ITU Asia-Pacific CoE Training

Broadband Quality of Service - End User Experience

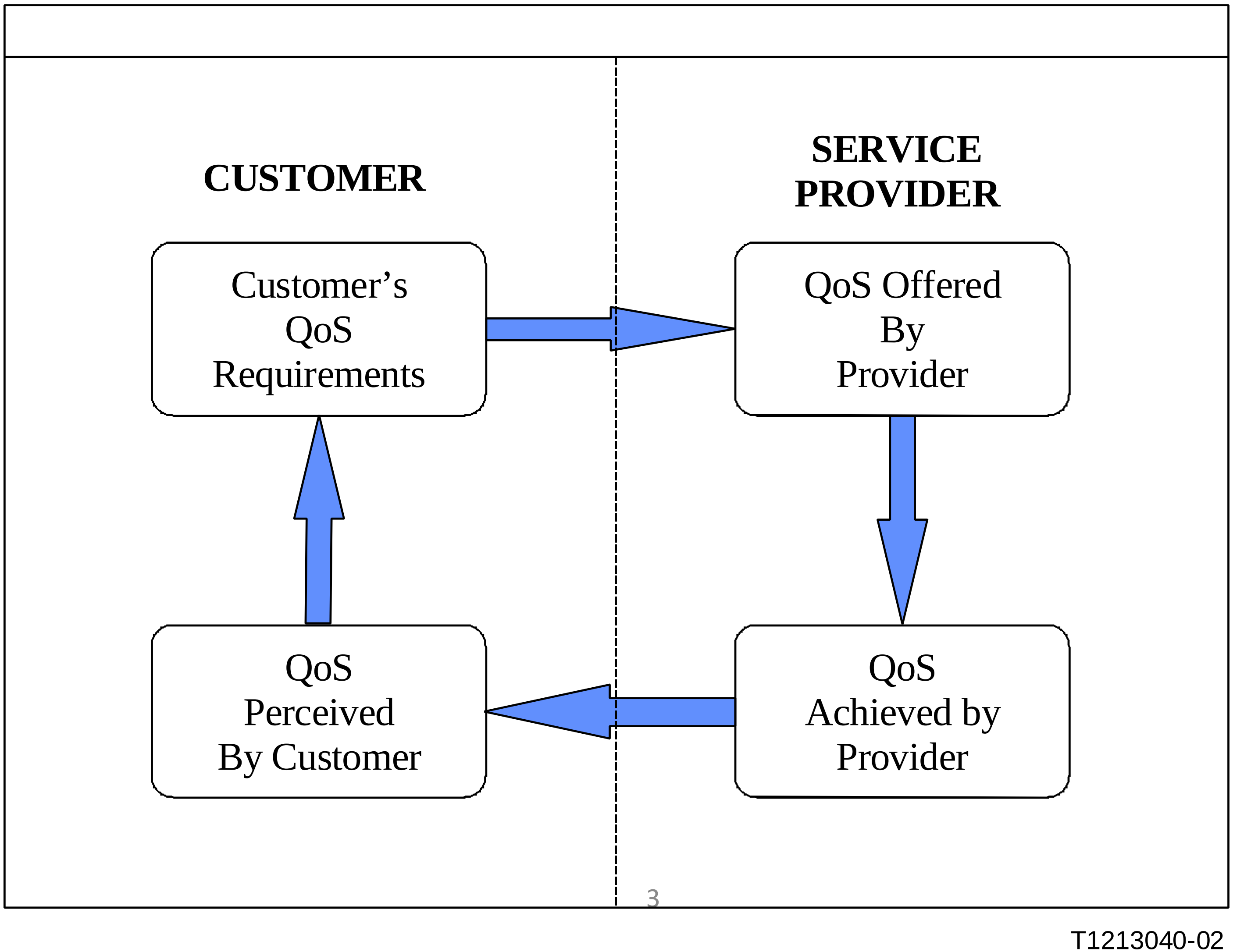
Session 14: Quality of Service / Experience in a Converged Environment

27-30 October, 2015

Bangkok, Thailand

- Objective: To examine the applicability of QoS / QoE frameworks for converged services and applications

QoS framework of Rec. G.1000



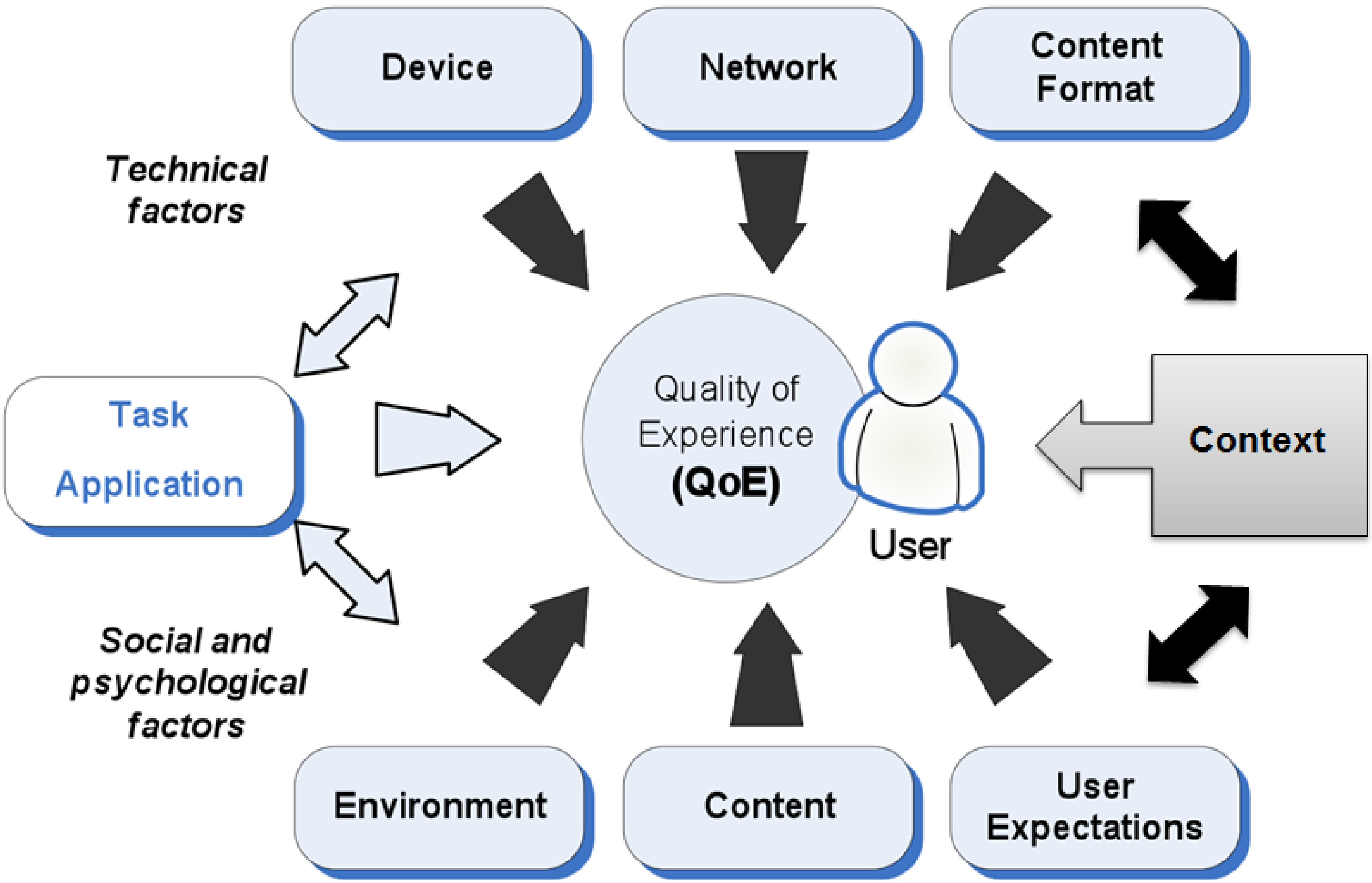
QoE definition from ITU-T P.10/G.100

- **Quality of Experience (QoE)**: The overall acceptability of an application or service, as perceived
- subjectively by the end-user.
- NOTE 1 – Quality of experience includes the complete end-to-end system effects (client, terminal, network,
- services infrastructure, etc.).
- NOTE 2 – Overall acceptability may be influenced by user expectations and context.

QoE Framework ?

- … under construction
  - since 1998
- Individual proposals / “solutions” available
- Service offer related framework exists
- Many proposals
- Many undertakings…
- Qualinet started in 2010 work on QoE
  - http://www.qualinet.eu/index.php?option=com_content&view=article&id=10&Itemid=10

Qualinet approach



Qualinet proposal

- To have a lasting impact, the proposed QoE definition shall fulfill the following basic requirements:
  - being simple and intuitive but also challenging, powerful and complete;
  - not confusing the concept with a given model or implementation;
  - making clear the relationship and distinction with other related concepts such as QoS

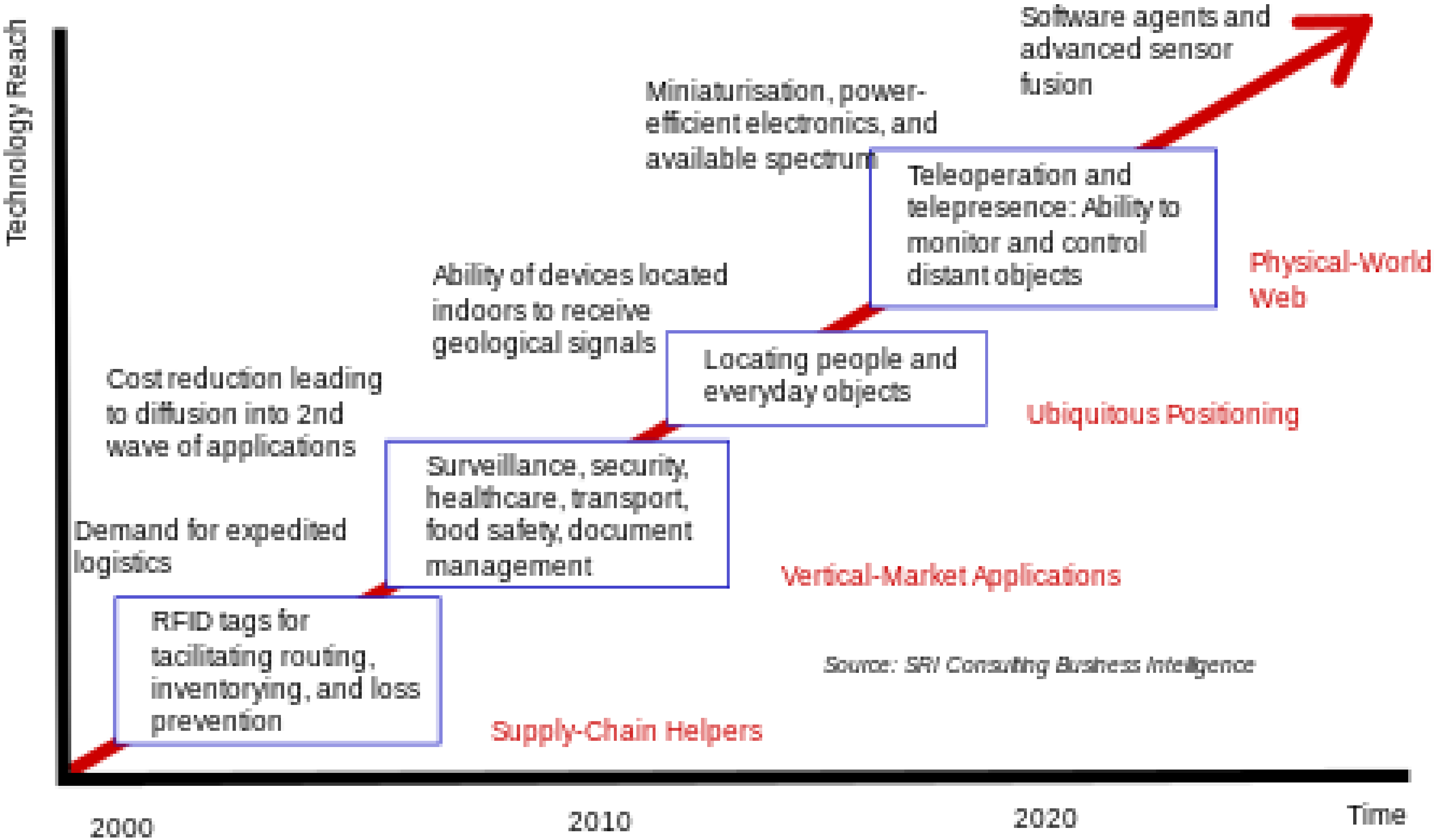
Working definition of QoE

- **Quality of Experience (QoE)**
  - is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user’s personality and current state.

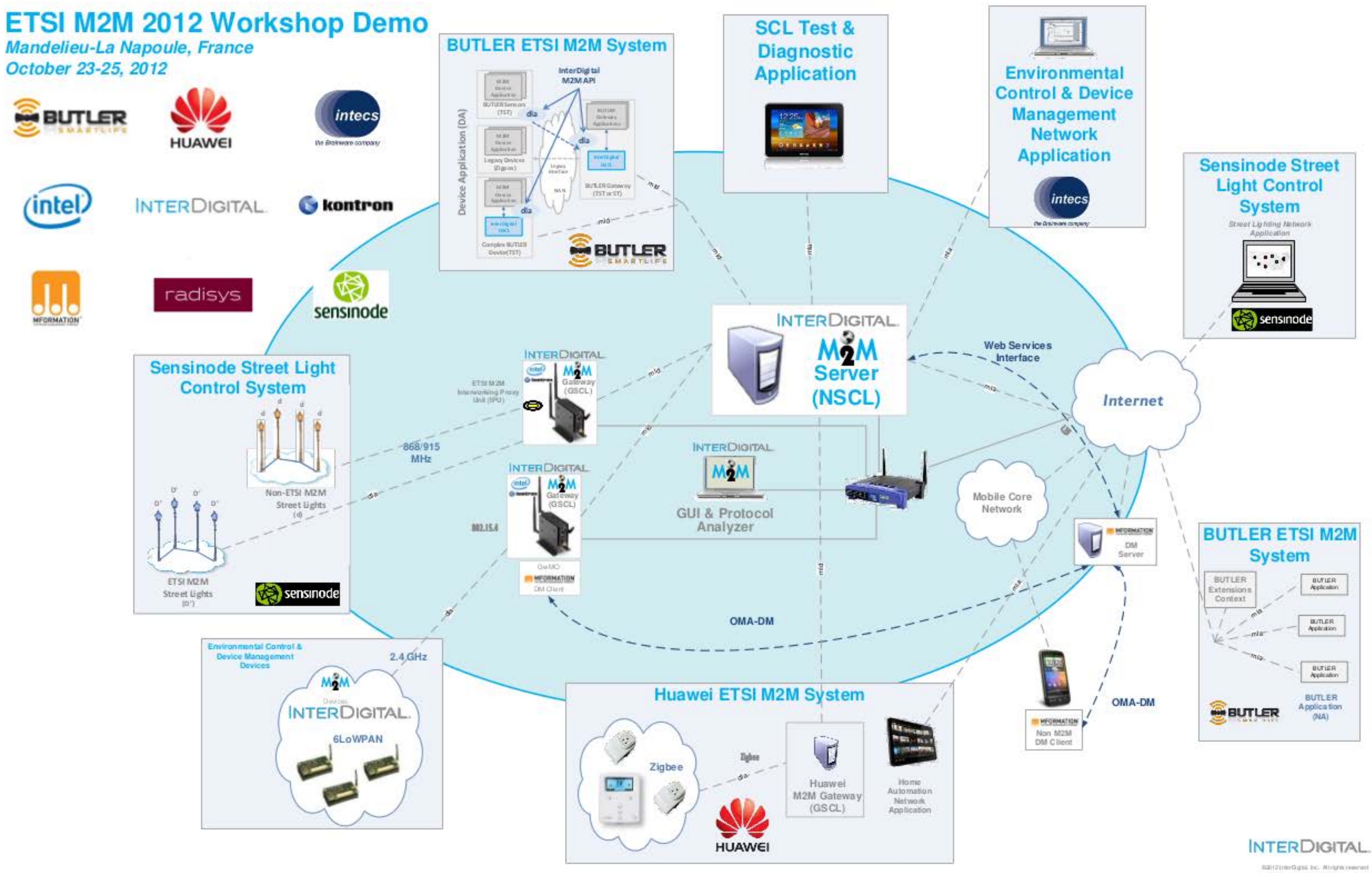
Source: ITU

- The Internet of Things (IoT) is the network of physical objects or "things"
  - embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.
  - The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.
  - Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

Technology roadmap: The Internet of Things

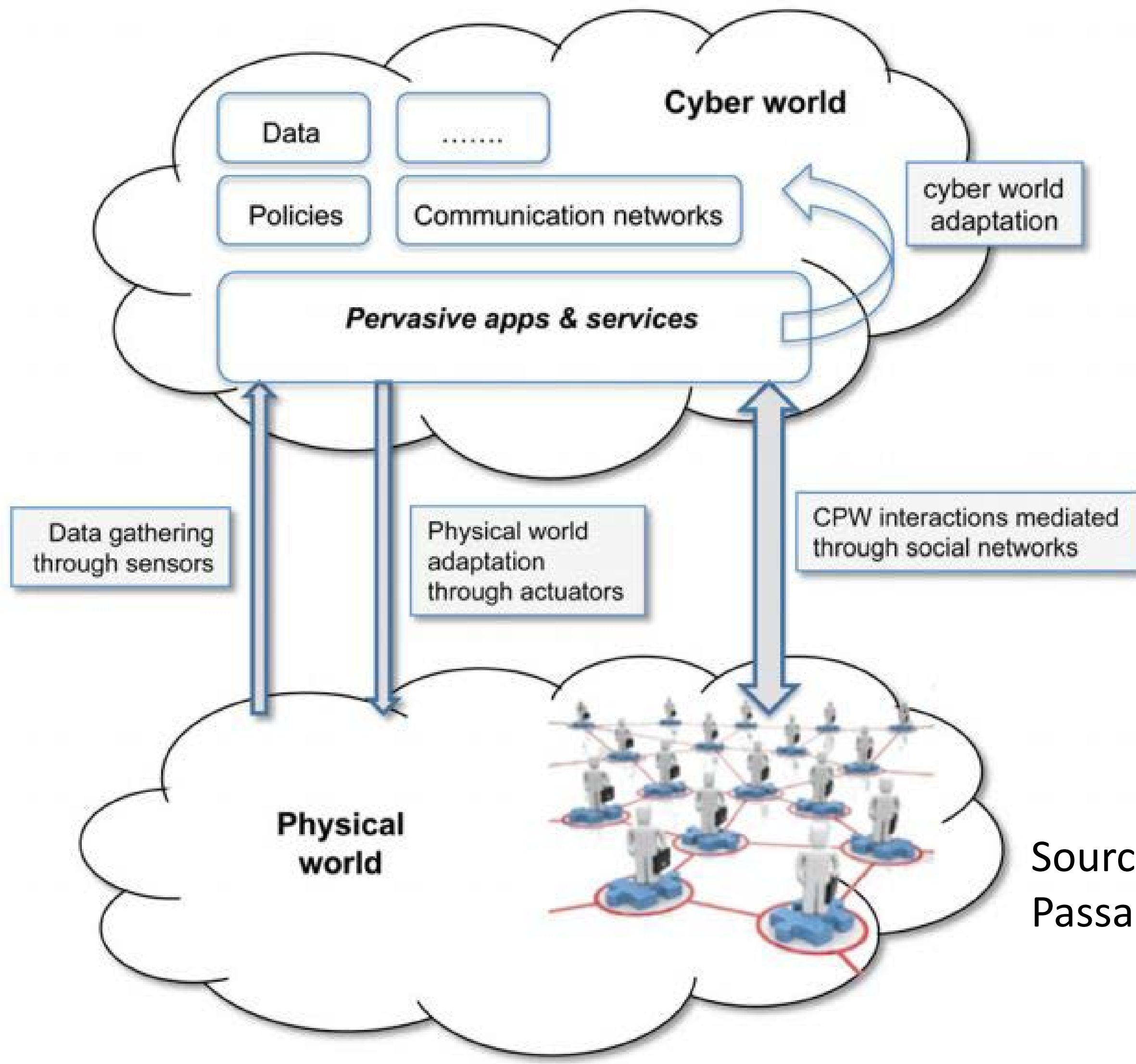


IoT = M2M ≠ IoP ?


ETSI M2M 2012 Workshop Demo
Mandelieu-La Napoule, France
October 23-25, 2012
BUTLER ETSI M2M System
SCL Test & Diagnostic Application
Environmental Control & Device Management Network Application
Sensinode Street Light Control System
Sensinode Street Light Control System
INTERDIGITAL M2M Server (NSCL)
Web Services Interface
Internet
868/915 MHz
GUI & Protocol Analyzer
Mobile Core Network
802.15.4
OMA-DM
BUTLER ETSI M2M System
Environmental Control & Device Management Devices
2.4 GHz
6LoWPAN
Huawei ETSI M2M System
Zigbee
Huawei M2M Gateway (GSCL)
Home Automation Network Application
OMA-DM
Non M2M DM Client
DM Server
INTERDIGITAL

IoT = M2M ≠ IoP ?

- Internet of People
  - QoE of M2M who decides M or M ?
  - QoE of IoT who decides T or T ?
  - QoE of IoP as perceived by P



Source: [Conti, Passarella et al. 2012]

- Starting point: rapid evolution of IoT vs cyber-physical convergence
- → integration of physical and cyber world
  - Consequence: -humans are placed right at the centre of the technical systems they use
  - resulting paradigm change: Anti-Copernican Revolution

- Main resulting scenarios: -"Human proxy": communication between devices acting as proxies
  - "Crowdsourcing": exploiting human resources for optimal system operation
  - "User Experience": behavior of devices is designed taking user reaction
- Economics of QoE in the resulting "Internet of People" (IoP)?

OTT

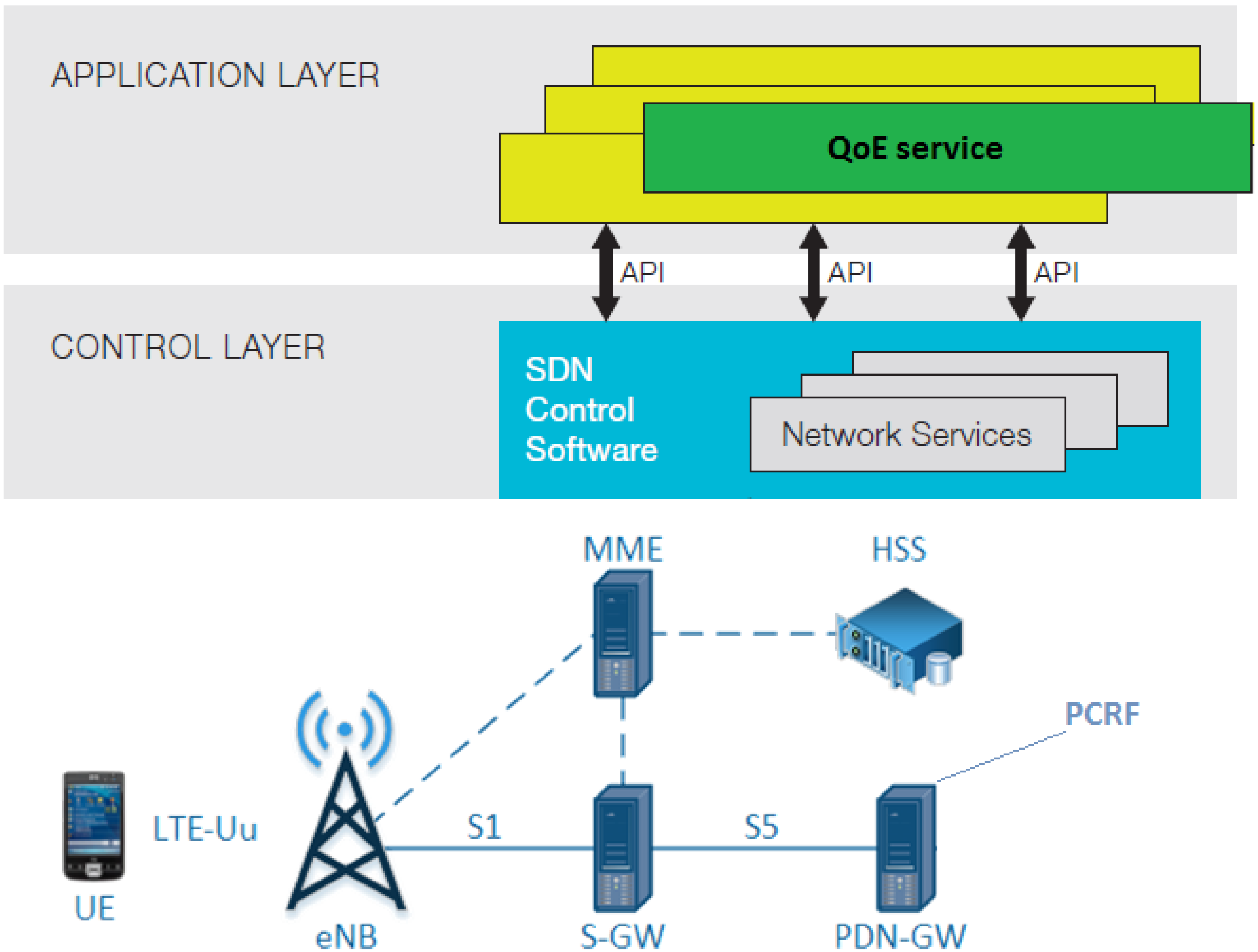
- MNOs face a tremendous increase of data traffic
  - Much of the traffic is originating from OTT Apps
  - MNOs lose money: profits are unaffected while cost is higher
- Increased App types with largeQoS diversity "compete" for the same pool of resources
  - OTT Apps are served without QoS guarantees, over the default best-effort bearer

Collaboration MNO –OTT ???

- **Then, why not go for a win-win paradigm of MNO-OTT "interfacing", where:**
  - **OTT Apps are served with better QoE (introducing some OTT control)**
  - **QoS differentiation per App type**
  - **App prioritization possible**
  - **Resources shared more efficiently**
  - **MNOs get into the revenue loop**

  - **Question: Are players equal-sized: MNO OTT ???**

Solution SDN ?



Improving quality of life..

Different Services, Different Requirements - Examples

PPDR services

Public Protection and Disaster Relief

- **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 immedia... ...ss on demand: the **Push-to-talk** (PTT)function and **all**... ...nal broadcasts).
- **Relay capabilities**
- **Support for Air-Gro**... **...A) communication** when and where needed.
- **Adequat**... **...service**
- **The ab**... **...roam onto commercial networks**
- **Interworking between various PPDR services,** and increasingly, across borders.

Fast call setup (<200ms)

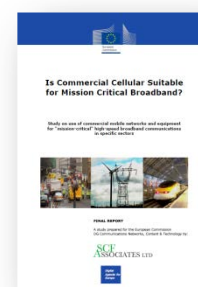
•Firefighting services

Speech intelligibility key issue

- **Voice is primary for fire commu**...
- **Speech intelligibility is a k**...
- **Part-time voluntee**... **...tant to the fire services in large areas of E**...
- **Securing** ... **...nication channels through encryption is rarel**... **...y.**
- **Ro**... **...vigation assistance and location tracking are essential**
- **In the near future, greater bandwidth for low-latency data transmissions will be needed**
- **Lower frequency radio bands, even into the VHF region, provide better signal penetration** into buildings, so they are preferred for fire communications.
- •... **...s**

Handsets must be usable with gloves

Intelligent Transport Services... *and more*



Different Services, Different Requirements - Examples

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 auto[illegible]store service after an interruption or an unpla[illegible]on.

• **Security** – systems [illegible]e safety and security of plant.

• **Voice service**[illegible]

• **Metering** [illegible]g data from smart meter[illegible]d communicat[illegible]g with them for various re[illegible] as demand management and to implement tari[illegible]

• **Connectivity** – telecommuni[illegible]orks to interconnect the above services in a r[illegible]esilient manner under all conditions.

99.999 % availability

Low latency <5ms

• Other operational req[illegible]ements 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,**

- **Electricity generation and distribution are the utility sector's primary users of radio.**

• **Utilities use radio mainly for the routine but business critical demands of managing their distribution networks and supply chains. Repairs and monitoring are typical tasks.**

- **Utilities require low data volumes at quite low transfer rates**
- **Even though utilities are turning to MNOs to support field workers, they still prefer to own dedicated communication networks**
- **Utilities do not need most of the PPDR-specific features sought from LTE**
- **Everyday teleprotection for electric utilities requires continuity of service with what commercial cellular operators would consider extreme even unattainable reliability (99.999% availability) and consistently low latency (<5ms)**
- **LPG gas depots, high-voltage electricity lines and nuclear power plants (along with their fuel/waste cycle) are critical infrastructures**
- **Gas and water utilities have similar but limited uses for radio**
- **National differences in market structure and business operation will make it hard for Europe's utility industries to find a single satisfactory answer to their wireless voice and data needs**

Intelligent Transport Systems

Different Services, Different Requirements - Examples

ITS industry :

•**The diversity of ITS applications** is greater than the diversity of PPDR and utility applications, and yet most ITS applications are still "on the horizon" with uncertain spectrum requirements. Cooperative movements of large numbers of self-driving vehicles, for example, could require substantial radio bandwidth, as well as high availability and security.

•• **Many current ITS applications are based on narrowband data**; GPRS is often an appropriate medium.

•• For ITS applications that are local (e.g. vehicle to roadside, vehicle to approaching vehicle) cellular network infrastructure is unnecessary.

•• **The only current ITS application requiring broadband is the delivery of multiple video streams** to traffic monitoring centres and for security in public transport.

• **Railways need broadband mainly to supply passengers with information and internet access. It is not needed for the "mission critical" activity of train control**.

•In fact, it can be argued that train control and internet access must be kept separate to prevent remote "hijackings" and cyber attacks on rail safety systems.

•• **Railways need secure talkgroup services** like those of first responders. DMO has not been used but it could be handy to have.

•• **The reliability of data links to "radio block centres" is a primary consideration** because in ETCS Level 2 (explained below) loss of this connection stops train movement.

•• **Many railway-specific communication requirements could probably be implemented as "apps" on top of any sufficiently reliable radio bearer.**

•• **Railways would be content to keep using GSM-R for another 30 years** but manufacturer support could end sooner, possibly even before major deployments are finished.

•• **GSM was presented to railways as a "future-proof" technology,** its huge popular base guaranteeing irreplaceability.

What type of network is required to deliver these services?

- Private networks
- Public networks

What preparations are required to make best use of commercial networks to deliver smart services (some of them such as Emergency Telecommunication, Utilities, Transportation critical in character)?

- Technical (e.g. coverage, resilience, quality, spectrum, interoperability)
- Commercial (e.g. availability, long term pricing, SLAs
- Policy & Regulatory (e.g. critical services as priority, quality of service, long term tariffs, security, privacy, USO, infrastructure sharing, licensing)

Figure 4.11. Compound network architecture for critical communications for multiple sectors

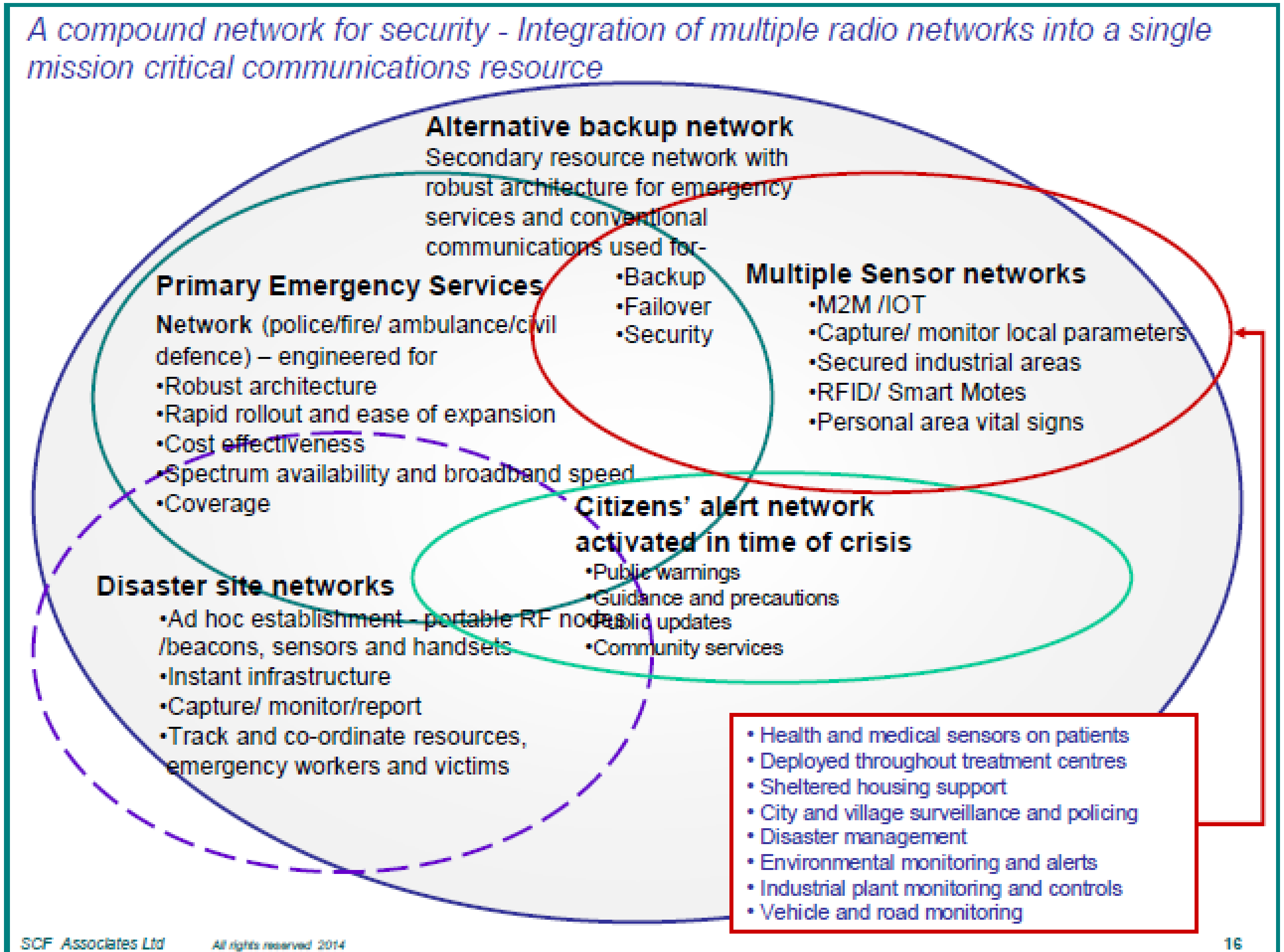
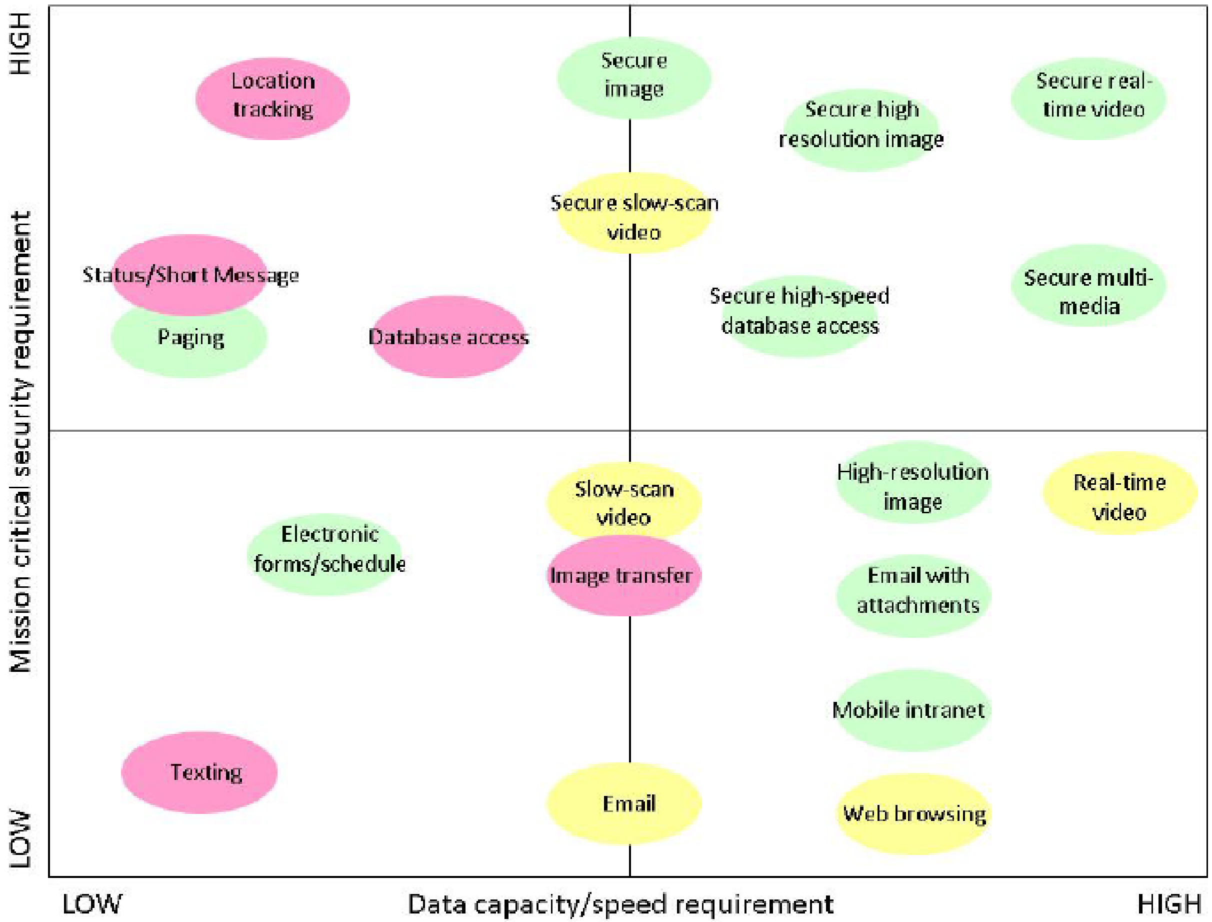
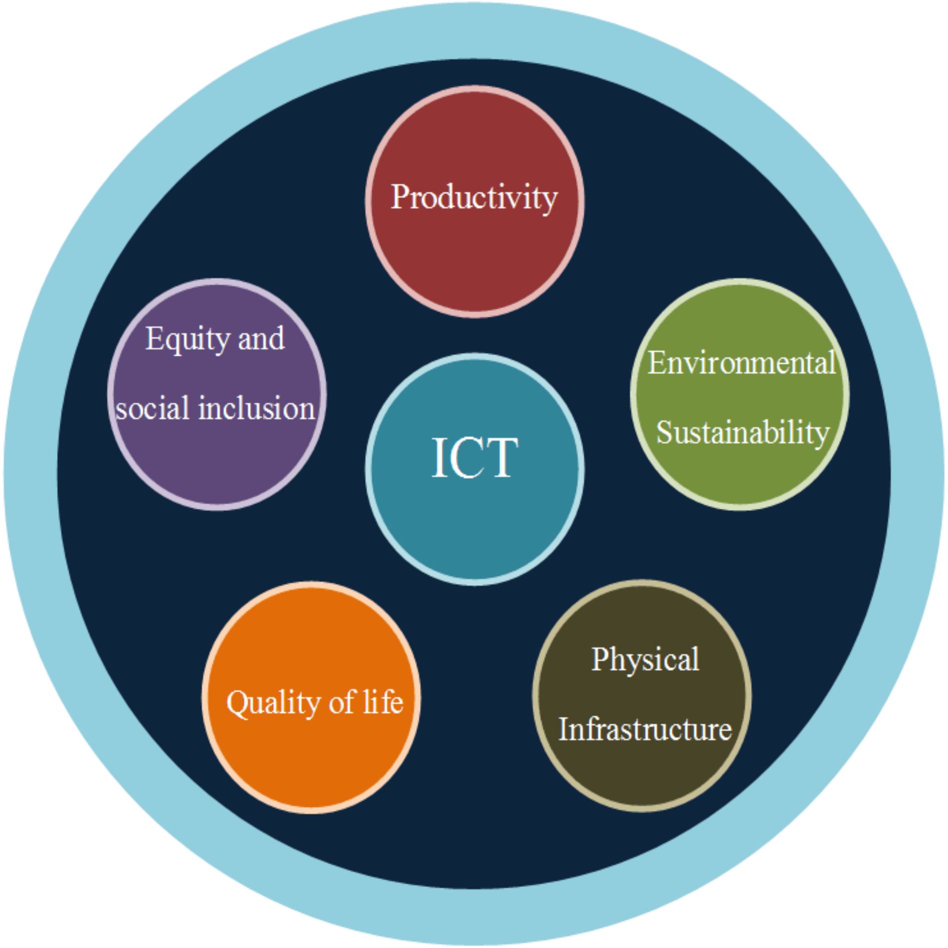


Figure 2.1. PPDR data applications' bandwidth requirements versus mission criticality



Adapted from Byrnes, 2013



Source: Overview of key performance indicators in smart sustainable cities, ITU-T Focus Group on Smart Sustainable Cities

Table 1 – Sub-dimension of KPIs

Dimension #	Dimension	Sub-dimension #	Sub-dimension
D1	Information and communication technology	D1.1	Network and access
		D1.2	Services and information platforms
		D1.3	Information security and privacy
		D1.4	Electromagnetic field
D2	Environmental sustainability	D2.1	Air quality
		D2.2	CO_2 emissions
		D2.3	Energy
		D2.4	Indoor pollution
		D2.5	Water , soil and noise
D3	Productivity	D3.1	Capital investment
		D3.2	Employment
		D3.3	Inflation
		D3.4	Trade
		D3.5	Savings
		D3.6	Export/import
		D3.7	Household income/consumption
		D3.8	Innovation
		D3.9	Knowledge economy
D4	Quality of life	D4.1	Education

Table 1 – Sub-dimension of KPIs

Dimension #	Dimension	Sub-dimension #	Sub-dimension
D4	Quality of life	D4.1	Education
		D4.2	Health
		D4.3	Safety/security public place
		D4.4	Convenience and comfort
D5	Equity and social inclusion	D5.1	Inequity of income/consumption (Gini coefficient)
		D5.2	Social and gender inequity of access to services and infrastructure
		D5.3	Openness and public participation
		D5.4	Governance
D6	Physical infrastructure	D6.1	Infrastructure/connection to services – piped water
		D6.2	Infrastructure/connection to services – sewage
		D6.3	Infrastructure/connection to services – electricity
		D6.4	Infrastructure/connection to services – waste management
		D6.5	Connection to services – knowledge infrastructure
		D6.6	Infrastructure/connection to services – health infrastructure
		D6.7	Infrastructure/connection to services – transport
		D6.8	Infrastructure/connection to services – road infrastructure
		D6.9	Housing – building materials
		D6.10	Housing – living space
		D6.11	Building

Recall

Agreed Global Telecommunication/ICT Targets - 2020

1865
2015

Goal 1 Growth : Enable and foster access to and increased use of telecommunications/IC

GROWTH

55%
of households should have access to the Internet

60%
of individuals should be using the Internet

40%
Telecommunications/ICTs should be **40%** more affordable

Goal 2 Inclusiveness – Bridge the digital divide and provide broadband for all

INCLUSION

50%
of households should have access to the Internet in the developing world; **15%** in the least developed countries

50%
of individuals should be using the Internet in the developing world; **20%** in the least developed countries

40%
affordability gap between developed and developing countries should be reduced by **40%**

5%
Broadband services should cost no more than **5%** of average monthly income in the developing countries

90% of the rural population should be covered by broadband services

Gender equality among Internet users should be reached

Enabling environments ensuring accessible ICTs for persons with disabilities should be established in all countries

Goal 3 Sustainability – Manage challenges resulting from the telecommunication/ICT development

SUSTAINABILITY

40%
improvement in cybersecurity readiness

50%
reduction in volume of redundant e-waste

30%
decrease in Green House Gas emissions per device generated by the telecommunication/ICT sector

Goal 4 Innovation and partnership – Lead, improve and adapt to the changing telecommunication/ICT environment

INNOVATION

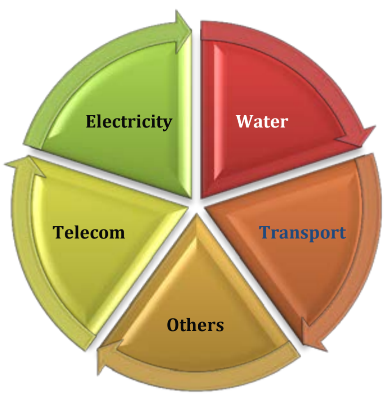
Telecommunication/ICT environment conducive to innovation

Effective partnerships of stakeholders in telecommunication/ICT environment

Source: ITU

Smart
Sustainable
Cities

Regulatory Collaboration



MULTI UTILITY
REGULATOR

Source: ITU

Any questions ?

Contact:
Consultant@joachimpomy.de