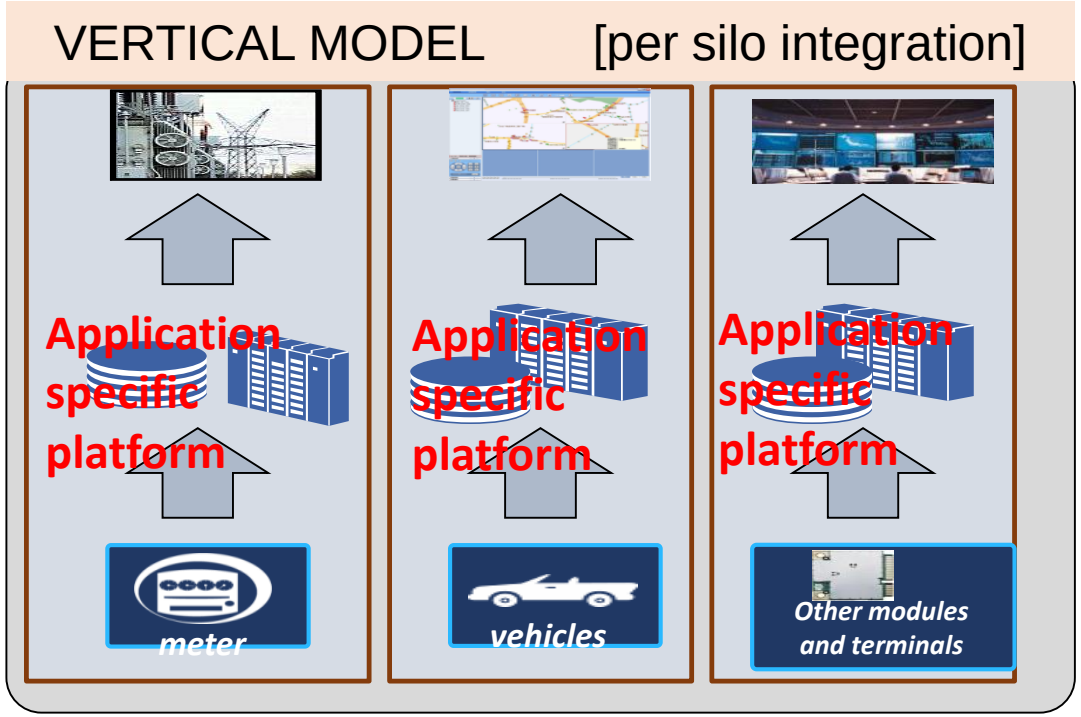
IoT Week 2018, Bilbao
IoT4SCC WS - Breakout D: Open APIs
7 June 2018, 12:30-13:30

Platforms Convergence and Open APIs: information about some recent activities in AIOTI WG03 HLA group and ITU-T IoT and SC&C related initiatives

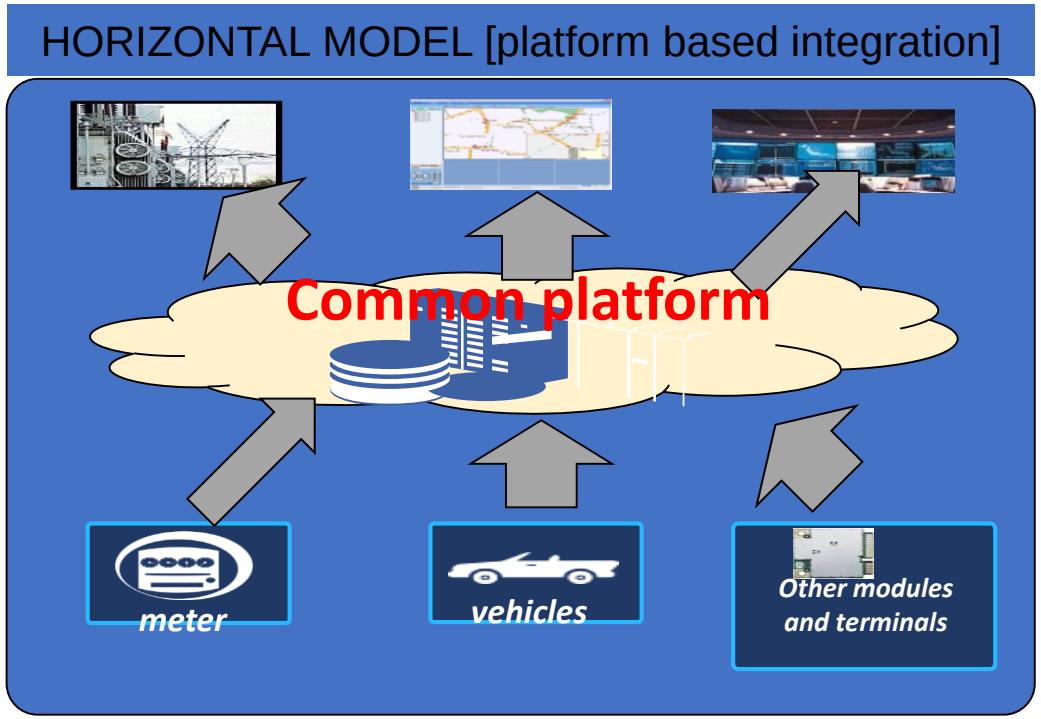
Marco Carugi
ITU-T SG20 and AIOTI WG03
Senior Consultant
marco.carugi@gmail.com

From vertical to horizontal platforms

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

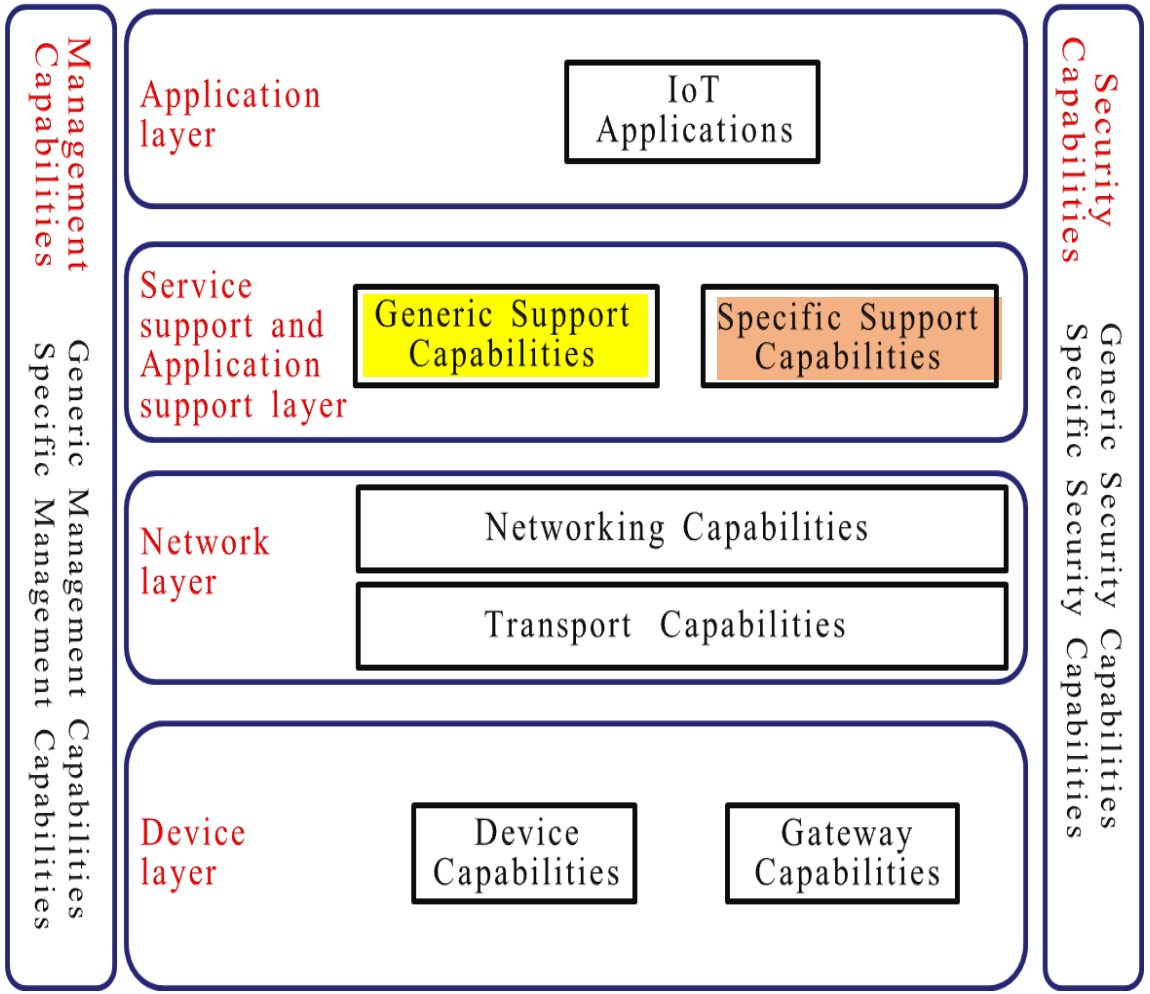
Per silo integration *does not scale and limits evolution possibilities*

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

The IoT Reference Model defined by ITU-T

Capability view of the IoT infrastructure

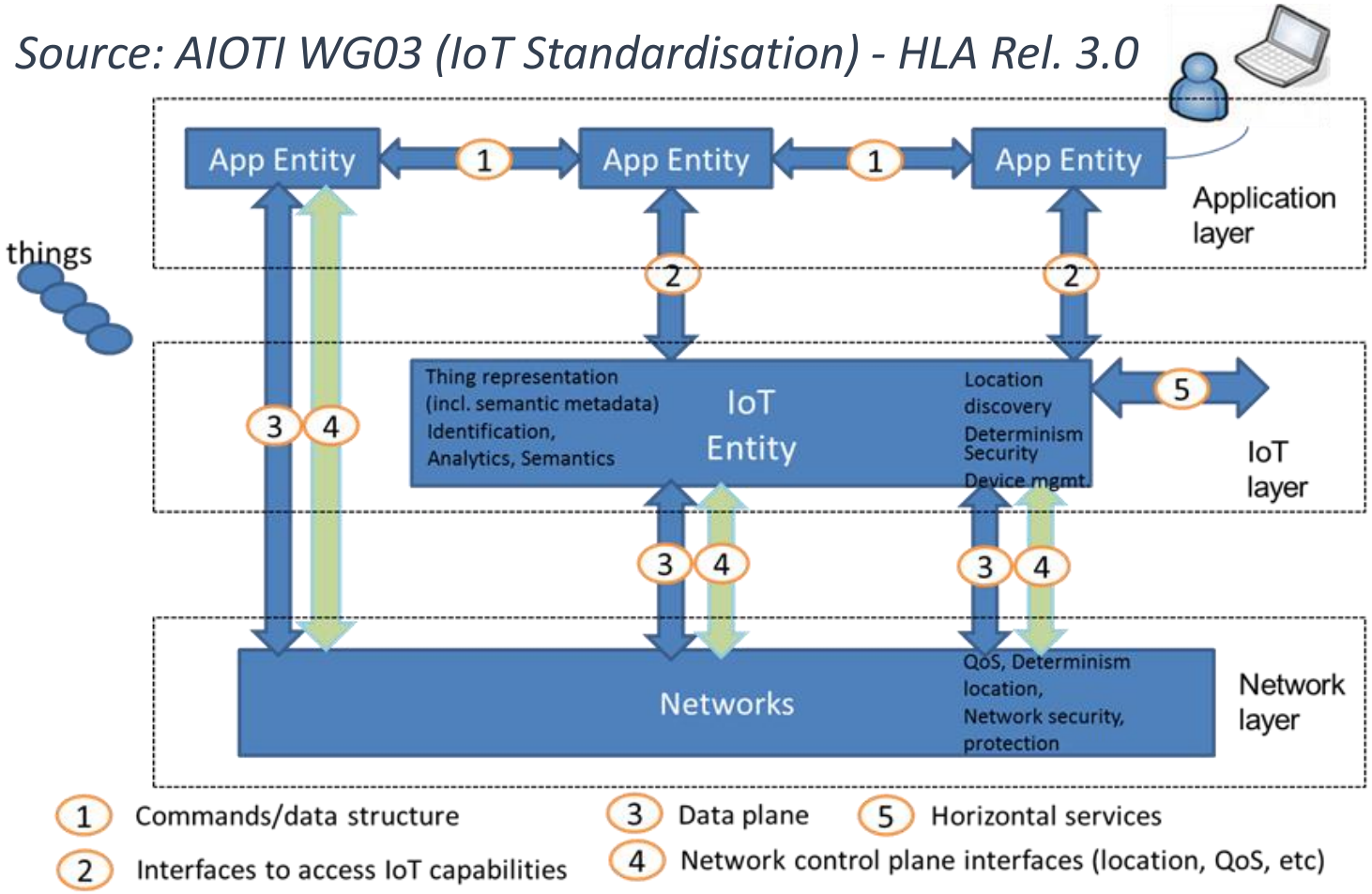
- Application capabilities
- Service Support and Application Support capabilities
- Network capabilities
- Device and Gateway capabilities
- Cross-layer Management Capabilities
- Cross-layer Security Capabilities



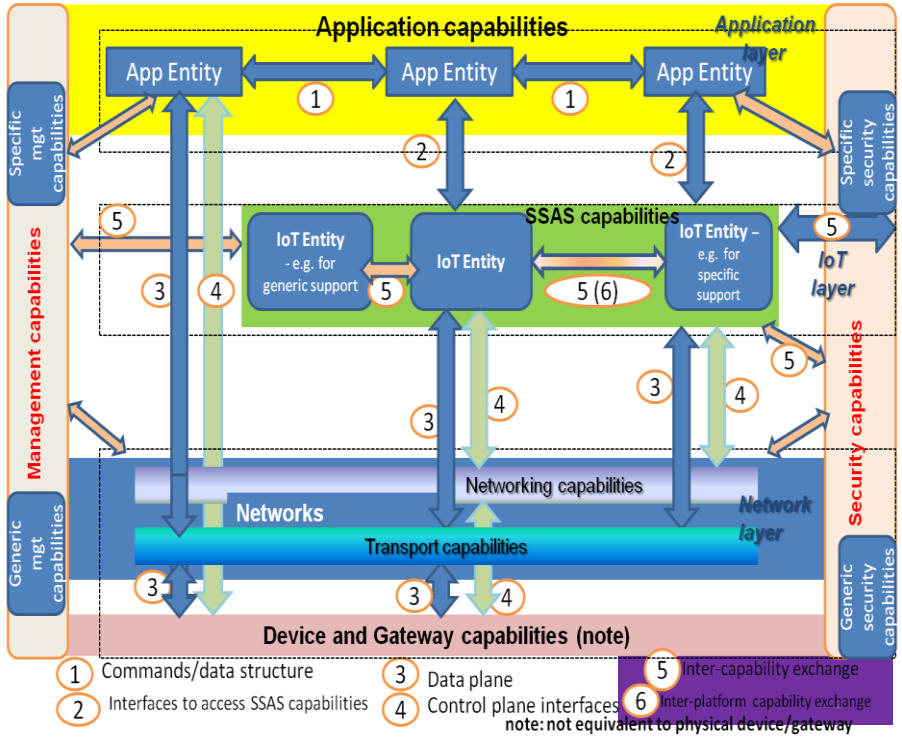
Source: ITU-T Y.2060 /Y.4000 "Overview of the Internet of things"

The AIOTI High Level Architecture (HLA) aiming to promote convergence and harmonization across the different IoT architecture standardization efforts

Source: AIOTI WG03 (IoT Standardisation) - HLA Rel. 3.0



AIOTI HLA functional model



ITU-T IoT Reference Model mapping to the AIOTI HLA

A number of IoT Reference Architectures across SDOs, projects and market deployments

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

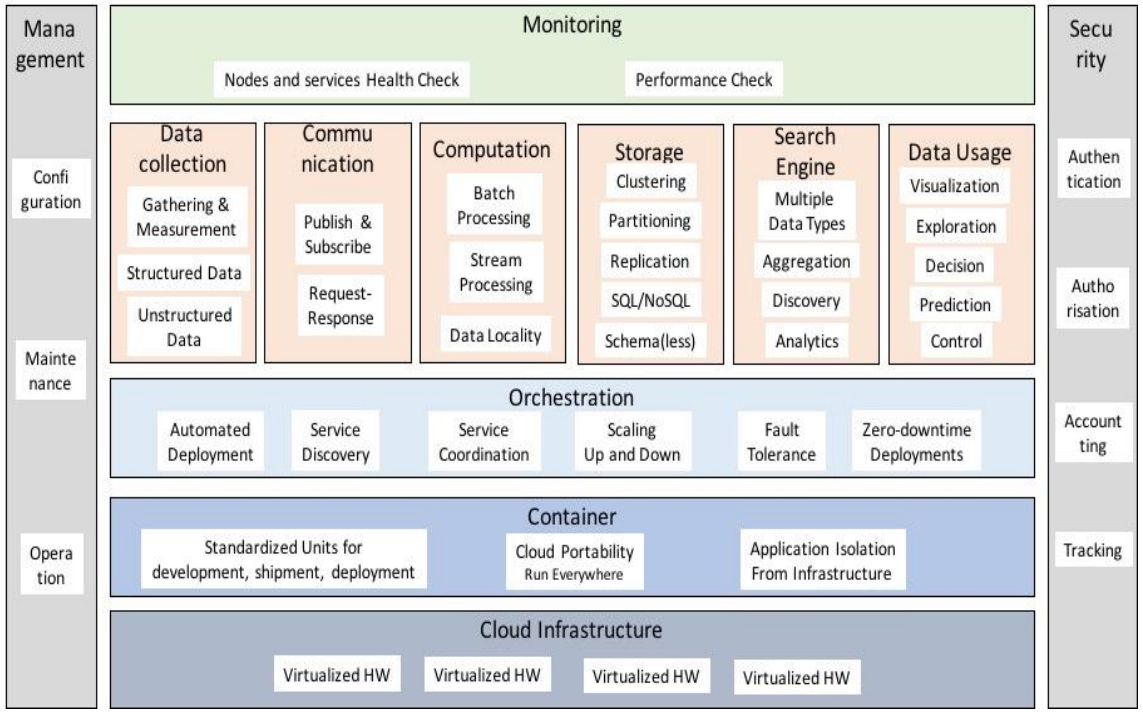
Data collection, analysis, knowledge, planning, action

The senses of the city

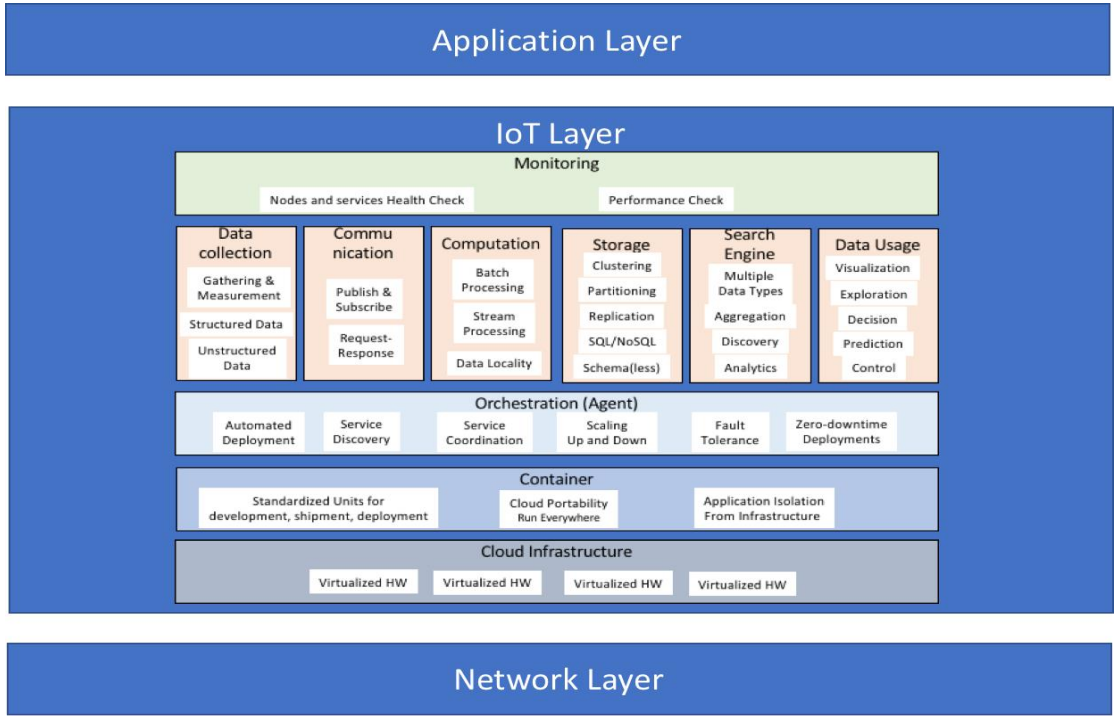
City data sources

Source: Dr. Levent Gürgen

IoT Virtualisation: the microservices-based architectural approach



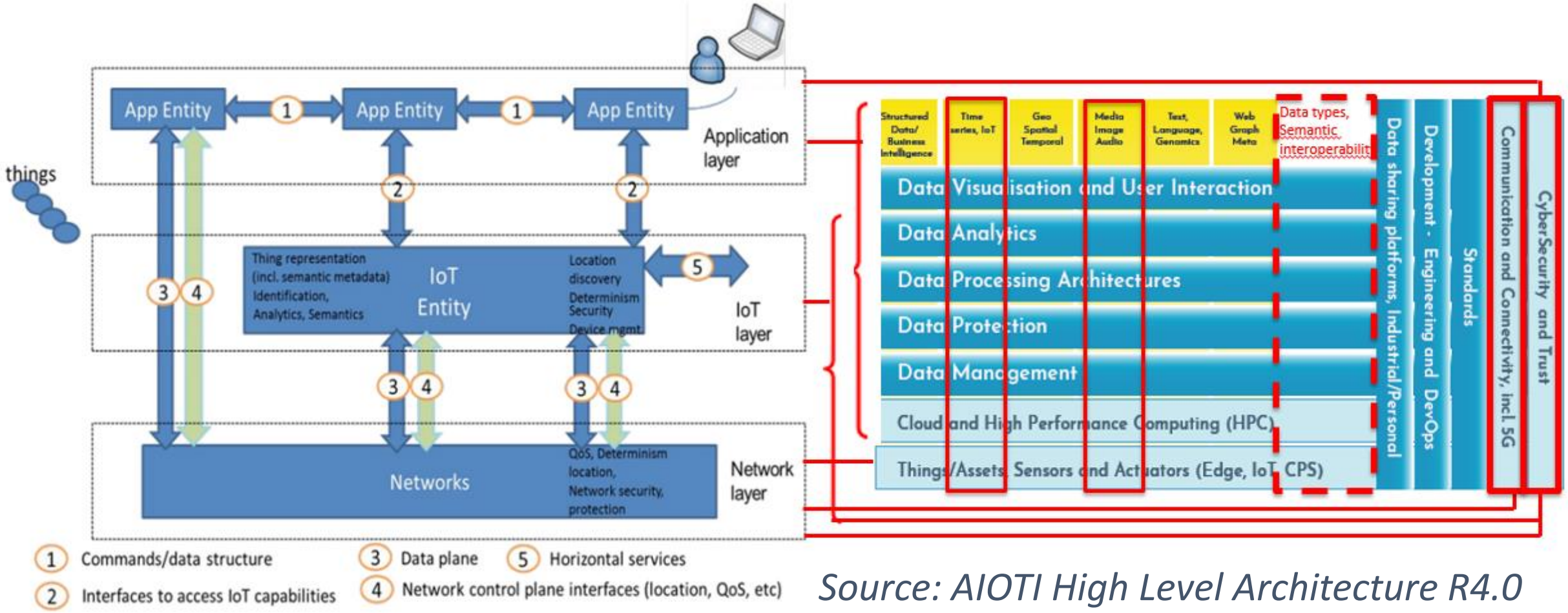
An example of microservices-based functional architecture for IoT Virtualisation



Mapping of microservices-based functional architecture on AIOTI HLA

Source: AIOTI High Level Architecture R4.0

BDVA's BDV Reference Model mapping to AIOTI High Level Architecture

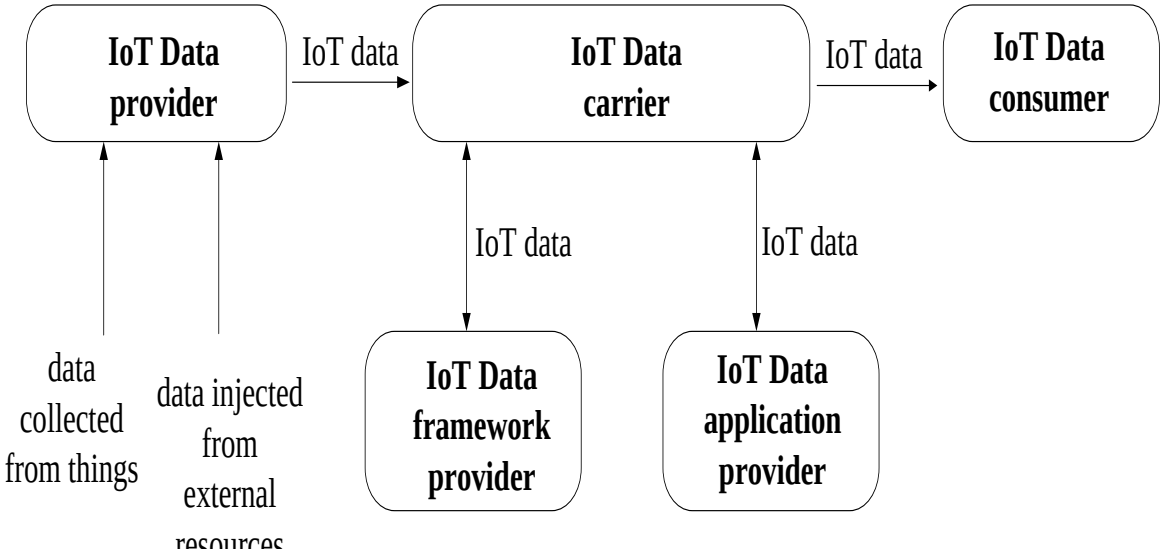


Source: AIOTI High Level Architecture R4.0

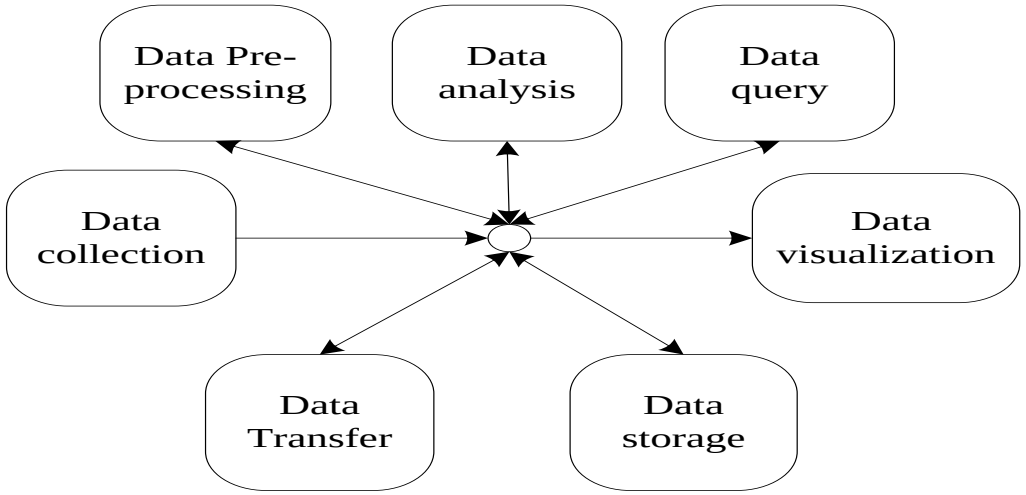
A key step in front of the IoT standardization work plan: Big Data-IoT architectural integration

A foundational ITU-T Recommendation on Big Data in IoT: ITU-T Y.4114 "Specific requirements and capabilities of the IoT for Big Data"

Specific 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)

ITU-T FG-DPM to build on it (e.g. "Data sharing" as critical additional data operation)

Description of the IoT data roles identified in Y.4114

- **IoT Data provider:** it collects data from things, injects data processed within the IoT system as well as data from external sources, and provides them via the IoT Data carrier to the IoT Data consumer (optionally, the applications provided by the IoT Data application provider may execute relevant data operations with the support of the IoT Data framework provider).
- **IoT Data application provider: it provides applications related to the execution of IoT data operations (e.g. applications for data analysis, data pre-processing, data visualization and data query).**

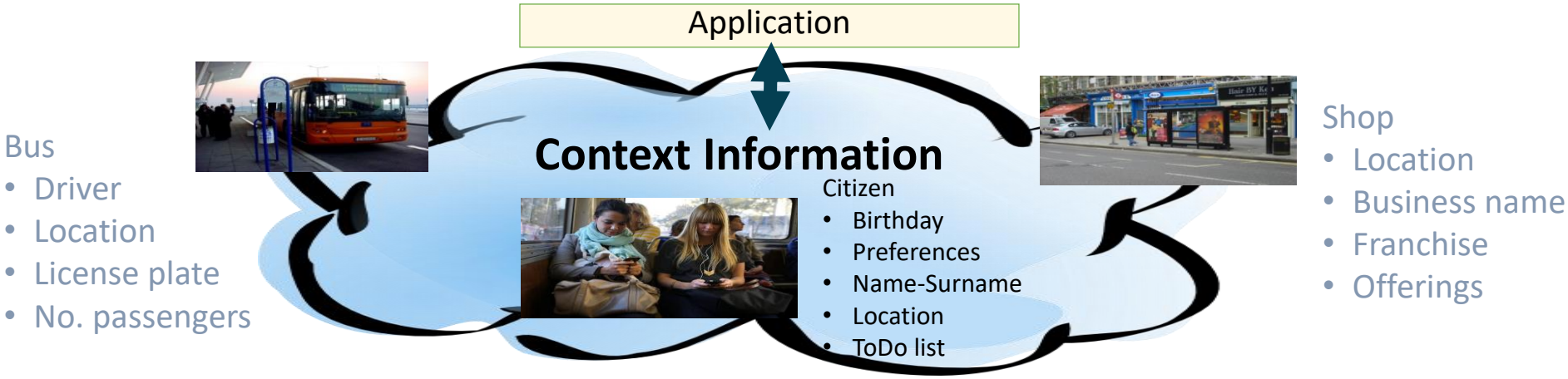
  NOTE - The applications provided by the IoT Data application provider can interact with the infrastructure (e.g. storage cloud) provided by the IoT Data framework provider through the IoT Data carrier or run on the infrastructure (e.g. scalable distributed computing platforms) provided by the IoT Data framework provider.
- **IoT Data framework provider: it provides general IoT data processing capabilities and related infrastructure (e.g. storage and computing resources, data processing run time environment)** as required by IoT Data provider, IoT Data carrier, IoT Data application provider and IoT Data consumer for the support of data operations execution.
- **IoT Data consumer:** it consumes IoT data. Usage of the consumed data depends on the application purposes.
- **IoT Data carrier:** it carries data among IoT Data provider, IoT Data framework provider, IoT Data application provider and IoT Data consumer.

  NOTE - An actor of a concrete IoT deployment can play multiple roles. As an example, an actor executing data analysis plays the role of IoT Data application provider, but it also plays the role of IoT Data provider when it sends the results of this data analysis to other actors.

Y.4114 describes also key possible mappings from IoT business roles [Y.2060] to IoT data roles, as well as an example of deployment scenarios with respect to IoT data roles (Appendix).

Cross-domain Data Sharing – example of context information management

Cross-domain uses cases require access to information from different domains that is normally held in separate silos - e.g. sharing of context information



Different sources of context information

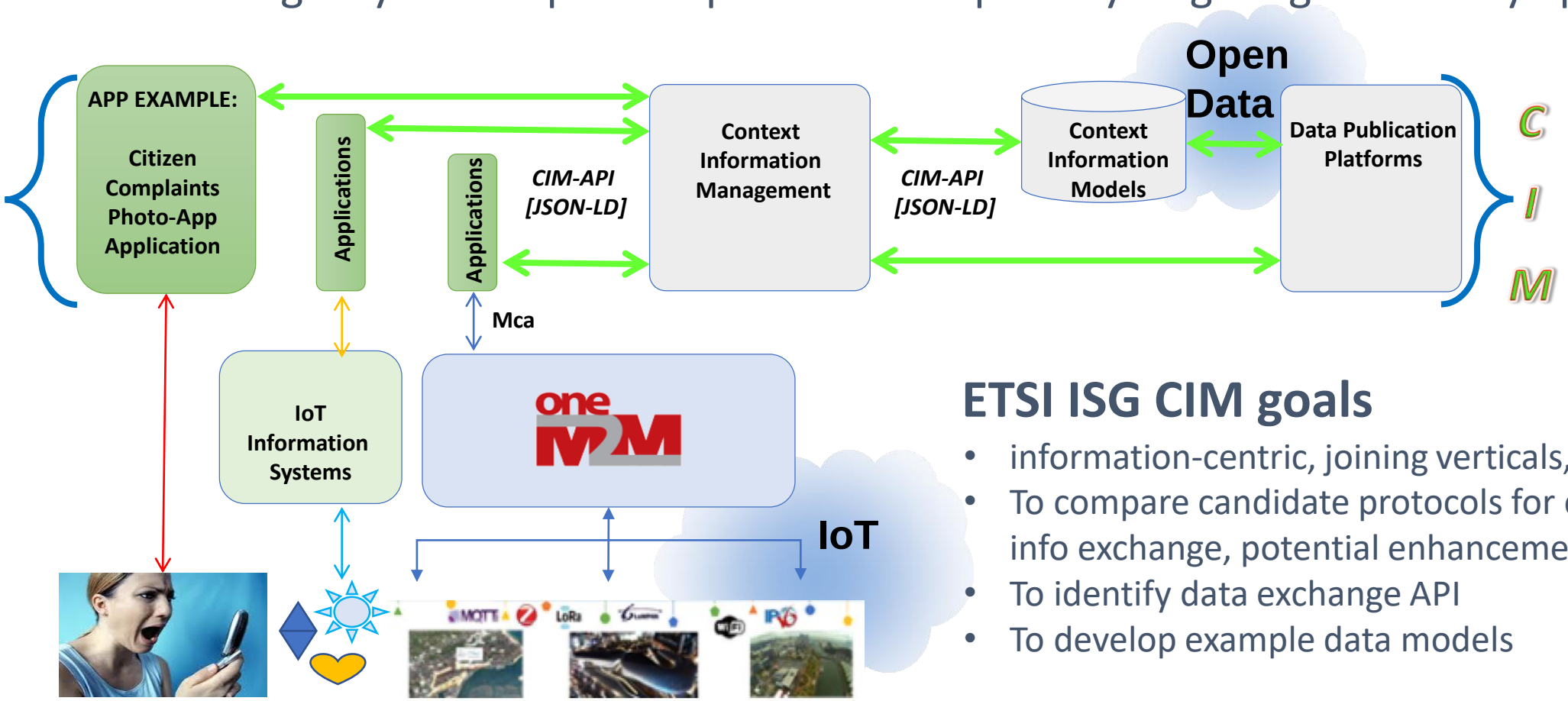
- Existing systems, users (through mobile apps), sensors/IoT devices

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 innovative services

Data sharing via a cross-domain Context Information Layer (ETSI ISG CIM)

An info-exchange layer on top of IoT platforms - especially targeting Smart City applications



ETSI ISG CIM goals

- information-centric, joining verticals, interoperable
- To compare candidate protocols for cross-domain info exchange, potential enhancements
- To identify data exchange API
- To develop example data models

Collaboration with SDOs (ITU-T FG-DPM, oneM2M, W3C ...) & open-source implementations

Enhancing the network's Data Processing and Management capabilities with Machine Learning (ML)

Potential of ML for network design, operation and optimization

- coping with massively increased complexity
- enhancing network operations' efficiency and robustness
- increasing network self-organization feasibility
- providing reliable predictions

As well as potential of ML to enable new advanced applications

But a number of challenges need to be addressed [beyond trust]

- how to deal with stringent requirements of many applications (latency)
- how to ensure robust ML given small data sets and under latency constraints
- how to deal with distribution of data at different locations and diverse data formats
- usage of distributed learning to have efficient usage of scarce resources
- how to deal with (wireless) channel noise, dynamicity and unreliability
- how to ensure good tracking capabilities
- how to exploit context info and expert knowledge (hybrid ML approaches)

Source: discussion in initial meetings of ITU-T FG-ML5G

ITU-T FG on "Machine Learning for Future Networks including 5G" (FG-ML5G)
- created in Nov 2017 , SG13 as Parent ITU-T Study Group
- a number of challenges and opportunities common to the IoT

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 DPM
- Identify key requirements ad capabilities for DPM
- 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 standards gaps and challenges

1st meeting in July 2017 (SG20 is parent SG)

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

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

Liaisons/interactions established with numerous SDOs, Fora, Alliances and projects
E.g. ISO, ETSI ISG CIM, BDVA, various H2020 projects

Ongoing studies in ITU-T FG-DPM

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

Partial list of deliverables

- **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**
- **D3.3 Framework to support data interoperability in IoT environment**
- 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
- D5.1 Modeling of Data Economy for value creation and Stakeholders identification
- D5.2 Business models, commercialization and monetization to support data economy
- D5.3 Data economy impact assessment, policy and sustainability implications
- Cross-WG studies: DPM taxonomies and vocabularies, gap analysis, DPM standardization roadmap

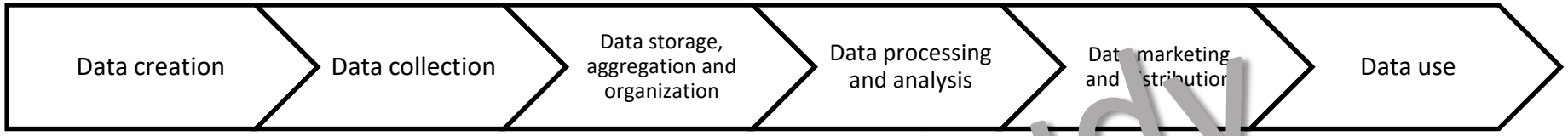
“Use Cases Analysis and General Requirements for DPM” (FG-DPM D1.1): a key entry point for the whole FG-DPM work

- **Objectives**
  - Identify from DPM perspective - per each use case - ecosystem’s actors and business roles, data characteristics, capabilities, requirements and other
  - **Facilitate comparison among different use cases (across single or multiple domains)** to enable common DPM features to be identified/adopted, and facilitate single/cross-domain applications’ implementation
  - **Allow creation of new services at little extra cost**
  - **Feed other FG-DPM deliverables** (DPM framework, area-specific frameworks, others)

- **Progress so far**
  - **“Unified DPM Use Case template”** developed and **disseminated to numerous potential DPM use cases contributors (incl. SDOs, Alliances, EU H2020 projects)**
  - Numerous DPM use cases collected
  - Comparison of DPM use cases started - identifying common/use case-specific requirements
  - DPM capabilities’ global picture discussion initiated (WG1, WG2, others)

Data Economy, commercialization and monetization (ongoing FG-DPM D5.1)

Data Core Activities



Data Support Activities

Ongoing study

Data Value Chain

(business perspective)

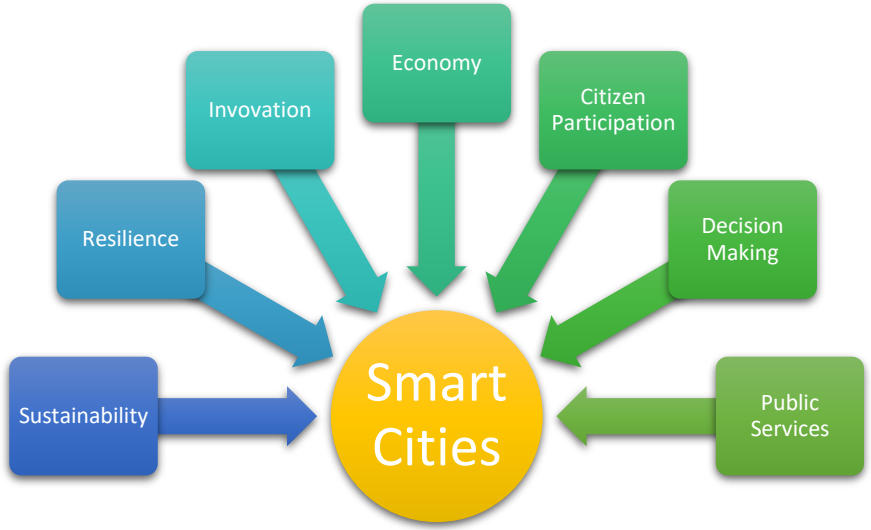
Data laws, regulations and policies: formulation and enforcement of data related laws, regulations and policies

Data security and privacy services: provisioning of data related security and privacy services for implementing and enforcing data laws, regulations and policies.

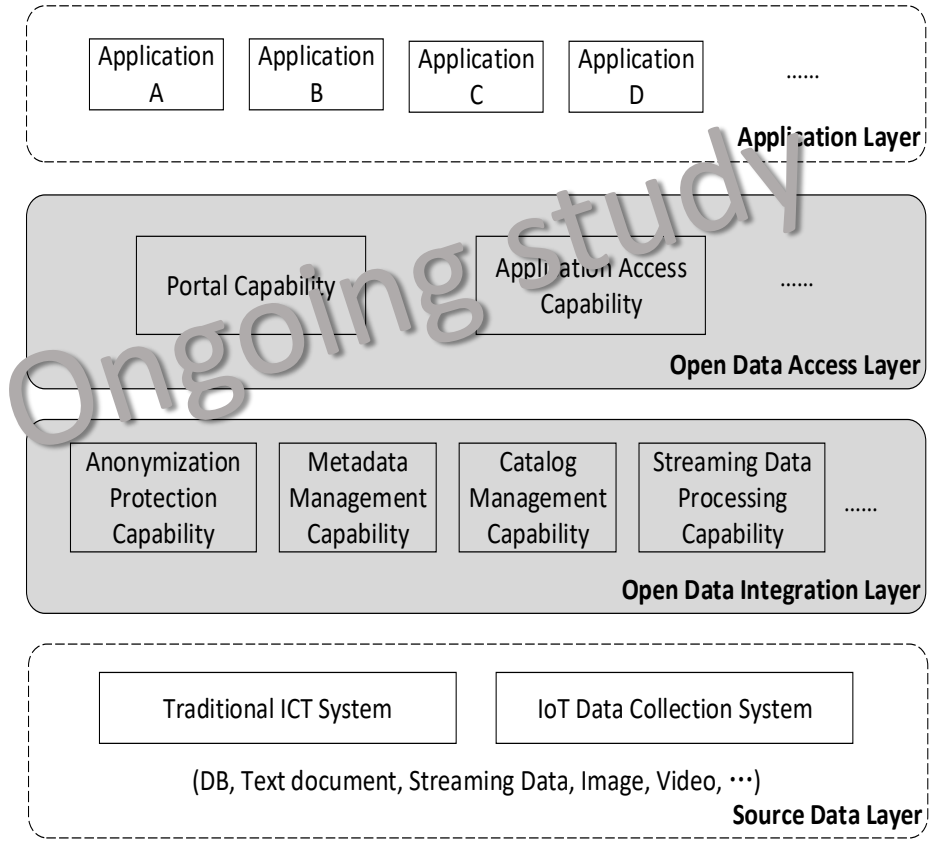
ICT connectivity and infrastructure services: provisioning of ICT connectivity and infrastructure services for implementing data value chain activities

Interaction between FG-DPM WG5 (business perspective on DPM) and FG-DPM WG1/WG2 (technical perspective on DPM)

Y.SC-OpenData "Framework of Open Data in Smart Cities" (ITU-T SG20)



Open Data facilitates the advancement of Smart Cities



Functional architecture of Open Data in Smart Cities

Fundamental requirements of Open Data in Smart Cities

Access and utilization of Open Data in Smart Cities

Integration and processing of Open Data in Smart Cities

Security and privacy of Open Data in Smart Cities

Laws and regulations related requirements

Y.API4IOT "Open data application programming interface for IoT data in smart cities and communities" (ITU-T SG20)

Ongoing study

A very concrete example of standardization work item where H2020 projects (e.g. LSPs) can contribute