M2M/IoT

in

Smart Cities and Industry 4.0

A Technology overview

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Government of India
A brief introduction

- TEC develops telecom product specification and interoperability (Interface) specification for seamless working of telecom networks and devices. These also cover safety and security requirement.

- TEC provides support and advice to DoT on technology, spectrum and licensing related issues and produces standards related documents.

- It strives to enhance Indian contribution in the development of international standards so that the national interests are adequately safeguarded.
Various divisions in TEC chair the National working Groups (NWGs) corresponding to the study group of ITU-T.

TEC also chair NWG-5 corresponding to study group 5 of ITU-R, which *inter-alia* deals standards for mobile radio systems.

TEC is having IPV6 Ready Logo test lab, Specific Absorption Rate (SAR) lab and Next Generation Network (NGN)/ Transport lab.

Working on Mandatory testing & certification of telecom equipment (MTCTE) to be implemented by 1st Jan 2019.

TEC also has MRA with Singapore for product certification.
Some Challenges of major Indian cities

- **Population**: Approx. 1.28 billion,
  - 32% living in urban areas.
  - 68% in rural area (in 0.65M villages or 0.25M VPs)

- **Migration from rural to urban areas?**
  - **Reasons**: In search of jobs, better education, health care etc.
  - Around 25-30 people migrate / minute to major India cities.

- **Average speed in most of the congested roads / highways – 10-15 Km/ Hr**
  - US $ 10 B worth fuel is lost due to congestion every year.

- Waste disposal
- Pollution
- Crime
- Power
- **Drinking Water shortage**: Non revenue water (NRW) in India: 40 - 65%
  - Singapore < 5%,
  - USA : 12- 15%

- Health Care
How to address these challenges efficiently:

- Needs to create **Smart Infrastructure** to manage complexities of public services, reduce expenses, increase efficiency and improve the quality of life.

- Smart Infrastructure may be in the verticals
  - Automotive sector - Intelligent Transport System
  - City Surveillance
  - Waste management
  - Water management
  - Power
  - Health

- Integrated command & Control centre, DC & DR, Platform to manage data, devices, communication network, gateways etc.

- Use M2M/ IoT and ICT to make all the verticals smart - will provide data in real time.

**Goal:** To improve the quality of life.
Products

Smarter Products

- Embedded and enhanced processing power
- Greater data capabilities
- Bi-directional communications

Isolated

Connected

- Pervasive coverage and greater bandwidth
- Multiple technologies
- Real time communications

Operational Technology

OT + IT Convergence

- Applications and data
- Integrated/advanced analytics
- Shift in traditional product design

Service Innovation

“Servitisation”

- Products designed with integrated services
- New business models

Source: Machina Research

Competitive Advantage
ITU-T in its Recommendation ITU-T Y.2060 (06/2012) has defined Internet of Things (IoT), as a 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.

ITU-T created a Study Group (SG)-20 in 2015 to study IoT and its applications in Smart cities and communities.

On the same lines, TEC created National Working Group (NWG)-20 to coordinate and submit contributions in SG-20.
M2M / IoT market: Projections

- 26 billion connected devices globally by 2020, business impact to be worth US$ 4.3 Trillion.
- $1.3 trillion revenue opportunities for mobile network operators

GSMA & Machina research

50 billion connected devices globally by 2020

CISCO / Ericson / ITU

Global projections varies from 26 billion to 50 billion

There may be around 2.6 billion connected devices by 2020 and 8 billion by 2026 and 24 billion by 2032 in India.

TEC TR

Create an ecosystem for 5Billion connected devices in India by 2022

NDCP 2018
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Industry / Vertical</th>
<th>M2M applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Smart City</td>
<td>Intelligent transport System, Waste management, Smart Street Light system, Electric vehicle charging, Water management, Smart Parking, Intelligent buildings, Safety &amp; Surveillance, Remote health management, e-ICU</td>
</tr>
</tbody>
</table>
Projections related to communication technologies

- GSMA study on IoT in 2014 – 40% of the total devices may be connected using SIM and a connection to mobile network.

- In MWC-2016, Ericsson has dropped the number of cellular connected IoT devices in 2020 from their previous estimate of (40%) 20 billion to just over (2%) 1 billion.

- In MWC – 2017, Ericsson projected 1.5 billion connected devices out of 28 billion, on cellular network by 2022.

- In India SIM based devices / Gateways may be around 15-20%.

- It shows that the low power wireless network and LPWAN will have a major share in device connectivity.
Emerging challenges in relation to IoT

Source: Harnessing the IoT for Global development, ITU, 2016
IoT Key Enabling Wireless Technologies
Heterogeneous Mix of Technologies

- Bluetooth LE
- ZigBee
- Thread (6LoWPAN)
- Z-Wave
- ANT+
- WirelessHART
- ISA100.11a (6LoWPAN)
- EnOcean
- Plus more

- 802.11a/b/g/n/ac
- 802.11af (white space)
- 802.11ah & 802.11p

- Wi-SUN (6LoWPAN)
- ZigBee-NAN (6LoWPAN)

- Cellular
  - 2G/3G/4G
  - LTE-MTC
  - 5G in the future
- Low Power Wide Area (LPWAN)
  - SIGFOX
  - LoRa
  - Telensa
  - PTC
  - Plus more

Note 1: No stringent definition of what is considered WPAN, WLAN, WWAN.
Note 2: What is shown is not a complete list of radio formats
Network QoS requirement

- Communication for M2M/IoT is different from the voice communication as size of data in M2M may vary from few bytes (meter reading) to several MBs (surveillance video in).

- Services requirement
  - Timely transmission is of utmost important.
  - Communication network is required to be more reliable with low latency.
Big data analytics

- Big data Analytics: Huge amount of data will be generated by the sensors. This raw data has got no value. Big data analytics may be used to create intelligence.
  
  Intelligence may be used for planning and operational activities.

- Edge computing, Cloud computing
- Facial recognition technologies, AI, Machine learning, deep learning based algorithms
M2M SIM

- **M2M SIM (Embedded SIM)**: The normal SIM card is not suitable for harsh conditions of vehicles like vibrations, temperature, and humidity.
  - Based on GSMA specifications.
  - 5 subscriptions, with Over-the-Air (OTA) provisioning.
  - Temperature variation range is from -40 degree to +125 degree Celsius. Embedded SIM technology offers big opportunities for auto manufacturers as the lifecycle of an eSIM is, around 10-15 years.

*Embedded SIM will be a game changer in IoT domain.*
# SIM card capabilities in different variant

<table>
<thead>
<tr>
<th>SIM Type</th>
<th>Consumer</th>
<th>Industrial</th>
<th>Automotive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-25 to +85°C</td>
<td>-40 to +105°C</td>
<td>-40 to +125°C</td>
</tr>
<tr>
<td>Data Retention</td>
<td>5 Years</td>
<td>12 Years</td>
<td>15 Years</td>
</tr>
<tr>
<td>Removable/Embedded</td>
<td>Removable</td>
<td>Removable/Embedded</td>
<td>Embedded</td>
</tr>
<tr>
<td>Owner</td>
<td>Mobile Operator (MNO)</td>
<td>MNO / OEM</td>
<td>OEM</td>
</tr>
</tbody>
</table>
eUICC and Remote subscription management

- Ecosystem to be created for remote subscription management

- Two nodes to be added to the mobile networks / M2M service providers / OEMs:
  - SM-DP (subscription management - data preparer)
  - SM-SR (subscription management - secure router)
Source: Cellular network for massive IoT, Ericsson
## Near Field Communication (NFC)

<table>
<thead>
<tr>
<th>Technology / Protocol</th>
<th>Frequency band (s)</th>
<th>Advantages</th>
<th>Limitations</th>
<th>Suitable for</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFC</td>
<td>13.56 MHz</td>
<td>• Consumes less power</td>
<td>• Extremely short range</td>
<td>• Healthcare devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Almost instantaneous connectivity between devices</td>
<td>• Expensive</td>
<td>• Fitness devices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No power is required in-case of passive Tags</td>
<td>• Low information security</td>
<td>• Smart Metering</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Low market penetration</td>
<td></td>
</tr>
</tbody>
</table>
## Bluetooth Low Energy (BLE)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Freq</th>
<th>Advantage</th>
<th>Limitations</th>
<th>Suitable for</th>
</tr>
</thead>
</table>
| Bluetooth Low Energy| 2.4 GHz | • Mature technology  
                      |                      | • Small data packets  
                      |                      | • Healthcare devices  
                      |                      | • Fitness devices  
                      |                      | • Smart Metering    
                      |                      | • Easy to implement  
                      |                      | • Longer battery life  
                      |                      | • Low Power  
                      |                      | • Powered by coin cell  
                      |                      |                      |                      |
## Wi-Fi

<table>
<thead>
<tr>
<th>Technology / Protocol</th>
<th>Frequency band (s)</th>
<th>Advantages</th>
<th>Limitations</th>
<th>Suitable for</th>
</tr>
</thead>
</table>
| Wi-Fi                 | 2.4 GHz / 5.8 GHz | • Mature technology  
• High home/office penetration  
• High data rates achievable  
• Easy to implement | • Limited range  
• Poor building penetration  
• High interference from other sources  
• Power consumption higher than those technologies that operate in the sub- GHz band | • Base station in Health Clinics  
• Smart Metering  
• Home Automation |
# Cellular Technologies

<table>
<thead>
<tr>
<th>Technology / Protocol</th>
<th>Frequency band(s)</th>
<th>Advantages</th>
<th>Limitations</th>
<th>Suitable for</th>
</tr>
</thead>
</table>
| Cellular (2G-GSM/EDGE, 3G-UMTS, 4G-LTE) | For India, 900 MHz, 1800 MHz, 2100 MHz and 2300 MHz is allocated. | • Mature technology  
• Developed by global community of 400+ companies from 39 countries  
• Rapid deployment  
• Communication modules are low cost and standardized.  
• Roaming  
• Wide availability of Network Infrastructure | • Coverage not 100%  
• Reliability not the best  
• Short technology lifecycle (2G, EDGE, 3G, LTE etc.) | • Tele-Health  
• Remote Health Monitoring  
• Smart Metering |
LPWAN Technologies

- **LPWAN (Low power wide area network) Technologies**: developed to carry a very small data to a large distance. Covers 2-3 Km in city (dense) areas and 12-15 Km in rural (open) areas. Expected battery life: around 10 years.

  **Low Power, Long range and low bandwidth**

  Requirement: Low cost and easy deployment

  **Use cases**: Smart metering, Smart farming (transmitting Soil testing data), Smart bin, transmitting pollution sensor data etc.

- **LPWAN technologies may be categorized as**: 

  **Non cellular (Non 3GPP) LPWAN technology**: Some organizations / alliances have developed **LoRa, Sigfox, Weightless, RPMA etc.**

  **Cellular (3GPP) LPWAN technologies**: Based on 3GPP Rel 13 onwards specifications, cellular networks may have **LTE MTC, NB-IoT** and **EC-GSM**
Cellular: EC GSM IoT

• Works in 2G Bands
• Advantages-
  – Network infrastructure is backwards-compatible to previous releases to allow the technology to be introduced into existing GSM networks
• Limitations-
  – Eco system is yet to be developed

• Applications-
  – Smart cities & homes
  – Smart utilities
  – Industrial automation
  – Wearables
  – Smart energy
  – Intelligent transport systems
Cellular: NB-IoT

- Works in Conventional LTE cellular bands like 700 MHz, 800 MHz and 900 MHz, and refarmed 2G bands
- Advantages-
  - Standards based defined by 3gpp, the global standardization organizations supported by a mature global ecosystem
  - Wide area ubiquitous coverage
- Limitations-
  - Limited Mobility is not yet supported (limited support based on cell reselection)
  - Voice is not supported
  - Low Data rate applications with link peak DL = 60~100kbps & UL=~50kbps
- Applications-
  - Sensor based applications, with low data rate requirement.
  - Applications not requiring high speed mobility handovers.
  - Systems where devices / sensor measurements are expected to be for long ~10 years
Cellular: eMTC

- Works in Conventional LTE cellular bands like 700 MHz, 800 MHz and 900 MHz
- Advantages-
  - Developed by 3GPP a mature global ecosystem
  - Low power consumption
  - Works over existing LTE networks
  - Easily configurable on demand scaling possible
  - Supports full mobility
  - Supports voice through VoLTE
  - high reliability and high carrier-class e2e network security (based on LTE)
- Limitations-
  - Support of higher bandwidth limits the other optimizations possible, compared to NB-IoT and EC-GSM-IoT
- Applications-
  - Wearables,
  - Asset Tracking,
  - Pet Trackers
  - Telematics,
  - KIOSK,
  - Parking,
  - Industry environment monitoring,
  - Connected Healthcare personal & Enterprise equipment
  - Industrial IoT with Emergency Voice call support
DSRC (Dedicated Short Range Communication)

- It is based on **IEEE 802.11p WLAN standards**, called as **Wireless Access in Vehicular Environment (WAVE)**.

- FCC allocated dedicated spectrum in 1999 in 5.825 – 5.925 GHz to ensure public safety operations without interference.

- Working in the frequency range 5.850 -5.925 GHz (with 75 MHz band ie 7 channel of 10MHz each and 5MHz reserved ) in USA and with 30 MHz in Europe.

- It Supports **low latency, Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I)** communication.

- Main use:
  - Vehicle Safety service,
  - Commerce transaction via cars,
  - Toll collection,
  - Traffic management.

- DSRC is in use in USA, Europe, Japan, Korea, Singapore.
Cellular V2X (C-V2X) is gaining momentum

Enhanced range and reliability for direct communication without network assistance

- **Vehicle-to-vehicle (V2V)**
  - e.g. collision avoidance safety systems

- **Vehicle-to-infrastructure (V2I)**
  - e.g. traffic signal timing/priority

- **Vehicle-to-pedestrian (V2P)**
  - e.g. safety alerts to pedestrians, bicyclists

- **Vehicle-to-network (V2N)**
  - e.g. real-time traffic / routing, cloud services

**C-V2X specification completed in March 2017**

**Broad industry support - 5GAA**

**Several global trials starting in 2017**
Continuous V2X technology evolution required

And careful spectrum planning to support this evolution

Evolution to 5G, while maintaining backward compatibility

Basic safety
802.11p or C-V2X R14

Established foundation for V2X

Advanced safety
C-V2X R16 (building upon R14)

Higher throughput
Higher reliability
Wideband ranging and positioning
Lower latency

Enhanced safety
C-V2X R14/15

Enhanced range and reliability
## Key Standards in V2X technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Region</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.11p</td>
<td>US</td>
<td>IEEE 802.11-2012, IEEE 1609.2 - .4, SAE J2735 and SAE J2945/x series</td>
</tr>
<tr>
<td>802.11p</td>
<td>Europe</td>
<td>“ITS-G5”, ETSI ITS series</td>
</tr>
<tr>
<td>802.11p</td>
<td>Japan</td>
<td>ARIB STD-109</td>
</tr>
<tr>
<td>Cellular LTE</td>
<td>Global</td>
<td>3GPP TS 22.185, TS 23.285 for V2X and LTE, and TS 36 series for radio access</td>
</tr>
<tr>
<td>Cellular 5G</td>
<td>Global</td>
<td>3GPP TS 22.186; TS 23.501 for network architecture 3GPP 38 series for the radio access</td>
</tr>
</tbody>
</table>

Source: Cellular V2X communication, 5G Americas, March 2018
Evolution in Cellular Technology

1G
- Analog
  - Voice capability, limited coverage and mobility
  - 2 kbps
  - AMPS

2G
- Digital
  - Better voice, improved coverage, text messaging
  - 64 kbps
  - GSM, CDMA

3G
- Mobile Data
  - Basic Internet, multimedia, smaller phones
  - 2 Mbps
  - HSPA, EVDO

4G
- Mobile Broadband
  - High-speed data, smartphones
  - 1 Gbps
  - LTE, LTE-A

5G
- Extreme speed, connectivity & reliability
  - A platform for future innovation
  - 10+ Gbps

Source: 5G Americas

Mobile connectivity beyond 2020: Every thing on wireless:

1. Enhanced Mobile broadband –
   - UHD video (4K, 8K) 3D video
   - Virtual Reality (VR), Augmented Reality (AR),
   - Tactile Internet, Cloud gaming, Broadband kiosks,
   - Real time simulation & training
   - Remote class room, Hologram

2. Mission critical services (Ultra reliable & low latency communication) –
   - Industrial Automation,
   - e-health, hazardous environments, rescue missions, etc.
   - Self-driving vehicles
   - Drones
   - Vehicular communication (V2V, V2I, V2P)

3. Massive Machine type communication / Massive IoT:
   - Smart home
   - Smart city
5G target performance

5G radio access will provide a total solution for wider range of requirements by 2020

- Higher data rate: 100x faster, peak data rate – 10 Gbps
- Reduced latency: RAN latency < 1ms
- Higher system capacity: 1000x per sq Km
- Massive device connectivity: 100x more connected devices
Global mobile subscriptions by technology

Source: 5G Americas, Nov 2017
Participation in standardization work

**International organizations:** TEC participates in the programmes of following standardization bodies:

- ITU
- IEEE
- OneM2M
- GSMA
- 3GPP

**Indian organizations:** collaborates with the following bodies

- BIS (Bureau of Indian Standards)
- TSDSI
ITU activities on IoT and Smart Cities

- ITU-T Study Group -20: Development & implementation of International Standards

- U4SSC: ITU, UNECE and other UN bodies created U4SSC. Released KPIs for the Smart sustainable cities to establish the criteria to evaluate the ICT’s contributions in making cities smarter and more sustainable

- ITU-T FGDPM: Research & pre standardization work on data processing & management
OneM2M

- OneM2M is a partnership project of ETSI and other SDOs.

- OneM2M was created in 2012 to specify and promote a standards for M2M/ IoT common service layer.

- Layers of OneM2M Architecture:
  - Application Layer
  - Service Layer – provides horizontal services that IoT applications across different industry segments commonly need.
  - Network layer
Important activities in ITU-T SG-20

Study Period : 2017-2020

WP1/20
Q1/20: End to end connectivity, networks, and interoperability, infrastructures and Big Data aspects related to IoT and SC&C

Q2/20: Requirements, capabilities, and use cases across verticals

Q3/20: Architectures, management, protocols and Quality of Service

Q4/20: e/Smart services, applications and supporting platforms

WP2/20
Q5/20: Research and emerging technologies, terminologies and definitions

Q6/20: Security, privacy, trust and identification

Q7/20: Evaluation and assessment of Smart Sustainable Cities and Communities
Important activities in ITU-T SG-20…

Draft recommendations consented in SG-20 meeting, Sept 2017

1. Common requirements and capabilities of a gateway for Internet of things applications.

2. High-level requirements and reference framework of smart city platform

3. Requirements for interoperability of smart city platforms

4. Requirements of transportation safety service including use cases and service scenarios

5. Requirements and capabilities of Internet of Things for support of wearable devices and related services

6. oneM2M- Functional Architecture

7. Reference architecture for IoT network capability exposure

8. Security capabilities supporting safety of the Internet of Things
Important activities in ITU-T SG-20....

17 draft recommendations consented in SG-20 meeting, Jan 2018.

Some are listed below:

- Internet of Things requirements and technical capabilities for support of accounting and charging.
- Requirements and capability framework for IoT-based automotive emergency response system.
- oneM2M Management enablement (BBF).
- oneM2M- Interoperability Testing
- Requirements and Functional Architecture for Smart Parking Lot in Smart City
- oneM2M- Testing framework
- oneM2M Base Ontology
- oneM2M- Service Layer Core Protocol Specification
Standardization activities in TEC, DoT, India

M2M / IoT domain

- 11 Multi stake holders working groups have been created in the last 2-3 years.
- Eleven Technical Reports (TRs) have been released in the last 3 years as detailed below:
  1. M2M Enablement in **Power Sector**
  2. M2M Enablement in **Intelligent Transport System**
  3. M2M Enablement in **Remote Health Management**
  4. M2M Enablement in **Safety & Surveillance System**
  5. M2M **Gateway & Architecture.**
  6. M2M Number resource requirement and options
  7. V2V / V2I Radio Communication and Embedded SIM
8. Spectrum requirements for PLC and Low Power RF Communications.
9. ICT Deployments and strategies for India’s smart cities: A curtain raiser.
10. M2M/IoT Enablement in Smart Homes.
11. Communication Technologies in M2M/IoT domain

- Technical reports (TRs) are available on www.tec.gov.in/technical-reports

- Work is in progress in Smart cities, Smart Village & Agriculture, Security and M2M Gateway & Architecture working groups (OneM2M specifications)
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);
Actionable points emerged from the Technical Reports (TRs):
Some are listed as below:

1. 13 digit M2M Numbering plan for SIM based devices/ Gateways which will co exist with existing 10 digit numbering scheme being used for mobile phones.
   - DoT has approved this scheme and issued orders to all the TSPs for implementation.
   - Five codes of 3 digit each (559, 575, 576, 579 and 597) have been allotted as a M2M identifier.

2. Embedded SIM & remote subscription management: DoT has approved the use of Embedded SIM with over the air (OTA) provisioning in India.

   Ministry of Road Transport and Highways, India has already included Embedded SIM in AIS140 standard mandated for Vehicle location tracking services (VLTS) to be implemented for consumer vehicles in first phase.
Actionable points emerged from the Technical Reports....

3. Based on TR, additional Spectrum requirement for Low power RF communications in Sub GHz band was recommended and in discussion.

4. Any device / Gateway having direct connectivity with PSTN / PLMN should have static IP (IPv6 or dual stack). **Bureau of Indian Standards (BIS) has mandated IPv6 for Smart meters to be connected on Cellular technologies, IS16444.**

5. Multi protocol gateways.

6. M2M Network architecture and various Service delivery models for providing services in M2M domain.

7. Spectrum requirement for DSRC technology.

8. Licensing for LPWAN on non cellular technologies, providing public services.

9. **Common service layer requirement at the platforms**, important for data sharing, Security and interoperability.
**Pipe (vertical)**
1 Application, 1 NW, 1 (or few) type of Device Point to point communications

**Horizontal Interoperability** (based on Common Service Layer)
Applications share common service and network infrastructure Multipoint communications

- Application
- Application
- Application

**Common Service Layer**

Things representations (including semantics)

© 2017 oneM2M
## Synopsis of delicensed spectrum in Sub GHz band

<table>
<thead>
<tr>
<th>Country / Region</th>
<th>Frequency Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America, Mexico and South America</td>
<td>433.075-434.775 MHz and 902-928 MHz</td>
</tr>
<tr>
<td>Africa and Middle-Eastern countries</td>
<td>433.05-434.79 MHz and 863-870 MHz</td>
</tr>
<tr>
<td>Europe</td>
<td>433.05-434.79 MHz, 863-870 MHz, 870 – 876 MHz, 915-921MHz</td>
</tr>
<tr>
<td>Japan</td>
<td>426-430 MHz and 920-928 MHz</td>
</tr>
<tr>
<td>Australia/New Zealand</td>
<td>915-928 MHz</td>
</tr>
<tr>
<td>India</td>
<td>433-434 MHz and 865-867 MHz</td>
</tr>
<tr>
<td>China</td>
<td>470-510 MHz and 920.5 – 924.5 MHz</td>
</tr>
<tr>
<td>Singapore</td>
<td>866 – 869 MHz and 920 – 925 MHz</td>
</tr>
<tr>
<td>Hong Kong/Thailand/Vietnam</td>
<td>920 – 925 MHz</td>
</tr>
<tr>
<td>Brazil</td>
<td>902-907.5 and 915-928</td>
</tr>
<tr>
<td>Philippines</td>
<td>915 – 918 MHz</td>
</tr>
<tr>
<td>Malaysia</td>
<td>919 – 923 MHz</td>
</tr>
</tbody>
</table>
Important contributions submitted in ITU-T SG-20

- Based on Indian contribution, template for use cases was approved in SG-20.

- Based on the Technical reports released in TEC, contributions have been submitted in ITU-T SG-20 meetings and are in the work item Y.IoT use cases:
  1. Vehicle emergency call system for automotive road safety
  2. Digitization and automation of Vehicle Tracking, Safety, Conformance, Registration and Transfer via the application of e-SIM and Digital Identity
  3. Remote monitoring the health of a patient
  4. Connected Smart homes.
  5. AMI (Advanced metering infrastructure)

- The technical report on “M2M enablement in Remote health management” has been recognized as a valuable information by e-Health expert of ITU-D Study group 2 and has been submitted as a contribution in the ITU-D meeting 7-11 September 2015, Geneva.
Testing and Certification requirements


- Regulatory and legal compliance requirements - Devices with communication facility needs testing and certification against
  - EMC (Electro magnetic compatibility),
  - Safety,
  - Technical protocols including Interoperability & Conformance testing,
  - Security
  - Others (SAR, IPv6 or RoHS)

- Testing will be done in the accredited labs in India

- In case of MRA (Mutual Recognition Arrangement) with the other countries, devices may be tested there and no need of further testing in India.

- To be implemented wef 1st Jan 2018.

- ERs framed for the smart devices.

*Test Once : Use anywhere*
Cross domain data utilization

Cross-domain Context Information Layer: numerous stakeholders

EXAMPLE:
Citizen Complaints Photo-App Application

IoT Information Systems

Applications

Context Information Management

Context Information Models

Data Publication Platforms

Public Authorities

Linked Data Experts

Smart City organisations

OpenSource developers

System Integrators

Citizens

CIM-API [JSON-LD]

Mca
M2M Identifiers can be operated on different M2M resource layers:

- Application identifiers: to identify uniquely applications and services used in the scope of IoT applications.

- Communication identifiers: to identify uniquely devices in the scope of communications with other devices, including internet-based communications.

- Device identifiers: may be used to uniquely identifying physical / virtual objects.
Naming and addressing in M2M / IoT domain….

- Identifiers: M2M service provider use for the M2M resource layers
  - Application identifiers: URI, URL
  - Communication identifiers: IPv4, IPv6, E.164
  - Device identifiers: Handle / DOI, EPC, UPC, OID, IMEI, UUID, MAC, Iccid etc.

Subject is under study in the working group and Technical Report will be released in near future.
National Telecom Policy – 2012: thrust on high quality broadband services, Cloud computing, Mobile Internet, IPv6, Machine to Machine communication and telecom equipment manufacturing.


MVNO policy released.

TRAI recommendations on Spectrum, Roaming and QoS related requirements in Machine-to-Machine (M2M) Communications accepted by DoT.

National Digital Communication Policy (NDCP) 2018 released. It will focus on strengthening telecom infrastructure, IoT, 5G, AI etc.
IoT framework for health monitoring: motivation to remain fit

Communications network

Field area network

GW

Applications

Things representations

A Device

A Device

A Device

Blood pressure

Pulse oximeter

Pedometer

Smart phone serving as an M2M device/ gateway

Linked things and digital representations

Smart bandage
Personal Health Devices: Interoperability Architecture approved by ITU

**Personal Device**
- Thermometer
- Pulse Oximeter
- Pulse / Blood Pressure
- Weight Scale
- Glucose Meter
- Cardio / Strength
- Independent Living Activity
- Peak Flow
- Medication Adherence
- Physical Activity
- Electrocardiogram
- Insulin Pump

**Aggregation Manager**

**Telehealth Service Center**

**Health Records/Networks**

- WiFi, 2G, 3G & 4G

**Interface**
- Personal Area Network (PAN)
- Wide Area Network (WAN)
- Health Record Network (HRN)
Use Cases in the Power Sector

The power sector has a number of use cases where M2M communications plays a vital part. These include (but are not limited to):

- Automatic Meter Reading (AMR)
- Advanced Metering Infrastructure (AMI)
- SCADA/EMS (Supervisory Control and Data Acquisition/Energy Management System) for TRANSCOS
- SCADA/DMS (Supervisory Control and Data Acquisition/Distribution Management System) for DISCOMS
- Substation Automation and Distribution Automation
- Distributed Generation
- Electric Vehicles Charging
- Energy Storage
- Microgrids
- Home Energy Management/Building Energy Management
- Enterprise Networks
Smart street lighting solutions are also available on other technologies such as Power line communication (PLC) / LoRa WAN.

Source: STMicroelectronics
Intelligence from the machines may be integrated with ERP, supply chain management system and even Point of sale.
Solid waste management

All the SWM field devices (GPS/RFID/Volumetric Sensors) will be connected to ICCC through the GSM network, in order to upload the SWM Data.
Primary macro nutrients
(Nitrogen (N), Phosphorus (P)
Potassium (K))

Secondary Nutrients
(Calcium (Ca), magnesium (Mg),
and sulphur (S);)

Tertiary Micro Nutrients
(copper (Cu), iron (Fe), manganese (Mn),
molybdenum (Mo), zinc (Zn), boron (B), and of
occasional significance there are silicon (Si), cobalt (Co), and vanadium (V) plus rare mineral catalysts.)

User Interface

Farmer’s name: GPS Location

Image/Video

Lux level

Colour of soil/leaf

pH

Conductivity
Type of soil

Temperature
(Ambient, inside the soil)
Emergency Response system - Process flow for 112

Source: NERS 2015
The input communication channels include:

- Fixed landline phone
- Mobile phone
- SMS
- Email
- Chat
- Panic button in public transport
- VoIP
- Mobile application
- Internet of Things (IoT)

Source: NERS 2015
JNNURM bus
M2M/ IoT applications in Automotive sector

- Vehicle tracking,
- e-call (911 in USA, 112 in Europe), For e-call 112 adopted in India
- V2X (V2V, V2I, V2N and V2P) applications
- traffic control,
- Navigation,
- Infotainment,
- Fleet management,
- asset tracking,
- manufacturing and logistics

- Waste management
- Smart parking
Connected vehicle scenario

- Vehicle tracking
- Monitoring the vehicle’s part for proper designing / running
- Applications to monitor driving patterns and fuel efficiency
- Pay-as-you-drive insurance
- Real-time localized navigation updates (for example, information about the availability of parking spaces)

As per MoRTH directive AIS 140, in the 1st phase all commercial passengers vehicles (around 8 million) should have VLTS device.
E-call call flow diagram

1. Citizen
2. Emergency Control Room
3. Operator Core network
4. GMLC
5. M2M infrastructure

Citizen
Incident Location
Nearest patrolling and Ambulance
V2V Communication scenario
Connected vehicle scenario

- Public Cloud: Subscription-based Services
- Private (OEM) Cloud: Data Center/Virtual Servers
- Enterprise Cloud: Enterprise Video, Voice, Data

VNO (Policy Enforcement, Flow-based Management, DPI)

Energy Service Providers (Smart Grid)

- Mobile WiFi Offload: Wi-Fi Hotspots, 802.11u, 3G/4G
- DSRC Roadside Infrastructure: 802.11p (V2I)
- Consumer Network: Home/Dealership Wi-Fi Hotspots, Femtocells
- Electrical Charging Network: Charging Stations, Other Services (802.11p ?)

V2I/Upstream Communication (Wi-Fi, 3G/4G, 802.11p, etc.)

V2V Communication (802.11p)

Source: CISCO
## Proposed Solution – example

<table>
<thead>
<tr>
<th>Proposed Solution</th>
<th>Implementation Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>360 degree Operation Monitoring &amp; Proactive decision making</td>
<td>ICCC - Integrated Command and Control System</td>
</tr>
</tbody>
</table>
| Safe and Secure City environment | City Surveillance Systems  
ECB - Emergency Call Boxes |
| Improved Traffic Management & Enforcement | Intelligent Traffic Management System - ITMS  
Adaptive Traffic Management System - ATMS  
ANPR & RLVD Systems, Smart Parking System |
| Citizen Interface | MERA AGRA Application  
Grievance System, Digital Signage with City Content |
| Better Quality of Life | Solid Waste Management & Environmental Sensors  
Air quality monitoring |

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**DC / DR**  
**Command and Control Center**  
**Smart Elements**
How IoT will add value?

- Surveillance will bring values to the cities as the citizens will feel safe. Real time video analytics may send alerts on the smart phones of police in that area.

- Wearable health devices may help in monitoring the health parameters especially in rural areas for remote monitoring and advising, help in reducing burden on hospitals.
  - Digital health is the part of health policy released in 2017 in India.
  - NoFN BW shall be used for extending health services in the rural areas.

- Save electricity by using smart lighting system in cities and homes.
  - Smart street lighting system are being implemented in a no. of cities.
  - Smart metering projects are in progress.

- Share data across verticals to create value.

  All these actions will improve the quality of life.
Global survey: Some Smart Cities

- Barcelona scored high on the environment and smart parking.
- New York City scored high on smart street lighting and smart traffic management.
- Singapore scored high on smart traffic management and creative use of technology.
- London scored high on technology and open data.
IoT as a Disruptive Technology is leading the next wave of Transformational Change
THANKS

(For detail, see the TR available on www.tec.gov.in/technical-reports/)

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