such requirements.

The roadmap provided here will endow all the M2M eco system partners in India to have a reference document and will enable us to realize the policy goals of Make in India and Digital India a reality.

The roadmap is a live document and feedback from all ecosystem partners and the public are invited for further innovations in the field of M2M communications, and formulation of Guidelines for adoption and facilitation of M2M based services in India.

## **Acknowledgements**

M2M/ IoT are going to be next generation of Internet revolution connecting about 10 time more devices on Internet in a couple of years. The NTP-2012 also recognizes futuristic role of M2M in furthering public welfare through affordable access and efficient service delivery. M2M represents tremendous opportunities, especially as their roll-out becomes more widespread. During the last one and half years, a lot of interactions have taken place with different stakeholders and the suggestions, opinions and feedback given by everyone have helped us in formulating this document.

We are ineffably indebted to Shri Rakesh Garg, Secretary (T), Shri S.S. Sirohi, Member (T), Smt. Rita Tevatia, Spl. Secretary (T) and Shri A K Bhargava, Advisor (T) for their conscientious guidance and encouragement. Without their broad vision, valuable guidance and support, it would not have been possible for us to accomplish this roadmap document in its present form.

We express our special thanks to Shri A.K. Mittal, Sr. DDG (TEC), Shri R.J.S. Kushwaha, Wireless Advisor, Shri Vipin Tyagi, Executive Director (C-DoT), officers from AS, WPC, TERM, Security cells of DoT, officers from C-DOT and TEC, who have facilitated arriving at consensus on contentious issues and guided us in different interactions, meetings and discussions that have been of great help.

We would like to thank COAI, AUSPI, FICCI, ISGF, ASSOCHAM, CII, ACTO, GSMA, TSDSI, ETSI, TEMA and TEC M2M working groups chairman, rapporteurs and members for their valuable interactions and inputs which led to formulation of this roadmap document.

We would like to express our special thanks to all the officers and staff of NT cell, DoT for their various inputs and continuous support during the entire period of preparation of this Roadmap.

We would like to sincerely thank everyone who has contributed directly or indirectly during the preparation of this document.

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(National Telecom M2M Roadmap)

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  - f. Safety and Surveillance
  - g. Agriculture
  - h. Supply Chain (PDS)
  - i. PoS – Fiscal Register

**GLOSSARY****73****REFERENCES****78**

# **CHAPTER 1**

## **BACKGROUND AND INTRODUCTION**

### **1.1 Machine to Machine: Definition**

M2M, the acronym for Machine-to-Machine communication is an emerging area in the field of telecom technologies. Machine to machine (M2M) refers to technologies that allow both wireless and wired systems to communicate with other devices of the same ability. M2M uses a device (such as a sensor or meter) to capture an event, which is relayed through a network (wireless, wired or hybrid) to an application, that translates the captured event into meaningful information.

Apart from M2M, other terms are also being used to describe such communication - Internet of Things (IoT), Internet of Everything, Embedded Wireless, Smart systems (Homes, Cities, Meters, Grids etc.) with slightly different attributes to each term. IoT is connected network of embedded devices capable of having M2M communication without human intervention. M2M Communication when combined with logic of cloud services and remote operation becomes “Smart”.

ITU-T in its recommendations, ITU-T Y.2060 (06/2012) has defined Internet of things (IoT) as ***“Global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.”*** ETSI has defined M2M Communications in ETSI TR 102 725 V1.1.1 (2013-06): as ***Physical telecommunication based interconnection for data exchange between two ETSI M2M compliant entities, like: device, gateways and network infrastructure.***

In M2M communication, machines can be interconnected through host of media depending on the specific requirements i.e. Indoor Electrical Wiring, Wired Networks (IEEE 802.3 Ethernets), WPANs (Bluetooth, Dash7, ZigBeeetc.), Wi-Fi (IEEE 802.11), PLC, PSTN/ DSL, 2G/3G/4G or even satellites.

Machines are having capability of communication with other machines for decades. But availability of Inexpensive electronics, use of Internet Protocol (IP) along with ubiquitous network availability and cloud computing has vastly enhanced the possibility of devices equipped with communication module capable of providing their status and other information, which can be aggregated, interpreted and can be in turn used to control these devices or can be used in more meaningful ways.

With traditional revenue streams getting saturated in most markets around the world, M2M holds the promise of generating new avenues for revenue generation for TSPs/ ISPs as well as opening new business opportunities for new service providers.

### **1.2 Applications of M2M:**

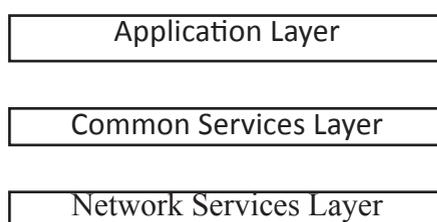
M2M Ecosystem comprises of telecom service providers, M2M application service providers, Sensors, hardware OEMs, supply chain, middleware, deployment and asset management. Varying requirement of mobility and dispersion level in different applications of M2M and Network Technology used can be explained as per the following diagram:

		NEED OF MOBILITY →	
		FIXED	MOBILE
GEOGRAPHICAL SPREAD →	DISPERSED	<p><b>Applications</b> Smart Grid, Smart Meters, Smart City Remote Monitoring</p> <p><b>Technology</b> PSTN Broadband 2G/3G/4G Power Line Communication</p>	<p><b>Applications</b> Car Automation eHealth Logistics Portable Consumer electronics</p> <p><b>Technology</b> 2G/3G/4G Satellite</p>
	CONCENTRATED	<p><b>Applications</b> Smart Home/ Smart Building Factory Automation eHealth</p> <p><b>Technology</b> Wireless Personal Area Network Wired Network Indoor Electrical Wiring Wi-Fi</p>	<p><b>Applications</b> On Site Logistics</p> <p><b>Technology</b> Wi-Fi WPAN</p>

M2M is driving an increasingly complex relationship between networks, service providers and an exploding number of devices in real time. These devices will be powered and connected by a complicated convergence of networks. Different types of applications have different needs in terms of network resources leading to requirement of different regulatory treatment to them. DoT endeavors to tackle the regulatory implications of usage of digital communication technologies, including wireless, wireline, MPLS, Ethernet, Private Line, etc. in M2M applications.

### 1.3 Typical Architecture of M2M communication network

All future M2M networks will cater to multiple M2M services in common geographical Area. The proposed M2M architecture by oneM2M partnership depicts the same as below:



**Fig: oneM2M Layered Model**

It comprises of the following functions:

**Application Entity (AE):** Application Entity represents an instantiation of Application logic for end-to-end M2M solutions. Examples of the Application Entities can be an instance of a fleet tracking application, a remote blood sugar monitoring application, a power metering application, or a controlling application.

**Common Services Entity (CSE):** A Common Services Entity represents an instantiation of a set of “common service functions” of the M2M environments. Such service functions are exposed to other entities through reference points. Examples of service functions offered by CSE include Data Management, Device Management, M2M Subscription Management, and Location Services.

**Underlying Network Services Entity (NSE):** A Network Services Entity provides services from the underlying network to the CSEs. Examples of such services include device management, location services and device triggering. No particular organization of the NSEs is assumed.

The applications, data storage and actuation may reside either on physical network entities/ captive data center/ cloud or may be in hybrid mode. Different arrangements are likely to have different implications and shall require different treatment specially w.r.t. security, privacy KYC etc. Globally, the SDO's are adopting such architecture and are trying to define standards interfaces etc. around the same. This document focuses on networking and telecom related aspects of M2M/ IoT.

## 1.4 M2M Opportunities:

Today industry is at the cusp of the new operating paradigm, marked most significantly by a transition from voice & data to M2M/ IoT and associated services and offerings. Traditional businesses, which earlier had nothing to do with IT, have not only started adopting it, but at the same time getting heavily dependent on IT.

Conscious of the changes in the landscape and overall industry drivers, the government came out with the New Telecom Policy in 2012. The prime objective of NTP-2012 is to maximize public good by making available affordable, reliable and secure telecommunications and broadband services across the entire country. In NTP-2012, there is further thrust on high quality broadband services, Cloud computing, Mobile Internet, IPv6, Machine to Machine communication and telecom equipment manufacturing.

M2M applications like remotely operated irrigation pumps, Smart Grid etc. as mentioned in the NTP-12 will play significant role in boosting the Indian economy. Current applications of M2M cover many areas and can be broadly grouped as below:

**(a) Transportation & Automotive:** Possible M2M applications in the transportation and automotive sectors include Fleet management Services, Vehicle driver performance, fuel consumption, Container/ Cargo management, GPS tracking, E-Toll, Vehicle information to third parties, Prevention of Vehicle Theft, Traffic control, Smart Parking, Emergency call (eCall) etc.

Current applications within the automotive industry are focused on delivering enhanced security for people such as emergency call applications – eCall Project of Europe; or assets tracking applications-SIMRAV of Brazil. Fleet management applications focus on increased operational efficiency and increased incremental revenue. These services are broad ranging and include remote diagnostics, navigation systems, pay-as-you-drive (PAYD) (insurance, in-car services).

**(b) Utilities:** M2M applications in this domain will be used to monitor and control the generation, transmission, Distribution and consumption by employing intelligent devices. The utility companies (electricity, water, gas etc.) deploy intelligent/prepaid metering services by installing M2M communication modules on metering devices which can send information automatically or on demand to a server application. Smart meters – water, energy & fuel consumption for home & industry, smart grid - monitor load in real time, Electric Vehicle Charging Infrastructure are a few examples under this category.

**(c) Financial Transactions in Retail:** In the case of remote located wireless/wired Point of Sale (PoS) terminals i.e. ATM machines (cash replacement, repair diagnostics, paper availability etc.), M2M modules are installed to provide communication for credit or debit card on-line financial transactions. A number of countries are using PoS integrated with government taxation system to monitor real time sales to stop possible leakage of Tax revenue.

**(d) Home/Buildings:** Home /Building Automation deploy M2M modules & sensors in various utilities available in Home to measure/ control energy, home health monitoring, HVAC, lighting, solar energy, wind energy and Building alarms - security, fire, intrusion, emergency.

**(e) Security and Surveillance:** Applications in use are Alarm System Monitoring, Video Surveillance, real time monitoring, video analytics, in banking, retail, buildings in addition to smart cards and Facility management.

**(f) Manufacturing:** Widely used Customized solutions in Asset management, smart sensors, Monitor/diagnostics for industrial controllers, Tank Monitoring, Data collection, diagnostics for managed print services.

**(g) Healthcare:** Smart body sensors, Remote patient monitoring of residential/ institutional, communicate with smart phone and central server. M2M can be used in primary health centres in rural areas to enable speedy diagnosis and timely treatment.

**(h) Consumer Electronics:** Use cases include Remote monitor and control, interoperability between e-Readers, Gaming Devices, Picture Frames, TVs and Refrigerators etc.

**(i) Other Sectors:** Provision of services for public sector and transportation such as traffic monitoring, parking permit machine, traffic signalling, street light control, Public Distribution System, Agriculture & Animal Husbandry, Mining, Conservation of wild life, Conservation of forests, pollution monitoring of water bodies, weather stations, disaster management, wholesale connectivity to M2M MVNO etc.

### 1.5 Future of M2M:

M2M applications have a great potential to transform businesses. Machine to Machine communication will challenge companies to be innovative in the same way as mobile internet did. Given the diverse nature of M2M applications, some sectors will be more successful/ innovative and emerge as winner than other sectors. However for M2M to gain acceptance among the general populace, service providers and others must deliver applications that bring tangible value to people's lives.

M2M has the power to reinvent business. The combination of backend service enablement platforms, service delivery platforms and intelligent devices in the field remove barriers that were previously hindering M2M market growth. In the coming years, millions of motor vehicles, utility meters, consumer electronics, tele-health/medical devices, security alarms and other machines will become networked using M2M, advanced service enablement and service delivery platform technologies.

Service delivery platforms provide a software service infrastructure that can manage multiple wireless edge device environments and store all of the edge data in a single database environment. Applications can use that data for a variety of reporting, management and service enablement purposes. Such service delivery platform should provide standards-based services and tools to:

- Collect and process data from multiple wireless devices
- Integrate data collected into existing applications and IT systems
- Manage wireless device provisioning, deployment and updating
- Secure remote access to control and manage assets

Through these tools, carriers and Mobile Virtual Network Operators can deliver vertical market solutions that enable customers and enterprises to access remote assets with real-time visibility for improved decision making. M2M can connect virtually anything. The result has been an explosion in the number of possible business and consumer M2M applications.

A large number of M2M/ IoT mega projects have been announced by Government of India and have the potential to impact socio-economic life. Few of them are listed as under:

1. Ministry of Urban development has proposed to develop 100 Smart cities
2. Ministry of Power has taken up 14 Smart Grid pilots with average Customer base of around 20000 each.
3. Ministry of Road transport has mandated that all commercial passenger vehicles of more than 22 seating capacity be enabled with GPS, emergency calls etc.

With technological, political and economic factors coming together; M2M will continue to see strong growth. As new infrastructure replaces the old, companies and governments have the opportunity to drastically alter their businesses by implementing a technology strategy that is not only more efficient, but enables new levels of service and economy.

Flexible, intelligent devices make M2M a transforming technology that enables businesses to simplify, renovate and enhance in entirely new ways. Coupling these devices with a robust service enablement and delivery platform makes these deployments scalable today, delivering actionable data directly into the enterprise applications. It enables in dynamically managing the end-to-end solutions from deployment to full life-cycle, including billing and expense management. The possibilities are endless.

## CHAPTER 2

# M2M : BUILDING COMMUNICATION INFRASTRUCTURE

### 2.1 M2M Communication Technologies:

In order to realize any M2M based smart network, M2M communication is considered as a building block to deploy a wide-scale communicating, monitoring and control infrastructure. The choice of communication technology for M2M would be based on the use case, MNP preference and ability to address the challenges. A typical M2M network consists of following building blocks:

1. Wide area Network (WAN)
2. Field area Network (FAN)
3. Neighborhood area Network (NAN)
4. Home area Network (HAN)/ Building Area Network (BAN) etc.
5. Local area Network (LAN)



prominent role in infrastructure. These networks, referred to as NANs support a variety of applications. FAN is the combination of NAN and local devices attached to a Field Area Router offering the backhaul WAN interface(s), which has emerged as a central component of the M2M network infrastructure. In fact, they can serve as backhaul networks, multi-tenant services, and data exchanges to home-area network (HAN) devices, all connected through a variety of wireless or wired-line technologies. The use of open standards that provide the reliability, scalability, high security, internetworking, and flexibility required to cope with the fast-growing number of critical applications that networks need to support, is desirable.

**WAN/ FAN technologies:** TSP fiber network and Cellular M2M technology using 2G/3G/4G plays an important role in M2M WAN& FAN communications.

**HAN & NAN:** There are large-scale wireless sensor and actuator deployed in a typical M2M network in order to carry out the monitoring task. These sensors with the collaborative and self-healing nature have an important role to play in realizing various functionalities needed in the M2M network. The various communication technologies available are briefly described below:

**6LoWPAN:** 6LoWPAN is an acronym for IPv6 over Low power Wireless Personal Area Networks. The 6LoWPAN concept originated from the idea that “the Internet Protocol could and should be applied even to the smallest devices,” and that low-power devices with limited processing capabilities should be able to participate in the Internet of Things. The 6LoWPAN group has defined encapsulation and header compression mechanisms that allow IPv6 packets to be sent and received over IEEE 802.15.4 based networks. IPv4 and IPv6 are the work horses for data delivery for local-area networks, metropolitan area networks, and wide-area networks such as the Internet.

**Power Line Communication:** Power-line communications systems operate by adding a modulated carrier signal to the power cable. Different types of power-line communications use different frequency bands. The main issue determining the frequencies of power-line communication is to limit interference with radio services. Many nations regulate unshielded wired emissions as if they were radio transmitters. Data rates and distance limits vary widely over many power-line communication standards. Low-frequency carriers impressed on high-voltage transmission lines may carry one or two analog voice circuits, or telemetry and control circuits with an equivalent data rate of a few hundred bits per second; however, these circuits may be many miles long. Higher data rates generally imply shorter ranges; a local area network operating at millions of bits per second may only cover one floor of an office building, but eliminates the need for installation of dedicated network cabling.

**Wi-Fi:** Wi-Fi proliferation is on the rise in India. Home networking devices may also use Wi-Fi wireless LAN connections by using technology under 802.11 IEEE standards. A wireless network can be used for communication between many electronic devices, to connect to the Internet or to the wired networks that use Ethernet technology.

**ZigBee:** ZigBee is a wireless mesh technology developed as an open standard to address the unique needs of low-cost and low-power wireless M2M networks. It uses digital radios based on IEEE 802.15.4 standard for home area network with a focus on monitoring, control and sensor application. It is targeted at applications that require a low data rate, long battery life, secure networking – as in wireless switches, electrical meters, lighting control, smart energy, HVAC control, health monitoring and so on. The success of ZigBee can be gauged by the fact that over 300 leading semiconductor manufacturers, technology firms, OEMs and service companies comprise the ZigBee Alliance membership. However, results in the field show that ZigBee is more suited to in-home networking.

**Ethernet:** Ethernet is by far the most deployed, most known and most trusted wired technology for LANs. These days, almost every device is Ethernet-enabled. Besides offering a good Quality of Service (QoS) and cost benefits, most of the users are well acquainted with this and installation is not an issue. However, newer installations do pose problems in terms of cabling and wiring within the building.

**HomePlug:** With HomePlug technology, electrical wires in a building can distribute broadband internet, HD video, digital music and smart energy applications. The major benefit is that users can easily establish a network using building's existing electrical wiring as the communication medium. The most widely deployed power line networking devices are "adapters", which are standalone modules that plug into wall outlets and provide one or more Ethernet ports. There are various specifications under HomePlug family – major ones being HomePlug AV for applications such as HDTV, VoIP and HomePlug GreenPHY targeted towards Smart Homes.

**RFID:** RFID sensors are Radio Frequency Identifiers embedded in the device. According to the RFID Journal the technology is "any method of identifying unique items using radio waves. Typically, a reader communicates with a transponder that holds digital information in a microchip". This technology relies on being within a close range. Warehousing inventories depend heavily on RFID to keep internal stock control for example.

**NFC:** Near Field Communication (NFC) – a standards based short range wireless connectivity technology, is a proximity technology embedded in, for example, smart phones. NFC provides applications such as contact less transactions, data exchange or receiving information from another 'passive' NFC chip called a tag. The technology was designed to make consumers lives easier by making it simpler to make transactions, exchange digital content, and connect electronic devices with a touch, in the words of the NFC Forum.

**Bluetooth:** The very popular Bluetooth technology is a global wireless standard enabling convenient and secure connectivity for an expanding range of devices and services. Its design purpose was to enable communication between devices and not network many devices as other technologies (like Wi-Fi) aim to do. Bluetooth mostly serves as a substitute for data cables. It is highly available in current devices. Its most common use is to connect point to point. The IoT/ M2M has embraced Bluetooth 4.0 (also called Smart, LE or low energy) as it is greatly improved in power consumption over the classic Bluetooth technology while maintaining a similar communication range. The Bluetooth SIG explains its main advantage is that it “collects data and runs for months or years on a tiny battery”. Many modern wearable and other connected devices use Bluetooth LE to connect to data hubs, mobile devices or computers.

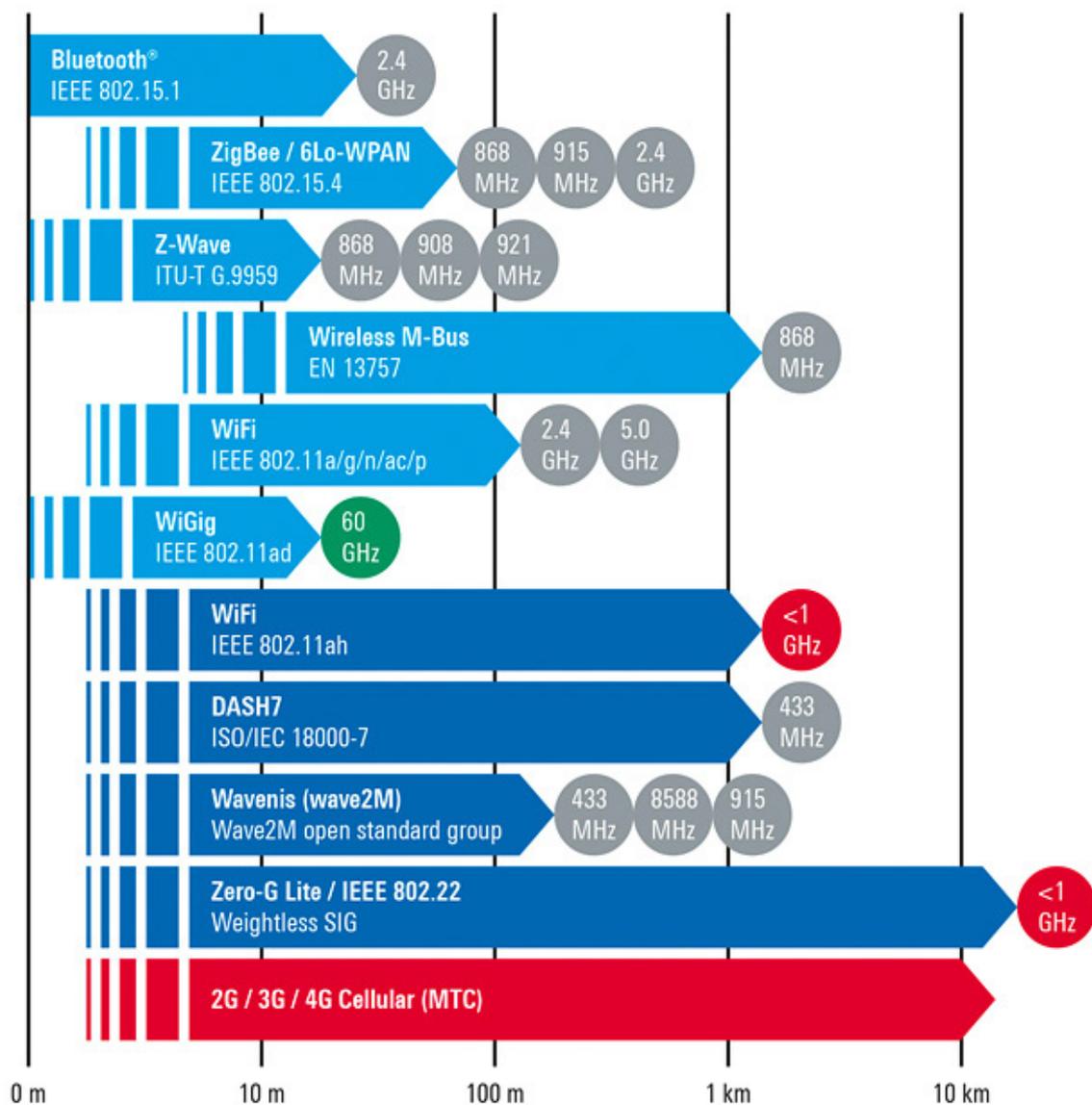
**Tetra (Terrestrial Trunked Radio):** TETRA (formerly known as Trans-European Trunked Radio) is a professional mobile radio and two-way transceiver (colloquially known as a walkie talkie) based on ETSI standards. TETRA was specifically designed for use by government agencies, emergency services, (police forces, fire departments, ambulance) for public safety networks, rail transport staff for train radios, transport services and the military. More than 114 countries are using TETRA systems in Western Europe, Eastern Europe, Middle East, Africa, Asia Pacific, Caribbean and Latin America in government secure networks. The main advantages of TETRA is the much lower frequency used giving it a longer range, which in turn permits very high levels of geographic coverage with a smaller number of transmitters. During a voice call, the communications are not interrupted when moving to another network site thus so called ‘mission critical’ networks can be built where all aspects are fail-safe/ multiple-redundant. Unlike cellular technologies, TETRA is built to do one-to-one, one-to-many and many-to-many function without the need for a control room operator.

**LoRa:** LoRa offers significantly longer range and improved radio performance compared to traditional wireless solutions resulting in greater transmission range and reduced capital expense and operational running costs by reducing the requirement for as many central controlling gateways. Operating 15dB below the noise floor which is currently unsurpassed and with a link budget up to 164 dB results in long range connectivity and increased building penetration of up to 4Km. LoRa also benefits from adaptive data rates (300 bps – 300 kbps), supports duplex communication, can operate in licensed and license free ISM bands including known bands such as 335Mhz, 433Mhz, 868Mhz, 915Mhz, 2.4Khz, 5Khz range and also supports frequencies in between the aforementioned. LoRa offers secure bi-directional communication which enables a notification and response.

Apart from above mentioned technologies, a number of open as well as proprietary communication technologies are in use at various locations at global level having their own set of advantages and disadvantages.

### **Operating frequencies of wireless technologies for M2M communications:**

Globally, frequency band used by various communication technologies are illustrated by the diagram on next page, which in itself is self-explanatory.



## 2.2 Spectrum availability for M2M Communication:

Radio spectrum will play an important role in enabling M2M communication, given the need to support a potentially significant number of wireless connections. To enable M2M service offerings, spectrum is utilized in various frequency ranges. Globally, the trend is to use telecom network of TSP and/ or free wireless bands in non-TSP frequency domains for M2M communications. In India also, de-licensed free bands are available in various frequency ranges, which can be used for M2M communication, as below:

1. Use of low power wireless equipment in the Citizen Band 26.957-27.383MHz with 5 Watt Effective Radiated Power and built-in antenna.
2. Use of low power wireless equipment in the 335MHz band at frequencies 335.7125, 335.7375, 335.7625, 335.7875, 335.8125, 335.8375 MHz with Inbuilt Antenna and up to 1 m W transmit power.
3. Use of low power wireless equipment in the 433-434 MHz with 10 m W of Maximum Effective Radiated Power and 10 kHz channel bandwidth.
4. Networks using low power wireless equipment in the frequency band 865-867MHz for RFID or any other device with maximum 1 Watt transmitter power, 4 Watts Effective Radiated Power and 200 kHz carrier bandwidth.
5. Wi-Fi based network in the frequency band 2.4 GHz to 2.4835GHz for Indoor use as well as to access in short range with 4 W of Maximum Effective Radiated Power and up to 5 meters above the rooftop antenna.
6. M2M network for indoor or campus use in the frequency band 5.150 to 5.350 GHz and 5.725

to 5.875 GHz for built-in or Indoor antenna with Maximum mean Effective Isotropic Radiated Power of 200 mW and a maximum mean Effective Isotropic Radiated Power density of 10 mW/ MHz in any 1 MHz bandwidth.

7. M2M network for outdoor use in the frequency band of 5.825-5.875GHz with 4 W peak of Maximum Effective Isotropic Radiated Power.

Apart from the above listed de-licensed bands, as per the requirements, the spectrum is also being allotted for testing and experimental purposes in different frequency bands on case to case basis by WPC wing of DoT.

### **2.3 QoS in M2M Communications:**

M2M communication show quite different characteristics compared with the traditional Human-to-Human (H2H) communications. QoS categorization of H2H communications is mainly based on delay, because voice is the main service in H2H communication. However, providing M2M data communications to large numbers of M2M devices and providing services to M2M application owners rather than end-users implies a different optimization of the network. Different M2M applications will have different QoS requirements. Although many M2M applications have no stringent QoS requirements and can deal perfectly well with best-effort QoS, some M2M applications have higher QoS or priority requirements than normal data services. TSP's and ISP's are increasingly providing QoS differentiation in their packet-based networks. This will represent an added value for many M2M applications.

The architecture of current-day packet-switched telecommunications networks will not need a complete overhaul, but a significant number of changes will be needed to support M2M market that really lives up to its promise. Some QoS requirements for M2M applications depend on the type of media being transported e.g. video surveillance requires a streaming-class QoS with sufficient bandwidth in very much the same way as other video-streaming services have QoS requirements. Other QoS requirements are more specific and are less frequent in current human-to-human data services. One of these is a more stringent requirement on transfer delay. Some remote-control applications require a lower latency than is currently the norm, at least in 2G and 3G mobile networks e.g. a feedback loop for controlling a generator would not be possible with round-trip delays of several hundred milliseconds. Fixed networks will be more suited to getting a sufficiently low transfer delay. However, the low latency of long term evolution (LTE) also provides an opportunity for M2M applications. Whereas latency in UMTS is generally in the order of 200 ms, the latency in LTE is typically as low as 15 ms. LTE was specifically designed to provide lower latency that provides possibilities for new M2M applications.

Another example is the allocation and retention priority (ARP). The ARP determines the priority that a device gets or maintains connectivity in the case of congestion in the network. Contrary to the different traffic classes, the ARP works on the connection instead of on individual IP packets. Many M2M applications can deal with a lower ARP than, for example, standard Internet connectivity. These M2M applications are not time-critical and can delay their data transfer until the congestion is over. But some M2M applications require a higher ARP. For example, seismic sensors need to be able to warn against earthquakes, even in the event that the earthquake results in congestion in the network. Applications can delay their data communication until congestion is over. Patients with a heart-monitoring device would also probably like their devices to have a somewhat higher priority than other data traffic in the mass of mobile communication on New Year's Eve. To cater to the M2M QoS needs it is important for the TSP's and ISP's to ensure good coverage along with QoS catering to Voice, Data and M2M Communications.

### **2.4 Energy Footprint Of M2M Networks**

There are going to be many devices in terms of sensors, network equipment and data centers to create the communication infrastructures and host servers for M2M services. All these equipment's also consumes energy. The energy footprint of all these elements could be huge. Hence while designing the M2M networks; it is important to ensure that low power devices are planned so that the Energy footprint is kept to the minimum.

However there has been little effort to evaluate the effect of global deployment of ICT and its additional

energy consumption and minimization. It is important to consider that all ICT equipment which is part of complete M2M network consumes less energy.

The energy footprint of existing ICT devices is non-negligible, and it is expected to grow over the next years. The additional deployment of sensors, networking equipment and computing devices would just raise future energy requirements. The huge number of such installations boosts very few additional watts in each location but at the scale of a nation, it consumes a huge amount of energy equivalent to the energy produced by several mid-size power plants. Globally several techniques are under study to lower the consumption of ICT devices, based on three main statements:

1. Silicon efficiency grows about half the rate of the capacity of new devices,
2. Power consumption does not linearly follow computational load,
3. Devices are often “on” just to maintain their presence in the network.

The evaluation of the impact of ICT technology must take into account the power consumption of single devices, as well as their number inside the network. This may lead to quite unexpected results, as even very low-power devices may be the major cause of energy consumption if they are massively deployed in the network. All communication systems should implement energy- optimized techniques dynamically adapting performance to the needs, and implementing heavily low power (sleep) modes, so as to minimize the overall energy footprint, while being able to cope with the communication requirements.

## **2.5 NOFN – Enabling M2M reach in rural India**

To offer M2M services in India, backbone networks of various TSP’s, ISP’s and carrier service providers will continued to be used. The capacity augmentation is a continuous process based on Industry requirements; however connectivity to remote areas is still a challenge. At present, the optical fiber has predominantly reached the state capitals, district and block headquarters. Through the National Optical Fiber Network (NOFN) project, a government of India initiative, it is planned to connect all the 2,50,000 Gram panchayats in the country through optical fiber utilizing existing fibers of PSUs viz. BSNL, RailTel & Power Grid and laying incremental fiber wherever necessary to bridge the connectivity gap between Gram Panchayats and Blocks, for providing broadband connectivity. The project is being executed through a Special Purpose Vehicle (SPV) Bharat Broadband Network Limited (BBNL), incorporated under Indian Companies Act 1956.

Dark fiber network thus created will be lit by appropriate technology to ensure a bandwidth of at least 100 Mbps at each Gram Panchayat. Non-discriminatory access to the network will be provided to all categories of service providers. These access providers/ service providers like mobile operators, Internet Service Providers (ISPs), cable TV operators, M2M Service providers, and content providers can launch various services in rural areas. Various applications for e-health, e-education, e-governance etc. will be provided using this network.

To have better understanding of the use cases, three Pilot Projects have been commissioned to cover all Gram Panchayats of Arain Block in Ajmer District (Rajasthan), Panisagar Block in North Tripura District (Tripura), and Paravada Block in Vishakhapatnam District (A.P.). Each of the 58 Gram Panchayats in these three Pilot Project Blocks have been provided with 100 Mbps bandwidth.

Once the project is completed, it will act as communication backbone for various M2M services offering in rural area. The last mile to extend services can be any of the communication technology mentioned in para 2.1.

## **2.6 Building M2M Network – The Indian Context**

In Indian context, massive investment is required in Infrastructure building. There are areas where existing infrastructure is in very poor state or almost non-existent and everything needs to be built. In such cases, few things needs to be taken care while building an M2M network at the design level itself as listed below:

1. While planning and upgrading road infrastructure, it is in the national interest to build ducts alongside planned roads to carry all kind of cables and pipelines including communication, power, water, gas, sewerage etc. If it is taken care, time and money spent will be drastically reduced to add communication, power, water, gas, sewerage infrastructure.
2. It needs to be mandated to provide for ducts/ ways for communication cables, similar to power and water while planning and designing a building. The building plans shall be approved only if these provisions are made.
3. While designing M2M services, it shall be planned to cater to services through common data center for the services of a common physical service area. Though currently government services are through common state level data center, large numbers of commercial and public sectors services are not covered from these data centers. In long run, such services shall also be covered from common data center.
4. At the stage of M2M networks design, to the extent possible, these shall be built based on standards. Considering this, a large part of the M2M service network can be built using existing networks of TSP/ ISP or other M2M service providers. It also provides an opportunity for future use of network components by other entities building M2M services in the same service area whereby adding revenue.
5. Energy footprint and environment plays a crucial role. All efforts should be made to use technologies and devices which consume lesser power and have minimal impact on environment. In the long run, there is need to evolve criteria to give weightage for the Environment and Climate effects of M2M devices (taking energy footprint and space needs into consideration) for use in procurement.
6. There is need to wisely choose communication technologies. Technologies such as LTE/ 4G/ and a few open and propriety one are emerging that support communication over longer ranges and could be used in either shared or dedicated spectrum with lesser number of network elements. Regulations and spectrum needs for these new technologies will be deliberated.
7. In the future, M2M/ IoT are likely to meld the virtual and physical worlds together in ways that are currently difficult to comprehend. From a security and privacy perspective, the predicted pervasive introduction of sensors and devices into currently intimate spaces – such as the home, the car and with wearables and ingestible, even the body – poses particular challenges. As physical objects in our everyday lives increasingly detect and share observations about us, consumers will likely continue to want privacy. Accordingly, there are security related suggestive guidelines which MSP shall try to incorporate in overall service design to the extent possible as under:
  - a. To the extent possible, only point to point data, SMS and voices services to predefined numbers only shall be enabled on M2M SIM.
  - b. Enable security of Embedded Sensors to protect from computer worms, viruses or other Malware by implementation of security features like e. g. MILS (Multiple Independent Levels of SECURITY AND SAFETY).
  - c. Additional security in sensors may be incorporated by IMEI & SIM PAIR LOCKING so that sensor shall work with the SIM configured by MSP. However the reverse is not encouraged i.e. locking by TSP as it will unnecessarily bind MSP with TSP.
8. In traditional approaches to development, all the infrastructure systems are managed in silos, with limited communication and information sharing among and across government departments and civil society. This could prove detrimental not only for the optimization of resource usage, but also for accessing vital information when needed to take informed decisions during a crisis or emergency situations. Therefore, it is essential to adopt a holistic approach, as well as strengthen the motivation for government & sector participation, the application of technology, and the integration of various smart infrastructures management systems combined with citizen collaboration.

## **CHAPTER 3**

# **GLOBAL SCENARIO ON M2M STANDARDS AND REGULATION**

### **3.1 Background**

The world, as it was known, 20 years ago is not what it is today. Similarly it will not be the same 20 years after. Such a dramatic change within a short period of time is mainly attributed to development of ICT and Internet. ICTs have provided today's society a vast array of communication capabilities and transformed the world into a global village. It is expected that future ICT developments will mainly ride on M2M and IoT.

The number of worldwide M2M connections is growing exponentially, with some forecasts as high as 50 billion by 2020. These connections will reside within virtually every major market category – from healthcare to transportation and energy to agriculture. Also huge investments in terms of billions and trillions for M2M based services have been announced by developing and developed countries. At present 468 mobile operators are offering M2M services across 190 countries.

All kinds of M2M services can be efficiently and economically made available to consumers if they are configured on common communication network which is open, scalable and standards based. However different kinds of M2M services have varying network requirements broadly categorized as under:

1. Very low Bandwidth <1Kbps (Monthly usage 10KB to 1MB) e.g. remote sensors
2. Low Bandwidth, 1kbps to 50 kbps (Monthly usage 1 MB to 10 MB) e.g. utility, health, security monitoring
3. Medium Bandwidth, 50kbps to few MB, (Monthly usage 10MB to 300MB) e.g. retail, ticketing, inventory control, gaming, digital picture frames
4. High Bandwidth, in Mbps (Monthly usage >300MB to 90GB) e.g. Digital signage, Video surveillance.

Keeping all these facts under consideration, the need of having a global Partnership in developing standards for Machine-to-Machine (M2M) communications and the Internet-of-Things (IoT) was strongly felt. Accordingly oneM2M partnership was formed to play a vital role to ensure that various industries – from healthcare to transportation and energy to agriculture – can benefit fully from the economic growth and innovation opportunities that M2M communications presents.

### **3.2 oneM2M Partnership:**

Seven of the world's leading information and communications technology (ICT) Standards Development Organizations (SDOs) launched a new global organization (partnership) to ensure the most efficient deployment of machine-to-machine (M2M) communication systems. The new organization, called oneM2M, is developing specifications to ensure the global functionality of M2M-allowing a range of industries to effectively take advantage of the benefits of this emerging technology. oneM2M is the partnership of the following major ICT SDOs:

- 1) Association of Radio Industries and Businesses (ARIB)
- 2) Telecommunication Technology Committee (TTC) of Japan
- 3) Alliance for Telecommunications Industry Solutions (ATIS)
- 4) Telecommunications Industry Association (TIA) of the USA
- 5) China Communications Standards Association (CCSA)
- 6) European Telecommunications Standards Institute (ETSI)
- 7) Telecommunications Technology Association (TTA) of Korea

Subsequently OneM2M partnership took nominations from countries which have huge potential towards M2M and may impact ongoing standardization process. From India, GISFI (Global ICT Standardizations Forum for India) gave a number of contributions till a year back. TSDSI, which is now recognized Industry

led standards organization of IT and Telecom domain in India, is on board of oneM2M partnership and will be responsible for ensuring Indian requirements are considered by the global M2M Standards.

The member organizations are devoted to developing technical specifications and reports to ensure M2M devices can successfully communicate on a global scale. The specifications developed by oneM2M will provide a common platform to be used by TSP/ ISP to support applications and services as diverse as smart grid, connected car, eHealth and telemedicine, enterprise supply chain, home automation and energy management, and public safety.

Initial goal of oneM2M is to confront the critical need for a common M2M Service Layer, which can be readily embedded within various hardware and software, and relied upon to connect the myriad of devices in the field with M2M application servers worldwide. With an “access independent” view of end-to-end services, oneM2M will develop globally agreed M2M end-to-end specifications using common use cases and architecture across multiple M2M applications.

OneM2M has already released its initial nine Technical Specifications for public comment as listed in Annexure III and is looking forward to receiving industry input on these foundation specifications for an M2M Service Layer which will enable scalable global deployment of M2M/IoT implementations and which aims at interoperability with existing standards.

### **3.3 M2M Standardization activities:**

With the mandate of oneM2M partnership, various standards development sub-activities are taking place at the level of individual TSDO listed as under:

**ETSI M2M:** The European Telecommunications Standards Institute (ETSI) Technical Committee is developing standards for M2M communications. The group aims to provide an end-to-end view of M2M standardization.

**3GPP:** Apart from ETSI, 3GPP is also active in M2M technology-related activities. In 3GPP M2M is also called machine-type communications (MTC) where work has been carried out on the optimization of access and core network infrastructure, allowing efficient delivery of M2M services.

**IETF ROLL:** IETF has created a set of activities related to sensor technologies and smart objects such as 6LoWPAN and ROLL (routing over low-power and lossy networks). These efforts are aiming at bringing the Internet Protocol to sensors and M2M devices needed for building a monitoring infrastructure for Smart Grid. Working Group ROLL is focusing on RPL (routing protocol for LLNs) for low-power and lossy networks (LLNs) where the nodes in the networks are many embedded devices with limited power, memory, and processing resources. The emphasis of the work is on providing an end-to-end IP-based solution in order to avoid the non-interoperable networks problem.

**ITU:** International Telecommunication Union has established various Focus Groups with the objective of developing recommendations from telecom/ ICT perspective. There are various focus groups in ITU developing recommendation relevant to M2M e.g. Focus Group on Smart Sustainable Cities (FG SSC); Focus Group on Smart Water Management (FG SWM); Focus Group on Disaster Relief Systems, Network Resilience and Recovery (FG-DR&NRR); Focus Group on Smart Cable Television (FG Smart Cable); Focus Group on M2M Service Layer (FG M2M); Focus Group “From/In/To Cars Communication” (FG CarCom); Focus Group on Smart Grid (FG Smart); Focus Group on Cloud Computing (FG Cloud)etc.

**TSDSI (Telecom Standards Development Society – India):** TSDSI M2M Study Group is working with an objective to understand, develop and promote India specific M2M/ IoT requirements, Standardizing these requirements and contribute to Global Standardization in field of M2M/ IoT, maintaining the technical standards and other deliverables of the organization. It intends to promote R&D in India and safe-guard the related IPR, helping create manufacturing expertise in the country. It is closely participating in GSC, 3GPP and oneM2M activities.

### 3.4 Global M2M policy initiatives

Top challenges towards mass adoption of M2M includes lack of standardization, Interoperability issues, availability of standards based Devices, Sensor, API, back end systems etc. Standards are being taken care by oneM2M partnership. Favorable regulations and government supports are other important aspect that needs to be taken care by various governments and associations to harness full potential of M2M.

In various countries, a number of government supported M2M projects are announced, however regulations around M2M are announced in bits and pieces. Till date, full-fledged regulations on M2M are not seen in any country. Action in this direction has started in some countries and consultation papers have come out.

GSMA (Groupe Speciale Mobile Association) has issued guidelines for IoT/ M2M market that outline how devices and applications should communicate via mobile networks. Telecom operators AT&T, China Mobile, China Telecom, China Unicom, Deutsche Telekom, Etisalat, KT Corp, Orange, NTT DOCOMO, Tata Teleservices, Telefonica, Telenor Connexion and VimpelCom as well as ecosystem partners including Sierra Wireless and Jasper are backing the GSMA guideline.

The guidelines include a number of best practice areas such as data aggregation within devices, non-synchronous network access, application scalability and guidance on how to manage signaling traffic from de-activated or out-of-subscription SIMs. These will help IoT/ M2M device and application developers to expand the number of devices connecting to mobile networks, whilst preventing service outages and ensuring optimal performance that will ultimately enable the market to scale across a diverse range of sectors including automotive, transportation, utilities and health.

GSMA is also undertaking a project to develop a common set of acceptance tests for IoT/ M2M devices and applications to ensure best practices are being followed. The project will establish a single, standard set of connection efficiency tests for IoT/ M2M devices and applications, enabling players across the industry to develop and deploy IoT/ M2M services with confidence.

#### Country specific M2M regulations

**European Union (EU):** Several governments are in the process of implementing 'regulatory mandates' on M2M. The European Union (EU) is currently implementing three broad mandates:

**1. Energy Services directive:** The policy was first articulated in 2006, with the objective of having each member state saving at least 9% of national energy consumption yearly. It targets efficiency in end-user consumption. Its main regulatory mandate is for 80% of European consumers to have smart energy meters installed in their homes and offices by 2020, using information technologies to monitor and cut energy consumption.

**2. eCall directive:** The goal of this policy is to improve road safety within the European Union. It aims to reduce the number of deaths and permanent injuries resulting from automobile accidents, ensuing fast response from emergency services by rapidly communicating details of accidents via in-vehicle equipment using mobile coverage to connect to public answering points. The deadline for implementation is 1<sup>st</sup> Oct 2015.

**3. M2M Numbering Plan:** The European Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) recommended that National Regulatory Authorities should set out numbering plans for M2M, including considering opening up new E.164 number ranges.

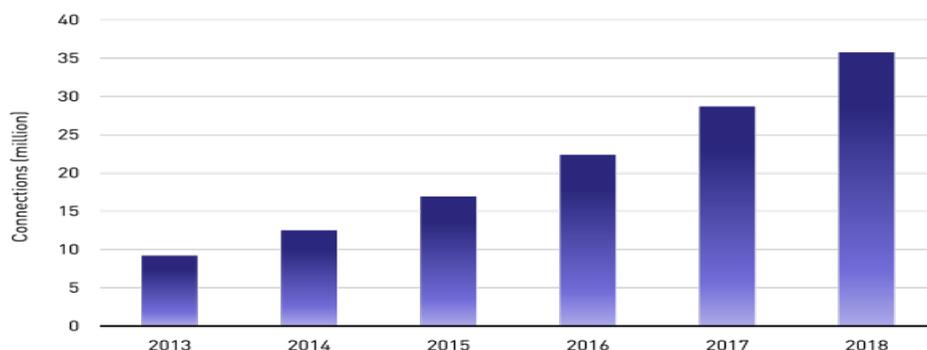
Apart from above mandates, in a number of southern and eastern European markets, **connected sales register systems** are deployed for monitoring of tax revenue. The system includes a cash register machine, a point of sale machine (PoS), a GPRS terminal, GSM connection and a centralized server at the authority data center. The compact setup can be linked with small retail outlets, standalone vending machines, parking voucher payment machines etc. so that daily turnover can be monitored for all such entities.

**Brazil:** Brazil is the fifth-largest country in the world by population, and has significant demand for M2M services – particularly in sectors such as security and industry. Security applications include vehicle tracking, personal tracking, residential and commercial alarms. In industry sectors that are important to Brazil’s economy, such as mining, companies are looking for M2M solutions that can assist them increase efficiency (e.g. remote monitoring of heavy equipment).

A number of regulatory developments have significantly improved prospects for the M2M market in Brazil.

- The M2M service providers are being registered in MVNO (Mobile Virtual Network Operator) category and brought under regulatory framework. Special Tax incentives were also granted to boost services.
- In September 2013, Minister of Communications announced plans to reduce the tax on M2M communications. It is worth highlighting that the Brazilian Government has significantly reduced SIM card tax on M2M devices by 80% providing a stimulus for operators to develop M2M services.
- The Departamento Nacional de Trânsito (DENATRAN) has also published an updated timeframe for the compulsory installation of location devices in new vehicles. Its June 2013 resolution states that by 2015 all new vehicles produced for the domestic market must have an M2M device to allow vehicle tracking and remote blocking services.
- In addition, the Brazilian Electricity Regulatory Agency (ANEEL) approved a resolution that regulates the basic requirements for smart meters. The resolution states that energy distributors have to start offering smart meters to consumers in a time bound manner, although the smart meter installation is only performed when requested by the consumer.

These changes could drive a period of high growth in Brazil’s M2M market. It is forecasted that the number of M2M connections in Brazil will grow to 35 million in 2018, at a CAGR of 32% from 2012 to 2018. The rest of Latin America (excluding Brazil) is forecasted to grow at a 25% CAGR over the same period.



*M2M connections, Brazil, 2013–2018*

**UK:** Till date, only a few regulators have taken initiatives towards M2M regulation and published formal consultation papers. The regulator - Ofcom has published a consultancy paper in July 2014, ‘Promoting innovation and investment in the Internet of Things’. The paper broadly asks:

1. Does IoT require a specific spectrum policy and what are the demands for spectrum of these new services?
2. How can privacy, security and reliability in IoT be assured?
3. How the huge demand for new ‘phone’ numbers and IP addresses can be managed?
4. What role, if any, should Ofcom play in promoting and regulating IoT, including whether or not it should get involved in setting common technical standards?

The Ofcom has also published “The Spectrum Management Strategy” to promote further innovation and the efficient use of this valuable resource. Ofcom is already supporting trials of ‘white space’ technology, a new concept that allows spectrum sharing and which can be used in a wide range of fields

such as transport, energy, healthcare and agriculture.

**France:** A week after Ofcom launched this consultation, French regulator Arcep launched its own, albeit less wide-ranging, on whether unlicensed spectrum (e.g. in 2.4 GHz & 5 GHz bands) should be opened for M2M communications, specifically for short-range devices.

**Approach of Other Countries:** At global level, most of the developing countries have also announced projects around M2M/ IoT. In several African countries, tax authorities are looking to make it compulsory to deploy **connected sales register systems** to monitor sales and stop any possible revenue leakage. Various issues and concerns arising out of such deployments are being addressed at individual level. Hardly any country has taken initiative towards full-fledged M2M policy and regulation taking care of overall M2M scenario.

### 3.5 Global M2M Policy issues and regulations

By linking large numbers of previously unconnected 'things' and sharing their data, M2M is unleashing a new age of innovation. The policy and regulatory challenges are enormous and involve reshaping regulations and opening up avenues for imaginative new policies. TSP's and ISP's, as connectivity providers, are familiar in dealing with telecom regulators. But when it comes to IoT/ M2M they are out of their comfort zone, as there are multiple regulators and data authorities for health, energy, road & transportation services and so on.

Further muddying the waters, many market segments, such as the automobile industry, are global in scope. As vehicles cross frontiers via exports, travel and cargo transportation, regulatory loopholes emerge such as 'permanent roaming' SIMs. While regulations have proved to be a constraint to IoT/ M2M growth, ironically they also can be a major driver for expansion. In long run, globally, following issues have to be dealt by regulators:

- 1. Permanent roaming** - The ability to offer services globally is critical for supporting many vertical sectors including automotive and consumer electronics. Regulatory prohibition of permanent roaming will fundamentally influence how connectivity is provided.
- 2. Making available Connectivity Anytime Anywhere** – The ability to make use of multiple networks within a territory will be useful for many M2M and IoT applications. Regulatory positions vary with some countries prohibiting the use of national roaming.
- 3. Numbering plan** – To address and uniquely identify ever increasing M2M sensors and devices across the networks.
- 4. Spectrum licensing** – Technology choices for delivering M2M services may depend on what and how much spectrum becomes available. The availability of *White Space* might have an influence of how M2M/IoT evolves, while there are licensing issues related to the use of alternative technologies such as Low Power Wide Area (LPWA) networks.
- 5. Data sovereignty and management** – There is increasingly stringent legislation on how data shall be managed e.g. EU's General Data Protection regulation is made a law. This covers more than just the much publicized "right to be forgotten" and will have implications for any organization looking to transfer or store data.
- 6. Other regulatory issues** – There are a number of other regulatory issues, including subscriber registration and taxation, which will have an impact on M2M and IoT.

## CHAPTER 4

### M2M INITIATIVES AND PLANS: ROAD AHEAD

#### 4.1 Policy formulation Process

Internet, since its advent has grown leaps and bounds. For the future Internet, the buzz word is around “Internet of Things - IoT” and “Machine to Machine communications – M2M” where not only humans will be accessing Internet, machines that have embedded processors will also access Internet and share the information for taking intelligent decisions. DoT has recognized the potential of IoT/ M2M and emphasis is laid in NTP - 2012 as under:

***“To facilitate the role of new technologies in furthering public welfare and enhanced customer choices through affordable access and efficient service delivery. The emergence of new service formats such as Machine-to-Machine (M2M) communications (e.g. remotely operated irrigation pumps, smart grid etc.) represent tremendous opportunities, especially as their roll-out becomes more widespread.”***

M2M communication requirements are bit different from general Internet access. End user devices in M2M scenario are large in numbers, consume low power and in general generate low data volume for communication. The concerned organizations have to build huge TCP-IP networks (IPv6 based networks to be more precise) who don't have any background and experience. Since they neither have expertise nor exposure to build such huge networks, they are finding it difficult to make progress. They also contemplate building captive networks/ proprietary networks which are not sustainable in the long run as at some point of time in future, there will be definite requirement of inter-communication at multiple points and at multiple levels in these networks.

The sensor or end devices for M2M/ IoT can be treated as combination of two components. One component may be taken as analogue sensor capturing/ generating the information at farthest end of network. Second component is part of communication network which carries the information to and fro to the desired destination.

Ideally communication technologies, communication network and design should be framed in a holistic manner. With such an adoption, Networks of various service providers shall be ready to carry M2M traffic, so that there is no need of independent captive networks to meet the communication requirements. This framework will also cater to inter-communication requirements at multiple points and at multiple levels.

To address M2M Policy and Regulatory Issues towards communication aspects of M2M networks, two level committees have been formed by DoT. A High level “Policy & Regulatory Committee” has been formed with DoT representatives to outline Government side policy and regulatory aspects. An Industry level Consultative Committee has been constituted to outline draft policy taking into consideration the industry view.

Following issues and actionable points were identified for consideration towards M2M Policy:

1. To bring Standards for M2M in line with global standards
2. Allocation of Spectrum for M2M local area network Layer
3. Revisit National Numbering Plan to accommodate the needs of M2M
4. To ensure the “Always on” requirements viz. Inter-Operator Roaming and Inter-Network Mobility
5. Address Privacy and Data Protection
6. Address KYC and customer traceability issues.
7. Address Security and Lawful Interception for M2M
8. To have policy around Customers ethical Issues
9. Close coordination with relevant global organizations

To have better understanding of issues and Industry requirements, an Industry consultation approach was adopted. A questionnaire was framed for M2M Industry (Provided at Annexure I). While framing the questionnaire itself, inputs were also taken from the consultative committee also, so that none of the important aspects remains unaddressed.

Total 53 responses to the questionnaire were received. The responses were from all kind of M2M stakeholders including Telecom service providers, M2M service providers, associations, government organizations, end users, Academia, Consultants, Content developers, Equipment Vendors, System Integrators etc. from India as well as from International stake holders. List of the respondents is available at Annexure II.

For each question of the questionnaire, responses were consolidated and gist was prepared by DoT sub-committee, separately categorizing response from stake holders with Sub-committee viewpoint at the end of each question. To have better understanding of the Industry response, open discussions were held with industry in five different workshops and seminars related to specific issue and industry expectations. On the basis of the gist and consultation, '**Terms of Reference**' was prepared for formation of M2M policies and regulation.

Based on the '**Terms of Reference**', guidelines towards specific issues have been framed as detailed in subsequent paras. While framing these guidelines it has been considered that:

- a. As M2M impacts services and applications of various Industry verticals, existing and future policies, regulations and guidelines for those Industry verticals are also to be taken into consideration while framing the M2M networks and services.
- b. There is generic concern towards data protection. Industry vertical specific data protection guidelines should apply to M2M, as applicable generally to other technology.

## **4.2 Policy and Regulatory Guidelines:**

Most of existing M2M implementations involve end devices tightly coupled with the platform either directly or through gateway. Data collection and analysis from M2M device and platform are controlled by same entity/ organization. This entity has been termed as "M2M service provider" in this document. Various M2M architectures may have different kinds of implementations and devices may have connectivity arrangements like SIM-based, wireline-based & wireless arrangements as detailed in Chapter 2. Each of these may have different policy and regulatory implications. Implications arising out of Wire line and SIM usage, as foreseen at present, have been dealt in the document. With maturity of M2M technologies other upcoming issues shall be dealt, as the need arises.

There may be possibility of open architecture based M2M solutions in future, in which device, gateway and back end platforms are independent of each other and any device can be coupled with any gateway & M2M platform. Already various standardization bodies (ITU, OneM2M globally; and TEC & TSDSI in India) are working towards developing open M2M standards and interfaces. In such situations, existing SIM & KYC related guidelines as applicable to individual customers should be applicable to M2M cases as well.

### **4.2.1 Registration of M2M service provider with DoT:**

M2M service providers are likely to have significantly different business and telecom resource utilization model compared to most of the services offered by Other Service Providers. In OSP services, end customer uses his own SIM/ telephone connection to avail services offered like tele-banking etc., whereas in most of the M2M services, individual SIMs or Internet connection is used exclusively for such services i.e. SIM fitted vehicle. In OSP services ownership of SIM normally lies with end user of services, whereas in M2M services, ownership shall be with M2M service Providers in most cases (as explained in subsequent sections). Hence, it would be prudent to have separate category of registration to have oversight over M2M service providers using Telecom resources from authorized TSPs.

In order to address concerns like interface issues with TSP, KYC, security and encryption (for the purpose of lawful interception at TSP level), all M2M service providers utilizing telecom facilities from authorized TSPs should have MSP (M2M service Provider) registration. The terms, conditions and related guidelines of MSP registration will be released in due course. MSP will be governed by DoT guidelines related to Communication infrastructure and respective regulations of the Industry vertical in addition to applicable laws of land.

#### **4.2.2 KYC Norms for M2M services:**

Security is of paramount importance in any public service and traceability of the subscriber of telecom services is a step in that direction. For fulfilling this objective, KYC norms are followed in telecom sector. Generally, M2M device fitted with SIM communicates only with fixed/ predefined APN, without voice and SMS facility and the same is configured by TSPs, though in a few cases (eCall, AMI in rural areas), voice & SMS facility is provided as well. Existing KYC norms are primarily centric to human communication and needs customization for M2M services.

**a. M2M services provided on wired connections:** In cases, where M2M devices are connected through wired telecommunication network i.e. Landline Broadband, existing KYC norms as applicable to such connections, should be sufficient to take care of M2M needs as well. KYC norms should be complied by individuals or corporates, as the case may be.

#### **b. M2M services provided on wireless connections:**

**1. In case of B2B/ B2B2C/ Corporate/ Bulk Customers/ MSP having ownership of Telecom connection:** KYC norms shall be completed in respect of M2M service provider, which uses the telecom services in such cases.

In this scenario, M2M service provider shall get the SIMs issued from TSP after fulfilling requisite KYC norms as required in case of corporate connections. Thus ownership of all such SIMs shall be with M2M service provider. The details of all the customers of M2M service, who shall be physical custodian of machines fitted with SIMs, should be maintained by MSP. Up-dated information regarding (i) details of M2M end device i.e. IMEI, ESN etc. (ii) Make, Model, Registration no etc. of the machines (i.e. Cars, Utility Meters, PoS etc.) and (iii) corresponding physical custodian's name and address should be made updated on a secured portal, developed by MSP for this purpose or through other suitable on line mechanisms to TSP by M2M service provider. At backend MSP may develop mechanisms to collate end user & machine related information from various available sources, as per its convenience. e.g.in case of electricity and similar utilities, meter related information already maintained by utility. In telematics, vehicle registration related information may be directly integrated with the portal maintained by MSP.

With above arrangement, traceability of M2M SIM can be ensured when asked by LEAs. MSP should develop suitable mechanism of collecting updated custodian information including in case of sale or transfer of such machines and access shall be made available to respective TSP. Present arrangement of making TSPs responsible of maintaining KYC detail of all the telecom connections should be made applicable in M2M cases as well so as to having single point contact for LEAs. Requirement of tele-verification prior to SIM activation in present guidelines is not possible in case of SIMs fitted in machines; hence this requirement can be dispensed with.

This arrangement of KYC compliance in order to ensure traceability of the customer is envisaged on current understanding of existing M2M architecture & business models. This shall be further updated based on future technological and business developments in M2M. The intention is to move towards e-KYC regime for M2M services, where requirement of physical CAF for end custodian can be dispensed with. In the long run, Aadhar based authentication and customer information collation may also be resorted to.

**2. In case of Individual/ retail M2M customers:** In situations, where customer directly approached TSP for procuring SIM to be exclusively used for M2M applications, existing KYC norms as applicable to individual customers, should be in force, with suitably simplified CAF for capturing machine or device related details along with other requisite information.

#### **4.2.3 International Roaming:**

There may be some scenarios, wherein MSP or manufacturer may be an entity located in foreign country and it may prefer to fit the foreign telecom service provider's SIM in the machine to be used in India always. Like, a car may be manufactured in a foreign country with a foreign telecom operator's SIM in it. In such cases, SIM shall be always in roaming state outside its home network (permanent roaming) and KYC details of car user shall not get updated in normal course in the database of Indian TSP. In case of TSPs devising some mechanism for affecting KYC compliance for M2M international In-roamers, there need not be any security related apprehension and resulting restriction in such cases. Government is of the view that Law Enforcement Agencies should have single point of interaction for getting the KYC details of SIM users which in present human usage scenario is TSPs.

There are logistical and technical difficulties in immediate prohibition of foreign SIM cards in machines imported in the country, as SIM modules are generally secured and not intended to be replaced in normal course. Also testing of machines at manufacturing stage may require fully equipped communication module.

Devices which are imported from foreign country may use embedded or soft SIMs or other such feasible technologies, where TSP profile/ IMSI can be updated over the air. Alternatively, manufacturers of M2M devices may tie up with Indian TSPs for equipping them with Indian SIMs. Keeping all these aspects in view, the government is of the opinion that in long run, foreign SIM should be permitted in the devices to be used in India only on the condition of fulfillment of traceability criteria. It is felt that reasonable notice time should be given to all stakeholders, particularly those selling devices or vehicles fitted with foreign SIMs, so as to enable them to enter into commercial arrangements with Indian TSPs and perform requisite technical integration & testing to enable them to use alternate feasible technologies i.e. Soft-SIMs, Embedded SIMs etc. To begin with, machines sold and manufactured in India may be allowed to be equipped with SIMs of Indian TSPs only.

Already operation devices or vehicles with foreign SIMs in customer's custody may prove tricky. The manufacturers of such devices may find it imprudent to maintain two categories of devices – one in perpetual roaming state and other in home network and will find it more economical to gradually retrofit all such devices with Indian SIMs. Thus the timelines for prohibiting selling of machines with foreign SIMs in the country and timeline for switchover of already operational machines with foreign SIMs to Indian SIM may be decided in consultation with relevant stakeholders.

#### **4.2.4 SIM related other Issues:**

Current regulations mandate SIM ownership with its custodian in case of individual connections and with organizations in case of bulk/ corporate connections. Transfer of SIM and use of Pre-activated SIM is not permitted due to its security related implications.

In most cases of M2M, the MSP ties up with TSP, fits the device with activated SIM card issued in his name and sells the device through its retail chain. SIM's are generally secured in the device so as to ward off the possibility of the customer removing it and using it for some other purpose. In continuity of same, device manufacturers & M2M application providers can get the SIM issued in their name after completing KYC requirements and get the M2M device tested after fitting it with SIM and subsequently communicate the actual custodian of the device to TSP after the sale/ resale of the device.

Present M2M arrangement precludes the possibility of custodian of the device to switch TSP's. In M2M model adopted by Brazil, M2M service providers are MVNO with separate IMSI block of their own. M2M customers have the option of changing TSP without the need of having physical SIM replacement. Similar kind of arrangement may be planned in India, as and when there is regulatory clarity for MVNOs.

In order to cater to unique requirements of M2M market, GSMA has recently floated the draft standards of embedded SIM, which tackles security concerns of Telecom operators with respect to ETSI standards of soft or virtual SIMs. In case of Soft SIMs, mobile operator's secret credentials are stored inside the operating system of mobile device whereas in the case of embedded SIM, it embeds existing hardware based UICC into devices and evolves the existing credential distribution mechanism into over the air mechanism. Thus SIM technology is fast evolving and future M2M devices are likely to adopt soft, virtual, embedded SIMs in place of physical SIMs so as to have the ease of remote configuration. Such SIMS should be adopted for M2M devices as it will facilitate change of Telecom Operator at the discretion of customer and will help in meeting KYC norms in case of device transfer, as same SIM can be used across different operators.

#### **4.2.5 Data Security Issues:**

For M2M services, in general data security and privacy issues will arise at three levels:

**(a) M2M data within telecom operator's domain:** License conditions enjoin all TSP's to take all necessary steps so as to maintain security of the network & confidentiality of data related to third parties. The encryptions used in the network should conform to the guidelines contained in IT Act. TSPs are limited to providing data transfer mechanism/ media transparently from end devices to M2M platform, hence existing security & encryption related regulation in licenses & IT Act governing current data services should be sufficient to deal with them. The existing provisions of the licenses applicable for TSP's for interception & monitoring of data by the LEAs shall also be applicable in case of M2M services.

**(b) M2M data within M2M service provider's domain:** M2M will enable creation of wealth of information covering various aspects of economy and society with its potential use for public welfare as well as giving rise to privacy concerns of individuals. The magnified potential for breach of privacy emanate in M2M is due to multiplicity of data recording points in the network i.e. Database of M2M service provider, Data points in database of TSPs, Home Gateways/ devices. The issues require comparison of M2M security and privacy framework with those of existing provisions of IT Act. Also M2M security framework is closely interlinked to interface and architecture standards, on which One M2M alliance and TEC working groups are currently deliberating. Standards need to be followed in conjunction with IT Act, governing current data services, which should be sufficient to deal with such requirements.

**(c) Security at sensor/ device level:** M2M device should use only genuine IMEIs & ESNs due to security concerns and non-genuine IMEIs & ESNs should not be allowed in devices. Thus, existing IMEIs guidelines for handset will be applicable in case of M2M devices as well.

**(d) Security at Network level:** M2M will result in availability of large number of devices on Internet or public network and any unauthorized access to/ by these devices may have serious implications. MSPs and TSPs need to device suitable mechanism for their respective network protection.

#### **4.2.6 Health/ Safety Regulations and environmental guidelines:**

In today's scenario, air space is crowded with waves. M2M is going to bring millions of devices powered on and connected, where last mile is mostly wire-less, it may have impact on health of human beings as well as on environment. Accordingly following suggestions are being made towards M2M deployments:

1. For the wireless devices connected to M2M networks, RF and radio emission standards have to be under safe zones to be finalized for M2M services i.e. SAR- Specific Absorption Rate, CE, Radiation norms etc.
2. To the extent possible, M2M devices should have low power consumption and shall meet highest energy ratings published by relevant standardization bodies.
3. When defining M2M sensors technical specifications, references shall be taken from existing guidelines applicable to a mobile handset, Consumer electronics safety requirements etc.
4. M2M devices need to adhere to industry & standards body specifications for emission, safety & integrity of services.
5. Efforts shall be made to meet global standards on environmental guidelines for the ICT sector including Dow Jones Sustainability Index (DJSI), GHG Protocol Corporate Standard, Global Reporting Initiative (GRI), ISO TC 207, ISO 14031, ISO 14064-1, and IEC TC 111 amongst others.

#### **4.2.7 Location and Connectivity Guidelines:**

While building M2M networks, connectivity and physical location of various elements is equally important. Accordingly following approach should be adopted towards M2M deployments:

1. All M2M services should be IP based. On network side of M2M, the communication should be over Internet protocol (IP), so that everyone adopts common standards.
2. From security perspective, there is a strong case for all M2M Gateways and application servers, servicing the customers in India, to be physically located in India. But MSP with small customer base in the country may find it difficult to have complete back-end technical setup due to lack of economy of scale. Also, trade reciprocity, privacy, non-disclosure conditions etc. may require us to have view based on practices adopted by other countries in this regard. Decision regarding location of servers in various other services i.e. e-mail, social media etc. is likely to have a bearing on M2M services as well. All such relevant factors needs consideration and physical location shall be in consonance with decisions in other services.

### **4.3 Issues under consideration**

M2M is evolving and accordingly policies and regulatory requirements are also evolving. Global standards are being framed and they will also lead to issues for regulators and policy makers. The Government is committed to resolve such requirements. Some issues that are already identified in the context of Indian M2M environments and are under active consideration are listed below:

#### **4.3.1 M2M Spectrum Requirement:**

M2M covers various Industry verticals and use different frequencies for various kinds of service offerings covering short range communication on high frequencies like Bluetooth, ZigBee, and 6LoWPAN to low frequency range for RF mesh etc. in neighborhood network connectivity requirements. Technological developments enabling utilization of White Space in different licensed bands have thrown new possibilities for efficient spectrum utilization benefitting M2M services as well. Globally, the trend is to use telecom network of TSP and/ or free wireless bands for M2M communications. In line with the requirement, there may be a need to fine-tune free spectrum bands. A few such requirements received at DoT includes requests for de-licensing of frequency bands 24-24.25 GHz, 76-77 GHz, 77-81 GHz for vehicular radar and request to do away with requirement of Import license for short distance and small power output devices.

#### **4.3.2 Define frequency range for PLC communication:**

PLC is gaining popularity across the globe and is being used in different domains such as Power Utilities, In-Home networking, Alarms and Security systems etc. Based on the Bandwidth utilization it can be categorized as narrow band PLC and Broad Band PLC. For PLC use, a number of standards are also available through various bodies like IEEE 1901.2 (2013), PRIME, G3-PLC, G.hnem, IEC 61334-5, TWACS standards for narrow band PLC. For Broadband PLC, IEEE 1901-2010 and ITU-T G.hn are widely used.

PLC technology is at a nascent stage as far as M2M products and services are concerned in India. It can be used for providing last mile connectivity as well as for creating a wide area network. A key requirement of this technology is the existence of a clean network of cables for carrying information.

There is a need to allocate frequency bands for both, narrowband and broadband PLC communications. Co-ordination activities shall be taken up in this regard with all relevant stake holders.

#### **4.3.3 M2M Numbering Plan**

M2M will enable millions of devices powered on and connected. To address and identify each and every connected device is going to be a challenge in the long run as all kinds of addressing schemes currently prevailing in telecom space will run short of addresses. In M2M domain, MSISDN-less communication seems promising as it may address the number crunch to some extent and also will ensure the optimization of MSISDN numbers and prohibit misuse of M2M devices for normal communication. Identities such as IMSI, IP address (IPv4/IPv6), user/email id etc. can be used for addressing purpose for such devices.

The national numbering scheme needs to be revisited taking into consideration M2M numbering requirements in line with internationally prevailing norms and practices. A number of inputs received at DoT in this regard are listed as under:

1. MSISDN less subscription/ Dummy MSISDN based subscription
2. Requirement of unique/ dedicated IP scheme and/ or APN.
3. ESN of the devices to be made mandatory part of communication protocol
4. Linking of IP/ MAC addresses with IMSI/ numbering to get unique numbering
5. Identification of category of M2M devices for ensuring service segregations by numbering Scheme.
6. Supporting more than one naming scheme
7. Single numbering scheme irrespective of local/ national/ international roaming
8. E.164 & E.212 addressing scheme adoption

#### **4.3.4 M2M Roaming Requirements:**

Present licensing regime allows licensees to enter into roaming agreements with other licensees as per their commercial arrangements for national roaming. For International Roaming, licensees can enter into agreements with foreign telecom Service Providers to provide roaming facility to its subscribers & vice versa. Roaming subscribers can only access services to which they have subscribed in their home networks. The guidelines are applicable to voice as well data services.

There are concerns on non-availability of M2M services in North Eastern States and J&K in case of imported devices pre-fitted with foreign SIM cards. This is due to restrictions placed on international SIMs roaming to these areas. As government is considering only Indian SIM to be used in M2M devices, this may no longer be an issue.

As per stakeholders, in general, quantum of M2M traffic and correspondingly ARPU is very less and therefore it may require separate roaming arrangements/ interconnect charges among TSPs. The stakeholders accordingly submitted that separate arrangements should be prescribed in the M2M policy in this regard. GSMA has also finalized separate template for roaming of M2M subscribers. In order to enable this, separate identifier like IMSI or MSISDN may be required to be allocated to M2M services, which is different from voice or data SIMs. The separate identifier is also required for making policy decision specific to the M2M communications based on the data relating to it. Accordingly requirement will be suitably dealt based on the M2M numbering plan.

In line with declared policy objective of One Nation - Free Roaming and no roaming charge across the nation in NTP - 12, there should not be any inter-circle roaming charges for M2M services, if the SIM fitted machine is being serviced by the same operator, from which it has been issued. This may give a boost to M2M services, as machines i.e. automobiles are more often likely to roam in different circles. The volume of data exchanged for mobile machines is small and this provision is not likely to have much revenue impact for operators.

In case of inter-operator roaming, arrangements between the TSP's are primarily guided by commercial considerations subject to TRAI regulations. Tariff being under the domain of TRAI, case will be taken up with TRAI for nil roaming charges in case of M2M services for both intra-operator and inter-operator roaming scenarios in view of low data volume, objectives of NTP - 12 and with an aim to providing a boost to M2M services.

#### **4.3.5 Cloud use for M2M:**

To harness full potential of M2M, Cloud use plays a major role. Favorable cloud use guidelines are the Industry demand. In this regards, it may be noted that:

1. Cloud based M2M services shall be inter-operable and comply with open-standards.
2. Applications interfaces should be based on OMA, Open API.
3. Some kind of management standard should be employed similar to TR-069.
4. Lawful interception shall be supported as per prevailing norms.
5. IPv6 support shall be built right from beginning.
6. Cloud specific regulations coming from various government agencies from time to time shall prevail.

During deliberations with stakeholders, it is learnt that the issues related with cloud use are related to whole telecom sector and not specific to M2M Services. TSPs and ISPs have also been referring this issue from time to time as they are not allowed to route telecom traffic destined for India, through foreign country. The issues related to cloud, when resolved, will also be applicable to M2M.

#### **4.3.6 Capturing SIM details/ mobile number as part of registration:**

For SIM based M2M services e.g. in Automobile, utilities etc., respective registrar/ authority may examine the possibility of mandatory capture of SIM details/ mobile number as part of registration. Such option will empower the authority with more knowledge about registrant and will improve traceability of registrant if need arises addressing country level security concerns.

### **4.4 M2M Standard Development Initiatives**

Industry needs a common, shared architecture for M2M, for the establishment of a horizontal platform for M2M services which would handle device activations and monitoring, among other services. Such a layer would allow M2M service providers to quickly and easily plug their offerings into a carrier network. The industry while responding to M2M questionnaire has highlighted following concerns as a road block to large scale M2M deployment:

- a. M2M standards at Country level
- b. Lack of standardization of Gateway/ Devices/ Sensor/ API level,
- c. Non availability of Standards for back end systems,
- d. Interoperability issues,
- e. M2M device management and remote configuration management
- f. SIM/eUICC standards
- g. Test and Interoperability Guideline for devices/services
- h. Minimize the "on-the-wire" footprint
- i. Deal with slow, poor quality networks

Globally, India is being seen as a promising market for M2M. There is huge interest among global standardization bodies to have understanding of India specific requirements towards standards. Bodies like ITU, ETSI, and GSMA have their regional offices in India. India is also well represented in oneM2M partnership through TSDSI.

GISFI started work of M2M/ IoT standardization in India way back in 2009. Related to IoT standardization, a large number of documents are under discussion and approval which are published on GISFI site.

TSDSI, in India is the government recognized body working on ICT including M2M standards. It is a not for profit industry led legal entity with participation from all stake holders including Government, service providers, equipment vendors, equipment manufacturers, academic institutes and research labs etc. It aims at developing and promoting research based India-specific requirements, standardizing solutions for meeting these requirements, contributing to global standardization in the field of telecommunications, maintaining the technical standards and other deliverables of the organization and safe-guarding the related IPR.

TEC (Telecommunication Engineering Center), the technical arm of DoT has started working on India Specific M2M standards in line with evolving global standards. Five Working Groups are formed to begin with in this regards as under:

1. Power
2. Automotive
3. Surveillance
4. Health
5. M2M Gateway & Architecture
6. Working group to cover M2M security is being formed.

Additional working groups may be created based on Industry/ Government requirements. All these groups are well represented from Industry and are working in close coordination with TSDSI, ETSI, oneM2M partnership etc.

TEC working groups will generate reports based on inputs from a large number of use cases. A template is being derived to define use cases from standards point of view. Use cases will be converted to the said templates so that it is easier to drive standards from it. Broad consensus are achieved towards standards and the draft standards for Industry consultation are expected soon. Any output of these documentations requiring research based standardization can be taken up by TSDSI in the M2M working group.

Industry is also concerned regarding vertical specific standards at the application level especially in Infrastructure based M2M deployments where stakes are quite high for each deployment. This has to be taken up by relevant standardization bodies only. As applications may have impact on communication standards and vice versa, such issues at the technical level can be handled in the respective working group of TEC.

Further applications specific standards may have impact on M2M communication standards, policies and regulations and vice versa at a macro level. Accordingly it is being felt that there is requirement of Inter-ministerial coordination as covered in subsequent para.

#### **4.5 Inter-ministerial coordination requirements**

Internet, 10 years back had a big impact on Industry and results can be seen in changed vision and products of companies. M2M is going to be the next big thing that will have vast impact on Industry. To have smooth and faster adoption of M2M with open and scalable networks, it is highly desirable to have coordinated standards and policies in place. Accordingly close coordination among policies and standards framing entities is required across Industry verticals.

To begin with, sectors like Power, Automobile, and Health can be brought in focus. Coordinated policies, regulations and standards will bring networks into order and other entities in most of the cases can follow best practices derived out of these sectors.

In Power sector, Government of India has already announced “Smart Grid vision and Roadmap for India”. This document already envisages close coordination between Ministry of Power, Ministry of new and renewable energy, Ministry of Heavy Industries (For electric Vehicles) and Ministry of Communications and IT. To coordinate the activities, an Inter-ministerial task force ISGTF ‘India Smart Grid Task Force’ is in place. To have Industry participation in power sector, ISGF ‘India Smart Grid Forum’ is formed under the aegis of ministry of Power.

As BIS is making standards for Power sector in India and TEC is framing standards for Telecom and Data networks in India, close coordination is required among both entities so that seamless open scalable communication networks are built for Smart Grids in India on which apart from Power, many more utilities and services can ride in future. This will also bring scale of economy with standardization of interfaces.

In Automobile sector, there are maximum M2M users as on date. However current networks and services are simple. Only vehicle manufacturer or logistics companies have built M2M connectivity in vehicles with point to point communication between vehicle and server of the service provider. In future when communication will become point to multi-point i.e. vehicle will communicate with large number of services, open scalable connectivity and standards will become a challenge.

For automobiles in India, Automotive Research Association of India (ARAI), a research Institute of the Automotive Industry with the Ministry of Heavy Industries & Public Enterprises, Govt. of India is spearheading Standards and certification activities. ARAI is providing various services to the Indian Automotive Industry in areas of design, development and know-how for manufacture & testing of components/ system to national/ international standards. With the globalization of economy and business, ARAI is enlarging its scope of services to meet requirements of automotive industries anywhere in the world.

Again close coordination is required among ARAI and TEC so that using open scalable M2M platform a vehicle can communicate seamlessly to any required service and network. Further coordinated policy approaches are required between DoT, Ministry of Road Transport & Highway and various Transport Authorities.

As covered in para 4.3.6 above, for the SIM based M2M services e.g. in Automobile, utilities etc., it is proposed that respective registrar/ authority shall examine the possibility of mandatory capture of SIM details/ mobile number as part of registration. This is among one of the coordination requirement that needs to be got addressed.

In Health sector, there are two kinds of M2M requirements on date. For personal care and monitoring, Smart devices are built for short distance communication and generally work on Bluetooth, NFC, and Wi-Fi etc. Another area of M2M based Technology is Tele-medicine, Smart Ambulance etc. In India, MCI "Medical council of India" is looking into the various aspects of these M2M requirements and thus coordination is required to have plug and play kind of devices in India. Apart from that, there is need for a well-defined policy on e- health and m-health, having citizen's consistent Electronic Health Record (EHR) system, automated health management systems etc. For all such policies, close coordination is required with Ministry of Health and Family welfare.

Smart cities are in focus in India with the announcement of developing 100 Smart cities. A smart city has M2M components in terms of Smart-Grid, Intelligent Transport System, Smart Health Care, Intelligent Water and piped Gas Distribution System, Intelligent Waste Management System, Intelligent Public Safety & Surveillance among others. The services are offered on a shared communication network and monitored from a centralized NOC. Coordination requirements in such cases is going to be immense, however this will come at a later stage when detailed planning starts for such cities.

An Apex body is proposed to address inter-ministerial coordination requirements involving all stake holders within M2M industry in the long run to take view of all concerned, synchronize overlapping policy requirements and address issues related to M2M in a single window concept. This will enable to have a holistic vision and synchronize the activities across ministries. The broad responsibilities of the Apex body are proposed as under:

1. To have an integrated approach
2. Avoid Fragmentation
3. Address Existing Connectivity Gaps
4. Ensure Inclusive approach
5. Enable cross organizational initiatives to gain synergies and achieve transformations.
6. Enable Information sharing and anticipate changes
7. Productive use of Multi sectorial expertise
8. Promoting collaboration between public and private sectors for M2M services in various sectors
9. For manufacturing boost, get addressed the need for preferential market allocation.

Under the ambit of this proposed Apex body, in the technology front, DoT will take steps to address the following issues:

- a. To facilitate M2M communication standards in alignment with global SDO's from Indian Perspective and to recognize such standards for India.
- b. To bring M2M related communication policies and regulations.
- c. To enforce encryption, quality, security and privacy standards for M2M communication.
- d. Support Human Resource and Capacity Building through making available M2M relevant technical content.
- e. Technically support Pilots and/ or Proof of concept.
- f. To address spectrum requirements.
- g. To address Quality of Service in M2M networks.

Apart from the Government Apex body, there is also need for Industry in India to act unitedly for M2M proliferation and cross Industry support and preferably form a sort of M2M Forum, as is happening in various countries.

## **CHAPTER 5**

### **MAKE IN INDIA: SUPPORTED THROUGH M2M ADOPTION**

#### **5.1 Indigenous Products and Services**

Government of India has launched a major new national program of “**Make in India**”. It is designed to facilitate investment, foster innovation, enhance skill development, protect intellectual property and build best-in-class manufacturing infrastructure and 25 Sectors are identified as focused sectors. The sector list is impressive as almost all of them are leading the M2M proliferation in India.

Indigenous capabilities and domestic manufacturing is important for the country’s security. Telecom being a strategic infrastructure, Indigenous technologies and manufacturing are important not only to keep the malware and other security vulnerabilities out but also to develop our knowledge base and expertise to help us in security testing and certification of telecom equipment.

NTP 2012 has stressed upon indigenous manufacturing of telecom equipment and preferential treatment to indigenous manufacturers. Relevant objectives and strategies mentioned in the NTP-2012 include:

- i. Promote innovation, indigenous R&D and manufacturing to serve domestic and global markets, by increasing skills and competencies (NTP 2012 Objectives-6)
- ii. Create a corpus to promote indigenous R&D, IPR creation, entrepreneurship, manufacturing, commercialization and deployment of state-of-the-art telecom products and services during the 12th five year plan period. (NTP 2012, Objectives-7)
- iii. Promote the ecosystem for design, R&D, IPR creation, testing, standardization and manufacturing i.e. complete value chain for domestic production of telecommunication equipment to meet Indian telecom sector demand to the extent of 60% and 80% by the year 2017 and 2020 respectively. (NTP 2012, Objectives-8)
- iv. Provide preference to domestically manufactured telecommunication products, in procurement of those telecommunication products which have security implications for the country and in Government procurement for its own use, consistent with our World Trade Organization (WTO) commitments. (NTP 2012, Objectives-9)

M2M deployment in general consists of large number of sensors and devices connected onto the network and quite different from standard IT setup. This in itself brings lot many challenges as well as opportunities. Further deployment cost and sensors cost is generally high resulting in high OPEX to ARPU ratio imposing questions on affordability of M2M deployment. All these can get addressed if indigenous manufacturing takes place in India.

Currently in India, M2M products being manufactured and serviced are mainly by Startups and SMEs. However basic components like Modules, silicon chips and sensors are mostly imported. Demand for most of the devices is currently low. Major reasons behind slow manufacturing growth are:

- a. Influx of cheaper devices from the neighboring country which have lower quality and result in too many failures resulting in loss of customer confidence in the devices.
- b. Gaps in ensuring compliance of continuation of the service.
- c. Lack of awareness, proper R&D, Spectrum and resources.
- d. Retro fitting of Global technologies: Indian ecosystem is diverse and unique. The Infrastructure conditions, human habits are different and hence requirements are completely different. Indianisation of products and services is a major concern.

To promote manufacturing in M2M domain, a large number of initiatives are being taken by DoT as listed in subsequent paras of this chapter. To market the electronic products in competition with devices available from neighboring countries, DeitY has issued a notification in February, 2012 for providing preference to domestically manufactured electronic products. As part of the notification, telecom

products which are procured across sectors would be notified by DoT. DoT has brought accordingly 23 articles in PMA notification. Keeping in view future M2M growth in India and increased M2M products manufacturing, a number of products can be brought into PMA framework like GPS, AMI, RFID, M2M Gateways, Connected personal health devices etc., for which action will be taken up separately based on Industry requirements.

Further in response to DoT questionnaire, a large number of requests were received to boost manufacturing, which are being taken up with respective ministries and are listed below:

1. Having mechanism towards easy Financing,
2. Availability of Government funded Venture Capitalist,
3. Subsidizing resources.
4. Tax benefits/ no tax regime/ reduced raw material import duties,
5. Clear Taxation policy with no retrospective taxing,
6. Provide attractive availability of building space, land at well-connected locations,
7. Creating manufacturing clusters with well-connected locations, as well as factories for building products
8. Rewards for early commercialization.
9. Encourage investment in R&D and IPR and incentivize companies having large number of patents.
10. Categorizing and giving “High Technology Status” to companies.
11. Institute M2M design awards - for technical institutes, industry

## **5.2 Creating Test Bed Facilities:**

To have manufacturing growth in India, supporting infrastructure for M2M in terms of test labs, test beds, products certification is required which is almost non-existent as on date. Only option in front of manufactures is to take product to global test labs for accreditation, which is lengthy and costly affair.

To have efficient manufacturing, apart from the product functional testing, there is also need for having world class testing facilities for connecting the product onto M2M network which should cater for:

1. Testing at Prototype stage.
2. Stable and efficient connectivity in all kind of network environments as well as traffic conditions.
3. Product interface testing for all kind of possible connectivity.
4. Conformity to security and lawful interception standards.
5. Inter-operability testing.

In communication field, infrastructure is already in place through TEC for the following test facilities:

- a. World class IPv6 ready logo Test Lab
- b. Transport Lab
- c. Customer Premises Equipment and Terminal Lab
- d. Control Lab
- e. Service/ application Lab
- f. Access Lab
- g. SAR Lab
- h. Security Lab
- i. Regional Test Centers at Delhi, Mumbai, Kolkata and Bengaluru

The labs in TEC are being set up in a phased manner. Each lab has been conceptualized as a test bed created by a host of DUTs (Device Under Test) offered by Telecom Equipment vendors connected in a network configuration. This network would be connected by test equipment that are themselves capable of emulating large virtual networks behind their connecting ports, and subjecting the test bed with simulated traffic relating to different tests. The testing shall require the utilization of multiple scripts (coded programs) that will facilitate automated testing.

These labs are envisaged to be self-contained and centrally managed for all test operations and report

generation. They are intended to serve Indian and International Telecom equipment manufacturers, Telecom operators, Regulators, Application/ Content Service Providers, independent Software developers, R&D Institutions, Educational Institutions, Chipset manufacturers etc., for conducting conformance, performance, functional and interoperability tests among public networks and to benchmark devices/ applications/ networks/ services for all real life scenarios.

The existing facilities of TEC shall be upgraded and fine-tuned to meet M2M testing requirements. Also more testing facilities can be added in PPP mode as per the industry requirements.

### 5.3 M2M Products Certification

Network Device Certification is a non-negotiable requirement for bringing new devices onto existing carrier networks. Regardless of whether the module (modem) component within a device has passed certification, any new device is required to pass certification prior to allowing commercial deployment. The goal of device certification is to identify and fix issues related to quality of service on the desired network. Device certification testing is done to ensure maximum device performance and minimum risk of service disruptions on the network due to rogue data consumption or other factors that could jeopardize the entire network infrastructure.

The EU Global Certification Forum (GCF) was founded in 1999, in response to changes in the regulatory environment in Europe, to give operators confidence in the interworking of new mobile devices at a time of rapid technological development and market growth. GCF was formed drawing together leading players from across the mobile industry including leading mobile network operators representing all the key markets worldwide, over 50 device manufacturers and other stakeholders, such as, the test system suppliers and test laboratories. In Indian context, TSDSI has signed cooperation agreement with GCF to take care of India specific requirements in global certification.

With a philosophy of ‘test once, use anywhere’, and an industry agreed set of Certification Criteria based on 3GPP and 3GPP2 standards, it is ensured that a mobile device will work effectively on mobile networks anywhere in the world. In devices such as handsets, USB modems, data cards and wireless modules – where communication over a mobile network is the primary function of a device – the tried-and-tested certification process remains unchanged. An optimized certification process has been launched for an increasingly diverse range of products where wireless communications has been incorporated by means of a GCF-certified embedded wireless module which is not fundamental to the primary function of the device but enhances its overall functionality.

As wireless connectivity is adopted for mHealth, utilities, intelligent transport, the motor industry and other applications, GCF is working on to engage with industry groups to make GCF Certification complement sector-specific certification requirements.

In USA, M2M device certification is mandatory. PTCRB was created by operators to establish a third party certification, giving confidence to the operator that the certified device meets a minimum set of requirements established by the members. This also resolves concerns that roaming partner’s device will not cause harm to operator network. Small operators get benefit with PTCRB as they do not have the resources to conduct testing in a lab of their own. PTCRB also gives the smaller operator a voice in the industry to have features/ functions introduced into the industry, when they might not have that voice on their own.

KORE Telematics is one such PTCRB member, testing vehicle location to utility metering, payment processing, landfill monitoring, asset management, offender tracking and more. It operates in Toronto, ON in Canada, Atlanta, GA, Cary, NC in United States and Melbourne, VIC in Australia. Various types of product certification include:

- a. FCC Part 15
- b. PTCRB (PCS Type Certification Review Board)
- c. Operator Level – GSM and CDMA providers

Telefónica Digital, the global business division of Telefónica, has launched its Telefónica Global M2M Module Certification Program. All modules certified by Telefónica have also achieved GCF and/or PTCRB certification. Modules from Sierra Wireless, Telit and u-blox have been certified. This provides customers with an additional level of confidence when using Telefónica certified modules. Sprint, Vodafone and lot many telecom global service providers through their arms are doing similar kind of product certification.

In response to DoT questionnaire, the Industry has stated that there is requirement of M2M product / service certification. Certifying criteria shall be clear and transparent while focusing on international standards. GSMA has already issued guidelines in this regards. 3GPP, ETSI, TTA are also having similar recommendations. TEC may also take up the responsibility of M2M specific Product certification inter alia with following objectives as applicable:

1. To facilitate modularity, scalability, seamless interoperability and roaming among devices.
2. Conformity with safety standards from radiation/ power perspectives.
3. Open standards and protocols including standard APIs.
4. Compatibility of devices and applications with SIM management platform.
5. In respect of data security and integrity
6. To enforce spectrum guidelines adherence.

It has come up that for any M2M product, testing of vertical specific functionality may be kept in the preview of domain expert. However communication components covering all modems, wired or wireless, standalone or embedded must be certified by some agencies.

In India, for the communication products, TEC has already published a large number of standards in terms of GR (Generic requirements), IR (Interface requirements) and SR (Service requirements). TEC is also doing product certification under following categories:

- i. Interface approval – to set conformity towards connecting onto networks
- ii. Type approval – overall product certification applicable only for products to be deployed in Telecom and data networks
- iii. Certificate of Approval

TEC is already engaged with the activity of product certification directly as well as in assistance with designated Conformity Assessment Bodies (CABs)/ Certification Bodies (CBs) located in India and abroad to perform testing and certification of telecom products. Details are available on the TEC website ([www.tec.gov.in](http://www.tec.gov.in)).

To achieve the objective of M2M products certification, the existing facilities of TEC may be upgraded and fine-tuned to meet requirements. Also more facilities can be added in terms of additional CAB and CB as per the industry requirements.

#### **5.4 Human Resource and Capacity Building:**

Human resources are an essential means for achieving economic, social and development goals of a nation. Japan, though a small nation, which had once been devastated by war and more recently by natural disasters, has high developmental indices, owing to its outstanding leadership in human resources development (HRD). Capacity building of human competencies form an integral part of HRD processes.

M2M technologies are being employed globally in ways never imagined. The rapid growth of M2M technologies in developing countries offers them opportunities to grow businesses, expand economies, and tackle larger social issues. Nevertheless, countries have yet to tap the enormous potential of M2M owing to challenges related to infrastructure and networks, capacity building, Internet governance, privacy and security policies. More research and better educational frameworks are needed to build potential user capacities with respect to M2M technologies.

M2M is being adopted in almost all sectors and changing products and services in a big way; Capacity Building needs to be planned at massive scale to get full advantage. Further capacity building needs to be domain specific and accordingly no single organization can take care of overall requirements. Current capacity building activities, being run by various government agencies and independent entities needs to be augmented to take advantage of M2M. In addition, new M2M focused capacity building initiatives are also required.

DoT through its premier training institute, National Telecom Institute for Policy Research, Innovation and Training (NTIPRIT) is taking care of training as well as innovation in Telecom. NTIPRIT is mandated to undertake/ support innovation and promote research in telecom sector through funding and in collaboration with educational institutions including application research for sustainable growth of Indian Telecom Sector. NTIPRIT has already been designated by DoT for skill development and they shall develop M2M demonstration centers for trainees and other stakeholders.

In association with Telecom Industry, to have Capacity Building in the field of telecom, Telecom Sector Skill Council (TSSC), a non-profit industry driven body is set up under the aegis of the NSDC. It is striving to narrow the existing gap between demand and supply of skills by increased collaboration between the three primary stakeholders i.e. HR, Industry and academia. TSSC shall also take up Capacity Building in M2M field to cater to the need of this emerging industry.

M2M is proliferating across domains and in Capacity Building towards M2M, course content need to cover domain knowledge and networking related content. Accordingly capacity building requirements are very vast. To meet these requirements, existing institutes of various sectors needs to be upgraded to bring additional course and also to upgrade course content. Institutes/ program like ICAR (Agriculture Education Division), National Institute of Rural Development (NIRD), ISGF, National PPP Capacity Building Program (NPCBP) can take up such activities.

**To sum-up, the government understands the importance of Human Resource and Capacity Building towards M2M and initiating following measures:**

1. DoT has already designated its premier training institute, NTIPRIT for skill development which shall develop suitable course content, M2M demonstration centers for trainees and other stakeholders.
2. DoT will have technical collaboration with Capacity Building centers across industries to make available global exposure towards standardization, policies, related R&D and technical content so that course contents can be always updated with the latest developments in the domain.

## **5.5 M2M Pilots**

Sectors like Automobile, Power, Banking, Health etc., have taken lead into M2M adoption and a significant M2M customer base already exists globally as well as in India. Still a major chunk of investment and deployment is on hold for want of standards, policies and significant customer base.

Looking at the Power sector in India, a large number of PoC (Proof of Concept) and pilots covering few hundred customers have been conducted to evaluate Smart Grid functionalities. Based on the outcome “Smart Grid vision and Roadmap for India” document has been published and government is going ahead with 14 pilots across India having customer base of approximately 20000 customers each.

With the emergence of M2M standards and future requirement of multiple services running through shared M2M communication infrastructure, there is tremendous scope for R&D and pilots across sectors.

To begin with, **C-DoT**, the premier technical institute of DoT has initiated a study project on M2M under which the major activities are:

1. Study evolving architecture of M2M from ETSI and ‘One M2M’.
2. Contribute towards framing India centric standards and specifications.
3. Study possible communication design implementation options for the smart meters, surveillance applications and M2M gateways.

The key deliverable of this project would be a pilot setup showcasing M2M Gateway functionality and also the demonstration of reading sensor data/ smart meter.

DoT intends to have more pilot project around M2M directly and also through proposed Center of Innovation focusing on standards and common communication network across Industry verticals. DoT may also extend technically support to the pilots taken up by various ministries as per the scope of Inter-ministerial apex body. DeitY is also planning IoT/ M2M pilot projects covering different Industry verticals towards its Smart city initiatives.

## 5.6 Center of Innovation

The futuristic role of M2M and its applications in different sectors of Indian economy has been recognized in NTP-2012. Accordingly, a dedicated Centre of Innovation (CoI) was envisaged in NTP-2012 as under:

***‘To establish a dedicated Centre of Innovation to engage in R&D, specialized training, development of various applications in the field of IPv6. This will also be responsible for support to various policies and standards development processes in close coordination with different international bodies’.***

With now focus coming on ‘Make in India’, there is need of having CoI to support manufacturing growth in telecom vertical in holistic manner. Accordingly, broad objectives of the proposed CoI shall be:

1. To develop model Experimental M2M Network.
2. To implement pilot projects which can showcase the technology and in turn more similar projects get implemented across country.
3. New application developments in the field of M2M as well as the porting legacy applications.
4. Bringing awareness as well as Human Resource and Capacity Building in collaboration with IITs, IISc, NITs & other organizations
5. Closely work with various global and Indian M2M Standards organization protecting overall interest of all stakeholders.
6. To collaborate with all international bodies in this field so that India is able to establish a lead role in M2M related international policies and standards.
7. Promotion of Research & Development (R&D) and IPR creation.
8. Any other work, role and function assigned by Government from time to time.

The CoI may be set up independently or as part of the upcoming CoI for other domains under the ambit of DoT. The broad roles and functions associated with CoI will be as follows:

- a. Coordination among various government bodies, regulators and standards bodies to take care of conflicting issues and policies.
- b. Establishment of Model Experimental M2M Network
- c. Pilot Projects
- d. R & D, Application Development & Support
- e. Training & Knowledge Resource Development
- f. Standardization of course content
- g. Provide inputs for International collaboration regarding policies & standards

## 5.7 Encouraging Entrepreneurs and Startups

Within the business world, there can be many barriers against entrepreneurs looking to enter a market. But every now and then a new technology will emerge that has the potential to disrupt markets and create many new business opportunities. M2M is poised to disrupt a multitude of industries across the globe and create an abundance of opportunities for those who can see beyond the status quo. To put this claim into perspective, consider that within five years, the M2M market is expected to grow from \$1.4B in 2011 to \$25.9B in 2016.

In order to take advantage of the opportunities M2M presents, entrepreneurs need to look beyond the “how” and instead think of “what-if” to find novel solutions to complex business problems. Let’s have a look at just a few of the possible market opportunities from M2M technology in three different industries:

**Construction:** With M2M, everything that can be connected will be connected. Future buildings are no exception. In an age of smart grids, buildings are being equipped with thousands of sensors to monitor, control and optimize everything. There’s tremendous opportunity for entrepreneurs to reinvent traditional products like connected plugs, light switches and heating/ cooling vents that can make predictive “decisions” by anticipating energy needs without human intervention.

**Transportation:** The transportation industry is also rich with M2M opportunities. A number of entrepreneurs have already started services like Fleet management, Radio Taxi, smartly managed logistics. Further, app developers could create smartphone apps for vehicles with wireless connections to remotely monitor and control fuel consumption, locate petrol pumps or pre-cool a car by remotely switching on AC based on past usage.

**Agriculture:** There is always a rising demand for food and reducing agriculture land that puts upward pressure on all food input costs. There are novel opportunities for M2M solutions in the agriculture industry, especially for raw materials and energy. Connected devices can help maximize production efficiency and yield to improve a grower’s profit margins. For example, entrepreneurs could build auto-pilot tractors that automate planting and plowing solutions to reduce labor costs, fuel and waste. Furthermore, wireless integration of farm vehicles with farm management software could integrate important factors such as tractor usage and crop yield information.

The need was never more urgent for an ecosystem for M2M manufacturing (consistent with the objectives laid out in NTP 2012) indigenously for meeting domestic demand along with tapping global export potential.

To promote entrepreneurs and startups, industry house like CII, FICCI, ASSOCHAM have taken lead and working closely with government. Ministry of Micro, Small and medium enterprises is taking lot of initiatives and have cluster based approach to address infrastructural issues and to provide right ecosystem. DeitY is also planning to support startups in IoT/ M2M domain by making available access to low cost fund, Venture Funds of Electronic Development Fund and ecosystem formulation for transfer of technology benefits amongst Startups & support for setting up incubation centers.

There is urgent need of indigenous manufacturing in Telecom and M2M domain as detailed in para 4.1. In NTP – 2012, it is envisaged to assist entrepreneurs to develop and commercialize Indian products by making available requisite funding (pre-venture and venture capital) to promote indigenous R&D, Intellectual Property creation, entrepreneurship, manufacturing, commercializing and deployment of state-of-the art telecom products and services. Accordingly following activities will be taken up:

1. Fund will be created for pre-venture and venture capital activities.
2. An incubation center will be setup under the aegis of NTIPRIT. Activities have been initiated in NTIPRIT to support innovations, R&D, capacity building and to establish M2M network leading to incubation center.

## **5.8 To evolve new M2M Business Models:**

The ubiquity of wireless data networks, the rapidly decreasing costs of modems, the widespread acceptance of the wireless standards, and the improvements in data rates and latency are all making

Wireless M2M a cost-effective and reliable enabler for a variety of industrial applications and services. There are potential billions of machines/ equipment's that could be networked using wireless technologies. This can be extended to a wide range of industries such as medical, retail, security, transportation, and utility.

TSPs and ISPs are going to play an important role in M2M value chain with their networks transporting the data traffic from sensors in target device back to the servers/ back-office-systems. The other form of emerging players in this space includes MVNO (Mobile Virtual Network Operators) in some countries that provides M2M services to the end users using TSP's resources.

To summarize, from communication perspective, following type of business models can be built by a M2M service provider (MSP):

1. MSP focusses on its own services, leaves choice of connectivity/ network on end customer allowing him/ her to choose TSP of their choice.
2. MSP becomes bulk customer of a TSP and provide end to end service along with SIM and connectivity to end customer. He settle bills of TSP directly as bulk customer and raises single bill to his customer for overall service offering including telecom services provided.
3. A TSP is also MSP and sells services to customer similar to value added services.
4. MSP becomes an MVNO (subjected to acceptance of upcoming DoT/ TRAI guidelines on MVNO) and accordingly offers services to its end customers.

At present in India MVNO are not in existence. NTP 2012 envisages facilitating resale at the service level under the proposed licensing regime – both wholesale and retail, for example, by introduction of virtual network operators. The issue is under consideration at TRAI, who is carrying out consultation with stakeholders on this issue. The process and resulting implications will be dealt after TRAI recommendations.

In India, for the telecom and data services being offered to end users, multiple business models coexist and similar situation is being envisaged for M2M services. Different kinds of businesses models will evolve based on the market forces. Government will support all such models in the requisite regulatory framework.

## CHAPTER 6

### M2M – SECTORIAL APPROACH

M2M can bring substantial and tangible social and economic benefits to consumers, businesses, citizens and governments, helping to limit healthcare costs, reducing the carbon footprint and resource wastage, increasing access to education and improving safety. GSMA forecast predicts that by 2020, India will have 24.6 million active cellular M2M connections, the 9th highest number in the world. The fixed M2M connections are going to be much more, increasing this number multi-fold.

In current environment, M2M can be used in almost all aspects of life. If we look at government setup across various ministries and departments, more than 70% of them are either using M2M or planning to use M2M technologies in one way or other. With better sensors, wireless networks and increased computing capability, deploying an M2M makes sense for many sectors. M2M has opened up immense opportunities in technology and business. Its myriad applications extend beyond the corporate world into our daily lives, and have transformed the way we live, work and play.

Globally, Telecom standard development organizations have taken lead to define and standardize the communication networks for various M2M applications and thereby supporting the specific sector allowing them to focus on their core competency. In Indian context, DoT has also received requests from government departments and utilities to extend support towards detailing their communication network to build M2M services.

With this background and taking into consideration various points covered in this roadmap, sector specific M2M applications in areas like Smart cities, Automotive, Power, Smart Water, Healthcare, Safety & Surveillance, Agriculture, Supply Chain (PDS), and PoS Fiscal Register are briefly given below to give a better idea of the possible use of standards and policies in a M2M network. While selecting these sectors, some of them are chosen as they are adopting M2M at a rapid pace and it is high time to build standards, policies and regulations for these. Some sectors are selected as they have tremendous opportunities and not much is being talked about them. Detailed use cases for these sectors are covered in Annexure IV.

**SMART CITY:** Becoming smarter and more sustainable is no longer an option, but an increasing priority for cities around the globe. The quality of life and of the environment, within which urban dwellers operate, is closely linked to the way in which the city functions. Despite the particular set of priorities that characterize each urban environment, cities in both developed and developing countries are facing the challenges posed by pollution and low air quality, high traffic volumes and congestion, increasing levels of greenhouse emissions, deterioration of the built environment and urban sprawl, which among other factors are increasing the pressure on existing natural resources, water supply and waste management systems. Rapid urbanization trends and climate change manifestations are exacerbating the impact of these challenges on the economic performance, the health, and the environment of cities around the world. Creating a smart city involves making key sectors and services in a city intelligent using M2M devices - Energy, Water, Buildings, Transportation, Parking, Waste disposal, Physical Safety and Security, Healthcare, Education.

The relevance of urban infrastructure has long been a critical aspect for a smart sustainable city. Traditionally, there have been two types of infrastructure: physical (buildings, roads, transportation, power plants for example) and digital (IT and Communications infrastructure). There is a distinction between these two types of infrastructure – physical and digital, with both operating on separate fields. A convergence of the two coupled with smart management of the different infrastructures, could provide a multiplier effect.

**AUTOMOTIVE:** M2M enabled transportation system include telematics and all kind of communications in vehicles, between vehicle and citizens/Authorities (car to application), between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure). M2M Applications in transport sector can enable Enhanced convenience and safety to use public transport. GPS devices have been made mandatory in several countries for the commercial vehicles to prevent theft and accidents. For Fleet Management most of the establishments make use of specific high end devices. Different services enabled by M2M in Automotive/ Transport sector include eCall(Emergency and public Security), Intelligent Transport System (ITS), Fleet Management, School bus tracking and attendance system, Smart Ambulance, Accidents and theft prevention of commercial vehicles, Automatic Road tolling, Emergency Response system against major natural happenings, Pay as you drive insurance, In-Car Infotainment, Electronic parking assistance & payments, Tracking of moveable assets like DG sets, Vehicle to Vehicle & Vehicle to infrastructure communications etc.

**POWER:** The conventional electricity grid is undergoing revolutionary changes. With smart metering, SCADA, WAMS, substation automation etc. the grids are already in the process of embracing M2M communications for reliable and efficient operation. The boundaries between generation, transmission and distribution are vanishing with increased share of distributed generation at consumer premises. This trend is set to gather momentum as several states in India have already issued net metering policies. In addition, technologies such as MW-scale grid connected batteries and other forms of energy storage technologies, micro grids, DC grids, electric vehicles etc. are going to bring about a paradigm shift in the way electricity grids will be built and operated in the 21st century. For all of these as well, M2M communications will pave way for better monitoring and control of the power flow.

**SMART WATER:** India is facing chronic water problems i.e.high water stress coupled with high population densities, high water demand by all sectors (agriculture, industry etc.), poor water quality and lack of infrastructure. Without smarter water management, the ability of the water system to meet the critical needs of people and business is being compromised in virtually every country of the world. Smart water is achieved by different types of sensors deployed across the water distribution network, and across the water cycle. Intelligent Electronic Devices, such as pressure and acoustic sensors, connected wirelessly allow detecting and pinpointing of leaks much quicker. The sensors may use cellular and short range 802.15.4/ZigBee connectivity to send information to control centre. In the case of agriculture, with sensors and smart controllers, it allows to automatically conserve water by watering only when it's needed - take in many different weather variables (temperature, humidity, wind, rainfall etc.) and the type of plants, sprinkler heads, and soil to calculate and adjust to the appropriate run time for that day.

**HEALTH CARE:** Smarter healthcare management converts health related data into clinical and business insights. M2M enabled sensor based devices and other basic equipment with connectivity, can facilitate backend access for experts to get clinical data captured by these devices to provide treatments, and thus help in filling the gaps in medical service availability to rural populace. M2M in Healthcare enables remote capture of health diagnostics data, which may or may not require immediate intervention. M2M uses a device (a surface or implanted sensor) to capture an event (e.g. BP Blood sugar, ECG) which is relayed through a network (wireless, wired or hybrid) to an application (software program), that translates the captured event into meaningful information through telemetry. This information can be analyzed by physician and corrective measures initiated. M2M health related applications can enable - Remote monitoring of patients after surgery, while resting at home; Transmission of vital parameters of a patient from ambulance to hospital; Remote monitoring of old aged patients; Remote consultation; rural medical assistance, e-ICU etc.

**SAFETY AND SURVEILLANCE SYSTEMS:** The emergence of smart technology using M2M is driving the creation of strong safety and surveillance systems. Vast communication and sensor networks across cities enable law enforcement and other government agencies related to citizen safety to gather greater quantities of data; interpret them and react effectively. Greater interoperability allows technologies and networks to be linked and advanced analytics provides departments with the data they need to make

effective decisions on time. This is driving changes to the way major cities across the world evaluate their security requirements. The safety and surveillance system consists of various M2M devices such as IP based Cameras, theft or burglary alarm, fire detection, alert systems coupled with other network and storage and analytics systems.

**AGRICULTURE:** Agriculture sector is showing worrying signs of stagnation in recent past, with lower productivity per hectare compared to many areas in the world. The use of technology especially M2M based sensors will help in improving the sector like - Weather stations to give most accurate view of micro climates in real-time, Wireless/wired soil moisture sensors to collect real time data both for outdoor and green house owners to find blind zones, Sensors to check fertilizers level, Sensors to quickly check the health of livestock, Sensors for measuring the environmental temperature, humidity and carbon dioxide, Sensors to measure storage conditions, monitoring of insect and pests to help farmers for precautionary measures to protect the crop damage, Land management to preserve the nutrients

**SUPPLY CHAIN (PDS):** Supply chain management is a generic concept applicable in all sectors. Perishability, seasonality & bulkiness are distinguishing factors in food supply chains. Use of M2M solutions in food supply chain have drastically improved quality check and minimized pilferage. The Public Distribution System (PDS) in particular shall have to account for all such aspects. PDS provides for management of scarcity and for distribution of food grains at affordable prices to the targeted population. A number of technical interventions have been made in various stages of PDS process i.e. Inventory Management, Ware House Environment, Beneficiary database and authentication process, which have brought marked improvement in PDS management.

M2M application in Supply Chain/PDS includes use of digitized database of targeted population integrated with fingerprint, Smart Cards, ubiquitous mobile phones with dedicated IPv6, automatic PoS weight mechanisms, GPS/ LBS based Fleet Tracking for Grain Transportation, RFID tag on grain bags, packaged goods with bar coding, automation of Fare Price shops (FPS), temperature and humidity sensors in warehouses to ensure the food grains are not deteriorated. All these, involve use of M2M devices at all stages in the supply chain to ensure efficient, economical and transparent distribution of goods.

**FISCAL CASH REGISTER:** M2M PoS applications are transforming the way merchants do business. From taxi cabs to storefronts, more and more companies are seeing the opportunities and value of wireless M2M point of sale which supports secure, real-time payments and transactions, and provide retailers with real-time visibility into their inventory. An exceptional value addition to the M2M PoS is the “M2M based PoS fiscal cash register” which uses electronic devices for collection, control and monitoring of Governments tax revenues online. A complete sales register system includes a cash register machine i.e. point of sale machine (PoS), a GPRS terminal, a GPRS / GSM mobile network connection and a server at the authority data center. PoS based fiscal registers can help the Government to increase tax compliance, provide changes in taxes to be affected online as all the PoS based fiscal register gets integrated to central database of the Government. Retailers also get benefited as they have the information of Tax amount to be paid.

In the long run, upcoming M2M services and networks in various domains will be having similarities with either one of the sector specific approach detailed above. Thus all sectors can see value in these approaches.

## **CHAPTER 7**

### **M2M: ROAD AHEAD**

M2M will be the nerve center of the future society. The actions that are planned to be taken by the Department of Telecommunications, Government of India to further the M2M ecosystem growth, that have evolved through this roadmap document, are detailed below. Due inter-ministerial consultation will be done as per the requirements for further detailing in this regard.

1. To facilitate M2M communication standards including encryption, quality, security and privacy standards from Indian Perspective and to recognize such standards for India.
2. To release national M2M Numbering Plan (within year 2015).
3. Addressal of M2M Quality of Service aspects.
4. To address M2M specific Roaming requirements.
5. To formulate M2M Service Provider (MSP) registration process.
6. To issue guidelines for M2M specific KYC, SIM Transfer, International roaming etc.
7. Formation of APEX body involving all concerned stake holders.
8. To address M2M specific spectrum requirements.
9. To define frequency bands for PLC communication for various Industry verticals
10. Finalization of M2M Product Certification process and responsibility centers.
11. Facilitating M2M Pilot projects.
12. Measures for M2M Capacity building.
13. To establish Center of Innovation for M2M.
14. To assist M2M entrepreneurs to develop and commercialize Indian products by making available requisite funding (pre-venture and venture capital), management and mentoring support.
15. Inclusion of M2M devices in PMA Policy.
16. To take up matters with relevant ministries to boost M2M products and services.
17. Define procedures for energy rating of M2M devices and implementation of same.
18. To evolve suitable guidelines of EMF radiation of M2M devices based on research and studies by relevant bodies.

## **ANNEXURE I**

### **Questionnaire - M2M communication in India – Response thereof for Policy formation**

DoT is in the process of making policy for Machine to Machine Communications (M2M) which will look into aspects of policies, standards, licensing, spectrum, KYC, security etc. In the process of formation of policy, we would like to have your valuable inputs being a key stakeholder.

In this regards, a questionnaire is enclosed for your reference. You are requested to give inputs on all those questions which you find relevant for your area of business.

#### **Questionnaire:-**

##### **Pl. share your personal information (optional):**

Name:

Organization:

Designation:

Mobile :

Email id:

##### **What is your role in the M2M value chain:**

- a) Equipment Vendor / Supplier
- b) System Integrator
- c) Telecom Service Provider
- d) End User
- e) Application / Content Developer
- f) Government Organisation
- g) Academia/ Consultant
- e) Others (please specify)

##### **Please respond to following questions:**

Category	Q.No	Questions	Response
General	1	What are the new technologies, approaches and emerging vertical markets and applications that are changing the face of M2M today?	
	2	What are the top challenges today for mass adoption of M2M solution?	
	3	In your opinion, which sectors in India offer maximum potential for deployment of M2M services?	
	4	What health, safety regulations and environmental guidelines do the M2M devices need to comply with?	
	5	What measures needs to be taken to protect customer interest in the scenario where multiple entities are involved in M2M service offerings – what will be the Telco operator’s role?	

Category	Q.No	Questions	Response
policy	6	What should be the policy objectives to facilitate faster adoption of M2M in the country?	
	7	Is there any requirement of M2M Product certification or M2M service certification?	
	8	Is there any need to allocate dedicated spectrum for any specific Industry vertical. If yes, specify the vertical and frequency band. Whether services on unlicensed band could be allowed?	
	9	What changes are required in the present telecom service licensing framework to accommodate M2M?	
	10	Will there be a new numbering system/ addressing scheme required to identify the ever growing devices?	
	11	Should the devices/ network components be location independent for seamless and resilient connectivity? Is there any impact on licensing or regulatory framework requirements?	
	12	Are you associated with M2M services in other countries directly or indirectly? What government regulations and policies encouraged you to offer M2M services in these countries?	
	13	When SIMs are pre-fitted in manufactured equipment, in most situations the equipment is sealed off (IP casing) for purposes of protection and warranty. What guidelines are required to permit such a process outside/ inside the country? Also what policy changes are required in terms of pre-activated devices?	
	14	How access by embedded and cloud applications be defined to make it technology neutral? If there should be regulations for embedded devices bought outside the country? Is it feasible to have domestic cloud to facilitate M2M services?	
15	Is there need to define separate KYC norms in the M2M scenario including System Integrators aspect?		

security	16	Is the current security framework sufficient for various verticals in which M2M applications are used? If not, what additional aspects need to be defined?	
	17	Is there need to define precautions/ security conditions for allowing Voice/ SMS/ MMS/ Video on M2M?	
standards	18	What minimal technical standards need to be created for M2M products and services?	
	19	How interoperability can be achieved across services providers?	
	20	Is there need to define policy/ standards to connect legacy and non-IP devices on existing network technologies?	
security	21	<p>In the scenario where multiple entities are involved in M2M service offerings, is there requirement to define specific standards and guidelines on standards:</p> <ul style="list-style-type: none"> <li>a. data ownership</li> <li>b. data retention period</li> <li>c. access rights</li> <li>d. storage of sensitive data</li> <li>e. security of sensitive data</li> <li>f. data privacy</li> <li>g. data encryption</li> <li>h. to ensure data authenticity</li> <li>i. minimum disclosure rules</li> <li>j. Location of application servers</li> <li>k. Location of Remote Terminal Units/ M2M devices</li> <li>l. Location of Core network elements</li> <li>m. Response time/ Latency requirements etc.</li> </ul>	

technology	22	What Bandwidth requirements are expected for M2M services in different Industry Verticals? a. Provide examples of minimum and maximum speed requirements of M2M devices in different Industry Verticals b. Provide examples of average monthly data consumption requirements of M2M devices in different Industry Verticals	
	23	How M2M end user devices can be connected to the external network? What are the alternatives available to connect other than SIM? If SIM is the only way to connect, then what standards be adopted?	
	24	When a M2M device is deployed with a mobile network operator, what are the unique aspects of system testing and software development that are required in order to ensure appropriate performance of the device in multi operator scenarios?	
	25	In M2M environment, devices need to be connected to the network at all times across different areas. How it can be ensured? Is network connectivity in rural areas adequate for making device both traceable and always on?	
	26	What would be the challenges to a manufacturer who has nationwide distribution channels if a device only operates on the network of one mobile network operator?	
	27	How to address device portability among Home Area network/ operator network as there is possibility of locking by operators given services offered by them?	

You may give wide circulation to the questionnaire and ask your industry colleagues also to respond to the same. The response shall reach to DoT latest by 4<sup>th</sup> October 2013 at email address [dirnt3-dot@nic.in](mailto:dirnt3-dot@nic.in)

With regards,

R.M.Agarwal  
DDG (NT), DoT HQ  
Sanchar Bhawan, New Delhi.

**Note:**

1. Any other aspect which has not been covered in this questionnaire and needs to be taken care in M2M policy may please be detailed.
2. The completed response may be sent to DoT by 4<sup>th</sup> Oct 2013 to Reena Malhotra, Dir (NT-III) at email id [dirnt3-dot@nic.in](mailto:dirnt3-dot@nic.in). You may also contact at +919868132627.

## **ANNEXURE II**

### **List of the respondents to DoT M2M Questionnaire**

1. Aircel
2. Airtel
3. American Express
4. Arogya mHealth Pvt. Ltd.
5. Association of Competitive Telecom Operators (ACTO)
6. Association of Unified Telecom Service Providers of India
7. AT&T Global Network Services India Private Limited
8. Beyond Evolution Tech Solutions Pvt Ltd (3 Responses)
9. CGI (India Zoho)
10. cni IT Services Pvt Ltd (India Zoho)
11. COAI
12. ConnectM Technology Solutions Private Limited
13. Deloitte
14. DEPARTMENT OF BIOTECHNOLOGY
15. DMICDC
16. DOT Chennai
17. DoT, A&N
18. DoT, Puducherry
19. ELEKTRONIK LAB
20. Ericsson
21. ETSI
22. Global ICT Standardization Forum for India (GISFI)
23. Huawei (2 Responses)
24. IBM India Ltd (2 Responses)
25. IDEA CELLULAR LIMITED
26. Kalki Communication Technologies Private Limited
27. Machina Research
28. MIT School of Telecom Management
29. Quattro Global Services Pvt Ltd
30. Regional Laboratory for Applied Research and Development (RLARD), Pune
31. Reliance Infrastructure Ltd
32. SenseGrow Technologies Private Limited
33. Stellapps Technologies Pvt Ltd
34. Sukrut Systems Pune
35. TATA CONSULTANCY SERVICES LTD
36. TEC
37. TECH MAHINDRA
38. TELIT WIRELESS SOLUTIONS CO. LTD.
39. Texas Instruments, WW Strategic Marketing
40. The American Chamber of Commerce in India
41. TTL
42. Uninor (2 Responses)
43. VAS.KSS, Research Scholar
44. Veninore Technologies (Ind.) Pvt Ltd
45. Verizon Communications India Private Limited
46. Vihaan Networks Limited
47. Vodafone India Limited and all its associate companies having Telecom Licenses
48. Wipro Technologies

## **ANNEXURE III**

### **OneM2M Candidate Release 2015:**

- 1) Functional Architecture Version 1.6.1 Dated 01/2015 (TS 0001)
- 2) Requirements Version 1.0.1 Dated 01/2015 (TS0002)
- 3) Security SolutionsVersion 1.0.1 Dated 01/2015 (TS 0003)
- 4) Service Layer Core Protocol Specification Version 1.0.1 Dated 01/2015 (TS 0004)
- 5) Management Enablement (OMA)Version 1.0.1 Dated 01/2015 (TS 0005)
- 6) Management Enablement(BBF) Version 1.0.1 Dated 01/2015 (TS 0006)
- 7) CoAP Protocol BindingVersion 1.0.1 Dated 01/2015 (TS 0008)
- 8) HTTP Protocol BindingVersion 1.0.1 Dated 01/2015 (TS 0009)
- 9) MQTT Protocol BindingVersion 1.0.1 Dated 01/2015 (TS 0010)
- 10) Common TerminologyVersion 1.2.1 Dated 01/2015 (TS 0011)

OneM2M had earlier invited interested parties to review the Candidate Release documents and provide comments which were reviewed and considered for inclusion in the initial Release by oneM2M. The public comment phase has ended on 01 November 2014. Updated initial Release of oneM2M specifications, approved by the oneM2M Technical Plenary is published by the oneM2M Partner standards development organizations in Jan 2015 as indicated above. On the similar lines, alliance members SDO are also coming up with draft releases for the detailed documentation responsibilities entrusted upon them.

Ultimately, the work of oneM2M will drive multiple industries towards the goals of lowering operating and capital expenses, shortening time-to-market, creating mass-market economies of scale, simplifying the development of applications, expanding and accelerating global business opportunities, and avoiding standardization overlap.

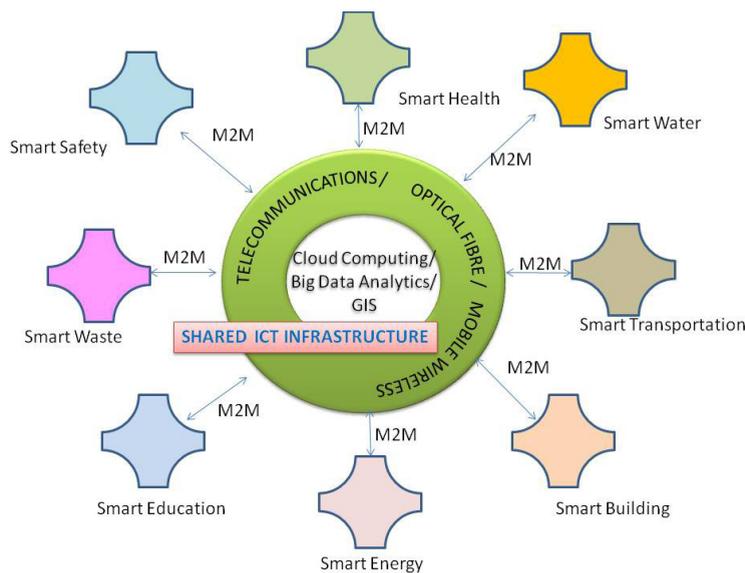
# ANNEXURE IV: M2M Applications in Various Sectors

## A. SMART CITIES

As per Census 2011, urban population of India was 377 Million and is expected to be about 600 Million by 2030. As a result, urban areas are getting more and more congested due to people's migration and is exerting enormous pressure on the resource base of a city, due to increase in demand for energy, water, sanitation, as well as for public services like transportation, education, health care etc.

Creating smart cities leveraging on the advancements, in Information and Communication Technologies (ICTs), will enable the authorities to provide eco-friendly and economically viable solutions for cities. Smart cities are on the increase worldwide and Government of India also plans to develop 100 smart cities in the country in addition to GIFT city (by Government of Gujarat) and other 7 cities along DMIC corridors.

**IV.A.1 KEY ASPECTS IN A SMART CITY:** The foundation for a smart city, involves systems and objects interconnected through various ICT technologies. The digital infrastructure provides the glue to enable the smart sustainable city to operate efficiently and in an optimal manner as depicted below:



Key aspects for a smart sustainable city are described below:

**SmartEnergy:** Smart energy management systems use sensors, advanced meters, digital controls and analytic tools to automate, monitor, and control the two-way flow of energy. These systems optimize grid operation and usage by keeping consumers, the producers and providers up-to-date with the latest technology advancements to deliver energy efficient solutions.

**Smart Buildings:** Smart building uses sensors and automations with intelligence to improve building energy efficiency, reduce wastage, and make optimum usage of resources to the satisfaction of the occupant. These modifications not only apply to new buildings, but existing buildings can also take advantage of the new and more energy efficient solutions and thus reduce their energy use by up to 50% through simple retrofit programs.

**Smart Transportation:** Smart transportation management systems use technology to collect information about mobility patterns. This information enables city administrators to make sure that with the current infrastructure and with lesser investments, the city provides cleaner, efficient and smarter transportation systems. This method lessens the level of wastage and overcomes the challenges of transporting goods, services and people from one point to another. In addition, ICT can help to reduce the overall need for transportation and travel by offering virtual alternatives to physical movements.

**Smart Water:** Smart water management systems use and apply ICT to provide access to safe water, manage demand and supply, reduce waste, monitor and control assets. It helps in providing continuous monitoring of water quality and availability via smart sensors, improving water and energy efficiency, enabling better overall water management.

**Smart Waste:** Cities are finding it difficult to segregate different kinds of waste and make use of a product which can potentially be bought back into consumer life cycle. Smart waste management systems will enable implementing waste tracking systems to monitor and control the movement of different kinds of waste, Sorting of waste without the operator coming into contact with it, Leveraging technology to collect and share data from source to transportation to disposal of waste, Connecting various smart waste management systems with local waste management service providers.

**Smart Physical Safety and Security:** Smart systems provide “on-the-go” data which become an important step in keeping human security related issues under check. Examples of ICT in physical security include the use of analytical tools which help to sense, respond and resolve incidents, as well as towards criminal identification, predictive analysis and criminal pattern identification. Command and control systems can be shared across multiple city departments such as Energy, Waste, Security, and Transport, enabling a holistic, city-wide approach. Security technology such as video surveillance, video analytics, and biometrics can be the main focus of a city’s security.

**Smart Healthcare:** Smarter healthcare management converts health related data into clinical and business insights. This data empowers health specialists to improve the productivity of the service provided at the point of contact of patients. Examples of smart healthcare includes availability of remote alternative diagnoses, remote treatment or tele-assistance, on-line medical services, requesting an appointment online or the possibility of having a digital record via an electronic health management system, remote home services, alarm systems or even remote patient monitoring systems.

**Smart Education:** Education is a crucial component of smart city services. As the world rapidly globalizes, one of the only ways to stay competitive is to develop and continue to build knowledge based skills – via education. This includes initial knowledge (e.g. through school, vocational and university education) as well as lifelong learning.

In addition to above, functions like Remote Outage Notification, Smart EV Charging, Emergency Response, Smart Parking, Intelligent Street lighting, Digital Signage, Location based Services, Smart Integrated transit solution including Rail, monorail, bus, last mile connectivity, RTV etc. are also features that can be built in a smart city.

**IV.A.2 ROLE OF M2M IN SMART-CITY:** Smart City involves creating a developed urban area, which has sustainable economic development and high quality of life through strong human capital, social capital and ICT infrastructure. Different systems and nodes in smart city are interconnected on common ICT infrastructure of the City through various technologies, like LAN, WAN and wireless networks. The interconnected and independent services of smart cities should evolve through well-defined digital master plan of the city and under a centralized governance dashboard of stakeholders, responsible for setting policies and processes, managing ICT assets, services and protocols, and ultimately administering the services for constituents. The technical basis for the Smart City is M2M between machines or between machines and a control center. Overall the essential components for making a city “smart” from the ICT perspective are as under:

**COMMUNICATION NETWORK:** Communication network is vital component of a smart city, necessary to establish all sorts of connectivity, including human to human, human to machine, machine to machine. Cloud services, videoconferencing, and such other services need high-speed and high-capacity communication networks like Optical Fiber Cable or Broadband wireless access. A well planned Optical Fiber overlay network is a must to create the backbone to carry the communication traffic.

A citywide robust broadband network creates the foundation for the ICT infrastructure for Smart Cities. The underlying fiber optic network works as metro loop around the city (like a ring road for traffic) and then local access that links buildings to this loop. The city master plan shall essentially cover all ducts for building this fiber network. Additional planning is also required to define scope of fiber to be laid by city administration and by TSP's. Wireless access to this underlying network can be provided by different wireless technologies as detailed in chapter 2.

**UBIQUITOUS SENSOR NETWORKS:** Ubiquitous Sensor Networks (USN) utilizes wire line and wireless networks. These networks consist of interconnected autonomous devices, distributed across the location, and use sensors to collectively monitor physical/ environmental conditions (e.g. temperature, sound, vibration, pressure, motion or pollutants). Smart meters and smart sensors are now available, for creating intelligent electric power grids, water and gas networks. Smart thermostats and building management systems, are some of the pieces needed to be smart, and on the cusp of being able to 'talk' and 'listen.' Electronic records, analytics and better access to healthcare with in-home consultations via computer are available to improve health care. The physical space and infrastructures of the city are to be enriched with embedded systems, smart devices, sensors, and actuators, offering real-time data management, alerts, and information processing for the city administration.

**CLOUD COMPUTING:** Cloud computing framework with centralized 'NOC' delivers efficiency and optimization in processing the big data generated by the thousands of sensors across the city. To work with real-time input from sensors, smart phones, electric and water meters, or other sources of input about the functions of cities, requires specialized hardware and software to store data, as well as applications to make sense of it. This need can be taken care using Cloud Computing Services.

**BIG DATA:** It will be essential to integrate standalone solutions into the Smart City eco-system, to analyze and utilize the mass of data generated – Big Data – in real time. Analysis of this Big Data and the resulting smart automation of process will enable to handle complex administrative tasks with a social, economic and ecological dimension.

**GEOSPATIAL INFORMATION SYSTEM (GIS):** The use of a GIS system is a key platform for disseminating Smart Data. Geospatial data has to be brought together in real time from multiple providers (static and real time data from sensors) like – Geo information, Land Information System, Environmental Information, Resource Information, Network Information, Picture Processing Information, Design Information, Spatial Data Processing and Multi-Purpose Cadastre, Integrated Planning and Response Citizen Centric services, AM/FM - Automated Mapping and Facilities Management

**SMART URBAN SPACES:** These are areas of a city that leverage ICT to deliver more efficient and sustainable services and infrastructures within that specific area. These can include services like electric car charge points, energy-efficient buildings that use smart heating and cooling systems, Wi-Fi hotspots and information kiosks that allow people to connect to the Internet on the move. The use of cloud computing, IoT, open data, semantic web, and future media technologies have much to offer cities looking to become smart.

**IV.A.3 STANDARDISATION INITIATIVES:** ICT being a key driver of smart city initiatives needs utmost attention of city planners and various stakeholders. Many component-level standards already exist; addressing various radio interfaces, different meshed or routed networking choices, or offering a choice of identity schemes. Each is optimized for a particular application scenario and there is therefore a degree of fragmentation. Details of standardization activities across the world in M2M sphere is given in Chapter 3.

**IV.A.4 APPROACH FORWARD:** While planning a Smart city, following will need to be considered from IT networking point of view:

- a. Core Fiber network of the city shall cater to all administrative and commercial services as detailed earlier so as to ensure interoperability across various platforms.
- b. Planning for Dedicated space for all utility providers and TSPs for establishing their core and access network and also provisioning for future demands.
- c. Adherence to global and Indian Standards consisting of well-defined set of parameters that needs to be followed for smart telecom components and attendant services in each vertical in the city so as to ensure interoperability and network reuse.
- d. Finalization & enforcement of standards for different verticals along with architecture to be followed in each of the smart services. This is crucial for ensuring interoperability of the components and service agnostic underlying architecture so that various smart applications are enabled on same underlying telecom & sensor network infrastructure.
- e. Wireless Spectrum, being a scarce commodity shall be optimally planned. Home and neighborhood networks shall be planned to use free bands as much as possible through common home gateway for multiple services.
- f. All the smart services in smart city should necessarily be IP based and not on propriety standards to provide flexibility to the planners in future so as to have interoperability. Government has already mandated use of ipv6 through its related roadmaps.
- g. IPv6 sensor based Energy efficient products and other monitoring and control expertise developed by countries like Japan may be suitably utilized. DoT is working in close coordination with IPv6 Ready-Logo & IPv6 Forum and is best placed to play the nodal role for similar coordination activities in future.
- h. To have city wide secure government communication, technologies like TETRA can be explored that provides seamless communication in all eventuality as an emergency response system as detailed in chapter 2.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **B. AUTOMOTIVE**

### **IV.B.1 Indian Automobile Scenario:**

India is placed as sixth largest motor vehicle/car manufacturer in the world in 2013. In terms of consumption (excluding exports), it lags behind China (around 18 million), USA (12 million), Japan, Brazil. In terms of per capita consumption of vehicles, it holds lowly position of around 129th in the world. Latest available data for registered vehicles RTO as per Government of India records (Ref:[http://data.gov.in/catalog/total-number-registered-motor-vehicles-india#web\\_catalog\\_tabs\\_block\\_10](http://data.gov.in/catalog/total-number-registered-motor-vehicles-india#web_catalog_tabs_block_10))

Year (As on 31st March)	All Vehicles	Two Wheelers*	Cars, Jeeps and Taxis	Buses	Goods Vehicles	Others**
2012	15949100	11541900	2156800	167700	765800	1316900

\*\* Tractors/Trailers etc. not classified into the above categories

Currently, it is estimated that India is home to more than 100 million vehicles. Huge market space of vehicles provides a tremendous opportunity for introduction of M2M devices and services in the sector. M2M enabled transportation system include telematics and all types of communications in vehicles, between vehicle and citizens/Authorities (car to application), between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure). M2M Applications in transport sector can enable:

1. Enhanced convenience and safety to use public transport connected Para transit and mass transit modes.
2. Optimized emergency Services.
3. Road Safety to commuters and driver.
4. Vehicle tracking including monitoring and regulating driving behavior.
5. Management of traffic optimized route and reduction in commutation time.
6. Monitoring and reduction in traffic violation including online challans.
7. Productivity enhancement
8. In vehicle entertainment
9. Automated Toll collection

GPS devices, one of the core items in telemetry, have been made mandatory in several countries in several segments of vehicles to prevent theft and accidents. For Fleet Management most of the establishments make use of specific high end devices.

### **IV.B.2 Enabling Factors for adoption of Domestic Connected Vehicle Market:**

In domestic Indian market, a large number of commercial vehicles are connected and using services like Fleet Management, monitoring and support from manufacturer etc. In passenger cars and vehicle mass adoption has yet to take place. The key enabling factors for M2M adoption towards connected vehicle are listed below:

1. Fast adoption of technology, gadgets and increasing disposable income.
2. Growing use of software in vehicles to control complex electronics.
3. Exponential increase in private cars and first time drivers.
4. Increasing complexities of Driving: Performance maintenance, theft, Navigation, breakdowns and accidents.

5. Severe traffic congestion and poor quality roads of India
6. Wide spread coverage of telecom service providers
7. Vehicle market in India is dominated by entry level cars with basic features.
8. Government & Regulatory bodies exploring possibilities for enhancing Public security, convenience and optimizing field operational efficiency.
9. Companies getting active for employee safety and managing their commutation
10. Logistics and fleet management companies looking for optimizing the operational efficiency and improving the productivity.

#### **IV.B.3 Possible M2M Applications in Indian Automobile Sector:**

There are numerous M2M applications in Telematics around the world. The Indian stake holders and entrepreneurs can get advantage of them and bring lot of innovative applications around them listed as below:

**1. eCall - (Emergency and public Security):** The end user can make emergency calls using his location (100 or other declared emergency number) and the emergency response teams can support the request generated.

**2. Intelligent Transport System (ITS):** It involves utilizing technology connecting People with Vehicles, with Infrastructure, with an objective to provide convenience, safety and entertainment. ITS enabled efficient public transport system can motivate public to use public transport instead of private cars. On an average two cars take the space of one bus and 90% of cars have 1-2 occupants.

**3. Fleet Management:** Vehicles which are part of a fleet can be monitored by deploying a telematics device in them along with a GPS module. The service is most used scenario in India in Logistics companies, Perishable Food product transportation, and high value items movements. It has further scope in municipality vehicle fleet for garbage collection and processing, passenger vehicles safety etc.

**4. School bus tracking and attendance system:** The school buses can be fitted with a GPS and telematics unit. The children may be issued RFID badges. Child taps his/her badge when entering/ leaving buses. Information is maintained in a central server keeping complete trace for the child. The real time information may be made available to parents as well as school authorities.

**5. Smart Ambulance:** Fleet management integrated with Telemedicine is an enabler and is widely deployed by private and a few state governments. The ambulances are fitted with tracking systems and dispatch to the nearest call is made. Telemedicine support can be provided in the ambulance e.g. Initial heart readings, ECG etc. and sending the data to hospital utilizing the travel time and saving the life of patient.

**6. Accidents and theft prevention of commercial vehicles:** Using telematics units in vehicles, information such as location, speeding, rash driving can be computed. If a vehicle is stolen, the same can be recovered by finding the vehicle on the map.

**7. Automatic Road tolling:** Using RFID tags and related communication channels via telematics box on vehicles, automated road toll collection can be enabled.

**8. Emergency Response system against major natural happenings:** Once telematics units are fitted on a reasonable number of vehicles, it can be deduced which roads are open and which are closed based on GPS tracks in emergency situations. This is extensively used in Japan during earthquakes/tsunamis.

**9. Pay as you drive insurance:**Using telematics units, User Based Insurance (UBI) can be deduced, i.e. if someone drives smaller distances and in a safe manner, insurance premium may be reduced compared to someone who drives a lot or drives in risky manner. The data from vehicle will be made available via telematics units.

**10. In Car Infotainment:**Touch screen systems available in car can be connected to high speed internet via telematics units for entertainment. Additional information such as traffic, live data feeds, parking etc. can be sent to the car on these connected screens.

**11. Electronic parking assistance & payments:**Using telematics units, parking can be monitored at respective places and this information can be made available on phones/connected cars. It is popular in congested cities such as New York, Tokyo.

**12. Tracking of moveable assets like DG sets:**Gensets / DG sets can be tracked and their fuel consumption can be calculated using telematics units. These DG sets may be deployed in far off places for construction etc. any centralized monitoring is possible.

**13. Vehicle to Vehicle & Vehicle to infrastructure:**Vehicles can share their details such as speed, acceleration, and much other information to other vehicles. This will help in automated driverless vehicles or in simpler situation like informing another vehicle about raining down the road, nearby obstacles,congestion etc.

#### **IV.B.4 Approach Forward:**

M2M adoption in vehicles is fast growing. Many countries have made telemetric mandates i.e. Brazil- Contran 245, EU-eCall(2015), Russia- ERA-GLONASS, Germany- LKW-Maut Toll Collect, France- HGV Eco-tax, US- electronic onboard recorder (EOBR)(2015). In India mandates are there from government to install GPS/GRPS device in all public transport with video camera and panic button with connectivity to police stations.Further mandate for installation of RFID tags on the medium and heavy motor vehicles for toll collection, M2M devices for automatic detection of valid Pollution Certificate for fuelling will give a boost to M2M telemetry sector. Domestic manufacturing ecosystem can get impetus through this.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **C. POWER**

### **IV.C.1 Background:**

**Electrification as made possible by the grid is considered as “the most significant engineering achievement of the 20th Century** – among the achievements which has massively improved people’s quality of life.

India, being the third largest producer of electricity in the world, has an installed capacity of 255 GW (as of November 2014). However the per capita electricity consumption is one-fourth of the world average, owing to lack of access to electricity to a significant proportion of the population. The demand by 2032 is estimated to be 900 GW.

Electricity grid is at a transformational phase. The traditional grid is being revamped to a smart grid by superimposing the information infrastructure over the electrical infrastructure by making use of communications, automation and information technology which will radically change people’s lives in the coming years. A smart grid involves several revolutionary changes including distributed generation at the distribution edges of the grid that is not owned and controlled by electric utilities.

The Smart Grid Vision as envisaged in the Smart Grid Road Map of Government of India is to transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all.

**Smart Grid Conceptual Model:** The National Institute of Standards and Technology (NIST) Smart Grid Conceptual Model provides a high-level representation of the interconnected networks and equipment that will compose the Smart Grid, dividing the whole system into seven domains of Bulk Generation, Transmissions, Distribution, Customer, Markets, Operations and Service Provider.

### **IV.C.2 M2M in smart grid:**

The current energy distribution networks have been designed for “unidirectional” energy flow from large plants to users and are not suitable for a massive integration of delocalized small/medium power renewable generation plants. A Smart Grid allows the massive integration of unpredictable and intermittent renewable sources, and distributes power efficiently using sophisticated control systems. Other features in a Smart Grid include Advanced Metering and new policies of demand management, widespread adoption of PEVs (Plug-in Electric Vehicles), PHEVs (Plug-in Hybrid Electric Vehicles), concept of semi-autonomous systems called micro-grid, Demand/Response (DR) to change the amount and/or timing of customers’ use of electricity in response to supply conditions.

Smart grids use sensors, smart meters, digital controls and analytic tools to automate, monitor and control the two-way flow of energy across operations—from power plant to end user. M2M technology is what makes the “Smart Grid” smart. Various uses of M2M in Power sector are listed below:

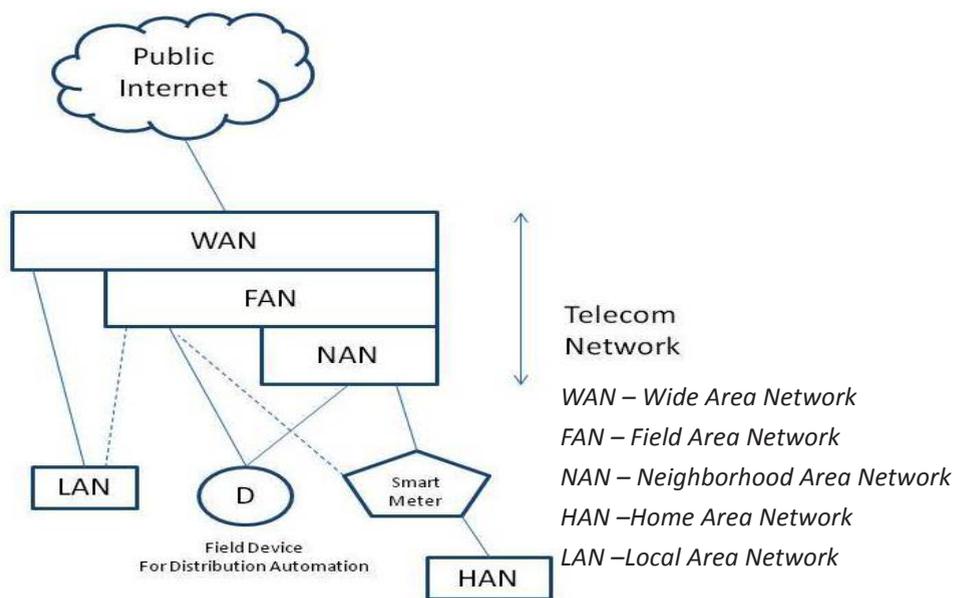
1. Automatic Meter Reading (AMR)
2. Advanced Metering Infrastructure (AMI)
3. Mini pillars
4. SCADA/EMS (Supervisory Control and Data Acquisition/Energy Management System) for TRANSCOS
5. SCADA/DMS (Supervisory Control and Data Acquisition/Distribution Management System) for DISCOMS
6. Wide Area Monitoring System
7. Substation Automation
8. Distributed Generation
9. Electric Vehicles
10. Energy Storage
11. Micro-grids

Future grids are expected to integrate a virtually unlimited number of sensors and meters in the distribution segments, sites and homes to support demand/ response, distributed generation and energy-aware applications; this will produce a huge amount of critical information for grid operation to be collected, exchanged and managed in a trustworthy way, requiring bidirectional flows among different layers. A number of such systems are in place in various DISTCOM's paving way for faster adoption of integrated Smart Grids.

To have an idea of the number of grid nodes involved in the system evolution, the Italian distribution grid would imply installing protection and control devices in about 400,000 MV/LV substations, having already installed over 30 million Automated Meters.

### IV.C.3 M2M Communication Technologies in Power Sector:

In order to realize the intelligent electricity network, M2M communication is considered as a building block for a Smart Grid as a means to deploy a wide-scale monitoring and control infrastructure. The choice of communication technology for M2M would be based on the use case, the large heterogeneity in services and applications building the smart grid, utility preference and ability to address the challenges depending on the location of the device in the GRID. However a typical Smart Grid communication network can be broadly envisaged as on next page.



For this, Cellular M2M & OFC will play an important role in M2M communications in WAN and FAN. In the case of HAN and NAN, there are various large-scale wireless sensor and actuator networks (WSAN) that can be deployed in Smart Grid in order to carry out the monitoring task. These WSANs with the collaborative and self-healing nature have an important role to play in realizing some of the functionalities needed in Smart Grid deployment. The various communication technologies available include 6LowPAN, Power Line Communication, Wi-Fi, ZigBee, Z-Wave, Ethernet, Home Plugs, RFID, NFC, Bluetooth etc., and are explained in Chapter 2. It is most desirable to use open standards that provide the reliability, scalability, high security, internetworking, and flexibility required to cope with the fast-growing number of critical applications for the electric grid.

**M2M Communication Standardization Activities for Smart Grid:** Many standards are available for exchanging information in smart grids including standards for reliable data acquisition and control over TCP/IP networks between SCADA masters and substations (IEC 60870-5), Distribution Management System (IEC 61968), substation automation (IEC 60870, IEC 61850), distributed energy resources (IEC

61850-7-420), head-end (IEC 61968-9) and cross-domain interaction (IEC 61970, IEC61968, IEC 61850, ETSI TS 102690). For other sectors standard formation is in process by oneM2M partnership, e.g. home automation and electric mobility; details of which are given in Chapter 3. TEC is bringing out India specific standards for Smart Grid.

The availability of multiple transmission technologies within the Internet is conducive to an early and cost-effective deployment of smart grids, because the wide variety of requirements and constraints could not be accomplished through a single architecture. The selection of suitable standards will have to take into account several considerations e.g. electromagnetic compatibility, communication paradigms, addressing schemes, quality of service, security, reliability, resilience, network extension, existing infrastructure etc.

**Security & Reliability:** Survivability of the communication network to blackouts is essential to enable automatic and prompt recovery from failures of the electrical grid. Current SCADA systems only implement raw security policies, mainly addressed to allow authorized operators to view and control all equipment, while excluding all others from access. Smart grids need fine-grained security policies that account for data confidentiality and integrity, identification and authentication of data, customers and devices, flexible protection level for specific flows and subscriptions, key management, prevention of traffic analysis, intrusion detection systems, protection against data injection attacks and privacy.

**IV.C.4 Approach Forward:** The successful implementation of smart grids requires a holistic and integrated approach so that communication infrastructure could account for different requirements. Ministry of Power has undertaken 14 Smart Grid Pilot projects for different distribution utilities. These pilots are expected to help as technology selection guides and business case developments for larger projects in the next phase. Broad strategy for the communication network may be suggested as under:

1. Selection of Standards needs to be done carefully as options are large and complex. The goal of achieving scalable, interoperable and secure Smart Grid should be consideration. Guidelines should be developed, including mechanisms for interoperability enforcement and, where appropriate, leverage commercial certification activities.
2. Network Security shall be complied carefully. The BIS standard, IS 3292 – Security Standard for Power Control Systems (currently in RFC stage) focusses on IT security and it is recommended to comply with this standard once this is released.
3. Particular care has to be devoted to the energy efficiency of all components as they will dominate the overall energy footprint of the Smart Grid due to their numerousness. As per ITU report on Smart Grid, the SG energy footprint in a nation could reach as much as 4% or could be limited to 1% depending on the technologies chosen.
4. Smart Grid is one of the major components in making a smart city, along with other sectors like transportation, health care, water, waste management etc. The common thread enabling the transformation of these sectors to become intelligent is communication, computing and electronics. Hence it is prudent, that shared ICT infrastructures are used across the various sectors.
5. Adopting IP Technology: IP has proved itself in regard to scalability, resilience, and as an open standard. Adopting IPv6 will enable to use the benefits of IP in the Smart Grid.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **D. SMART WATER**

### **IV.D.1 Background:**

Water is one of the world's most abundant substances. However the continued rapid urbanization is causing immense pressure on the water resources. The ability to effectively manage the water supply impacts almost every aspect of human life, from health and nourishment, to business and commerce, to energy and transportation. Access to clean water is a critical issue that affects economic activity, development and business around the world. With deteriorating resources, water leaks and exponential growth in water demand, an alarming percentage of the water is going to waste.

India is facing chronic water problems; high water stress coupled with high population densities, high water demand by all sectors, poor water quality and lack of infrastructure. As per ITU study 150 million people lack access to clean water in India with 21 states unable to provide access to clean drinking water to its rural inhabitants. Furthermore by depleting its groundwater reserves at a rate far greater than natural cycles can replenish in some states as well as fluoride contamination have both further crippled the provision of safe drinking water in India.

### **IV.D.2 Major Areas in Smart Water:**

A smart water system is an integrated set of sensors and ICT systems that enable utilities to remotely and continuously monitor and diagnose problems, prioritize and manage maintenance issues and use data to optimize all aspects of the water distribution network helping to better manage their water assets. It includes two-way real time communications with field sensors, measurement and control devices; along with software and services.

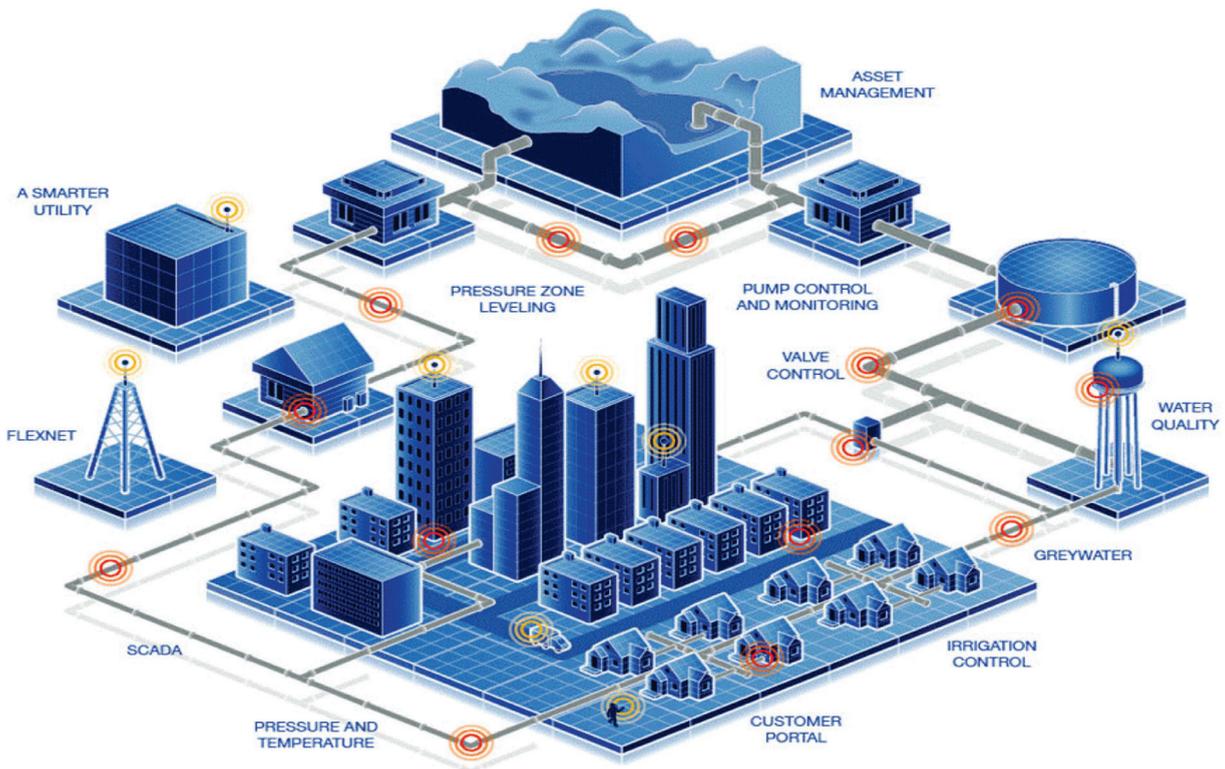
Data collection is obtained in part from integrated wireless sensing multi-probes which are deployed within the water distribution network, enabling sampling and transmittance of relevant data such as hydraulics (pressure, flow), acoustics (hydrophone) and water quality (pH, ORP and conductivity) in real-time. However pipes are buried under streets and sidewalks and are difficult and expensive to access. Further there is no inherent power supply in pipes as there is with electric utilities.

In the case of agriculture, with sensors and smart controllers, it allows to automatically conserve water by watering only when it's needed - take in many different weather variables (temperature, humidity, wind, and rainfall) and the type of plants, sprinkler heads, and soil to calculate and adjust to the appropriate run time for that day.

Following are the main entities that constitute Smart Water Management system:

1. Smart pipes - Pipeline condition assessment
2. Valve management
3. Pressure management
4. Real time risk assessment & Just in time repairs
5. Supervisory Control and Data Acquisition (SCADA)
6. Smart metering & Meter Data Management
7. Asset Management for water & Buried asset identification and electronic tagging
8. Knowledge Systems, Big data and analytics, GIS leading to water efficiency
9. Managed aquifer recharge
10. In-situ terrestrial sensing systems
11. Flood management
12. Monitoring Rain/Storm water harvesting
13. Smart irrigation systems

A typical integrated Smart Water system is depicted in the figure below:



#### IV.D.3 M2M in SMART WATER:

Smart water is achieved by different types of sensors deployed across the water distribution network and across the water cycle. Intelligent Electronic Devices, such as pressure and acoustic sensors, connected in real time to centralised monitoring systems allows detecting and pinpointing of leaks much quicker. The sensors may use cellular and short range communication technologies as mentioned in Chapter 2. The network architecture will be similar to Power communication network giving option of use of common network. There is need to implement systems like AMR/ AMI/ GIS/ SCADA similar to those in power sector to utilize full potential of M2M in Smart Water.

Smart water metering technology will enable to track usage more accurately at the consumer end and implement intelligent water pricing plans which would encourage water conservation. Different types of sensors that are used in Smart water controllers include:

1. Flow sensors
2. Pressure sensors
3. Sensors for potable water monitoring,
4. Sensors for chemical leakage detection in rivers
5. Sensors for pollution.
6. Rain sensors
7. Moisture sensors

Sensors placed throughout the water distribution network and smart meters at consumer place will help manage end-to-end distribution, from reservoirs to pumping stations to smart pipes to intelligent metering at the user site. The sensors could be remotely monitored to provide information about the state of the pipe and allow taking proactive action on problems detected on the distribution network and better control over assets. Actions can be taken remotely (e.g. Pressure regulation within a system, bypassing a section of pipe until maintenance carried out), or even self-healing triggered within a 'smart pipeline system' by the sensors themselves.

**Innovations:** New innovations in powering the sensors are being developed. An innovation in micro-generators from an Israeli start-up may be able to power remote monitoring systems with energy

generated from the water in the pipes themselves. Hydro Spin has developed a set of unique in-pipe generators that generate electricity from the flow of water inside distribution pipes. Enough power can be generated to support low-energy devices throughout the water network; such as sensors, probes and transmission devices.

#### **IV.D.4 SMART WATER Use Cases:**

**Cauvery Smart Water Project:** Nearly 40 per cent Cauvery water does not reach Bangalore’s homes, being lost as it course through a maze of old leaky pipelines, or through unauthorised connections. Now Bangalore Water Supply and Sewerage Board (BWSSB) has partnered with IBM and Indian Institute of Science to monitor how and where this precious drinking water is wasted. At 219 critical junctions in the water transmission lines, the Board has installed ultrasonic flow meters linked to an IBM-designed dashboard to capture the rate of flow.

The software converts the data into a geo-spatial visual map to help BWSSB engineers to better monitor water flow and distribution, and to even get an alert when water thresholds are not met in any area. The supply drawn from the four stages of the Cauvery water supply scheme is inadequate to meet the exponentially growing demand in Bangalore. But by incorporating a ‘smart’ network such as this, BWSSB could save both water and revenue. This software helps the Board allocate water equally per connection, curb theft and wastage, and monitor the 55 ground-level reservoirs through which water is supplied.

**Mumbai Smart Water Project:** Smart meter use in Mumbai, eliminated 50 percent of the 700 million litres a day of water that’s wasted or leaked by broken pipes. Mumbai installed the meters, which can be read remotely, to help improve supplies from a system that provides tap water to half of the city’s 13 million residents for a few hours a day and no water at all for everyone else. The target was, with the same level of resource to provide water to a larger portion of the population. Initial results show a “significant” improvement in supply and new customers though detailed analytical reports are awaited.

#### **IV.D.5 Approach Forward:**

It is necessary to adopt smart water technology solutions to streamline water operations, better manage the assets and distribution network, reduce maintenance and repair cost, reduce energy costs in pumping water, enhance customer engagement in water conservation, and most importantly reduces non reversible water losses due to leaks and theft. The broad strategy towards Smart Water deployment can be taken as follows:

1. A common GIS platform and cloud platform shall be planned and established, for use across the various smart activities, which can be used for planning, asset mapping and operational use of smart water project. A shared infrastructure can significantly reduce the requirement of CAPEX to enable smart Water.
2. Evaluate the energy footprint and communication infrastructure required for deploying the smart electronic devices.
3. Install common smart meters on shared communication infrastructure for electricity, water and gas to save costs.
4. Each area is unique, and therefore planning has to be done based on assessment of local conditions and usage pattern.
5. Adoptopen, scalable, interoperable and resilient network architecture with use of IP Technology. Adopting IPv6 will enable to use the benefits of IP in the Smart Water.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **E. HEALTHCARE**

### **IV.E.1 Importance of Healthcare:**

Healthy population of the country has a great impact on all the spheres of the nation and target achievements in all other fields are dependent to a large extent on healthy people. In order to harness demographic dividend, it is essential to reduce premature death and minimizing the effects of disease, disability and injury. This requires universal health coverage i.e. everyone, irrespective of his socio-economic condition, can use the health services they need without risk of financial ruin or impoverishment.

Country has made tremendous progress on healthcare front since independence with all health related parameters like life expectancy, infant mortality ratio, and maternal mortality ratio showing marked improvements; still we are finding it tough to achieve health related millennium development goals and are way behind developed countries. Bed availability in the hospitals in India is 1.3 beds per thousand populace against WHO standards of 3.5 beds. Availability of Doctors in India is 0.59 per thousand persons against 1.1 doctors in China, 2.15 in UK & 3.31 in USA. Overall challenges on healthcare front in the country include:

1. Availability: Quantitatively inadequate.
2. Affordability: Out of Pocket expenses, one of the highest in the world.
3. Timely delivery of quality services to Patients at the Hospitals: Qualitatively inadequate
4. Information availability to Citizens and Patients: IT Applications based interfaces to citizen
5. Data Collection & Reporting: Manual processes hinder sharing of resources & results
6. ICT related issues
  - a. Tools to Health Workers
  - b. IT Infrastructure
  - c. Interoperability issue
  - d. Data Privacy & Security

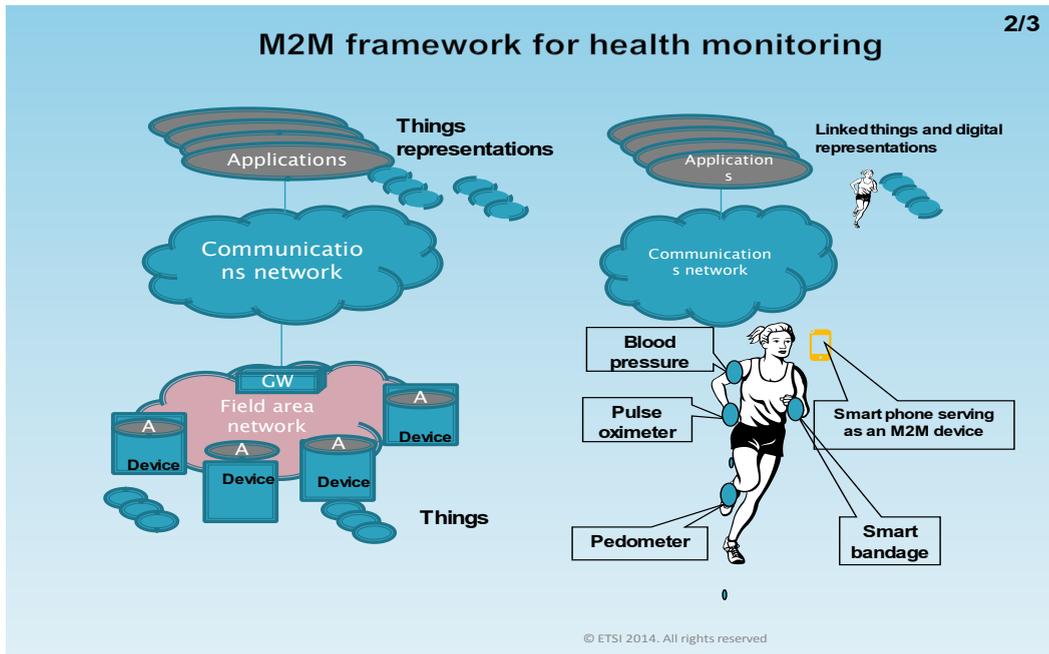
### **IV.E.2 M2M Applications in Healthcare:**

M2M in Healthcare shall enable remote capture of health diagnostics data, which may or may not require immediate intervention. Mobile devices & technologies are pervasive, ubiquitous and will play a key role in the future of healthcare. M2M uses a device (a surface or implanted sensor) to capture an event (e.g. BP Blood sugar, ECG) which is relayed through a network (wireless, wired or hybrid) to an application (software program), that translates the captured event into meaningful information through telemetry. This information can be analysed by physician and corrective measures instituted.

With good hospitals located mainly in big cities, there is acute shortage of healthcare in the rural areas. E-Health, m-health & telemedicine can help mitigate this shortage and enable the authorities achieve universal healthcare goal without establishing qualified doctors with physical healthcare infrastructure in every nook and corner. Tele medicine, e-health, m-health and wearable personal health devices along with Aadhar application for identification may help in improving the health services in the rural areas. Specialist sitting in the urban areas may monitor the vital parameters and advise the doctors/ patients in the rural areas.

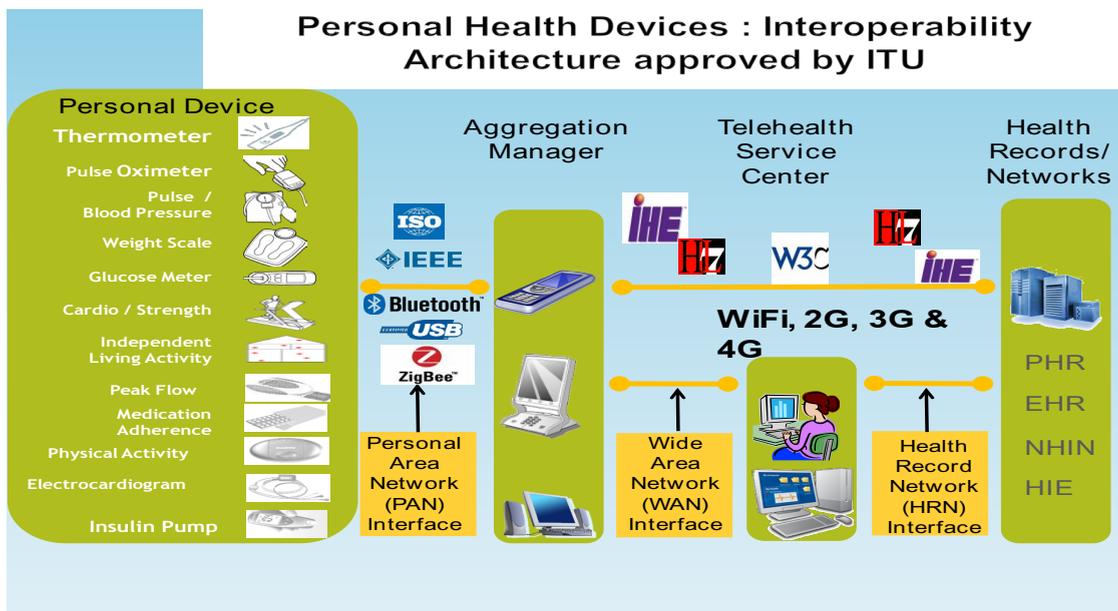
Though ICT & M2M can't be substituted for human brain, it is definitely useful as a neutral platform for unbiased analysis to assist the physician against commission of error. M2M health related applications can enable:

- e-ICU
- Remote monitoring of patients after surgery, while resting at home.
- Transmission of vital parameters of a patient from ambulance to hospital.
- Remote monitoring of old aged patients.
- Remote consultation



### IV.E.3 Possible M2M Models in Rural Health Care:

Interoperability architecture of Personal Health Devices has been approved by ITU-T study group 16 via its technical Paper “Introduction to the ITU-T H.810 Continua Design Guidelines”. IEEE 11073 protocols (Bluetooth, Wi Fi, ZigBee) in PAN/ LAN and broad band in WAN has been approved in this document. The finalized architecture by ITU can be the basis for future rural M2M deployments in the country. The deployments can leverage 100 Mbps data connectivity on OFC being provided under NOFN. A part of total bandwidth available in WAN may be apportioned for extending the health services in each village panchayat.



Rural Healthcare is largely catered through primary health centres (PHC), where rural populace visit in person to get necessary care. To supplement this, ASHA or ANM workers visit individual user’s home to help monitor health. In both situations, monitoring is done using multi-user personal health devices. ASHAs are performing tremendous job as an intermediary between government and citizens for providing basic health care facilities in rural areas. However lack of infrastructural facilities and lack of healthcare devices is an impediment for them. Past experiences of technological supplements to ASHA’s efforts have shown encouraging results i.e. M-Shakhi in Manthan Projects, MAMA (Mobile alliance for

Maternal Action). M2M enabled sensor based devices and other basic equipment with connectivity can help in filling the gaps in medical service availability to rural populace. Such devices need to cater to following aspects:

- a. Authentication of device
- b. Authentication of user
- c. Collection of data from health device to gateway device
- d. Transfer of data from gateway device to central location
- e. Data storage at central location
- f. Data visualization from remote location
- g. End to end data privacy
- h. End to end security for all data transfer

For user identification, collection or creation of an accurate user database either from Census data or data from other local authorities such as Panchayatis necessary. The data has to be uploaded to a central location, which the local gateway or device has to access and match with. Either of following two methods can be adopted for user identification:

**1. User identification built-in the device-** The device itself exchanges data with a central server and has a process to identify the user e.g. the device has a finger scanner which then connects to central server and responds with the matching user identification. In this case, the device will directly connect to the network (hence will have a SIM card) and will have an IP address.

**2. User identification through a gateway device-** Tablet or smart phone with SIM (with IP address). In this case, the tablet may have either a finger scanner for greater accuracy, or for cheap practical use, have a database of users from which the health personnel can select user identification. The minimum requirement in case of a database will be to display user's name, father's name and/or address, so that the user can be chosen uniquely. In case, Aadhaar has been implemented, that could become an identifier through local database.

Generally, the data ownership should lie with the user. However, since the rural user is not a technologically advanced user, the Ministry of Health shall support the processes and database management.

#### **IV.E.4 Approach Forward**

M2M has tremendous potential in preventive and supportive healthcare in all segments. Following approach is suggested in this regards:

1. A mechanism need to be developed for central data management for healthcare. Currently whatever digitization has happened, it is limited to boundary of a hospital.
2. Regulators working in healthcare shall bring broad outline towards IT use in healthcare so that development happening in the sector remains open and standards based with possibility of future integration of networks and evolvement of common health data.
3. For rural healthcare, Pilots can be taken in two districts to be selected on the basis of level of Health care status and technological advancements in health delivery system:
  - a. One district from states having good health indicator and high level of technological advancements in health delivery system.
  - b. Other district from relatively undeveloped state and low level of technological advancements in health delivery system.
  - c. After successful implementation in Pilot districts the proposal may be expanded further nationwide taking into account the learnings from pilot.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **F. SAFETY AND SURVEILLANCE**

### **IV.F.1 Background:**

In the current age, threats to our lives, identities, and freedom come from an increasing number of sources, from terrorists to hackers and from organized crime. As the population and GDP continue to rise through urbanization, so does the threat level, with increased populations leading to anonymity and the prevalence and clustering of high threat targets presenting anti-social groups with attractive opportunities. Safety and surveillance is a plan to enhance public security and welfare by deploying networked security systems across several entities in a society to optimize the necessary response from detection to action. The key drivers for adoption of safety and surveillance system include increase of Crime rate, Urbanization, Disaster and Terror threats and socio-economic transformation and safety of children/women.

The emergence of smart technology using M2M is driving the creation of strong safety and surveillance systems at a reasonable cost. Vast communication and sensor networks across cities enable law enforcement and other government agencies related to citizen safety to gather data; interpret it and react effectively. Greater interoperability allows technologies and networks to be linked and advanced analytics provides various agencies with the data they need to make effective decisions on time. This is driving changes to the way major cities across the world evaluate their security requirements.

Smart technology is already present through the aid of smart phones, contactless payments, nearfield communication, integration of smart cards with biometrics etc. The next stage involves the integration of smart technologies with video surveillance, biometrics, access cards etc. The M2M devices play a decisive role for collection of data and can be integrated with the cloud system for remote monitoring. Through this integration and availability of data mining & analytics techniques, law enforcement agencies will be able to identify criminals/offenders and take steps towards apprehension. The key establishments which can be monitored using M2M surveillance system are Utilities, Airports, Railways, Transport system including vehicle movement, Emergency systems, ATMs etc.

The safety and surveillance system consists of various M2M devices such as IP based Cameras, theft or burglary alarm, fire detection, alert systems coupled with other network, storage and analytics systems. An IP camera combines a camera and image processing in one unit that includes the digitization and compression of the video, as well as network connection either wired or wireless. The wireless connectivity is preferred in view of the possibility of intentional disconnection by the anti-social elements. The video is transported and recorded in the cloud systems for further analysis and monitoring. The theft or burglary alarm triggered using the sensors installed at the individual homes or the public/private establishments. The decision support system/alert system takes necessary action for deploying the emergency services based on the location details received from the alarm system for reaching to the place without losing much time.

### **IV.F.2 Ecosystem of safety and surveillance system:**

Various applications for Safety and Surveillance include Access and Mobility control, Alarm management, Home security, Vehicle security, Surveillance cameras etc. Ecosystem for the safety and surveillance systems can be explained by table below:

Regulatory			
Network and Telecom service Providers			
Technology providers	OEMs for M2M devices	Users	O&M Players
Software and Analytics	Surveillance	Government	System Integrators
Semiconductor manufacturers	Alarm	Industrial	OEMs
	Alert	Commercial	
Storage providers		Residential	

M2M Safety and Surveillance systems include everything from the most simple home monitoring systems and burglar alarms, to high-definition, motion-detecting cameras and retina scanning security solutions. Various forms of connectivity, both fixed-line and wireless enables remote monitoring. It is expected that the security and surveillance device connections growing to 170 million by 2021.

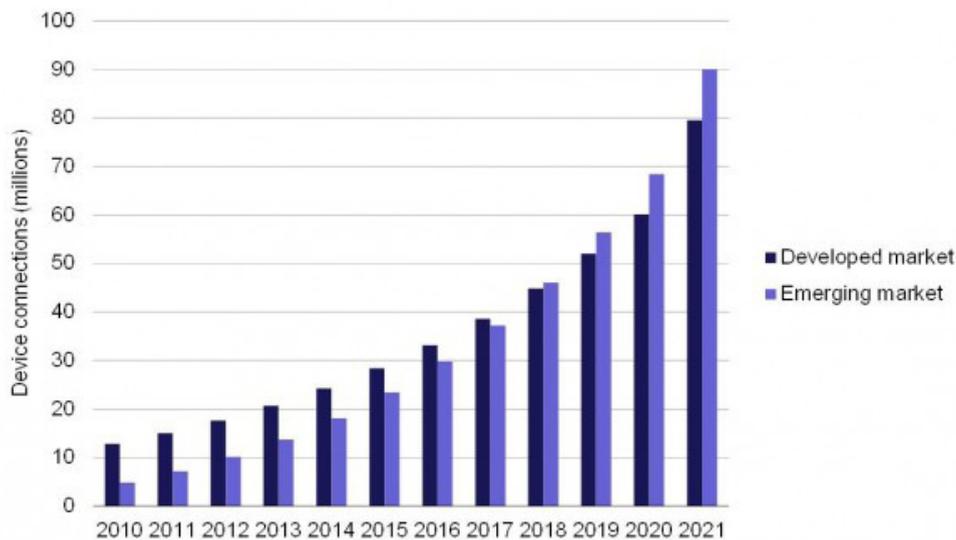


Figure: Security and surveillance IoT device connections, worldwide, 2010-2021 [Source: Analysis Mason, 2013]

A typical safety and surveillance system protects public/private places, office, homes etc. This system consists of communication network with Sensors, storage and analytics systems connected with alarm/ alert systems. Here the sensors with M2M devices will play the major role in object detection, conversion of measurement metrics and object mobility detection. These sensors can be easily mountable to any place. In a network, there can be multiple sensors capturing data. The systems may have features like detection of anomalies in surveillance site and sending of alert notifications to the security person over the network. The surveillance control unit will store the video stream and measured parameters for certain duration and check for any abnormality in the site by using measured parameters from the sensors. The control unit yields the results with any abnormality, the system would raise alert to the security supervisor person. Based on the severity of the issue, security person would send the request to the control unit to get video stream for the further duration. The security supervisor can also take real-time action against any identified wrong doing which will improve the security in public/private places. This system can be used for long distance automatic remote site monitoring since the wireless network provides longer coverage as per the 3GGP technical specification. These M2M devices can be remotely controlled for actions like closing of the entrance in the establishments, switching on/ off power in the buildings, automatic triggering of public addressing in case of emergencies etc. The important aspects on which the future security and surveillance systems will grow:

**1. IP enablement:** It is anticipated that there will be increased reliance on IP connectivity for security and surveillance solutions. This will facilitate introduction of new solutions and services including various home management solutions, video-based surveillance, facial recognition solutions and others. This will also help in simplify the integration of various solutions, simplify deployments and lower overall costs for these solutions.

**2. Integration with other home and business automation systems:** It is essential that home/ commercial security and surveillance solutions to be integrated with other systems including home energy management, security of uniquely-tagged, valuable residential and commercial assets and building automation solutions. This bundling of solutions with a common userinterface will add simplicity to the customer experience and provide a richer set of information to customers.

**3. Video:** Higher bandwidth speeds and standardized applications for things like facial recognition and sophisticated movement identification make video based surveillance solutions more common in both homes and businesses.

**4. Mobile access:** Being able to use standard mobile devices including smart phones and tablets to access security and surveillance data, whether historical records or real time activities, is something demanded by many buyers of security and surveillance solutions. The proliferation of mobile devices and active application developer communities makes offering mobile device integration much more feasible than several years ago.

#### **IV.F.3 Use Cases:**

1. With adoption of safety and surveillance system, a dramatic reduction of 12.5% and 33% in burglaries and vandalism respectively was seen in Moscow within first six months of the operation.
2. With adoption of safety and surveillance system, a 12.5% decrease in major criminal activities was seen in Mexico.
3. In Australia, several State Police Forces, and the Department of Justice use both fixed and Mbile Automatic Number Plate Recognition systems (ANPR) since 2005. In 2009 they began a roll-out of a mobile ANPR system (known officially as MANPR) with three infrared cameras fitted to its Highway Patrol fleet. The system identifies unregistered and stolen vehicles as well as disqualified or suspended drivers as well as other 'persons of interest' such as persons having outstanding warrants.
4. A pilot project of Surveillance system is being implemented by the police authorities in the City of Surat, Gujrat where data captured in real time is being analyzed using face detection technologies to identify possible movement of terrorists.

#### **IV.F.4 Approach Forward:**

Current safety and surveillance systems are not just about capturing images and videos; lot more intelligence can be built in overall systems with technologies of real time high speed data transfer, face detection, image processing etc. Accordingly from technology perspective, following approach is suggested:

1. By integrating M2M to existing security systems, alarms could be triggered automatically when potential dangers emerge and corresponding actions taken automatically to ensure safety.
2. End to end safety and surveillance systems shall be planned with use of technology like face detection, Automatic Number Plate Recognition, real time data transfer etc.
3. To have storage efficiency with high resolution video, technology support storage of selective frames at remote area, such options can be explored.
4. Technology supports capturing and storing images only when movement is predicted where by bringing economy and efficiency in overall system as per the requirements.
5. The integrated approach needs to be taken between the various stakeholders of the city management for cost savings to achieve zero time response in case of emergency with proactive approach using the M2M solutions.
6. Implementation of embedded M2M tracking device in the vehicles for monitoring the vehicular movement on highways at regular intervals.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **G. AGRICULTURE**

### **IV.G.1 Introduction:**

Though our country has taken giant strides from being a food grain deficient state in 50's & 60's to a present surplus state, agriculture sector is showing worrying signs of stagnation in recent past. Declining size of land holdings without any alternative income is resulting in fall in agriculture income causing distress among farming community. It is estimated that nearly 120.72 million hectare of land is degraded so far due to soil erosion and about 8.4 million hectare has soil salinity and water logging problems. Huge quantities of nutrients are lost during crop production cycle. About 8% of GDP is spent on fertilizer subsidies.

The agri-marketing in India is showing 18 to 25% losses in the entire supply-chain. High dependence on oil and non-renewable sources of energy are making the agriculture sector more risk prone and less profitable. The productivity in agriculture sector is very low compared to the international standards. It is observed that the annual growth rate for land productivity has risen from 2.6 % to 3.1 % and labor productivity rose from 2.2 % to 4.8 % during 1997-98 to 2012-13.

It is estimated that the demand for food grains would be 355 million tons in 2030 and to meet this demand, production of food grains needs to be increased at the rate of 5.5 million tons annually. The demand for high value commodities such as horticulture, dairy, livestock and fish is expected to increase by more than 100% and these commodities are perishable and require infrastructure for handling, value-addition, processing, storage and marketing. In such a scenario, where over dependence on traditional fertilizers are a serious drain on farm productivity, quality of produce and also exchequer, it is imperative that we look towards other alternative technological inputs to raise productivity. M2M based applications can be one of the focus areas for this.

### **IV.G.2 Possible M2M applications in Agriculture:**

M2M can bring lot of innovation and efficiency in Agriculture sector. The potential use of M2M in agriculture is summarized as under:

1. Weather stations can transmit real-time environmental data to farmers, agricultural companies and research organizations to enable accurate view of micro climates.
2. Wireless/wired soil moisture sensors can collect real time data both for outdoor and green house owners to check need of watering and to find blind zones. Smart irrigation systems by collecting the soil content and other environmental factors enabled by real time action with selective plant based watering on need.
3. Sensors may enable farmers and keepers to quickly check the health of livestock.
4. Sensors can support applications for measuring the temperature, humidity and carbon dioxide enabling effective utilization of farm implements such as tractors.
5. Precise and efficient farming by monitoring water wastage and fertilizers waste.
6. On line monitoring of insect count to help farmers for precautionary measures to protect the crop damage and also to access requirements of pesticide.
7. Ensuring the food safety and improved quality by monitoring the store conditions.
8. Online monitoring including climatic condition of trucks while transport of food grains.
9. Effective Land management to preserve the nutrients
10. Cloud based applications for sharing of information in the farming community.

#### **Expected Benefits to the farmers:**

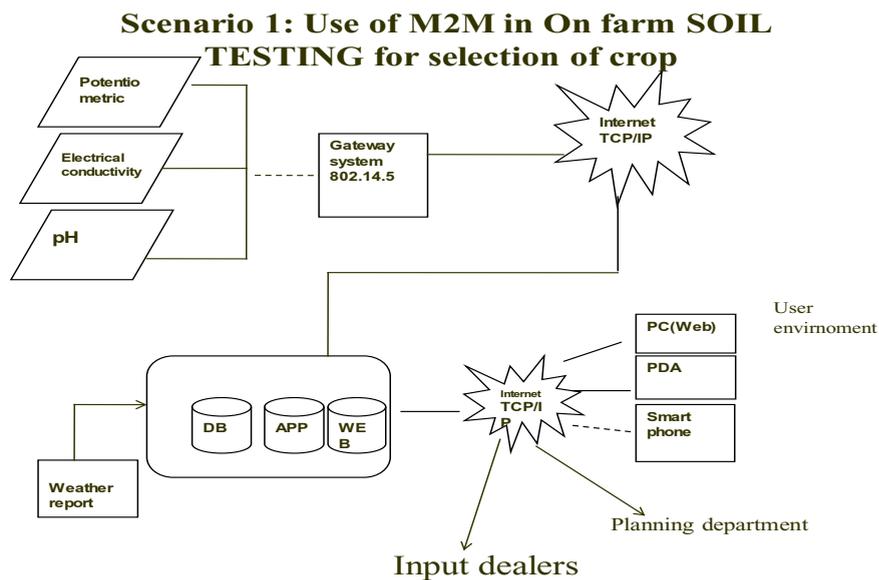
- a. Timely and accurate Guidance from qualified professionals.
- b. Customized information as per need.
- c. Increased productivity and better access to market.
- d. Better return on investment.
- e. Less manpower requirement on fields and no need for round the clock monitoring.

#### **Expected Benefits to the Policy Planners:**

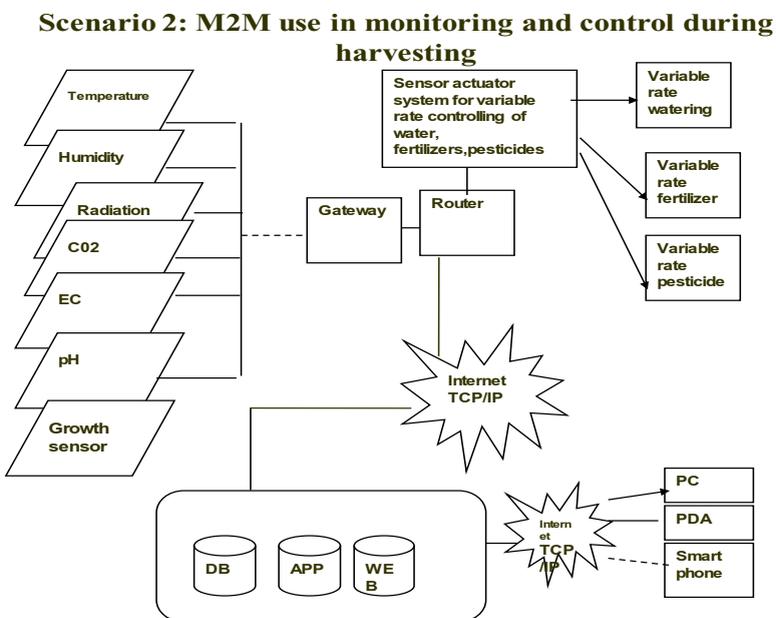
- i. Availability of country wide real time information for produce forecasting, procurement and storage planning, fertilizer requirement assessment etc.

- ii. Better Preparedness in case of agricultural calamities.
- iii. Better coordination between agricultural R & D activities and its actual users.

### IV.G.3 Possible M2M implementation approaches:



There are numerous ways to implement the use cases for M2M. Two of them are illustrated by use of figures which are self-explanatory.



### IV.G.4 Approach Forward:

Agriculture scenario being dominated by marginal farmers, Government bodies will have to take the lead in introducing M2M based applications at least in initial stages as below:

1. At the outset, representative sensors at village level may be installed to provide the agro climatic data and soil testing related information in customized format to the farmers. The kiosks using the planned NOFN connectivity may also be used for providing advisory information about the suitability of crops, micro climatic details, input factors and market information.
2. The complete information thus collected can be collated at district and state level for planning and monitoring of these pilots for further scaling up. Based on learnings from initial stages, complete solution can be implemented for big farmers on cost basis and minor and medium farmers on the basis of government assistance.

# **ANNEXURE IV: M2M Applications in Various Sectors**

## **H. SUPPLY CHAIN (PDS)**

### **IV.H.1 Background:**

The Public Distribution System (PDS) provides for management of scarcity and for distribution of food grains at affordable prices to the targeted population. Centre and States have shared responsibility in affairs of PDS with Central Government being responsible for procurement, storage, transportation and bulk allocation of food grains and states entrusted with operational responsibilities like allocation within State, identification of families below the poverty line, issue of Ration Cards. Overall responsibility to supervise PDS rests with the State Governments.

Key Challenges in PDS includes:

1. Leakages- Inclusion and exclusion errors
2. Scale and Quality of Food grain Issued to beneficiary
3. System Transparency and Accountability making monitoring extremely difficult
4. Grievance Redressal Mechanisms for beneficiary

A number of technical interventions have been made in various stages of PDS process i.e. Inventory Management, Automated allocation, Ware House Environment, Beneficiary database and authentication process, which have resulted in marked improvement in PDS management in the country. Barcoded and Smart card based ration cards linked with biometric authentication are gaining popularity. Further augmentation and scaling up those technical interventions coupled with introduction of M2M and cloud based solutions can help in achieving the goal of foolproof mechanism of subsidized food grain disbursement with minimal leakages.

### **IV.H.2 Possible M2M usages in PDS supply chain and its rationale:**

While supply chain management is a generic concept applicable in all sectors, perishability, seasonality & bulkiness are distinguishing factors in food supply chains. Food grains being essential commodity, consumed by every citizen and produced by appreciable proportion, Public policies and regulation have a significant role in influencing food supply chains. Hence M2M solutions used in food supply chain in general and PDS system in particular shall have to account all these aspects.

The states having relatively advanced IT application in their PDS infrastructure have lower extent of pilferage and are able to achieve better targeted distribution of the food grains. Various empirical studies of Planning Commission have confirmed the crucial role played by technology in reducing leakage in the system. Following approaches of M2M applications in various processes involved in PDS may be helpful in curbing the ills plaguing the system (Many of the measures have already been introduced/ are being introduced in PDS system and have been included here to present holistic picture on the role of technology):

**1. Creation & Management of Digitized Beneficiary Database:** UIDAI authentication of beneficiary is by and large universally accepted as most feasible means for removing duplication at beneficiary level. National Sample Survey Organization (NSSO) or other surveys of credible organizations can be used for identifying actual APL/BPL beneficiary. The digitized database shall contain biometrics details and photographs of all family members. Either Smart Card containing biometric and other details of beneficiary or normal ration card with UID number recorded on it may be issued to each beneficiary household.

Alternatively, ubiquitous mobile phones with dedicated IPv6 address with the beneficiary can be used to weed out duplicity. The IPv6 address along with Mobile identity numbers needs to be mapped to beneficiary in PDS database, which shall uniquely identify the beneficiary prior to his transaction for getting monthly entitlement. This will require mechanism to make the smartphone along with customized app available to the beneficiary. In all, multiple approaches and solutions suited to different regions are required.

**2. Electronic Weight Management System:** Currently the manually weighing using a beam scale at storage godowns and retail outlets are common. Ideally at godowns level small sealed and barcoded packing of requisite quantity e.g. ½ Kg, 1 Kg, 2 Kg, 5 Kg, 10 kg etc. shall be prepared. These shall be further packed to form bar coded bulk packing removing need of weighing at subsequent stages. It will also help in preserving food quality. Bar Codes can easily be read in short span at each physical location in whole supply chain so as to ensure correct amount of delivery at each level.

To cater to intermediate requirements, manual scales shall be replaced with electronic scales, as former is unreliable being dependent on human intervention and is also susceptible to manipulation. Weighing mechanism needs to be integrated with the PoS device. This will enable automatic reflection of quantity transferred from one stakeholder to another in Inventory Management System resulting in better transparency and accountability bringing possibility of mismatch to nil.

**3. GPS/ LBS based Fleet Tracking for Grain Transportation:** All trucks transporting food grain from FCI to godowns needs to be fitted with GPS+GPRS devices, which transmit their physical location information on real-time basis. Alerts should also be generated when the truck leaves the source or arrives at the destination. All trucks should be tracked online on maps. Monitoring activities may cover change of route of truck, undue long stoppage of truck on the route, change in weight of load in truck etc. Currently most of the Indian transporters are using Fleet Managements services which have such features built in and can be easily made available to government officials monitoring transportation.

**4. Radio Frequency Identification (RFID):** An RFID tag can be attached to each grain bag after proper sealing at the time of its procurement/ sourcing, which shall remain affixed to it till its delivery to the FPS shops. At the time of each entry and exit from any warehouse (FCI or of state authorities), tampering with RFID can reveal manipulation with the bag. Also data in the tag can be updated at the time of each entry or exit from warehouse regarding date and time of entry/exit. The issue of stock from warehouses can be streamlined with implementation of First-In First-Out mechanism through RFID tags attached to the grain bags so that older stocks are consumed first. Also the RFID matching device at exit & entry points of the warehouse can be connected to Integrated Weight & Inventory Management System, so that effect of entry or exit of stock from warehouse is automatically reflected in MIS and stock position.

**5. Management of Environment inside Warehouses and its Stock:** Storage of the grains sourced by FCI is handled initially in FCI warehouses. The process of making these stocks available to FPS subsequent to its allotment to the states differs from state to state. In some of the states, it is made directly available to the FPS from FCI warehouses, whereas some states store it in their warehouses prior to its delivery to Fair Price Shops. In order to check the degradation and wastage of grain stocks due to fluctuating and adverse temperature, humidity etc. inside the warehouses, a network of temperature and humidity sensors can be installed with a mechanism to monitor the parameters centrally for different warehouses. Applications can be developed to have alarms/ notifications to concerned persons in case of breach of pre-defined threshold of parameters measured by these sensors.

**6. FPS Automation:** Twin objective of beneficiary authentication and correct commodity issuance can be achieved through different mechanisms e.g.

- (a) Deployment of a Point of Sale (PoS) system equipped with a biometric reader to positively identify a beneficiary before an issue is made. The PoS system can generate a receipt and automate the bookkeeping reducing the time required for a transaction.
- (b) Mobile phone with beneficiary: Using message on mobile phone of the beneficiary may ensure uniqueness and remove duplication of beneficiaries. It can provide information to beneficiary regarding stock availability. On receipt of the acknowledgement message from a beneficiary, system can message FPS dealer regarding allotted quantity to the beneficiary. On confirmation receipt from beneficiary, inventory stock of respective FPS is automatically updated centrally.

**7. Inventory Management and MIS:** Data updated through integrated weight management system, Bar code readers and RFID updates shall allow the warehouses to decide the quantity of grains that need to be buffered for maintenance of an uninterrupted supply chain. Inventory reports can be made available on the web portal with real-time updates. The MIS data of the godowns, transporters and trucks, movement of grains, stocks, FPS and consumers shall lead to automated generation and exchange of reports related to daily activity in PDS resulting in better planning and operational handling.

**Use Case:** Supermarkets and Large retail chains have adopted most of the technology detailed above. Weighing is not done at retail outlets reducing time to sale and manpower requirement. Centrally integrated PoS provide complete information of sale and inventory. GPS enabled supply chain system provides correct information of supply in transit, indirectly helping in reducing inventory level at retail location. Also proper sealed bar coded packing ensures that quality is maintained, pilferage is minimized and rodent problem also remains under control.

### **IV.H.3 Approach forward:**

Keeping in view the magnitude of operations of PDS system many procedural change and infrastructural augmentation requires substantial investment, however overall benefits are also of the similar magnitude. Accordingly it is advisable to gauge efficacy and feasibility of different solutions through pilots in initial stages. After addressing the problems and issues faced during pilots, the finalized model can be replicated in additional areas on larger scale.

Items covered under IV.H.2 may be targeted in totality. Additional costs implicit in required process and infrastructural changes in M2M and IT applications are likely to be far outweighed by the welfare gains and savings generated out.

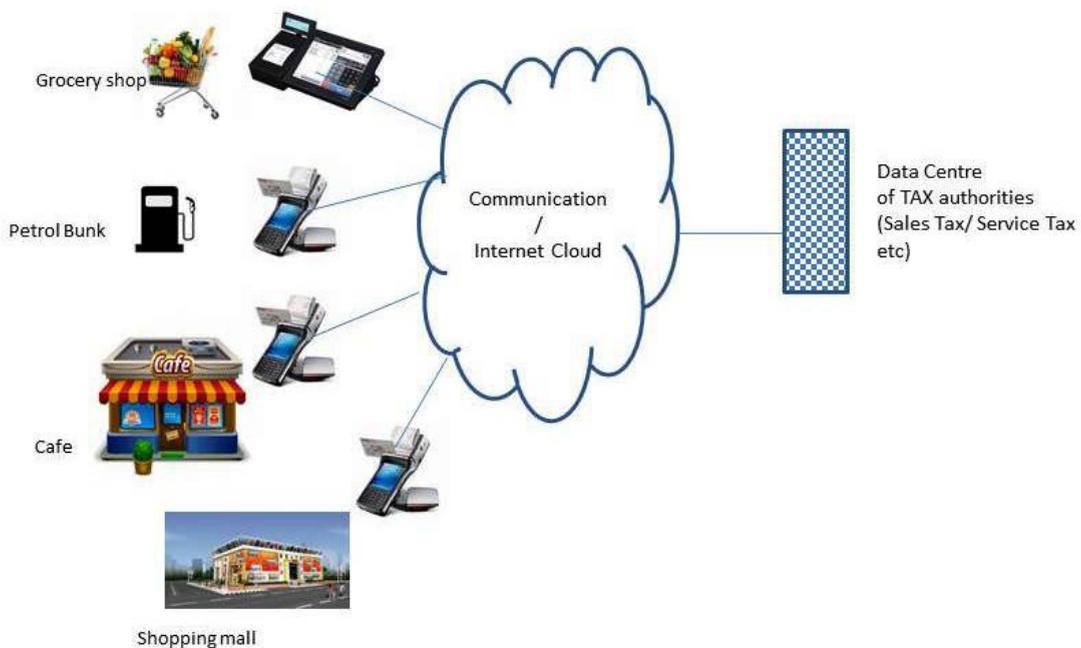
# ANNEXURE IV: M2M Applications in Various Sectors

## I. PoS-FISCAL REGISTER

### IV.I.1 M2M PoS (Point of Sale):

M2M POS applications are transforming the way merchants do business. From taxi cabs to parking slips to storefronts, more and more companies are seeing the opportunities and value of wireless M2M PoS which supports secure, real-time payments and transactions, and provide retailers with real-time visibility into their inventory. M2M PoS applications are used by citizens every day when they make payment by credit/ debit cards, or use an ATM or a ticketing machine. The retail sector increasingly uses wireless technology to enable sale transactions. Banks use M2M technology to keep track of remote wireless financial transactions at retail outlets and ATMs. M2M can also be used in vending machines to track purchases and relay information for better supply chain management. Wireless PoS solutions can also include value-added customer applications, such as self-service solutions; secure, real-time payments and transactions; and customer profiling.

An exceptional value addition to the M2M POS is the **M2M connected fiscal cash register** targeted towards small and medium merchants and retailers. It uses electronic devices for collection, control and monitoring of Governments tax revenues online. A complete sales register system includes a cash register machine i.e.a PoS, a GPRS terminal, a mobile network connection and a server at central data centre as depicted in the figure below.



**M2M based PoS – FISCAL REGISTER**

M2M enabled PoS Fiscal Cash register can be linked with the Adhaar card which in turn is being linked to bank account and PAN, sales Tax/ Service tax registration details of the shop or enterprise owner. All the sales transactions will get automatically reflected in the central servers at the data centre of the tax authorities, and the tax due to the Government will automatically get calculated and credited to the Government accounts from the bank account of the establishment.

Tax authorities get enabled to monitor and use data analytics to check whether sales are being made through PoS or not or there is any kind of possible tampering. This will ensure better compliance in tax collection, and earn more revenue for the Government.

#### **IV.I.2 Advantages of Wireless M2M PoS:**

There are many direct and indirect advantages of M2M connected fiscal cash register as listed below:

1. Ease of use –It gives more flexibility, as transactions can be conducted from anywhere.
2. Growth of business –It helps business grow due to the speed, security provided to the customers.
3. Enhance customer experience – They need not wait in line.
4. Increased profits - Increased number of customers that can be served by the existing number of sales people.
5. Increased flexibility of design of store: As wireless PoS is portable, there is no need to design stores around central cash register.
6. Online tax collection by Government – Removing requirement of filing additional tax returns and undergo calculations and verifications by third party.

#### **IV.I.3 USE CASES:**

M2M connected fiscal cash register are getting popularity in many developing countries as a tool for online monitoring of Government Taxes in retail segment reducing the possibility of revenue leakage. Currently they are widely used in many countries around the world, including Russia, Bulgaria, Serbia, Romania, Macedonia, Albania, Poland, Moldova, Bosnia and Herzegovina, Kazakhstan, Armenia, Georgia, Kenya, Tanzania and Ethiopia. It also helps owners of unattended kiosks and stores being managed by third party/ employees providing online real time details of sales and inventory. Few examples are listed as under:

1. Sweden adopted connected fiscal cash register in 2008 and brought full fledged regulation in this regard covering scope of regulations, which are covered by regulations, which are not covered by regulations, related certified control units and how supervision will be taken care by Government.
2. Fiscal cash registers are deployed in a number of Southern and Eastern European markets to counter tax avoidance. In several African countries, tax authorities are also looking to make it compulsory to deploy these services. For example, in Ethiopia the online cash register machine was introduced in 2008 to businesses that are registered as federal tax payers.
3. In Bulgaria all coffee vending machines, parking voucher payment machines, snack dispensers and even machines that dispense bouncing balls to children are required to be linked electronically to the National Revenue Agency. Bulgarian law requires sales outlets to record and report incomes to tax authorities with provision for fiscal devices to be linked to the National Revenue Agency so that daily turnover can be tracked. Government uses wireless network and SIM cards to collect data from shops, supermarkets and malls to communicate with server.

#### **IV.I.4 Approach Forward:**

Traditional retailers generally avoid different types of government taxes either due to ignorance, or difficulty in calculating the tax on each transaction and preparing of returns. Introducing compulsory PoS based fiscal registers will help the Government to increase tax collection, provide changes in taxes to be affected online as all the PoS based fiscal register gets integrated to central database of the Government.

The retailer gets advantage of increased profits due to increase in efficiencies as well as in sales as detailed on pre page. Such PoS are already in use by some retailers in India. Only missing link is connectivity to tax authorities servers as such provisions don't exist today and can be extended easily as and when required.

## GLOSSARY

2G	2 <sup>nd</sup> Generation wireless communication
3G	3 <sup>rd</sup> Generation wireless communication
3GPP	3 <sup>rd</sup> Generation Partnership Project
4G	4 <sup>th</sup> Generation wireless communication
6LoWPAN	IPv6 Low power Wireless Personal Area Network
AMFM	Automated Mapping and Facilities Management
ANEEL	Agência Nacional de EnergiaElétrica (Brazilian Electricity Regulatory Agency)
API	Application Program Interface
APL/BPL	Above/Below poverty line
APN	Access Point Name
ARAI	Automotive Research Association of India
ARIB	Association of Radio Industries and Businesses
ARPU	Average Revenue Per Unit
ASSOCHAM	Associated chamber of commerce
AT&C Losses	Aggregate Technical & Commercial losses
ATIC	Alliance for Telecommunications Industry Solutions
ATM	Automatic Teller Machine
BBNL	Bharat Broadband Network Limited
BIS	Bureau of Indian Standards
Bluetooth SIG	Bluetooth Special Interest Group
BSNL	Bharat Sanchar Nigam Limited
CAB	Conformity Assessment Bodies
CAGR	Compound Annual Growth Rate
CB	Certification Body
CCEA	Cabinet Committee on Economic Affairs
CCSA	China Communications Standards Association
CENELEC	European Committee for Electro technical Standardization
CEPT	European Conference of Postal and Telecommunications Administrations
C-GARD	Centre on Geo-Informatics Application in Rural Development
CII	Confederation of Indian Industry
Co2e	carbon dioxide equivalent
CoI	Centre of Innovation
DeitY	Department of Electronics and Information Technology
DENATRAN	Departamento Nacional de Trânsito, Brazil
DISCOM	An abbreviation for Power Distribution Company
DJSI	Dow Jones Sustainability Index
DMIC	Delhi Mumbai Industrial Corridor
DOT	Department of Telecommunications
DUT	Device Under Test
E.164	International Public Telecommunication Numbering Plan
E.212	The international identification plan for public networks and subscriptions.
eCall	Emergency Call
ECC	European Communications Committee
e-Education	Electronic Education
e-Governance	Electronic Governance

e-Health	Electronic Health
EHR	Electronic Health Record
e-ICU	Electronic Intensive Care Unit
ERC	Eastern Regional Centre
ESN	Electronic Serial Number
E-Toll	Electronic Toll
ETSI	European Telecommunications Standards Institute
EU	European Union
EUICC	Embedded Universal Integrated Circuit
FAN	Field Area Network
FAR	Field Area Router
FCC	Federal Communication Commission
FCI	Food Corporation of India
FICCI	Federation of Indian Chambers of Commerce and Industry
FPS	Fair Price Shop
GB	Giga Byte
GCF	Global Certification Forum
GDP	Gross Domestic Product
GHG	Greenhouse gasses
GIFT	Gujarat International Finance Tec-City
GIS	Geo spatial Information System/Geographic Information System
GISFI	Global ICT Standardizations Forum for India
GPRS	General Packet Radio Service
GPS	Global Positioning System
GR	Generic Requirement
GRI	Global Reporting Initiative
GSMA	Groupe Speciale Mobile Association
Gt	Giga-tonnes
HAN	Home Area Network
HRD	Human Resource Department
HVAC	Heating, Ventilation and Air Conditioning
ICAR	Indian Council of Agricultural Research
ICT	Information and Communications Technology
IEC TC	International Electro technical Commission Technical Committee
IED	Intelligent Electronic Devices
IEEE	The Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
Iisc	Indian Institute of Science
IIT	Indian Institute of Technology
IMEI	International Mobile Station Equipment Identity
IMSI	International Mobile Subscriber Identity
IoT	Internet of Things
IP	Internet Protocol
IPR	Intellectual Property Rights
IPv6	Internet Protocol Version 6
ISGF	India Smart Grid Forum
ISGTF	India Smart Grid Task Force'
ISM	Industrial, Scientific and Medical (ISM) radio bands

ISO	International Standards Organization
ISO TC	International Standards Organization Technical Committee
ISP	Internet Service Provider
IT	Information Technology
ITS	Intelligent Transport System
ITU-T	International Telecom Union-Technology/ ITU's Telecommunication Standardization Sector (ITU-T)
KB	Kilo Byte
Kbps	Kilo bits per Second
KYC	Know Your Customer
LBS	Location Based Services
LEA	Law Enforcement Agency
LLN	Low Power Lossy Networks
LoRa	Low power Radio
LPWA	Low Power Wide Area
M2M	Machine to Machine Communication
MAC	Medium Access Control
MB	Mega Byte
Mbps	Mega bits per Second
MCI	Medical council of India
mHealth	Mobile Health
MIS	Management Information System
MLIS	Multiple Independent Levels of Security and Safety
MNO	Mobile Network Operator
MOU	Memorandum of Understanding
MOU	Minutes of Use
MSISDN	Mobile Station International Subscriber Directory Number)
MSP	M2M service provider
MTC	Machine Type Communication
MVNO	Mobile Virtual Network Operator
NAN	Neighborhood Area Network
NARS	National Agricultural Research System
NCIIPC	National Critical Information Infrastructure Protection Centre
NeGP	National e-Governance Plan
NERC	North Eastern Regional Centre
NFC	Near Field Communication
NIRD	National Institute of Rural Development
NIST	National Institute of Standards and Technology
NOC	Network Operation Control
NOFN	National Optical Fiber Network
NPCBP	National PPP Capacity Building Program
NSDC	National Skill Development Council
NSSO	National Sample Survey Organization
NTIPRIT	National Telecom Institute for Policy Research, Innovation and Training
NTP	National Telecom Policy
OEM	Original Equipment Manufacturer
Ofcom	Independent regulator and competition authority for the UK communications industries.
OMA	Open Mobile Alliance

OneM2M	Global standards initiative for Machine to Machine Communications and the Internet of Things
OPEX	Operational Expenditure
OSP	Other Service Provider
OSS/BSS	Operating Support System/Business Support System
PEV	Plug-in Electric Vehicles
PGCIL	Power Grid Corporation Of India Limited a PSU under Ministry of Power
PHEV	Plug-in Hybrid Electric Vehicles
PLC	Power Line Communication
PMA	Preferential Market Access
PoC	Proof of Concept
PoS	Point of Sale
PPP	Public-Private Partnership
PSTN	Public Switched Telephone Network
PTCC	Power Telecom Coordination Committee
PTRCB	PCS Type Certification Review Board
QoS	Quality of Service
RailTEL	PSU of India Railways
RF	Radio Frequency
RFID	Radio Frequency Identification
ROLL	Routing Over Low-power and Lossy networks
RPDS	Revamped Public Distribution System
RPL	Routing Protocol for LLNs
SaaS	Software as a Service
SAR	Specific Absorption Rate
SDO	Standard Development Organization
SG	Smart Grid
SI	System Integrator
SIM	Subscriber Identity Module
SIMRAV	National electronic vehicle registration program initiated by DENATRAN (Departamento Nacional de Trânsito), Brazil
SMS	Short Messaging Service
Soft SIM	Virtual SIM
SPV	Special Purpose Vehicle
SWS	Summer-Winter Schools
TCP/IP	Transmission Control Protocol/Internet Protocol
TEC	Telecom Engineering Centre
TETRA	Terrestrial Trunked Radio
TIA	Telecommunications Industry Association
TPDS	Targeted Public Distribution System
TR-069	Technical Report 069) is a Broadband Forum (formerly known as DSL Forum)
TRAI	Telecom Regulatory Authority of India
TRANSCO	Transmission Company
TSDO	Telecom Standards Development Organization
TSDSI	Telecommunications Standards Development Society, India
TSP	Telecom Service Provider
TSSKC	Telecom Sector Skill Council
TTA	Telecommunications Technology Association
TTC	Telecommunication Technology Committee

TVWS	TV White space Spectrum
TWACS	Two way automatic communication systems
UBI	User based Insurance
UIADI	Unique Identification Authority of India
UICC	Universal Integrated Circuit Card
UNB	Ultra narrow band
USN	Ubiquitous Sensor Networks
VoIP	Voice Over IP
WAN	Wide Area Network
WHO	World Health Organization
Wi-Fi	Wireless local area network (WLAN) Wi-Fi is a trademark name
WPAN	Wireless Personal Area Network
WPC	Wireless Planning Commission
WSAN	Wireless Sensor Actuator Network
WSN	Wireless Sensor Network
WTO	World Trade Organization

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