Internet of Things in Trade Facilitation
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Overview of the ITU-T standardization activities related to the Internet of Things

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Outline

- Internet of Things (IoT)
- Introduction to the main ITU-T activities on Internet of Things
- Some detailed information on IoT activities in ITU-T SG20
  - few foundational concepts and achievements
  - some application studies
- Some detailed information on activities concerning data processing and management in IoT (ITU-T SG20 and ITU-T FG-DPM)
- Two current hot topics in the IoT space (and beyond): blockchain and data protection

Internet of Things

The IoT is fundamentally changing the business and drives convergence between ICT and industries

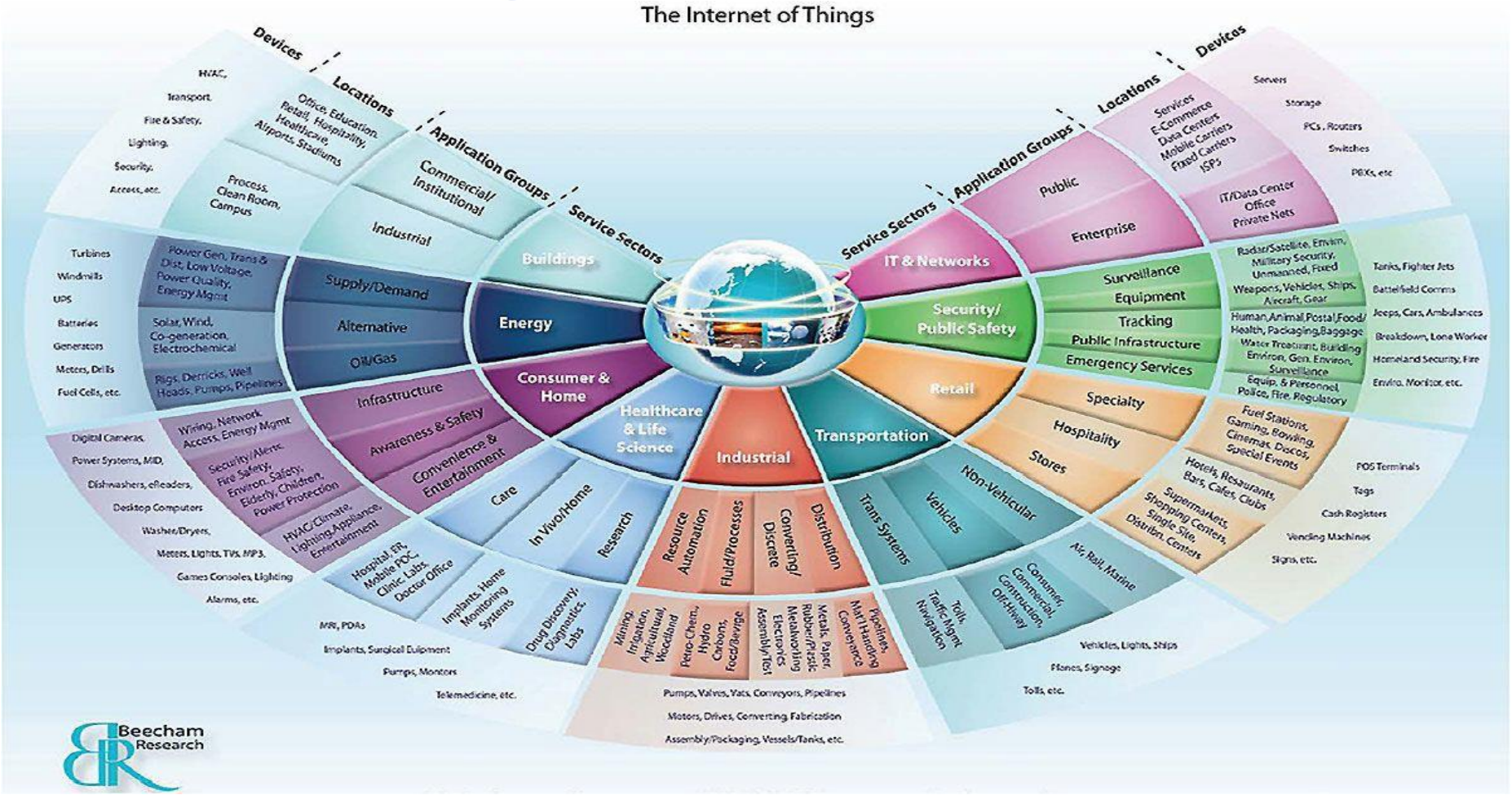
Products	**Smarter Products**	• *Embedded and enhanced processing power* • *Greater data capabilities* • *Bi-directional communications*
Isolated	**Connected**	• *Pervasive coverage and greater bandwidth* • *Multiple technologies* • *Real time communications*
Operational Technology	**OT + IT Convergence**	• *Applications and data* • *Integrated/advanced analytics* • *Shift in traditional product design*
Service Innovation	**"Servitisation"**	• *Products designed with integrated services* • ***New business models***

Competitive Advantage

Source: Machina Research

IoT is driving a profound transformation of the industries, the digitalization impacting products, processes, business models and ecosystems, social life

"Ultimately, digitalization is connecting all industries into a giant ecosystem" [source: Harvard webinar]


The Internet of Things
Devices
Locations
Application Groups
Service Sectors
HVAC,
Transport,
Fire & Safety,
Lighting,
Security,
Access, etc.
Office, Education, Retail, Hospitality, Healthcare, Airports, Stadiums
Process, Clean Room, Campus
Commercial/ Institutional
Industrial
Buildings
Energy
Consumer & Home
Healthcare & Life Science
Industrial
Transportation
Retail
Security/ Public Safety
IT & Networks
Public
Enterprise
Services, E-Commerce, Data Centers, Mobile Carriers, Fixed Carriers, ISPs
IT/Data Center, Office, Private Nets
Servers
Storage
PCs, Routers
Switches
PBXs, etc
Turbines
Windmills
UPS
Batteries
Generators
Meters, Drills
Fuel Cells, etc.
Power Gen, Trans & Dist, Low Voltage, Power Quality, Energy Mgmt
Solar, Wind, Co-generation, Electrochemical
Rigs, Derricks, Well Heads, Pumps, Pipelines
Supply/Demand
Alternative
Oil/Gas
Digital Cameras,
Power Systems, MID,
Dishwashers, eReaders,
Desktop Computers
Washer/Dryers,
Meters, Lights, TVs, MP3,
Games Consoles, Lighting
Alarms, etc.
Wiring, Network Access, Energy Mgmt
Security/Alerts, Fire Safety, Environ. Safety, Elderly, Children, Power Protection
HVAC/Climate, Lighting/Appliance, Entertainment
Infrastructure
Awareness & Safety
Convenience & Entertainment
Hospital, ER, Mobile POC, Clinic Labs, Doctor Office
Implants, Home Monitoring Systems
Drug Discovery, Diagnostics, Labs
Care
In Vivo/Home
Research
MRI, PDAs
Implants, Surgical Equipment
Pumps, Monitors
Telemedicine, etc.
Resource Automation
Fluid/Processes
Converting/ Discrete
Distribution
Mining, Irrigation, Agricultural, Woodland
Petro-Chem., Hydro Carbons, Food/Bevrge
Assembly/Test
Electronics
Metalworking
Rubber/Plastic
Metals, Paper
Mat'l Handling
Conveyance
Pipelines
Pumps, Valves, Vacs, Conveyors, Pipelines
Motors, Drives, Converting, Fabrication
Assembly/Packaging, Vessels/Tanks, etc.
Trans-Systems
Vehicles
Non-Vehicular
Toll, Traffic Mgmt Navigation
Consumer, Commercial, Construction, Off-Hwy
Air, Rail, Marine
Vehicles, Lights, Ships
Planes, Signage
Tolls, etc.
Specialty
Hospitality
Stores
Hotels, Resaurants, Bars, Cafes, Clubs
Supermarkets, Shopping Centers, Single Site, Distribn. Centers
Fuel Stations, Gaming, Bowling, Cinemas, DisCos, Special Events
POS Terminals
Tags
Cash Registers
Vending Machines
Signs, etc.
Surveillance
Equipment
Tracking
Public Infrastructure
Emergency Services
Radar/Satellite, Environ. Military Security, Unmanned, Fixed
Weapons, Vehicles, Ships, Aircraft, Gear
Human, Animal, Postal, Food/ Health, Packaging, Baggage
Water Treatment, Building Environ, Gen. Environ. Surveillance
Equip. & Personnel, Police, Fire, Regulatory
Tanks, Fighter Jets
Battlefield Comms
Jeeps, Cars, Ambulances
Breakdown, Lone Worker
Homeland Security, Fire
Enviro. Monitor, etc.
Beecham Research

IoT and leading technologies

The IoT will benefit from the integration of a number of leading technologies, including those for

- **Machine to Machine Communications**
- **Advanced sensing and actuation**
- **Security, Privacy and Trust**
- **Big Data management**
- **Semantics support**
- **Machine Learning (AI)**
- **Cloud Computing (and distributed computing)**
- Softwarization (incl. Software Defined Networking, Network Functions Virtualization)
- Autonomic Networking
- Service Delivery Platforms
- specific applications/industries

The key role of Standardization for IoT interoperability

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 =>> the key role of international SDOs in standards convergence/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

IoT SDOs and Alliances Landscape (Technology and Marketing Dimensions)

Source: AIOTI WG3 (IoT Standardisation) – Release 2.8

Introduction to the main ITU-T activities on Internet of Things

International Telecommunication Union (ITU)

The three ITU Sectors:

- **Standardization (ITU-T)**: platform for governments and private sector to coordinate development of telecom networks & services. It promotes enabling technical, policy and regulatory frameworks to boost ICT development.
  - Development of **Interoperable, non-discriminatory** international standards
  - Assistance in **bridging the standardization gap** for developing countries
  - Facilitation of **international cooperation** among international/regional/national SDOs
- **Radiocommunication (ITU-R)**: it coordinates the shared global use of radio spectrum and geostationary satellite orbit.
- **Development (ITU-D)**: it works to improve telecom infrastructure in the developing world.

ITU-T Study Groups - 2017-2020

SG2 - Operational aspects

SG3 - Economic and policy issues

SG5 - Environment and climate change

SG9 - Broadband cable and TV

SG11 - Protocols and test specifications

SG12 - Performance, QoS and QoE

SG13 - Future networks, with focus on IMT- 2020, cloud computing and trusted network infrastructures

SG15 - Transport, Access and Home

SG16 - Multimedia

SG17 - Security

SG20 - Internet of Things (IoT) and smart cities and communities (SC&C)

ITU activities on the Internet of Things

ITU-T Study Group 20:
Development and implementation of international standards

ITU-T FG-DPM :
Research and pre-standardization work on data processing and management to support IoT and Smart Cities

U4SSC (United for Smart Sustainable Cities):
UN global platform for knowledge sharing (coordination ensured by ITU and UNECE)

Resolution 98
Enhancing the standardization of IoT and Smart Cities and Communities for global development

IoT4SDGs: *Considers the importance of IoT to contribute to achieving the 2030 Agenda for Sustainable Development.*

ITU-T Study Group 20: Internet of things (IoT) and smart cities & communities (SC&C)

Lead Study Group on

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

Expert group	Mandate of the SG20 expert groups
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
Regional groups	
SG20RG-LATAM	ITU-T SG20 Regional Group for the Latin American Region
SG20RG-EECAT	ITU-T SG20 Regional Group for Eastern Europe, Central Asia and Transcaucasia
SG20RG-ARB	ITU-T SG20 Regional Group for the Arab Region
SG20RG-AFR	ITU-T SG20 Regional Group for the Africa Region
Other groups under SG20	
JCA-IoT and SC&C	Joint Coordination Activity on IoT and SC&C [it maintains the IoT and SC&C standards roadmap]
FG-DPM	FG on Data Processing and Management to support IoT and SC&C

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

Last SG20 meeting on 4-15 Sept 2017, Geneva

Last SG20/WP1 Rapporteurs Group meeting on 15-24 Jan 2018, Geneva

Next SG20 meeting on 6-16 May 2018, Cairo

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

Internet of Things and Data

Huge volume of data produced by IoT devices

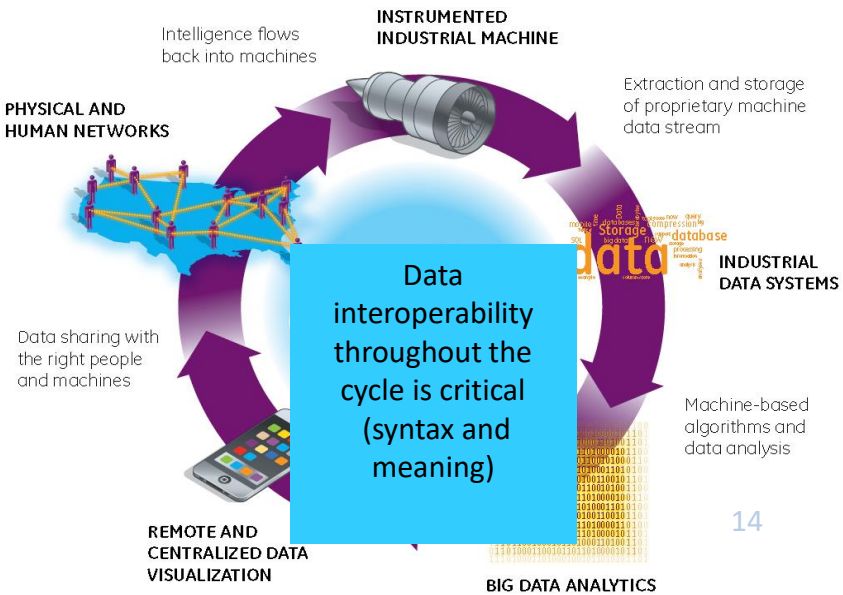
Multiple data sources (things, context, historical data, social data)

Data with different velocity, formats, precision, confidence, quality

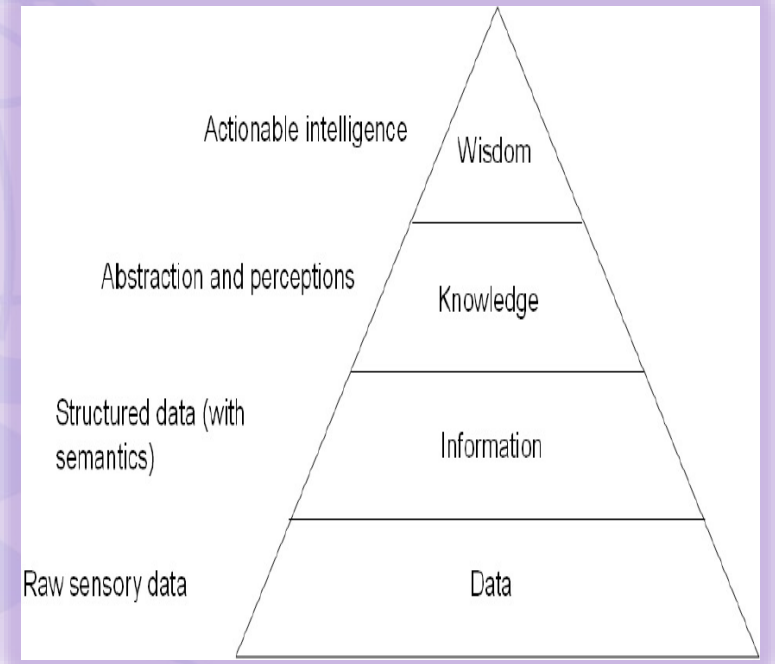
Different operations on data for extraction of actionable intelligence

A key goal is to have ready for use the right data, at the right time, at the right location

The Industrial Internet Data loop *[source: GE whitepaper]*



From Data to Actionable Intelligence



Knowledge hierarchy applied in data processing

Source: Barnaghi and al., IJSWIS, 2012

Opportunities and challenges of Data in the IoT

Process optimization and data monetization via analytics (driving revenue by sharing, analyzing and interpreting data, for multiple purposes)

- Extraction of tangible business and technology value
- **Response and action in real time**, improving productivity/business processes, lowering costs
- **Long-range forecasts enabling strategic actions** - business differentiation, addressing society challenges
- **New/improved business models and service offer**, faster, more efficiently and agile

Technical and non-technical challenges

- **Dealing with the "V"s of data : Volume, Variety, Velocity, Variability, Veracity**
- Discovery of appropriate devices and data sources
- **Integration of heterogeneous devices, networks and data**
- Scalability to cope with large numbers of devices, diverse and huge data, computational complexity of data interpretation
- **Massive data mining, efficient computing and processing, flexible learning**
- Data query
- Availability and (open) access to data (resources)
- **Trust, security and privacy of data**
- Interpretation (extraction of actionable intelligence from data)
- **Other non-technical challenges also essential (incl. data ownership and data governance)**

ITU-T Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities (ITU-T FG-DPM)

Essential tasks

- Identify challenges in IoT and smart cities for data processing and management
- Identify key requirements ad capabilities for data processing and management
- Promote the establishment of trust-based data management frameworks for IoT and SC&C
- Investigate the role of emerging technologies to support data management incl. blockchain
- Identify and address standardization gaps and challenges

WG1 - Use Cases, Requirements and Applications/ Services

WG2 - DPM Framework, Architectures and Core Components

WG3 - Data sharing, Interoperability and Blockchain

WG4 - Security, Privacy and Trust including Governance

WG5 - Data Economy, commercialization and monetization

5 Working Groups

Main priority

To propose mechanisms , frameworks and guidelines for supporting security, privacy and interoperability of datasets and data-management systems in IoT and smart cities

First meeting: Geneva, 17-19 July 2017
Second meeting: Geneva, 20-25 October 2017
Third meeting: Brussels, 20-23 Feb 2018
Fourth meeting: Cairo, 1-3 May 2018

1st ITU Workshop on Data Processing and Management for IoT and Smart Cities & Communities: Brussels, Belgium, 19 Feb. 2018

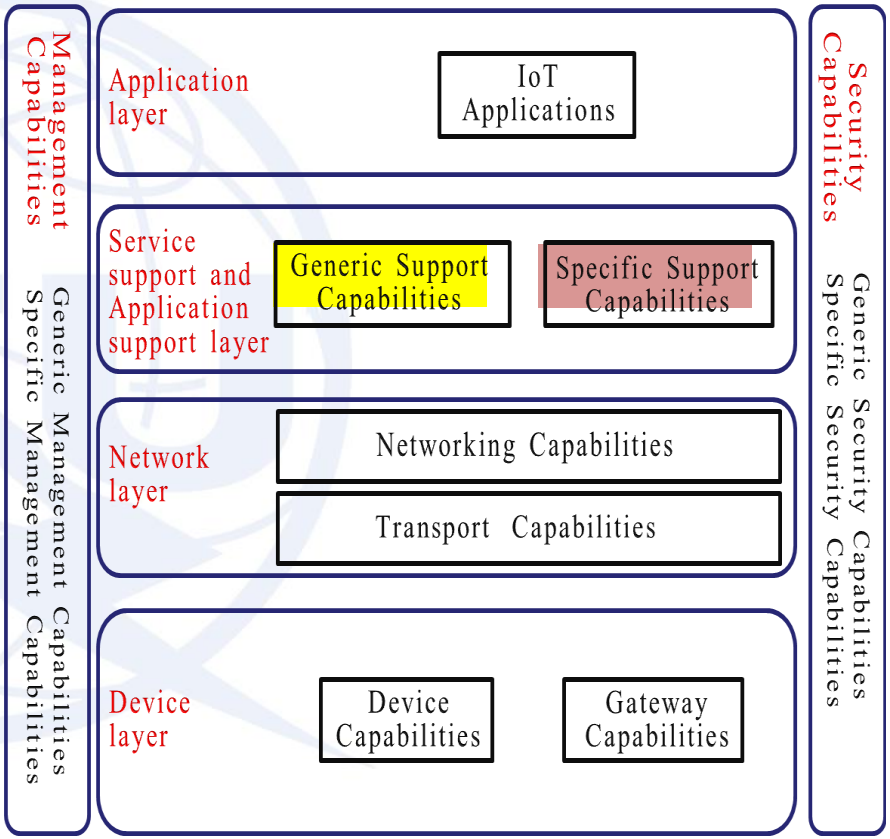
FG-DPM Home page: https://www.itu.int/en/ITU-T/focusgroups/dpm/Pages/default.aspx

Some detailed information on IoT activities in ITU-T SG20: few foundational concepts and achievements, some application studies

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

Capability view of the IoT infrastructure

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

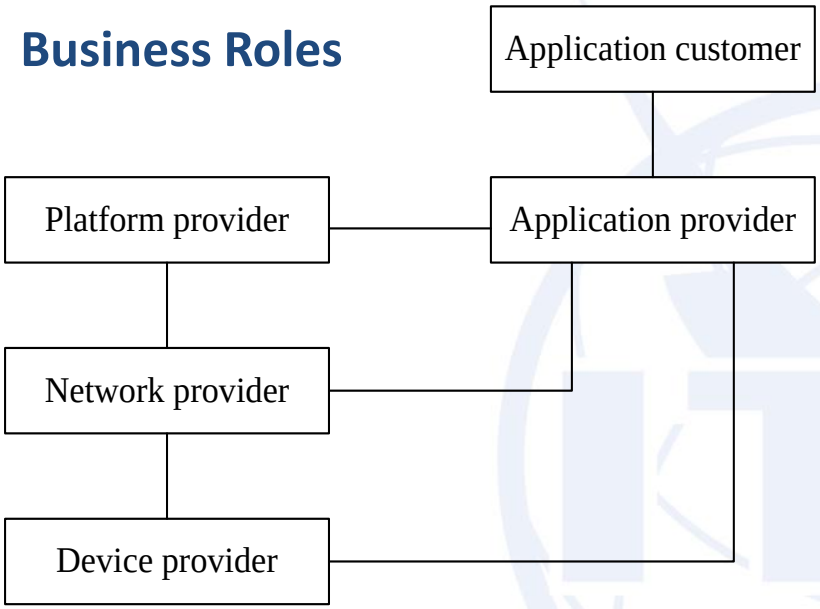


Source: ITU-T Y.2060 /Y.4000 "Overview of the Internet of things"

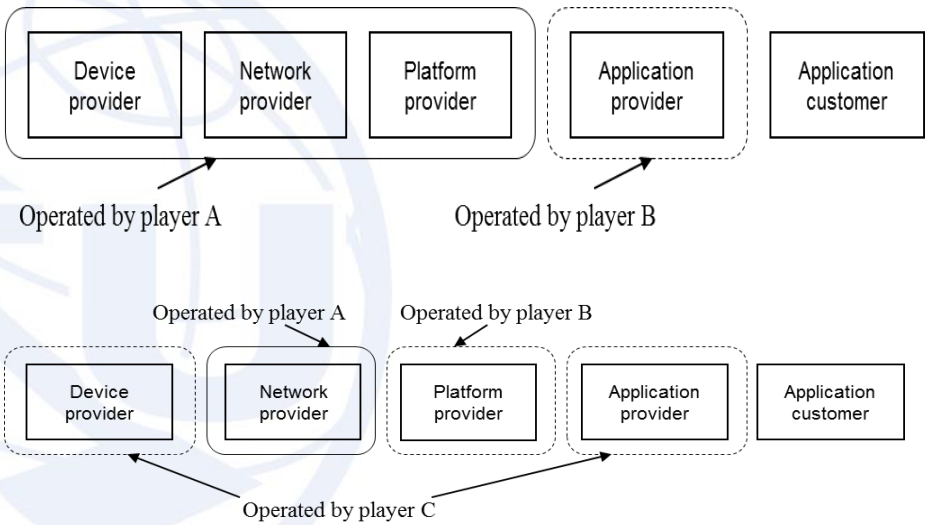
IoT ecosystem(s): business roles and models

[source: Appendixes of ITU-T Y.4000/Y.2060]

Business Roles



Business models (5 typical examples in Y.2060)



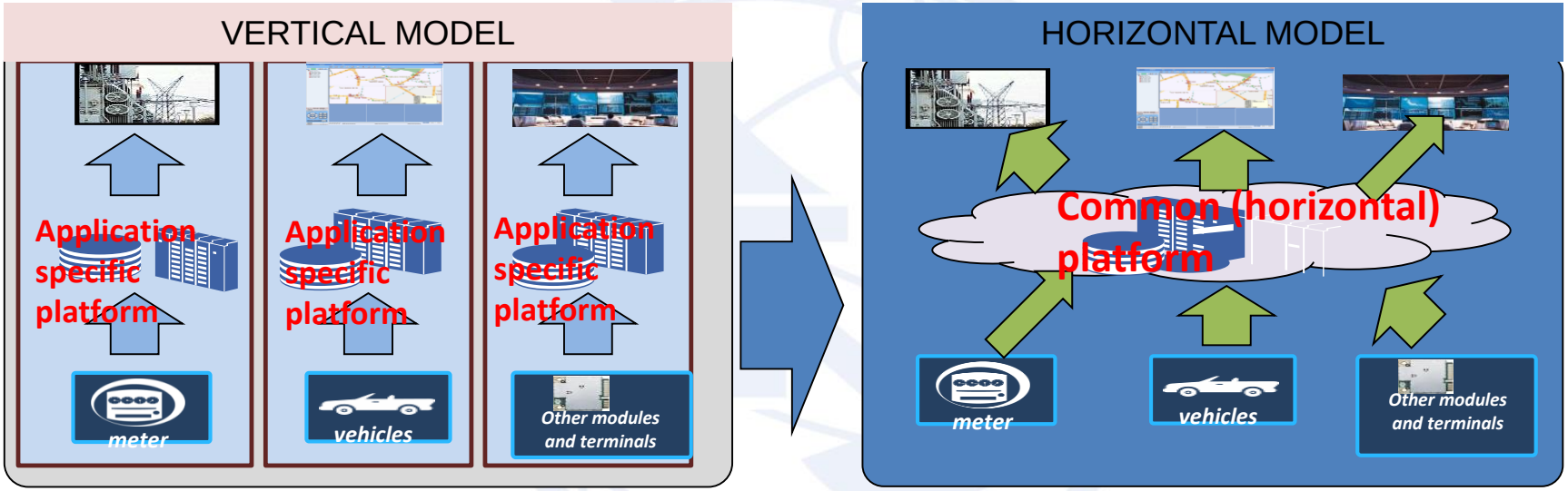
"Simplified view" of business roles and relationships (no ambition to represent all roles and relationships across the huge number of real IoT business deployments)

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

NOTE - This exercise has been replicated in specific domains (e.g. e-health, Big Data)

A fundamental shift promoted by IoT: from vertical to horizontal platforms

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



Platform configured **per vertical application** (domain)

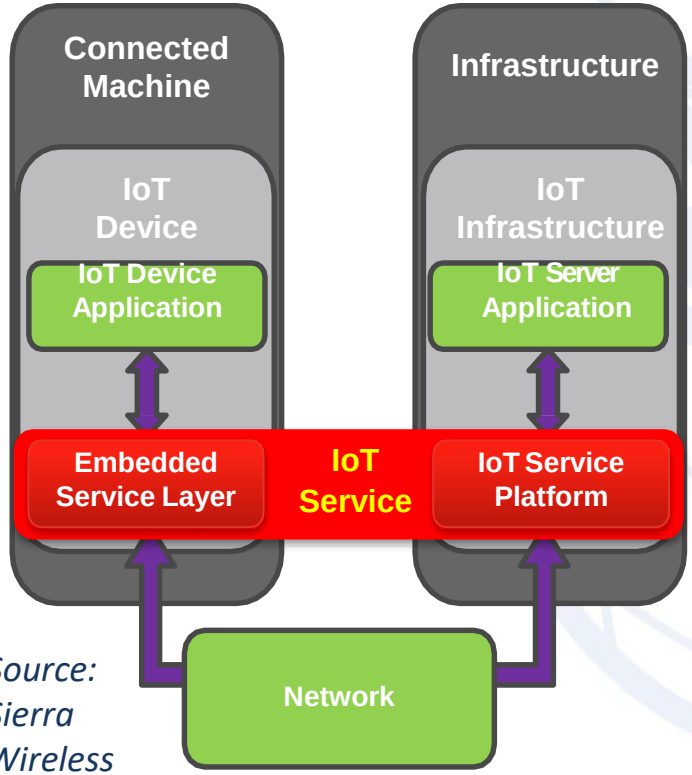
Horizontal platform supporting multiple applications (with common components and application-specific components)

Deployment reality: different (per domain) platforms will continue to be deployed and need to interoperate

Per silo integration does not scale and limits evolution possibilities

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

The oneM2M architecture approach adopted by ITU-T



Source: Sierra Wireless

oneM2M architecture layering

Application Layer

Software "framework" that sits between IoT applications and communication networking components

(Common) Service Layer

Provides horizontal services that IoT applications across different industry segments commonly need (e.g. data management, security, …)

Network Layer

Can be deployed on devices, gateways and servers in highly distributed deployments

As the result of concrete collaboration between ITU-T SG20 and oneM2M, various oneM2M specifications are under adoption (since Sept 2017) as ITU-T Recommendations or Supplements*, the oneM2M Architecture specification being part of this process*

IoT applications: a non-exhaustive list of (completed or ongoing) studies in SG20

IoT and SC&C application domains (relates studies at different levels)

- **Smart Cities** (parking, lightning, water management etc.)
- Smart Rural Communities
- Smart Residential Communities
- **Smart Tourist destinations**
- **Smart Port**
- **Smart Transportation** (Cooperative ITS apps, Automotive Emergency Response System, Transportation Safety Services, Unmanned Aircraft Systems, others)
- **Smart Retail**
- **Wearables**
- **Smart Farming/Agriculture**
- Smart Manufacturing (framework in the context of Industrial IoT)
- Smart monitoring (environment, animals' movement)
- Monitoring and study of Global Processes of the Earth for disaster preparedness
- **Micro-Grids and Advanced Metering Infrastructure**
- Home Networks
- **E-health**
- Others (incl. specific use cases from developing countries, Smart Evacuation during emergencies, …)

Numerous other technical areas (than the application domains) are addressed by SG20 studies (horizontal frameworks and capabilities, support of specific technologies, other).

Smart Cities as super application domain of the IoT

Integration of multiple verticals

Citizen-centric services

Still a number of technical challenges, incl. interoperability, scalability, dynamicity, security and privacy

The brain of the city

Data collection, analysis, knowledge, planning, action

The senses of the city

City data sources

Source: Dr. Levent Gürgen

Various approved ITU-T Recommendations on smart cities: Key Performance Indicators, smart city platforms, etc.

A large number of ongoing studies on smart cities: ecosystem, applications and services; requirements and capabilities; general reference models; maturity model; assessment framework for digital transformation; efficient service analysis, strategic planning, deployment and implementation; ICT use for smart city physical infrastructure; Open Data; etc.

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

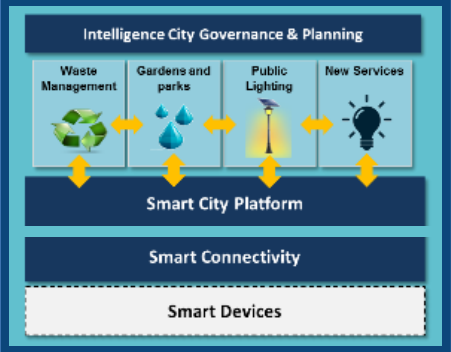
1 — 2 — 3 — 4

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

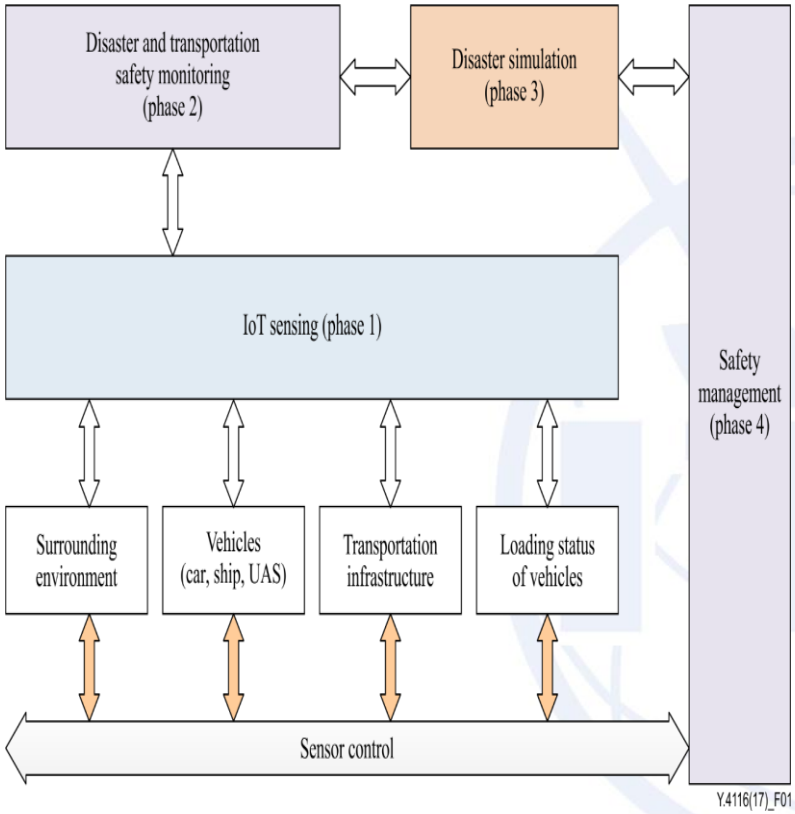
Support to Data Economy

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

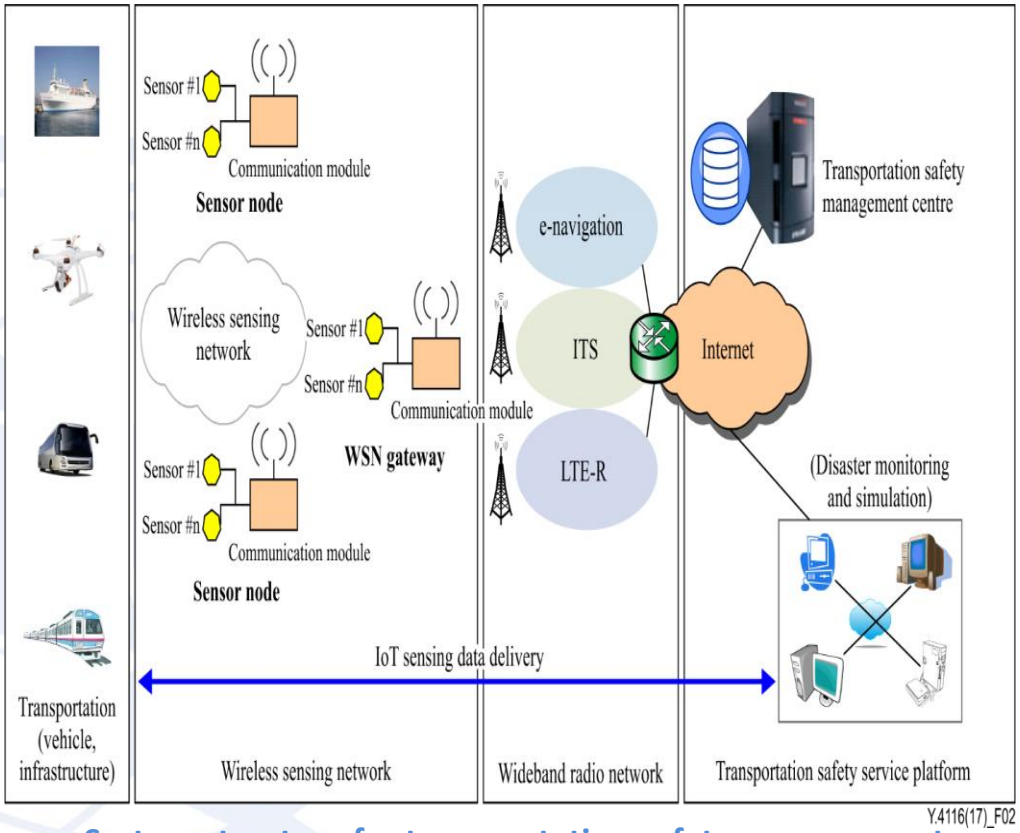
Source: FIWARE

Smart Transportation:

Transportation safety services (ITU-T Y.4116)



Concept of transportation safety management

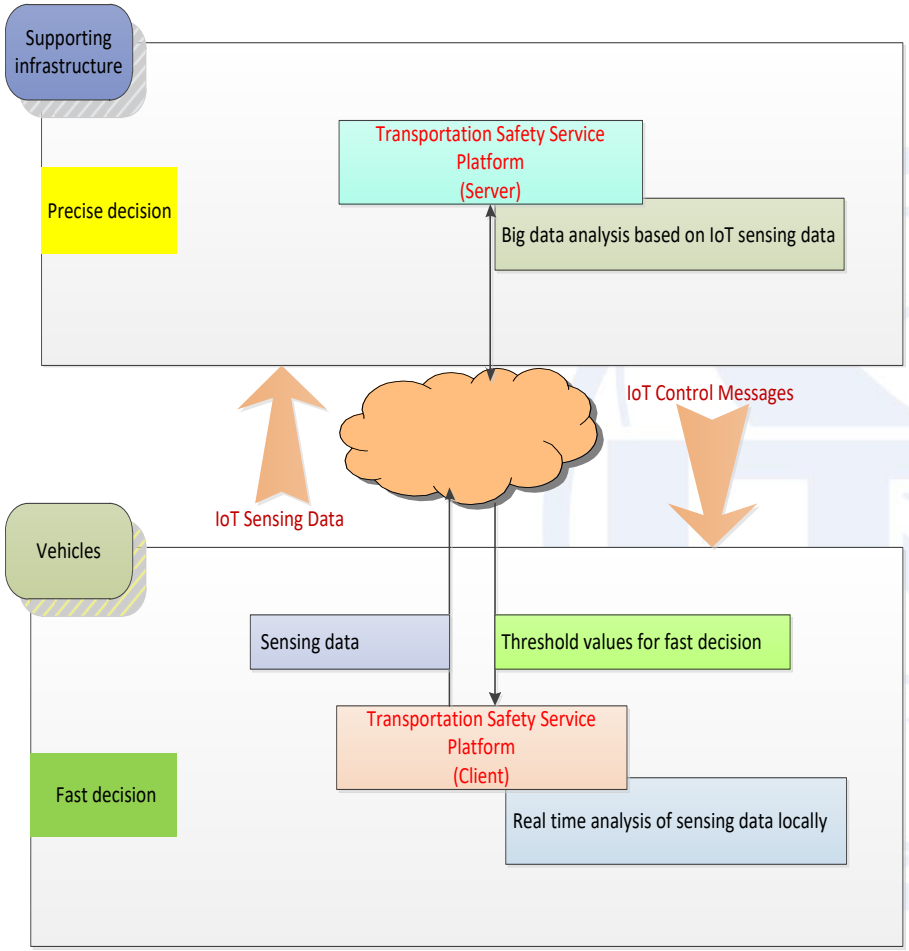


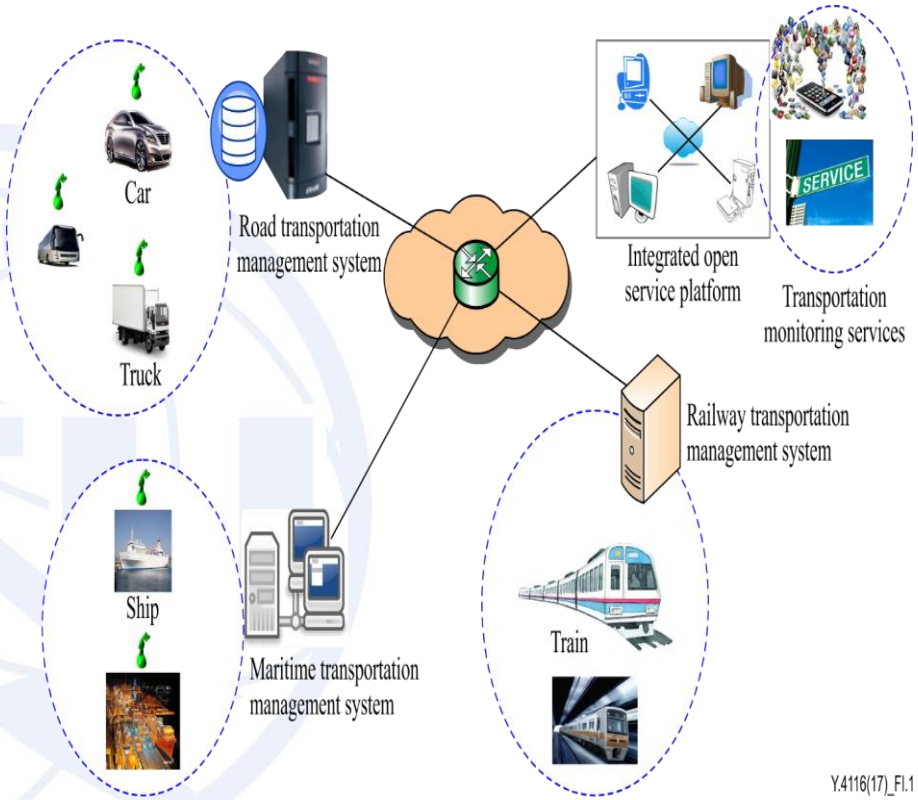
System structure for transportation safety management

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

The transportation safety 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.

Transportation safety services (ITU-T Y.4116) – continued



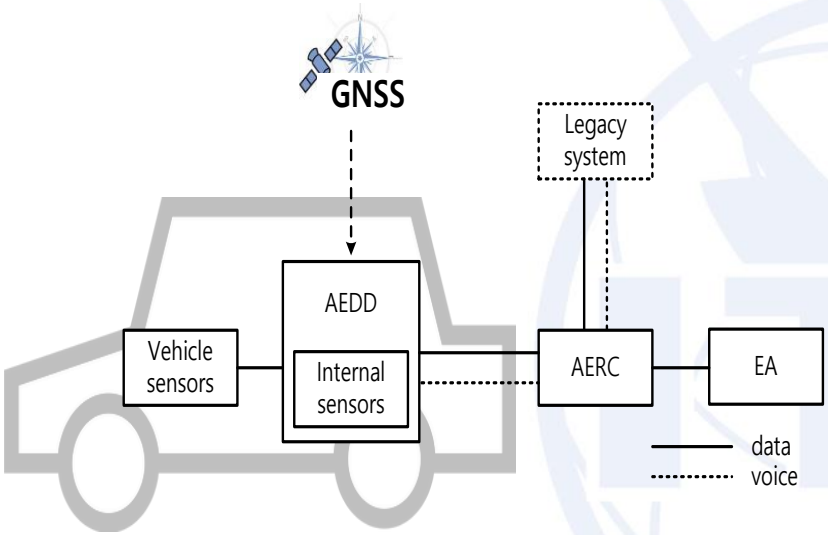


Example of decision making based on distributed processing technology

Example of transportation safety management services: Transportation status monitoring service

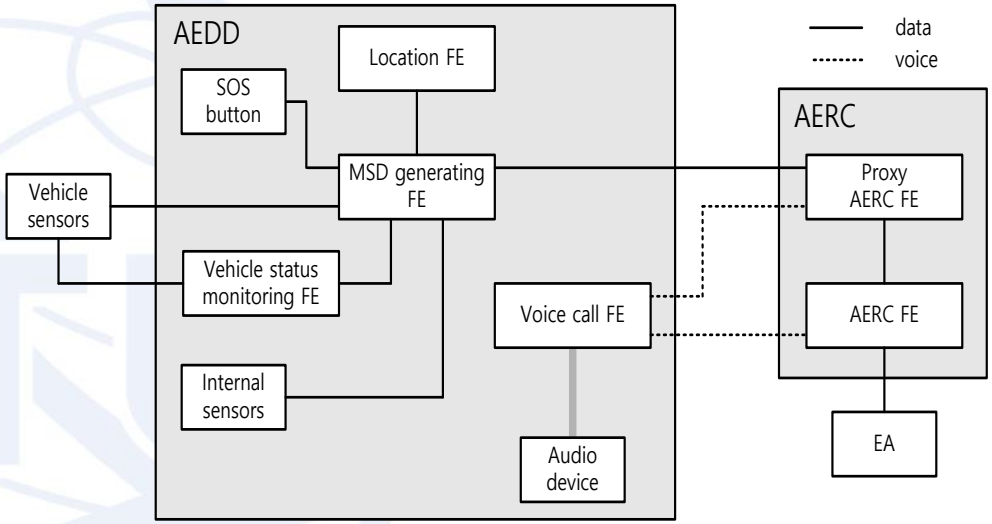
IoT-based Automotive Emergency Response System (AERS) (ITU-T Y.4119)

Overview of the AERS



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

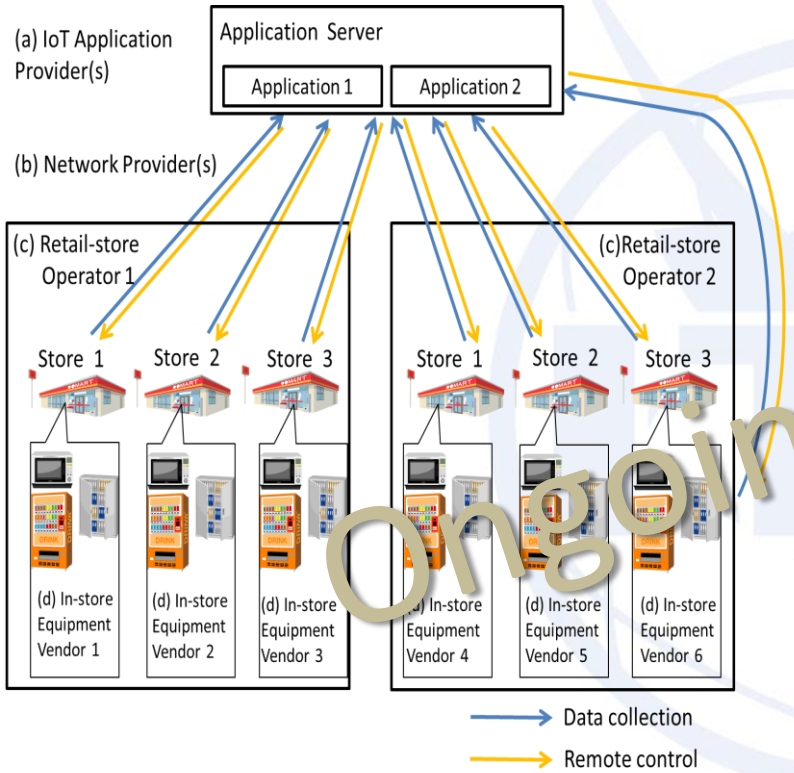
Capability framework of the AERS



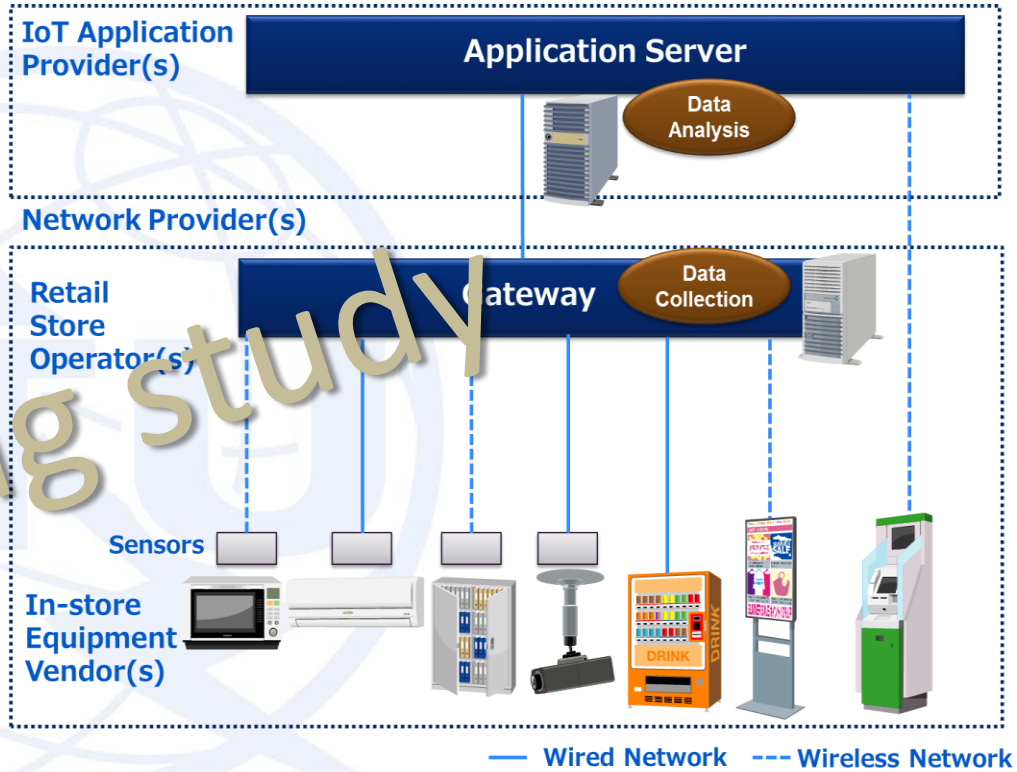
An IoT-based automotive emergency response system is expected ***to reduce the automobile accident detection and reporting times*** *using automatic accident detection-report procedures. Furthermore, since a sensor assisted geographical positioning allows to pinpoint the exact location of the accident,*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

Smart Retail:

applications for retail stores enabled by IoT technologies (ongoing study)



Smart retail store ecosystem



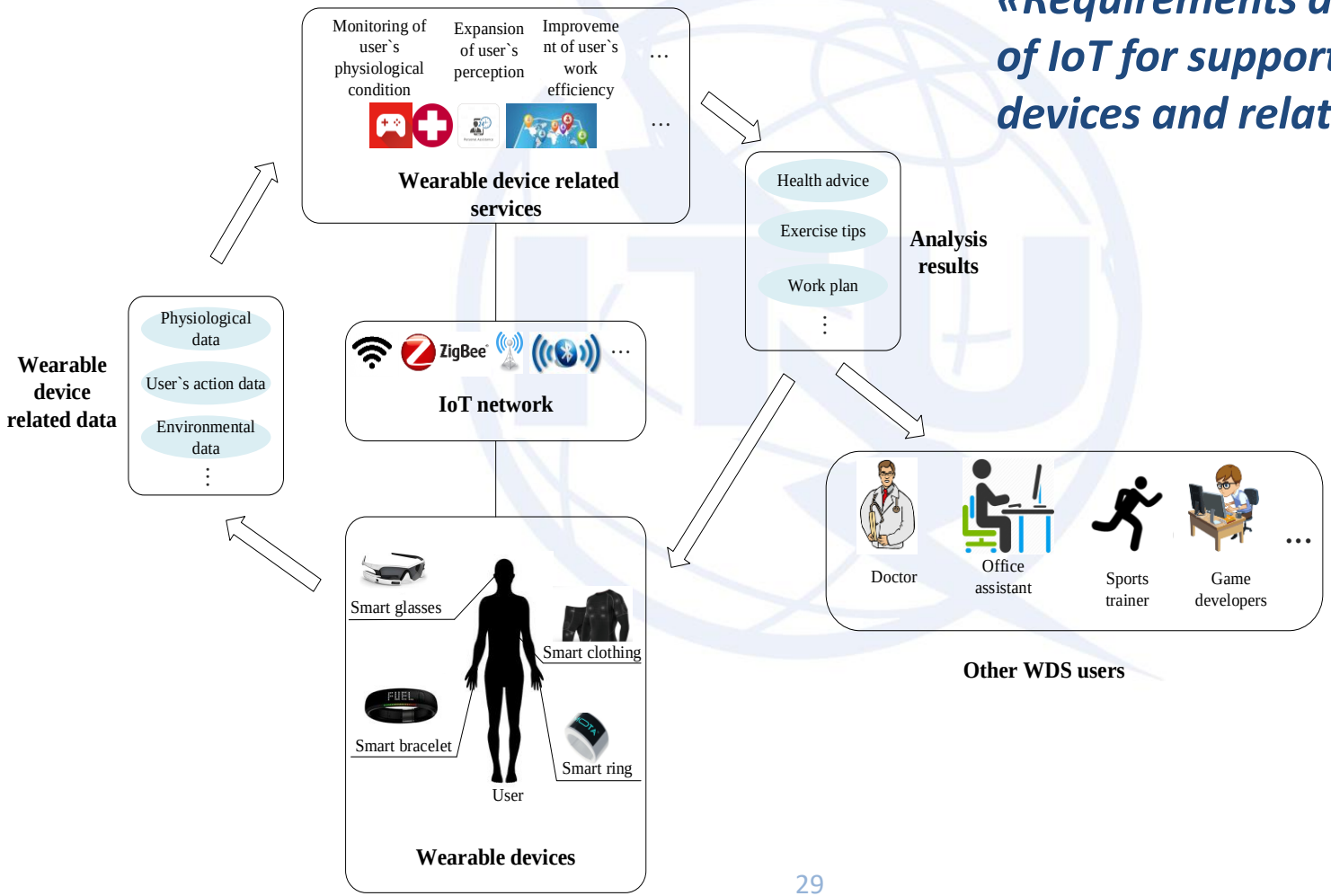
Data collection and analysis in smart retail store ecosystem

Ongoing study

*IoT technologies can enable **a safe and efficient retail store management system for non-stop operation (24 hours / 365 days)**: the 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.*

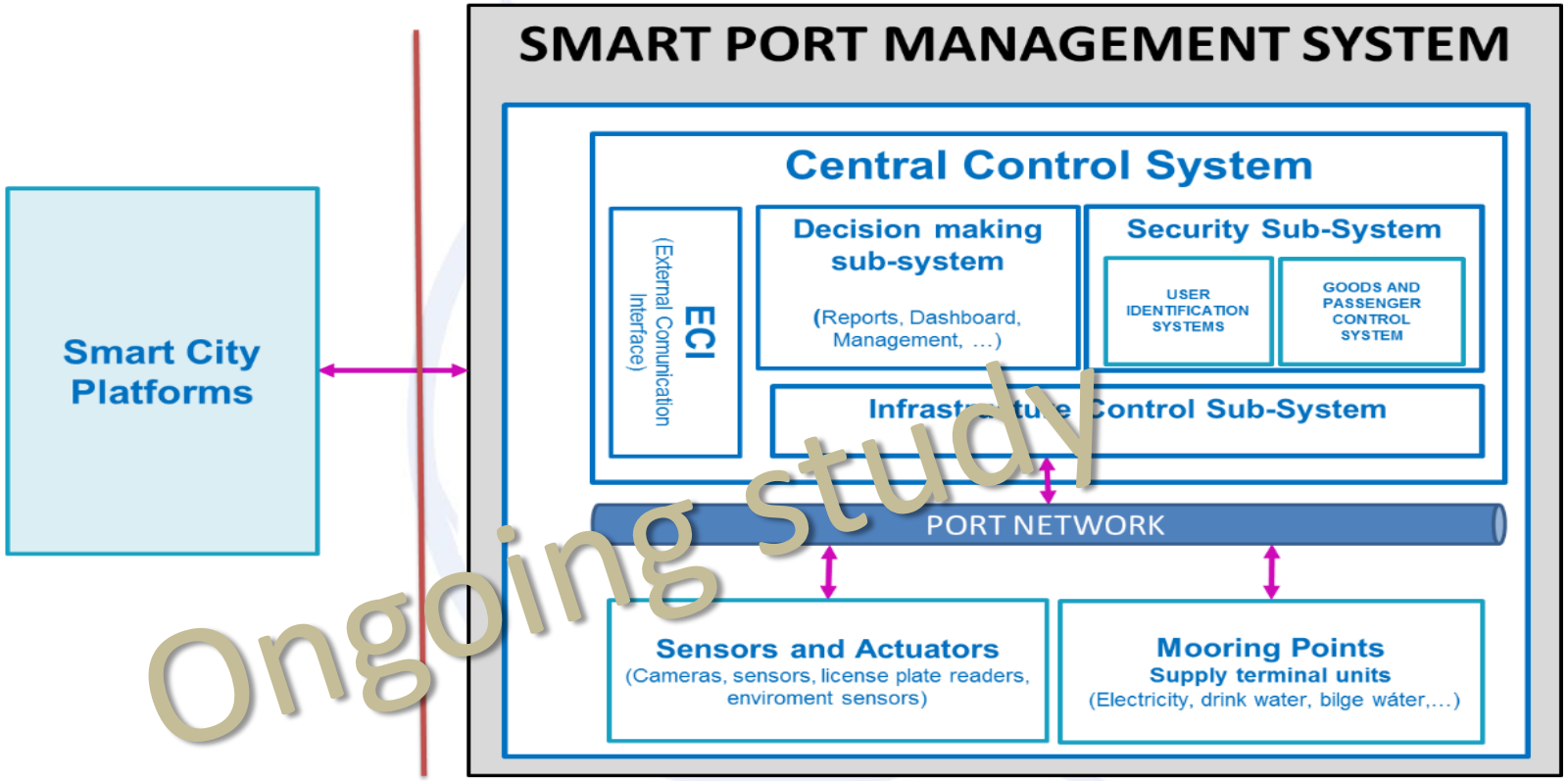
IoT for wearable devices and related services

Source: ITU-T Y.4117 «Requirements and capabilities of IoT for support of wearable devices and related services»



Smart Port:

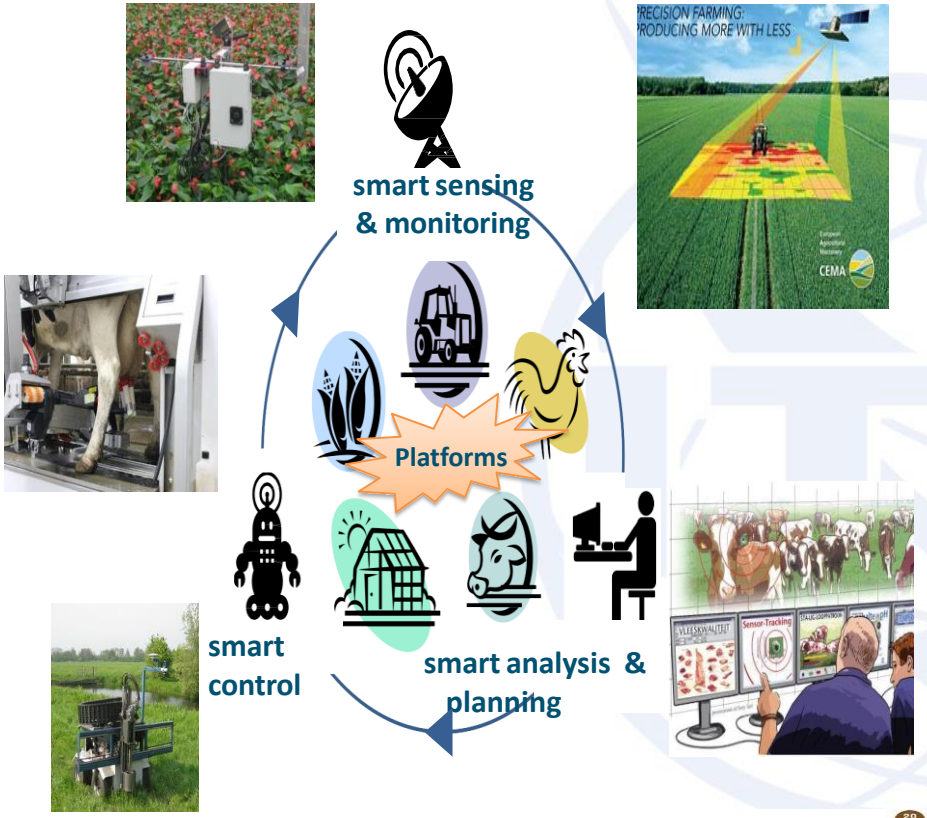
Smart management of supply services in smart port (ongoing study)



Smart Port [including interface for interaction with Smart City Platforms]

IoT technologies can deployed in ports ***to improve ports' operation and service offer to customers****.*
The integration between port and city enables reciprocal access to the respective services*.*
Cities can also improve their services*, e.g. controlling their resources according to the information provided by port remote management systems in real time.*

Internet of Things in Food & Farming



Source: IOF 2020 INTERNET OF FOOD & FARM

Source: ISO

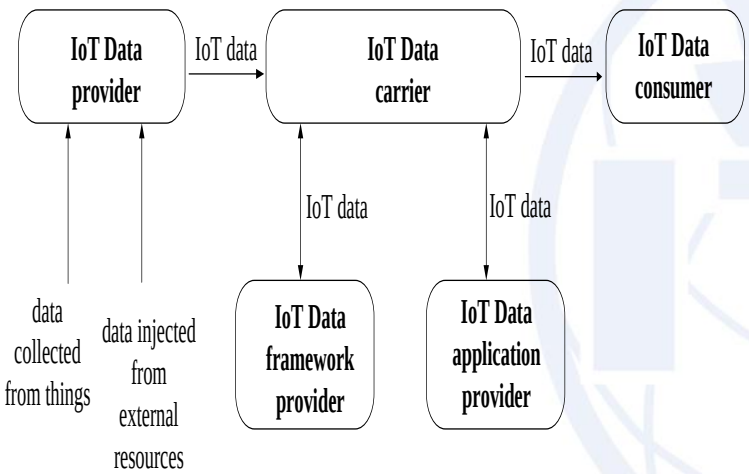
The SG20 studies in this application domain are at initial stage - use cases such as livestock farming etc.

Some detailed information on activities concerning data processing and management in IoT (ITU-T SG20 and ITU-T FG-DPM)

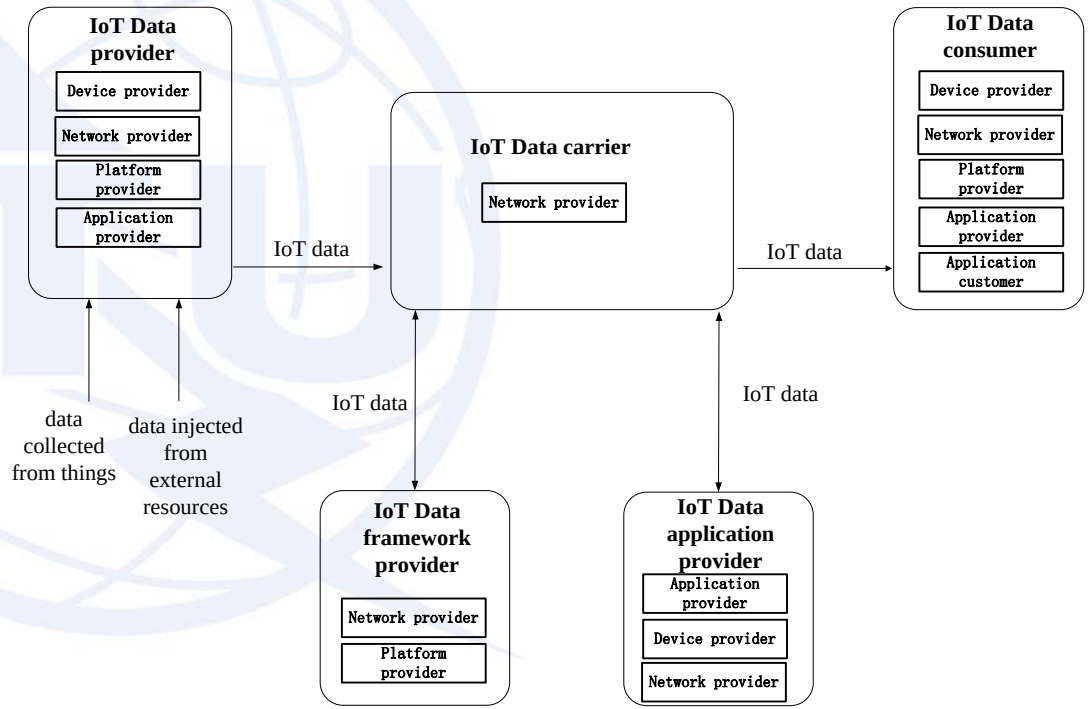
A foundational Recommendation on Big Data:

Y.4114 "Specific requirements and capabilities of the IoT for Big Data"

Specific requirements and capabilities that the IoT is expected to support in order to address the challenges related to Big Data



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

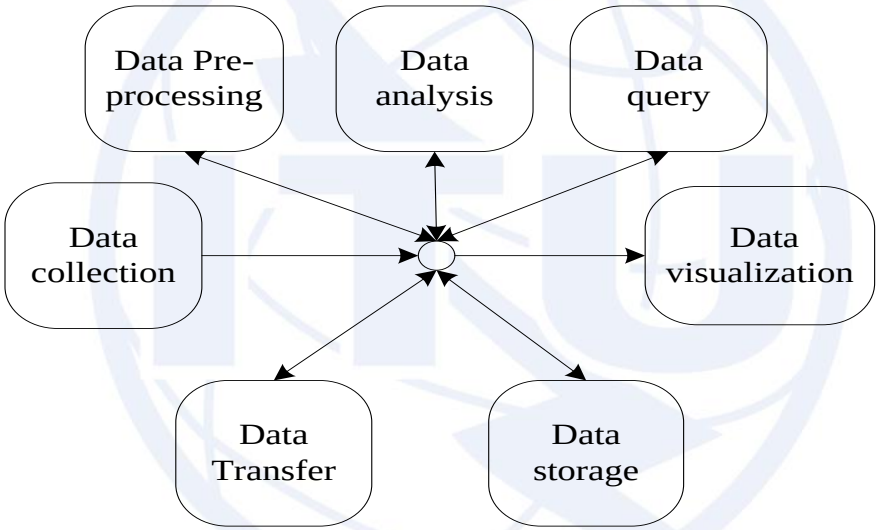


Mappings of IoT business roles to IoT data roles

Y.4114 – IoT data operations

Abstract representation of the various IoT data operations and related data flows (considering that the diverse set of concrete IoT deployments do not imply a unique logical sequencing of the various IoT data operations)

IoT data operations



The sequencing of IoT data operations in IoT highly depends on the service and deployment scenarios (e.g. data analysis with respect to scenarios implementing cloud computing vs edge computing)

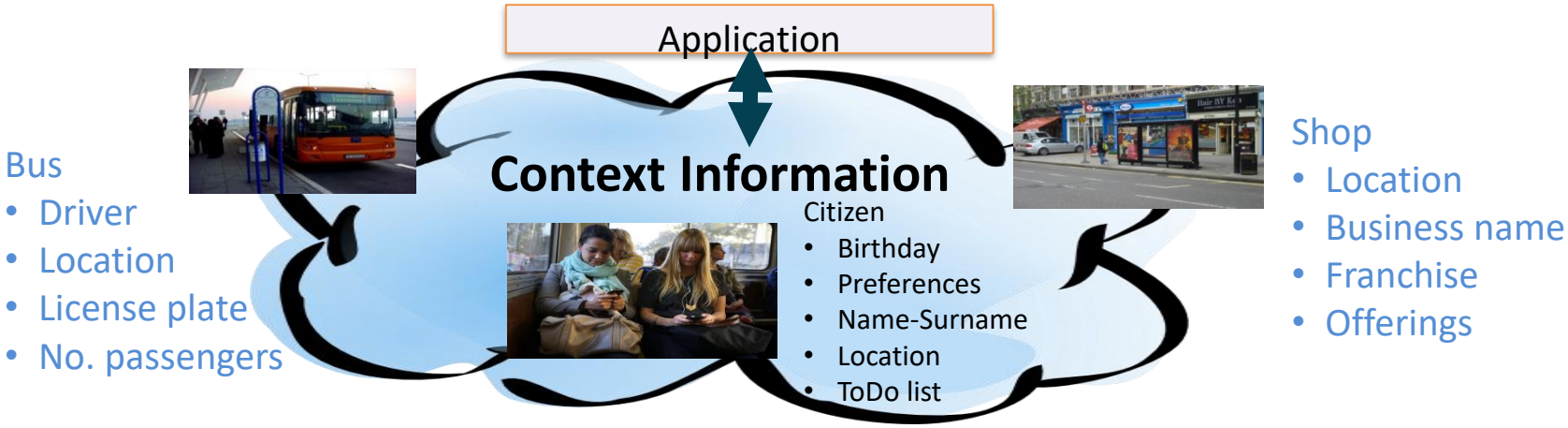
Key ongoing studies in ITU-T FG-DPM (selected list)

FG-DPM Working Groups
WG1 Use Cases, Requirements and Applications/Services
WG2 DPM Framework, Architectures and Core Components
WG3 Data sharing, Interoperability and Blockchain
WG4 Security, Privacy and Trust including Governance
WG5 Data Economy, commercialization, and monetization

- D1.1 Use Cases Analysis and General Requirements for DPM
- D2.1 DPM Framework for Data-driven IoT and SC&C
- D2.2 DPM Functional Architectures
- D2.3 Data Modeling and Formats Specification for DPM
- D3.1 Framework of Open/Private Data
- D3.2 Technical Enablers for Open Data Platform
- D3.6 Blockchain-based Data Exchange and Sharing Technology
- D4.1 Framework of Security and Privacy in DPM
- D4.5 Data Governance Framework for IoT and SC&C
- D5.2 Business models, commercialization and monetization to support data economy
- D5.3 Data economy impact assessment, policy and sustainability implications

(Cross-domain) data sharing - context information

- Smart Digital Services need to share context information



Different sources of context information:

- Existing systems, users (through mobile apps), sensors/IoT devices

Standard specifications are needed for context information management:

- To ensure vendor neutrality for users such as Cities
- To reduce technological barriers to development/deployment, to enable entrepreneurs' innovative services

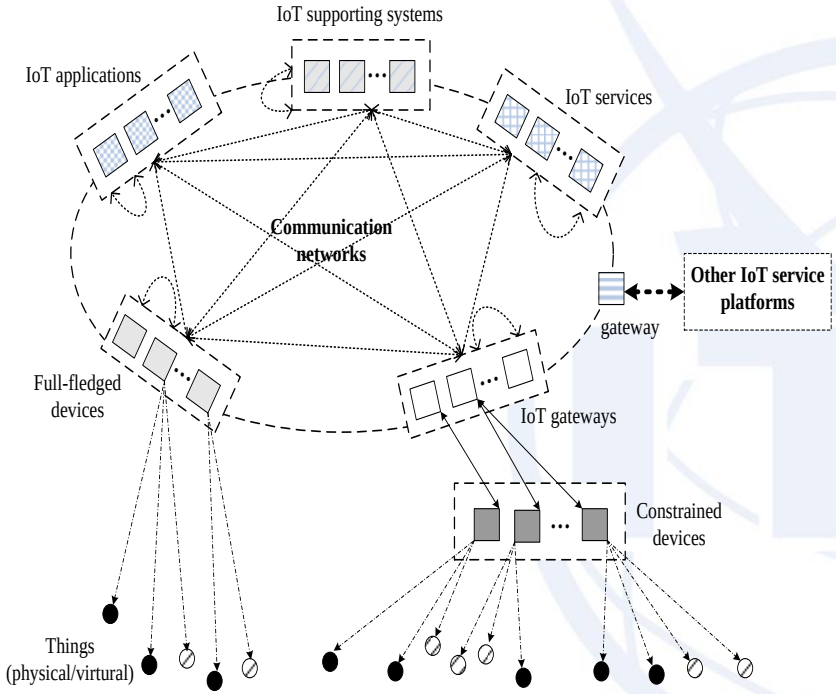
Ongoing standardization work (ITU-T FG-DPM cooperation with relevant efforts such as ETSI ISG CIM)

Two current hot topics in the IoT space (and beyond): blockchain and data protection

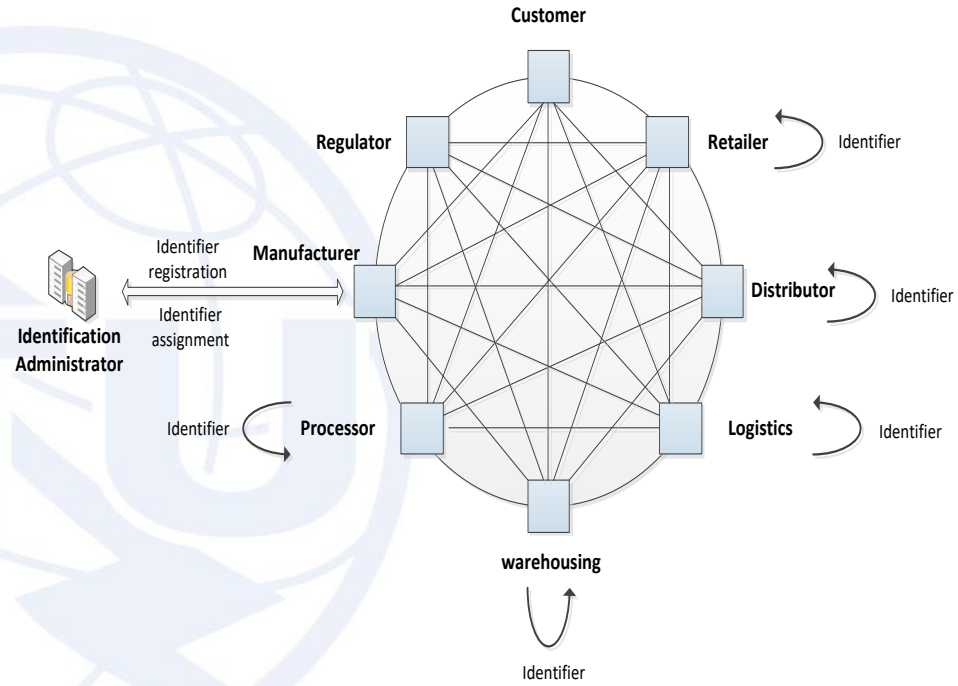
Blockchain technology for the IoT

(ongoing studies in both ITU-T SG20 and ITU-T FG-DPM)

Ongoing Y.IoT-BoT-fw in SG20



Ongoing D.3.6 in FG-DPM



Blockchain of things as decentralized service platform – with increase of connected things and other demands (e.g., trusts and transactions), centralized IoT service platforms may become key bottlenecks

Blockchain-based supply chain traceability (use case example) - exchanging and sharing static and dynamic information among the supply chain actors

*Blockchain technology fosters a new generation of transactional applications that **establish trust, accountability, transparency and efficiency.** And it shows great promises across a wide range of business applications in many fields, including IoT and smart cities.*

Just few words on the European "General Data Protection Regulation (GDPR)"

GDPR has been adopted by EU Parliament in 2016, its enforcement date is 25th May 2018

The GDPR principles

- Processed lawfully, fairly and in a transparent manner ("Lawfullness, fairness and transparency")
- Collected for specified, explicit and legitimate purposes ("Purpose limitation")
- Adequate, relevant and limited to what is necessary ("Data minimization")
- Accurate and, where necessary, kept up to date ("Accuracy")
- Identification no longer as necessary for the purposes ("Storage limitation")
- Processed in an appropriate manner to maintain security ("Integrity and confidentiality ")
- Accountability (documentation)

Source: Austrian Data Protection Authority

Among the current technical issues in the IoT space with respect to the compliance to GDPR, ***how to implement the GDPR principles in IoT technical architectures (mechanisms, standards, testing) requires attention and specific work in the standardization arena***

Thanks for your attention

Complementary information

ITU-T published Recs on IoT and SC&C aspects
[10 Jan 2018 status, incl. pre-SG20 achievements]

ITU-T Y.4000 series	Recommendation category	Number of published Recs
Y.4000-Y.4049	General	3
Y.4050-Y.4099	Definitions and terminologies	1
Y.4100-Y.4249	Requirements and use cases	18
Y.4250-Y.4399	Infrastructure, connectivity and networks	3 (+ 2 in AAP)
Y.4400-Y.4549	Frameworks, architectures and protocols	20 (+ 1 in AAP)
Y.4550-Y.4699	Services, applications, computation and data processing	3
Y.4700-Y.4799	Management, control and performance	3
Y.4800-Y.4899	Identification and security	6
Y.4900-Y.4999	Evaluation and assessment	4
Y.4000-Y.4999	**Informative docs (Suppl., Tech. Report)**	20

All approved and ongoing ITU-T IoT and SC&C specifications are collected in the "IoT and SC&C Standards Roadmap" [cross-SDO roadmap] maintained by JCA-IoT and SC&C

ITU