ITU-SUDACAD Regional Forum on Internet of Things for Development of Smart and Sustainable Cities

Khartoum, Sudan 13-14 Dec 2017

Standardized architectures and important standards defining organizations

Gopi Garge

IoT Architectures

- Generic Architecture

- Domain-based variations

- Implementation-based variations

- A range of protocols
  - **Infrastructure** (ex: 6LowPAN, IPv4/IPv6, RPL)
  - **Identification** (ex: EPC, uCode, IPv6, URIs)
  - **Comms / Transport** (ex: Wifi, Bluetooth, LPWAN)
  - **Discovery** (ex: Physical Web, mDNS, DNS-SD)
  - **Data Protocols** (ex: MQTT, CoAP, AMQP, Websocket, Node)
  - **Device Management** (ex: TR-069, OMA-DM)
  - **Semantic** (ex: JSON-LD, Web Thing Model)
  - **Multi-layer Frameworks** (ex: Alljoyn, IoTivity, Weave, Homekit)

- Several domain-based IoT architectures in literature - RFID, SoA, WSN, Supply-chain Management, Industry automation, Healthcare, Smart society, Cloud services, Social computing security
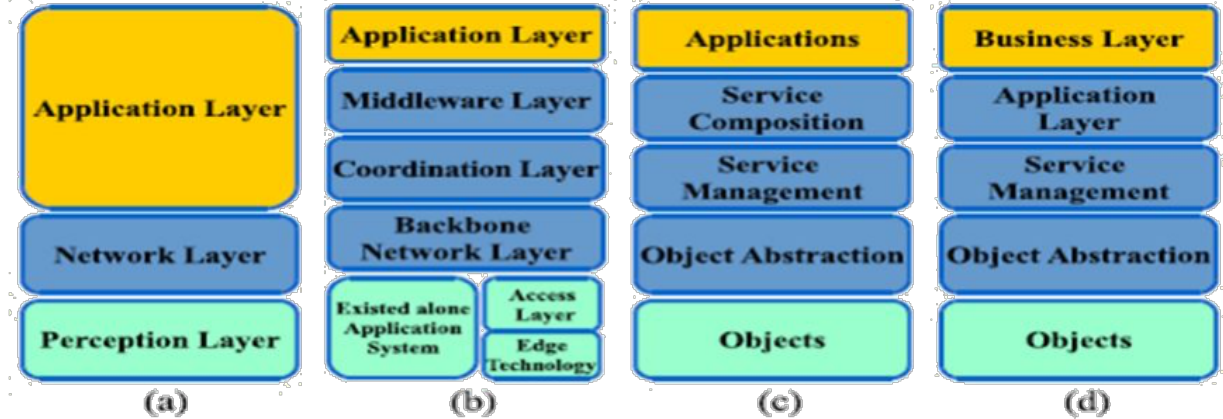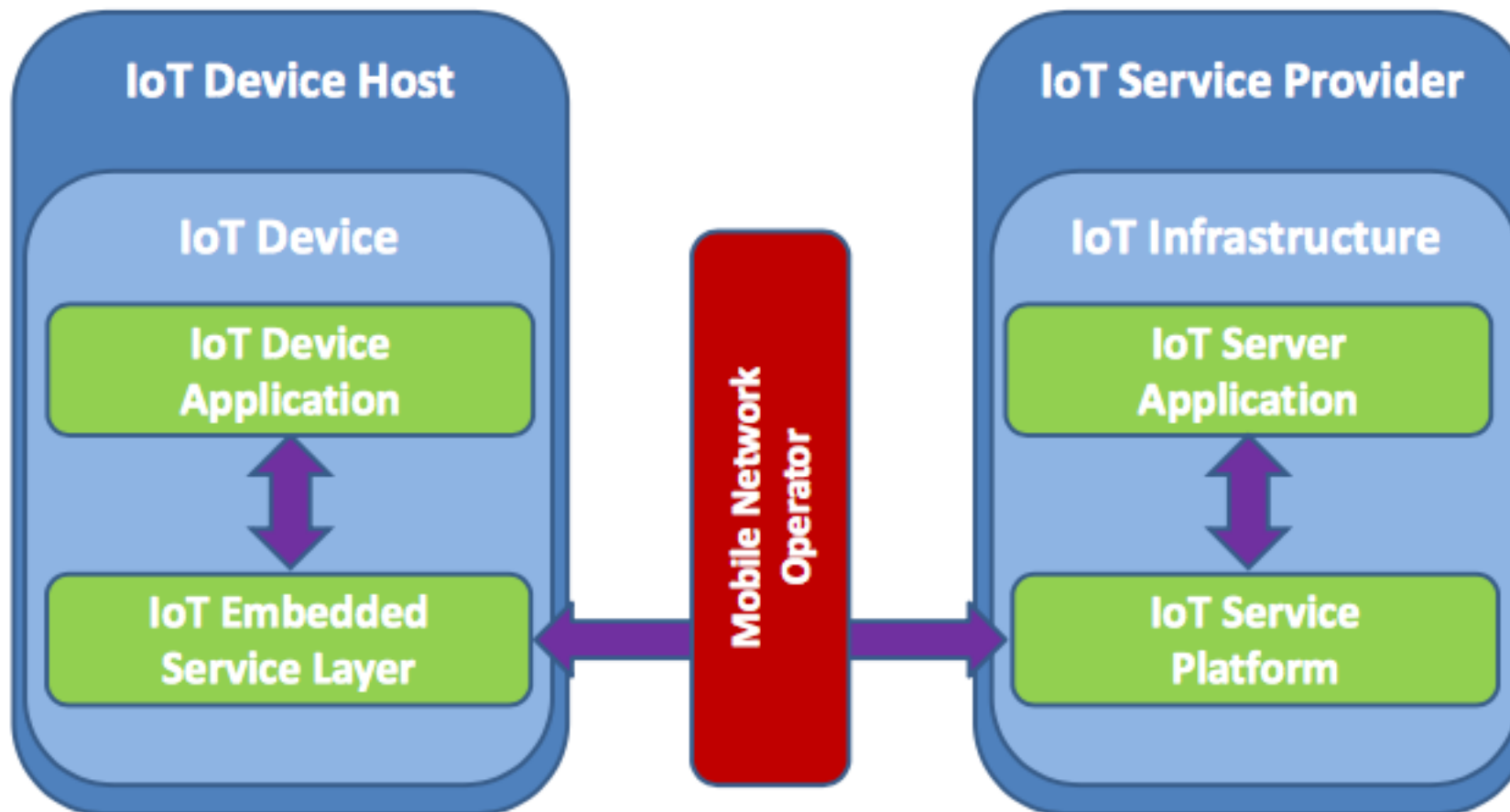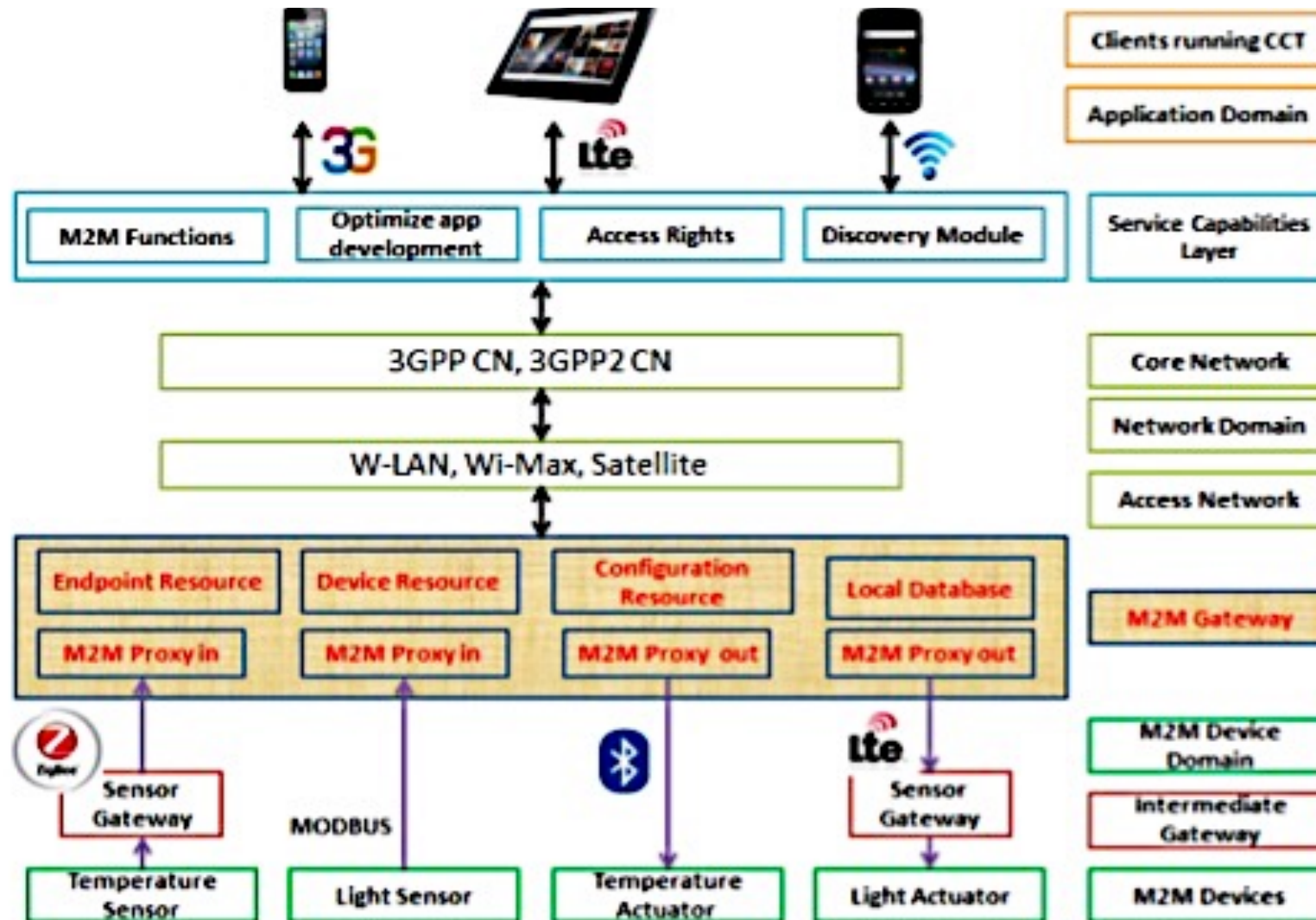

The IoT architecture. (a) Three-layer. (b) Middle-ware based. (c) SOA (d) Five Layer
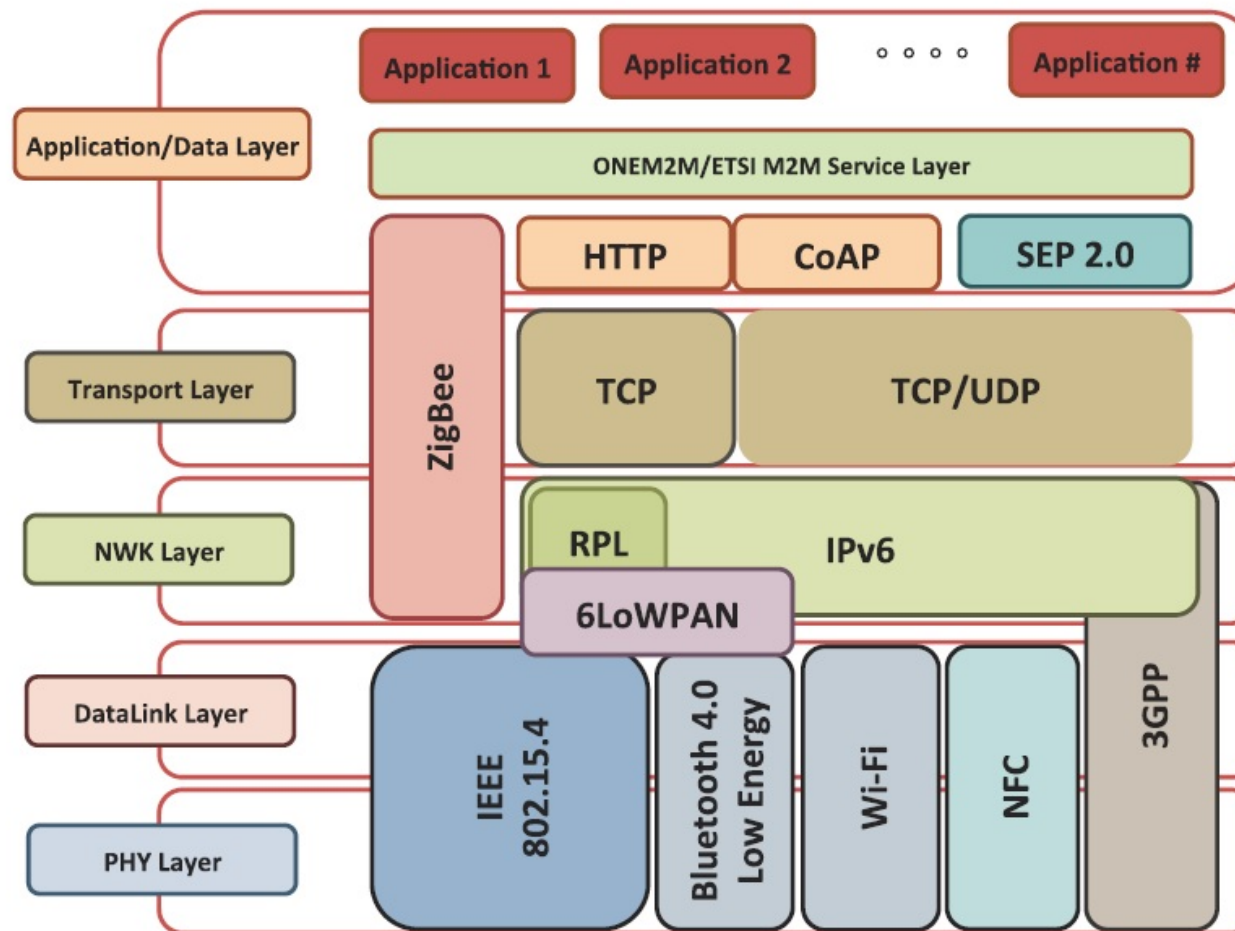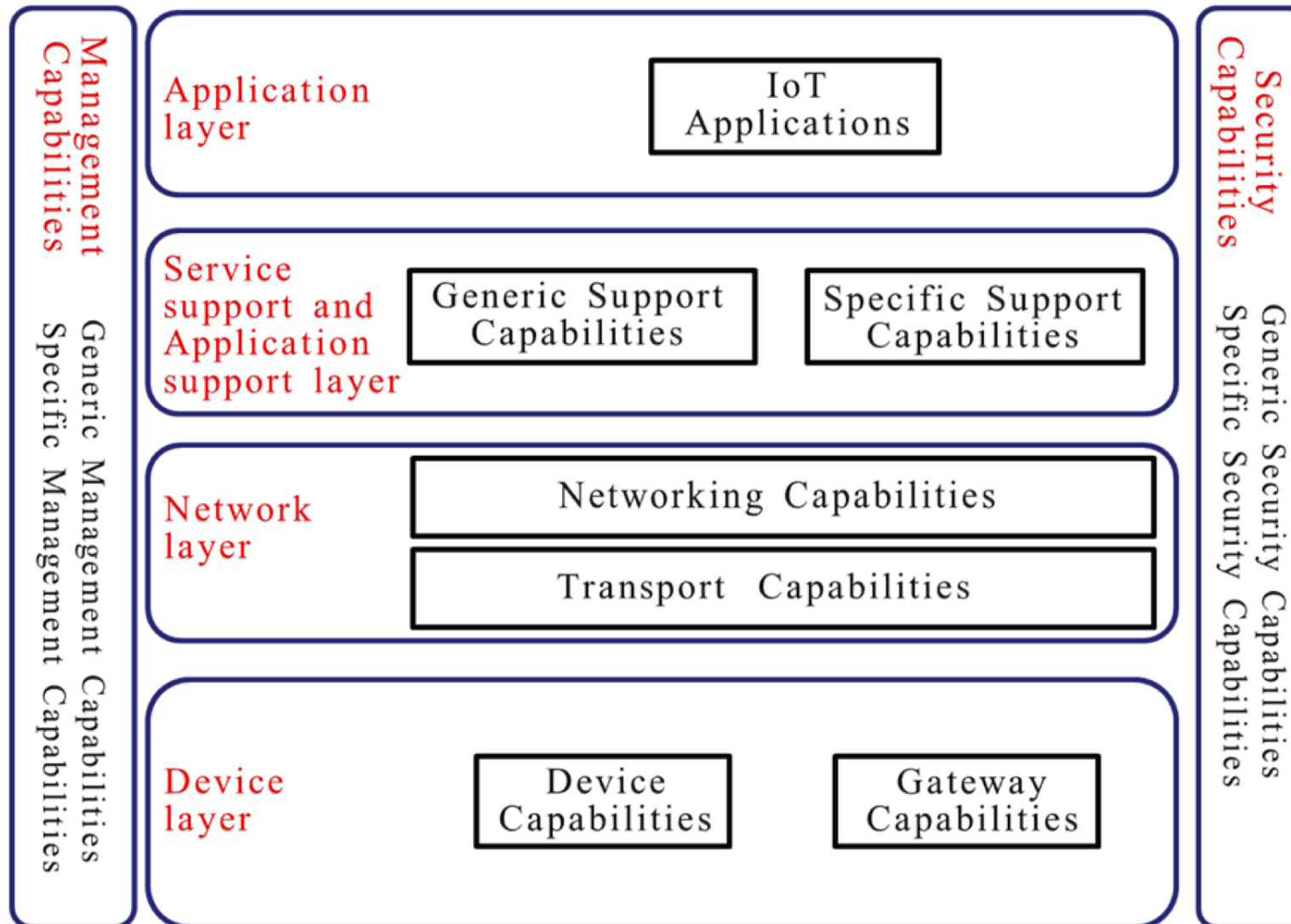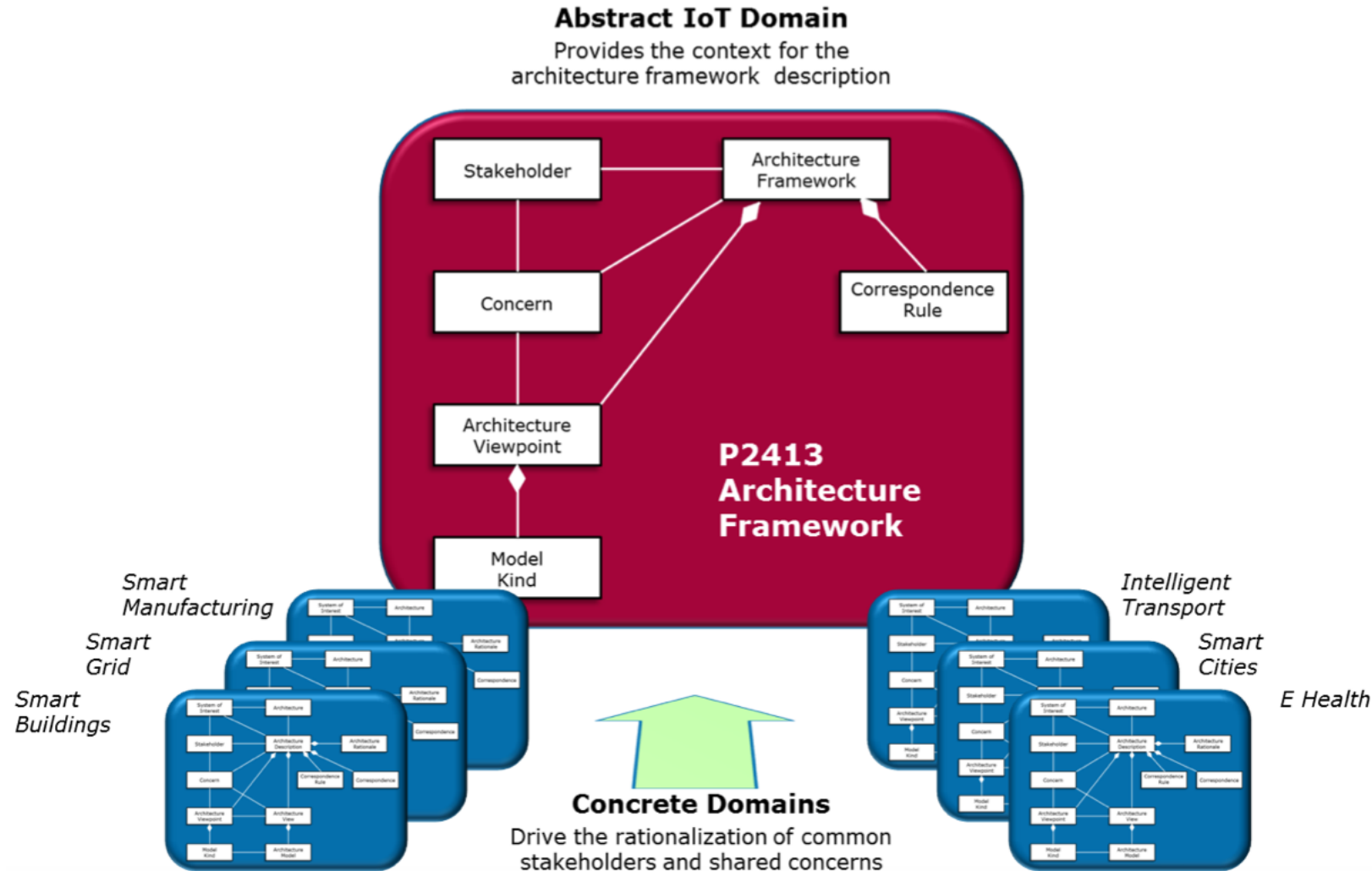
A Standards Reference Model
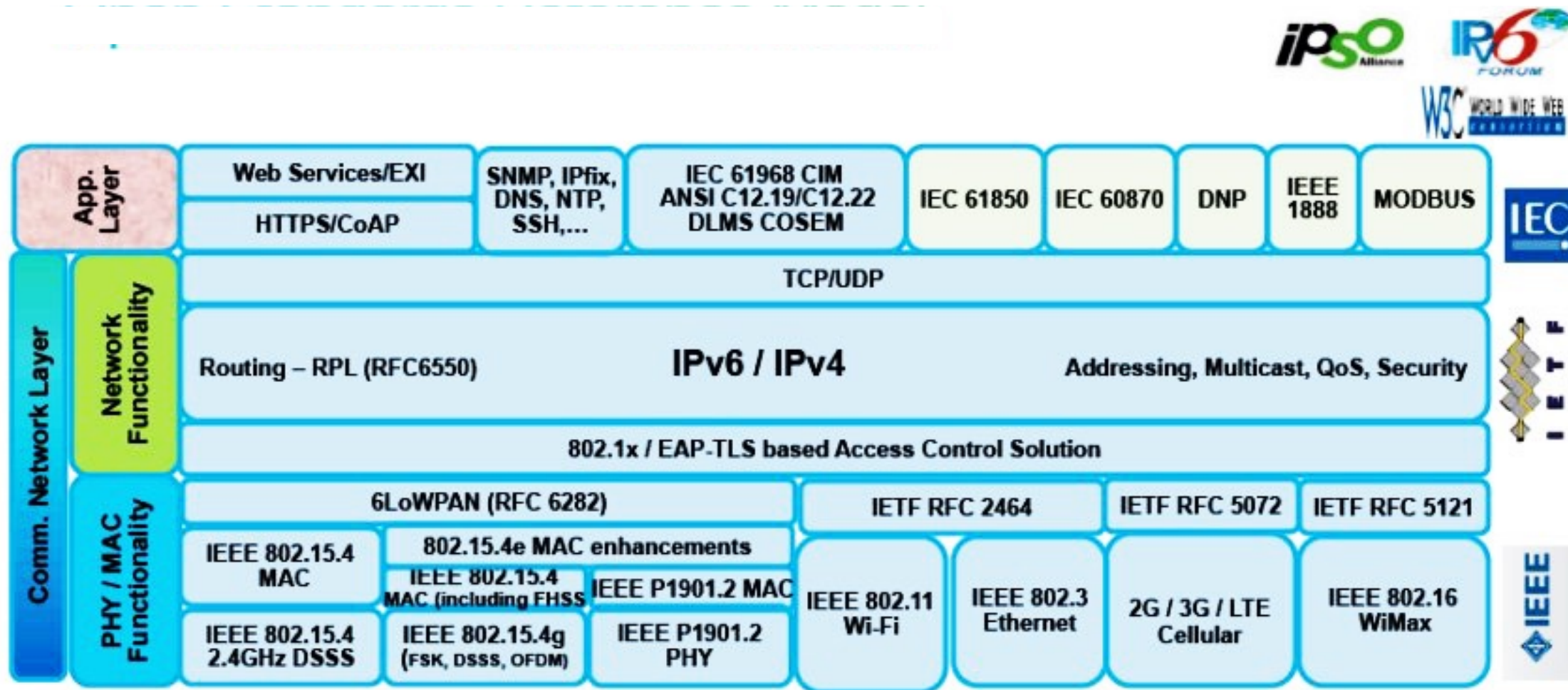
GSMA

ETSI IoT (M2M) Architecture

RA - heterogeneous communication technologies

Source: ITU-T Y.4000/Y.2060

IEEE P2413 Architectural Framework

Source: grouper.ieee.org.groups/2413/

Functional view of the IoT-A Architecture

- Functions

- Functional views

- *A view is a representation of one or more structural aspects of an reference architecture that illustrates how this reference architecture can be adopted to address one or more concerns held by its stakeholders*

- A *viewpoint* is a collection of patterns, templates, and conventions for constructing one type of view
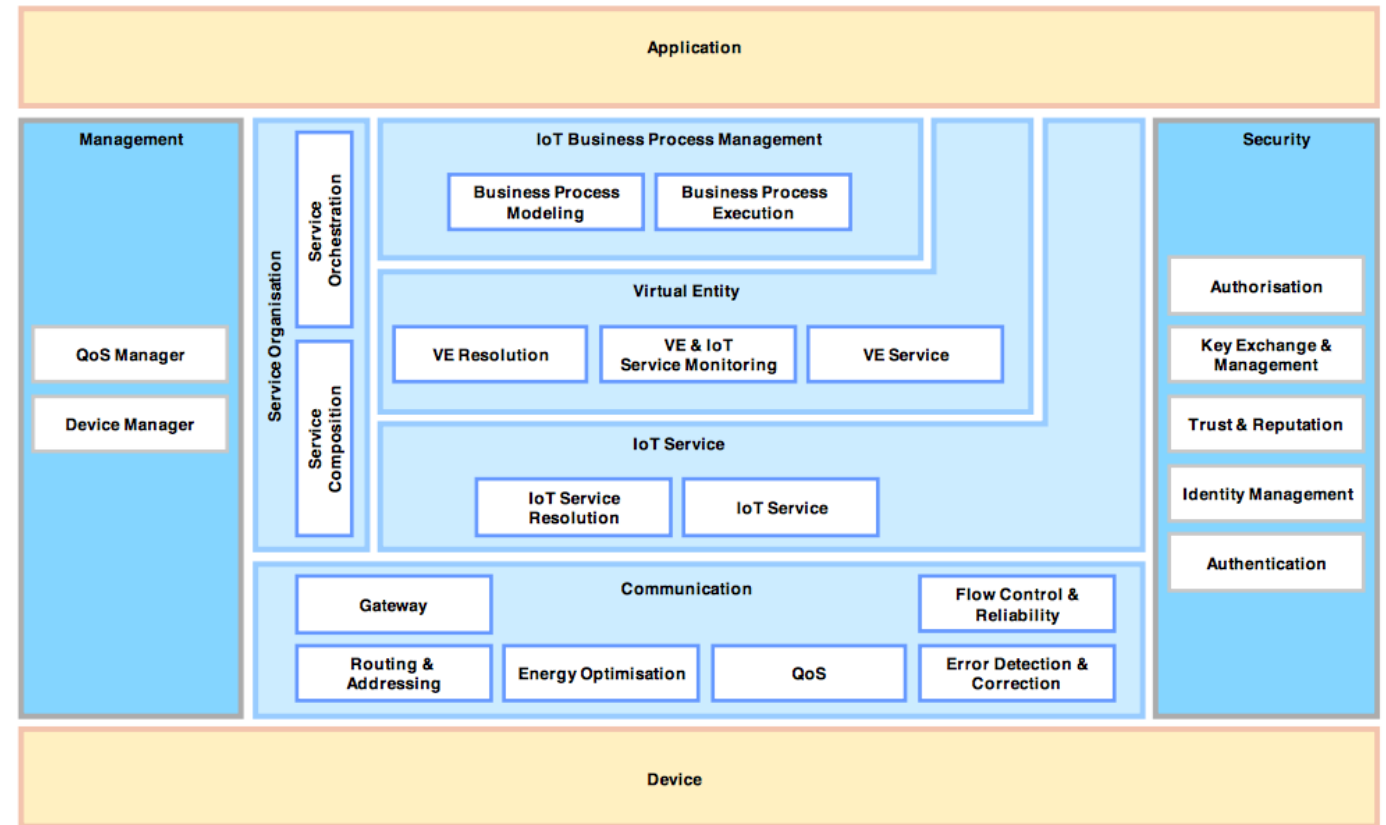
IoT-A RA – Detailed View
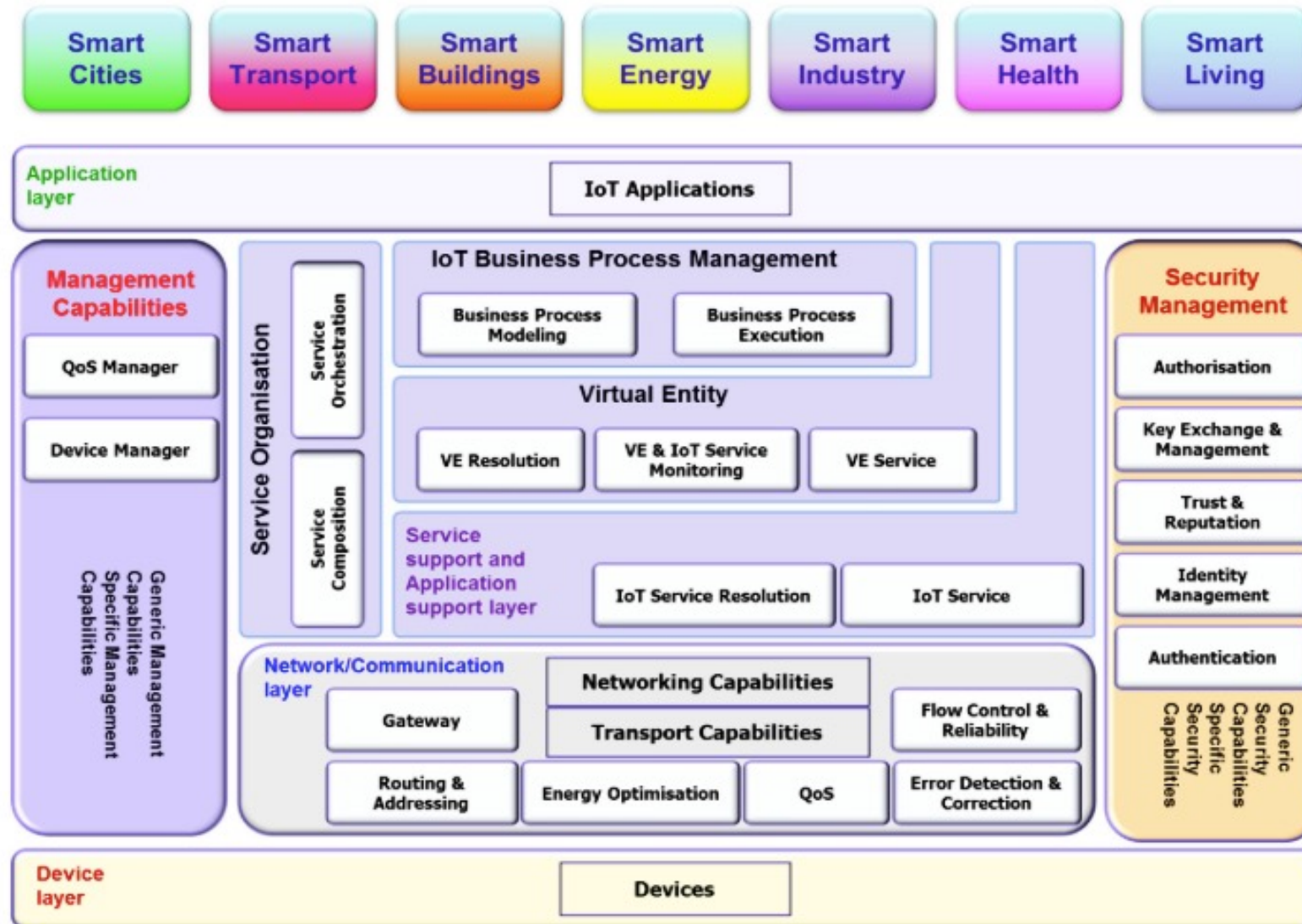
IoT Reference Architecture (IoT RA)

- IoT-A project initiated the RA efforts

- Previously, ETSI's M2M was referenced

- ISO/IEC 30141, IEEE P2413 are RA standards

- OneM2M is working on an RA

- AIOTI – consolidates recommendations
  - RA is the consolidation
  - Includes open source efforts
  - Semantic interoperability
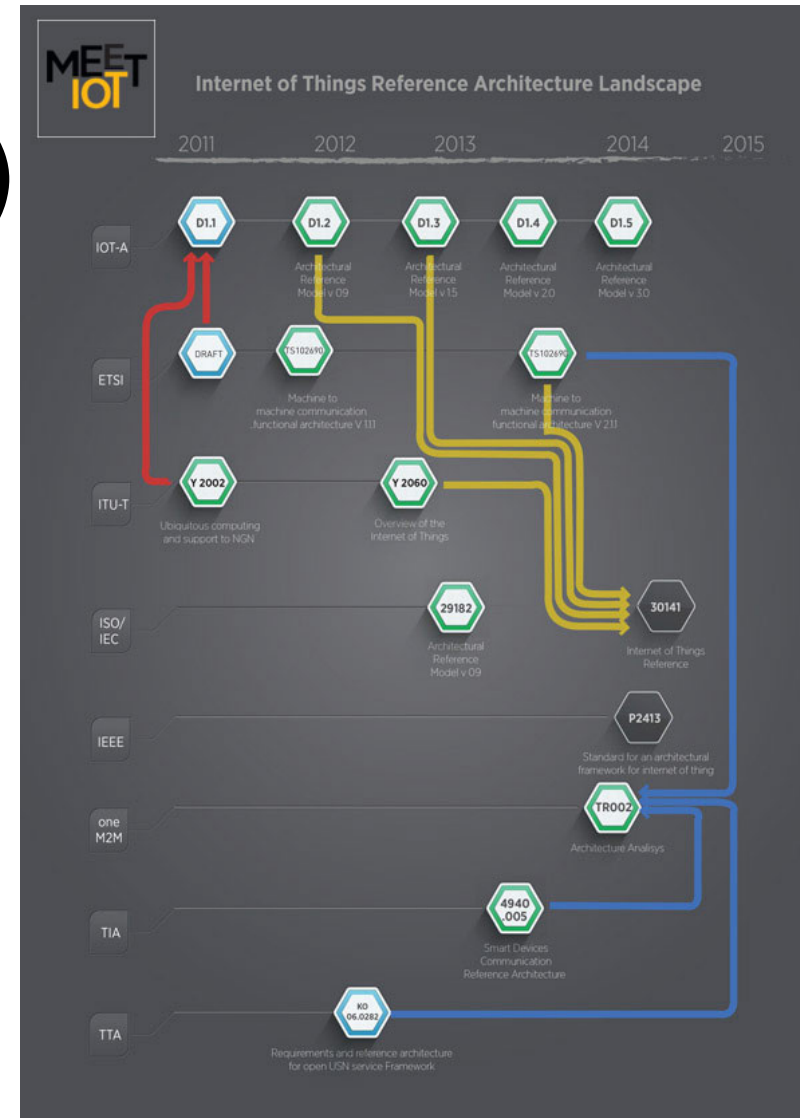
Source: meet-iot.eu

AIOTI RA

- Consolidates
- IOT-A, OneM2M
- IEEE P2413
- ITU-T
- ISO/IEC JTC1
- ISO/IEC 42010 based architectural views
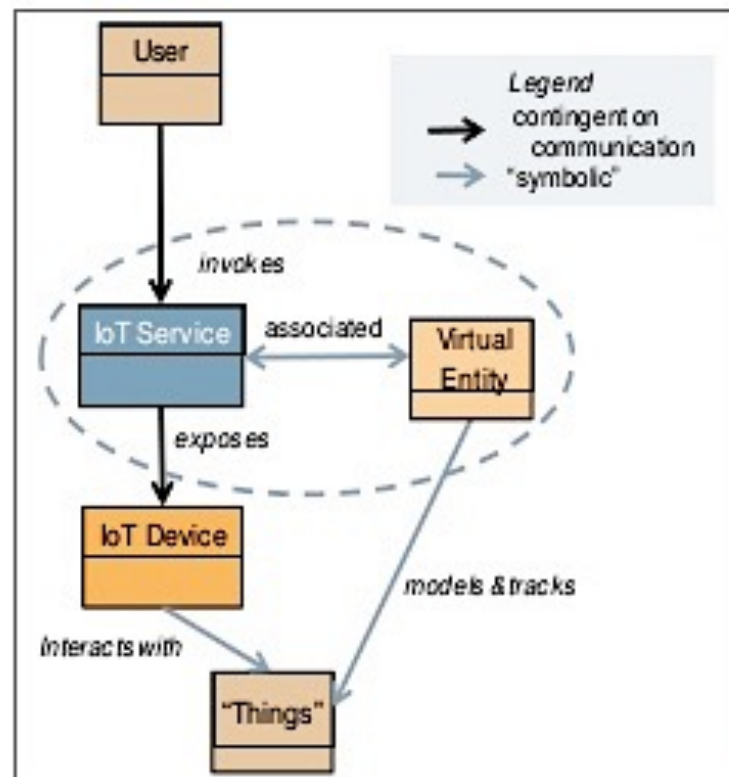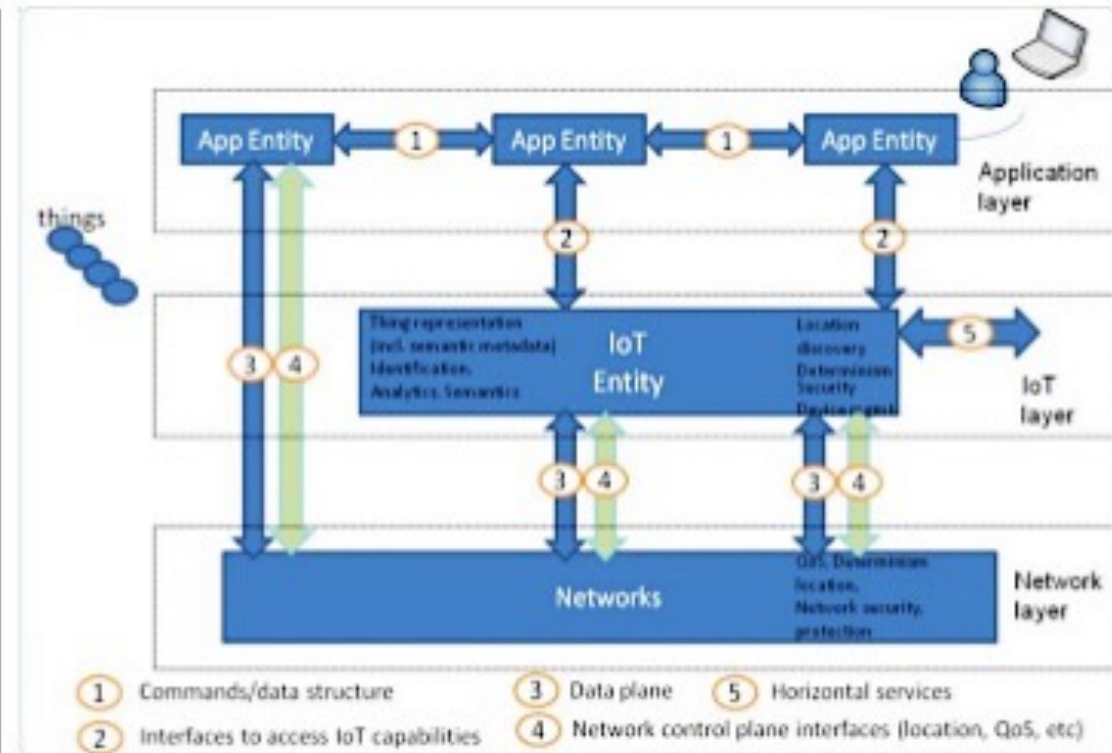
SDOs and Alliances Landscape
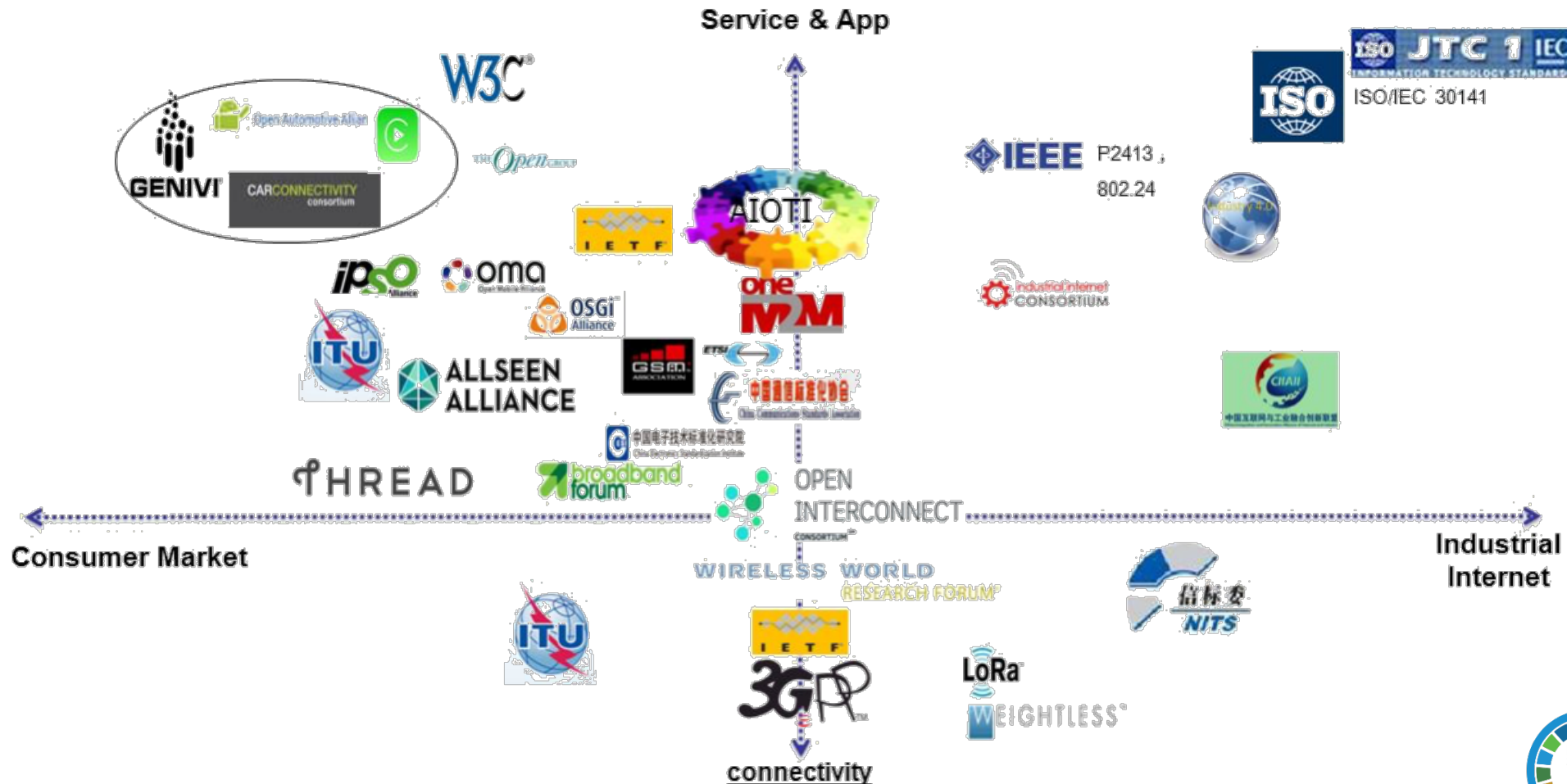
Exploring interoperability between architectures of different SDOs

Interoperability

- Interconnectivity
  - Media, media access control, encoding and integrity check, encryption, addressability and routing, data transport

- Data
  - Syntax, semantics, exchange format, policy structure, representation, interpretation

- Security
  - Levels/types, adaptation, resilience across domains

- Functions
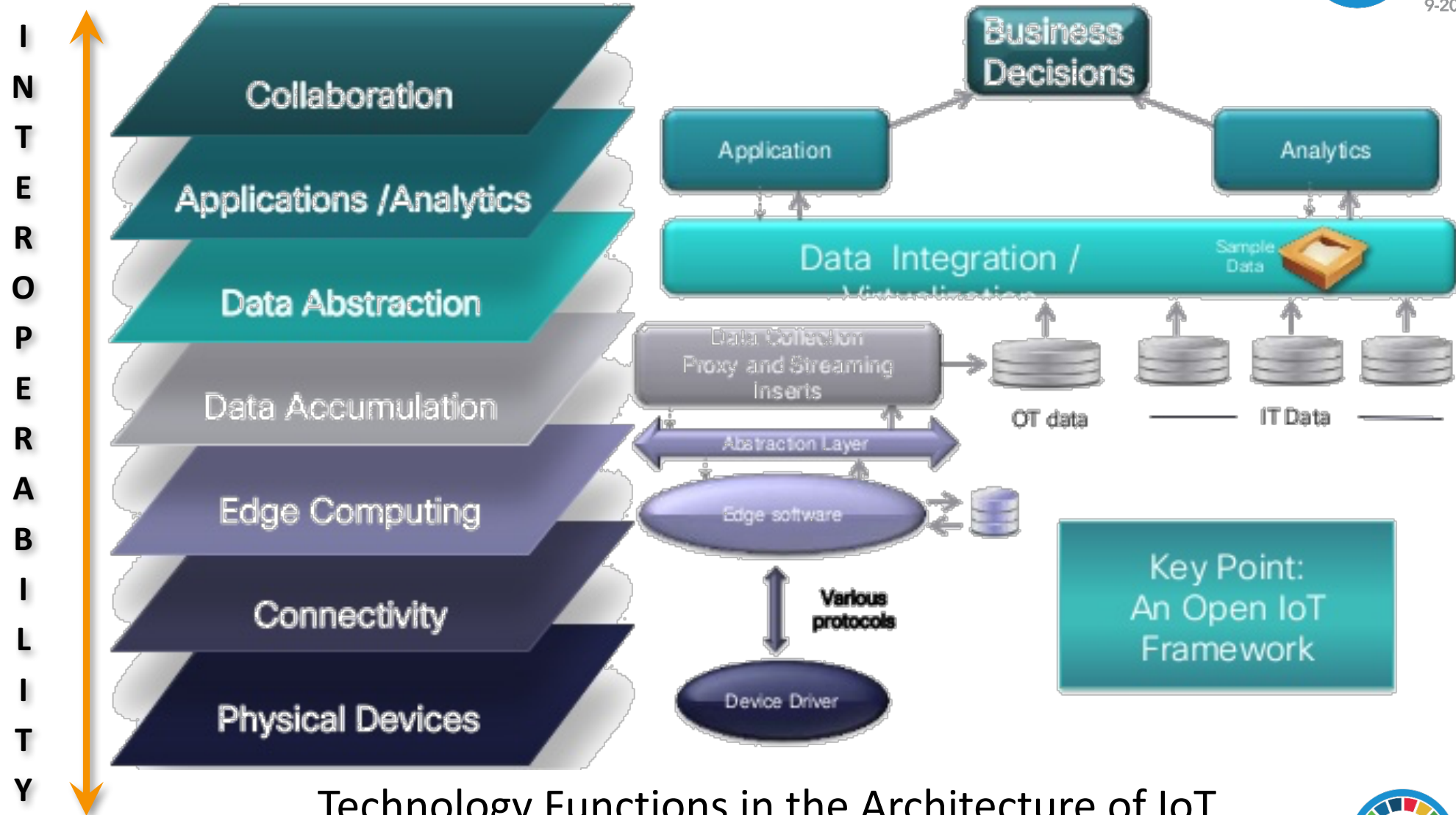
Technology Functions in the Architecture of IoT

Source: Cisco

Interoperability

- Requirements not well identified or missing

- Ambiguous requirements

- Varying technical quality and use of language

- Inadequate handling of options

- Lack of clear system overview

- Loose definition of interfaces (reference points)

- Poor maintenance

- Using standards beyond their original purpose

Syntactical Interoperability

Technical Interoperability

Semantic Interoperability

Organisational Interoperability

Source: van der Veer, H. and Wiles, A., 2008. Achieving technical interoperability. *European Telecommunications Standards Institute*.
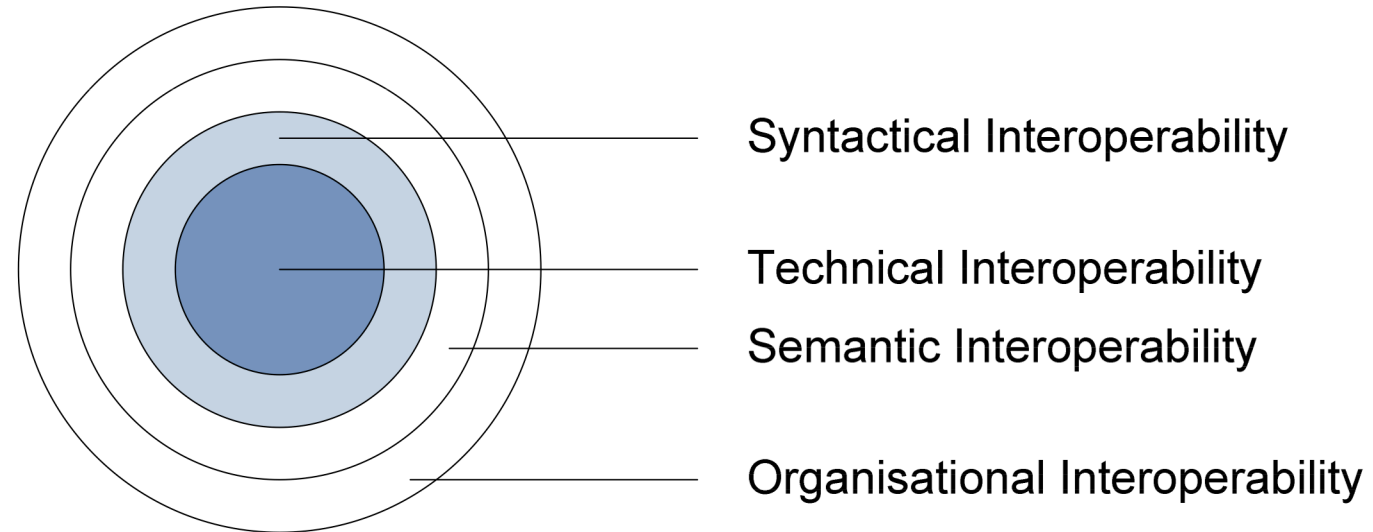
Interoperability

- **Technical Interoperability** is usually associated with hardware/software components, systems and platforms that enable machine-to-machine communication to take place. Such interoperability is centered on protocols and the infrastructure needed for protocol operation

- **Syntactical Interoperability** is usually associated with data formats. Many protocols carry data or content using high-level transfer syntaxes such as HTML, XML or ASN.1

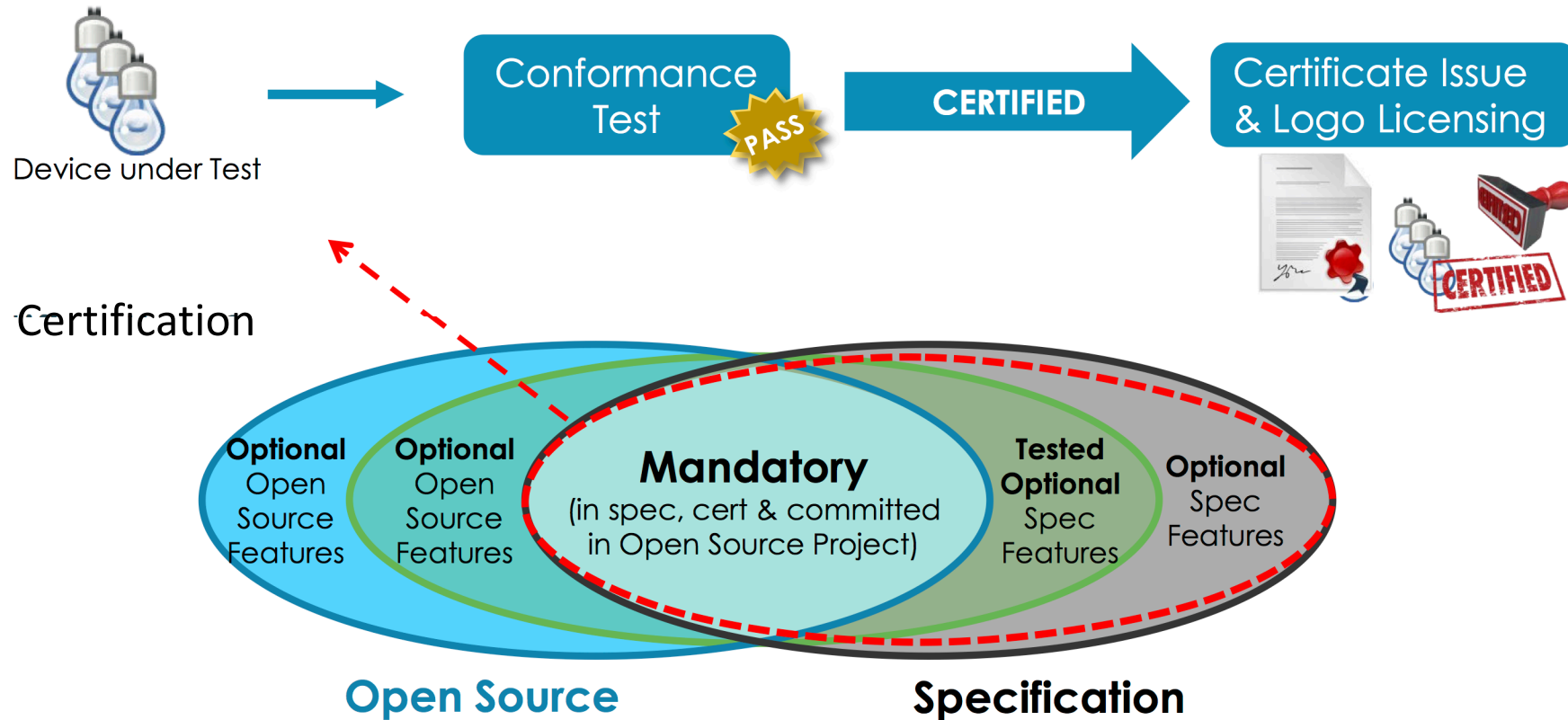- **Semantic Interoperability** is usually associated with the meaning of content and concerns the human rather than machine *interpretation* of the content. Thus, interoperability on this level means that there is a common understanding between people of the meaning of the content (information) being exchanged.

- **Organizational Interoperability**, as the name implies, is the ability of organizations to effectively communicate and transfer (meaningful) data (information) even though they may be using a variety of different information systems over widely different infrastructures, possibly across different geographic regions and cultures.

Source: van der Veer, H. and Wiles, A., 2008. Achieving technical interoperability. *European Telecommunications Standards Institute*.

Open Connectivity Forum (OCF)

- Technical specification(s) comprising of the core architectural framework, messaging, interfaces and protocols based on approved use-case scenarios

- Enables the development of vertical profiles (e.g. Smart Home) on top of the core while maintaining fundamental interoperability

- Framework that is scalable from resource constrained devices to resource rich devices

- Resource models that are vertical (domain)-agnostic and models for ecosystem mapping

- Certification – Test plans, procedures and policies

OCF – Conformance and Certification

Source: openconnectivity.org:OCF_1.0_Specification_Overview.pdf

Bridging for Interoperability

OCF Resource Model ⟷ Derived Model ⟷ Partner Ecosystem Resource Model

Resource Spec
Device Spec

Bridging Spec
Mapping Spec
Security Spec

Other Ecosystem Spec

OCF Ecosystem | Partner Ecosystem

OCF Server

OCF Client

Bridge (oic.d.bridge)

OCF Bridging Security Filter & Mapping

Partner Ecosystem Client

Partner Ecosystem Server

Source: openconnectivity.org:OCF_1.0_Specification_Overview.pdf

OCF Framework Specification
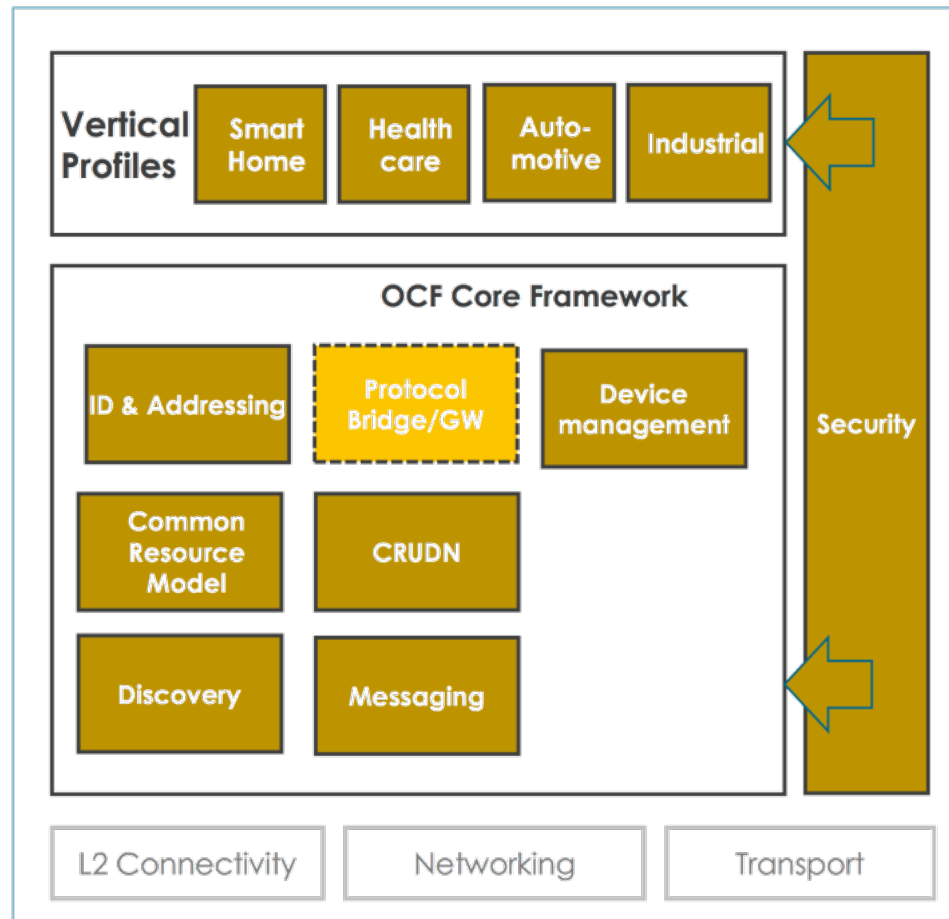
① **Discovery:** Common method for device discovery (IETF CoRE)

② **Messaging:** Constrained device support as default (IETF CoAP) as well as protocol translation via bridges

③ **Common Resource Model:** Real world entities defined as data models (resources)

④ **CRUDN:** Simple Request/Response mechanism with Create, Retrieve, Update, Delete and Notify commands

⑤ **ID & Addressing:** OCF IDs and addressing for OCF entities (Devices, Clients, Servers, Resources)

⑥ **Protocol Bridge/GW:** Handled by the Bridging Spec with some implications on the Core

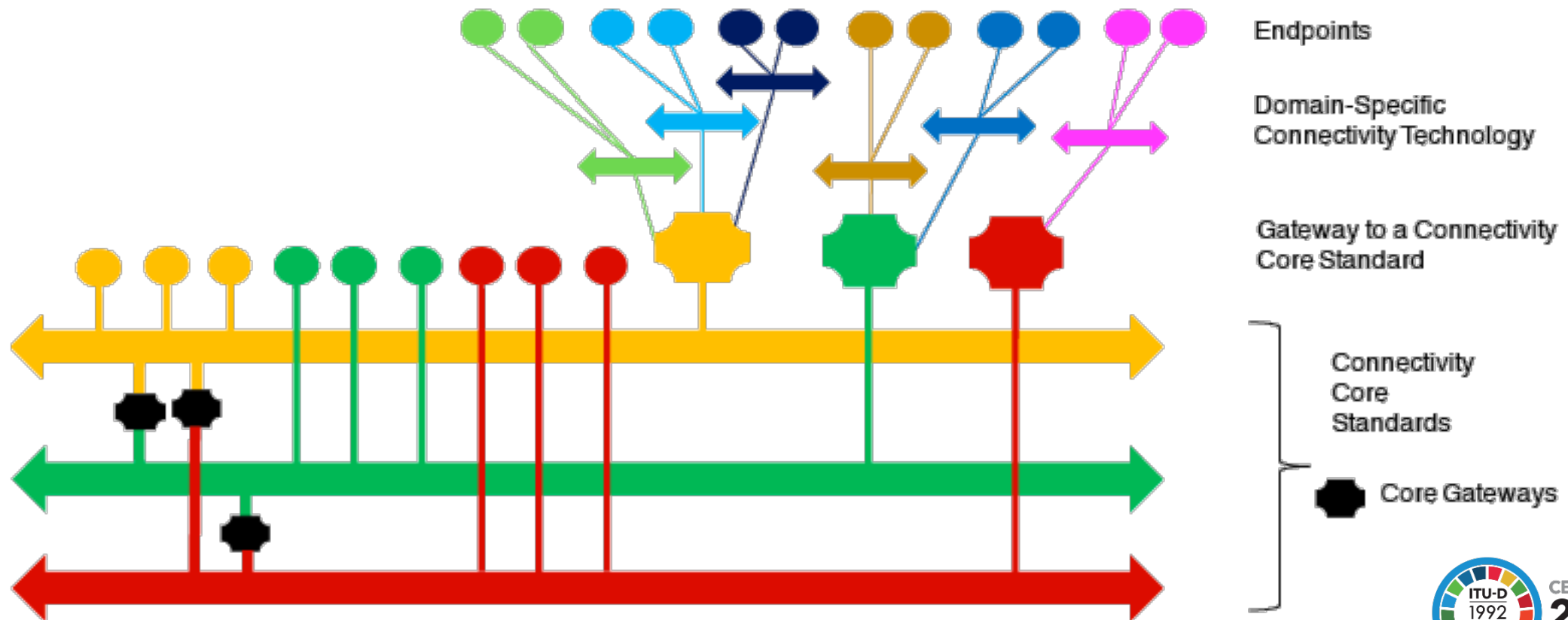Security is fundamental to the OCF ecosystem and applies to all elements
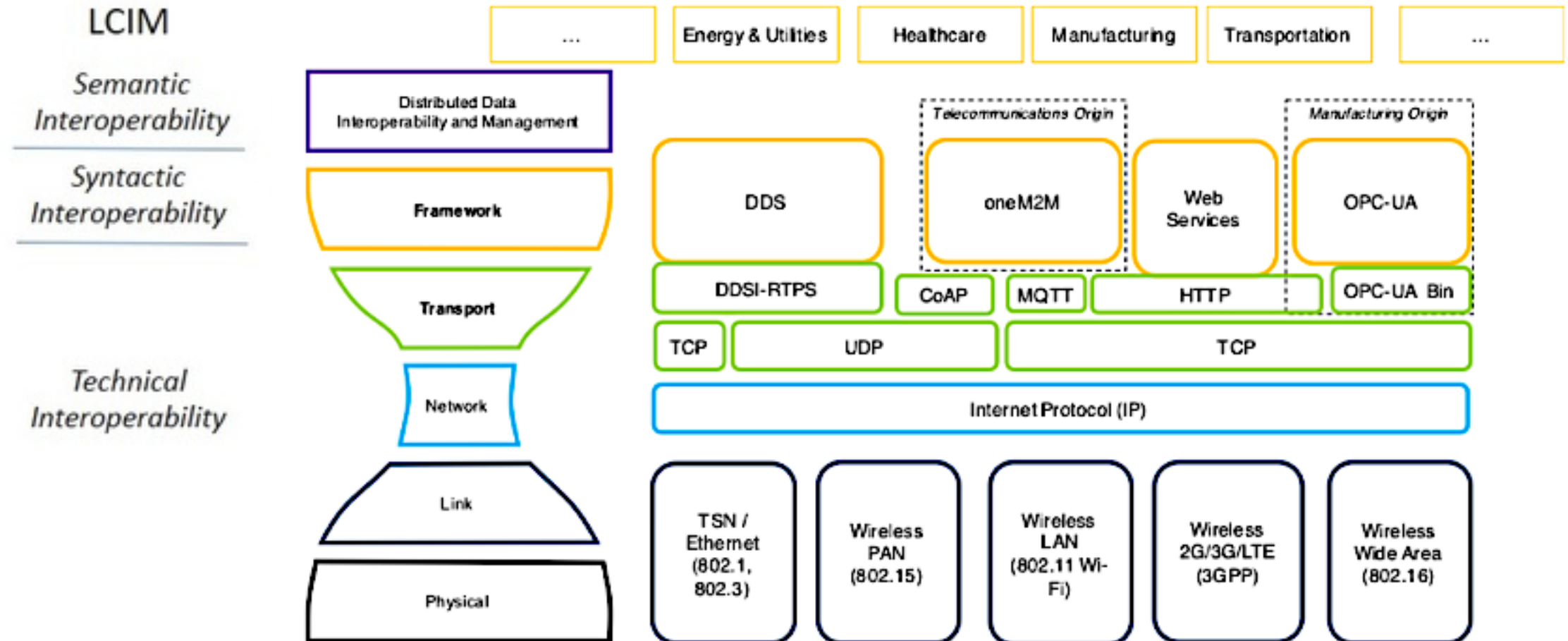
Open Connectivity Forum - OCF

Source: OCF
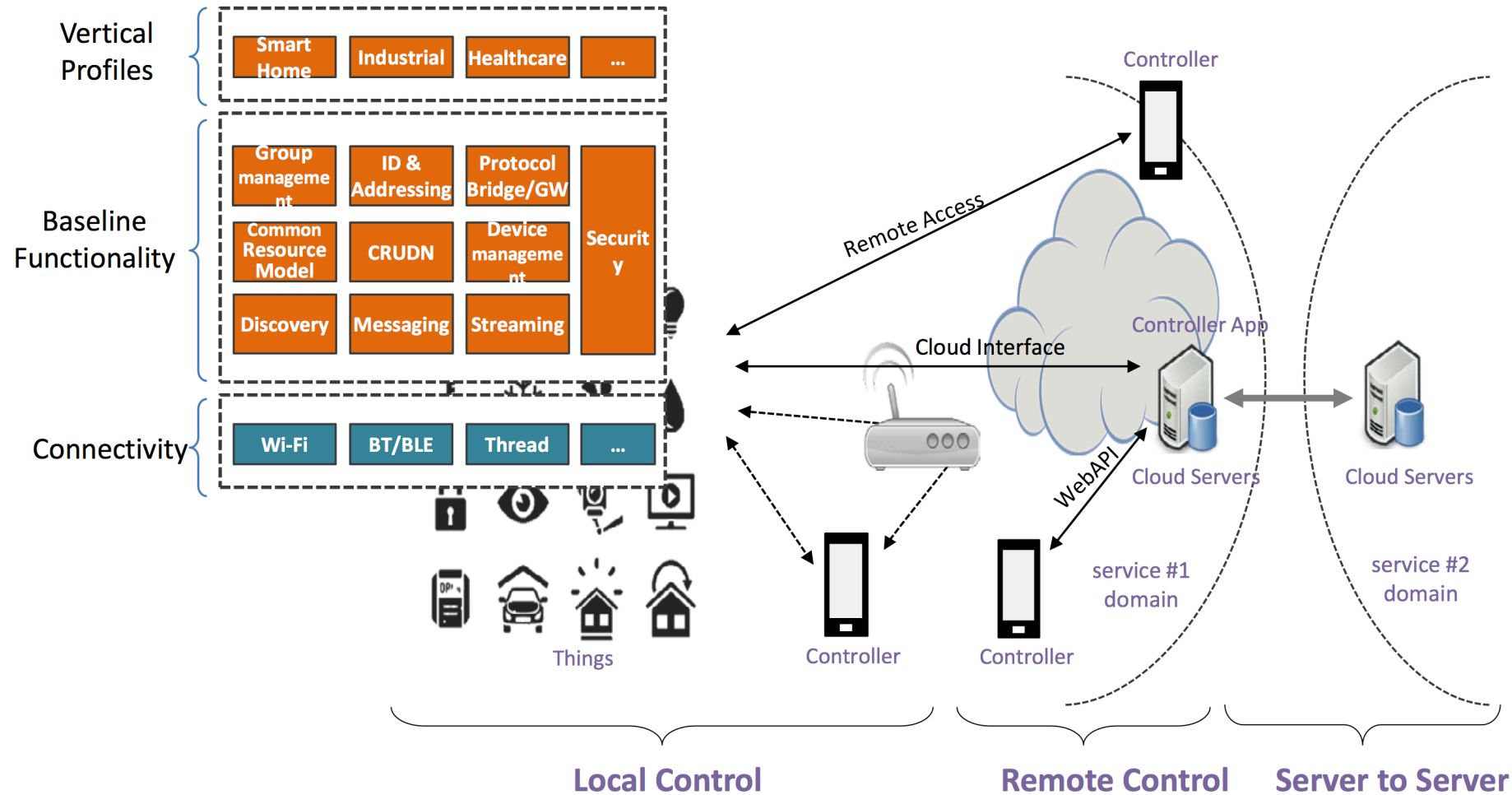
Industrial Internet Consortium (IIC)

- Industrial embedded systems
- Several domains with specific requirements

IIC standards stack

Conforming to the standard?

|	Core Standard Criterion	DDS	Web Services	OPC-UA	oneM2M
1	Provide **syntactic interoperability**#	✔	Need XML or JSON	✔	✔
2	Open standard with strong **independent, international** governance#	✔	✔	✔	✔
3	**Horizontal** and neutral in its applicability across industries#	✔	✔	✔	✔
4	**Stable** and **deployed** across multiple vertical industries#	Software Integration & Autonomy	✔	Manufacturing	Home Automation
5	Have **standards-defined** *Core Gateways* to all other core connectivity standards#	Web Services, OPC-UA*, oneM2M*	DDS, OPC-UA, oneM2M	Web Services, DDS*, oneM2M*	Web Services, OPC-UA*, DDS*
6	Meet the connectivity framework **functional** requirements	✔	✖	Pub-Sub in development	✔
7	Meet **non-functional** requirements of performance, scalability, reliability, resilience	✔	✖	Real-time in development	Reports not yet documented or public
8	Meet **security** and **safety** requirements	✔	✔	✔	✔
9	Not require any single component from any single vendor	✔	✔	✔	✔
10	Have readily-available SDKs both **commercial** and **open source**	✔	✔	✔	✔

#green = Gating Criteria   * = work in progress, ✔ = supported, ✖ = **not** supported
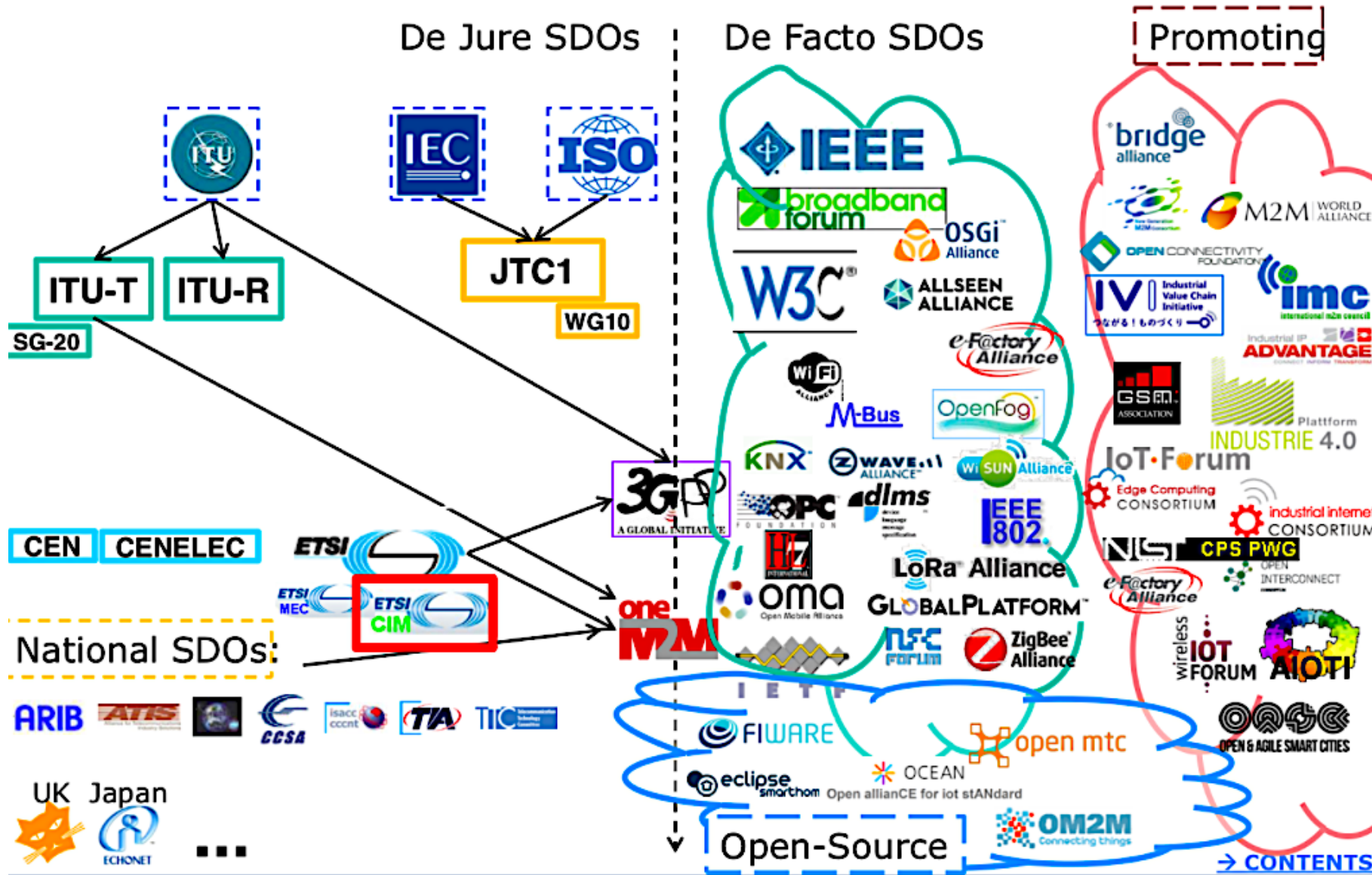
ETSI – Context Information Management (CIM)

- **Definition of a standard API for Context Information Management**, enabling close to real-time update and access to information coming from many different sources (not only IoT). Such an API will enable applications to perform updates on context, register context providers which can be queried to get updates on context, query information on current and historic context information and subscribe for receiving notifications on context changes.

- **Specifications to be fulfilled by Data Publication Platforms** supporting open data publication, data privacy and/or authorization of access, including enablers for multi-party access contracts will be considered.

- **Cross-domain Context Information Models** that will deal with the definition of the models that are common to several of the domains being targeted, together with the meta models, definition languages and processes needed for the specification, curation, publication and evolution of Context Information Models will be defined and applied.

- **Smart Cities Information Models**, where the specific models for the Smart Cities domain will be defined.

- **Information Models targeting other specific domains** besides Smart Cities (for example Smart Agrifood, Smart Industry, etc.) will also be considered.

CIM

ISG CIM (Context Information Management)
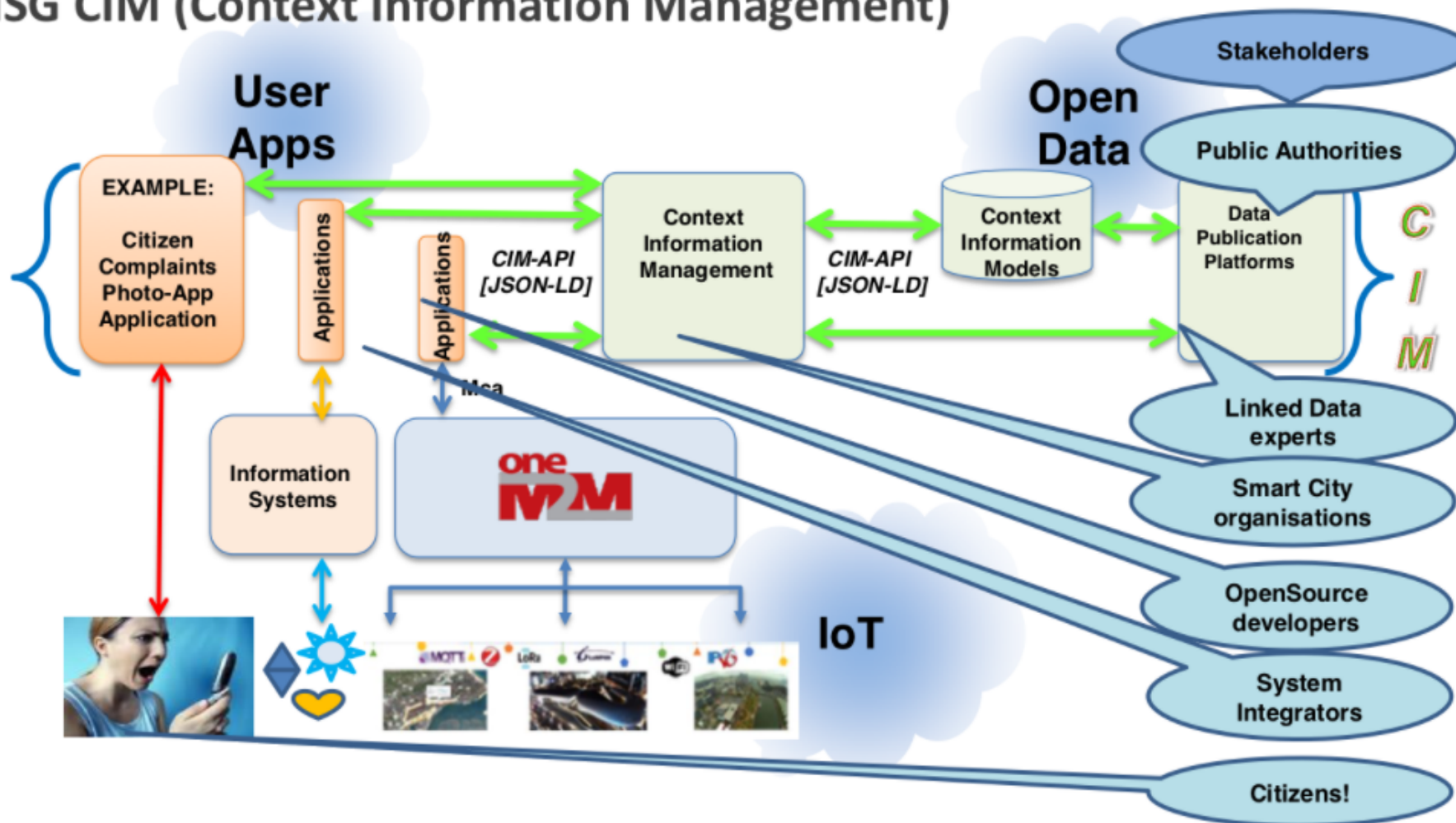
Goal = interoperable exchange of data & metadata between systems

Conclusion

Thank You