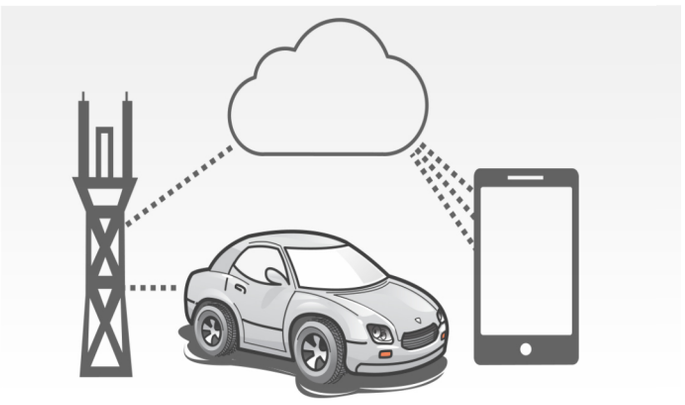
TECHNICAL REPORT

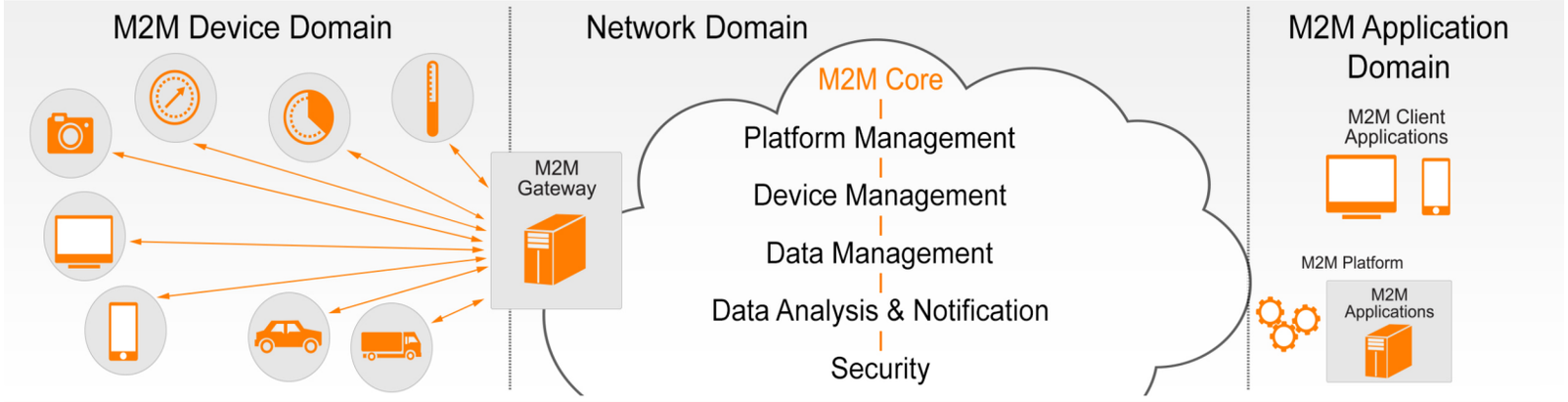
M2M GATEWAY & ARCHITECTURE

M2M NUMBER RESOURCE REQUIREMENTS & OPTIONS

TEC-TR-S&D-M2M-001-02

M2M GATEWAY & ARCHITECTURE WORKING GROUP





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TELECOMMUNICATION ENGINEERING CENTRE
DEPARTMENT OF TELECOMMUNICATIONS
MINISTRY OF COMMUNICATIONS & INFORMATION TECHNOLOGY
GOVERNMENT OF INDIA

RELEASE 2.0

NOVEMBER 2015

सत्यमेव जयते

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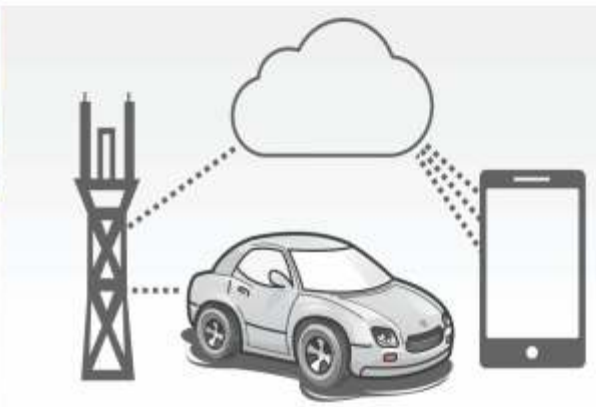

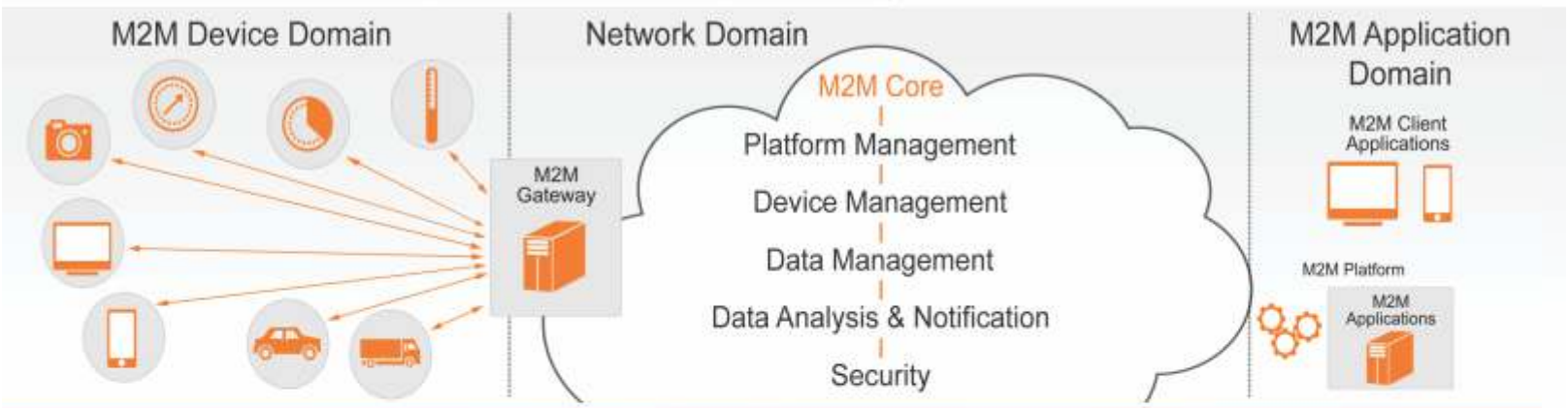

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Revision History

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20-11-2015	R2.0	TEC-TR-S&D-M2M-001-02	Technical report on M2M Number resource requirements and options

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List of Contributors

A. Joint Working Group (JWG) Chairman

Name	Designation	Organization	E-mail Address
Ajay Kumar Mittal	Sr.DDG	Telecommunications Engineering Centre (TEC)	srddg.tec@gov.in

B. Joint Working Group (JWG) Secretariat

Name	Designation	Organization	E-mail Address
Sushil Kumar	DDG(S&D)	Telecommunications Engineering Centre (TEC)	ddgsd.tec@gov.in

C. Working Group (WG) Chairs

	Name	Organization	E-mail Address
Chairman	Aurindam Bhattacharya	Centre for Development of Telematics(C-DOT)	aurindam@cdot.in
Vice Chairman	Niranth Amogh	Huawei	namogh@huawei.com
Rapporteur	Anupama Chopra	Centre for Development of Telematics(C-DOT)	anupama@cdot.in

D. Primary Authors

Name	Organisation	E-mail Address
Sushil Kumar	TEC	ddgsd.tec@gov.in
Aurindam Bhattacharya	C-DOT	aurindam@cdot.in

E. Contributors

S.No.	Name	Organization
1.	Aurindam Bhattacharya	C-DOT
2.	Anupama Chopra	C-DOT
3.	Sushil Kumar	TEC
4.	Niranth Amogh	Huawei
5.	Ashwani Kumar	Ericsson
6.	C Varaparsad	Airtel
7.	Anuj Ashokan	TTSL
8.	Hem Thukral	ISGF
9.	Aditya Jaiswal	Vodafone
10.	Narang N. Kishore	Narnix Technolabs
11.	Mukesh Dhingra	TTSL
12.	Summit Monga	RCom
13.	Rajeev Tyagi	TEC

14.	Kishore Narang	Narnix Techno Labs
15.	Naveen Kumar	TEC
16.	R R Mittar	TEC
17.	Sudeep Kumar	NTIPRIT
18.	Sunil Sharma	VIDEOCON
19.	Ranjeet Jha	Vodafone
20.	Kishore Bhagtani	BSNL
21.	Narendra K Saini	M2M / IoT Asia Pacific
22.	Rajeev Bansal	TEC
23.	Atul Kumar Chowdhary	TEC
24.	R K Soni	TEC

F. Editorial Team

S.No.	**Name**	**Organization**
1	Ajay Kumar Mittal	TEC
2	Sushil Kumar	TEC
3	Aurindam Bhattacharya	C-DOT
4	Sharad Arora	Sensorise Digital Services Pvt. Ltd.

Executive Summary

Release 1 of the TEC WG on Gateway and Architecture on M2M had introduced / suggested generalized architecture of M2M communication and various service delivery models. One of the work items identified by the WG for next release was numbering for M2M / IoT devices.

As the projections for connected devices indicate that there will be a requirement of over 10 billion numbers to uniquely identify the devices working on mobile and fixed networks.

International scenario has been studied which indicates that new number range is required to take care of the projected growth of connected devices. Some countries have already adopted increased number length.

It is noted that utilization of fixed line numbers/ levels allocated for use is only 0.91% as out of possible 2889.4 million numbers, only 26.26 million numbers are in use. Hence there is enough scope for providing numbers for devices on fixed line switching networks out of the existing numbering plan.

It is estimated that of the total connected objects, approximately 40% of these will use cellular connections. Since the number of M2M / IoT devices in the next 15-20 years using cellular connections is likely to be around 10 billion (40% of 24 billion), it is apparent that the number of digits in the numbering plan must be increased. After study of international trends and our requirements, a 13 digit number length has been suggested.

1. Introduction

1.1 Background of the work

First Technical Report on M2M Gateway & Architecture was released along with four other Technical Reports on M2M Enablement in Power Sector, Remote Health Management, Intelligent Transport System and Safety & Surveillance Systems and National Telecom M2M Roadmap by MoC&IT in May, 2015. Technical Reports are available on www.tec.gov.in/technical-reports/ and M2M Roadmap on www.dot.gov.in/ntcell.

a) The aim of the four sectoral reports was to examine the use cases in the concerned sector for M2M applications and carry out gap analysis and identify further action points.

b) One of the item of work identified in the recommendation was Numbering, Naming and Addressing.

c) For quick reference, the brief of the previous report (Rel 1) covering architecture, network technologies and applications is as given below:

The M2M ecosystem is considered to be organized in a 3-Layer model:

- Network Services Layer
- M2M Services Layer: Based on Internet Protocol (IP) and provided by the M2M Service Provider. (*The development of this layer is the key focus area towards standardization of M2M communications*)
- Application Layer: Provided by the Application Service Provider catering to End User Applications.

Based upon this, a generalized M2M network architecture model is as shown in figure–1 below. This contains devices, gateways, M2M Platform, Head end system and underlying network:

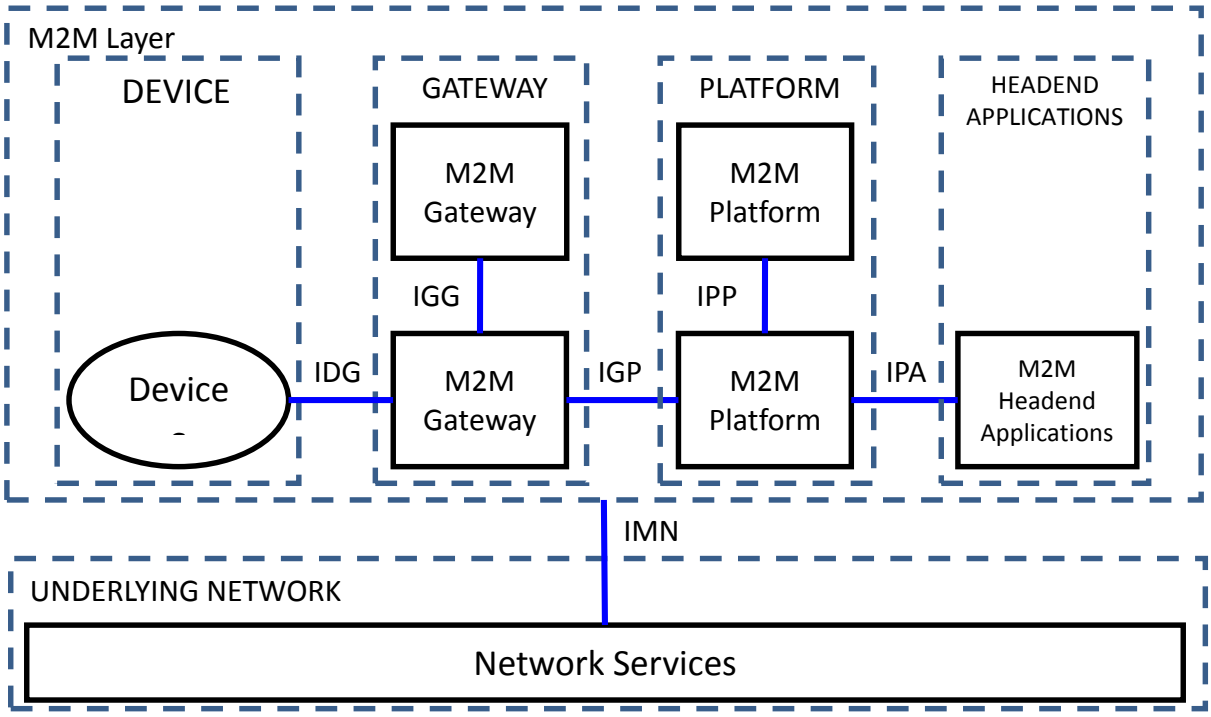

Figure – 1: General M2M Network Architecture

In the above diagram, Network Services may consist of Field Area Network for connecting the devices with the Gateway. M2M gateway may be owned by a user or provided by Telecom Service Provider (TSP). Beyond gateway, Network services are provided by TSPs. Various service delivery models have been illustrated on page no. 12 to 20 of Rel 1 on M2M Gateway & Architecture.

There can be various types of service providers in M2M implementation like Field Providers (provisioning of devices & LAN / FAN), M2M service providers (M2M SPs), Application Service providers and Network Service Providers.

Telecom Service providers (TSPs) themselves may provide End to End services or connect other service providers network (LAN / FAN etc.) at the Gateway and carry the traffic to the M2M platform, which may belong to TSPs or may be of third party.

2. Scope and Purpose

This report has been prepared by M2M Gateway & Architecture Working Group after exhaustively studying and discussing over Conference Calls and Face to Face Meetings by the Group members on various aspects of the numbering plan.

India being a large country in the context of geographical expanse as well as demography, the complexity of addressing the m2m devices is of very high degree when compared to the same issue in other countries. The use of telecom network (read mobile network) in the M2M communication and the existing numbering scheme multiplies the already complex issue by a few times. Given the fact that there are many operators in India currently providing telecom services, any change in the existing scheme without careful planning would prove to be very difficult to implement. M2M communications solutions are already in operation in India utilizing the existing national numbering Plan, a situation that has been sufficient so far. However, use of existing numbering resources would be grossly insufficient for the large number of M2M applications that are expected in the coming years.

It is therefore necessary to investigate the possibility of a more targeted long term Numbering Plan for the exclusive use of M2M applications and services. This report considers specific numbering solutions for M2M applications.

As use of IPv6 was already unanimously agreed by all as the way to go for the addressing of M2M devices beyond the Gateway, and that it was also accepted that it would take a long time to completely implement IPv6 across every network, it was kept out of scope for the current report.

Similarly Naming, though extremely important, was kept out of scope from the current report as it requires extensive and in-depth study to arrive at a comprehensive naming convention which would take care for all the devices across various verticals. It was agreed that a separate Study Item would be created to arrive at a universal naming convention.

3. M2M Networks, devices and applications

3.1 M2M Networks

M2M devices may be fixed or mobile. Some examples of the fixed M2M applications are Smart metering, City Surveillance cameras, Home automation (remote monitoring of the house and communicating with Fridge, Air conditioners etc.). Examples of mobile applications are vehicle tracking, Fitness health care devices, e-call, woman safety bands, V2V and V2I etc. These are enabled by various telecommunication technologies depending upon the applications, some of them are as given below:

a) RFID, wireless sensor networks (WSNs), Location based services (LBS).

b) Bluetooth Low Energy (BLE), NFC, WLAN (IEEE 802.11), Low power personal area network (IEEE 802.15.4) such as ZigBee, 6LoWPAN, Thread for short range communication (TAN / BAN/ FAN/ NAN/ LAN).

c) Cellular 2G/ 3G / 4G/ LTE MTC/ fixed line BB for WAN depending upon the applications.

d) LPWWAN technology such as LoRa and Sigfox.

e) PLC Narrow band in LAN/ FAN and PLC broadband for WAN.

f) IPv6 capable of providing unique IP addresses to all the devices available on earth.

3.2 Connectivity of M2M Devices

Devices may be connected directly to the M2M platform or through Gateway / aggregator, depending upon the design of the network. Fixed M2M devices may be connected through gateways having connectivity on leased lines / fixed line BB or on wireless data SIM or non SIM based. Connectivity to the gateway may be on fixed line connectivity (RS232 / PLC) or on low power personnel area network mentioned in para 3.1 above. Most of the moving M2M devices may have SIM based connectivity.

Typical connectivity of devices using variety of networks is shown in figure-2

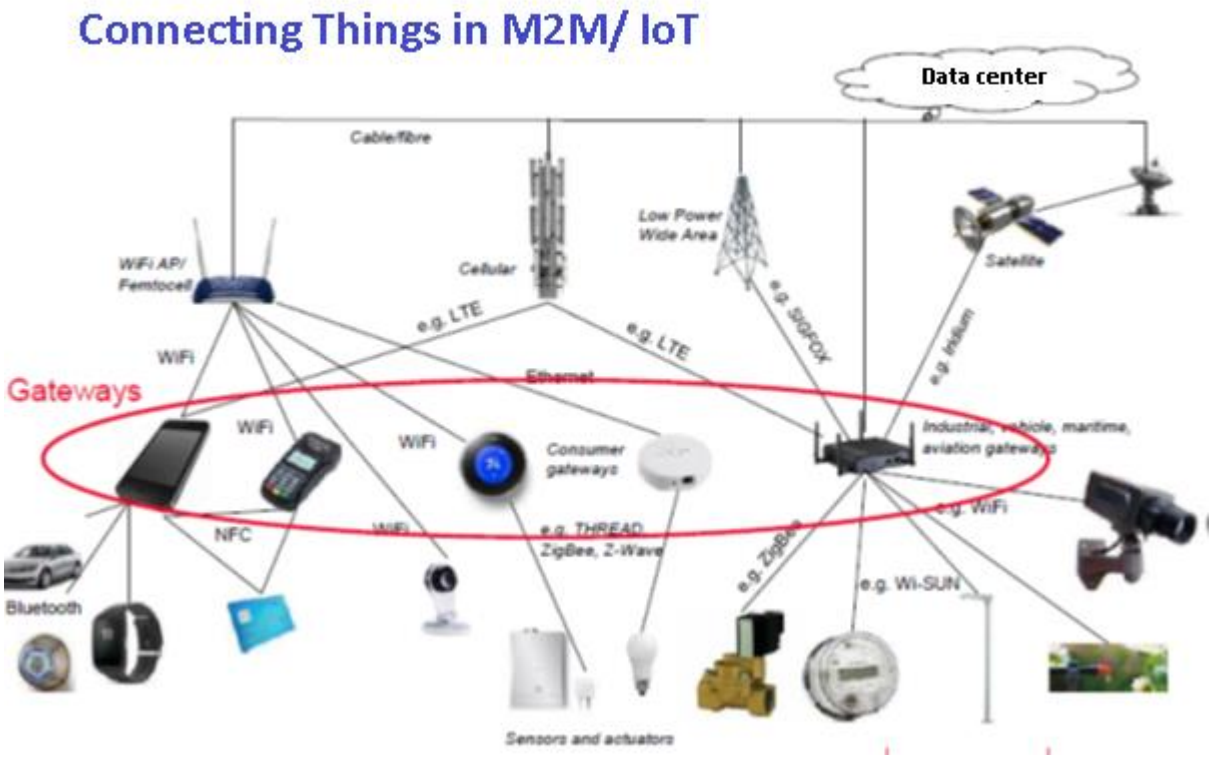

Figure - 2: (Typical M2M connectivity network)
[Source: Adopted from Keysight technologies]

3.3 M2M applications

There may be a various types of applications in different verticals. Some verticals and related M2M applications as per industry are given in table-1 below:

S. No.	Industry / Vertical	M2M applications
1.	Automotive / Transportation	Vehicle tracking, e-call, V2V and V2I applications, traffic control, Navigation, Infotainment, Fleet management, asset tracking, manufacturing and logistics
2.	Utilities / Energy	Smart metering, smart grid, Electric line monitoring, gas / oil / water pipeline monitoring.
3.	Health care	Remote monitoring of patient after surgery (e-health), remote diagnostics, medication reminders, Tele-medicine, wearable health devices
4.	Safety & Surveillance	Women Safety Bands, Commercial and home security monitoring, Surveillance applications, Fire alarm, Police / medical alert
5.	Financial /Retail	Point of sale (POS), ATM, Kiosk, Vending machines, digital signage and handheld terminals.
6.	Public Safety	Highway, bridge, traffic management, homeland security, police, fire and emergency services.
7.	Smart City	Intelligent transport System, Waste management, Street Light control system, Water distribution, Smart Parking
8.	Agriculture	Remotely controlled irrigation pump, Remote Monitoring of Soil Data

Table-1:M2M Applications

4. Connected devices projections

4.1 Types of Connectivity

For accessing the requirement of numbering resources, it is important to first analyze the device connectivity:

4.1.1 Devices / Gateways with WAN connectivity on leased lines/ Internet leased line

Such type of devices/ Gateways will have static IP addresses in IPv4 or IPv6.

4.1.2 Devices / Gateways with WAN connectivity on fixed line broadband connection (DSL)

Fixed connection being in PSTN are covered under E.164 numbering plan. However for data, static IP will be required for the DSL connection in most of the M2M applications.

4.1.3 Device / Gateway with WAN connectivity on public mobile network

Like in the case of PSTN based connectivity, E.164 numbering will need to be used for the current status of the technology. MSISDN numbers are required for authentication in mobile network. Keeping in view the fact that approx. 40% of M2M devices are expected to be connected using mobile networks, there will be a requirement of approx. 10 billion numbers in the next 12-15 years in India.

4.2 Projections

Ericsson / CISCO/ ITU have projected that there may be up to 50 billion connected smart devices globally by 2020.

4.2.1 Machina research 2012

As per study by Machina Research in 2012, presented in the paper by Ericsson, approximately 275 million connected devices were projected in India by 2020(shown in the figure-3 below):

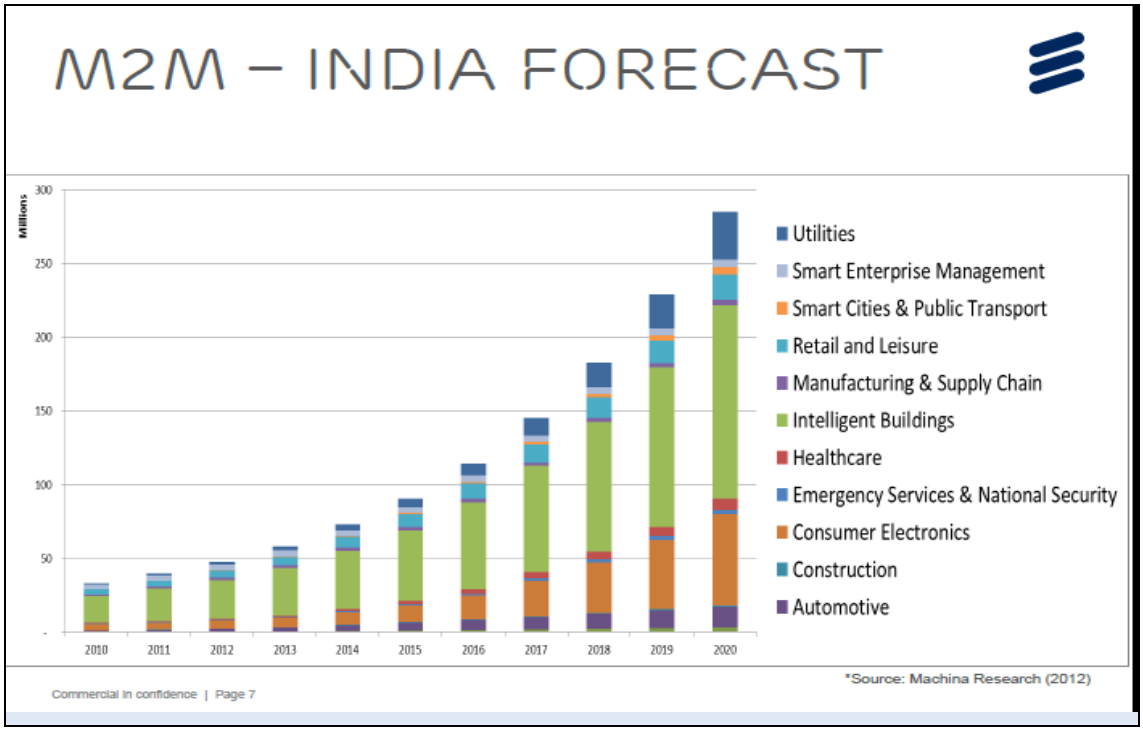

Figure – 3: M2M India forecast (Machina Research 2012)

[Source: Ericsson]

As shown in the above figure, connected devices will be in various verticals such as Automotive, Power (smart metering and smart grid), consumer electronics (Smart fridge, Smart Air conditioners etc.), Health care (Telehealth, transmission of vital parameters, e-ICU etc.), supply chain management, Intelligent buildings, Smart homes, Smart cities, Smart Enterprise management, Smart manufacturing etc.

4.2.2 CISCO IBSG Study 2011

As per CISCO IBSG report of April 2011, world with a population of around 7.6 billion in 2020 there may be 6.58 devices / person. Whereas connected devices / person was around 1.84 in 2010 and has reached 3.47 in 2015.

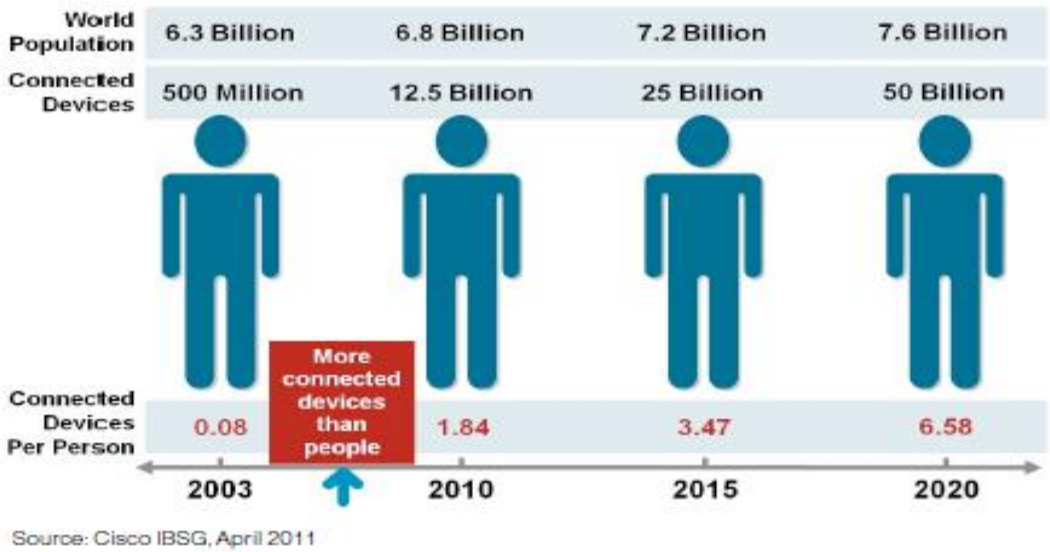

Figure – 4: Connected devices per person

4.2.3 CISCO study 2015

CISCO estimates that there will be around 50billion connected devices globally by 2020. But the share of computers (including PCs, tablets, and smart phones) will be just 17 percent of all Internet connections; the other 83 percent will result from IoT including wearable and smart home devices. [11]

4.2.4 Broadband target and growth in fixed and mobile broadband connections in India

As per NTP 2012, DoT has already set a target for 175 million broadband connections by 2017 and 600 million by 2020 with a minimum download speed of 2Mbps and making available 100Mbps on demand.

As per TRAI report of 31st August 2015, there are around 117 million broadband connection (down load speed >= 512 kbps) in India. Details have been shown in the table given below:

Segment	Broad band users (in Millions)		% growth
	As on 31st July 2015	As on 31st Aug 2015	
Wireline	15.84	16.00	1.02
Mobile device users (Smart phones / dongles)	97.04	100.88	3.96
Fixed wireless users WiFi, WiMax, VSAT etc	0.44	0.45	3.51
Total	113.32	117.34	3.55

Table -2: Broadband Users

It may be seen from the above table that the no. of Internet users in mobile segment are increasing sharply as compared to wire line / fixed wireless. This trend may further increase in view of increase in coverage of mobile networks and rollout of 4G networks and Bharatnet in the rural areas leading to achievement of NTP targets in near future.

As per the current trends broadband connections become almost double in five years. Therefore we may expect at least one billion broadband connections by 2025. Most of the connections will be on wireless media.

As per TRAI report of 31st August 2015 there were 988.69 million mobile connections. Approximately five million mobile connections are being added per month at present.

4.2.5 Ericsson Mobility report 2014

As per Ericsson mobility report, Indian mobile subscription may rise to around 1.4 billion in 2020. Smart phones subscription may rise from 130 million in 2014 to 750 million in 2020, which is around 6 times. Report has also quoted that the data traffic per month per smart phone may also rise from 1GB in 2014 to 4.5GB in 2020. It shows that more than 50% of the mobile users will be having smart phones.

Now a days Smart phones are equipped with BLE, WiFi and NFC technologies, in future smart phones may be more technically equipped, therefore smart phones may / will be used as a M2M Gateway for connecting the devices to the head end system / M2M SP. Smart phone / tablet are being used as a gateway in health services even today. If the devices are easily available, people at large may use the health monitoring devices for their wellness. Woman safety bands which are under development may also be used by women and children for personal safety. Large no. of devices will be required in various verticals of M2M domain.

4.2.6 GSMA study on IoT, 2014

GSMA study on Connected Living "Understanding Internet of Things – July 2014" forecasted that by 2020, the number of connected devices in the world will almost triple from more than 9 billion in 2014 to 25.6 billion in 2020. Of these, 10.5 billion i.e. approx. 40% of the total devices will connect using mobile technology, with a dedicated SIM and a connection to a mobile network. The remaining devices will use alternative communication technologies such as low power wireless network in LAN to a communications gateway and Low Power Wireless, fixed line DSL, Lease lines and WiFi in WAN.

4.2.7 Projections for connected devices in India

Projection mentioned in para 4.2.1 is of year 2012, seems to be quite on the lower side as the projections of the later date have shown a quantum jump.

As per para 4.2, connected devices per person will be 6.58 in 2020. Indian population is expected to be around 1.32 billion in 2020. Therefore connected devices in India may be around 8.6 billion in 2020.

Global projections by various research agencies varies from 26 billion to 50 billion by 2020. Keeping in view the population of India and the growth in telecom connectivity, it is safe to estimate that India may have around 10% share of the global connected devices. Taking the conservative figure, India may have at least 2.6 billion connected devices by 2020. Presuming a linear rise of 3 times in six years as per GSMA projections, there may be around 8 billion connected devices by 2026 and 24 billion by 2032. Rise may be on higher side in India after 2020 as the IoT ecosystem may be well placed.

Taking 40% connections on cellular technology as per GSMA projections, around 10 billion (i.e. 40% of 24 billion) numbering resources may be required in India in mobile segment by 2032. Taking 70% efficiency of utilization of the numbering resources, around 15 billion numbering resources are required to be planned as these will be distributed among TSPs across all LSAs.

5. M2M Numbering

5.1 International Scenario

As part of its deliberations, the WG studied international trends/ practices / documents as listed below.

5.1.1 Singapore

5.1.1.1 Public Consultation

There was a public Consultation on Proposed M2M Access Code Allocation Framework, by iDA Singapore. Important points on M2M Numbering, described in this paper are:

a) In developing the pilot M2M framework in 2010, IDA assessed that it would not be appropriate to open up existing telephone number levels for M2M services as these number levels are established primarily for persons-to-persons telecommunication. For instance, the NNP provided the 8-digit number levels for fixed-line telephone services (starting with prefix "6") and mobile telephone services (starting with prefixes "8" and "9"), took into consideration the total capacity to cater for the long-term growth of these services and the ease of dialing by users. Allowing M2M services to use these number levels may exhaust the numbering capacity much sooner than expected.

b) To ensure that there is sufficient numbering capacity for all M2M devices and machines in the future, and to differentiate M2M services from other services, IDA has reserved a block of 4-digit M2M Access Code (i.e. "144X") for M2M services. IDA also took the view that a maximum digit length should be adopted. Based on the International Telecommunication Union ("**ITU**") E.164 numbering format, Singapore would allow numbers of up to 13-digit length, using the designated 4-digit Access Code (excluding the country code), based on current network routing technology and arrangements.

5.1.1.2 National Numbering Plan, iDA Singapore

Important points on M2M Numbering plan in Singapore:

a) Service-based Operator (SBO) (Individual) licensees providing M2M services are eligible for '144XX' access code.

b) The M2M access code allocated may be used with international connectivity and international roaming services.

c) Licensees providing M2M services using the M2M access codes, i.e. '144XX' are encouraged to maximize the allowable numbering capacity with a 13-digit numbering format (excluding country code) for each M2M access code.

In Singapore, mobile as well as fixed line numbers are of 8 digits. Without using the existing numbering resource, they have planned a new 13 digits numbering scheme for M2M services.

5.1.2 Hong Kong

5.1.2.1 Code of Practice Relating to the Use of Numbers and Codes

Hong Kong is having 8 digit numbering scheme in fixed and mobile service, excluding country code. The code of practice relating to the use of numbers and codes in the Hong Kong Numbering Plan was revised in April 2015. Important points related to M2M numbering proposed in Hong Kong are as given below:

a) In differentiating the "4500X" M2M numbers from the ordinary subscriber numbers, following guidelines were issued to the operators while assigning "4500X" numbers:

I. The numbers should be of 12 digits in length.
II. The numbers shall not be required to support number portability.
III. No mandatory requirement of inter-network routing is imposed on the numbers. Operators may freely enter into commercial arrangements with their interconnecting partners for routing of 12-digit "4500X" M2M numbers across networks based on their own business decisions.
IV. The numbers should not be used for voice and SMS communications. In case any M2M application would require communications via SMS, operators should assign ordinary 8-digit subscriber numbers for the application.

Mobile network operators, MVNOs, fixed network operators, services-based operators in providing Class 1 or Class 2 services, and paging operators who provide M2M communications through the public telecommunications network using E.164 numbers may apply for the allocation of "4500X" M2M numbers.

5.1.3 ECC Reports

ECC has carried out comprehensive analysis of numbering requirement and various solutions which are available in its various reports which are detailed in the following sections.

5.1.3.1 Important points of ECC report 153, November, 2010

i. The number length of network external numbers should be as long as possible (max 15 digits according to ITU-T Rec. E.164).

ii. As a long term solution IPv6 addresses, or numbers/addresses other than E.164 n**u**mbers should preferably be used for device based communication applications. **T**hese numbering/addressing schemes or switching from E.164 numbering plan to a new plan should not prohibit market development or competition.

iii. T**h**ere are possible situations where a new number range should be opened. For **e**xample, the number range in question may require different regulatory treatment, e.g. relating access to emergency services, or the services to be provided have certain

characteristics (e.g. M2M applications in fixed networks) where existing mobile number ranges may not be adequate.

5.1.3.2 Options suggested by ECC

For planning MSISDN (ITU Rec E.164) numbering resources for M2M devices / Gateways, ECC documents have suggested the following four options:

***Option A**:*

Existing mobile number ranges, including possible expansion of them (E.164 numbers)

Option B:

A new number range for M2M or similar applications (E.164 numbers) (for example longer numbers than normally, however max 15 digits according to E.164)

Option C:

An international numbering solution (E.164 numbers)

Option D:

Network internal numbers

Analysis of these options are as given below:

5.1.3.2.1 *Option A: Existing mobile number ranges*

Complies with ITU-T Rec. E.164 (interconnection and international traffic is possible; max. 15 digits), In India we have 12 digits (2 digit country code, 91, ten digits for subscriber number including STD codes)

- Number portability is directly applicable (flexibility to change operator)
- May not allow separate back-office solutions for M2M applications
- A risk of exhausting the existing ranges
- Less new capacity than the network internal number option D
- In the case of non-geographic and existing PRS numbers, limitations on access from overseas;
- Inter-operator billing difficulties and a risk of incurring unnecessary expense

5.1.3.2.2 *Option B: New number range*

- Must comply with ITU-T Rec. E.164 (interconnection and international traffic is possible; max 15 digits)
- Number portability is applicable (flexibility to change operator)

- Enough capacity available if full number length is used
- A fresh start for number analysis
- Different regulatory requirements possible if needed
- May allow easier back-office solutions, such as charging and billing

5.1.3.2.3 *Option C: international number range*

- Comply with ITU-T Rec. E.164 (interconnection and international traffic is possible; max 15 digits)
- Number portability is applicable (flexibility to change operator)
- Full capacity of numbers is available
- Number range needs to be assigned by the ITU and the applicant needs to be qualified
- International number, i.e. international prefix has to be always used
- Challenges in number analysis and effective routing
- New interconnection agreements might be negotiated
- May need to be treated in the same way as other international Traffic

5.1.3.2.4 *Option D: Network internal numbers*

- Not regulated in many countries; decisions and management by operators
- Same numbers can be used in every network allowing multiplied capacity
- Allows long numbers with much capacity – even longer than 15 digits numbers are possible if technical feasible
- No need for determining number length
- Allows use of hexadecimal digits if technical feasible
- Number portability is in practice not possible
- M2M SP is locked with one operator => possible competition issues
- Difficult or impossible to evolve to 'network external' mode if required for some reason
- Didn't comply with ITU-T Rec. E.164

5.1.3.3 Significant points of ECC/REC/ (11)03, May 2011

a) The number length in the new number range(s) accommodating future mass M2M applications should be as long as possible (in case of E.164 numbers maximum of 15 digits according to ITU-T Rec. E.164).

b) The NRA should ensure that the new number range(s) are not used as an alternative to existing number ranges to escape regulatory requirements.

c) As some existing regulatory requirements (e.g. access to emergency services) may not be relevant or useful for M2M applications, exceptions regarding existing regulatory requirements could be applied to new numbering range(s) accommodating these applications.

5.1.3.4 ECC report on M2M, Brussels, November, 2013

Electronic Communications Committee (ECC) had published a report in November, 2013 in Brussels, ensuring the availability of numbering and addressing resource. The conclusions are as given below:

a) The potential number of M2M applications/connections may have a big impact on National Numbering Plans;

b) Reports helps regulators to develop efficient numbering solutions and to avoid numbering exhaustion (existing and new national numbering ranges);

c) Meet the needs of operators and M2M SP and to avoid possible lock-in of M2M users

d) The IP addresses might be a long term solution;

e) The E.164 number length for new M2M numbering range should be as long as possible (maximum of 15 digits including Country Code);

5.1.3.5 ECC recommendations (15)02, April, 2015

ECC vide their recommendations (15)02, issued guidelines for major changes to National numbering and dialing plans concerning E. 164 numbers which was approved in April, 2015. The important recommendations of this report are as given below:

Sufficient capacity is always made available for the growing demand for numbers for mobile services, and also for M2M services in accordance with **ECC/REC/(11)03 of May 5, 2011.**

5.1.4 AT&T comments on Ofcom consultation document

AT&T had commented on Ofcom consultation document, promoting investment and innovation in IoT, during October 2014. The important points related to Numbering and addressing taken from the paper are as given below:

Machines are required to be uniquely identified and addressed in order to communicate, therefore, it is likely that E.164 numbers will be necessary for a long term with the M2M / IoT devices. For many devices and applications developed today, E.164 numbers are used and will continue to be used throughout the lifecycle of the product. With many consumer and industrial products having lifetimes of 10 to 20 years, an ongoing supply of E.164 numbers will be needed. For the highly integrated nature of high-volume, low-cost, electronic modules, a

retrofit or upgrade to an alternate numbering resource would be uneconomical. For instance, after expending substantial effort and incurring considerable expense, IPv6 use has seen considerable growth over the last few years.

While the IPv6 deployment by the leading core network providers in Europe has crossed 20% for example, Deutsche Telekom AG shows 26.34% , AT&T at 23.95 %, many operators are still at an early stage of IPv6 deployment due to a variety of factors including limitations in current equipment, cost to upgrade or replace, and lack of demand. To reach a global IoT market, device manufacturers will consider the breadth of IPv6 deployment before beginning development on IPv6-only devices.

There may be a substantial overlap period where both IPv6 and E.164 numbers are in use. It is estimated that it will take 5 to 10 years for IPv6 to become widely available. If the field lifecycle of a device is 20 years, E.164 numbers could be needed for the next 30 years. However, issuance of new E.164 numbers could only begin to be phased out when IPv6 becomes widely available and then only for those devices that do not need to rely on PSTN-based addressing.

AT&T had advised Ofcom to consider the approach of several European countries (For example, Belgium, Bulgaria, Croatia, Denmark, Finland, France, Netherlands, Norway, Portugal, Spain, and Sweden), which have introduced a special range of numbers for M2M communication. These special ranges typically have number blocks which use a longer number sequence (up to the full 15 digits) in E.164 format. The length of E.164 numbers for mobile users was selected to balance the needs of the efficient use of numbering with the human factors of communicating and dialing a convenient length. To achieve that balance, in Europe (including the UK) the average length of E.164 number ranges typically does not exceed 12 digits, which includes trunk code. Machines, however, have no such need for convenience and so for M2M communications a full 15-digit number allocation, as described in ITU E.164, could be considered. [Extract from page 9].

From the above details, it can be concluded that the E.164 numbering resources (i.e. numbers in the national numbering plan) are the most viable solution for addressing M2M applications at least in the short and medium run. It is expected that most M2M applications will be based on mobile networks, and therefore within E.164 numbers the present mobile number ranges seem to be most suitable for M2M solutions. It is possible that IP-based solutions with IPv6 addressing will become more important in the long run.

5.1.5 MSISDN less Numbering plan

In 3GPP Release-12/13, M2M HLR has a feature “MSISDN-less subscription”. This feature makes it possible to define MSISDN-less M2M subscriptions in R12/13 HLR, meaning that this type of subscription may not have a valid MSISDN assigned to it. This feature may potentially reduce the pressure on MSISDN number series assigned to the PLMN operators and to some extent the risk of running into shortage of MSISDN numbers during large scale deployment of M2M services. The MSISDN sent to the network for a MSISDN-less M2M subscription is the Network Application specific dummy MSISDN stored in M2M profile.

3GPP Release 13 is yet to be finalized and majority of the networks in India have been implemented with Rel 9/10. Implementation of Release 13 may take further 8-10 years. Further there may be issues related to security with such subscription. Therefore MSISDN less M2M subscription cannot be examined at this stage.

5.2 Indian Scenario

5.2.1 Fixed line Numbering Resources for M2M Applications

In India, 10-digit numbering scheme is being used for Wireless as well as Wire line telephone connections and Level '2' to Level '7'are being used for fixed line numbers. The present distribution of different fixed line levels is as follows-

S. No.	Levels	Operator using levels	* Working Connections
1.	Level '2'	BSNL/ MTNL	19.580983 Million
2.	Level '3'	Reliance Comm.	1.177817 Million
3.	Level '4'	Bharti	3.431250 Million
4.	Level '5'	Quadrant	0.228648 Million
5.	Level '6'	Tata	1.708977 Million
6.	Level '71'	Vodafone	0.082290 Million
7.	Level '793'	Sistema	0.081240 Million
Total			26.267601 Million

*{*Figures as per TRAI Release dated 10th July 2015 indicating Telecom Subscription data as on 31st May 2015}*

Table-3: Fixed line working connections

The 10 digit fixed line numbers are inclusive of SDCA STD codes. The digit length of STD codes varies from 2 digits to 4 digits. Therefore the subscriber number length varies from 6 digits to 8 digits. The available capacity in SDCAs with different STD code number length is as follows:

S. No.	STD Code Length	Subscriber Number Length	Capacity available in each Level (e.g. Lv '2')	Number of Fixed Line Levels (Lv 2,3,4,5 6,7)	Total Capacity in all Levels
1.	2 digits	8 digits	10 Million	6	60 Million
2.	3 digits	7 digits	1 Million	6	6 Million
3.	4 digits	6 digits	0.1 Million	6	0.6 Million

Table -4: Total capacity in all Levels

As per National Numbering Plan 2003, the details of working STD codes and total fixed line numbering resource available in the country is as follow:

S. No.	STD Code Length	Number of Working STD codes	Total Capacity in each Fixed Line Levels (e.g. Lv'2')	Total Capacity in all 6 Fixed Line Levels
1.	2 digits	8	80.0 Million	480.0 Million
2.	3 digits	153	153.0 Million	918.0 Million
3.	4 digits	2484	248.4 Million	1490.4 Million
Total		2645	481.4 Million	2888.4 Million

Table -5: Total Numbering resource in fixed line

The present utilization of fixed line numbering resource by each operator in the country is as follow-

S. No.	Operator	Level	Total Numbering Resource (In Millions)	Working Connections (In Millions)	%age Utilization
1.	BSNL/ MTNL	Level '2'	481.4	19.580983	4.07%
2.	Reliance Comm.	Level '3'	481.4	1.177817	0.25%
3.	Bharti	Level '4'	481.4	3.431250	0.71%
4.	Quadrant	Level '5'	481.4	0.228648	0.05%
5.	Tata	Level '6'	481.4	1.708977	0.36%
6.	Vodafone, Sistema	Level '7'	481.4	0.16353	0.03%
Total			2888.4	26.267601	0.91%

Table -6: Total Numbering resource vs utilization in fixed line

From the above table, it is evident that in the country maximum numbers of fixed line connections are provided by BSNL/MTNL but utilization of total capacity available with BSNL/MTNL is only 4%. The utilization of total capacity available with other operators is much less than 1%. The overall capacity utilization by all operators is only 0.91%. There is negative overall growth in the fixed line connections and at present sufficient fixed line numbering resource is available with all operators which can be used for M2M numbering.

These numbers may be used for the Gateways connected on x-DSL broadband to public network. Devices behind the gateway may be on fixed line connectivity or low power wireless local area network such as 6LoWPAN, ZigBee, Thread, Bluetooth Low Energy etc.

5.2.1.1 Sparing / Allocation of numbering resource:

As around 2.5 billion numbering resource are lying spare in the levels being used in fixed line services. For M2M applications, either some level may be vacated by TSPs or every service provider may allocate specific number series out of their allocations for M2M applications, if separate KYC norms are required for M2M connections in fixed line services.

5.2.2 Details of Numbering resource for SIM based services in India

In India, 10-digit numbering scheme is being used for Wireline as well Wireless telephone connections. The present distribution of different levels for wireless connections is as follows-

S. No.	Levels	Used for Wireline/ Wireless	Operator using levels	Total Capacity	*Working Connections	Capacity Available
1.	Level '7' **	Wireless	Pvt /PSU	622.5 Million	988.69 Million	685.5 Million
2.	Level '8' **	Wireless	Pvt /PSU			
3.	Level '9'	Wireless	Pvt /PSU	1000 Million		

{*Figures as per TRAI release on Telecom Subscription data as on 31st August 2015}

{** Sublevels in working and spare STD codes in Level'7' & '8' are used for wireless services}

Table -7: Total Numbering resource vs utilization in Mobile

The entire level '9' is used for Wireless service. Additionally, the sublevel '0', '7', '8' & '9' in the working STD codes and the spare STD codes in Level '7' & '8' are also being used for Wireless service. The details of total capacity, working connections and available capacity for future growth of wireless connections are as follows-

i. Total Capacity (In Level '7', '8' & '9') = 1000+622.5 = 1622.5 Millions
ii. Effective capacity to be utilized (Assuming 70% utilization) = 1135.75 Million (70% of 1622.5)
iii. Working Wireless connections = 988.69 Million
iv. Effective Capacity available for Future Growth = 1135.75-988.69 = 147.06 Million
v. Monthly average growth of Wireless connections = 5 Million

It is clear from the above that existing number length of 10 digits cannot meet the requirement of M2M device connecting and there is need for making available additional numbering resource.

The working group noted that ECC reports provide an excellent analysis of available options as brought out in para 5.1.3. Based on the detailed study of options considered by TEC, it can be conclude that

Option (A) as detailed in para 5.1.3.2.1 is not suitable as the numbering resource are not available to cater the requirement even for the next 5-10 years.

Option (C) as detailed in para 5.1.3.2.3 would require a coordinated international approach led by the ITU and will have complex routing plan and is therefore not suitable.

Option (D) as detailed in para 5.1.3.2.4 doesn't comply the ITU E.164 therefore cannot be implemented.

Option (B) as detailed in para 5.1.3.2.2 seems to be suitable and has been recommended in a number of countries. Therefore a new number range for M2M applications with Number length as long as possible (maximum of 15 digits for E.164 numbers) will need to be planned.

While studying various scenario as described above, it is evident that the number of digits of MSISDN will be required to be extended from the existing 10 to 13 digits for the numbering scheme for M2M services. It will enable the max allowable limit of 15 digit under ITU E.164 recommendation.

5.2.2.1 First option:

After two digits of country code (CC) for India (+91), out of 13 digits, first two digits may be taken as M2M service identifier. The next three digits for identifying licensees (M2M service providers) for LSA wise license, next8 digits are available for device numbers. One block will provide 100 million numbers. There will be 1000 blocks of 100 million each.

Country code 2 digit (+91)	M2M Identifier 2 digit	Licensee Identifier 3 digit (1000 blocks)	Device Number 8 digits (100 million)

Table-8: First option of 13 digit M2M number

5.2.2.2 Second Option:

CC and the M2M identifier will be the same as in first option. But the Licensee identifier will have four digits and rest 7 digits will be for device numbering. There will be 10000 blocks of 10 million each. Therefore numbering resource will be used more efficiently.

Country code 2 digit (+91)	M2M Identifier 2 digit	Licensee Identifier 4 digit (10000 blocks)	Device Number 7 digits (10 million)

Table-9: Second option of 13 digit M2M number

5.2.3 Industry Feedback:

As the new numbering scheme needs to co-exist with the present 10 digit numbering scheme, a questionnaire was prepared and circulated to all the Telecom service Providers (TSPs)

relating to implementation experts (Airtel, BSNL, Vodafone, TTSL, MTNL, RCOM, Reliance Jio, Idea, Videocon, Aircel, SSTL/MTS, Uninor), Original Equipment manufacturers (OEMs)(Ericsson, Huawei, ALU, NSN, ZTE) and Lawful Interception vendors (ZEEL, VERINT) to access the possibilities and the impact of such possible changes.

Responses received from some TSPs, OEMs and LI vendor were discussed in detail in meeting of all stake holders in TEC. The questions and the summary of the responses is as given below:

Q1. Which elements in your network will require a change while adopting a 13-digit MSISDN number for M2M devices (in addition to 10-digit MSISDN for voice)? Please explain the type of changes.

Summary of the responses:

Co-existence of 13-digit MSISDN based M2M Services (data only, no voice, no SMS) with 10 digit numbering of existing services will require some changes in Core Network elements such as MSC, GMSC, SGSN, GGSN, HLR, IN, STP, NLD / ILD switches, apart from systems related to CRM, Billing, Mediation, Provisioning etc.

Number portability of 13 digits series:

The feasibility of 13 digit number series for MNP needs to be studied. MNP DBs need to support of 13 digits and 10 digits simultaneously. While changes in NPDB is to be studied the STP requires considerable development if 13 digit schema is to be introduced to meet 13 requirement. If 13 digit numbering for M2M is being considered then number portability of such numbers should not be made available. Since it is M2M communication, the requirement may also not be there.

Impact on Lawful interception

Lawful interception is impacted with change in numbering schema. The X1/X2 interfaces are impacted and require customization both on core nodes like GGSN, MSC s etc., along with an impact on LI systems

	Impact on Lawful Interception	Impact on Core network nodes
13 digits for voice, SMS & data	Impact is there in voice, SMS & Data	MSC, GMSC, GGSN, SGSN,MME,PGW & LI systems
13 digits for data alone	Impact is there only in data	GGSN, SGSN, MME, PGW & LI systems

Table-10: Impact on Lawful Interception

Response from LI equipment manufacture:

It has been intimated by M/s ZEEL Infotech Pvt Ltd, that their system accepts the international numbering format and there will not be any issue for accepting 91+13 digit numbers and 91+10 digit numbers.

Q2. Is/Are there any element(s) in your network for which this change is technically not feasible?

Summary of the responses:

MSISDN digit change in the network will take significant time, the STP/NPDB would have to support both 10 Digit and 13 Digit MSISDN at the same time for one customer. This function is not supported in the SSTP/AAA current version and needs to be developed.

Q3. What are the alternate solutions/ways to make it feasible?

Summary of the responses:

Some TSPs have mentioned that the unused numbers in fixed line networks need to be vacated and used for M2M services.

Q4. Please mention any other impact that you foresee as a result of these changes?

Summary of the responses:

Implementation may have impact on existing node capacities etc. and there may be some commercial involved for enhancement of network elements.

Along with the capacity concerns; Inter-working between various operators, Security, legal interception and emergency services may be impacted and shall require more deliberations.

6. Recommendations

1. **Existing fixed line numbering plan is sufficient to cater to the requirement of M2M devices. If as a policy separate KYC treatment is required for devices connected using PSTN network, TSPs will need to earmark sublevels "XX" within their allotted number resources for identification of M2M related numbers. For TSPs who are working in shared levels, may need to be allotted separate sub levels.**

2. **Existing 10 digit numbering plan for mobile networks (PLMN) will not be sufficient to cater to the requirement of SIM connected devices. A 13 digit plan will need to be implemented as indicated in para 5.2.2.1 and 5.2.2.2. TSPs will need some time to make changes in their network. Option given in para 5.2.2.2 is considered to be more efficient. In both the cases, more than one licensee identifier code can be allotted to a licensee depending upon utilization.**

3. **Any device / gateway having direct connectivity with the PSTN / PLMN, will be required to have static IP (IPv4 / IPv6) addresses in most of the cases. As the IPv4 addresses are getting exhausted, early adoption of IPv6 addressing at device, network and application level will be necessary.**

4. **For devices behind the M2M gateways, private numbering / public numbering may be used based on the government policy on security.**

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8. Terms and Abbreviations

3GPP	3rd Generation Partnership Project
6LoWPAN	IPv6 over Low power Wireless Personal Area Networks
AE	Application Entity
AHD	Application Hosting Device
ANT	Proprietary wireless technology Protocol
API	Application Programming Interface
ASP	Application Service Provider
ASN	Autonomous system number
AS Node	Application Server Node
AUE Node	Application User Equipment Node
BLE	Bluetooth Low Energy
CoAP	Constrained Application Protocol
DCU	Data Concentrator Unit
DG	Device Gateway
DOT	Department of Telecom
DSL	Digital Subscriber Line
ECC	Electronic Communications Committee
E2ESP	End to End M2M Service Provider
GPRS	General Packet Radio Service
GSM	Global System for Mobiles
FP	Field Provider
HATEOAS	Hypermedia as the Engine of Application State
HCD	High Capability Node
HIE	Health information exchange
HTTP	Hyper Text Transfer Protocol
IDG	Interaction between Device and Gateway
IETF	Internet Engineering Task Force
IGG	Interaction between two Gateways
IGP	Interaction between Gateway and Platform
IMN	Interaction between M2M layer and underlying Network
IP	Internet Protocol
ITU	International Telecommunications Union
ISM	Industrial, Scientific and Medical Band of Spectrum (like 2.4GHz, 865-868MHz)
IVR	Interactive Voice Response
LAN	Local Area Network
LPWAN	Low power wireless area network
LoRa	Long range applications
M2M	Machine-to-Machine
MN	Mobile Node
MSO	Multi Service Operator

M2M SP	M2M Service Provider
MQTT	Message Queue Telemetry Protocol
NAN	Neighborhood Area Network
NFC	Near Field Communication
NOC	Network Operation Centre
No LCD	Non-oneM2M Low Capability Device
NSE	Network Service Entity
NSP	Network Service Provider
N&SP	Network and Service Provider
NRA	National Regulatory Authority
PAN	Personal Area Network
PG	Platform Gateway
PHI	Protected Health Information
PLC	Power Line Carrier
PSP	Platform Service Provider
PRS	Premium Rate Service
QoS	Quality of Service
QOL	Quality of Life
REST	Representational State Transfer
RFID	Radio Frequency Identifier
RMD	Remote Monitoring Device
SAG	Sensor & Alarm Gateway
SMS	Short Message Service
Sub-Gig	Sub Giga Hz Radio Communication
TAN	Touch Area Network
TCP / IP	Transmission Control Protocol/ Internet Protocol
TEC	Telecom Engineering Centre
UDP	User Datagram Protocol
USB	Universal Serial Bus
WAN	Wide Area Network

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