M2M / Internet of Things (IoT)

Enablement in

Smart Cities

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Telecommunication Engineering Centre

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.

Telecommunication Engineering Centre

➢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.

➢TEC also has MRA with Singapore for product certification
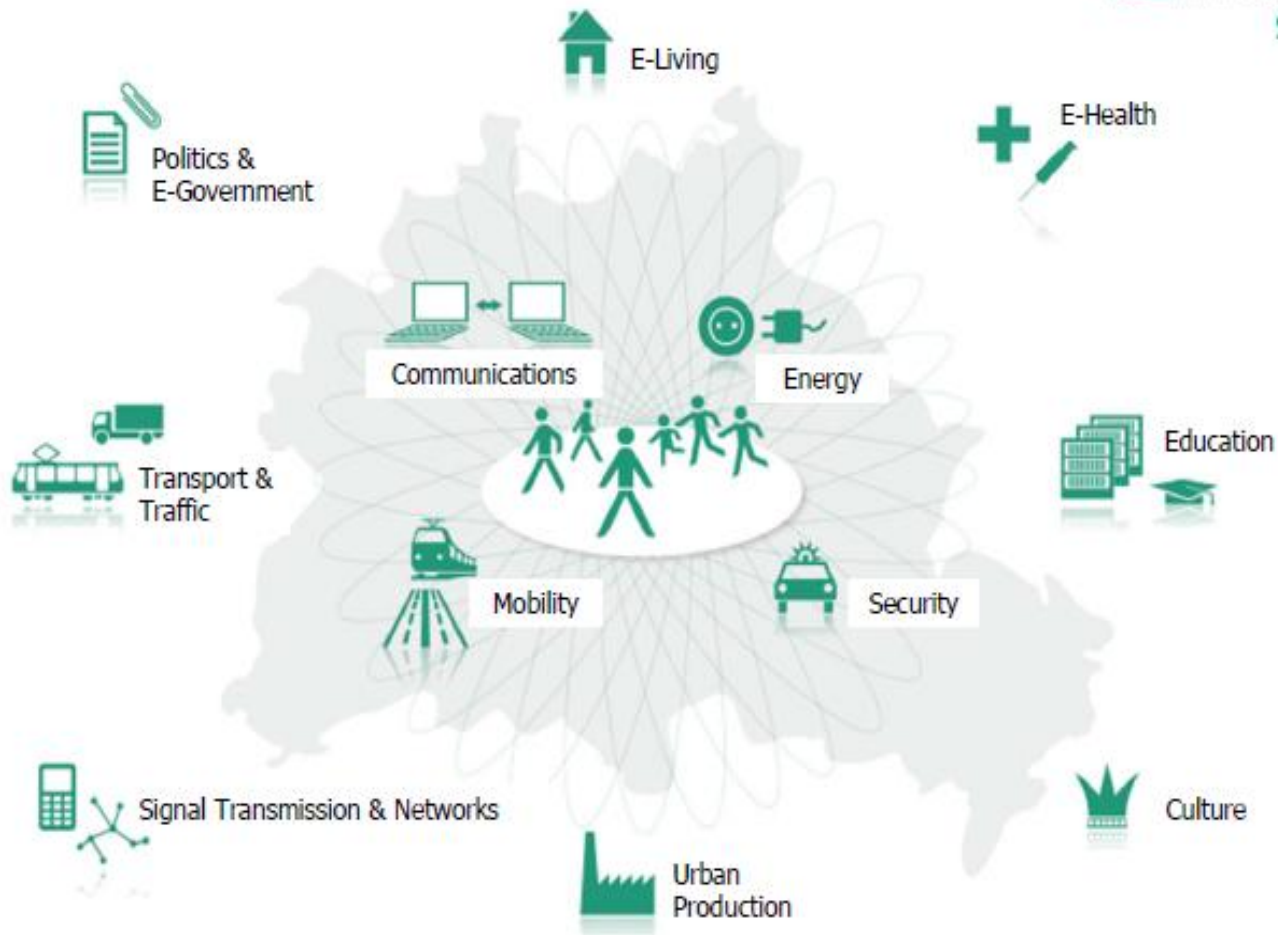
Challenges in India

➢ **Population :** Approx. 1.25 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.

It is also estimated that by the year 2050, the number of people living in Indian cities may touch around 843 million.

➢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.

➢Power

➢Waste disposal

➢Safety & Surveillance

➢Drinking Water shortage : Non revenue water in India > 65%

Singapore < 5%,

USA : 12- 15%

- Health Care : As per estimation, shortage of 600k doctors and 1M Nurses.

  Good hospitals are limited to metros and big cities only.

  Bed availability in the hospital : In India   :1.3 beds / 1000 population
  WHO standards   : 3.5 beds / 1000 population

  Doctors in India : 0.59 / 1000 population
  China : 1.1 /1000,   UK   : 2.15 / 1000,   USA : 3.31 / 1000

- Non-communicable diseases (NCD) such as **hypertension, diabetes and cardiovascular diseases** affect more than 100 million people in India today.

- Most of these diseases cannot be addressed by any quick measures, but require **regular monitoring and lifestyle management**.

- The aging population increases the need for chronic disease management, and that means cost pressures will grow in healthcare in the years ahead.

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.

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

➢ Big data analytics to create intelligence.

➢ Use intelligence for planning and operational activities.

Goal : To improve the quality of life.

What is M2M?

A Conceptual Picture

A "**DEVICE**", sensor, meter, etc., captures "something", e.g., location, level, heat, motion, vital sign, usage, etc.

that is transported through a "**NETWORK**" (wireless, wired or mixed)

to an "**APPLICATION**", **which makes sense of the captured data, e.g., stolen vehicle is located, etc.**

M2M Vs IoT

➢ Energy efficiency and wireless connectivity are the key for M2M / IoT.

➢ M2M Communication is a subset of IoT.   IoT comprises M2M and H2M (Human to Machine) communication.

➢ In practice the IoT will consist of hybrid infrastructure of non IP and IP connected devices through IP connected gateways.

M2M / IoT market: Global projections

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

GSMA & Machina research

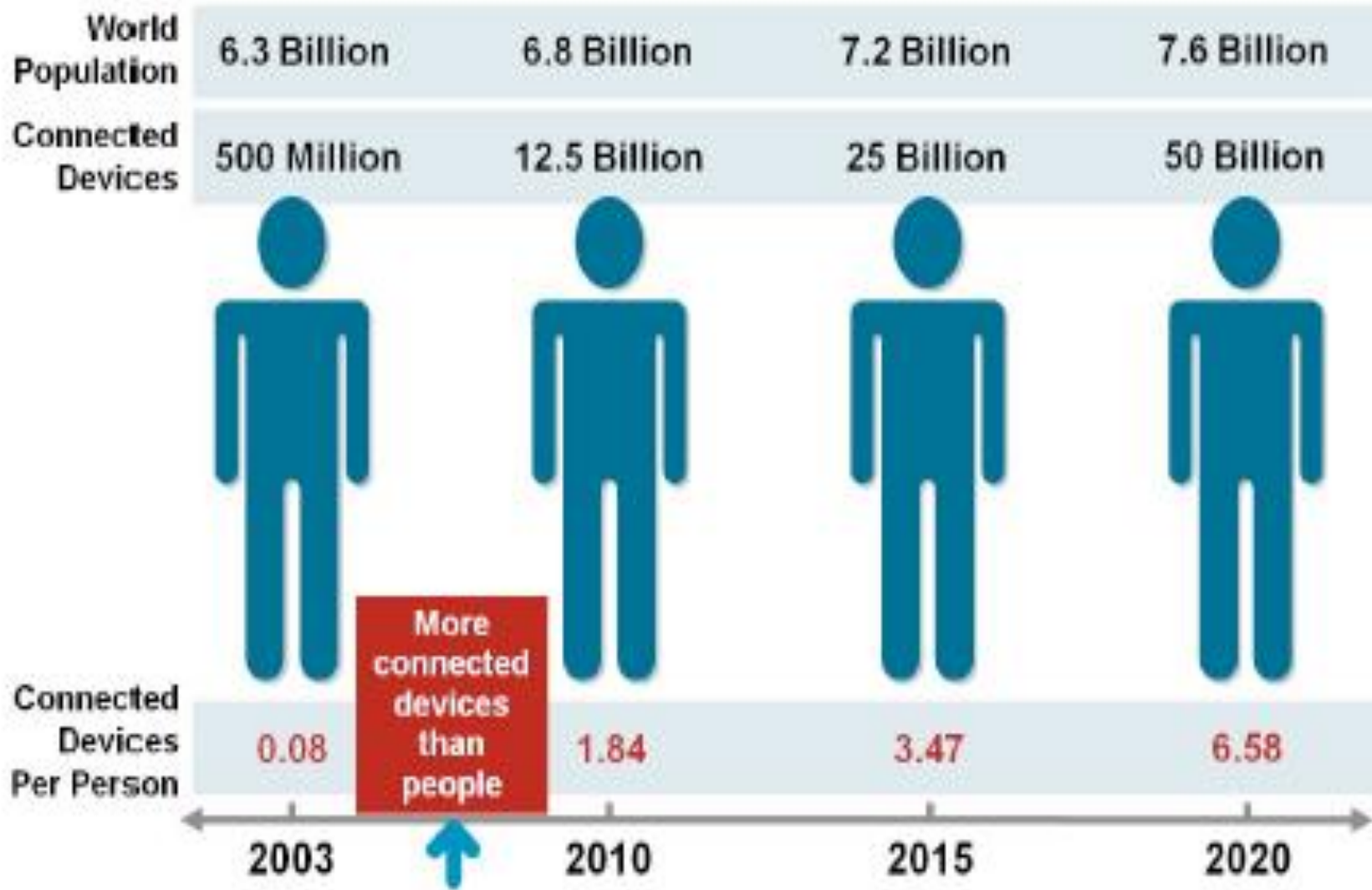- 50 billion connected devices by 2020

CISCO / Ericson / ITU

- 17% will be Smart phones, tablets, Laptop.
- 83 percent will result from devices from various verticals including wearables and smart-home devices. -

CISCO

Global projections varies from 26 billion to 50 billion

Connected devices / Person

World Population	6.3 Billion	6.8 Billion	7.2 Billion	7.6 Billion
Connected Devices	500 Million	12.5 Billion	25 Billion	50 Billion

More connected devices than people

Connected Devices Per Person	0.08	1.84	3.47	6.58
	2003	2010	2015	2020

Source: Cisco IBSG, April 2011

Projection on device connectivity

➤ 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.

➤ It means around 49 B   of the total 50 B devices will be connected on other networks.

M2M / IoT Applications

S. No.	Industry / Vertical	M2M applications
1.	Smart City	Intelligent transport System, Waste management, Smart Street Light system, Electric vehicle charging, Water management, Smart Parking, Intelligent buildings, Safety & Surveillance,
2.	Automotive / Intelligent Transport System	Vehicle tracking, e-call, V2V and V2I applications, traffic control, Navigation, Infotainment, Fleet management, asset tracking, manufacturing and logistics
3.	Safety & Surveillance	Commercial and home security monitoring, Surveillance applications, Video analytics and sending alerts, Fire alarm, Police / medical alert
4.	Utilities / Energy	Smart metering, smart grid, Electric line monitoring, gas / oil / water pipeline monitoring.
5.	Health care	Remote monitoring of patient after surgery (e-health), remote diagnostics, medication reminders, Tele-medicine, wearable health devices
6.	Smart Homes	Video monitoring of home, Security & Alarm, Door control, HVAC control, Smart lighting for efficiency, Controlling appliances through Smart phones etc.
7.	Financial /Retail	Point of sale (POS), ATM, Kiosk, Vending machines, digital signage and handheld terminals.
8.	Water	Smart metering, Water leakage management

M2M / IoT Network

How to Connect ?

Enabling technologies for M2M

➢ Sensor networks, Radio frequency Identification (RFID) chips, GPS, *Location-Based Services* (LBS), nanotechnologies, cloud services, data analytics.

➢ **WLAN (IEEE 802.11), Bluetooth Low Energy (BLE), NFC,** DSRC for short range communication.

➢ Low Power RF for LAN / FAN such as 6LowPAN, Zigbee, Zwave, Wi-SUN etc

➢ Cellular 2G/ 3G/ LTE / Satellite for Long range communication depending upon the applications.

➢ Wire line BB / Lease line to connect infrastructure

➢ Power Line Communication Technologies: Narrowband PLC for LAN / FAN and Broadband PLC for WAN

➢ Low power RF for WAN: LoRa, Sigfox .

- ➤ **Embedded SIM**

- ➤ **Static IP (IPv4 / IPv6)**

- ➤ **Smart Phone**

- ➤ **High speed internet on fixed line and mobile phones.**

Backbone network
- ➤ OFC in ring with multiple access points. Smooth & high speed WiFi coverage, WiFi offloading with the TSPs. Control plane at the center whereas data   may be in distributed servers.
- ➤ Data centers in the cloud for storing large amount of data from the devices. Big data analytics to   create intelligence.   Use of intelligence for different activities. Open APIs
- ➤ ICT Infrastructure

- ➤ **RFID**   based Electronic Toll Collection operates in the 865 MHz – 867 MHz band in India on Delhi- Mumbai NH.

DSRC (Dedicated Short Range Communication)

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

➢ 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.**

LTE for D2D Communications / NBLTE

➤ 3GPP release 12 which talks about LTE direct / LTE MTC/ LTE D2D and further improvements have been proposed in 3GPP Rel 13 and 14.

➤ **5G will bring ultra high reliability, ultra low latency, wide coverage and high security network, suitable for M2M / IoT.**

➤ Combination of ultra low latency and high reliability is not achievable with current wireless technologies. However 5G will be the ultimate solution.

➤ The standards for 5G will be frozen in 2020 and may take further 5 years for implementation.

Network QoS requirement

➢M2M communication 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).

➢M2M services requirement

- **Timely transmission is of utmost important.**

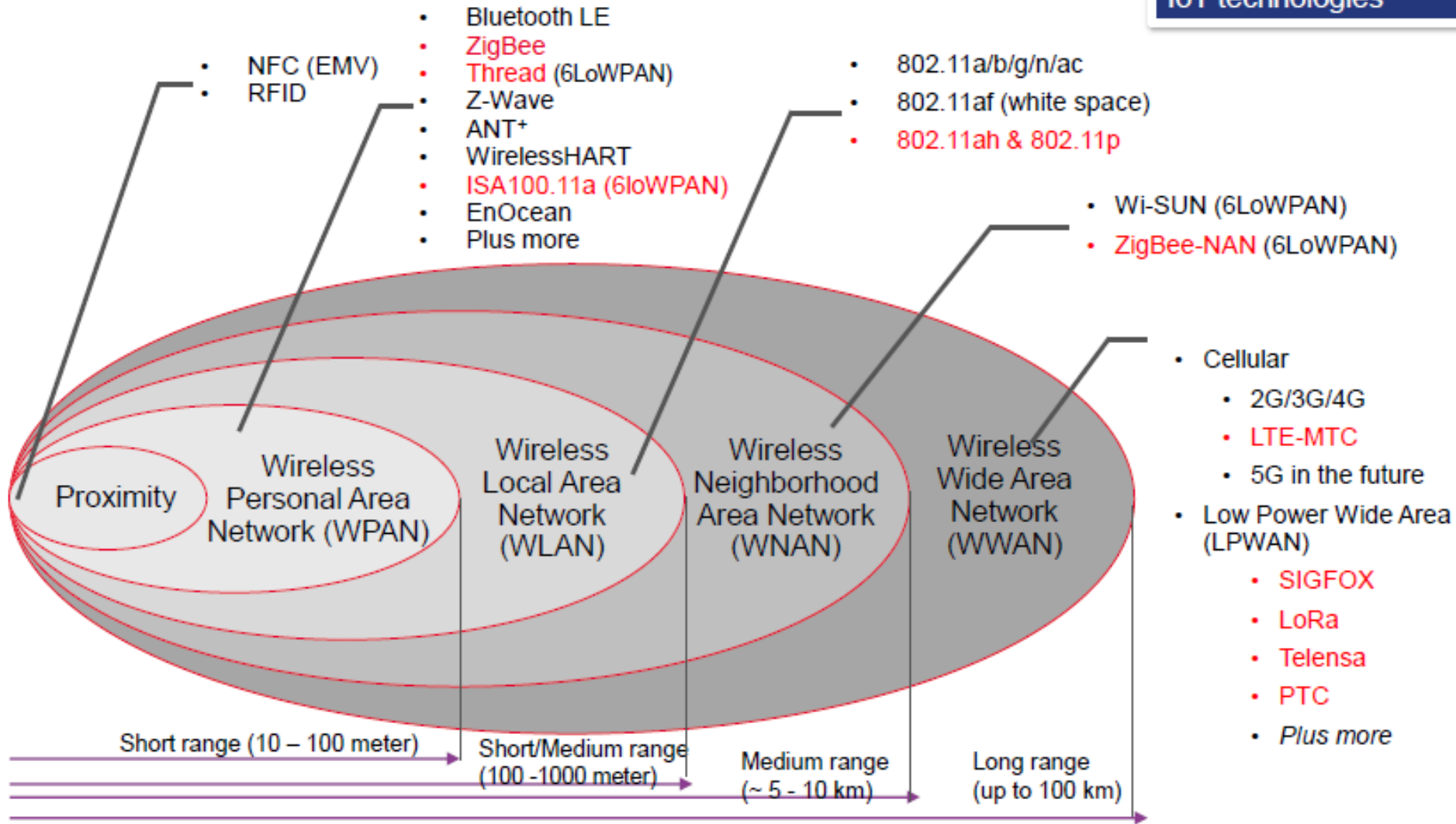- **Communication network is required to be more reliable with low latency**
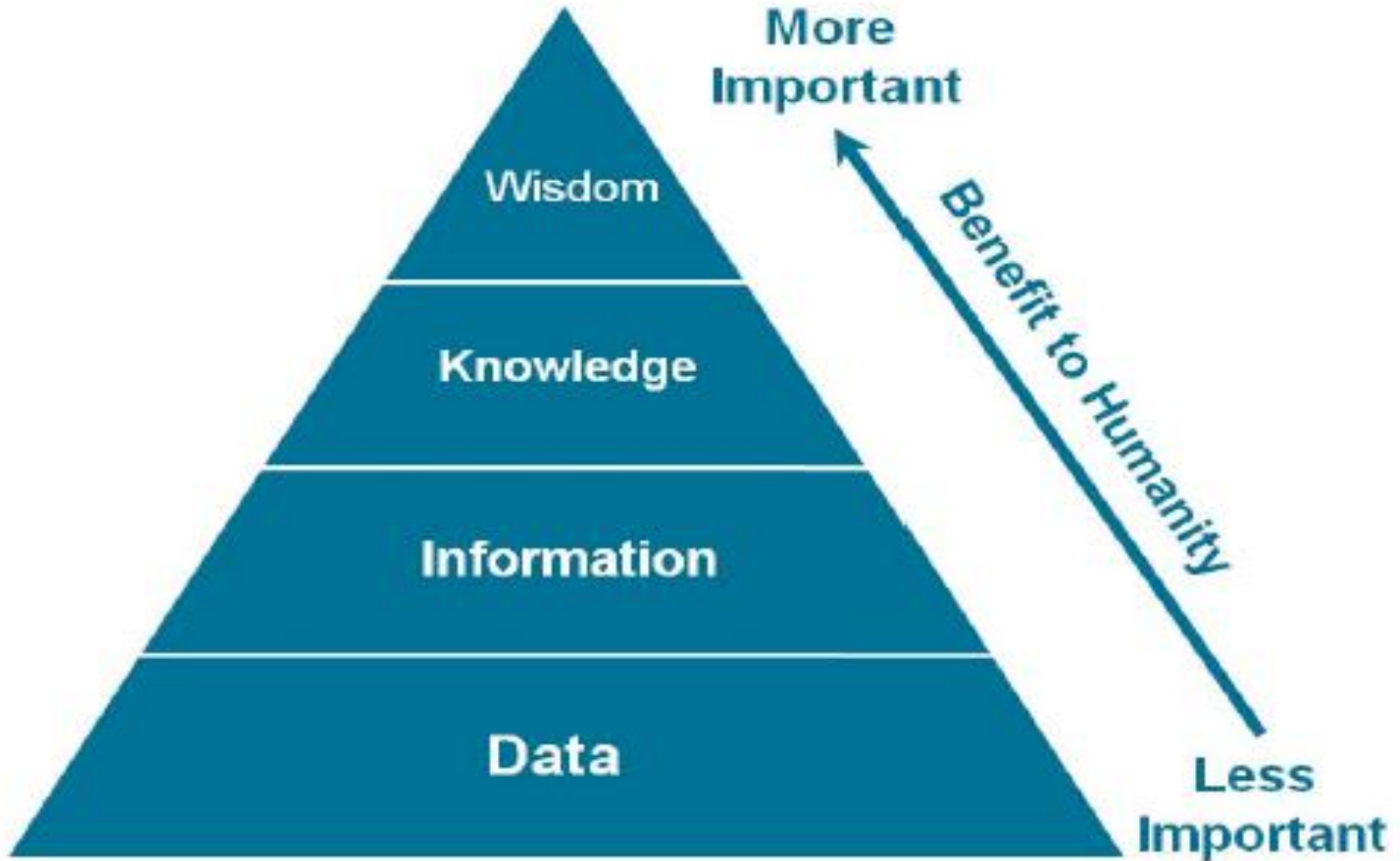
Connecting "Things" to the Cloud

Source: Keysight technologies
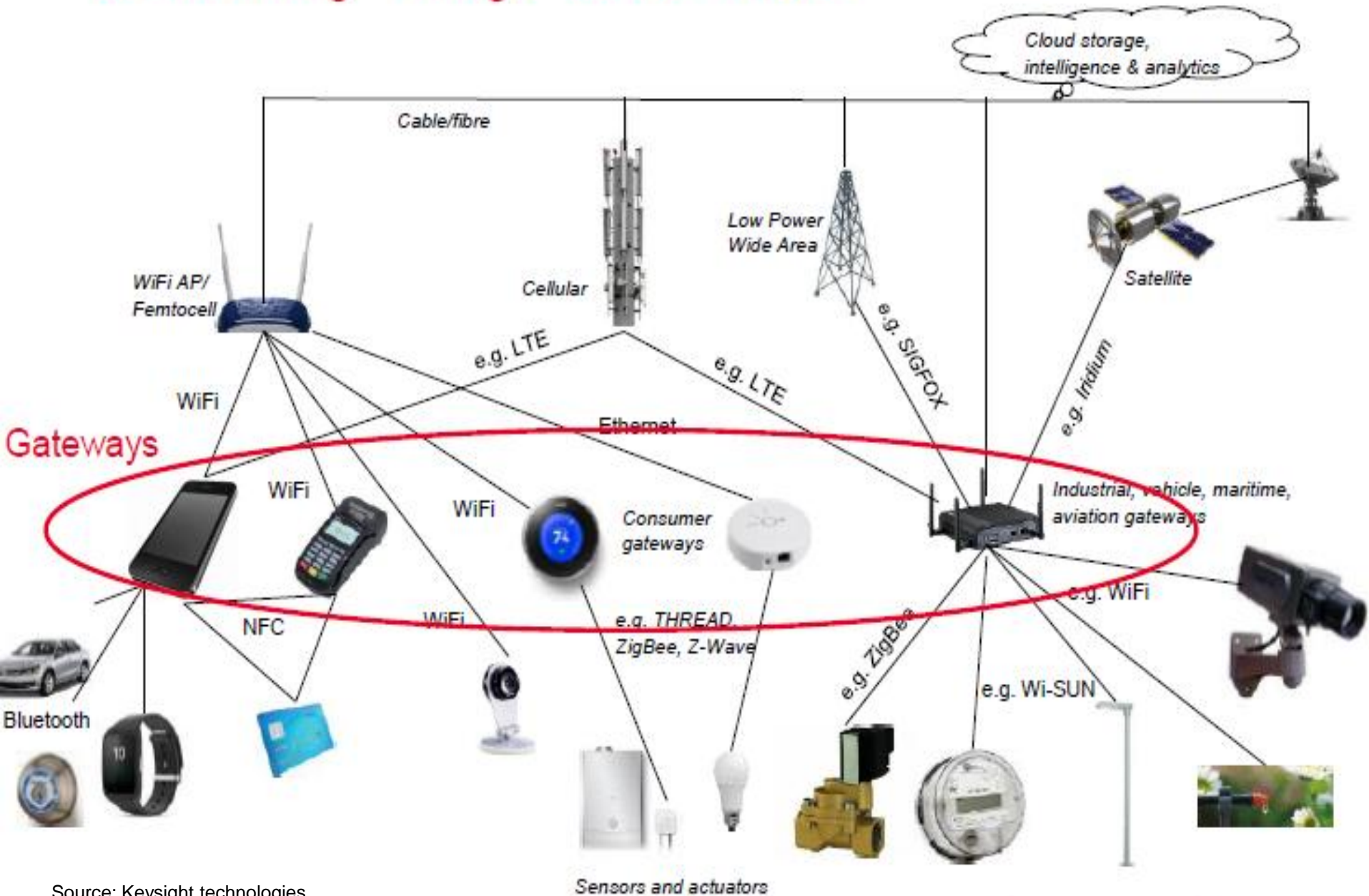
IoT Key Enabling Wireless Technologies
Heterogeneous Mix of Technologies

Red text – emerging IoT technologies

- NFC (EMV)
- RFID

- 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*

Proximity

Wireless Personal Area Network (WPAN)

Wireless Local Area Network (WLAN)

Wireless Neighborhood Area Network (WNAN)

Wireless Wide Area Network (WWAN)

Short range (10 – 100 meter)

Short/Medium range (100 -1000 meter)

Medium range (~ 5 - 10 km)

Long range (up to 100 km)

KEYSIGHT

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

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Big data Analytics : Driving intelligence from Data

Source: Cisco IBSG, April 2011

Challenges and need for standards

➢ Lack of standards and interoperable technologies

➢ Technologies for sustainability or low power consumption / long life batteries required for sensors.

➢ There should be interoperability at device, network and application levels.

➢ Slow deployment of IPv6

➢ Low cost devices (affordability)

➢ Data Security & Privacy

➢Health care regulations

Emerging challenges in relation to IoT

Technical
- Reliability
- Scaling
- Power
- Connectivity
- Cost
- Capacity
- IPv6

Standards
Interoperability
Security
Privacy
Spectrum & Bandwidth Constraints

Policy
- Data Localization
- Access to data/ Open data
- Legacy Regulatory Models
- IPR
- Cross – border traffic
- Governance

Source: Harnessing the IoT for Global development, ITU, 2016
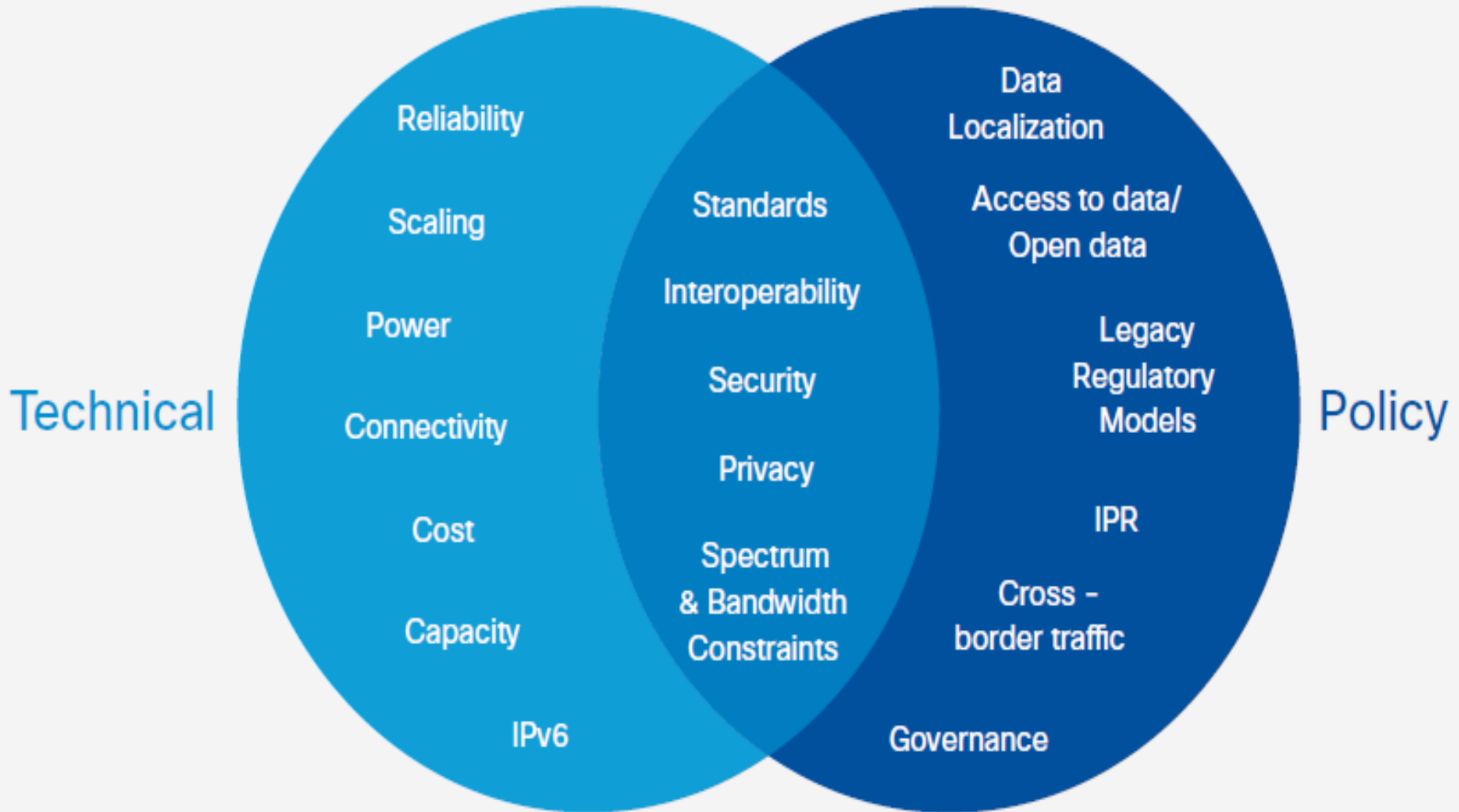
M2M Standardization at International level

➢ ETSI(Europe), TTC, ARIB (Japan), ATIS, TIA (USA), TTA (Korea) CCSA (China) had come together and created a **partnership project OneM2M** in 2012, to avoid creation of competing M2M standards. Later on TSDSI (India) also joined OneM2M. They are working to **create standards for the common service layer**.

➢ 3GPP, WHO, Continua, ISO, IEEE, W3C, cen/ Cenlec etc are also contributing in OneM2M. OneM2M having around 250 members.

➢ **OneM2M has released first set of specifications in Jan 2015 and IInd in March 2016.**

➢ **ITU :** having around 190 member states and 700 industries as members. Any standard approved by ITU is accepted globally. ITU is having a no. of Study groups. SG-20 is for IoT and its applications in Smart Cities and communities.

➢ **Alliance for Internet of Things Innovation (AIoTI)** – created by EU.

➢ **Continua design guidelines -2014** have already been approved by ITU-T and are available as "**Introduction to the ITU-T H.810 Continua Design Guidelines**".

Evolution of Common Service Layer

Pipe (vertical):
1 Application, 1 NW,
1 (or few) type of Device
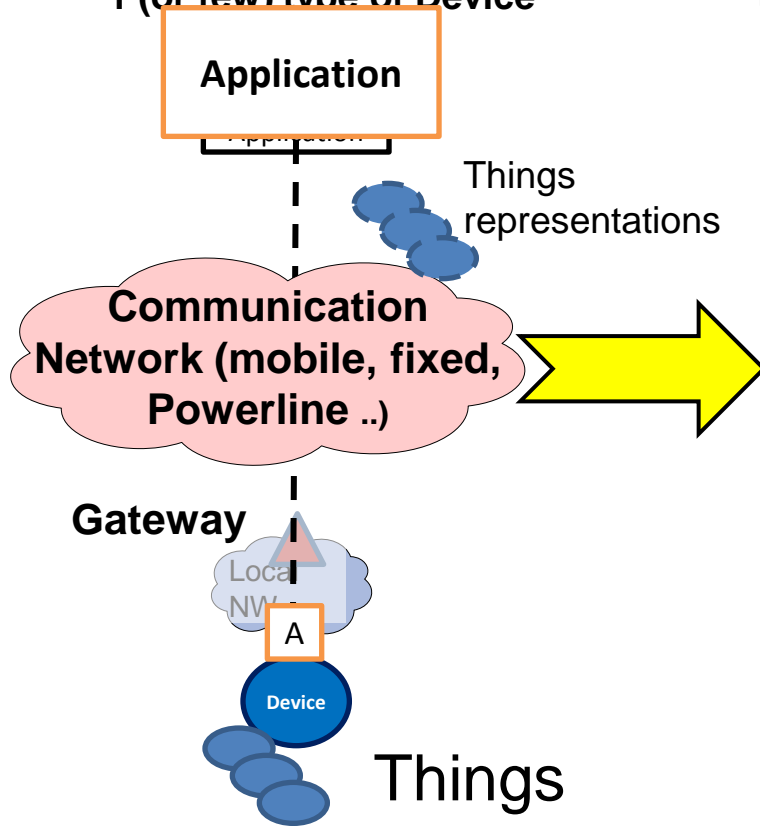
Horizontal (based on common Service Layer)
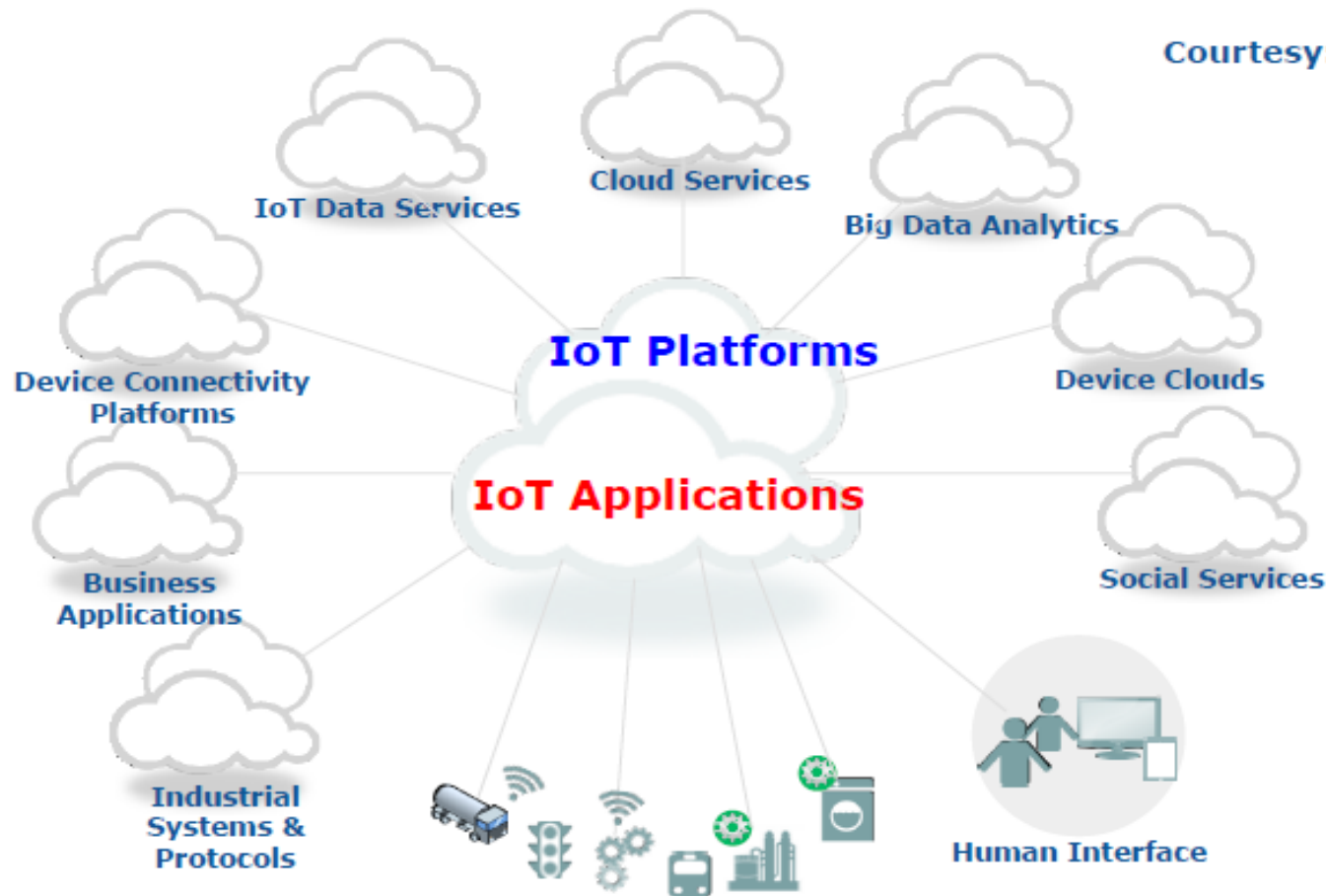Applications share common infrastructure, environments and network elements
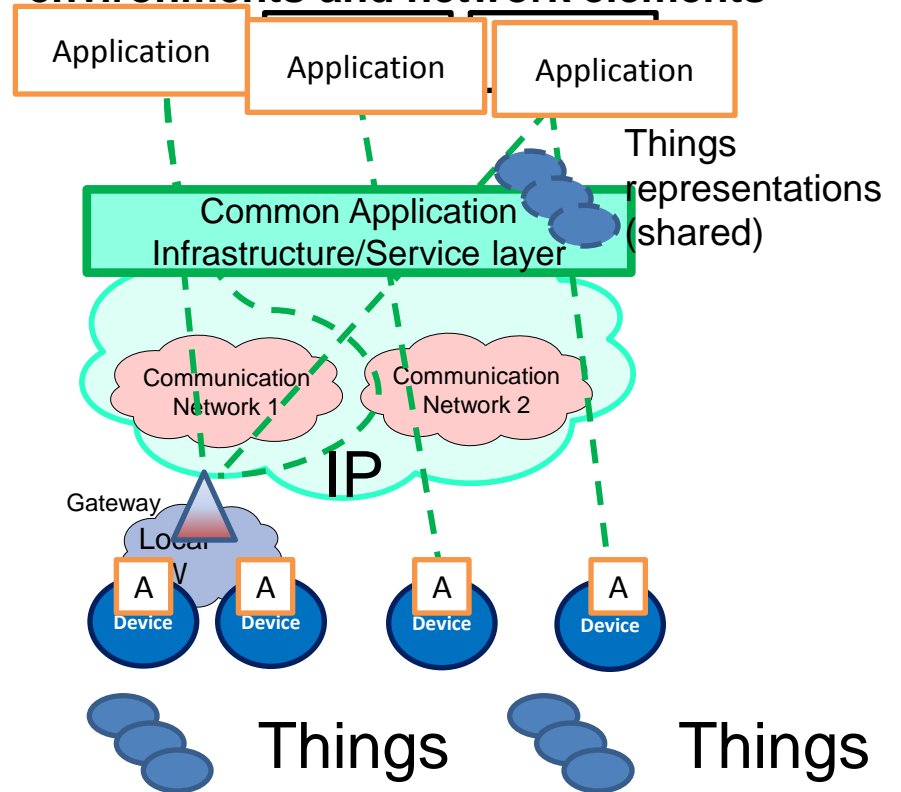
AIoTI view on IoT architecture

IOT COMPLEXITY:
Devices, Applications and Business models

Courtesy: IERC 2015

M2M Standardization activities in TEC

Working Groups in M2M domain formed in TEC

M2M being a new area was taken up by TEC for standardisation in Dec 2013.
To begin with following sectoral working groups were formed having multi stakeholders:

Automotive (Intelligent transport Systems)

Power (Smart Grid & Smart Metering)

Health (Remote health management)

Safety & surveillance

M2M Gateway & Architecture

Security of M2M domain (device to head end system)

At present total members of the WGs are > 120.

M2M Standardization activities in TEC

First set of Technical Reports were released by Hon'ble MoC&IT in May 2015 (www.tec.gov.in/technical-report/) along with National Telecom M2M roadmap (www.dot.gov.in/ntcell). These Technical Reports are

- a. M2M Enablement in Power Sector
- b. M2M Enablement in Intelligent Transport System
- c. M2M Enablement in Remote Health Management
- d. M2M Enablement in Safety & Surveillance Systems
- e. M2M gateway & Architecture.

➢ These Reports were sent to Secretaries of concerned ministries/ Departments by Secretary (T).

New Working Groups, formed in June 2015

1. Smart Cities

2. Smart Homes

3. Smart Villages & Agriculture

4. Environment & Pollution control

5. Smart governance

6. Security

IInd set of Technical Reports, released in Nov 2015

1. M2M Number resource requirement and options

2. V2V / V2I Radio Communication and Embedded SIM

3. Spectrum requirements for PLC and Low Power RF Communications.

4. ICT Deployments and strategies for India's smart cities: A curtain raiser

 www.tec.gov.in/technical-report/.

These reports have been sent to Secretary Ministry of Power, Ministry of Transport & Highways and MoUD by Member(T).

Action points emerged from the Technical Reports

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

2. **13 digit M2M Numbering plan for SIM based devices/ Gateways**.

3. Spectrum requirements for Narrowband and wideband PLC.

4. **Spectrum requirement for Low power RF communications.**

5. Spectrum requirement for DSRC technology.

6. **Embedded SIM**

7. Any device / Gateway having direct connectivity with PSTN / PLMN will be required to have static IP. As IPv4 are going to exhaust, adoption of IPv6 at device, network and application level will be necessary.

ITU-T SG-20 Recommendation in January 2016 on IoT

➢ **Common requirements and capabilities of device management in the Internet of Things.**

➢ **Requirements of the smartphone as sink node for IoT applications and services.**

M2M Enablement in Remote Health Management

Typical applications in Health care

➢ 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

➢ e-ICU

➢ Medication reminders

e-health, m-health and e-ICU solutions are required to provide the health services in the country to bridge the gaps.

They will become essential in rural areas where there is a scarcity of doctors and the hospitals.

IoT framework for health monitoring

Personal Connected Health (PCH) allows providers and patients to:

➢ Use technology to collect data conveniently and securely, without human intervention

➢ Communicate more frequently with little manual intervention

➢ Effectively monitor and better understand personal health data.

➢ Using M2M communication along with ICT infrastructure, various vital parameters of patients like temperature, pulse-rate, respiration rate, heart conditions or patient location can be sent from remote locations for further analysis.

➢ This may be required for preventive healthcare, post-surgery conditions, patients from hospitals and old age people.

IoT framework for health monitoring : motivation to remain fit
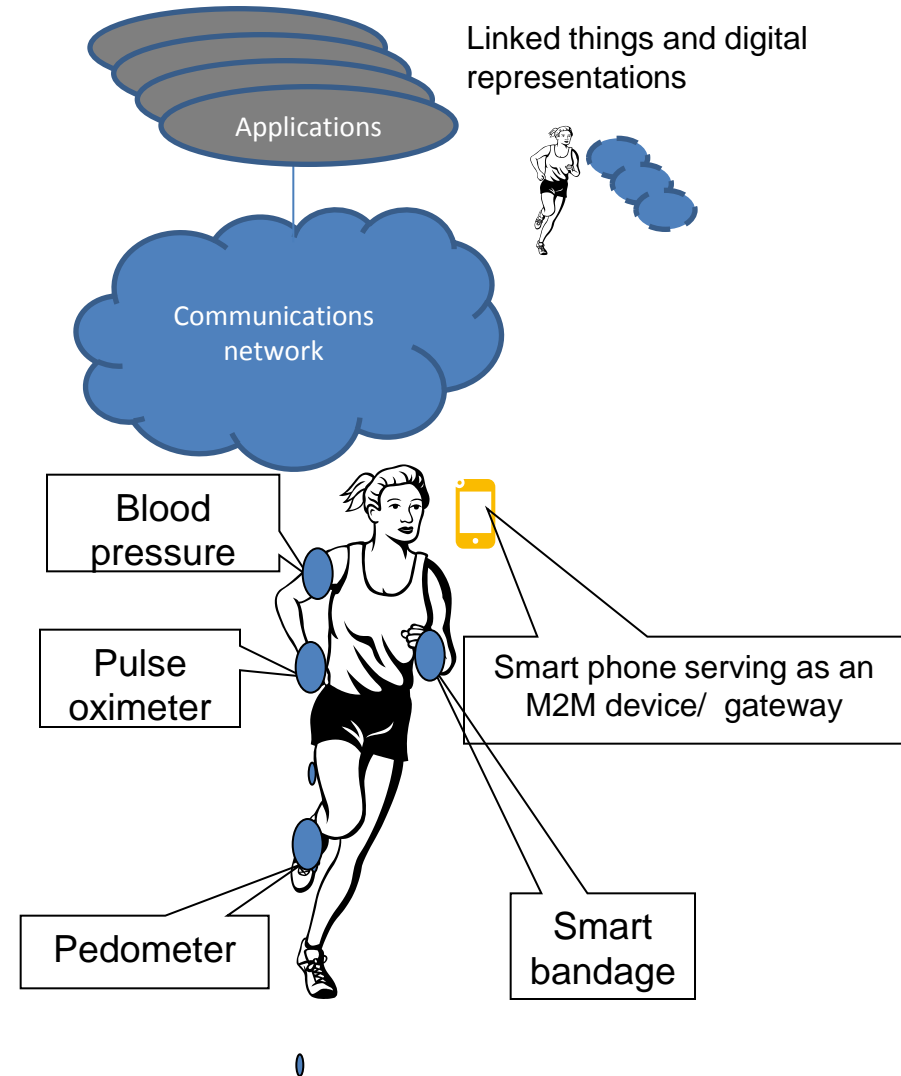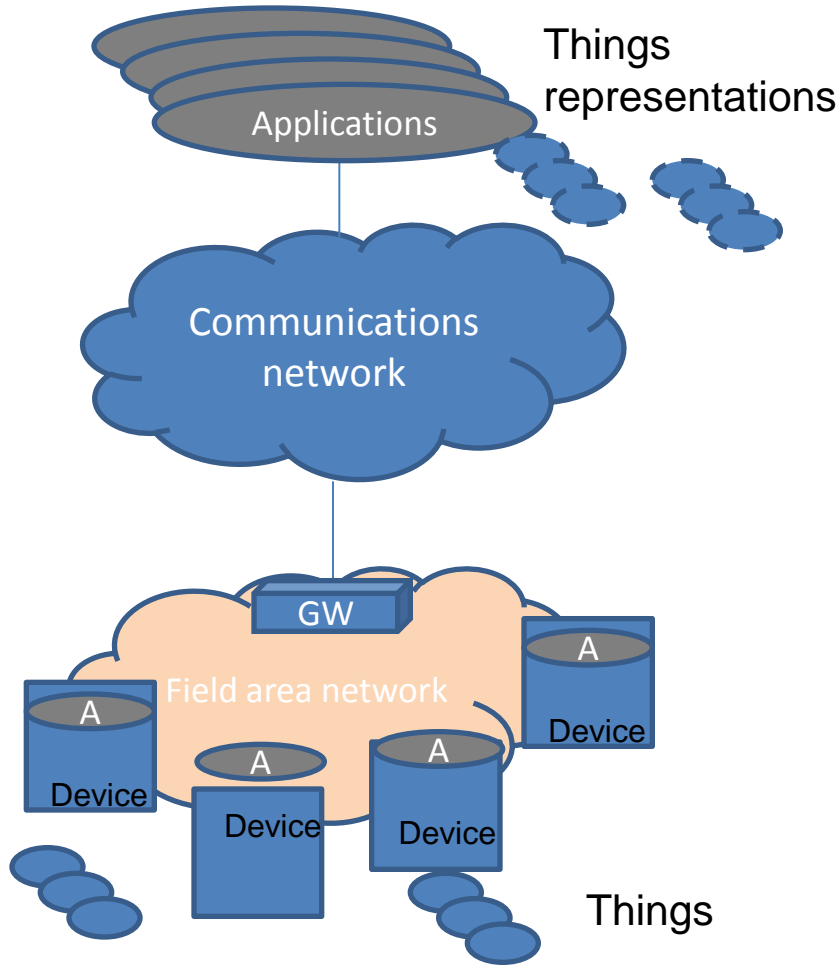
Things representations

Applications

Communications network

GW

Field area network

A

Device

A

Device

A

Device

A

Device

Things

Linked things and digital representations

Applications

Communications network

Blood pressure

Pulse oximeter

Smart phone serving as an M2M device/ gateway

Pedometer

Smart bandage

Versatile offering of connected devices

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

ISO
IEEE
Bluetooth
CERTIFIED USB
ZigBee

IHE
Hl7
W3C
Hl7
IHE

WiFi, 2G, 3G & 4G

Personal Area Network (PAN) Interface

Wide Area Network (WAN) Interface

Health Record Network (HRN) Interface

PHR
EHR
NHIN
HIE

Remote patient monitoring / assisted living

Remote patient monitoring / assisted living is the service category currently identified by FG M2M as work focus in ITU. E-health ecosystem is shown below
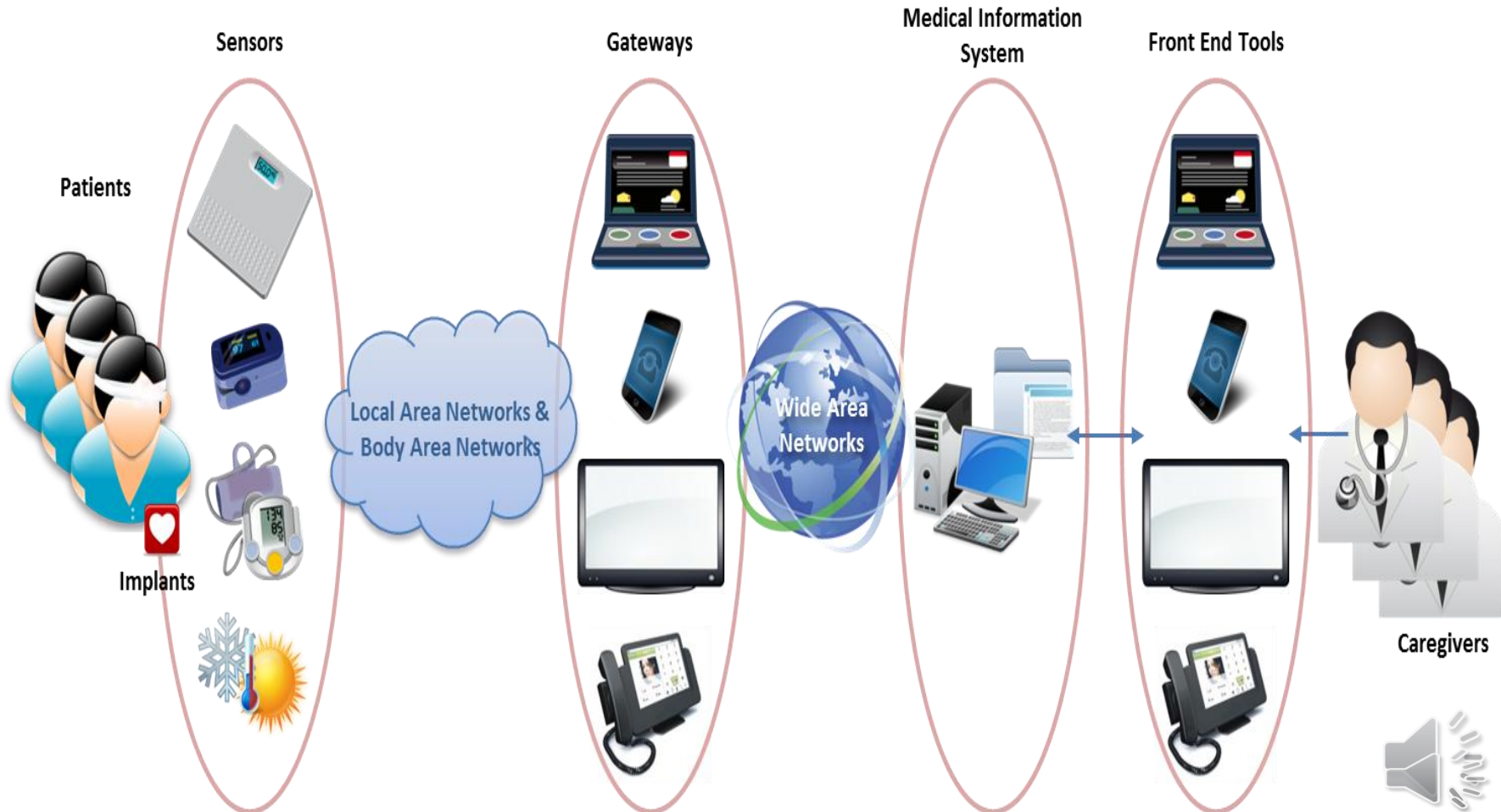
Smart glasses / Google glasses may work with face recognition and provide hospital personnel with patient data such as test results and medication information right in front of their eyes. So they no longer need to refer to paper-based medical records.

M2M health care use cases

Following use cases were studied in the working group wrt type of communication Channel requirement in TAN /PAN/ LAN /WAN, data bandwidth requirement, compliance to standards, challenges, criticality of QoS and patient safety requirement. Detail available in the technical report

1. **Remote patient monitoring**

2. **Rural Health** :- The solution comprises of a mobile device (phone or a tablet) connected to the Medical Device with wired or wireless interface and enabled with Biometric ID, Camera and GPS with a mobile network connectivity to the backend Server where data can be submitted individually or in a consolidated manner. Patient ID can be validated through Aadhaar.

3. **Patient identification** : Aadhar, Phone number, iris, smart card

4. **Assisted living** : Fall condition, vital sign monitoring, schedule for medicine reminder, activity monitoring, home dialysis, geo fencing etc.

M2M health care use cases

5. **Smart wearable devices**

6. **Ambulance management system (transmission of vital parameters of a patient from ambulance to the hospital).**

7. **Medical assets tracking**

8. **Radiology data transfer**

9. **Remote drug delivery** :-Remote drug delivery will increase the effectiveness of treatment. To increase the patient compliance with treatment regime, which require daily mediations for long periods of time, drug delivery from an implantable microchip wirelessly controlled by a doctor would help. This technology will help to improve treatment for humans.

10. **Laboratory information System** :-Laboratory information system shall provide automatic data upload on the EHR based on the Patient identity

Future Scenario of Healthcare

	As-Is	Foreseeable Future	Utopia
	Location-bound & disease treatment	Preventive treatment	Wellness mgmt. : Self-Care & Self Diagnose
❷ Patient	• Disease management	• Preventive	• Wellness management
❸ Doctor	• Diagnose	• Early treatment	• Prognoses
❶ Hospital provider	• In-patient care • Competing for specialized doctors	• Remote patient monitoring	• Home-based care • Sharing of knowledge-based doctors • Medical knowledge as a service
❺ Pharma-ceutical	• Generic drug	• Personalized drug	• Targeted medication • Nutraceuticals
❹ Insurance / Payer	• Risk-based premium	• Personalised fitness-based premium	• Health credit

M2M Enablement in Intelligent Transport System

Need of M2M Communication in Transport Sector

There are approx. 200 million vehicles on the roads in India. In view of fast rise in number of vehicles with respect to development of infrastructure in the last 10-15 years, some studies show that India faces

- loss of around Rs. 600bn ($10.8bn) a year due to congestion, slow speed of freight and waiting time at toll plazas,

- average Indian spends about 90 minutes a day travelling in major cities, with an average speed of 10km/hr on some major roads,

- India, around 5 lakhs road accidents happen, causing a loss of around $20 billion, with 6 lakhs people injured and 1.5 lakhs killed

- every year, nearly 36,000 vehicles are stolen, which amount to Rs. 115 crore with only about 14,500 getting traced, often in un-roadworthy conditions, with many components missing,

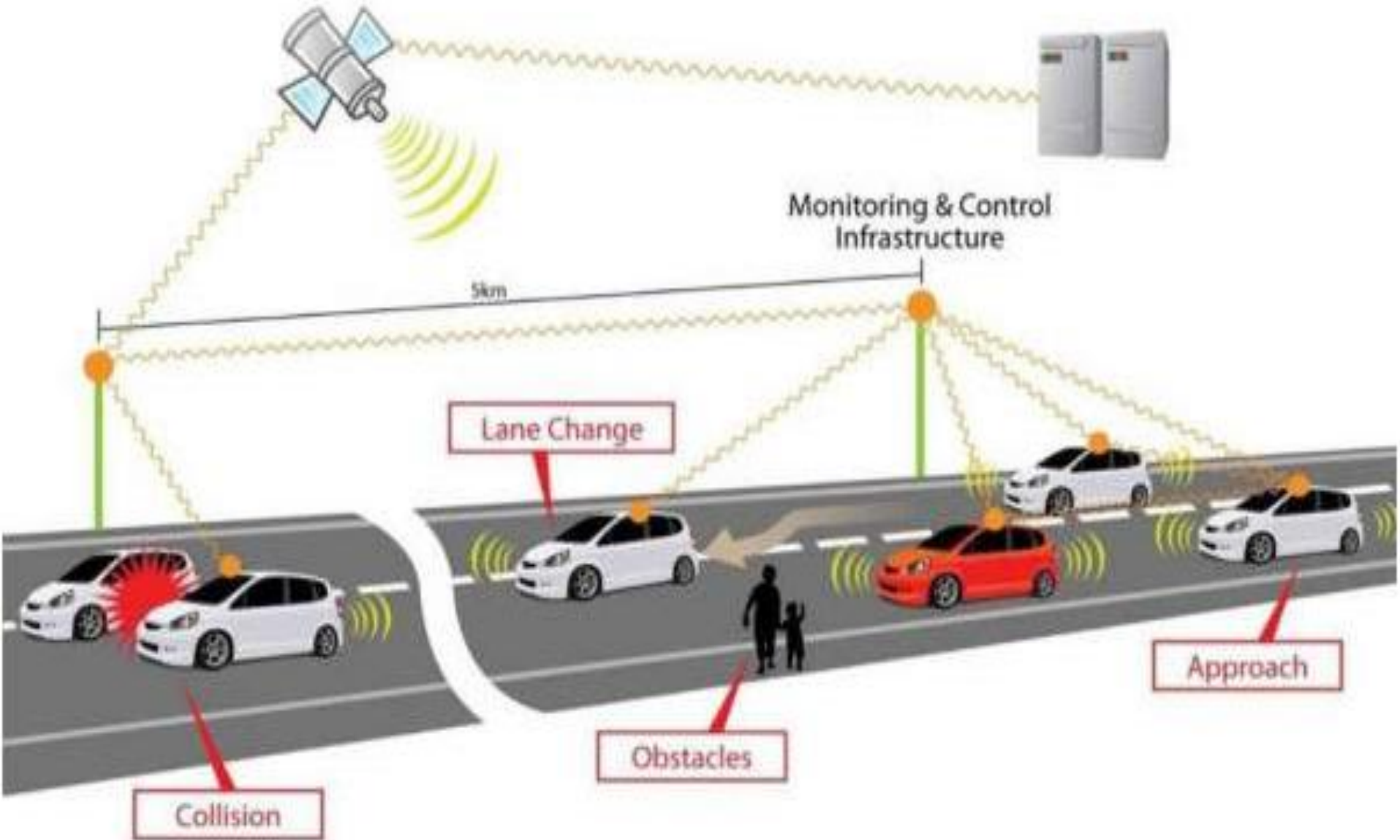- vehicles are the major contributor to AIR pollution.

Applications of V2V/ V2I

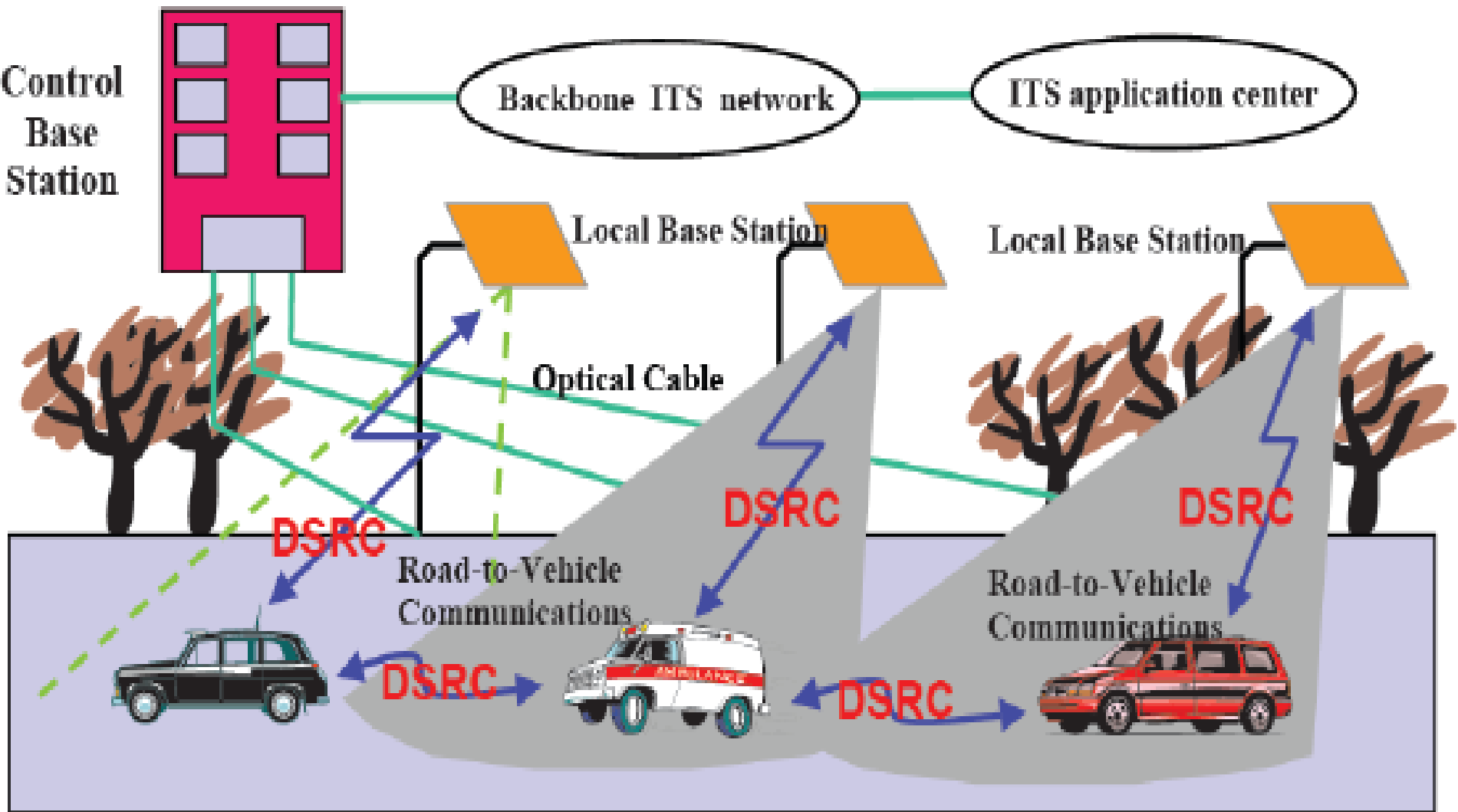Main uses of Intelligent transport system having V2V/ V2I are to transmit information for:

➢ Roadside beacons

➢ Traffic signals/controls

➢ Toll collections

➢ Petrol pumps and charging centres (for electric vehicles)

➢ Digital signage

➢ Safety Applications such as red light violations, overloading or crossing speed limits

➢ eCall (911 in USA and 112 in Europe)

➢ Infotainment

➢ Maintenance

➢ Navigation
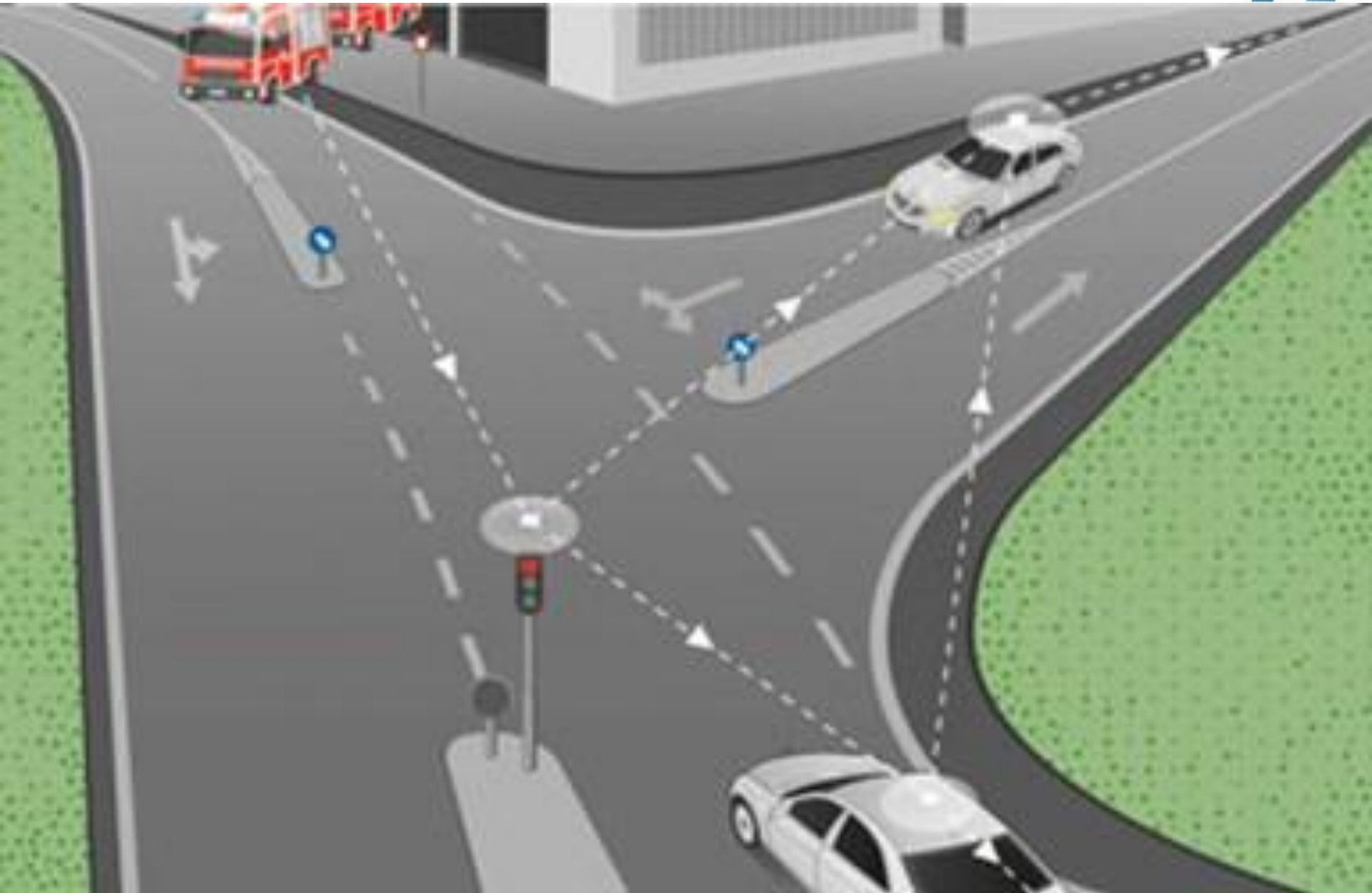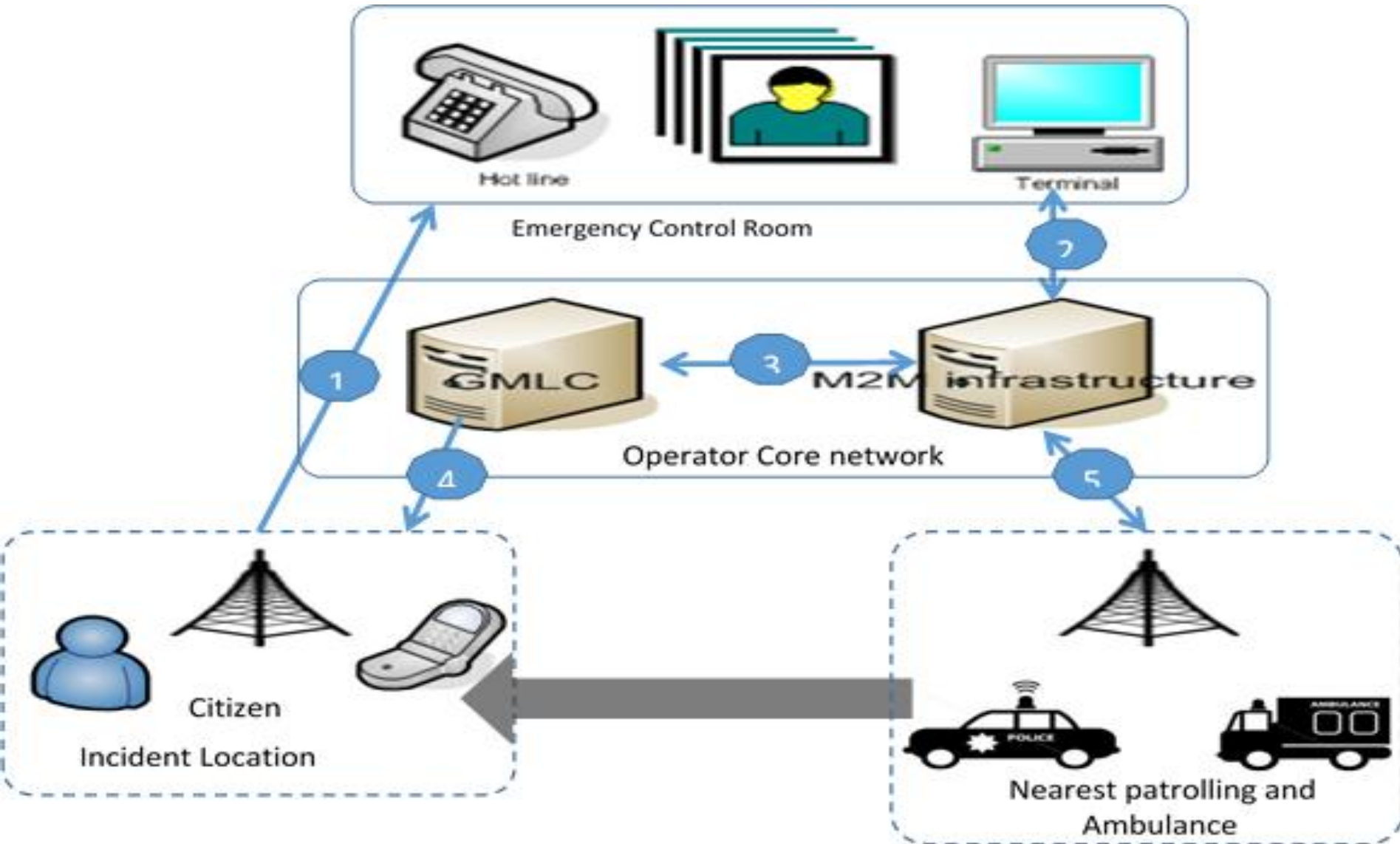
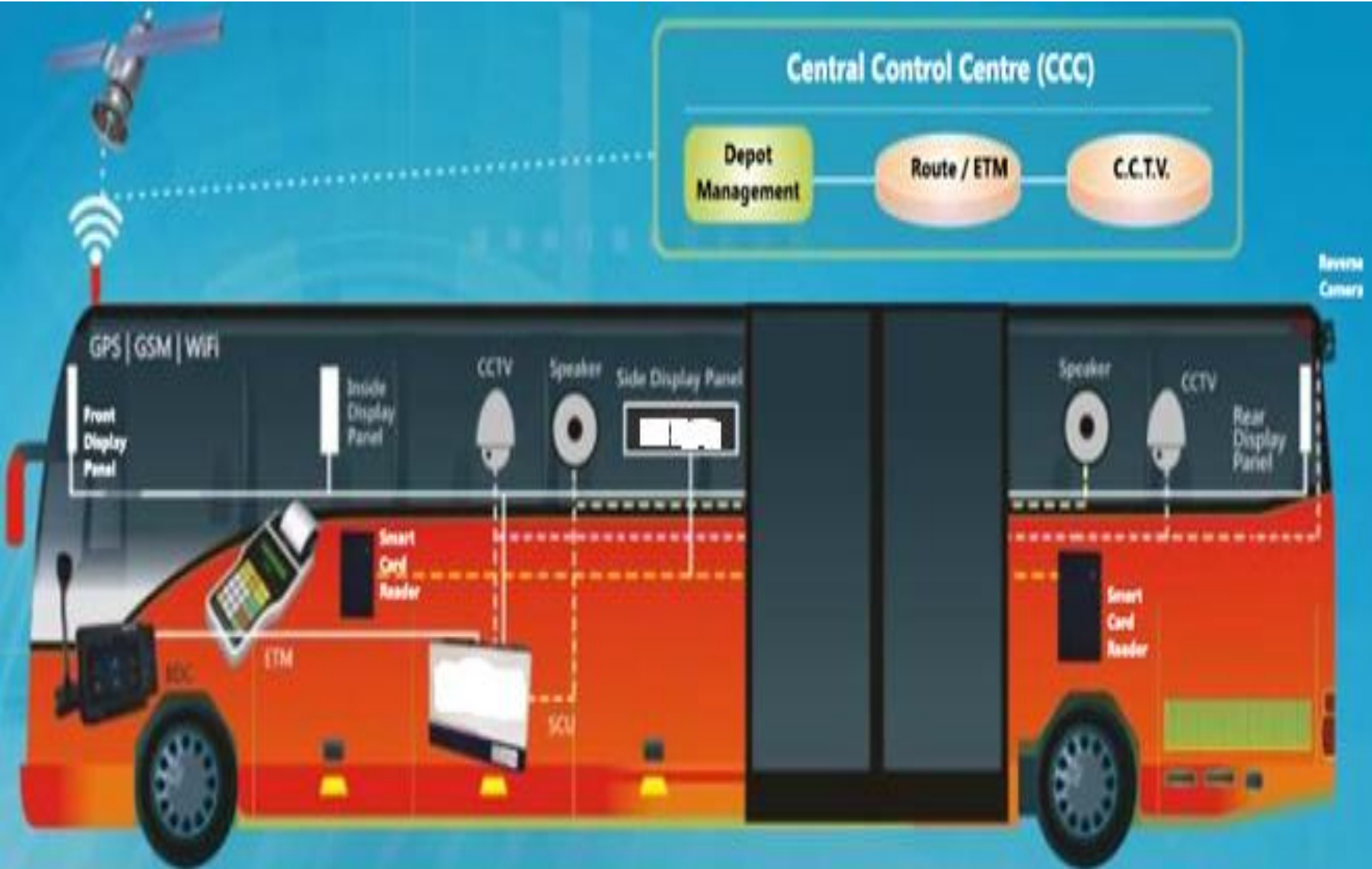# V2V and V2I Communication scenerio

V2V Communication using DSRC

E-call call flow diagram

JNNURM bus

Example of IoT in Smart City application

Smart streetlights dim based on ambient conditions to save energy costs

Smart traffic lights using cameras at every signal, increasing average speed in the city

Real time updates for passengers via smart devices or display board

Cameras reduce crime and enable faster emergency response times

Self-driving autonomous vehicles enabling increased safety, reduced CO2 emissions, more leisure and work time for motorists

Pay-as-you-drive car insurance, charges users according to driving behavior and can enable savings for drivers of up to USD 1300 per year

Source: McKinsey internal research, GSMA

How IoT will add value ?

➢Reduce congestion on the roads using Intelligent Transport Systems applications such as intelligent signalling, Electronic toll collection, Smart parking etc..

➢Geo fence will help in monitoring the vehicles deployed for specific task such as garbage collection, pick & drop etc.

➢Vehicle tracking will reduce crime.

➢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.

➢ Save electricity by using smart lighting system in cities and homes.

➢Share data across verticals to create value.

All these actions will improve the quality of life.

Measure Citizen satisfaction / Happiness index ?

THANKS