NBTC – ITU Training
on Building IoT solutions for e-applications

Session 5: IOT Standards and ITU

CELEBRATING 25 YEARS OF ACHIEVEMENTS

ITU Definition

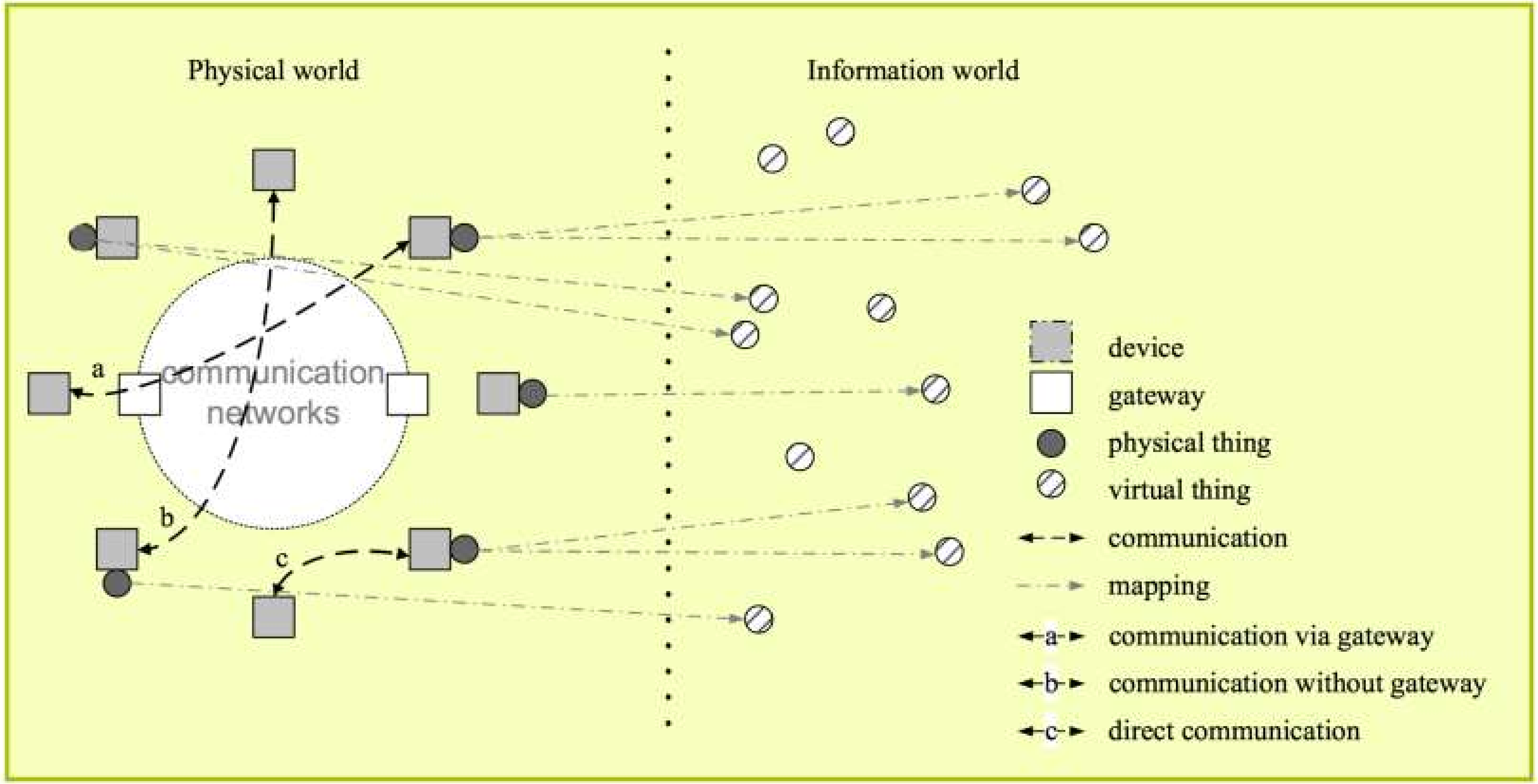
The IoT can be viewed as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT).

Things are objects of the physical world (physical things) or of the information world (virtual world) which are capable of being identified and integrated into communication networks. Things have associated information, which can be static and dynamic.

- **Physical things** exist in the physical world and are capable of being sensed, actuated and connected. Examples of physical things include the surrounding environment, industrial robots, goods and electrical equipment.
- **Virtual things** exist in the information world and are capable of being stored, processed and accessed. Examples of virtual things include multimedia content and application software.

Source: Recommendation **ITU-T Y.2060**

ITU Definition



Source: Recommendation **ITU-T Y.2060**

High-level requirements

- **Identification-based connectivity**: The IoT needs to support that the connectivity between a thing and the IoT is established based on the thing's identifier. Also, this includes that possibly heterogeneous identifiers of the different things are processed in a unified way.
- **Interoperability**: Interoperability needs to be ensured among heterogeneous and distributed systems for provision and consumption of a variety of information and services.
- **Autonomic networking**: Autonomic networking (including self-management, self-configuring, self-healing, self-optimizing and self-protecting techniques and/or mechanisms) needs to be supported in the networking control functions of the IoT, in order to adapt to different application domains, different communication environments and large numbers and types of devices.

Source: Recommendation **ITU-T Y.2060**

High-level requirements

- **Location-based capabilities**: Location-based capabilities need to be supported in the IoT.
- **Security**: In the IoT, every 'thing' is connected which results in significant security threats, such as threats towards confidentiality, authenticity and integrity of both data and services. A critical example of security requirements is the need to integrate different security policies and techniques related to the variety of devices and user networks in the IoT.
- **Privacy protection**: Privacy protection needs to be supported in the IoT. Many things have their owners and users. Sensed data of things may contain private information concerning their owners or users. The IoT needs to support privacy protection during data transmission, aggregation, storage, mining and processing.

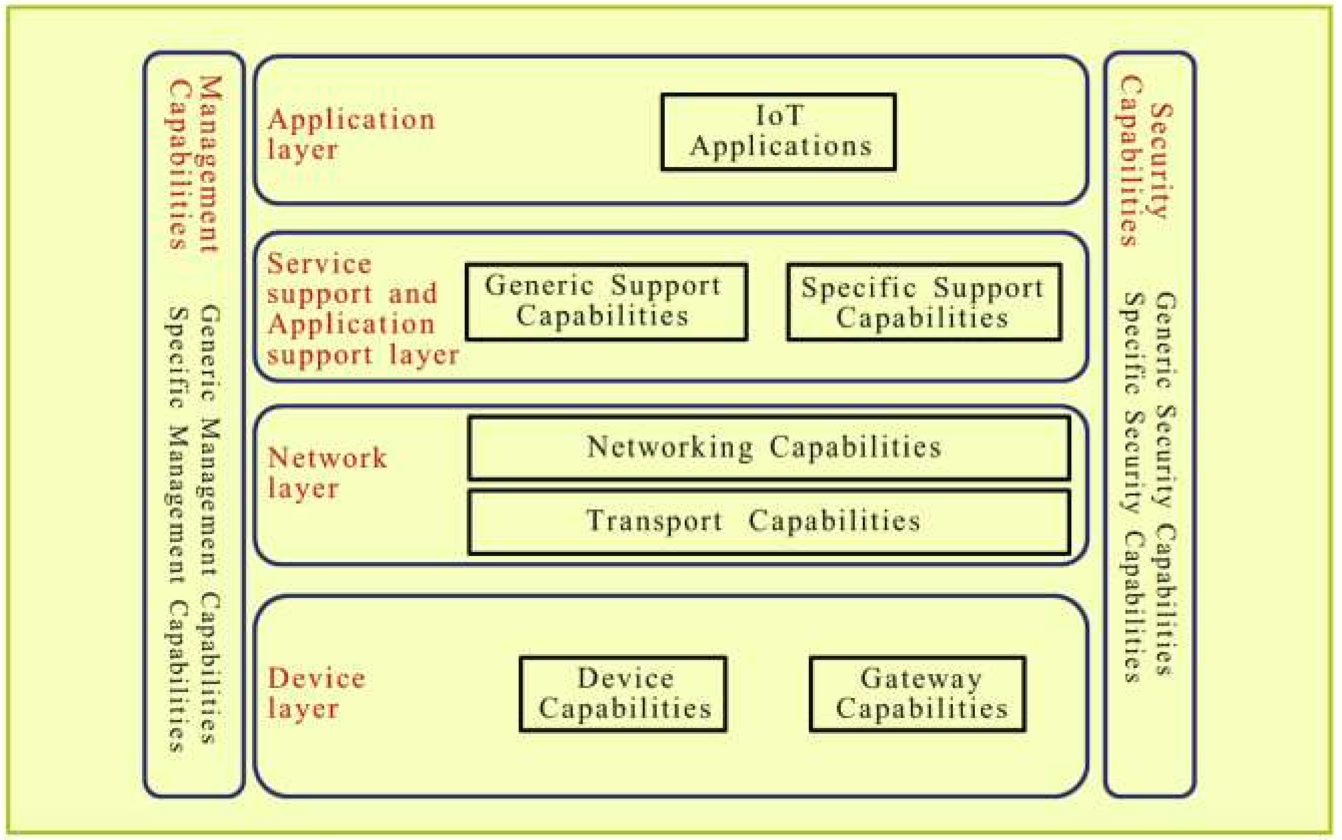
Source: Recommendation **ITU-T Y.2060**

High-level requirements

- **Plug and play:** Plug and play capability needs to be supported in the IoT in order to enable on-the-fly generation, composition or the acquiring of semantic-based configurations for seamless integration and cooperation of interconnected things with applications, and responsiveness to application requirements.
- **Manageability:** Manageability needs to be supported in the IoT in order to ensure normal network operations. IoT applications usually work automatically without the participation of people, but their whole operation process should be manageable by the relevant parties.

Source: Recommendation **ITU-T Y.2060**

IoT reference model

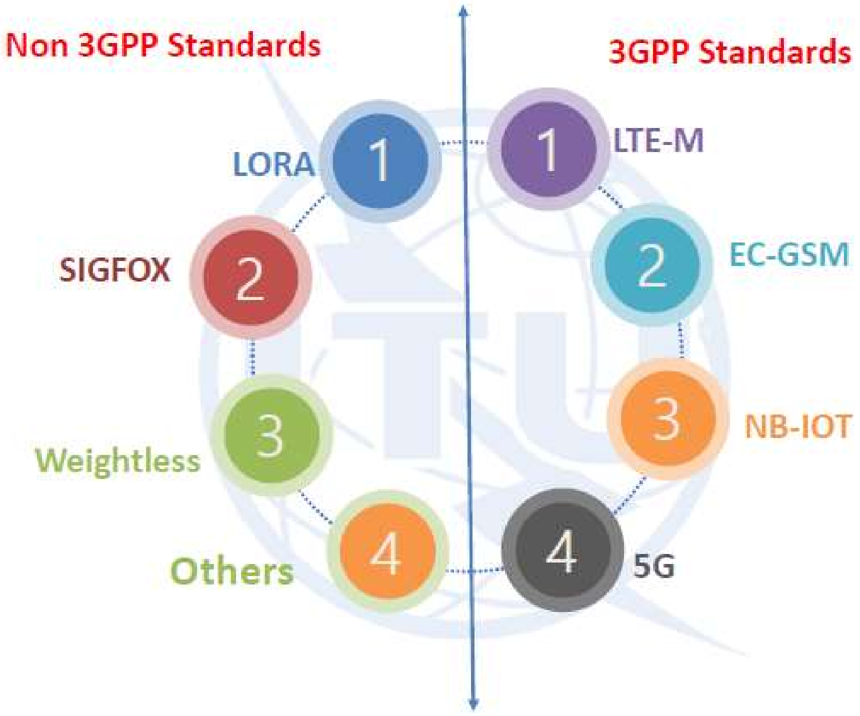


Source: Recommendation **ITU-T Y.2060**

IoT Technologies

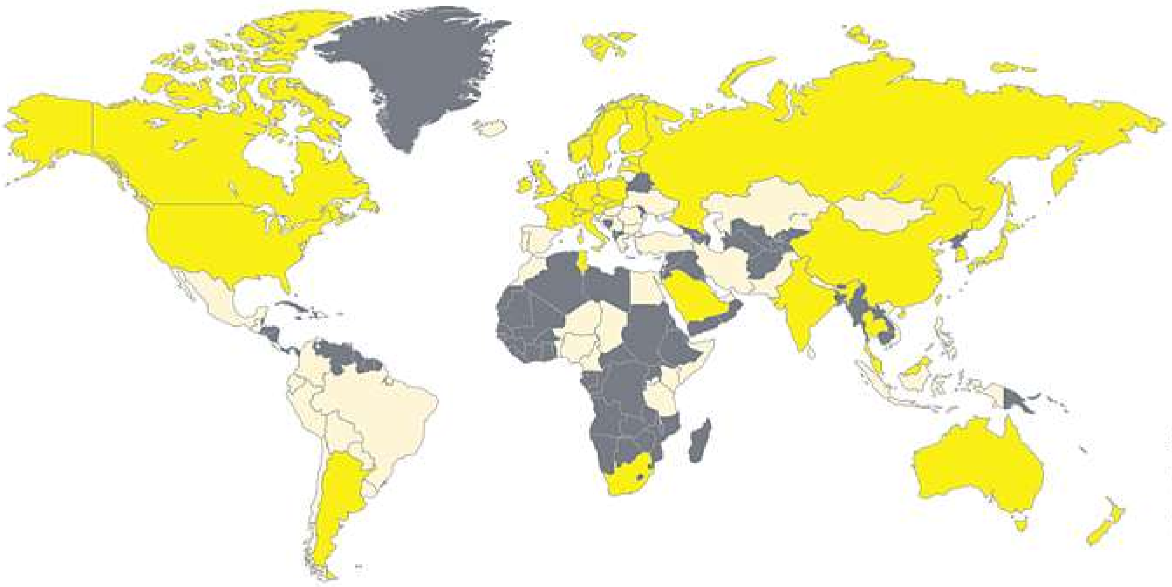
Fixed & Short Range

i. RFID
ii. Bluetooth
iii. Zigbee
iv. WiFi



LoRaWAN

Countries — LoRaWAN™ Networks **1**



- 47 Publicly Announced Operators
- 43 Alliance Member Operators
- 350+ on-going trials & city deployments
- 500+ members in the Alliance

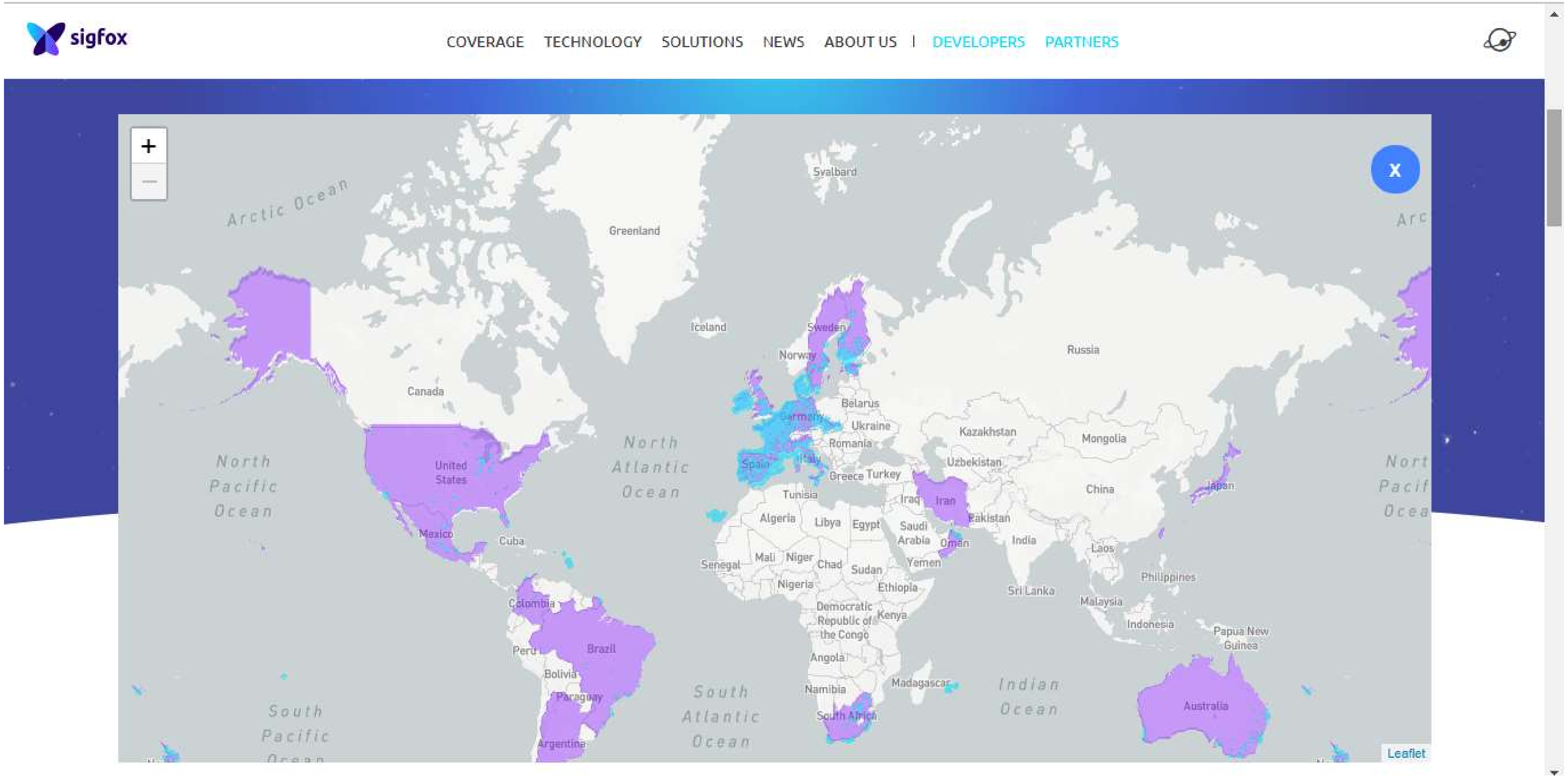
Legend:

- Country with Publicly Announced Network
- Other LoRaWAN deployment

LoRa Alliance

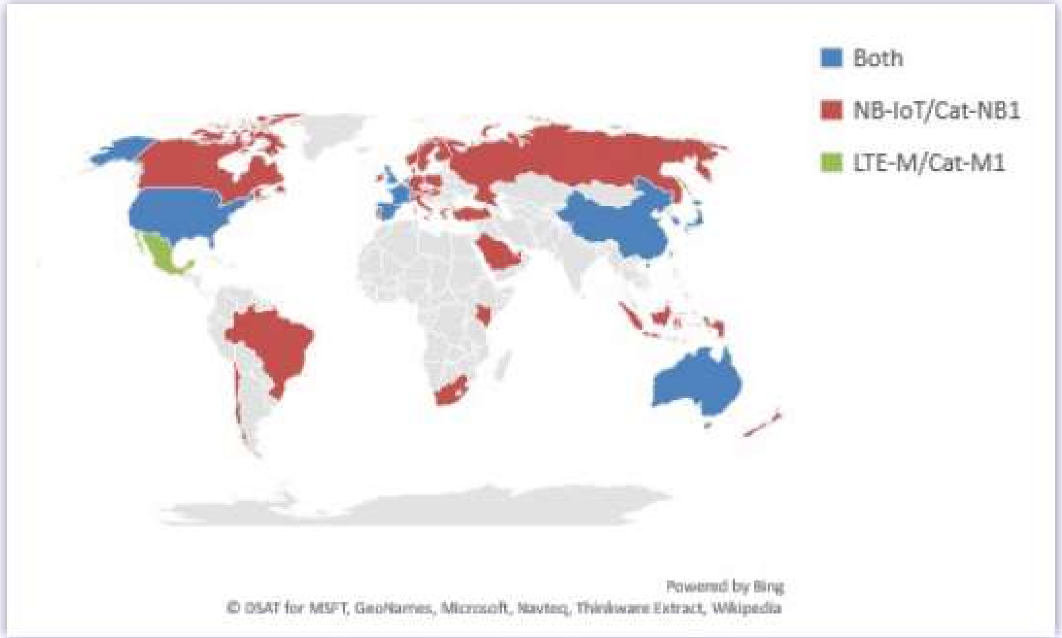
August 2017

Sigfox



sigfox
COVERAGE
TECHNOLOGY
SOLUTIONS
NEWS
ABOUT US
DEVELOPERS
PARTNERS
Arctic Ocean
Svalbard
Greenland
Iceland
Sweden
Norway
Russia
Canada
Belarus
Germany
Ukraine
Kazakhstan
Mongolia
Romania
Uzbekistan
Spain
Italy
Greece
Turkey
China
Japan
North Atlantic Ocean
North Pacific Ocean
United States
Tunisia
Iraq
Iran
Algeria
Libya
Egypt
Saudi Arabia
Pakistan
Mexico
Cuba
Oman
India
Laos
Senegal
Mali
Niger
Chad
Sudan
Yemen
Philippines
Nigeria
Ethiopia
Sri Lanka
Malaysia
Colombia
Democratic Republic of the Congo
Kenya
Indonesia
Papua New Guinea
Brazil
Peru
Angola
Bolivia
Paraguay
Namibia
Madagascar
Indian Ocean
South Atlantic Ocean
South Pacific Ocean
South Africa
Australia
Argentina
Leaflet

NB-IOT mobile network deployments



6 commercial NB-IoT networks (Telus Canada, T-Mobile Netherlands (nationwide since May 2017), Telia Norway, Vodafone Spain, Deutsche Telekom, and Vodacom South Africa).

A further **55 networks in 37 countries** trialling, demonstrating or planning to deploy NB-IoT/Cat-NB1 (18 of them with a stated commitment to launch during 2017).

••**2 commercial LTE-M networks** (Verizon USA and AT&T USA).

••**16 other networks in 10 countries** trialling, demonstrating or planning to deploy LTE-M/Cat-M1 (7 of them with a stated commitment to launch during 2017).

Report: Evolution from LTE to 5G GSA

CELEBRATING 25 YEARS OF ACHIEVEMENTS

Different Services, Different Requirements - Examples

PPDR services

• **Constant availability** –

• **Ubiquitous coverage** – not just outdoors, but inside buildings (including large ferroconcrete structures such as shopping malls) and in tunnels (including subways).

• **Regionally harmonised spectrum** –

• **Differentiated priority classes** .

• **Support for dynamic talkgroups,**

• **Automatic identification with authentication.**

• **Automatic location discovery and tracking**

• **The ability to maintain connectivity**

• **Fast call setup** (<200ms) and immediate access on demand: the **Push-to-talk** (PTT)function and **all-calls** (internal broadcasts).

• **Relay capabilities**

• **Support for Air-Ground-Air (AGA) communication** when and where needed.

• **Adequate quality of service**

• **The ability to roam onto commercial networks**

•**Interworking between various PPDR services,** and increasingly, across borders.

Utility industry :

•**Teleprotection** – safeguarding infrastructure and isolating sections of the network during fault conditions whilst maintaining service in unaffected parts of the network.

•**Data monitoring** via SCADA (Supervisory, Control And Data Acquisition) systems.

•**Automation** – systems to autonomously restore service after an interruption or an unplanned situation.

• **Security** – systems to ensure the safety and security of plant.

• **Voice services** –.

• **Metering** – collecting data from smart meters and communicating with them for various reasons, such as demand management and to implement tariff changes.

• **Connectivity** – telecommunication networks to interconnect the above services in a reliable and resilient manner under all conditions.

• Other operational requirements include:

• **Coverage of all populated areas with points of presence throughout the service territory**

• **Costs must be low**

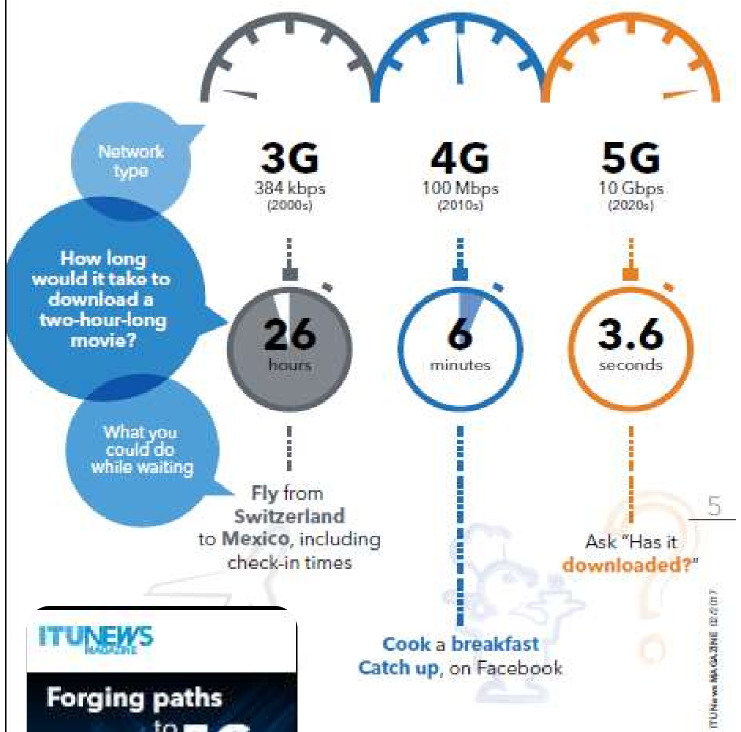
• **Continuity of service is vital,** and price stability

• **Utilities want network separation,**

Intelligent Transport Services… *and more*

(5G Infographics)

Looking forward to 5G video



5

ITUNews MAGAZINE 02/2017

What could 5G bring to you?	What's new with 5G?	Why not today?
Amazing volume, amazingly fast	Spectrum extension; millemetre waves; cell densification; increased spectrum efficiency; advanced antennas; 3D beam-forming techniques; new electronic components; backhaul optimization; D2D; moving networks (vehicle-based cells)	Spectrum saturation; limited spectrum aggregation; current hardware not able to function at high frequencies; expensive deployment and maintenance of small cells
Always best connected	Combination of 4G, 3G, Wi-Fi, and new radio access to create an integrated and dynamic radio access network; connectivity management mechanisms	Seamless handover (e.g. cellular to Wi-Fi) not supported
No perceived delay	Ultra-low latency; software-defined networks; decoupling functional architecture from the underlying physical infrastructure; network intelligence closer to users; mobile edge computing (MEC); D2D	4G latency ≥ 10ms
Massive amounts of connected things and people	New waveform; cell densification; much less signalling traffic and no synchronization; radio access network (RAN) architecture	Current frequency-division multiplexing (FDM) waveform limitations; interference prevents scaling up; 4G chipset cost; energy consumption
Energy efficiency	Millimetre waves for front-haul and backhaul; new operation mechanisms for dense networks; pooling of base station processing; on-demand consumption; massive machine communications; power amplifiers; digital signal processing (DSP) – enabled optical transceivers; harvesting ambient energy; optimization of sleep mode switching	Base stations' idle time not optimized; unused functions activated; air interface/ hardware not energy optimized
Flexible, programmable networks	Software-defined networks; network function virtualization; decoupling functional architecture from the underlying physical infrastructure; application program interfaces (APIs)	Many various network management software; not interoperable; bundling of network functions in hardware boxes
Secure networks	Physical channel authentication; virtualized authentication	Security as add-on not by design; fragmented approach

Source: European Commission 2015.
A Digital Single Market Strategy for Europe

3

ITUNews MAGAZINE 02/2017

5G in an ideal world

Transport

- Transport data flows freely between once closed sub-transport sectors
- Opportunities for new collaborations and applications
- The delivery of a true Internet-of-Things experience connecting everything on the road
- Data and advanced data products are acknowledged by all stakeholders and protected as the fuel in the new value chain
- Transport data sharing and access is fundamental

Automotive

- The industry is open to change
- New business models emerge
- High trust from users and related sectors
- Effective governmental frameworks and standardization

Utilities

- High levels of connectivity supported by a strong regulatory environment
- There is inter-vertical and cross-vertical collaboration
- There is interoperability and integration
- A new ecosystem of devices and networks is designed to meet user needs

Health care

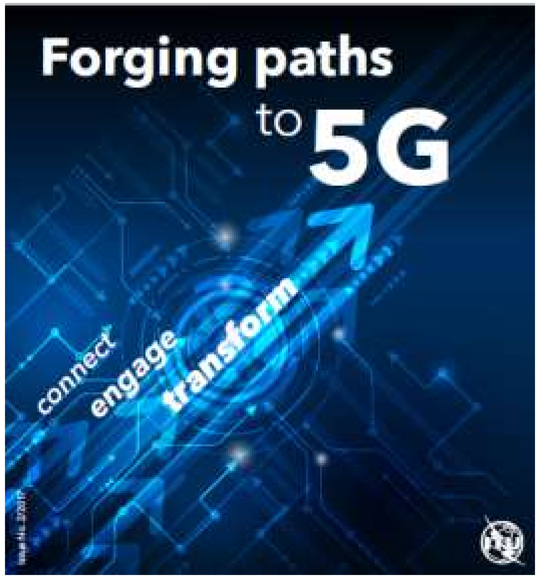
- Widespread acceptance of technology-driven innovation
- Health practitioners are open to change
- New emerging business models which are supported by strong, clear regulations
- Health care involves preventing illness and not just treating illness
- Health care involves enhancing wellbeing and quality of life

The above shows results of scenario development activities at workshops led by the European Commission.
Source: European Commission 2015.
A Digital Single Market Strategy for Europe (Chapter 5)

4

ITUNews MAGAZINE 02/2017

ITUNEWS MAGAZINE



1970s [1G]
First generation

First generation (1G) analogue systems for mobile communications saw two key improvements to the first radiotelephone services: the invention of the microprocessor and the digitization of the control link between the mobile phone and the cell site.

1980s-1990s [2G]
Second generation

Second generation (2G) digital cellular systems were first developed at the end of the 80s and initially deployed in the early 90s.

These systems digitized not only the control link but also the voice signal. The new system provided better quality and higher capacity at lower costs to consumers.

Regional/global operation of these systems was hampered by having multiple incompatible standards as well as different frequency bands and channel arrangements being used in different parts of the world.

A historic decision was taken at the ITU World Administrative Radio Conference 1992 (WARC-92) to identify globally agreed frequency bands for the operation of future public land mobile telecommunication systems – now called international mobile telecommunication (IMT) systems – in the Radio Regulations.

2000s [3G]
Third generation

After over ten years of hard work, the ITU Radiocommunication Sector (ITU-R), in close collaboration with national and regional standards development organizations, finalized the technical standards for the radio interfaces of third generation systems under the brand IMT-2000.

ITU's IMT-2000 global standard for 3G was unanimously approved at the ITU Radiocommunication Assembly 2000 (RA-2000), which opened the way to enabling innovative applications and services (e.g. multimedia entertainment, infotainment and location-based services, among others).

2012 [4G]
Fourth generation

Specifications for fourth generation mobile technologies – IMT-Advanced – were agreed in January 2012 at the ITU Radiocommunication Assembly (RA-12) in Geneva.

IMT-Advanced systems include the new capabilities that go beyond IMT-2000, providing access to a wide range of telecommunication services supported by mobile and fixed networks, which are increasingly packet based.

2012-2020 [5G]
Fifth generation

In early 2012, ITU-R embarked on a programme to develop "IMT for 2020 and beyond", setting the stage for 5G research activities that were emerging around the world.

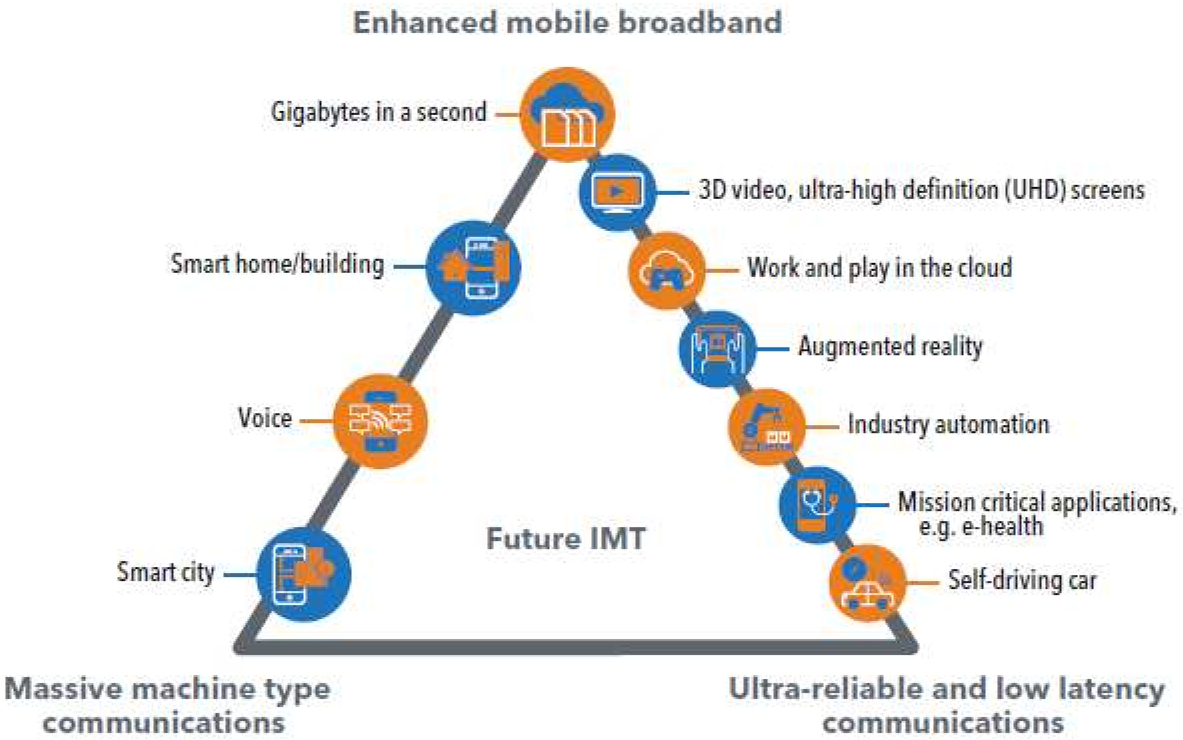
In September 2015, ITU-R finalized its "Vision" of IMT for 2020 5G mobile broadband connected society. The technical standards for IMT-2020 will be finalized by ITU-R in 2020. While enhancing mobile broadband communications, 5G will also extend the application of this technology to use cases involving ultra-reliable and low latency communications, and massive machine-type communications. In addition, the ITU World Radiocommunication Conference 2019 (WRC-19) will address the need to identify additional spectrum to support the future growth of IMT.

CELEBRATING 25 YEARS OF ACHIEVEMENTS

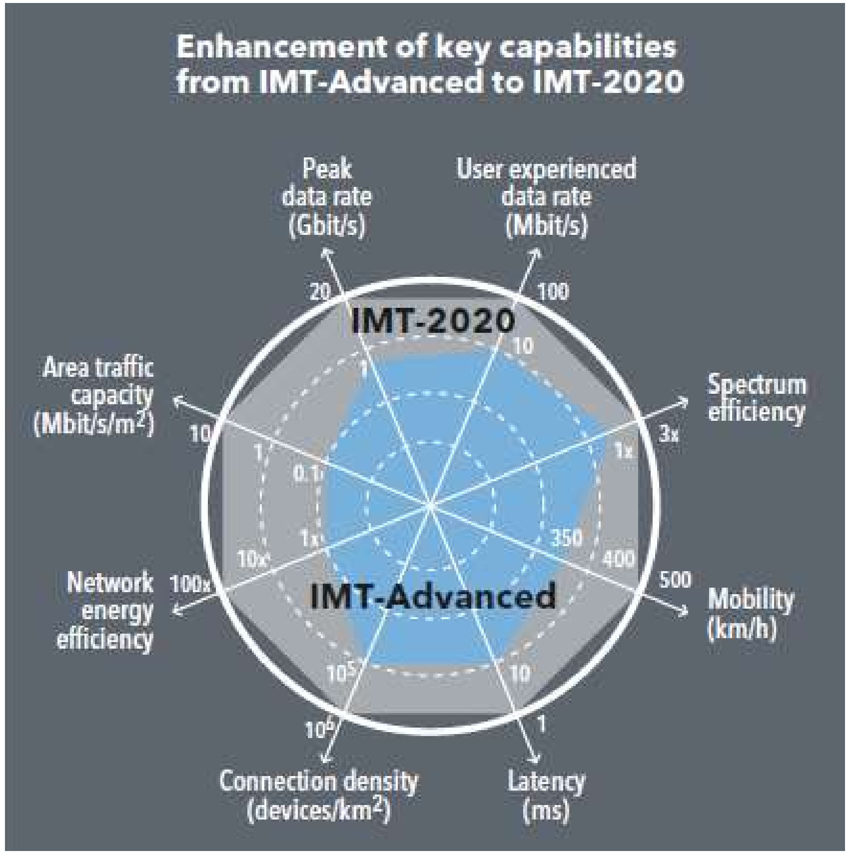
Source: **Standards and spectrum for international mobile telecommunications, François Rancy, Director, ITU Radiocommunication Bureau, ITU News, 02/2017**

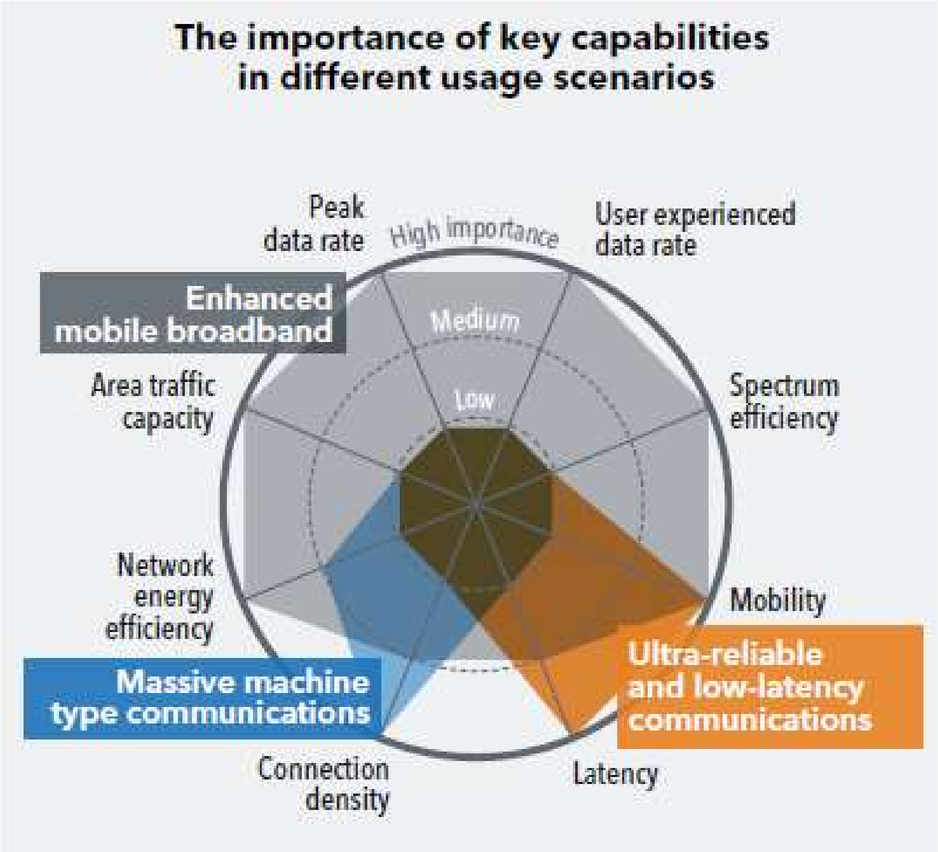
IMT-2020 standardization process

5G usage scenarios from the ITU-R IMT-2020 Vision Recommendation



Source: **Forging paths to IMT-2020 (5G), Stephen M. Blust,** Chairman, ITU Radiocommunication Sector (ITU–R) **Working Party 5D, Sergio Buonomo,** Counsellor, ITU–R **Study Group 5, ITU News, 02/2017**





The values in the figures above are targets for research and investigation for IMT-2020 and may be revised in the light of future studies. Further information is available in the IMT-2020 Vision (Recommendation ITU-R M.2083)

Source: **ITU-R Recommendations M.2083**

Emerging ICT Infrastructure

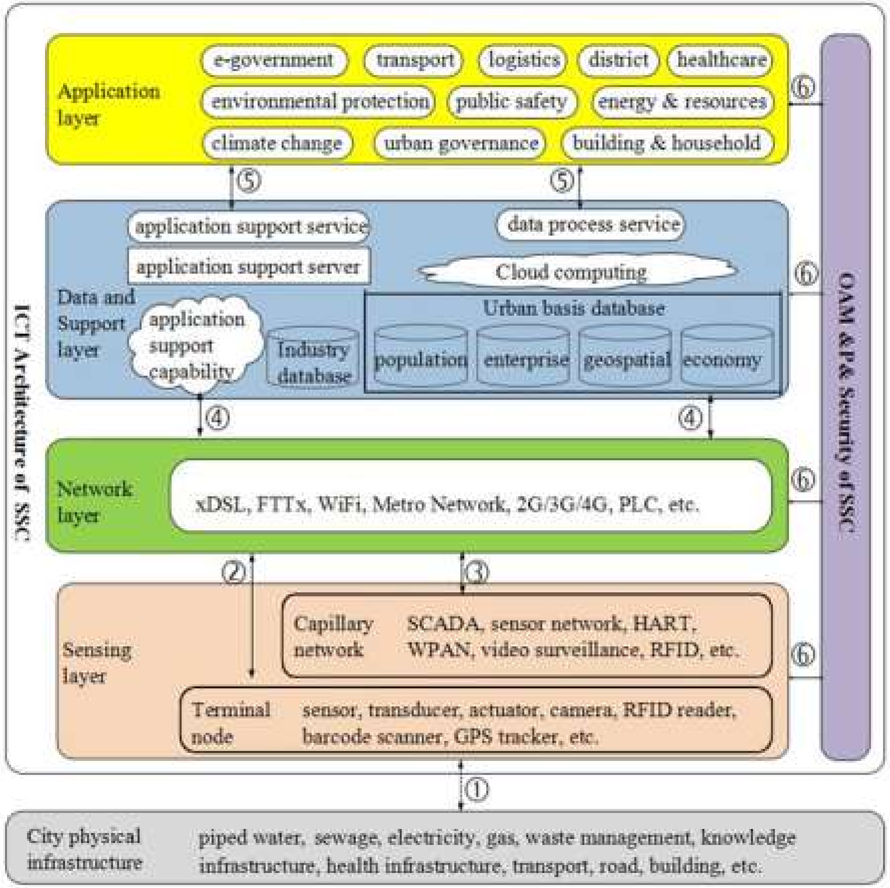
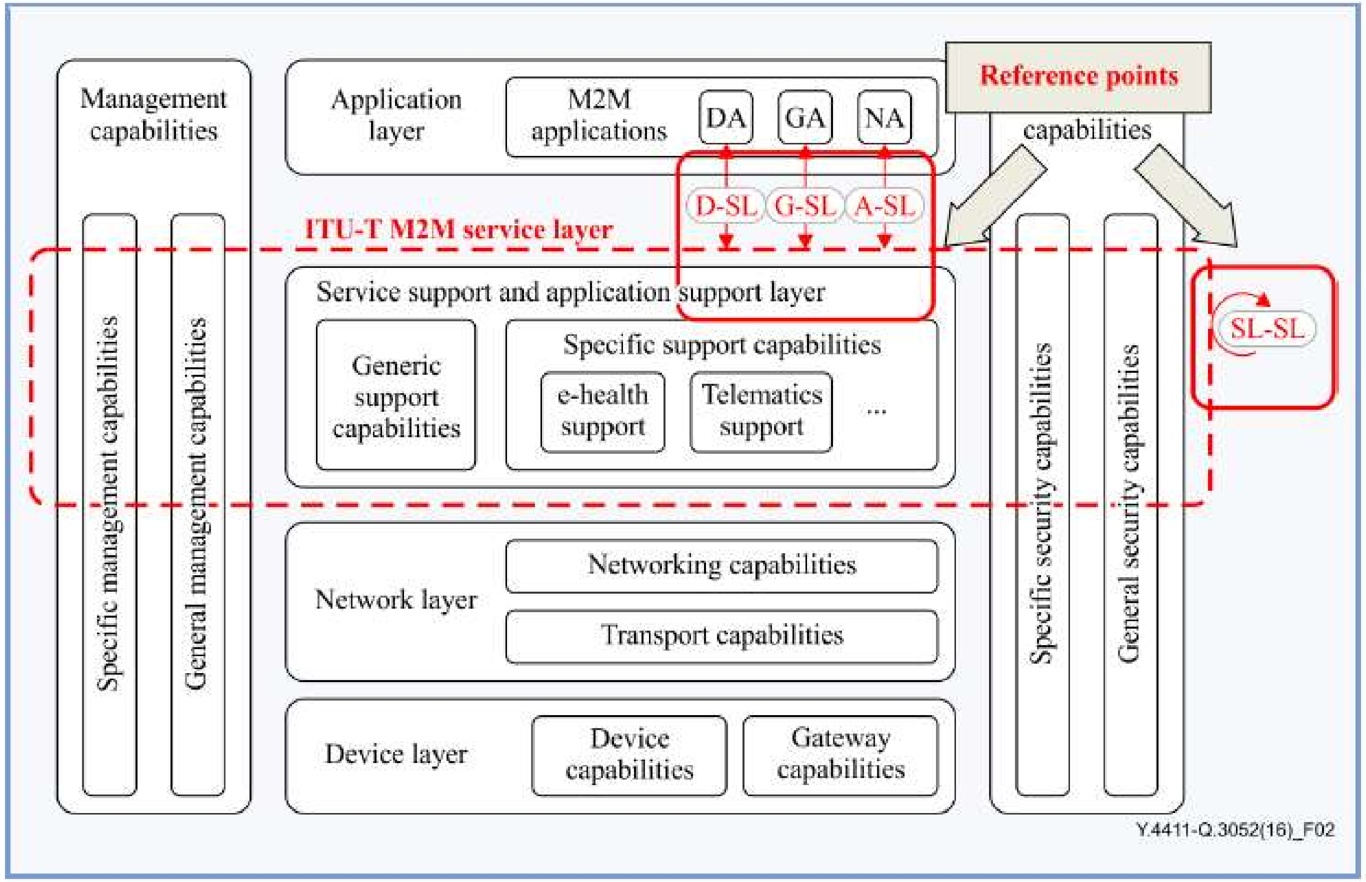


Figure source: ITU-T Focus Group on Smart Sustainable Cities: *Overview of smart sustainable cities infrastructure*

A multi-tier SSC (smart sustainable city) ICT architecture from communication view (physical perspective)

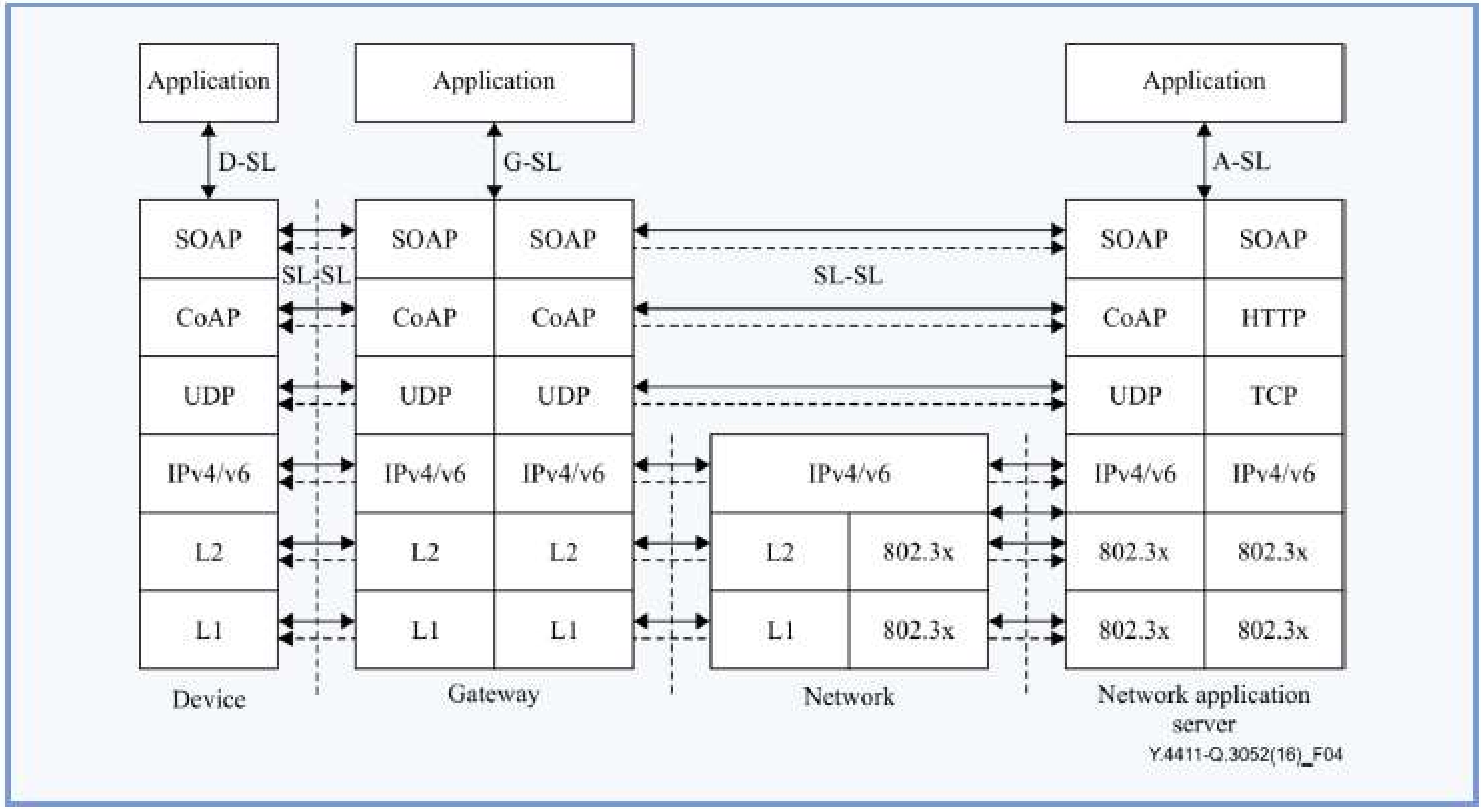
Internet of Things use a wide variety of networks: mobile and fixed

Reference points of the ITU-T M2M service layer



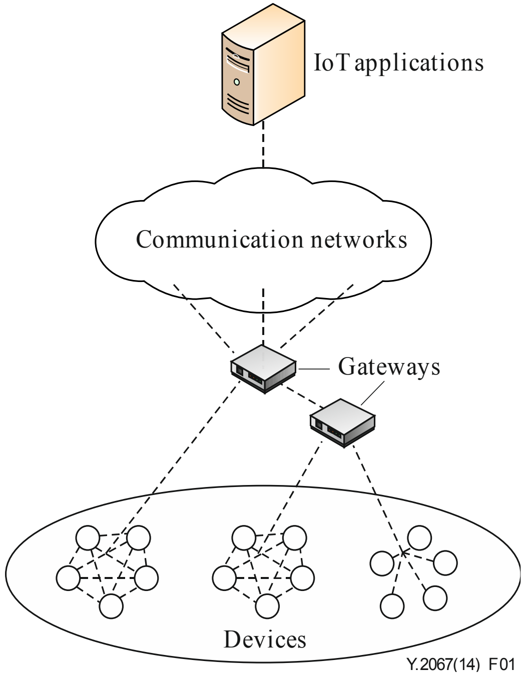
Source: ITU-T Recommendation **Y.4411/Q.3052 (02/2016)**

Example of protocol stacks in the component-based M2M reference model

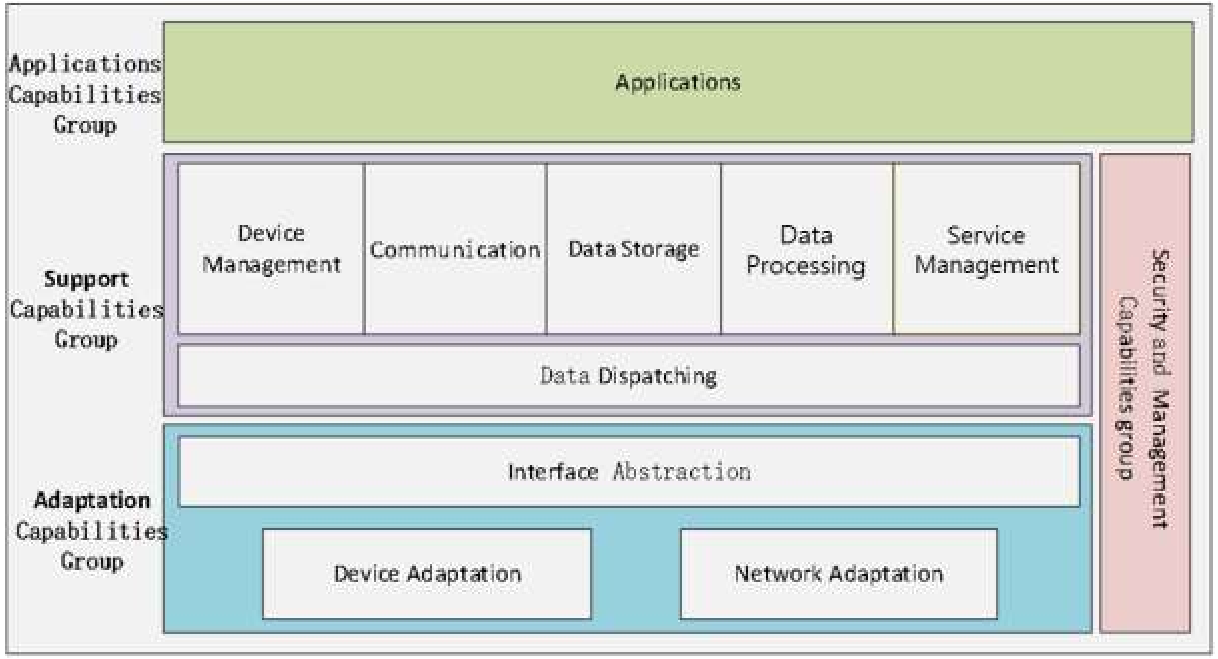


Source: ITU-T Recommendation **Y.4411/Q.3052 (02/2016)**

Typical deployment scenario of gateways for IoT applications

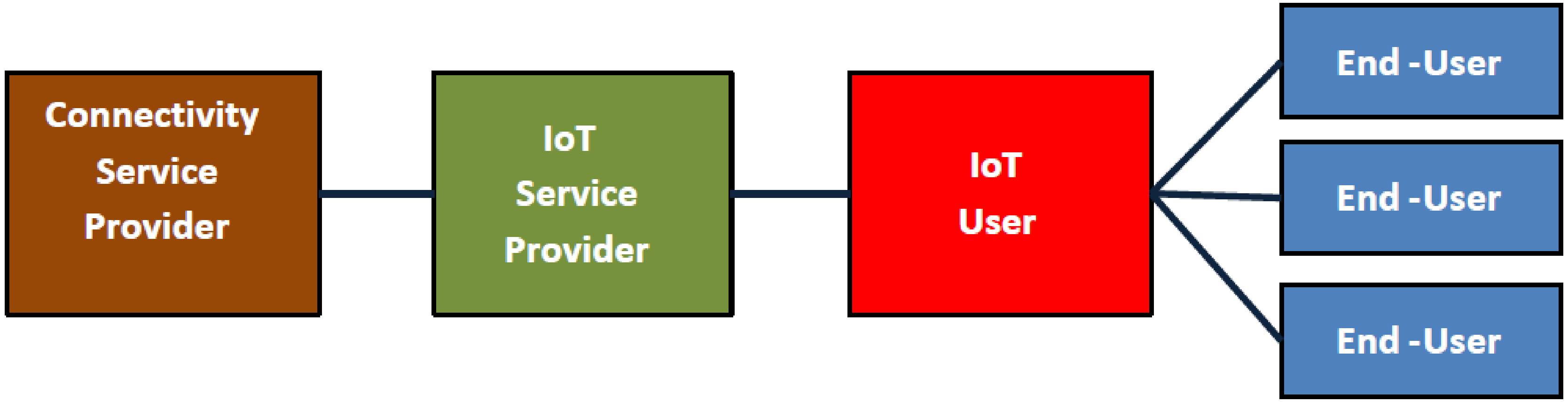


Reference technical framework of a gateway for IoT applications



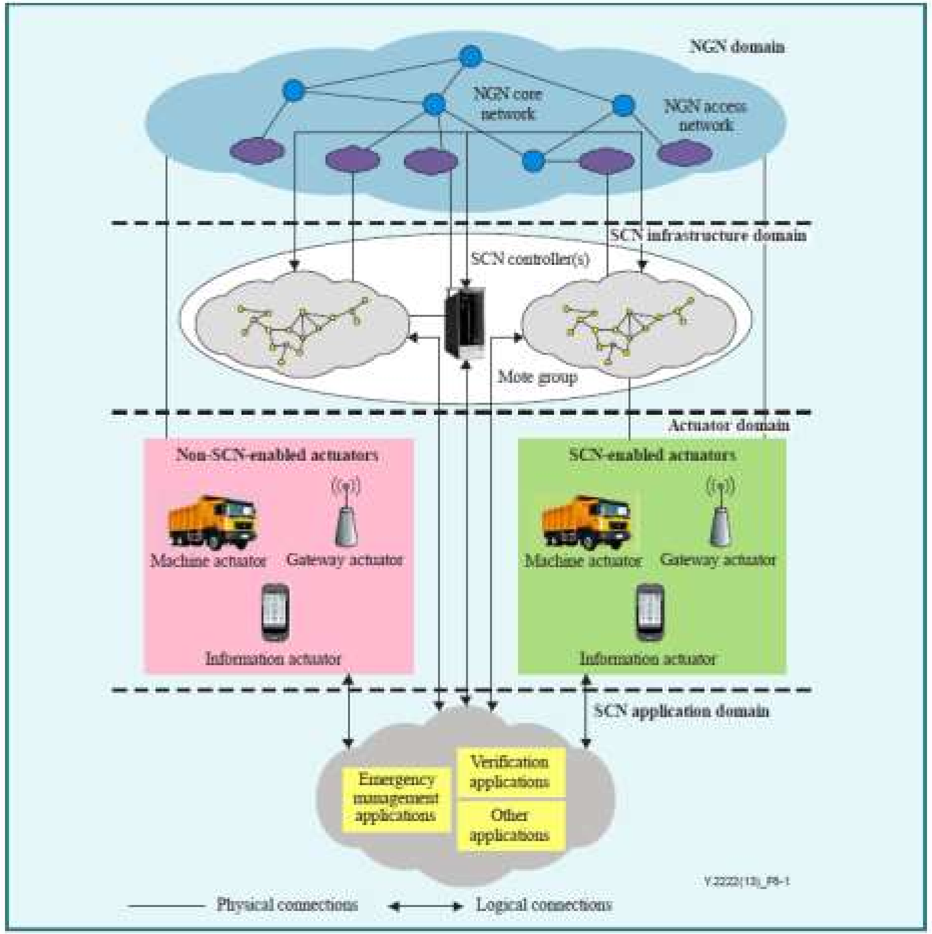
Source: **Draft revised Recommendation ITU-T Y.4101/Y.2067**

IOT Value Chain



Source: BEREC **Report “Enabling the Internet of Things”**12 February 2016

Overview of Sensor Control Network (SCN)

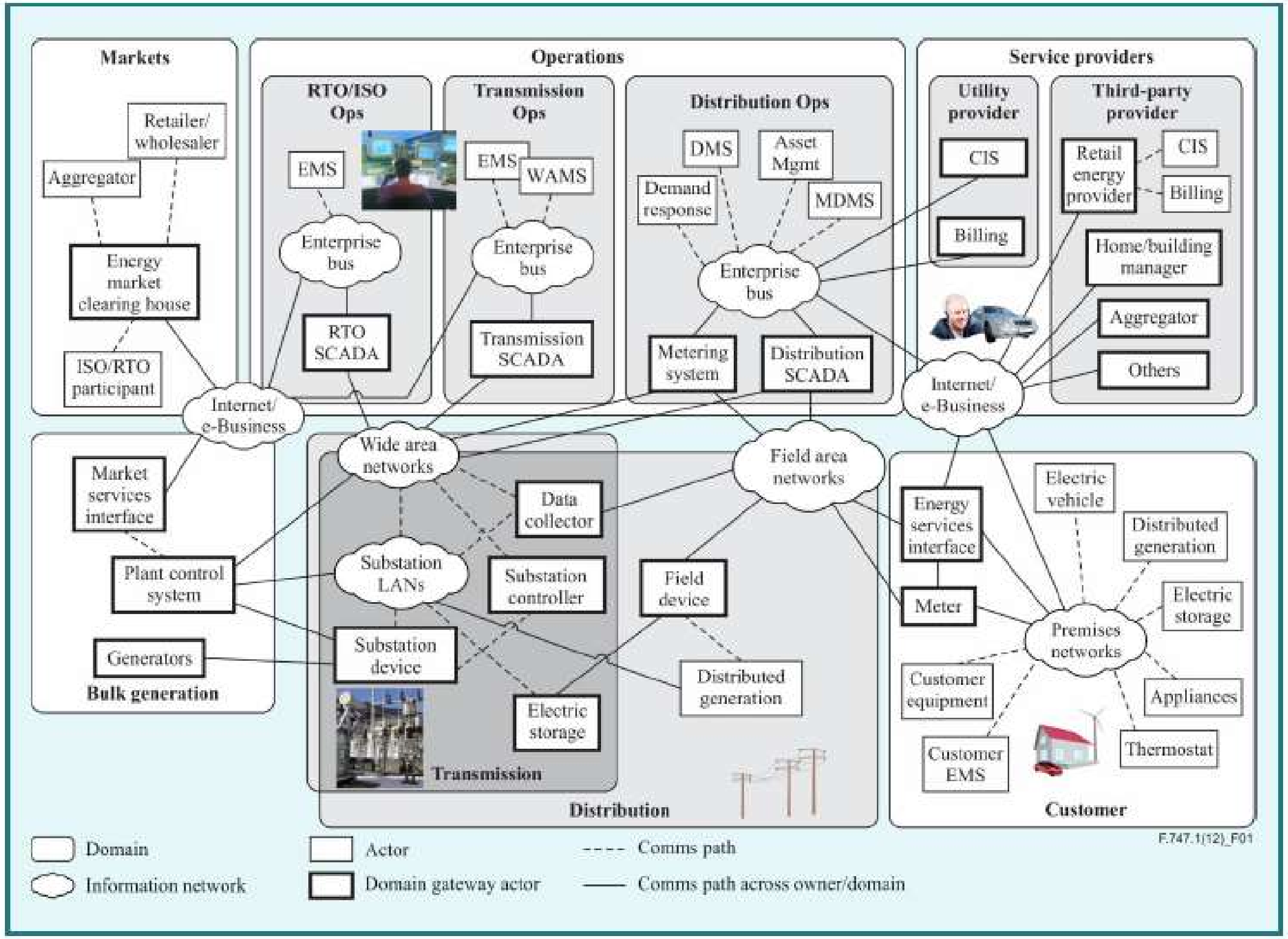


Source: Recommendation ITU-T T.4250/Y.2222

Service requirements of SCN applications

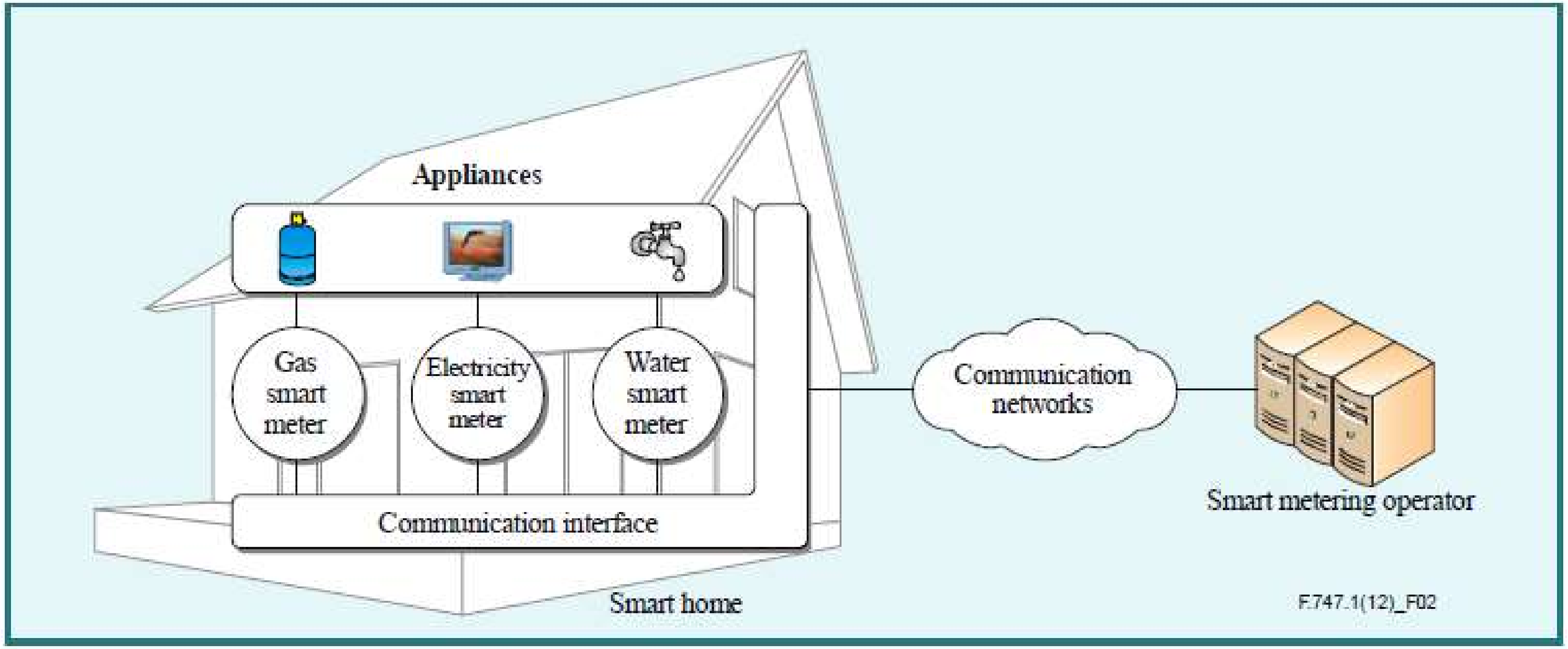
- Connectivity
- Mobility support
- Context awareness
- Location awareness
- Presence awareness
- Traffic and load awareness
- Fault awareness
- Routing
- Load balancing
- Scalability
- Fault tolerance
- Quality of service
- Management
- Pledging of security of decisions
- Open service environment (OSE) support
- NGN service integration and delivery environment (NGN-SIDE) support
- Mass mobile user terminal support
- Emergency management applications
- Security

IOT Example: Smart Grid Architecture



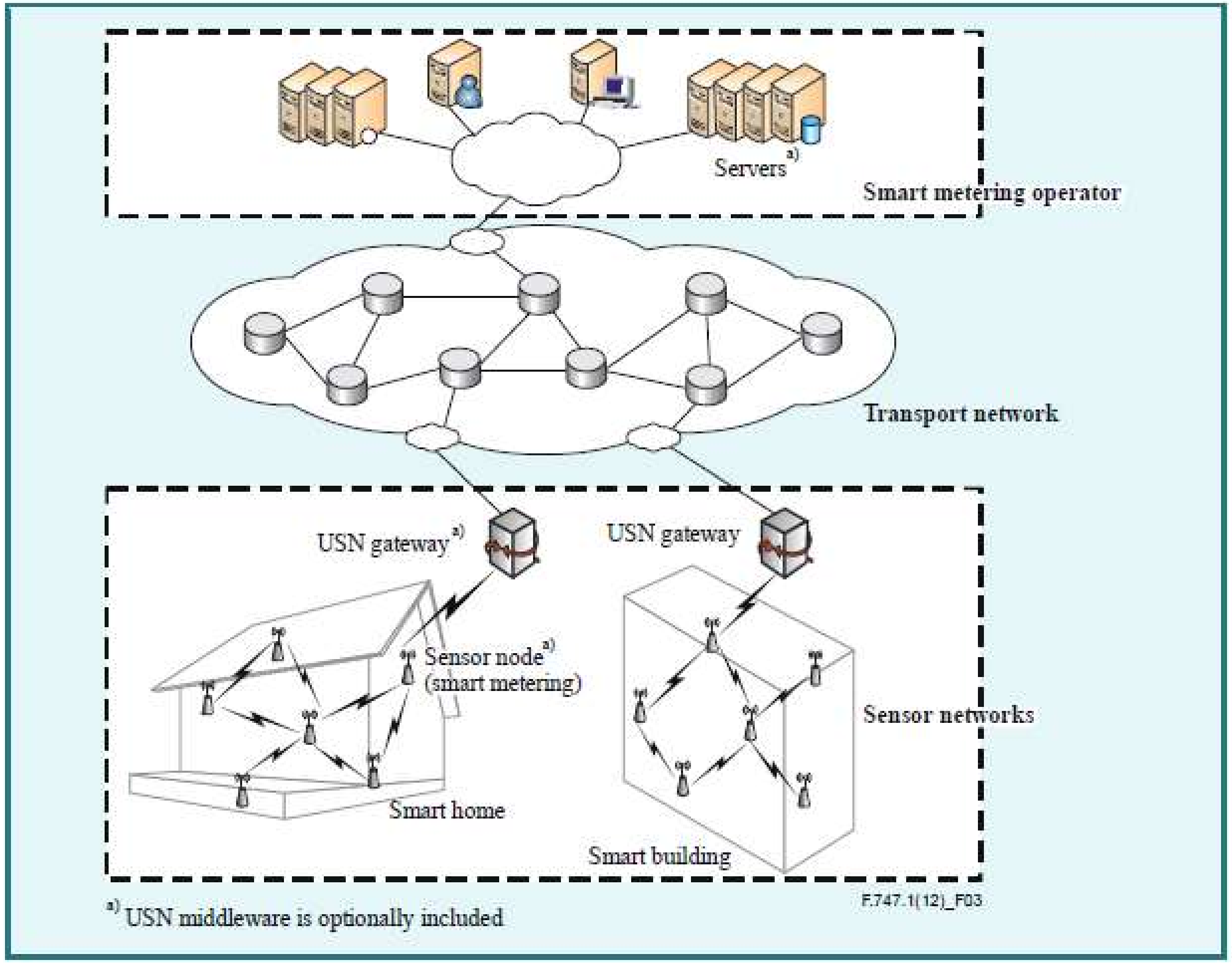
Source: Recommendation ITU-T Y.4251/F.747.1 (06/2012)

IOT Example: Technical Overview of Smart Metering



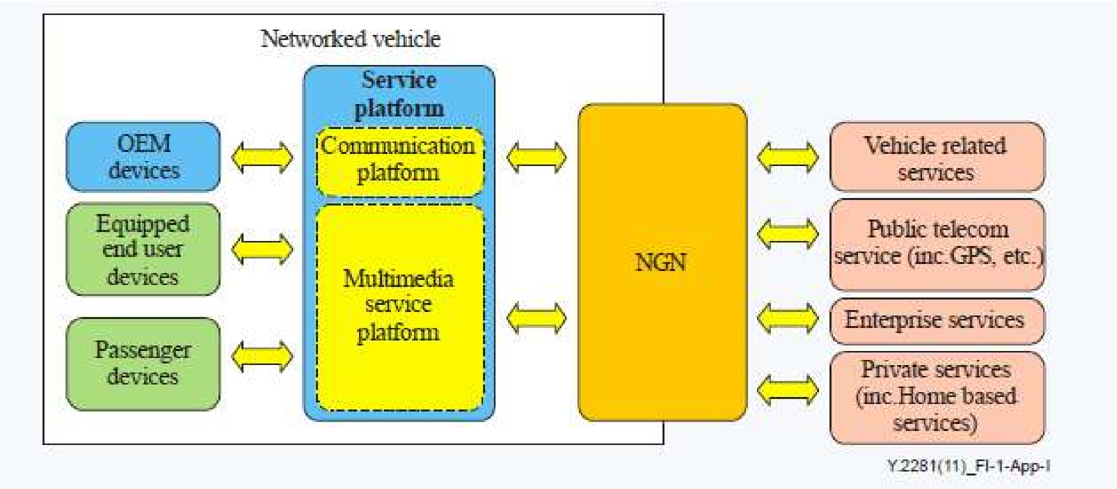
Source: Recommendation ITU-T Y.4251/F.747.1 (06/2012)

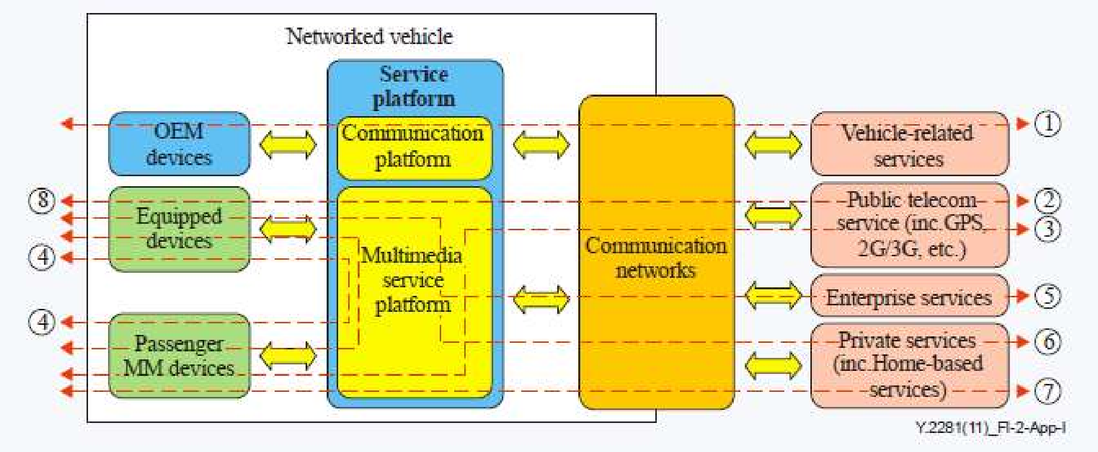
IOT Example: USN-based smart metering services



Source: Recommendation ITU-T Y.4251/F.747.1 (06/2012)

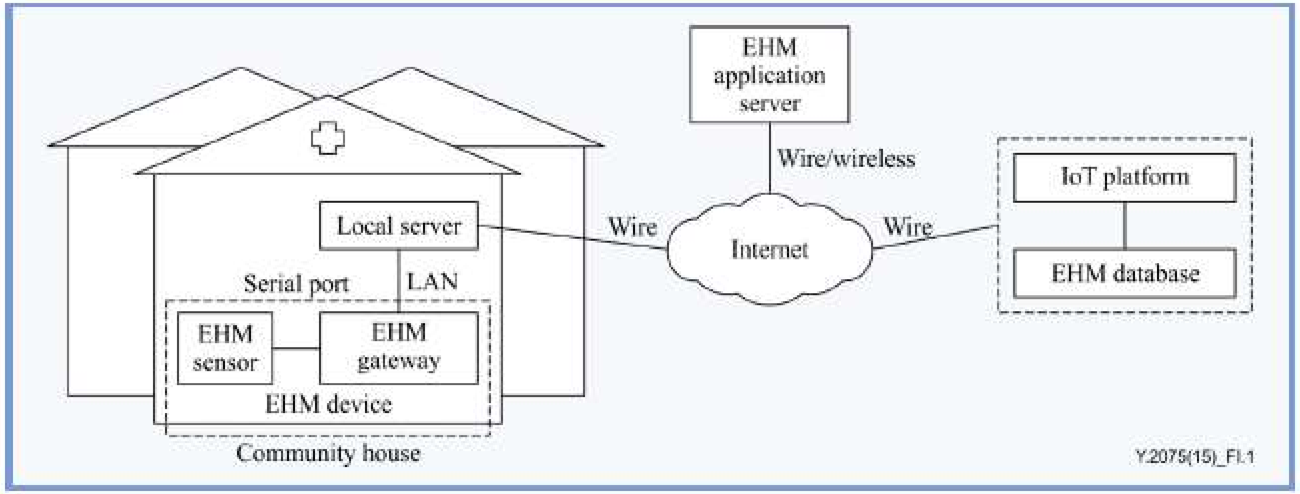
IOT Example: Service configuration model of a networked vehicle

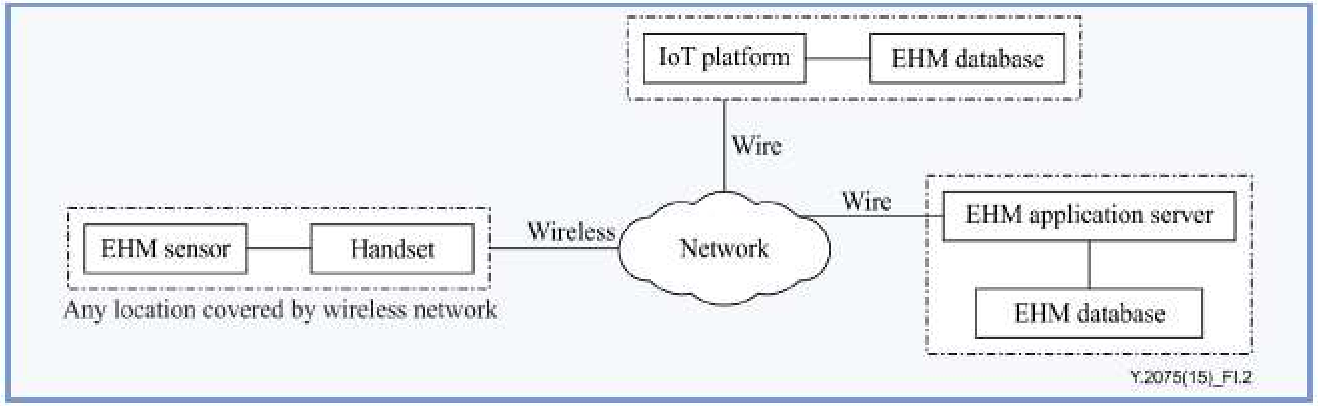




Source: Recommendation ITU-T **Y.4407/Y.2281 (01/2011)**

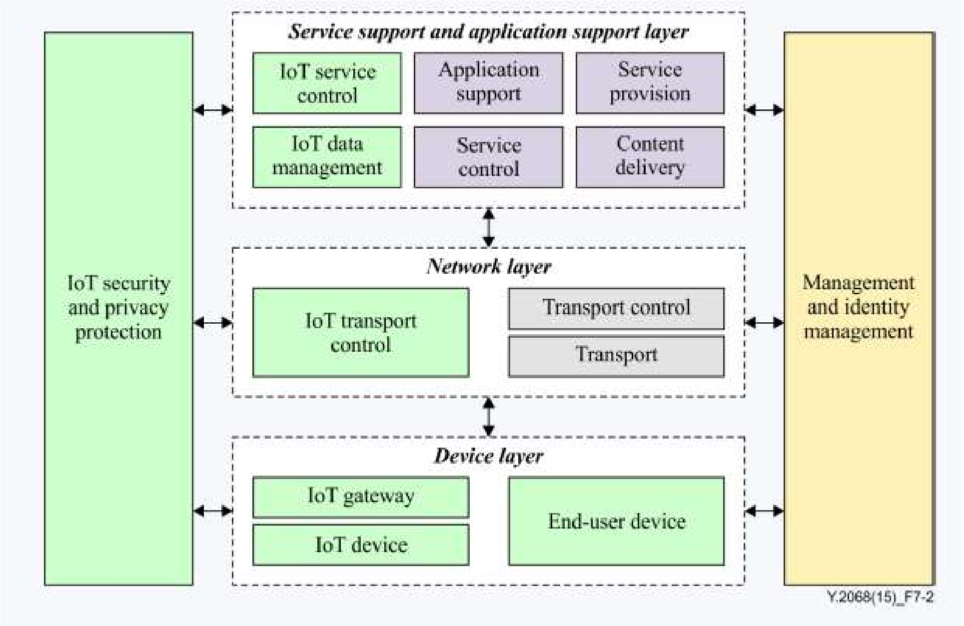
IOT Example: E-Health Monitoring (EHM) service deployment technical scenarios



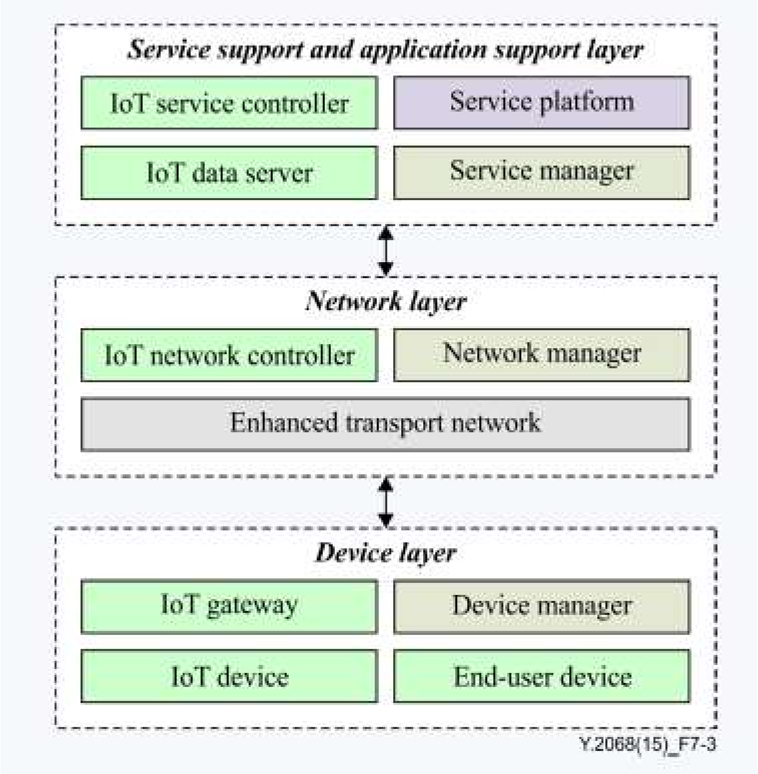


Source: Recommendation ITU-T **Y.4408/Y.2075 (09/2015))**

Implementation view of the IoT functional framework building over the NGN functional architecture

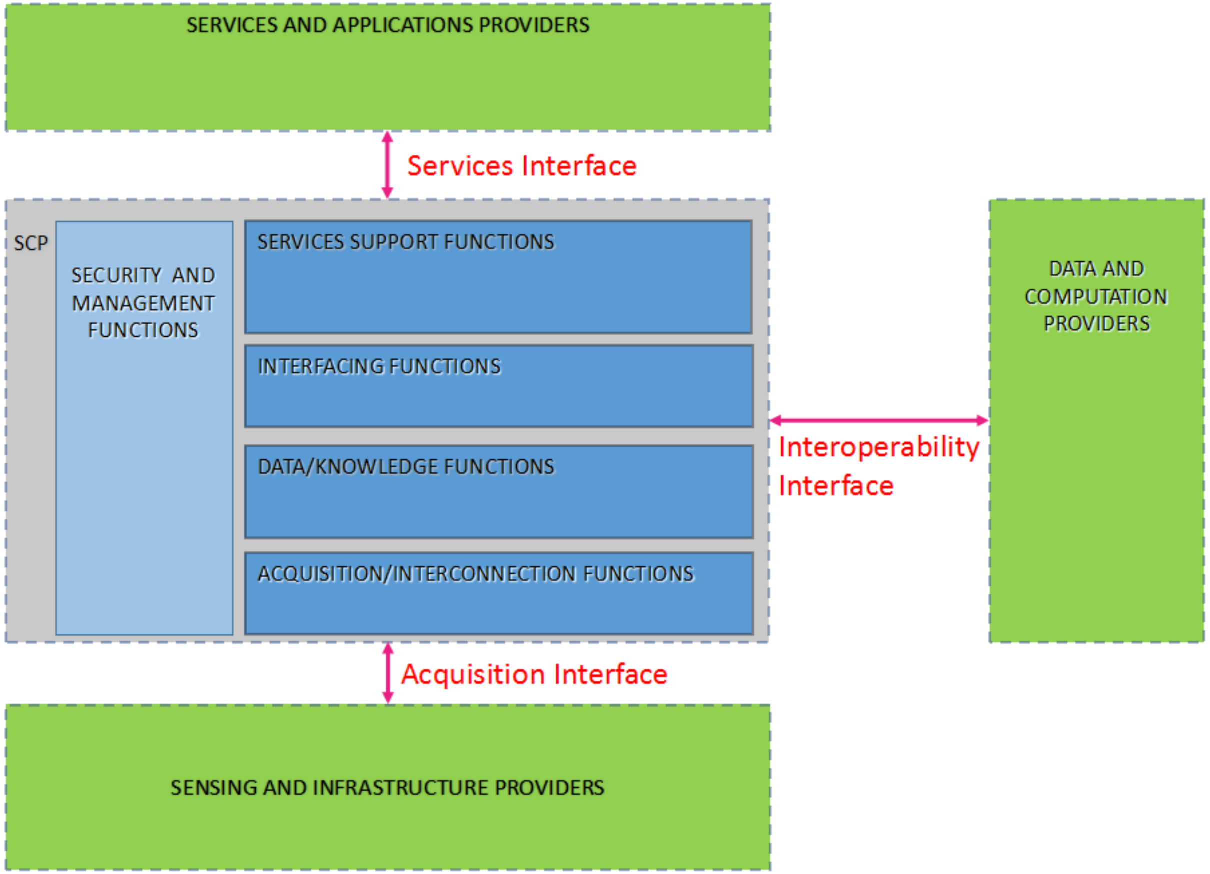


Deployment view of the IoT functional framework building over the NGN components



Source: Recommendation ITU-T Y.4401/Y.2068 (03/2015))

Overview of a smart city platform (SCP) and external systems/platforms



Draft new Recommendation ITU-T Y.4200 (ex.Y.SCP)

Thank You