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Internet of Things and Smart Cities: perspectives and advances in some technical standardization areas (focus on activities of Question 2 of ITU-T SG20)

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Outline

- Internet of Things and Smart Cities – the role of standardization
- Perspectives and advances in some technical standardization areas (focus on activities of Question 2 of ITU-T SG20)
  - IoT application domains and verticals incl. Smart Cities (selected list)
  - Horizontal capabilities and technologies (selected list)

Internet of Things and Smart Cities – the role of standardization

IoT and leading technologies

The IoT is expected to benefit from integration of a number of leading technologies and their advances, including those for

- Machine to Machine Communications
- Advanced sensing and actuation
- Cloud Computing (and distributed computing)
- Softwarization (incl. Software Defined Networking, Network Functions Virtualization)
- Autonomic Networking and other network features (e.g. IMT2020/5G advances such as network slicing)
- Big Data processing, management and governance
- Semantics and ontologies support
- Distributed Ledgers (Blockchain)
- Machine Learning and Artificial Intelligence
- Security, Privacy and Trust (data, infrastructure, applications)

It is hoped that the IoT and Smart Cities international standardization reuses as much as possible the standards developed in the different technology areas,
but also that it addresses lacks and issues coming from their integration as well as from the specific needs of IoT and Smart Cities ecosystems' stakeholders

IoT SDOs and Alliances Landscape (Technology and Marketing Dimensions)

Landscape in continuous evolution

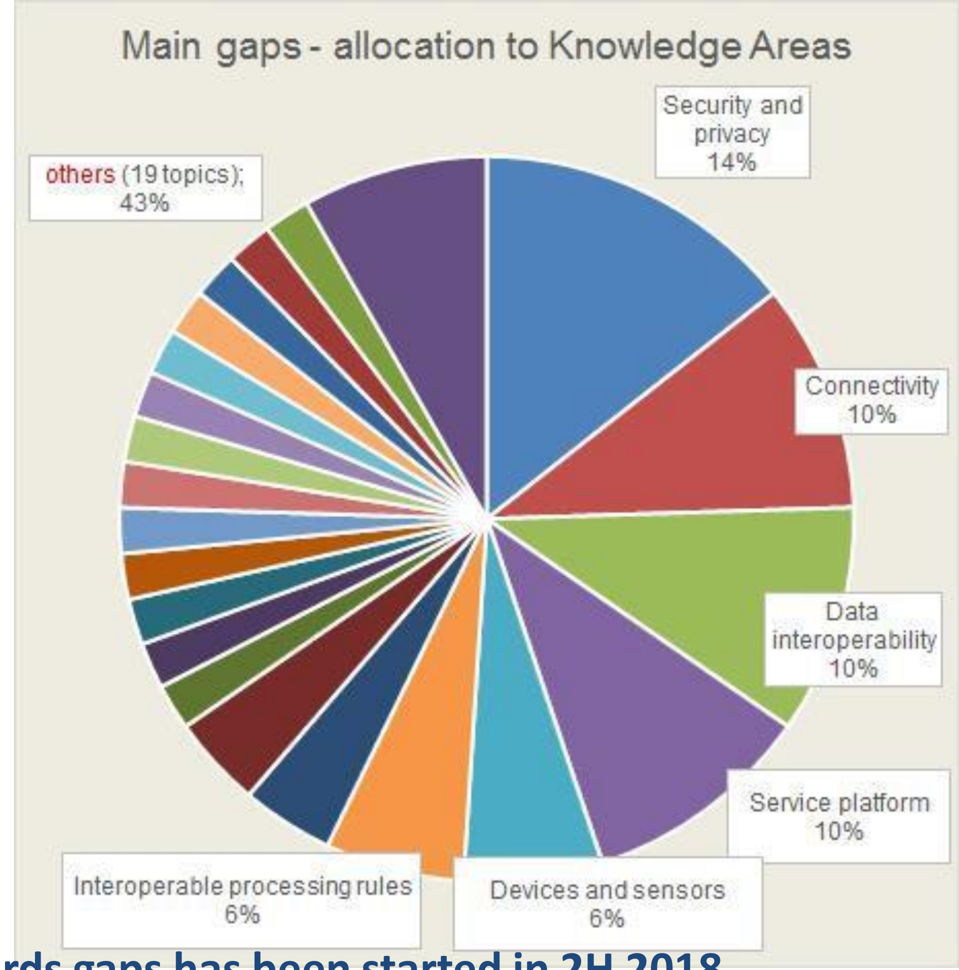
Source: AIOTI WG3 (IoT Standardisation) – Release 2.8

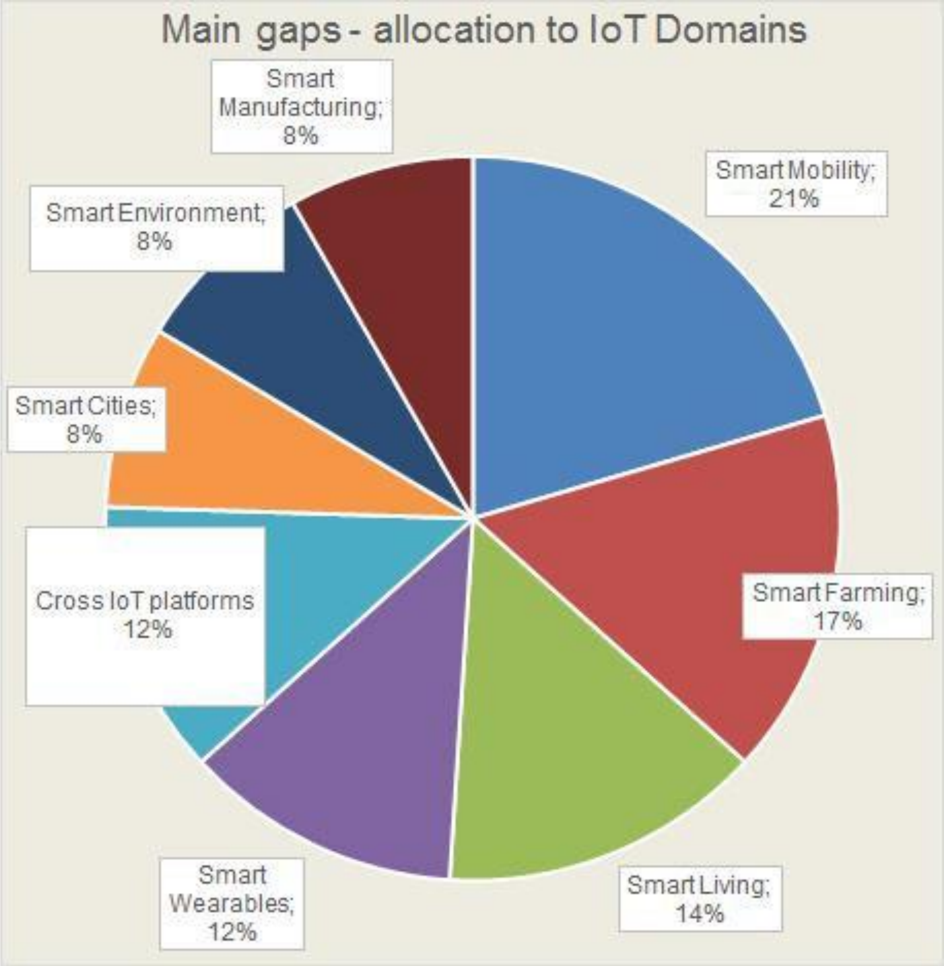
The standardization journey of IoT and Smart Cities is ongoing: standards gaps (technical, but also business and societal)

Consolidated view of 49 main gaps

[extract from AIOTI WG03-EC workshop, Feb 2017 (results published as ETSI TR) (*)]

Standards gaps in terms of both missing and competing standards





(*) A renewed study on standards gaps has been started in 2H 2018

IoT interoperability and the role of standardization

Market research: “nearly 40% of economic impact of the IoT requires interoperability between IoT systems”
IoT value will come solving interoperability issues within/across IoT domains (different interoperability dimensions)

Key issue with IoT interoperability is current diversity =>> international SDOs have a key role in promoting standards convergence and harmonization (ITU-T as key actor)

Open innovation systems move fast =>> Standardization needs to cope - process, collaboration

Source: AIOTI WG3 (IoT Standardisation) – Release 2.8

ITU-T Study Group 20: “IoT and Smart Cities & Communities”

Lead Study Group on

- Internet of things and its applications
- Smart Cities and Communities, incl. its e-services and smart services
- IoT identification

SG20 structure	
WP1/20	
Q1/20	End to end connectivity, networks, 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, terminology and definitions
Q6/20	Security, privacy, trust and identification
Q7/20	Evaluation and assessment of Smart Sustainable Cities and Communities

Established in June 2015 to consolidate the various ITU-T activities on IoT

Last SG20 meeting in Dec 2018, Wuxi (China)

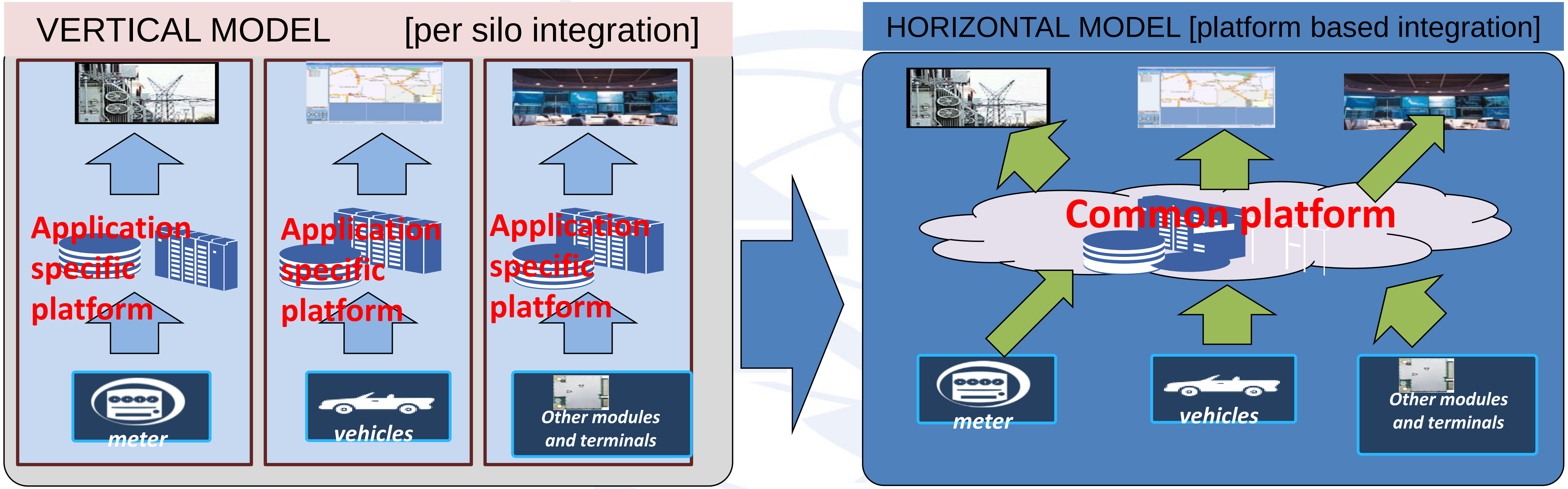
Next SG20 meeting on 9-18 April 2019, Geneva (Switzerland)

SG20 Home page: http://www.itu.int/en/ITU-T/studygroups/2017-2020/20/Pages/default.aspx

Perspectives and advances in some technical standardization areas (with focus on activities of Question 2 of ITU-T SG20)

From vertical to horizontal approach (common platform)

The situation of technology separation among IoT application domains produces market separation



Platform configured per vertical application (application domain)

Horizontal platform supporting multiple vertical apps
(with common components and application-specific components)

Deployment reality: different (domain) platforms will continue to co-exist and need to interoperate

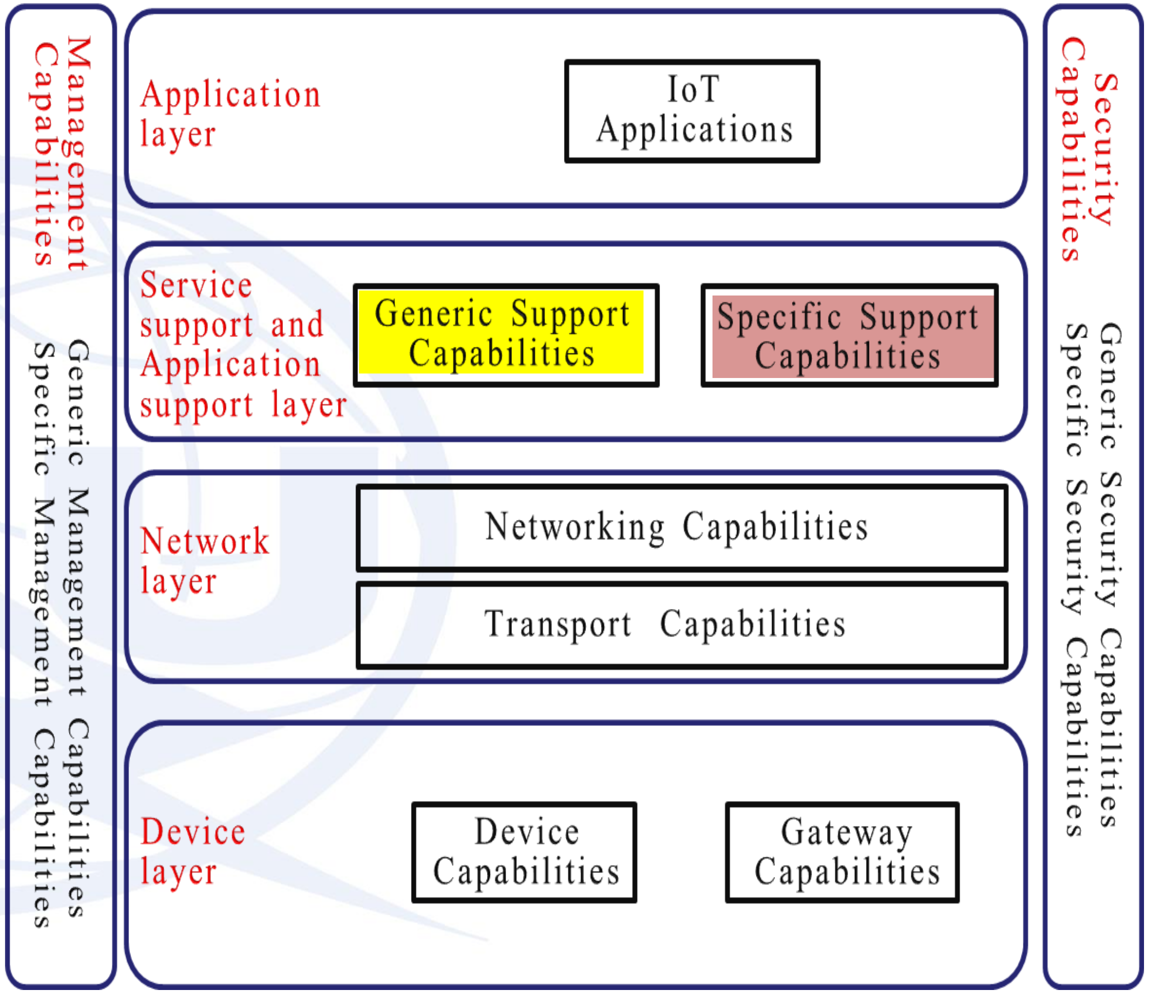
Per silo integration *does not scale and limits the evolution possibilities*

Platform based integration is needed *with the key role of open standards and open source*

A basic reference - the IoT Reference Model defined by ITU-T

Capability view of IoT infrastructure

- Application capabilities
- Service Support and Application Support capabilities
- Network capabilities
- Device and Gateway capabilities
- Cross-layer Management Capabilities
- Cross-layer Security Capabilities



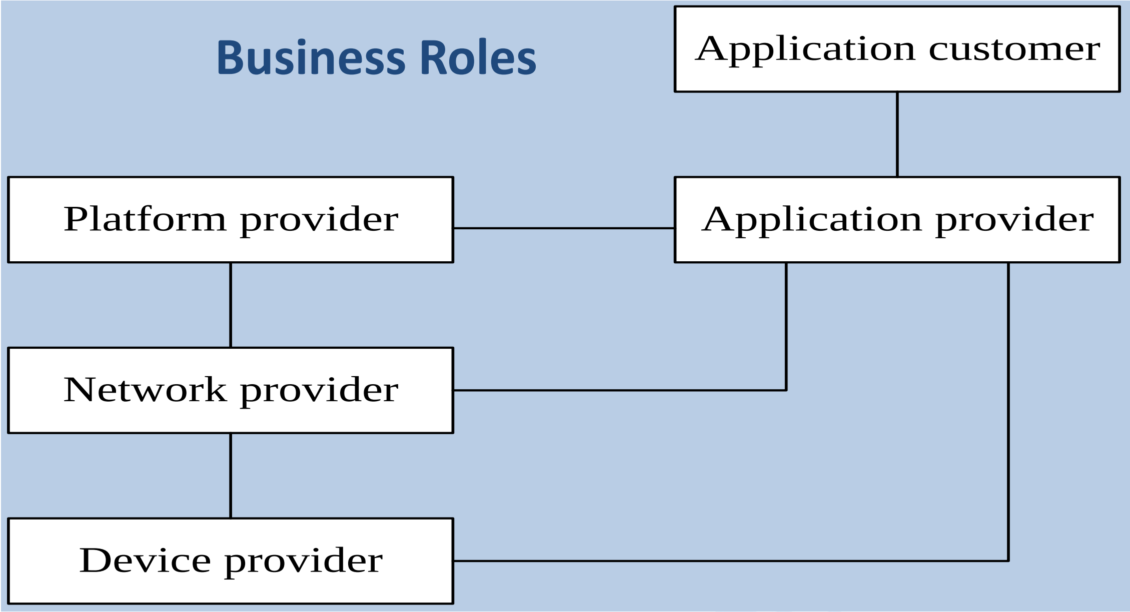
Source: Y.4000/Y.2060 "Overview of the Internet of things" (2012)

Other foundational ITU-T Recommendations on IoT include:

Y.4100 Common requirements of the Internet of things

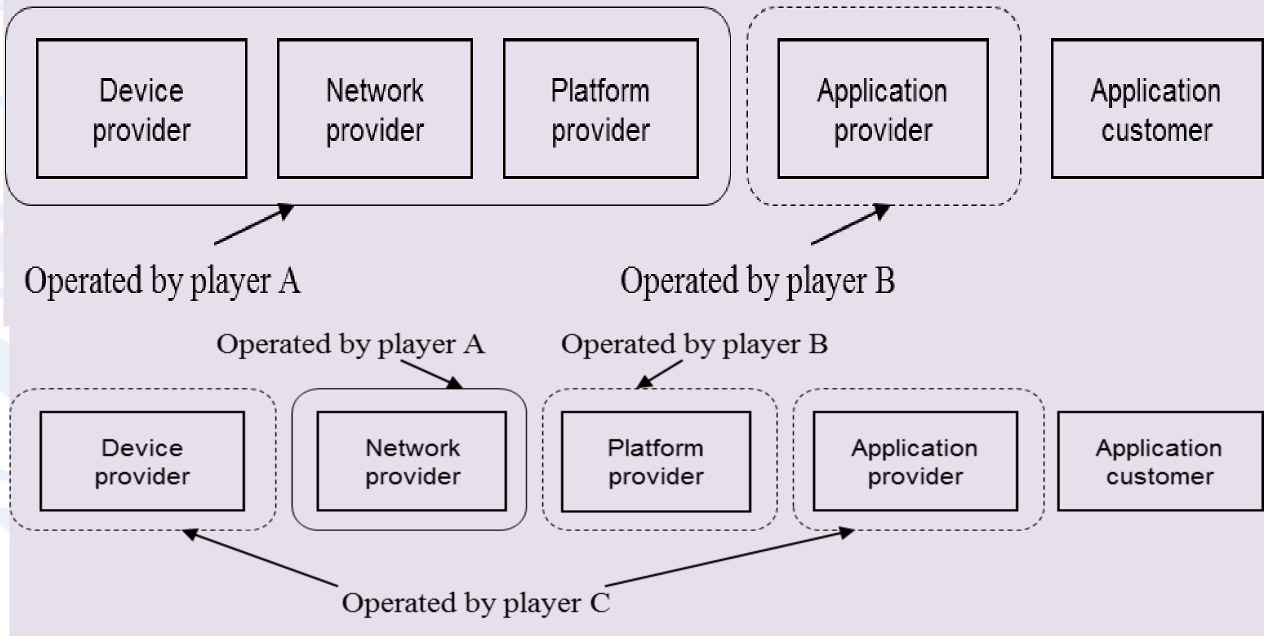
Y.4401 Functional framework and capabilities of the Internet of things

The growing importance of the IoT ecosystems: business roles and models [source: Appendixes of ITU-T Y.4000]



Simplified view of business relationships
(not representing all what can be found across the huge number of real IoT business deployments)

Business models – one of examples described in Y.4000)



Main objective of Y.4000 analysis: building a proactive linkage between real deployments and technical standardization (requirements, capabilities and functions, open interfaces)

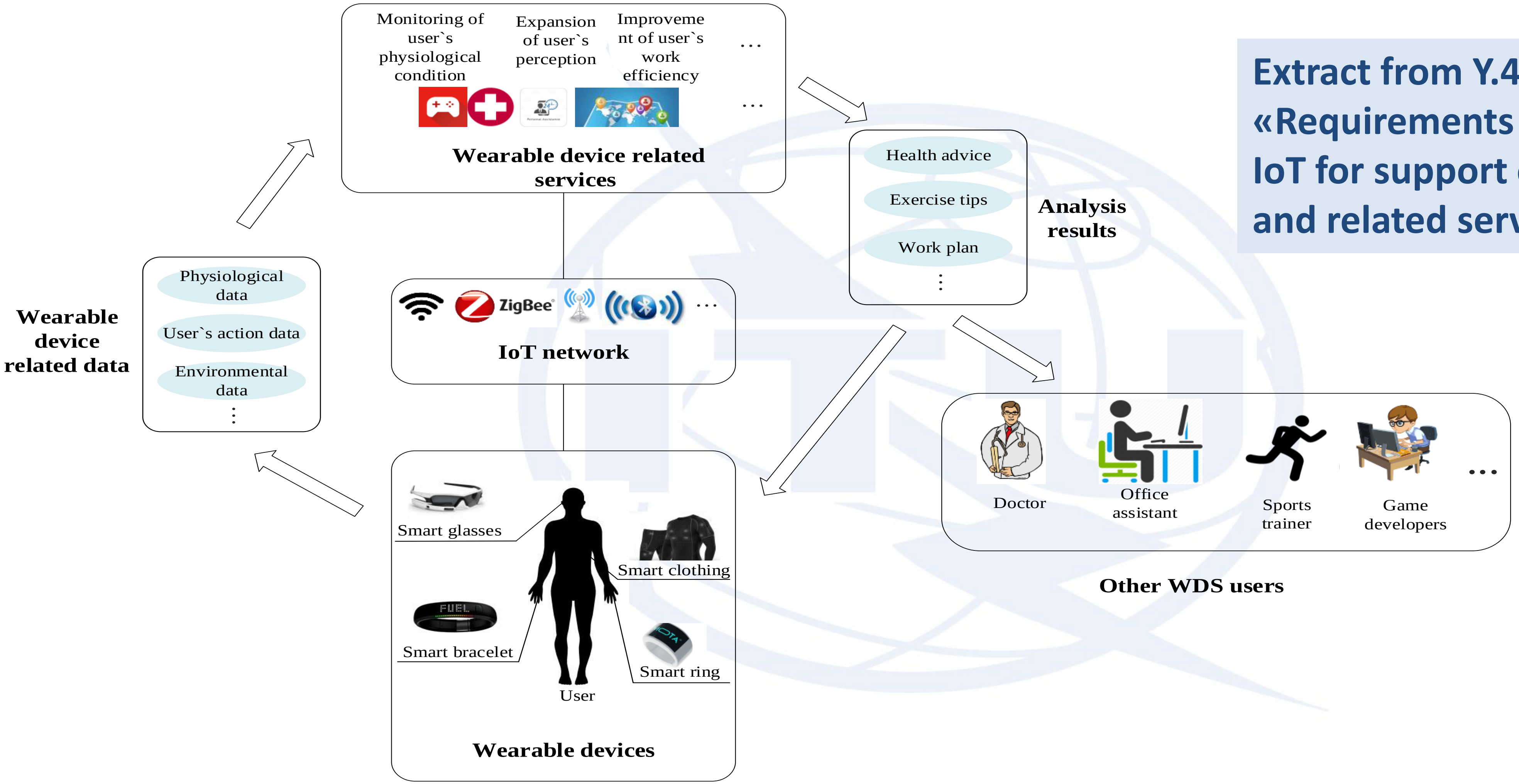
This exercise has been later adopted in numerous domain-specific studies s (e.g. e-health, wearables, Big Data), investigating stakeholders of those ecosystems and related requirements to support in standards development

IoT application domains and verticals (selected list)

IoT and SC&C application domains and verticals (studies at different levels): a non-exhaustive list of completed and ongoing work items in ITU-T SG20

- Smart Cities (parking, lightning, water and waste management, buildings, citizens' safety services, physical city assets monitoring etc.)
- Smart Rural Communities and Smart Residential Communities
- Smart Tourist destinations
- Smart Port, Smart Airport, Smart Stations
- Smart Transportation (Cooperative Intelligent Transport Systems, Automotive Emergency Response Systems, Transportation Safety Services, Unmanned Aircraft Systems, Autonomous Driving, other)
- Smart Retail
- Smart Farming (Agriculture, Livestock)
- Smart Manufacturing (Framework in the context of Industrial IoT)
- Wearables
- E-health Monitoring
- Smart Environmental Monitoring
- Monitoring and study of Global Processes of the Earth for disaster preparedness
- Micro-Grids and Advanced Metering Infrastructure
- Connected Home Networks
- Others

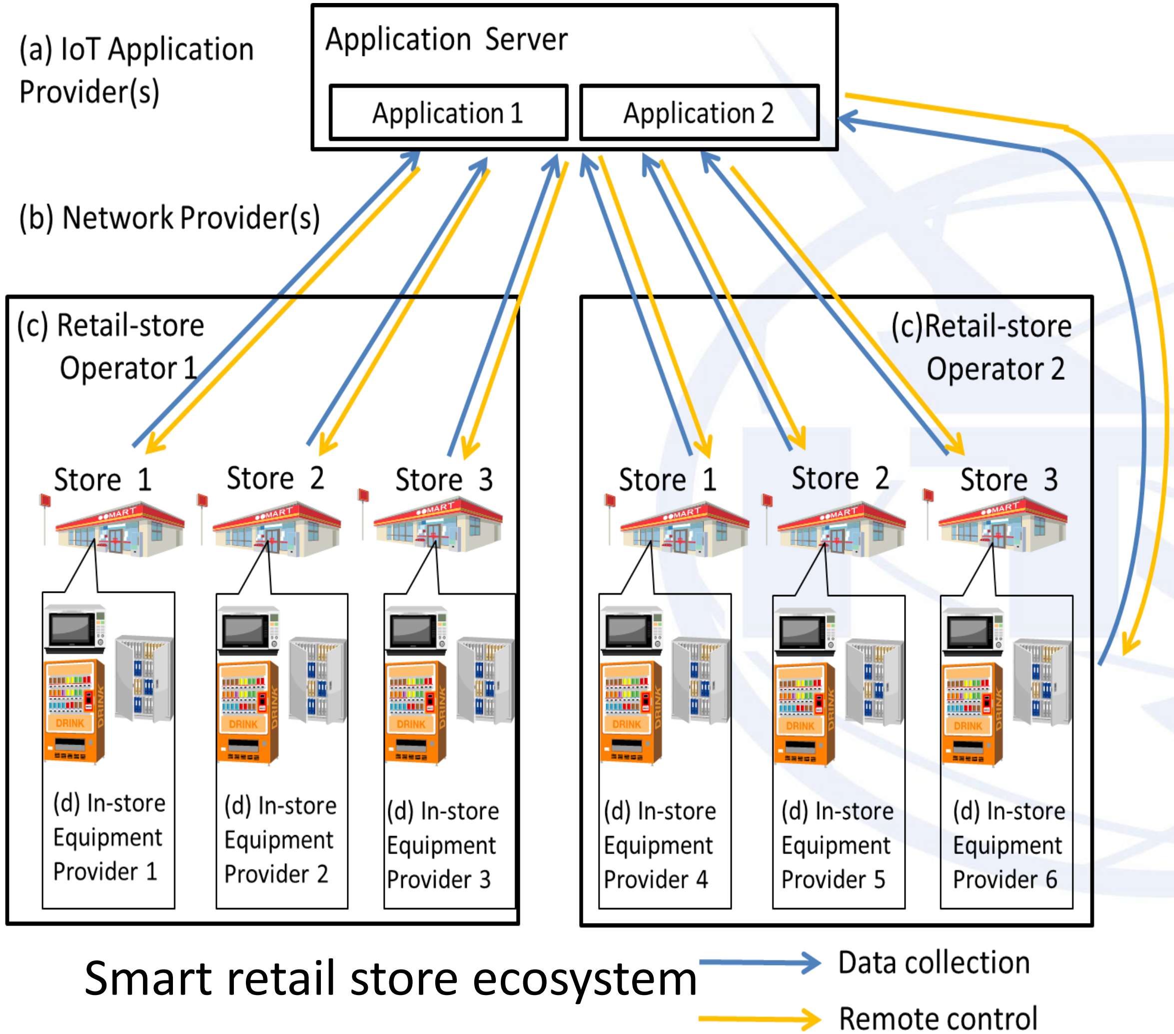
IoT for wearable devices and related services [Y.4117]



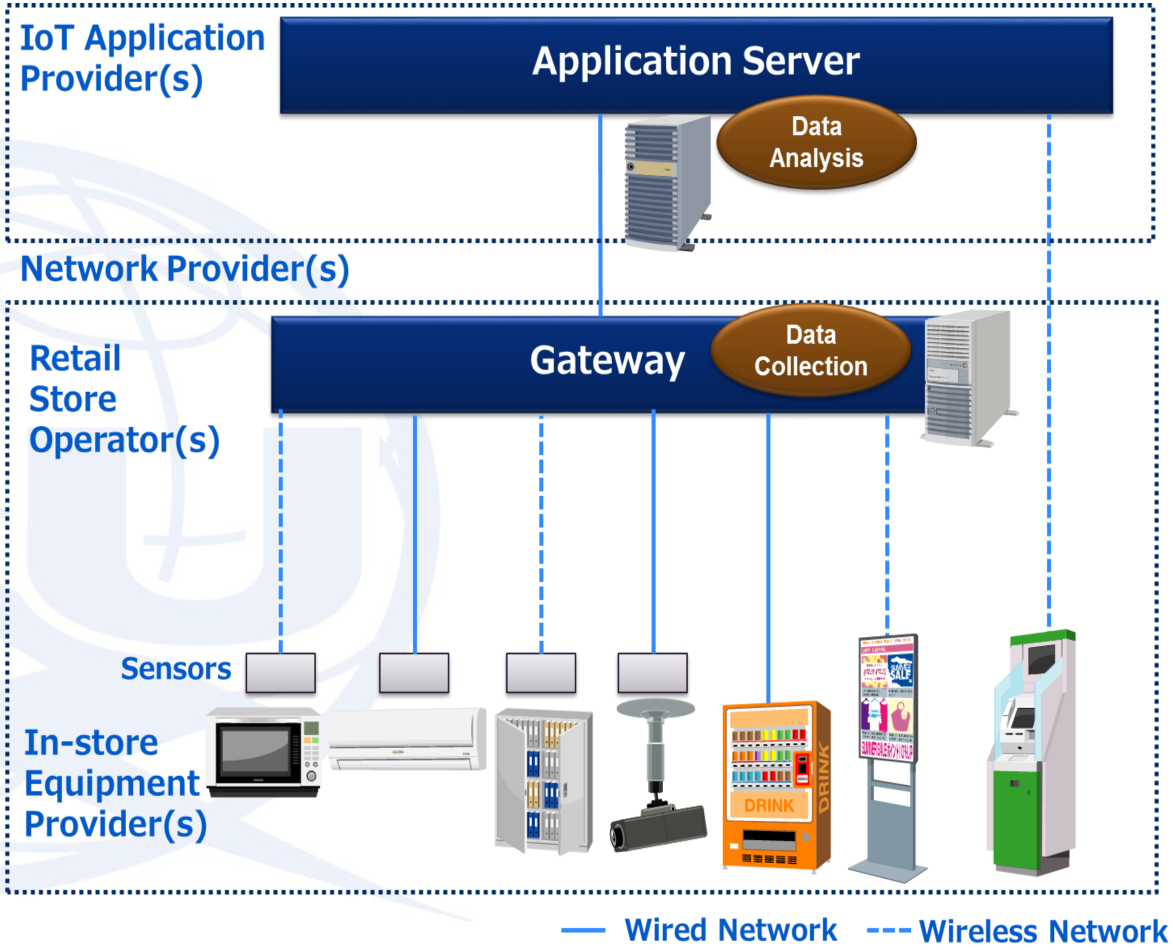
Extract from Y.4117 «Requirements and capabilities of IoT for support of wearable devices and related services»

Y.4117 identifies 4 classes of wearable services, with their distinct characteristics and requirements for the supporting IoT network

IoT enabled applications for retail stores [Y.4120]



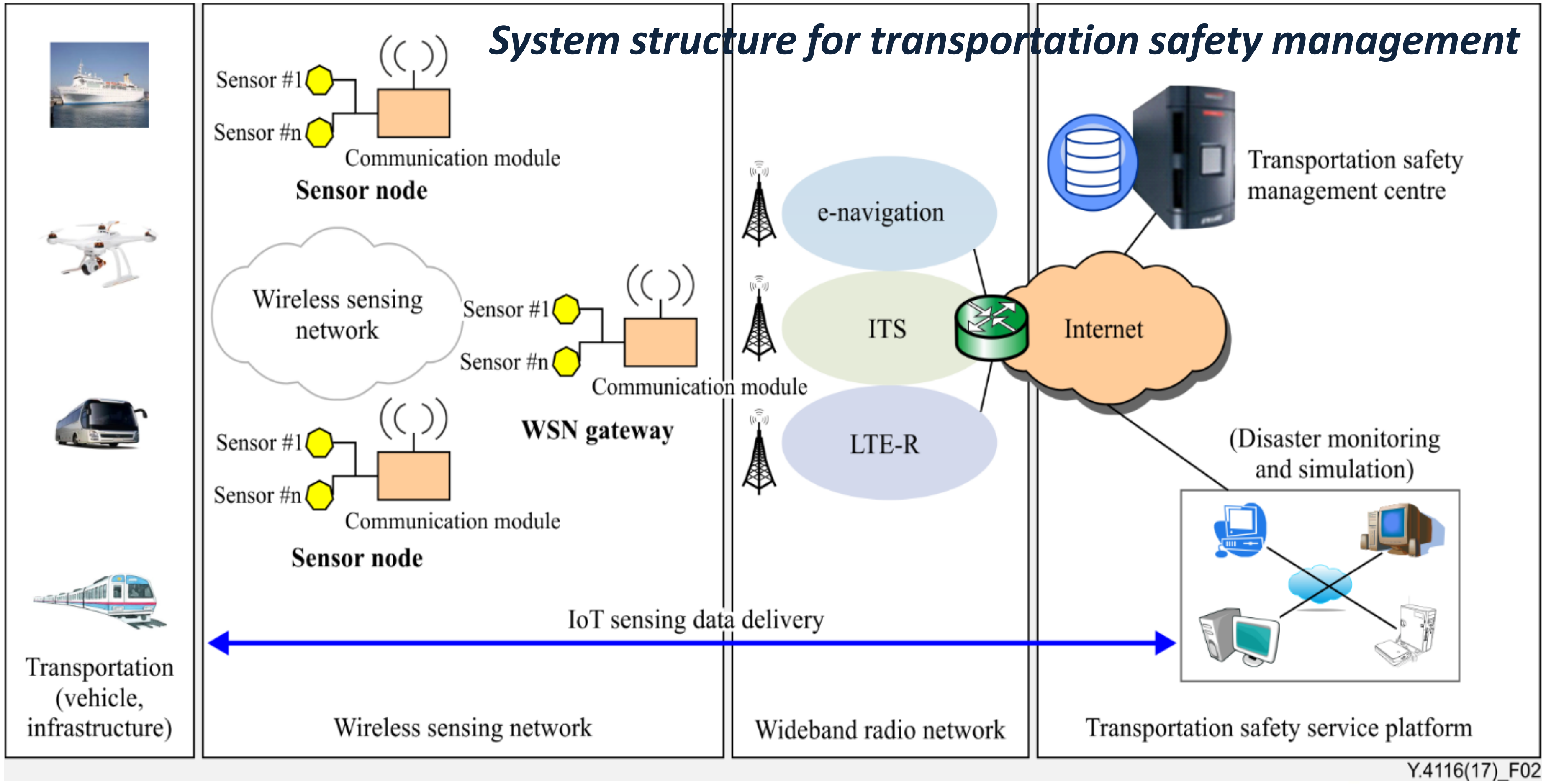
Smart retail store ecosystem



Data collection and analysis for smart retail stores

IoT technologies can enable ***safe and efficient retail store management system for non-stop operation (24 hours / 365 days)****: collection and monitoring in real time of information related to the various kinds of equipment in stores may allow early detection of equipment failure and accurate prediction of equipment problems.*

IoT for transportation safety services [Y.4116]



Extract from Y.4116 "Requirements of transportation safety services including use cases and service scenarios"

IoT technologies usage can reduce/prevent occurrence of accidents and disasters

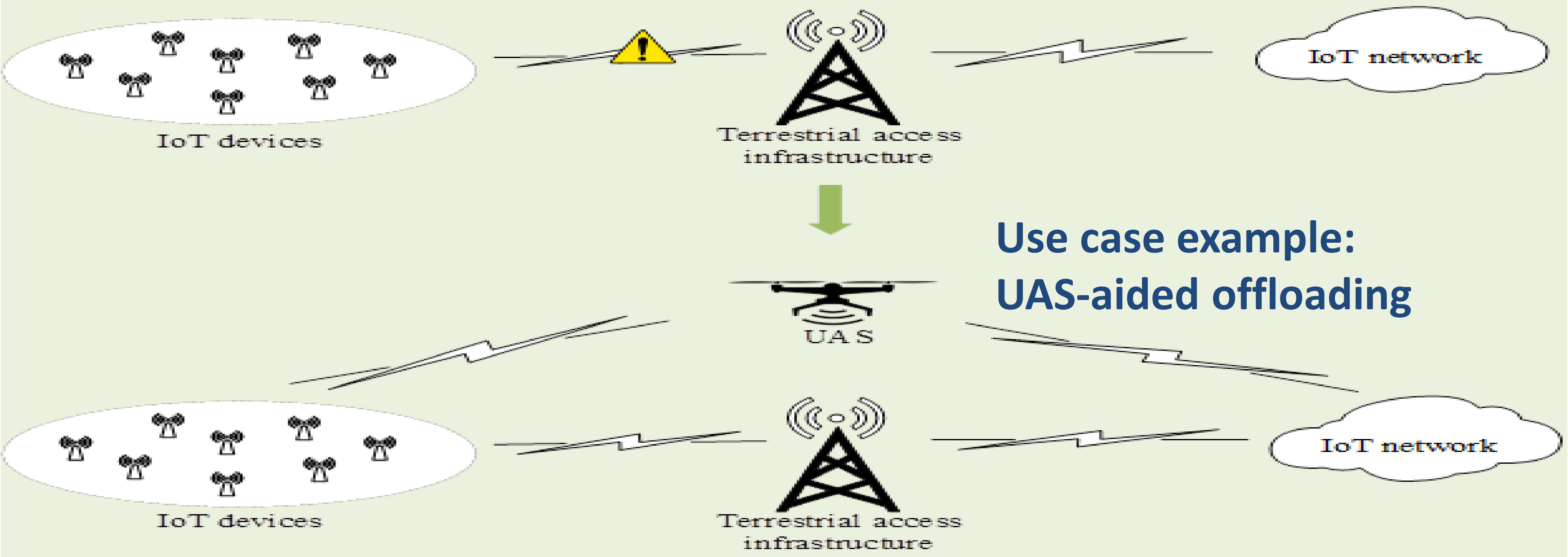
The transportation service platform monitors transportation safety relevant conditions and parameters, performs disaster simulations and decides the threshold values for disaster prediction and detection.

The transportation safety management centre monitors the safety status of vehicles and transportation infrastructure, and influences the operations of vehicles and infrastructure, by collaborating with the transportation safety service platform, including generation of alarms.

Unmanned aircraft systems (drones) [ongoing Y.IoT-UAS-Reqts]

Y.IoT-UAS-Reqts "Use cases, requirements and capabilities of unmanned aircraft systems (UAS) for Internet of Things"

UASs can act as as wireless communication platforms in the IoT



Use case example:
UAS-aided offloading

Smart City as
super application domain of the IoT

A Smart City in simple layers

Integration of multiple verticals

Citizen-centric services incl. open data apps, 3rd party apps, city apps and dashboards

The brain of the city

Data collection, analysis, knowledge, planning, action

The senses of the city

City data sources

Source: Dr. Levent Gürgen

Still a number of technical challenges to be addressed incl. interoperability, security and privacy

Q2/20 is progressing some work items on Smart Cities:

- *common requirements and capabilities for Smart Cities*
- *application-specific studies*

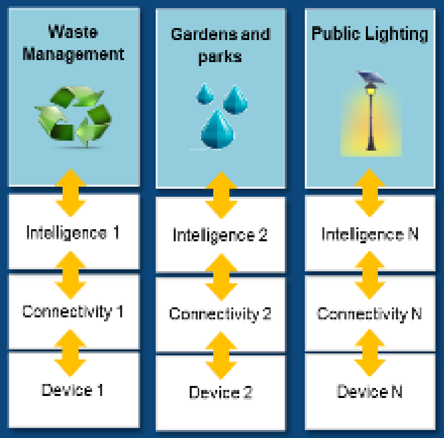
A number of smart city studies in SG20 overall

Smart Cities: an incremental and participatory journey towards full support to Data Economy

1 ---------- 2 ---------- 3 ---------- 4

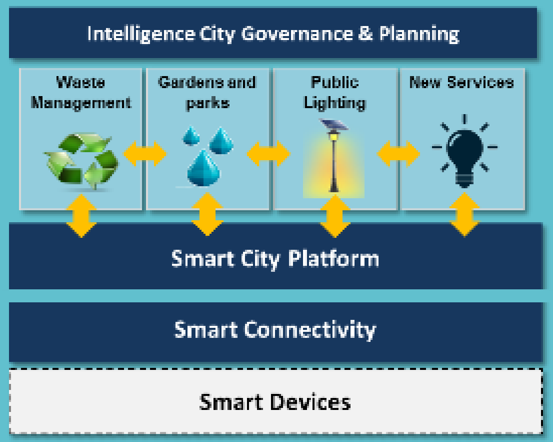
Efficient and Open

- Vertical solutions bringing efficiency in silos
- Historic data as open data
- Information still in vertical silos, no global picture



Truly Smart

- Horizontal platform integrating “right-time” context info from different vertical services
- Predictive and prescriptive models



Unleashing Right-time Open Data

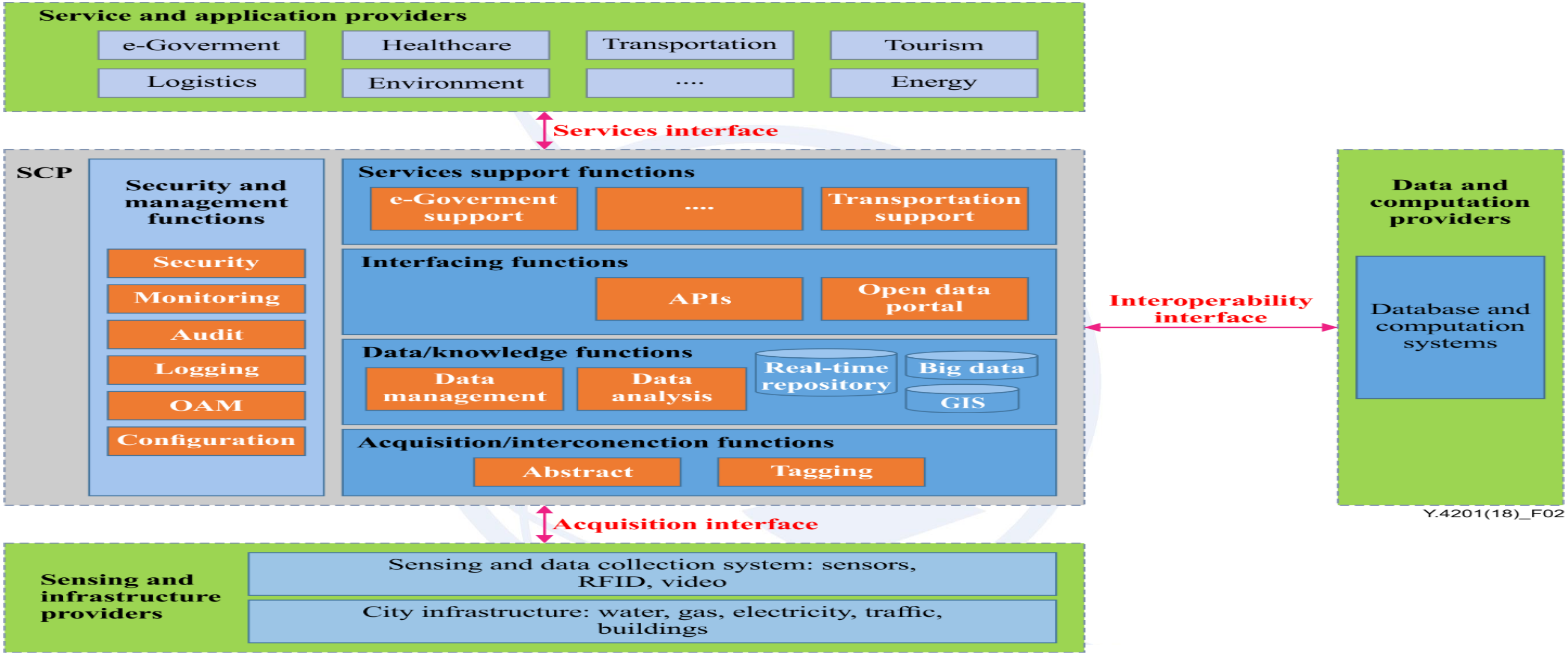
- Right-time context info published to third parties
- Exchange of context info with systems from other domains

Support to Data Economy

- City as a platform including also 3rd party data enabling innovative business models
- Open and commercial data enabling multi-side markets

Source: FIWARE

Smart City Platform [Y.4200/Y.4201]

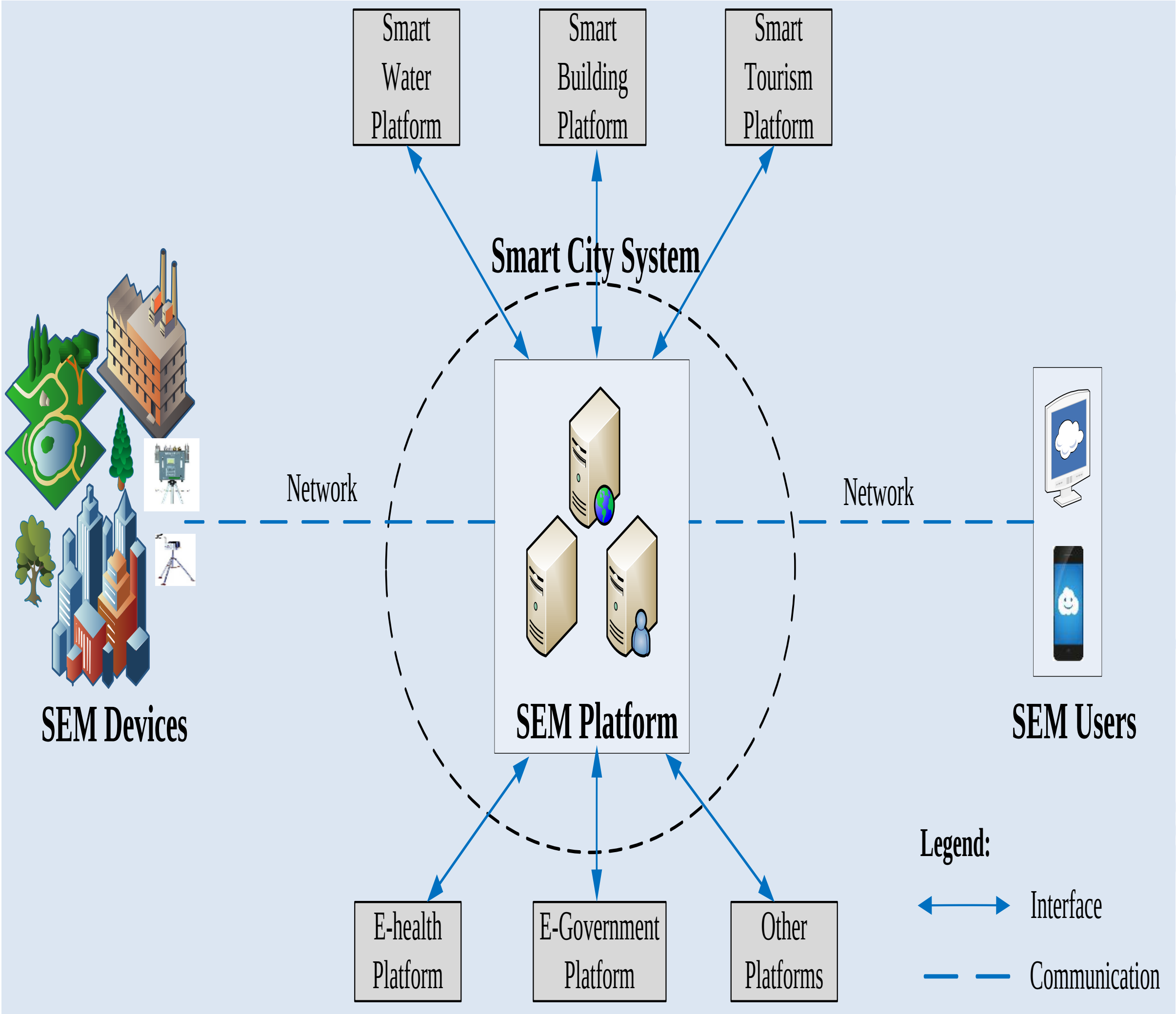


Reference framework of Smart City Platform (SCP)

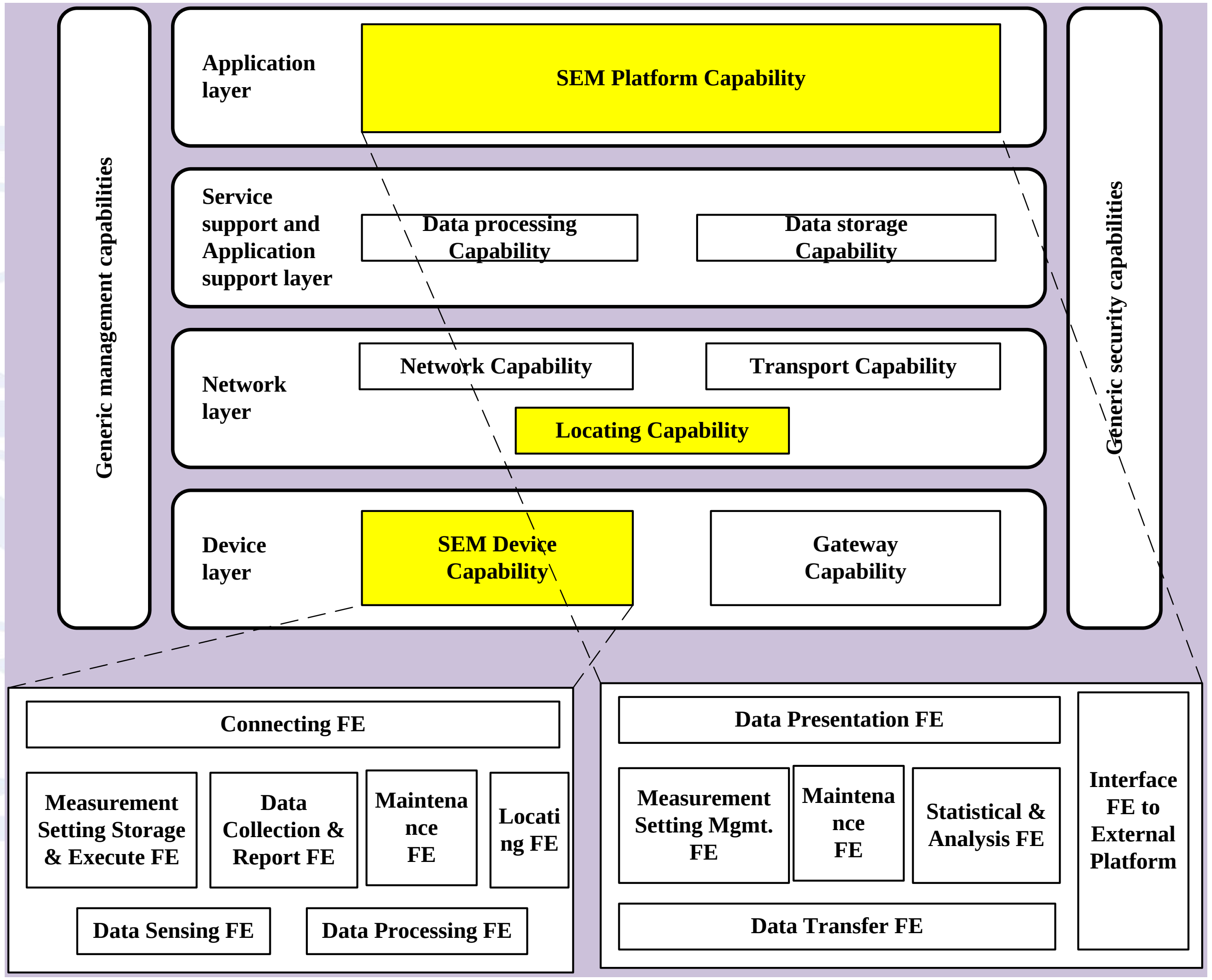
Y.4200 Requirements for the interoperability of Smart City Platforms

Y.4201 High-level requirements and reference framework of smart city platforms

IoT-based smart environmental monitoring (SEM) [ongoing Y.SEM]



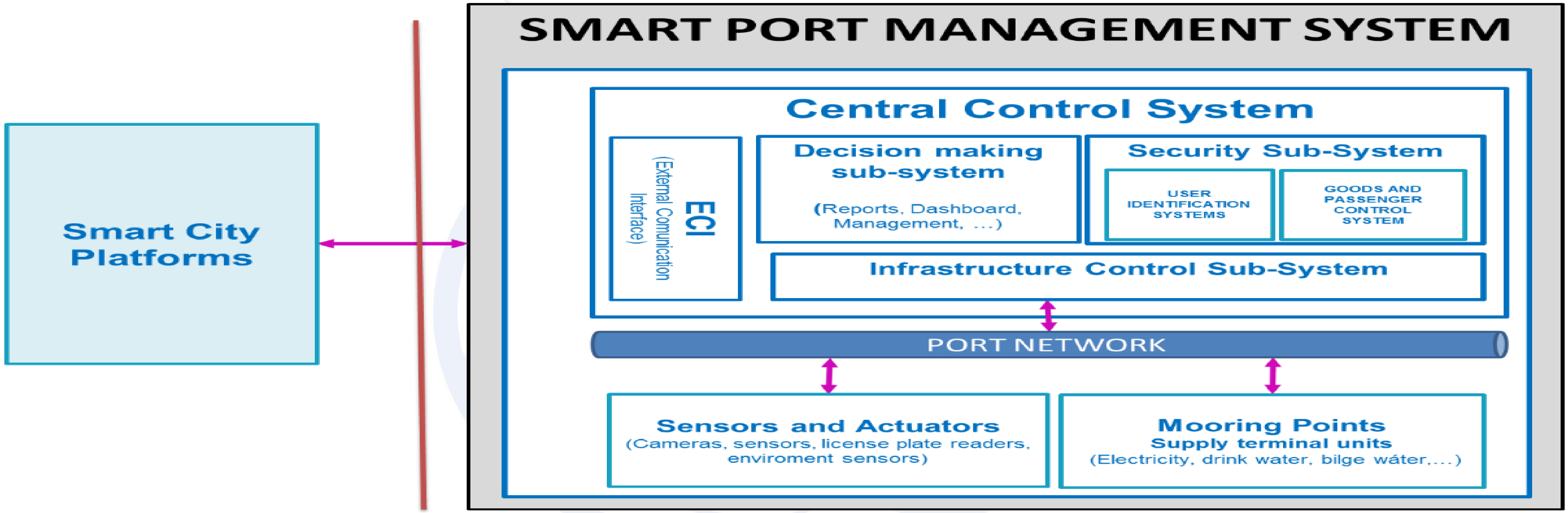
Conceptual diagram of SEM platform



SEM capability framework

Smart port [ongoing Y.smartport]

"Requirements of smart management of supply services in smart port"



IoT technologies deployment in ports can improve ports' operation and service offer

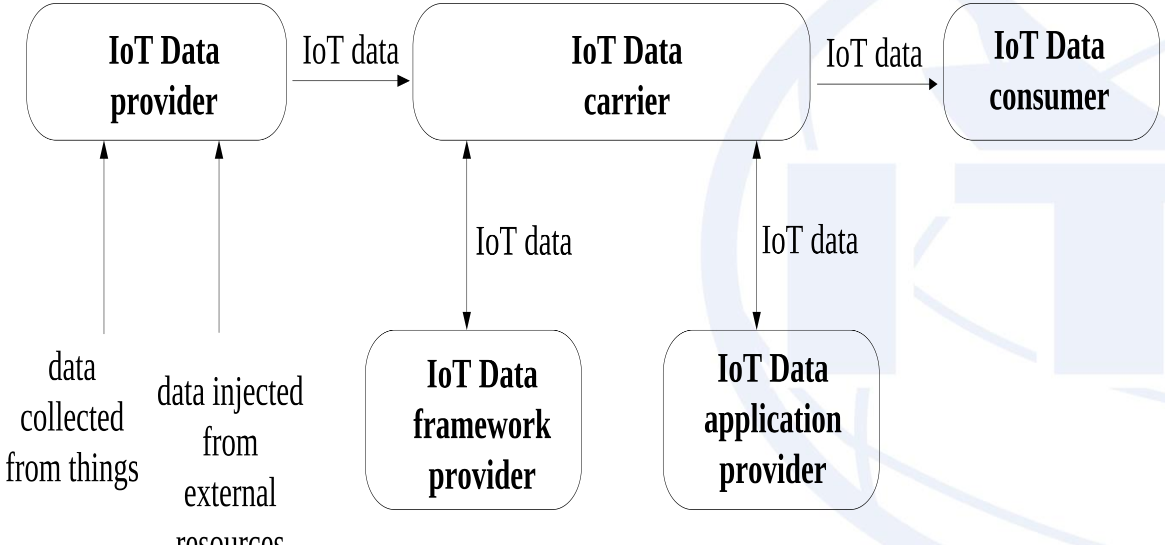
The integration between port and city enables reciprocal access to the respective services. And cities can improve their services too (e.g. controlling their resources according to the information provided by port remote management systems in real time)

Similar studies recently started in the areas of Smart Stations and Smart Airports

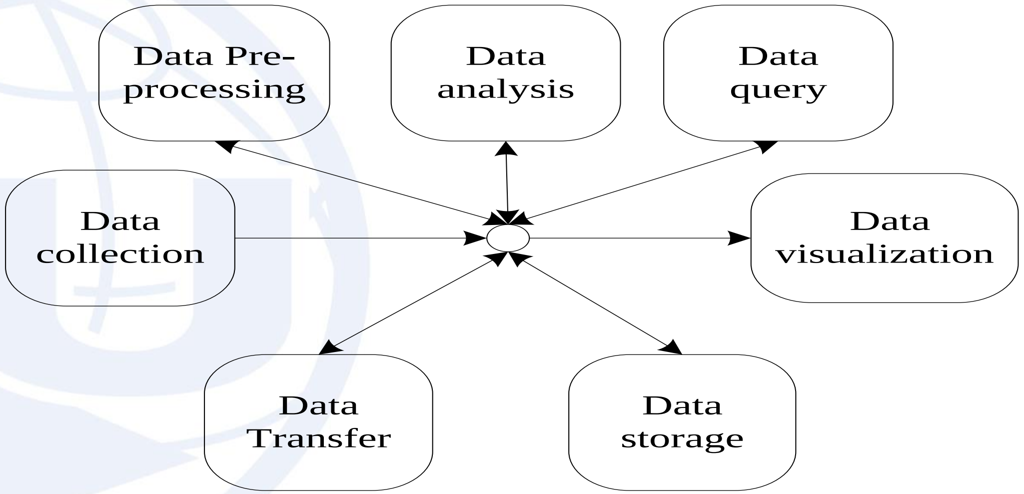
Horizontal capabilities and technologies (selected list)

A key next step in IoT standardization:
standards for the integration of (Big) Data support capabilities in the IoT

The first study in ITU-T: Y.4114 “Specific requirements and capabilities of the IoT for Big Data”
[Requirements and capabilities the IoT is expected to support to address the challenges related to Big Data]



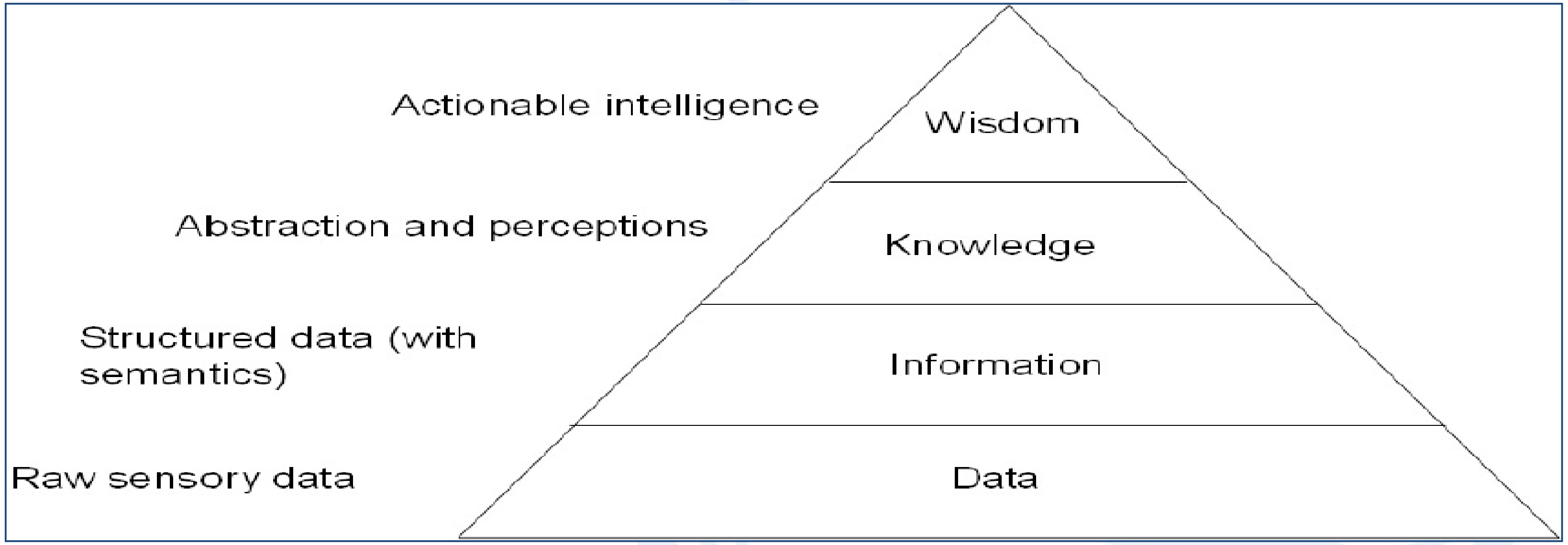
The IoT data roles identified in Y.4114
[the key roles relevant in an IoT deployment from a data operation perspective]



Abstract representation of IoT data operations and related data flows (diverse concrete IoT deployments do not imply unique logical sequencing of IoT data operations)

Relevant ongoing initiative for further progress of data management standardization: ITU-T Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities (ITU-T FG-DPM)

Data transformation from raw data to actionable intelligence



The knowledge hierarchy applied in data processing
Source: Barnaghi and al., "Semantics for the IoT: early progress and back to the future" (IJSWIS, 2012)

- **Raw data are generated**
- **Additional information enables creation of structured metadata (first step of data enrichment)**
- **Abstraction and perceptions give detailed insights of data by reasoning , using knowledge (ontologies, rules) of relevant domains (second step of data enrichment)**
- **Actionable intelligence allows decision making**

Semantics based technologies: a promising tool for intelligence enablement from data

Shared vocabularies and their relationships [ontologies]

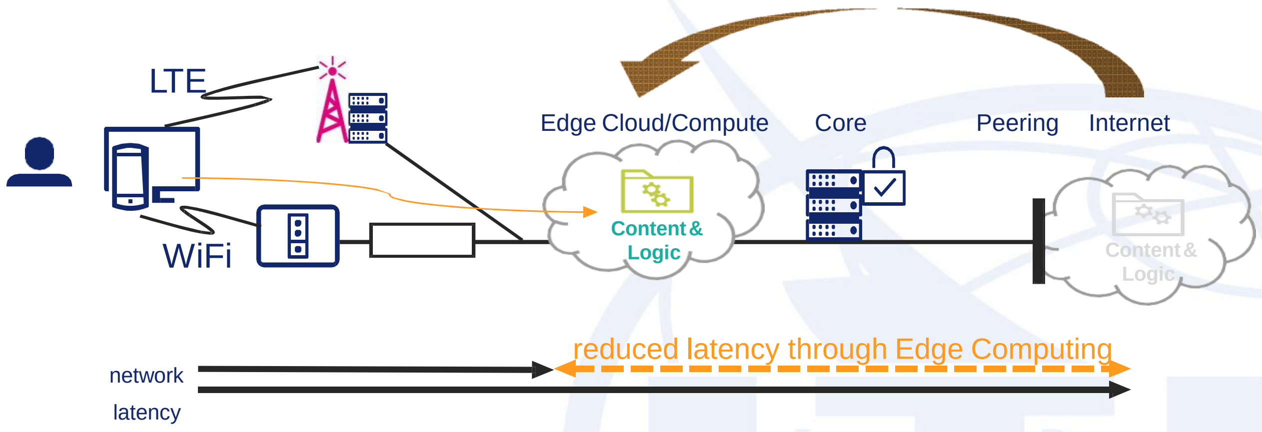
The IoT has requirements for interoperability, scalability, consistency, discovery, reusability, composability, automatic operations, analysis and processing of data

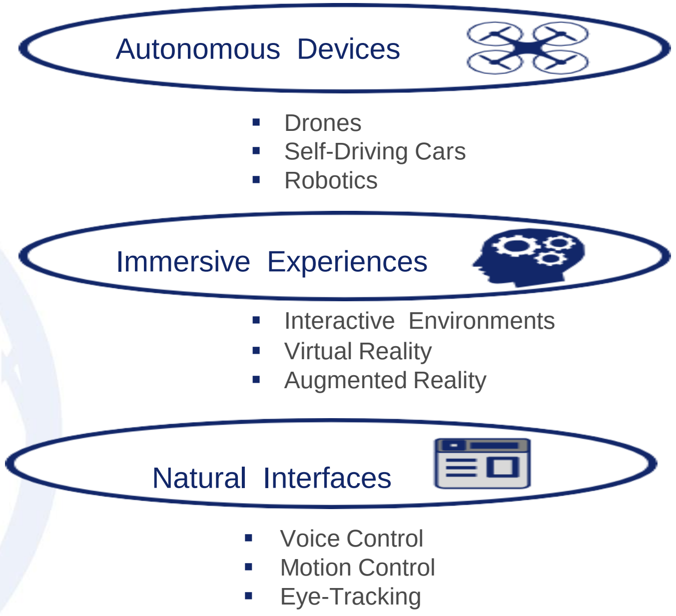
- ***Semantics based approaches have outstanding features towards these requirements***
- Promising experimentations of semantic technologies, although further development, validation, standardization are needed

Standardization of semantics based capabilities is ongoing in various expert groups, incl. W3C, ETSI SmartM2M/oneM2M (see SAREF), OGC

Y.4111: "Semantics based requirements and framework of the IoT"

Edge Computing technology [ongoing Y.IoT-EC-Reqts and Y.IoT-EC-GW]





Pure centralized cloud solutions will not scale for continuous and timely processing of growing amounts of real-time streams => solutions mixing edge and central cloud processing with high performance computing capabilities are required

Low latency applications

Edge Computing benefits

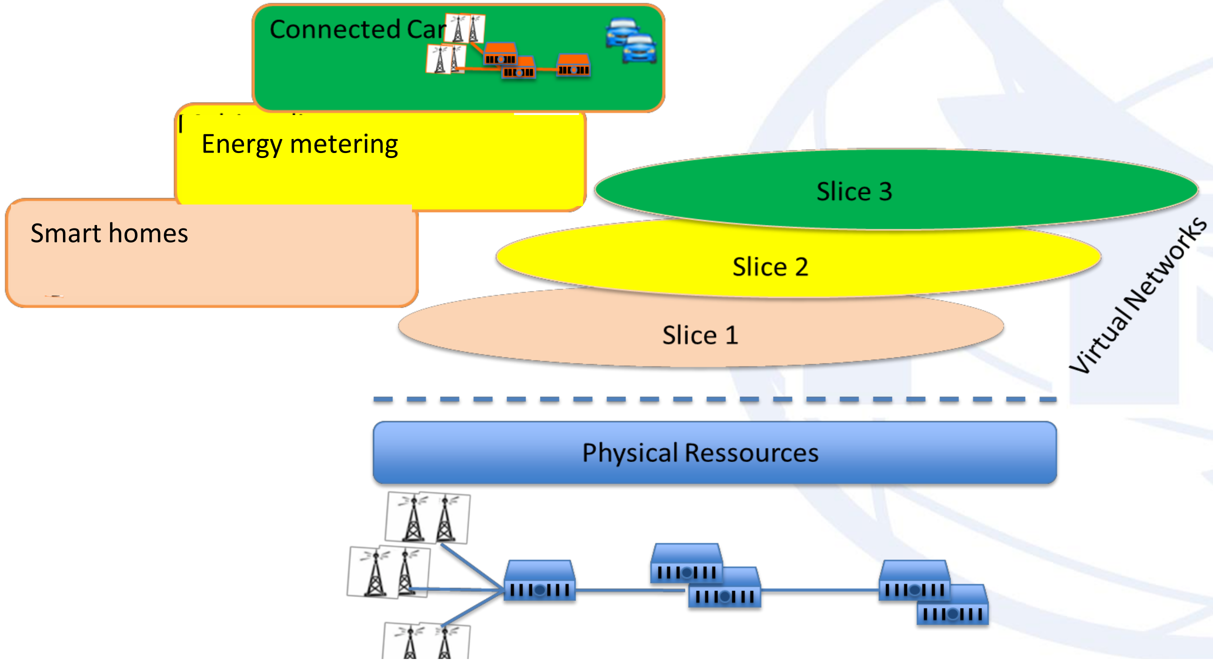
- **(Ultra)low latency**: disruptive improvement of customer experience
- **Reduction of backhaul/core network traffic**: cloud services near to user
- **In-network data processing**

Edge Computing … and more: Fog/Device Computing

Some issues are not fully addressed yet

Advanced network features for customized support of IoT applications: 5G network slicing via dedicated logical networks over single infrastructure

Slicing addresses limitations of classical approaches («All-in-One» too complex, «Multiple networks» too costly)



Each slice is architected and optimized for specific app(s)

Each slide can have its own network architecture, engineering mechanisms and network provision

Network slice [ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

Large number of studies these days on network slicing (incl. in standardization, e.g. ITU-T SG13, 3GPP, 5GAA)

Future SG20 studies – in cooperation with network-specific expert groups (SG13) – are expected to investigate the support of different IoT applications and verticals by 5G/IMT-2020 networks (which specific requirements, which functionalities and interfaces, incl. specifically for network slicing)

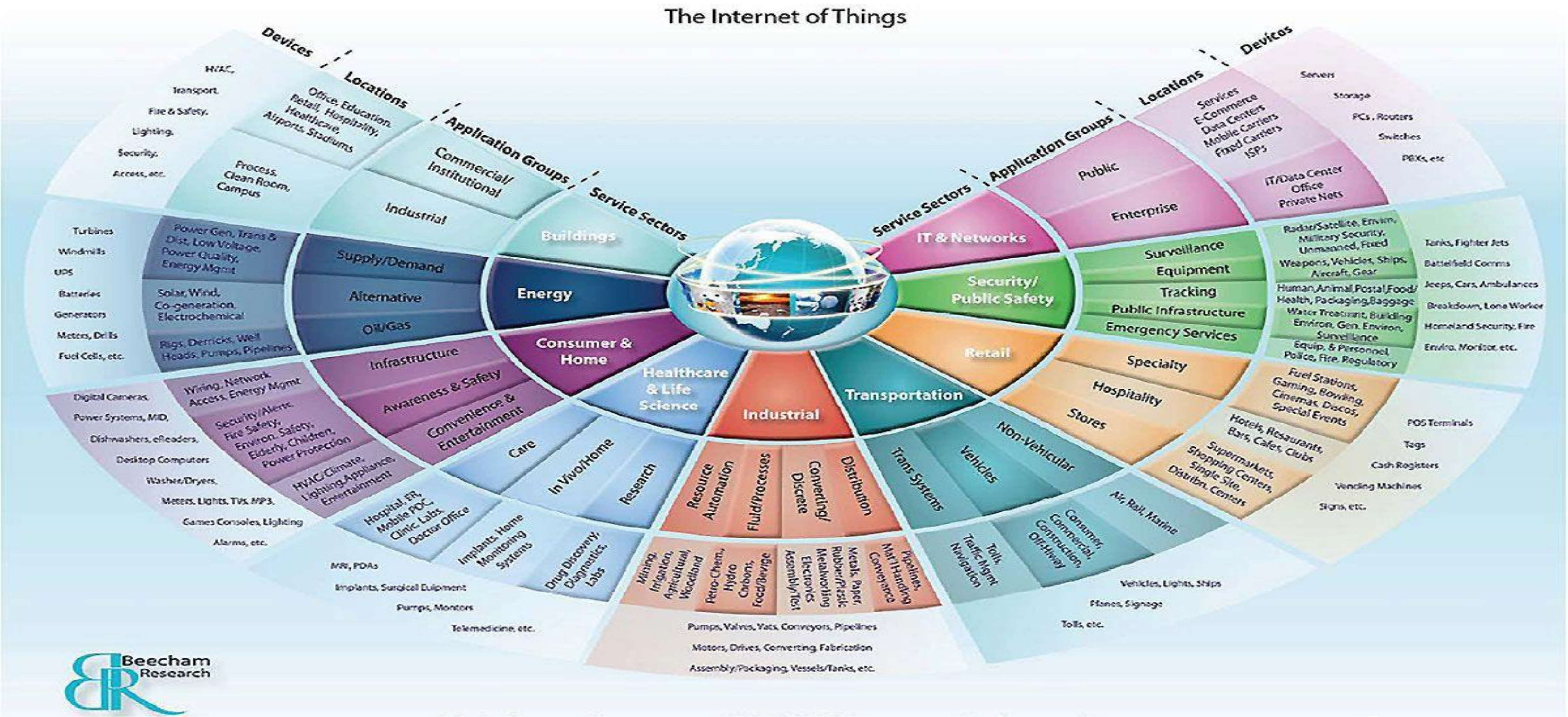
Thank you very much for your attention

Вялікі дзякуй за ўвагу

Спасибо вам большое за ваше внимание

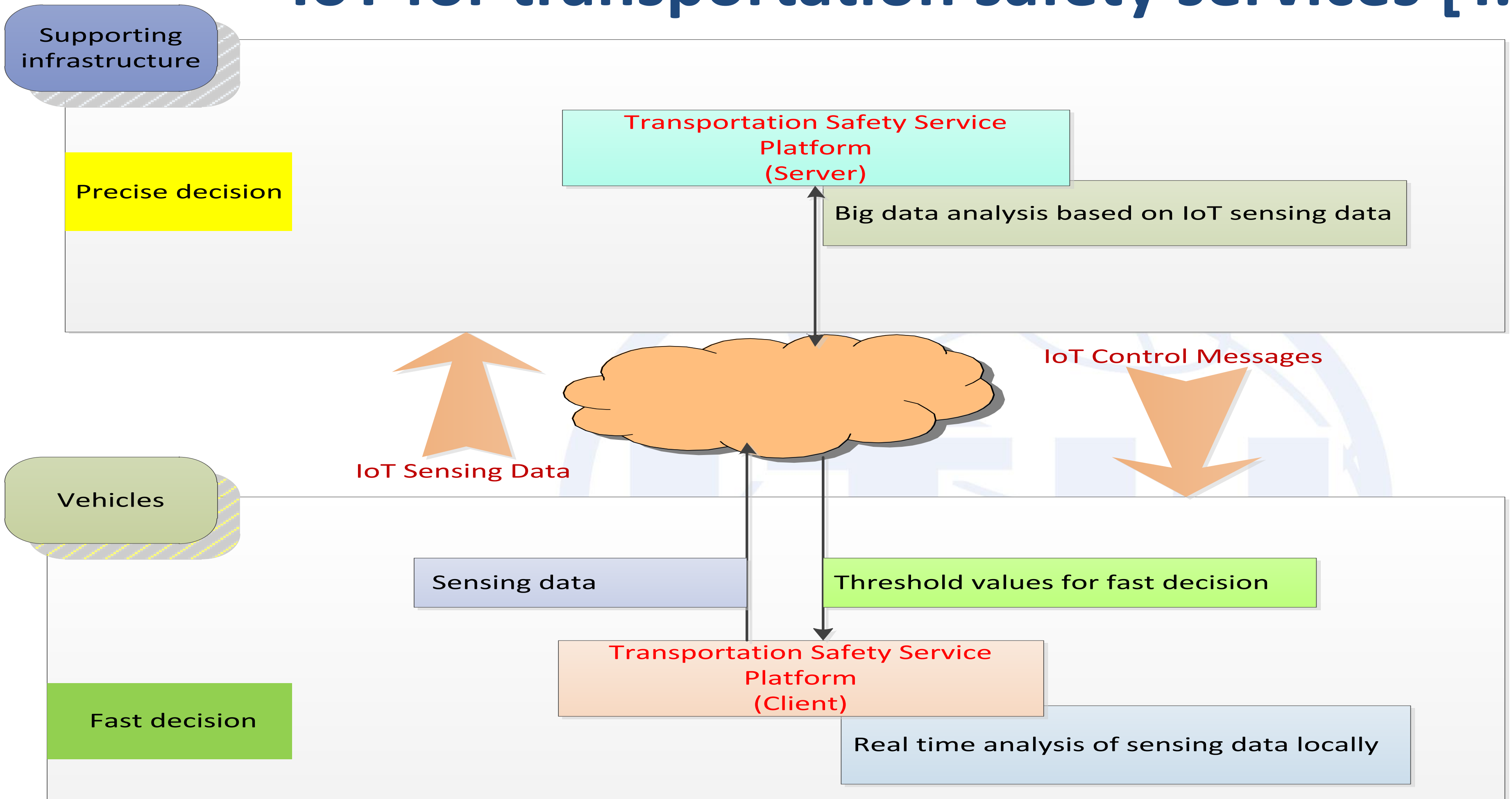
31

Backup information



IoT is driving a profound transformation of the industries, with impact on products, processes, business models and ecosystems, social life

IoT for transportation safety services [Y.4116]



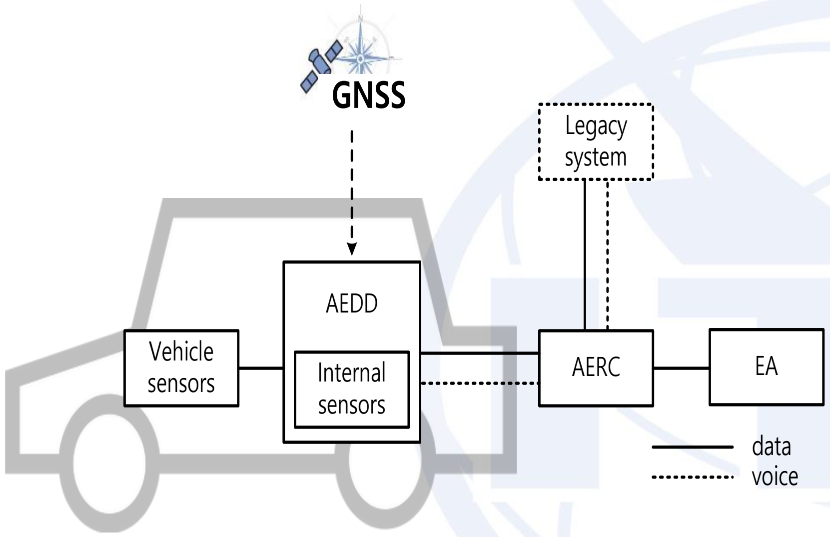
Example of distributed processing-based decision making

Extract from Y.4116 "Requirements of transportation safety services including use cases and service scenarios"

Vehicles locally process and compare **sensing data** to threshold values for fast decision.
Sensing data from vehicles and transportation infrastructure are delivered to the transportation safety service platform (server side).
The platform generates threshold values (e.g. safety indexes) for more accurate decision based on big data analysis.
The generated threshold values are delivered to vehicles for appropriate adjustment of the local decision making process.

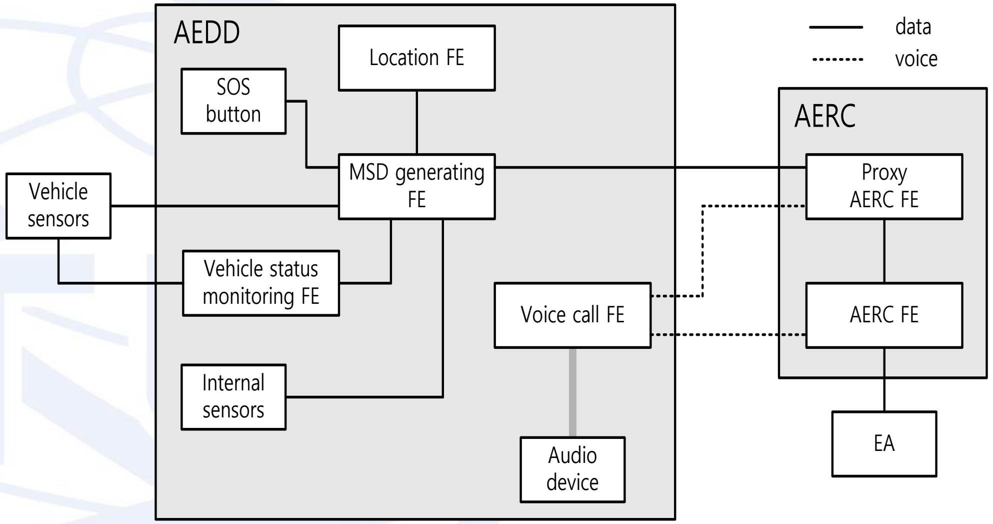
IoT-based Automotive Emergency Response System [Y.4119]

Overview of the AERS



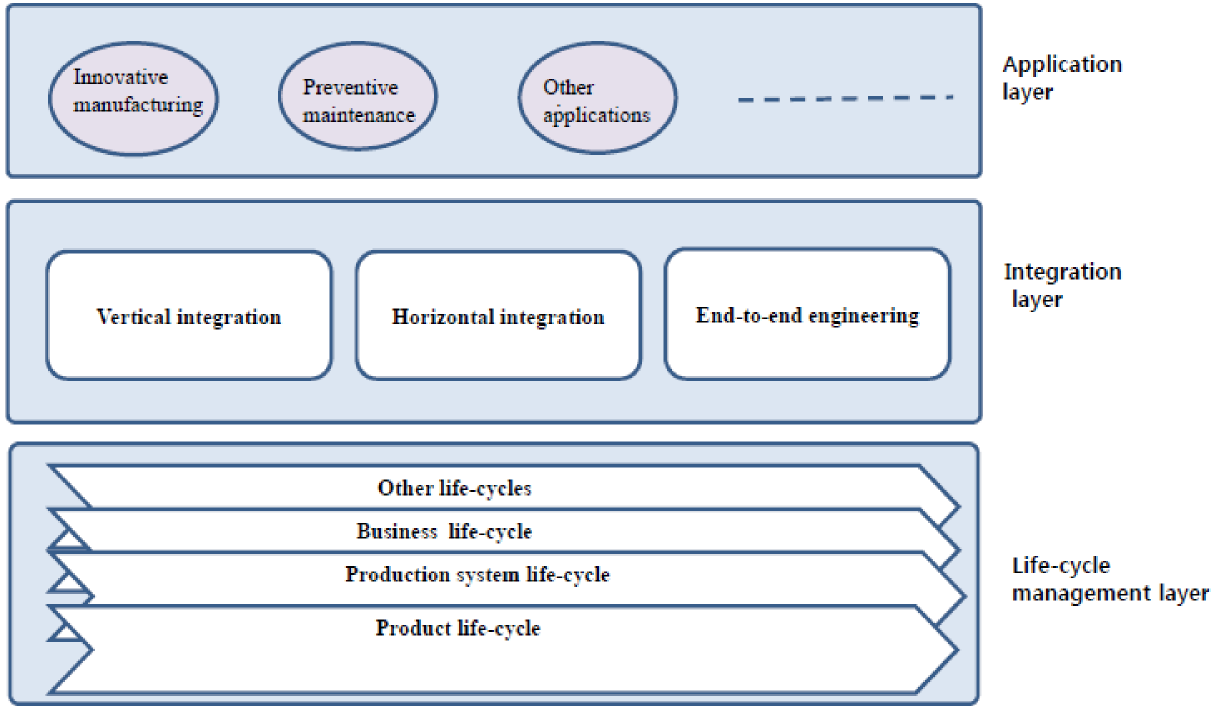
AEDD automotive emergency detection device
AERC automotive emergency response center
EA emergency authority
GNSS global navigation satellite system

Capability framework of the AERS

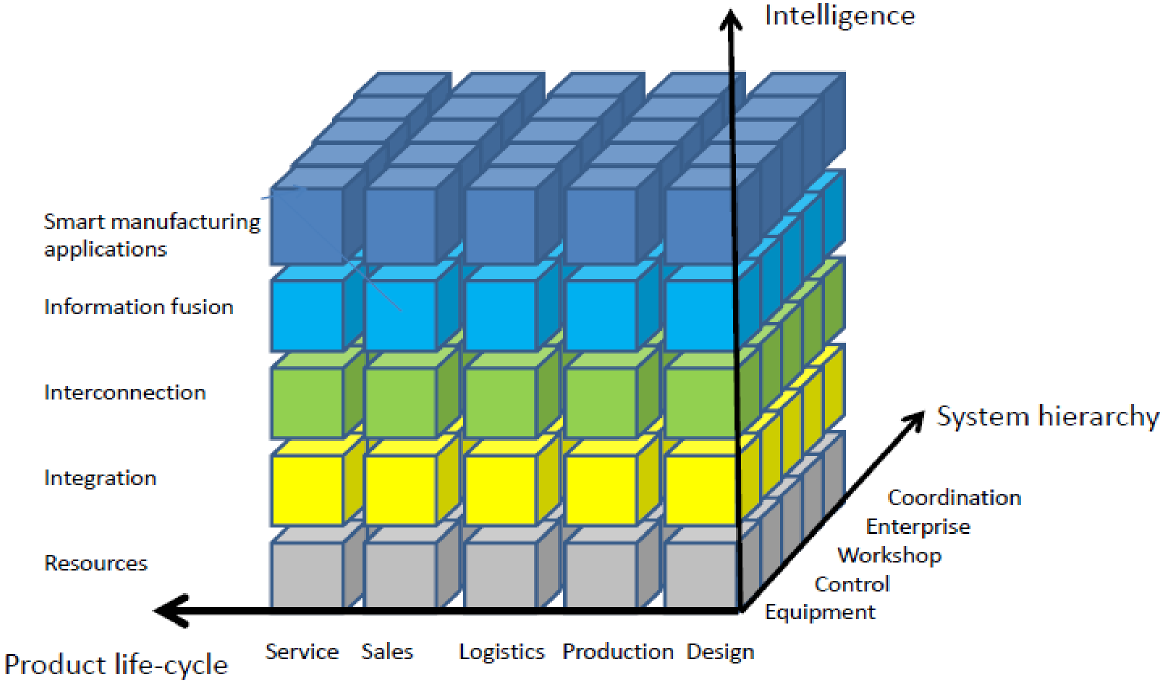


An IoT-based automotive emergency response system is expected ***to reduce the automobile accident detection and reporting times*** *using automatic accident detection-report procedures.*
Furthermore, since a sensor assisted geographical positioning allows to pinpoint the exact location of the accident, ***the time for rescue to reach the accident scene is expected to be shortened significantly.***

Smart Manufacturing in the context of the Industrial IoT [Y.4003]



Overview of smart manufacturing from the functional layering perspective

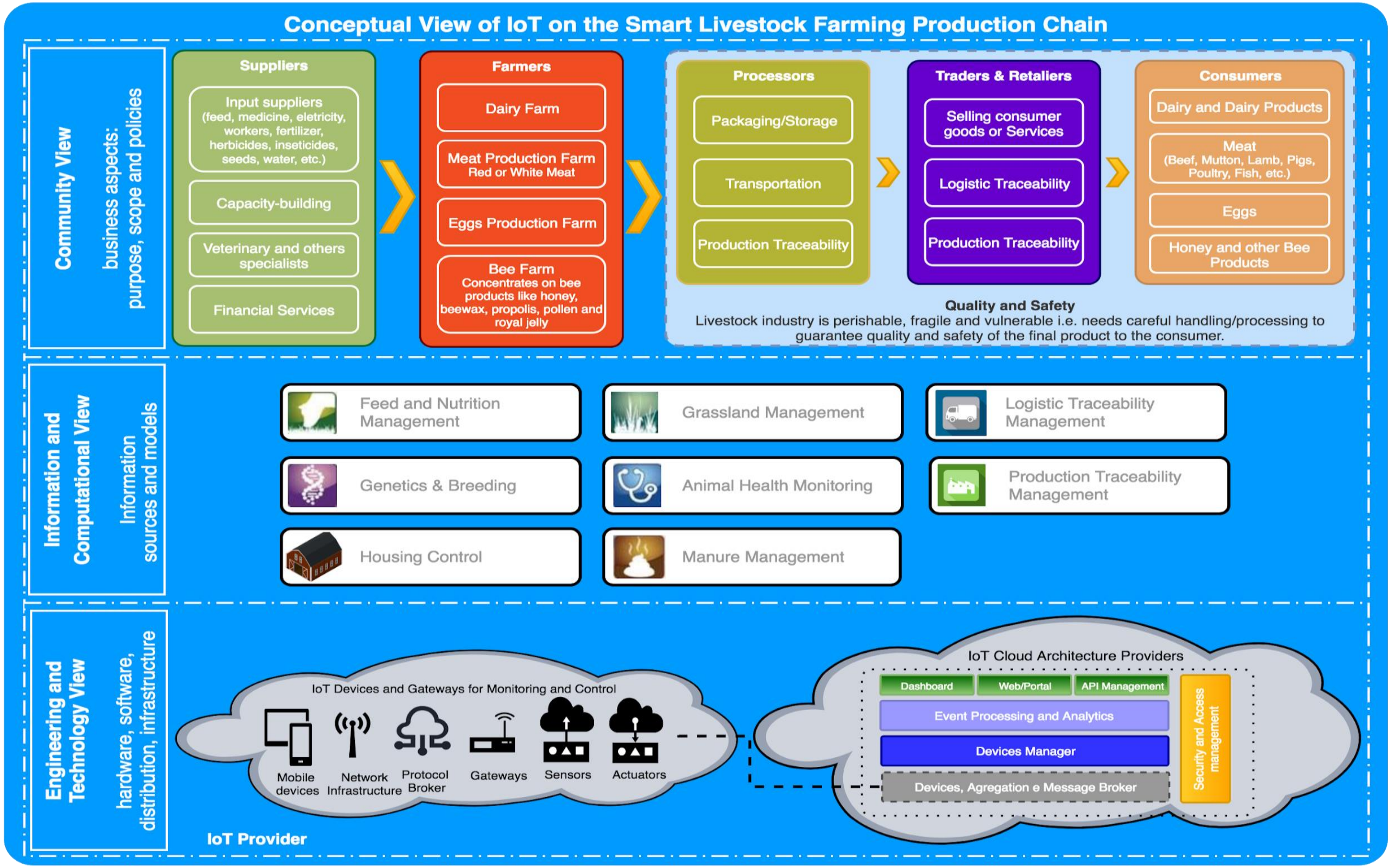


Reference model of smart manufacturing in the context of the Industrial IoT from the product life-cycle view

Y.4003: Overview of smart manufacturing in the context of the industrial Internet of things

Smart Manufacturing, and Industrial IoT in general, is a strategic business objective in the international competition, as well as a hot standardization topic with numerous regional/national standards initiatives

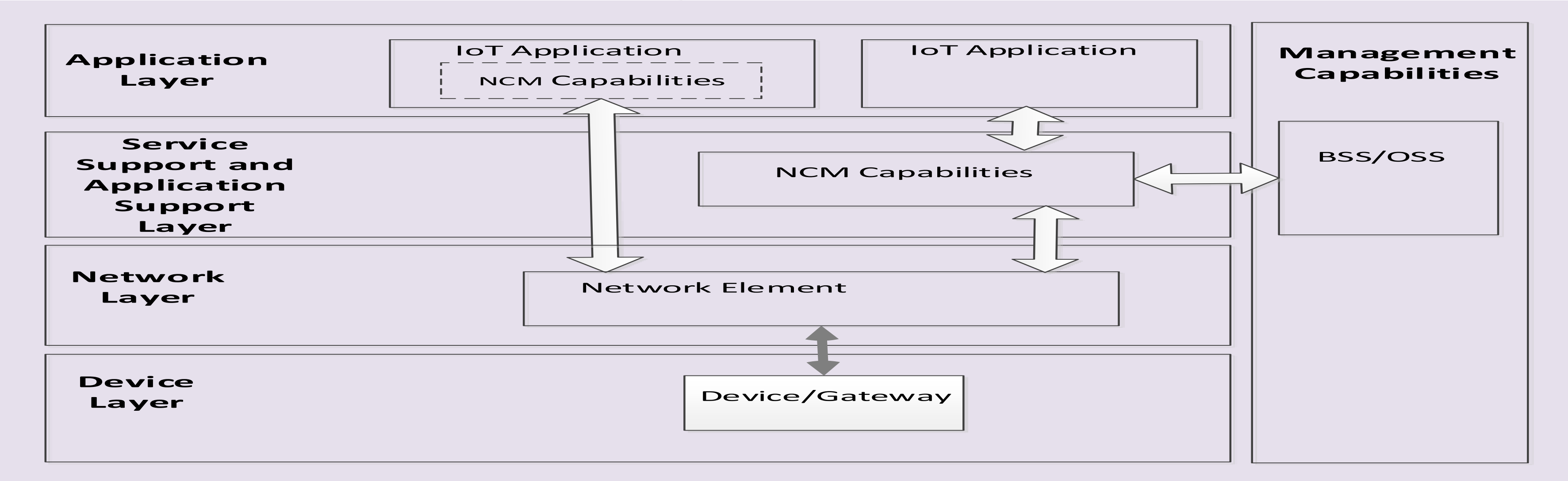
Smart Livestock Farming [ongoing Y.IoT-SLF]



Extract from ongoing Y.IoT-SLF «Framework and Capabilities for Smart Livestock Farming Based on Internet of Things»

Three tier conceptual model for the Smart Livestock Farming production chain

Capabilities for management of network connectivity in large scale device deployments (connectivity platforms)



Extract from ongoing Y.IoT-NCM-Reqts «Requirements and capabilities of network connectivity management in the Internet of Things»

Enterprise customers and IoT service providers offer products and services to end users, with Wide Area Network connectivity embedded in. Quality and reliability of embedded network connectivity of each IoT device needs to be ensured.

With a large number of deployed devices, it is difficult to monitor and manage network connections manually through traditional customer care services provided by network operators.

To solve this problem, standardized Network Connectivity Management (NCM) should be provided to enterprise customers and IoT service providers by network operators.

Support for self-service provisioning, network connectivity status monitoring and diagnosis, network connectivity control, event notification and analysis.

ITU