securityandtrust.lu

Day 2 (April 20th): Data collection for Internet of Things

Data Publication & Discovery based on Open IoT Messaging Standards

Sylvain Kubler:
sylvain.kubler@uni.lu
Luxembourg University, Interdisciplinary Centre for Security, Reliability & Trust

UNIVERSITÉ DU LUXEMBOURG

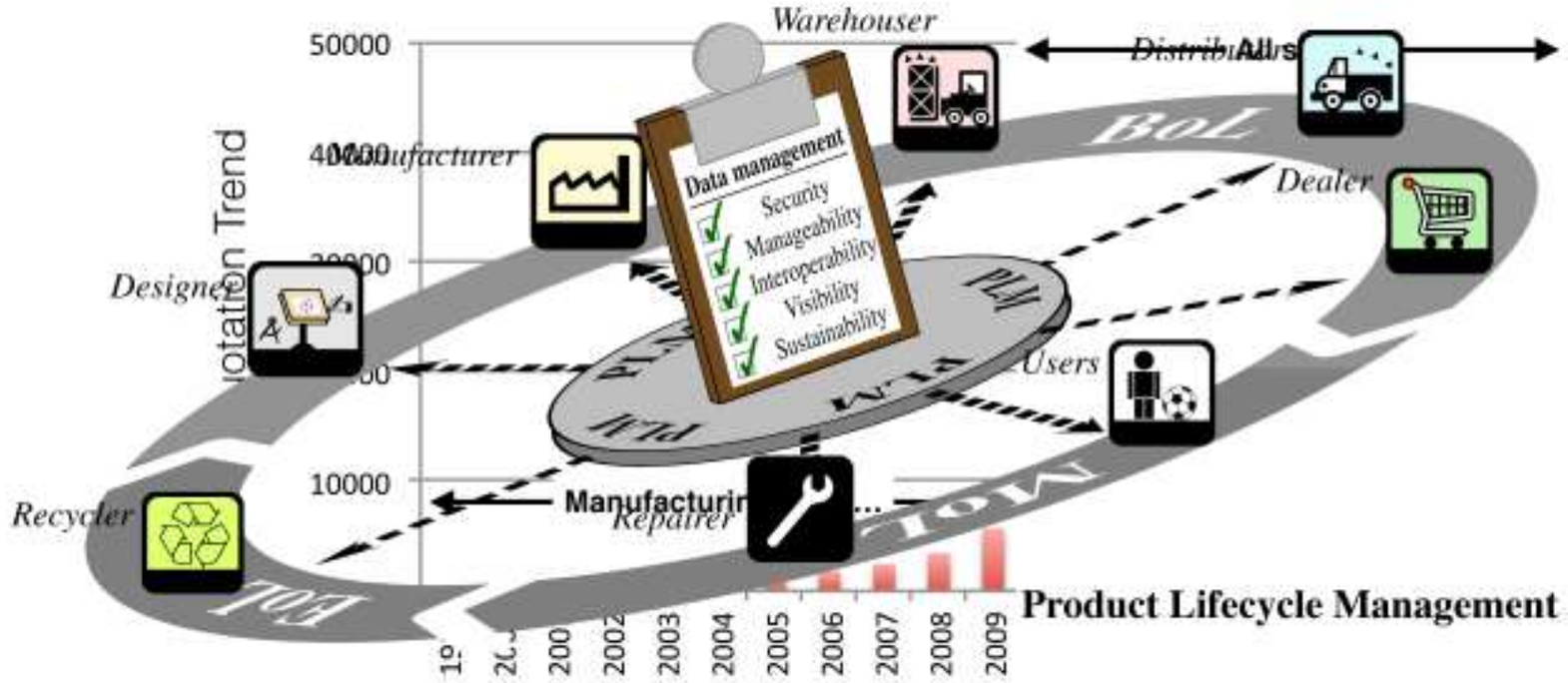
SUMMARY

- IoT (Internet of Things) — The road ahead
- EU's Vision & Ambition
- O-MI & O-DF Messaging Standards used as Foundation of the bloTope (H2020 ICT30) project
- bloTope Large-Scale Pilots
- Conclusion

IoT (Internet of Things) — The road ahead

Genesis

Ashton, K. (2000) Internet things - MIT, embedded technology and the next internet revolution, Baltic Conventions, The Commonwealth Conference and Events Centre, London



IoT (Internet of Things) — The road ahead

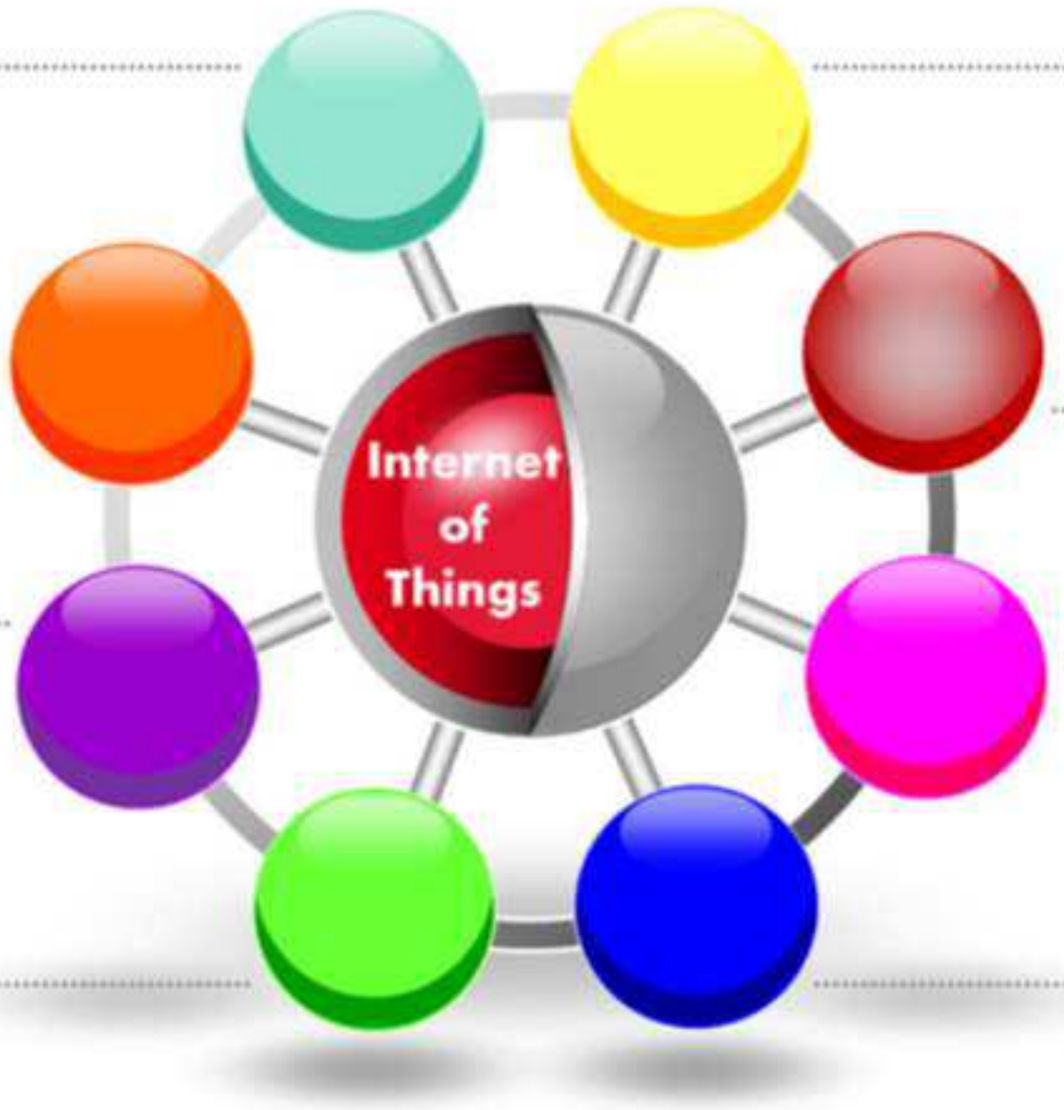
Definition

A *dynamic global network infrastructure*

with *self configuring capabilities*

based on *standard and interoperable communication protocols*

where *physical and virtual "things"*



have *identities, physical attributes, and virtual personalities*

use *intelligent interfaces*,

and are *seamlessly integrated*

into *the information network.*

Source: O. Vermesan, P. Friess, P. Guillemin, S. Gusmeroli, et al. (2011) "Internet of Things Strategic Research Agenda", Chapter 2 in Internet of Things - Global Technological and Societal Trends, River Publishers, ISBN 978–87-92329–67-7

IoT (Internet of Things) — The road ahead

A new trend

Smart Planet

Green Environment

- Environmental sensors
- Water, power leak detection
- Pollution, weather monitoring

Smart Cities

Connected Communities

- Lighting, water management
- Monitoring & security
- Traffic control

Smart Energy

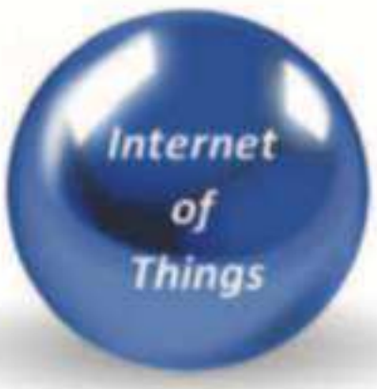
Electric Grid

- Voltage and power sensors
- Meters and breakers
- Fault detection

Smart Buildings

Buildings, Smart Homes

- Thermostats, HVAC, lighting
- Presence sensors, lockers, actuators
- Meters, smart-plugs, HEC



Smart Transport

ITS, MEVs, EVs

- Electric Mobility, EVs and HEVs
- High Speed Trains
- Infrastructure, V2I, V2V, V2I+I

Smart Industry

Industrial Environments

- Lightning, security, actuators
- Production control
- Robotics

Smart Health

Healthcare System

- People monitoring
- Bio sensors, probes
- Remote health

Smart Living

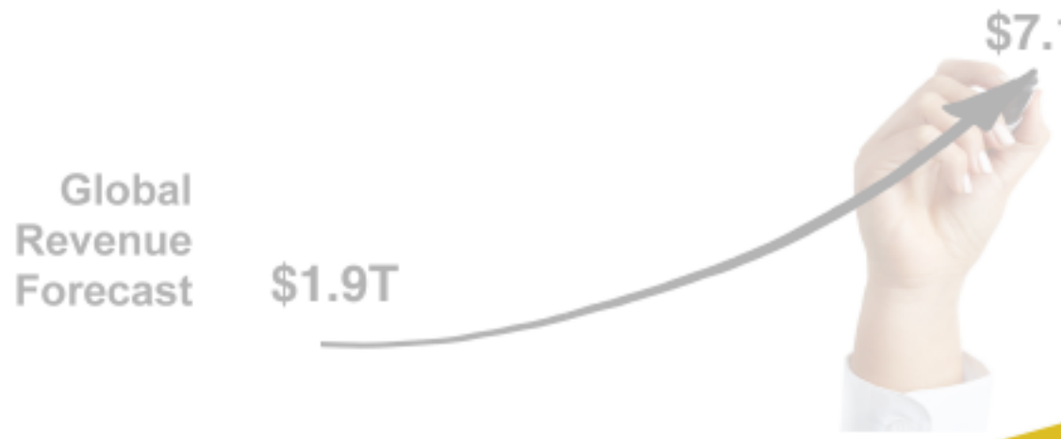
Entertaining, Leisure

- Independence through technology
- Information when you need it
- Connected when you need it

Source: Vermesan, O. and Friess, P. (2013) Internet of things: converging technologies for smart environments and integrated ecosystems, River Publishers,

IoT (Internet of Things) — The road ahead

Forecasting the Future of the IoT in the EU (according to IDC-DG Connect)

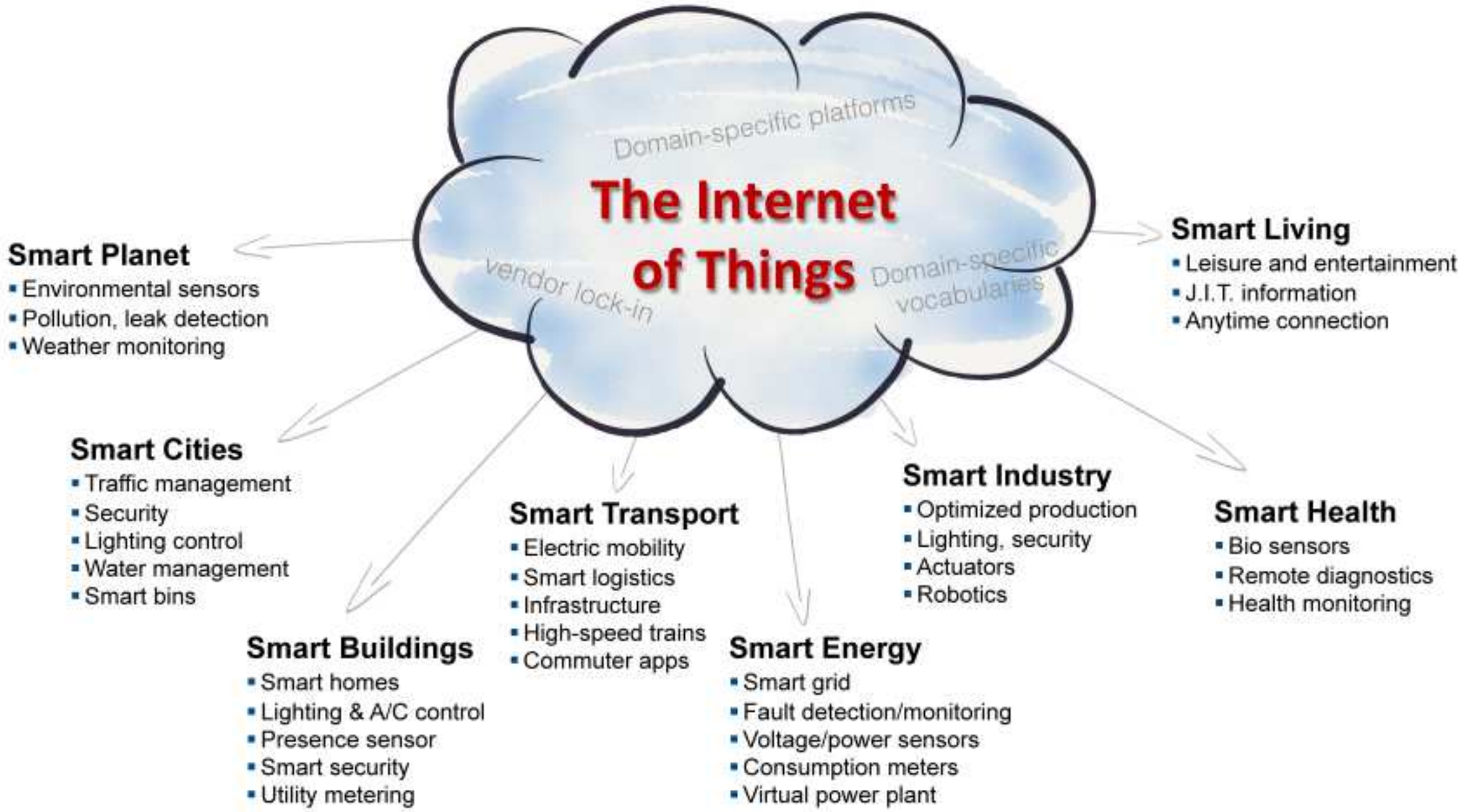


Architectural issues & Structural considerations still need to be addressed for businesses to benefit !

*Source: Definition of a R&I strategy leveraging The combination of **IoT & Cloud** for DG CONNECT*

IoT (Internet of Things) — The road ahead

Vertical Ecosystems Dominate



*Source: Definition of a R&I strategy leveraging The combination of **IoT & Cloud** for DG CONNECT*

IoT (Internet of Things) — The road ahead

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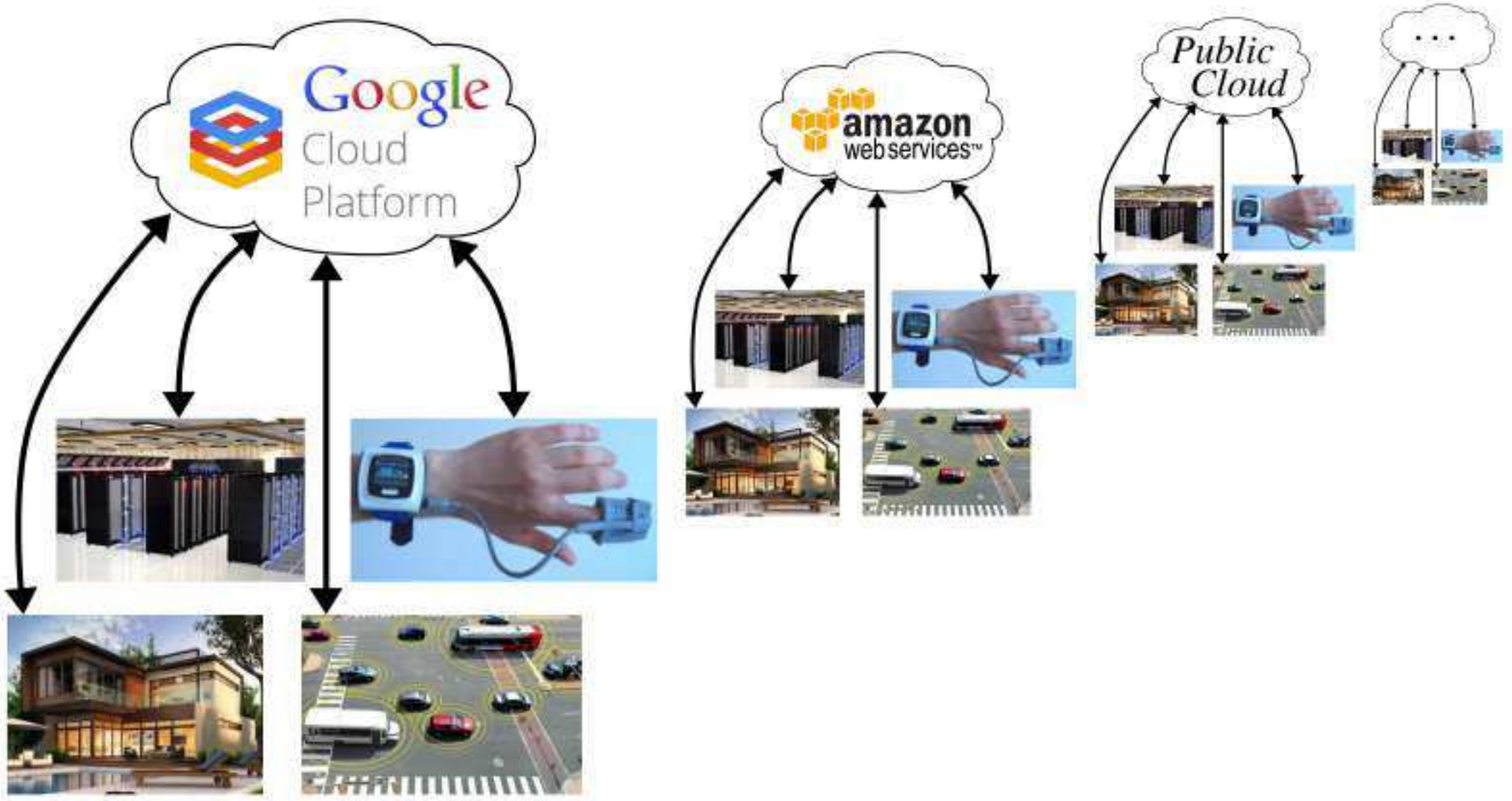
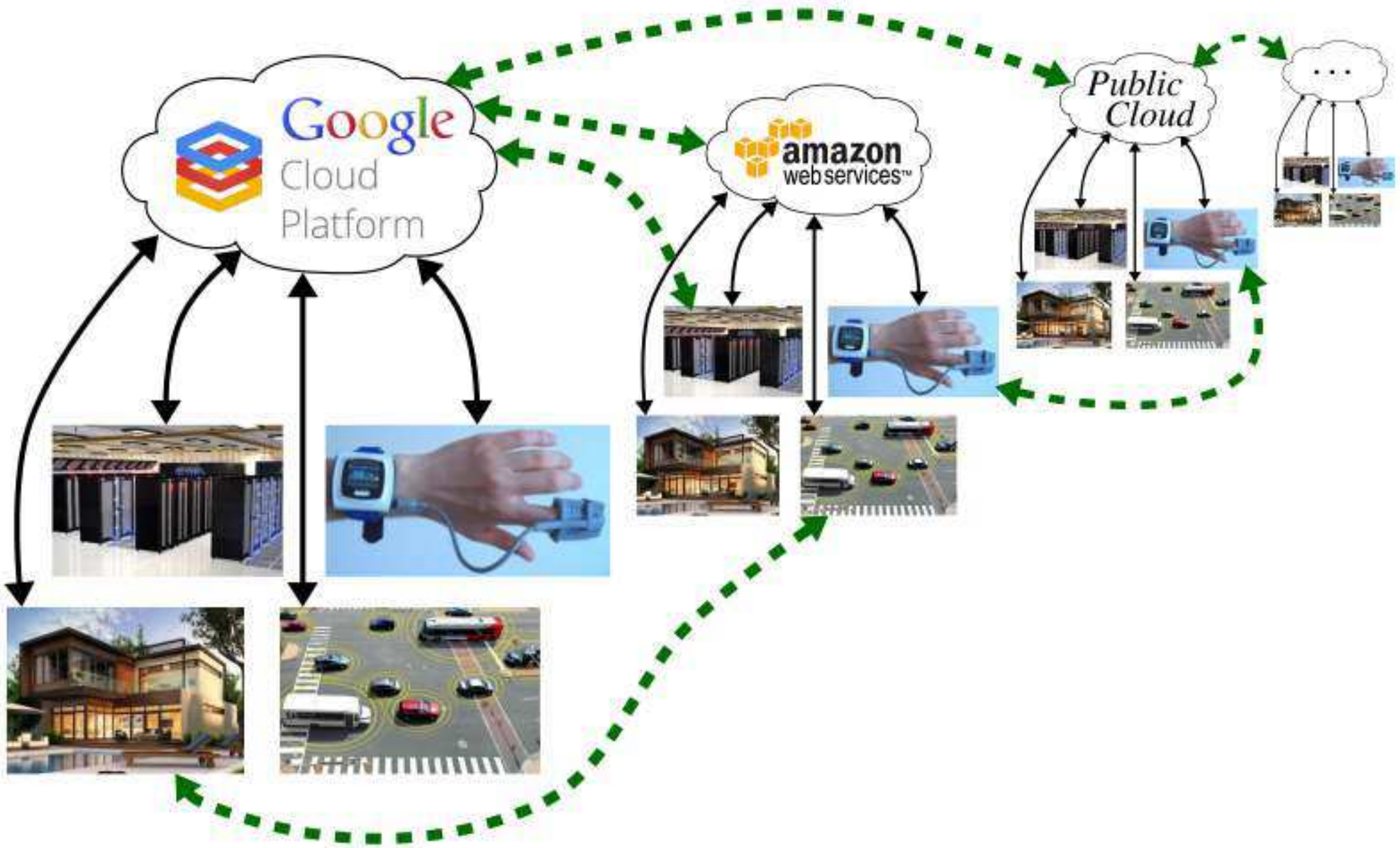


Legend

⟷ Today's IoT : Data collected into vertical silos (pushed to vertical servers)

IoT (Internet of Things) — The road ahead

Vertical Ecosystems Dominate



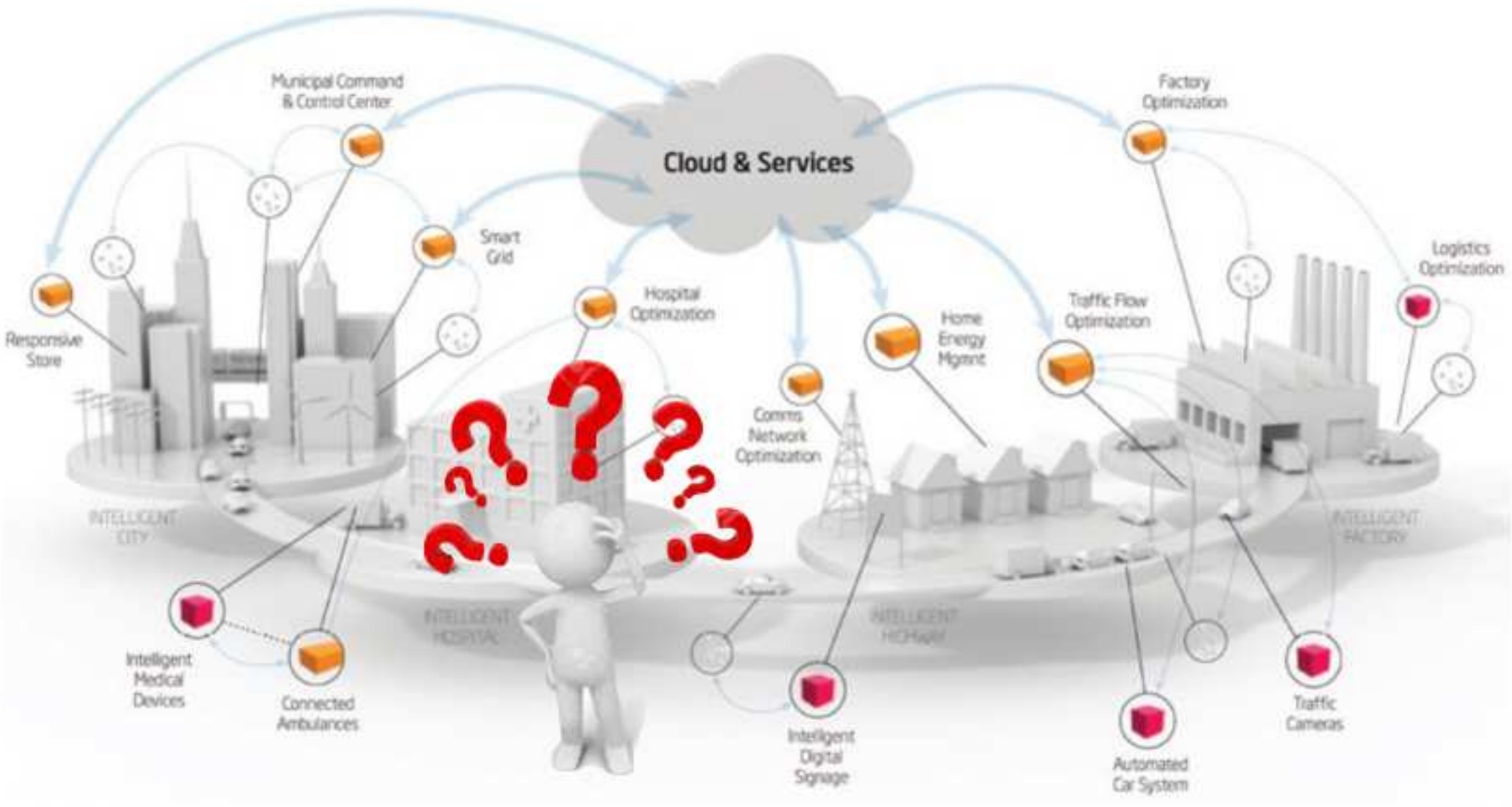
Legend

Today's IoT : Data collected into vertical silos (pushed to vertical servers)

Ideal IoT : Communication allowed between vertically-oriented closed systems

IoT (Internet of Things) — The road ahead

Security & Privacy at the heart of any IoT solution adoption



- Major ICT players hand over customer data and are not willing to let the customers have a full end-to-end control, resulting in user frustration;

- The non-maturity of the IoT makes it challenging to develop a clear approach to foster innovation, trust and ownership of data, while at the same time respecting security and privacy in complex environments.

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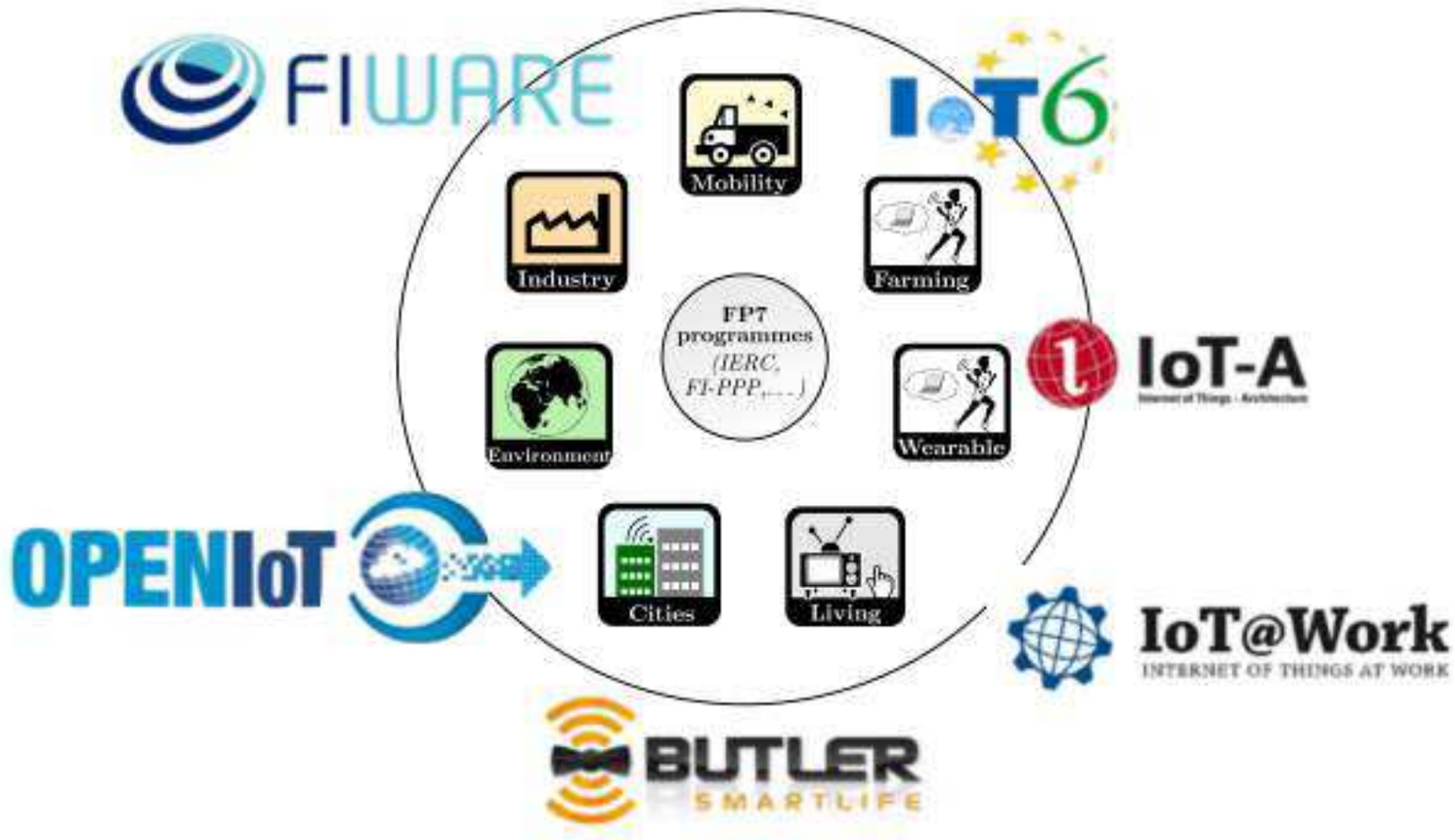
EU's Vision & Ambition

Past & Ongoing Initiatives



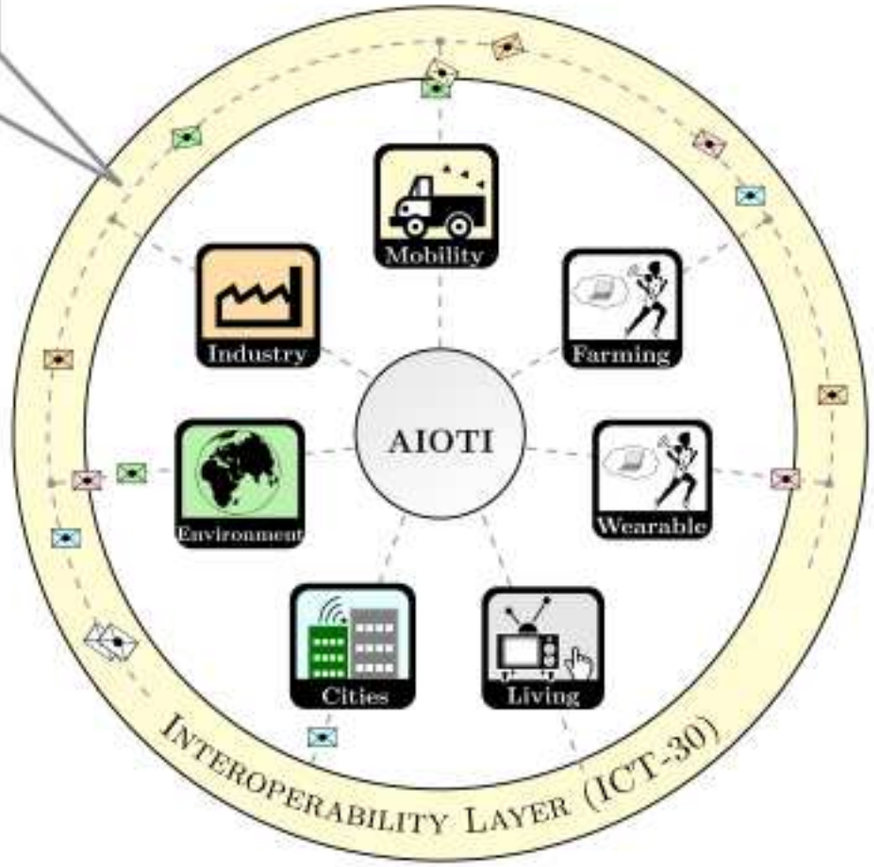
EU's Vision & Ambition

Past & Ongoing Initiatives

bIoTope

BUILDING AN IoT OPEN INNOVATION ECOSYSTEM FOR CONNECTED SMART OBJECTS

http://www.aioti.eu



Project Name	Integration of devices	Creation of platforms	Interoperable APIs	Autonomous reasoning
AGILE – Adoptive gateways for diverse multiple environments	✓	✗	✓	✗
BIG IoT – Bridging the Interoperability Gap of the Internet of Things	✗	✓	✓	✓
bIoTope – Building an IoT oPen innovation ecosystem for connected smart objects	✗	✓	✓	✓
INTER-IoT – Interoperability of heterogenous IoT platforms	✓	✓	✓	✗
symbIoTe – Symbiosis of smart objects across IoT environments	✓	✓	✗	✗
TagItSmart – Smart Tags driven service platform for enabling ecosystems of connected objects	✓	✓	✗	✗
VICINITY – Open virtual neighbourhood network to connect intelligent buildings & smart objects	✗	✓	✓	✗

EU's Vision & Ambition

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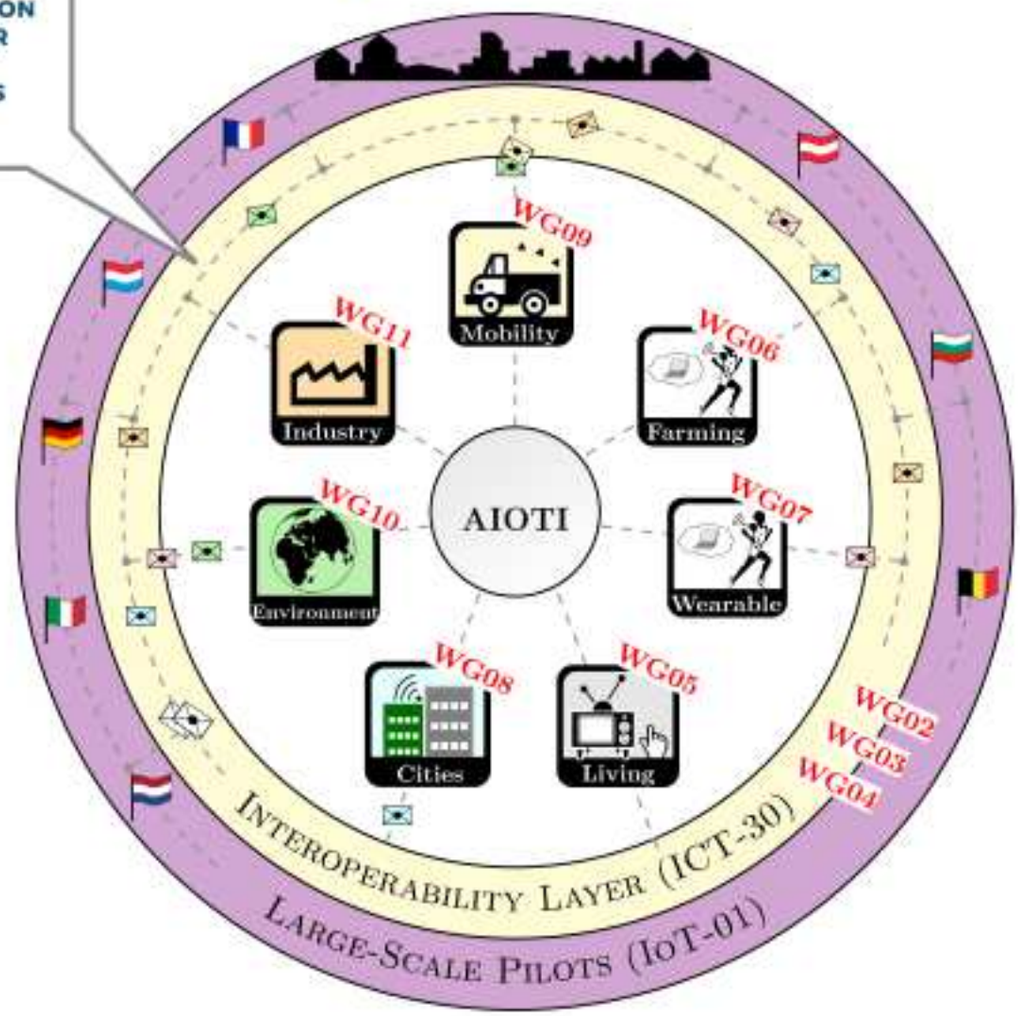


WG01: IoT European Research Cluster (IERC)

WG02: Innovation Ecosystems

WG03: IoT Standardisation

WG04: Policy Issues

WG05: Smart Living Environments for Ageing Well

WG06: Smart Framing & Food Security

WG07: Wearables

WG08: Smart Cities

WG09: Smart Mobility

WG10: Smart Environment

WG11: Smart Manufacturing

Project Coordinator

Aalto University (Finland)

Prof. Kary FRÄMLING
School of Science and Technology
☎ +358 505 980 451
✉ kary.framling@aalto.fi

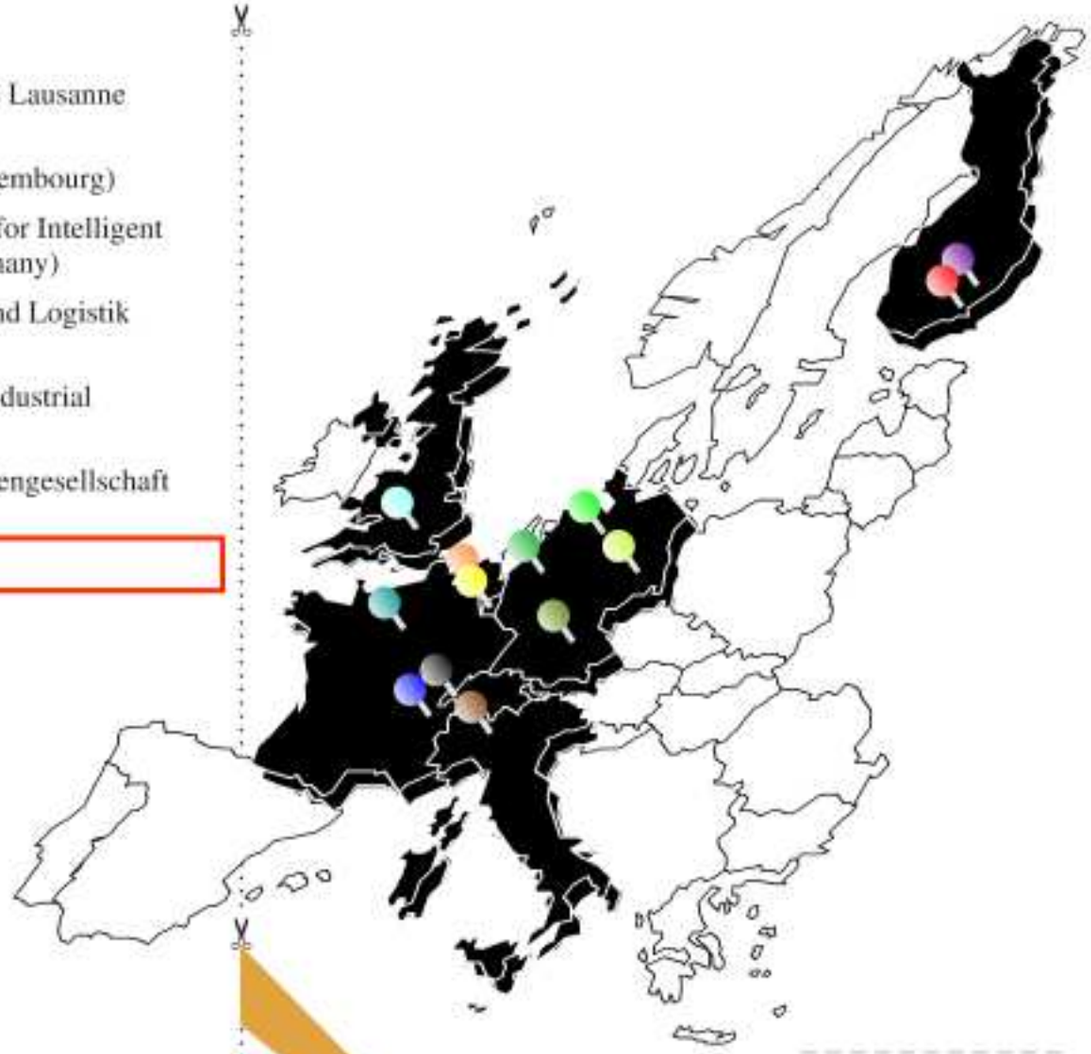
Project Consortium

- **EPFL:** École Polytechnique Fédérale de Lausanne (Switzerland)
- **Uni.lu:** University of Luxembourg (Luxembourg)
- **Fraunhofer IAIS:** Fraunhofer Institute for Intelligent Analysis and Information Systems (Germany)
- **BIBA:** Bremer Institut für Produktion und Logistik GmbH (Germany)
- **CSIRO:** Commonwealth Scientific & Industrial Research Organisation (Australia)
- **BMW:** Bayerische Motoren Werke Aktiengesellschaft (Germany)
- **The Open Group** (United Kingdom)
- **eccenca GmbH** (Germany)
- **OpenDataSoft** (France)
- **Cityzen Data** (France)
- **Holonix** (Italy)
- **itrust consulting** (Luxembourg)
- **Enervent Oy** (Finland)
- **ControlThings** (Finland)
- **IS-Practice** (Belgium)
- **Forum Virium Helsinki** (Finland)
- **Grand Lyon La Métropole** (France)
- **IRISnet** (Belgium)
- **CIRB:** Centre Informatique pour la Région Bruxelloise (Belgium)
- **Brussels Mobility** (Belgium)

This project has received funding from the European Union's H2020 Programme for research, technological development and demonstration under grant agreement n° 688203.

Visit & Join us

- www.bIoTope-project.eu
- Twitter: @bIoTope_project

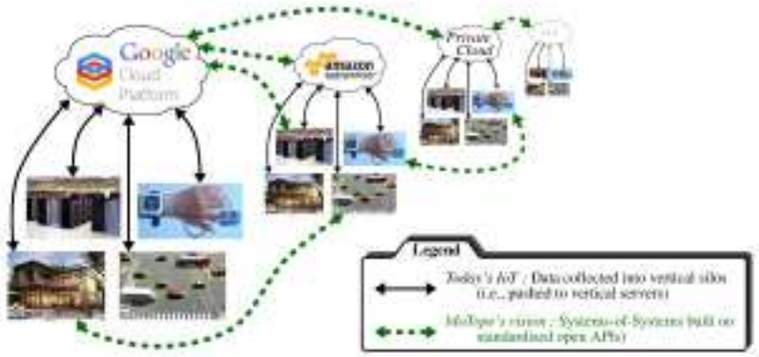


Building an IoT Open Innovation Ecosystem for Connected Smart Objects

bIoTope

Scope & Objectives

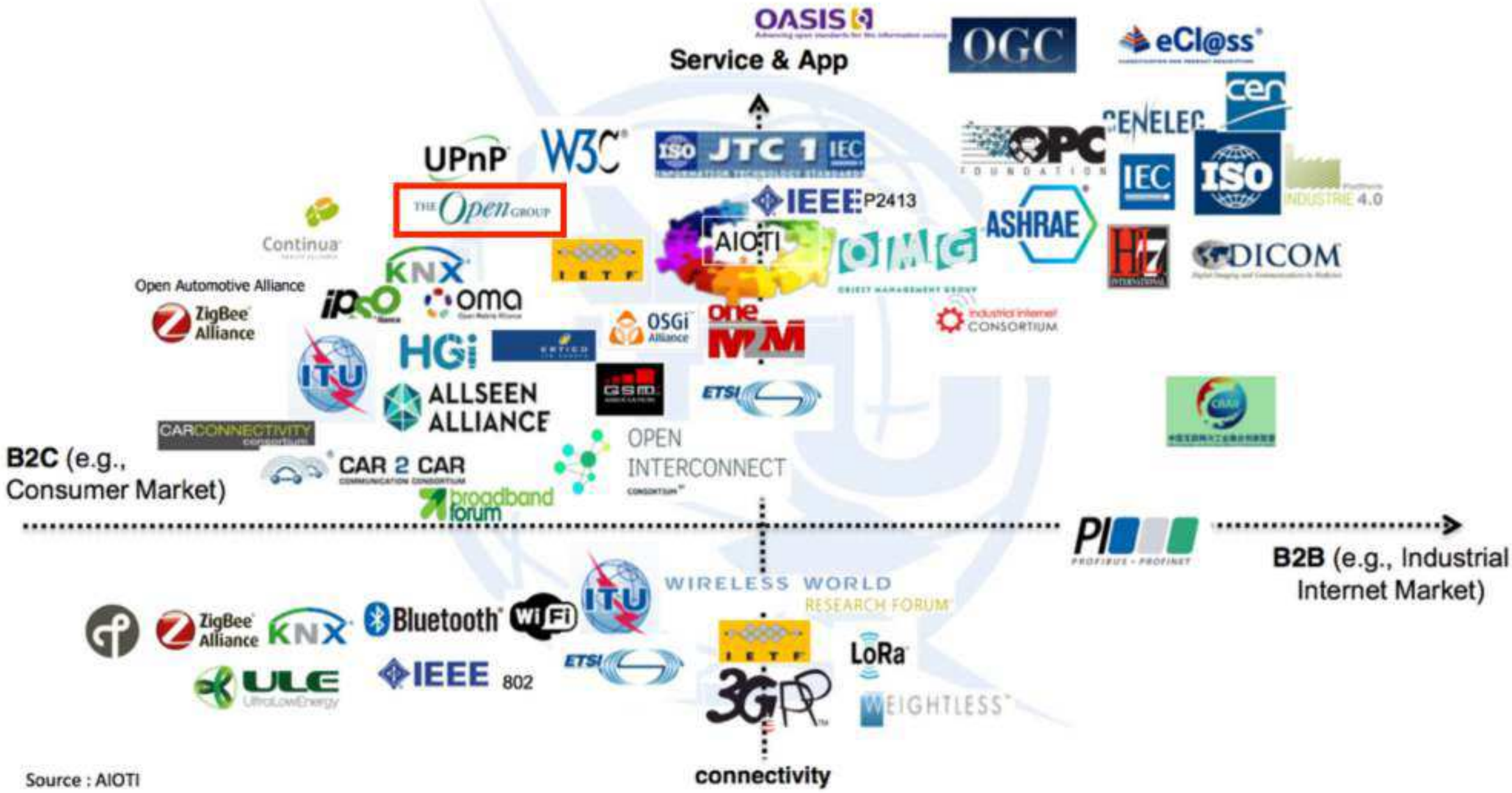
The Internet of Things (IoT) brings opportunities to create new services and products, reducing costs for societies, and changing how services are sold and consumed. A critical obstacle to further IoT innovation is the "vertical silos" that shape today's IoT landscape. These silos impede the creation of cross-industry, cross-platform and cross-organisational services due to their lack of interoperability and openness.



bIoTope lays the foundation for creating open innovation ecosystems by providing a platform that enables companies to easily create new IoT systems and to rapidly harness available information using advanced Systems-of-Systems (SoS) capabilities for Connected Smart Objects – *with minimal investment*.

IoT (Internet of Things) — The road ahead

Standardization initiatives



Source : AIOTI

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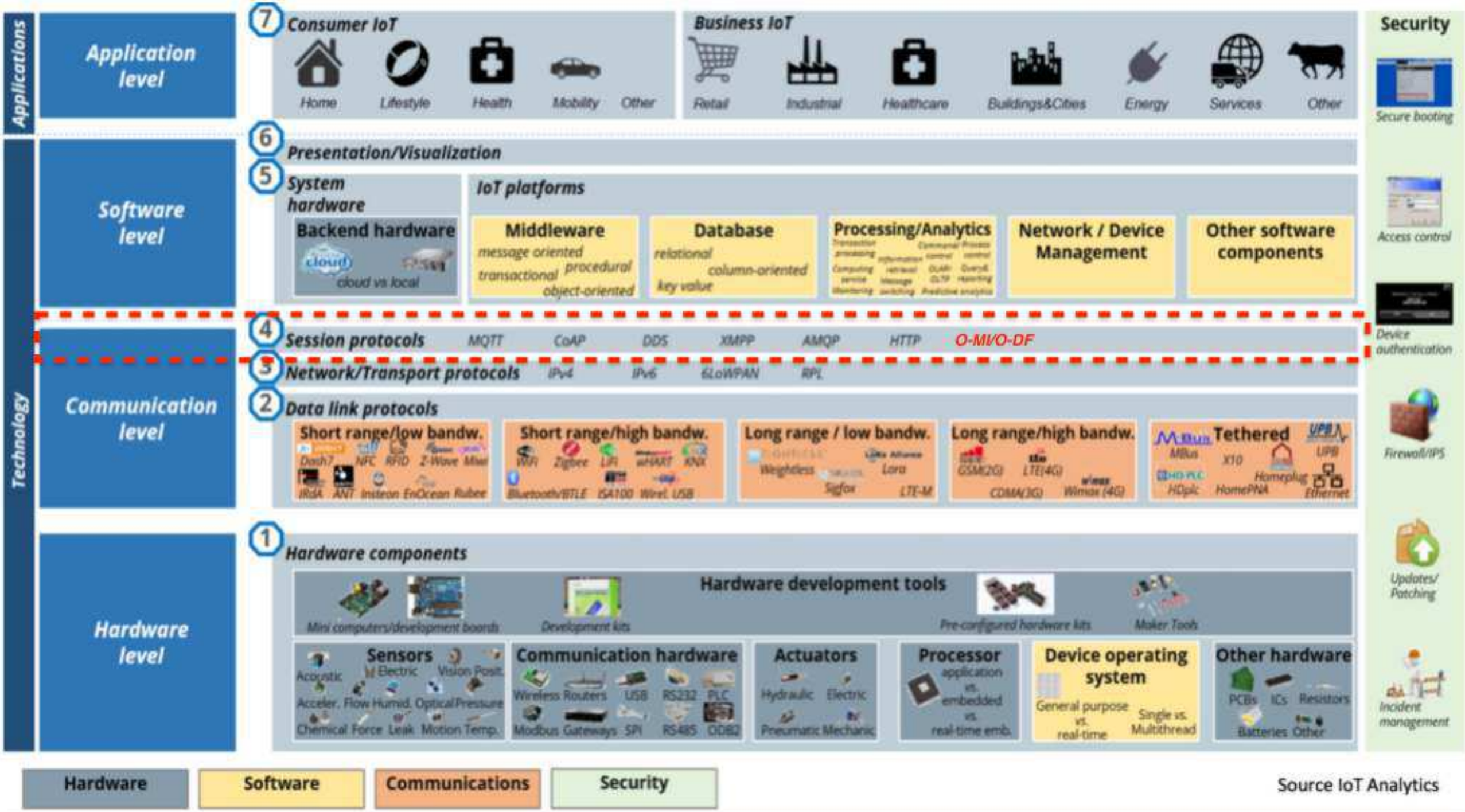
O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications



Hardware | Software | Communications | Security

Source IoT Analytics

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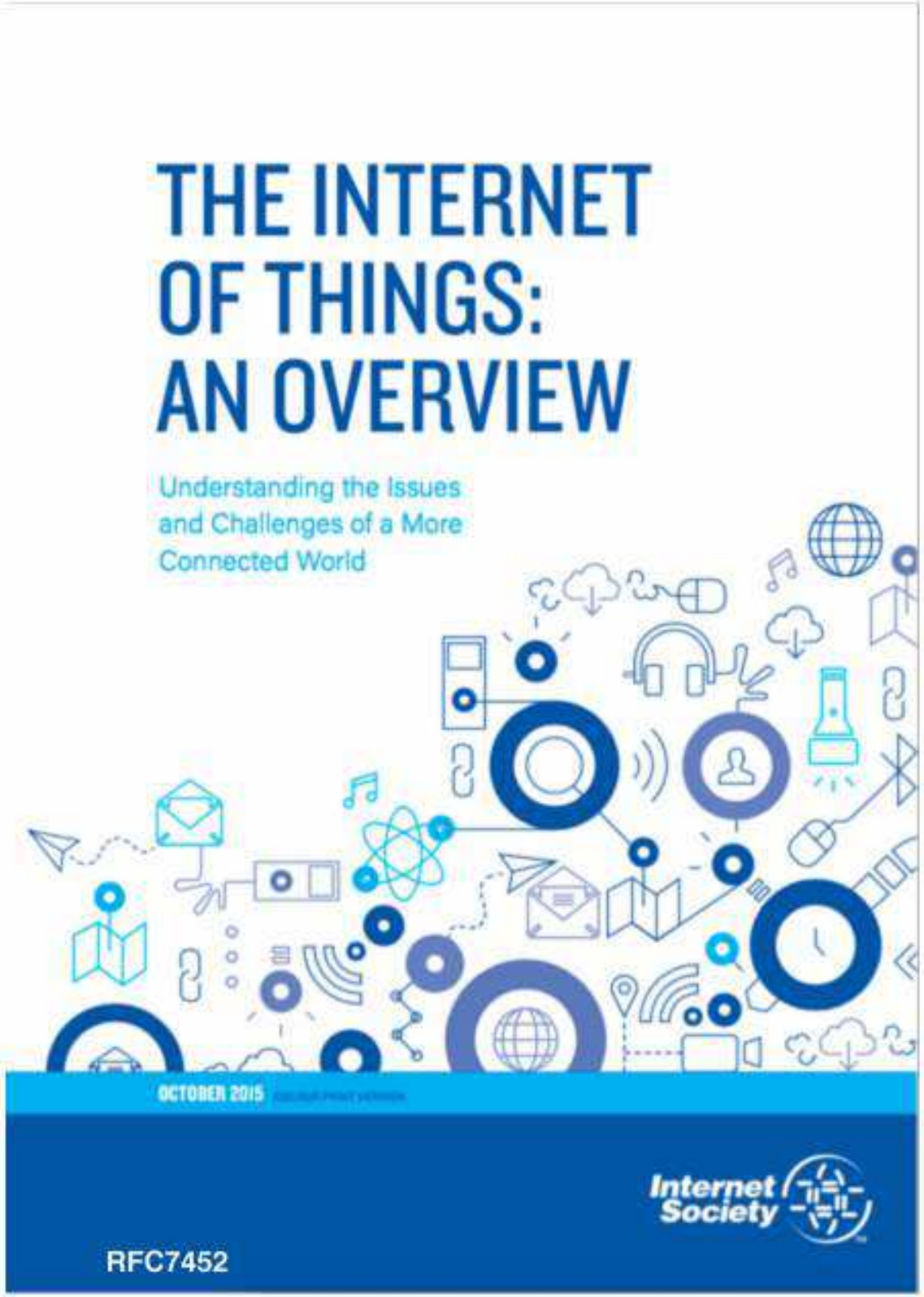

Four common **IoT communication models**:

- Device-to-Device (D2D)
- Device-to-Gateway (D2G)
- Device-to-Cloud (D2C)
- Backend Data Sharing Model (S2S + Analytics)

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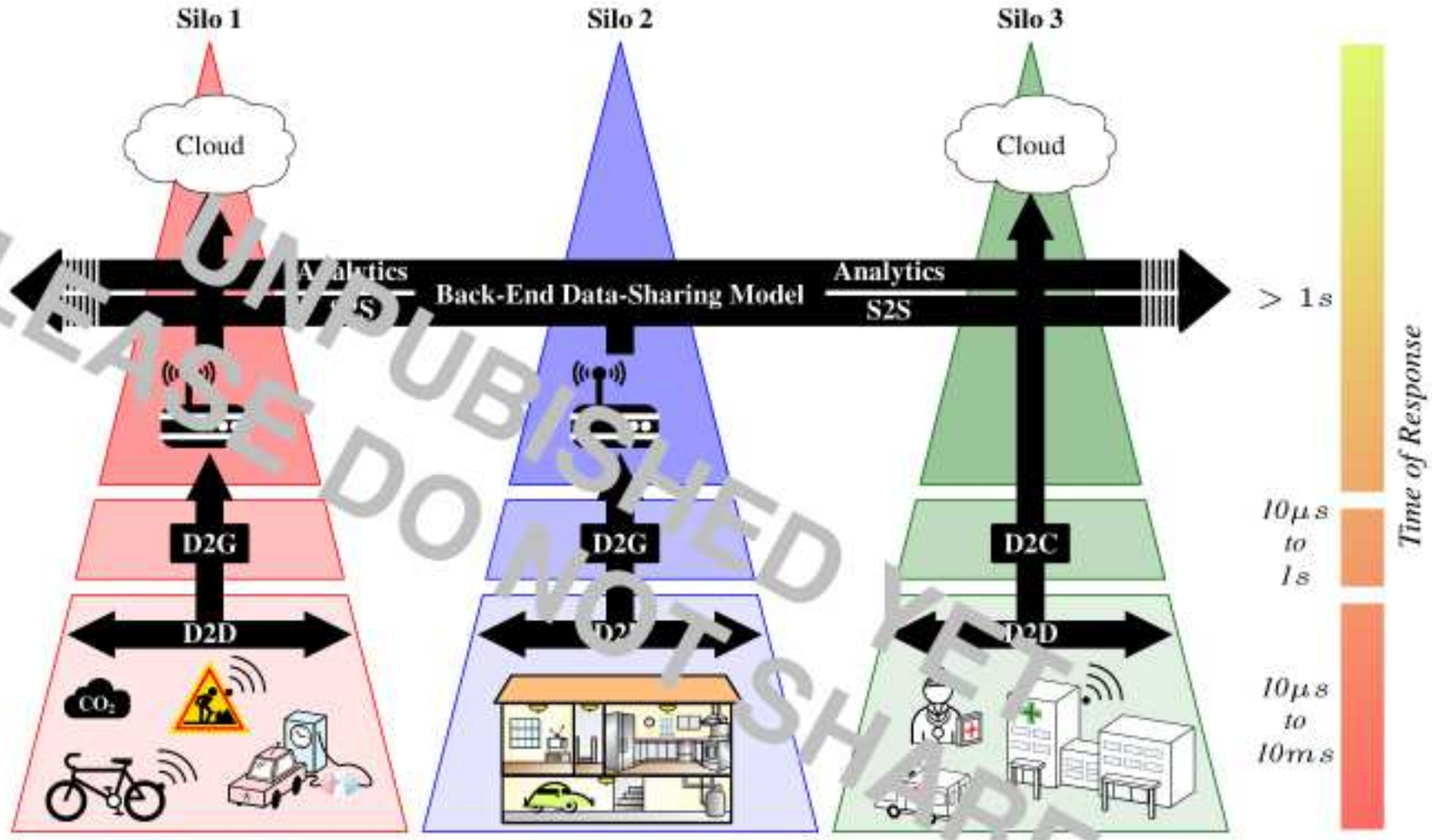


	D2D	D2G	D2C	S2S
DDS	x	x	x	x
MQTT	x	x	x	
AMQP		x	x	x
JMS				x
CoAP	x	x		
XMPP				x
O-MI	(*)	(*)	(*)	x (**)

(*) There is no "implementation" of the O-MI standards for resource-constrained devices at this date

(**) Initially designed for Systems in lifecycle management applications

O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications

"Table 2 - Summary of Key Comparison Criteria" has been complemented with **O-MI standard**.

O-MI & O-DF Messaging Standards

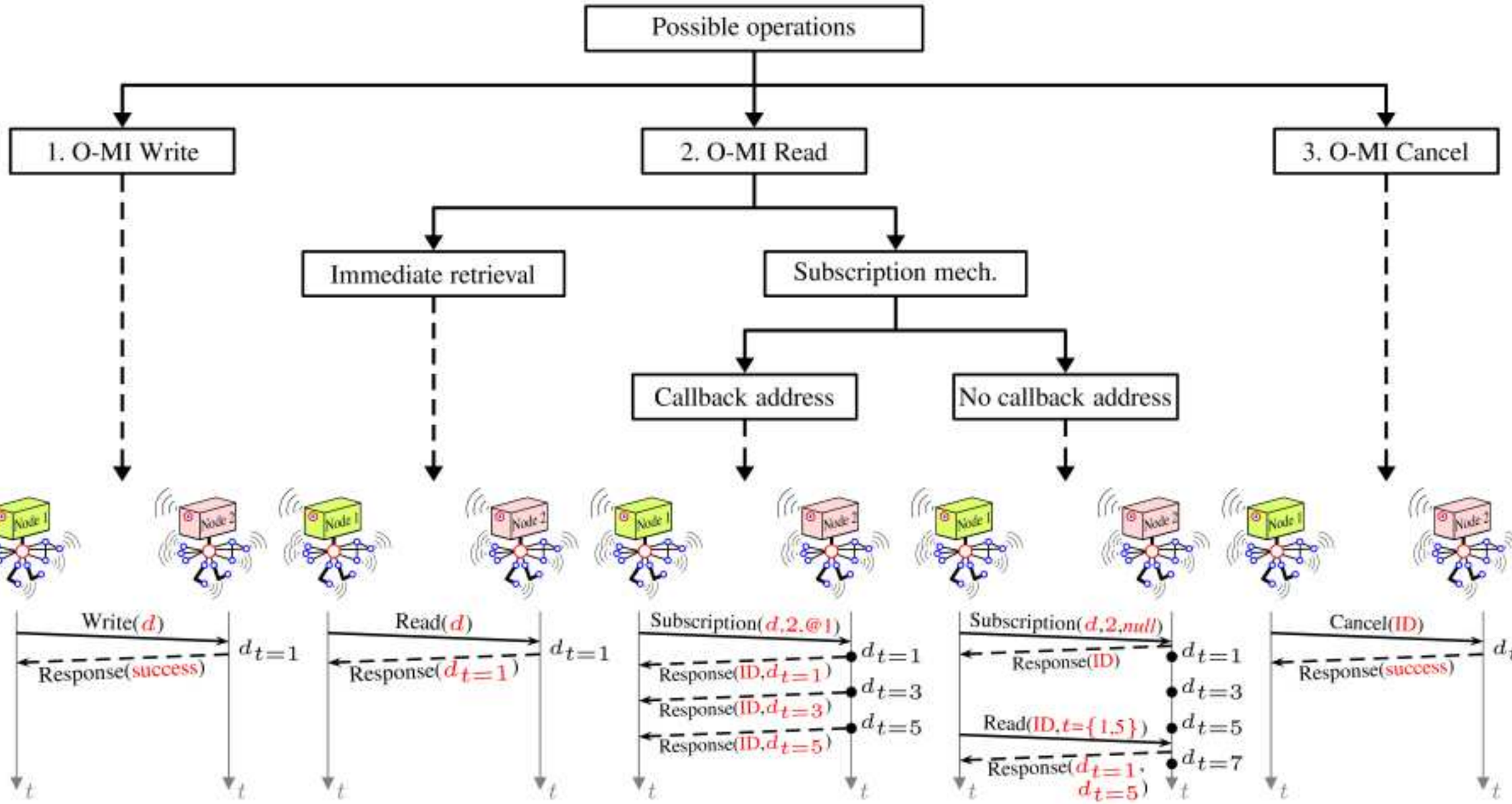
A High-level Introduction of the standard specifications

	DDS	MQTT	AMQP	JMS	REST/HTTP	CoAP	XMPP	O-MI
Abstraction	Pub/Sub	Pub/Sub	P2P or Pub/Sub	Pub/Sub	Request/Reply	Request/Reply	P2P or Pub/Sub	P2P or Pub/Sub
Implementation style	Global Data Space	Brokered	Brokered	Brokered	Client/Server	P2P	Brokered (XMPP Server)	Client/Server
QoS	22	3	3	3	Provided by transport e.g. TCP	Confirmable or nonconfirmable messages	None	Provided by transport e.g. TCP
Interoperability	Yes	Partial	Yes	No	Yes	Yes	Yes	Yes
Performance	10s of 1000s of messages per second. Massive fan-out performance	Typically 100s to 1000+ messages per second per broker	Typically 100s to 1000+ messages per second per broker	Typically 100s to 1000+ messages per second per broker	Typically 100s of requests per second	Typically 100s of requests per second	Typically 100s of messages per second	Depending on the (reference) implentation
Transports	UDP by default but other transports such as TCP can be used	TCP	TCP	Not specified but typically TCP	TCP	UDP	TCP	TCP by default but other transports such as UDP can be used
Subscription Control	Partitions, Topics with message filtering	Topics with hierarchical matching	Exchanges, Queues and bindings in v0.9.1 standard, undefined in latest v1.0 standard	Topics and Queues with message filtering	N/A	Provides support for Multicast addressing	Nodes which are analogous to a Topic defined In draft spec XEP- 0060	4 types of subscriptions - With Callback/Event-based - Without Callback/Event-based - With Callback/Interval-based - Without Callback/Interval-based
Data Serialization	CDR	Undefined	AMQP type system or user defined	Undefined	No	Configurable	XML	Yes (e.g. when using O-DF)**
Standards	OMG's RTPS and DDSI standards	Proposed OASIS MQTT standard M	OASIS AMQP	JCP JMS standard	Is an architectural style rather than a standard	Proposed IETF CoAP standard	XMPP Standards Foundation	The Open Group
Encoding	Binary	Binary	Binary	Binary	Plain Text	Binary	Plain Text	Plain Text
Licensing Model	Open Source & Commercially Licensed	Open Source & Commercially Licensed	Open Source & Commercially Licensed	Open Source & Commercially Licensed	HTTP available for free on most platforms	Open Source & Commercially Licensed	Open Source & Commercially Licensed	Open Source
Dynamic Discovery	Yes	No	No	No	No	Yes	Yes	Yes
Mobile devices (Android, iOS)	Yes	Yes	Yes	Dependent on JAVA capabilities of the OS	Yes	Via HTTP proxy	Yes	Via HTTP proxy
6LoWPAN devices	Yes	Yes	Implementation specific	Implementation specific	Yes	Yes	No	Yes
Multi-phase Transactions	No	No	Yes	Yes	No	No	No	No
Security	Vendor specific but typically based on SSL or TLS with proprietary access control	Simple Username/ Passwor d Authentication, SSL for data encryption	SASL authentication, TLS for data encryption	Vendor specific but typically based on SSL or TLS. Commonly used with JAAS API	Typically based on SSL or TLS	DTLS	TLS and SASL	SSL, TLS

** data serialization scheme ensures that both parties understand the message payload.

O-MI & O-DF Messaging Standards

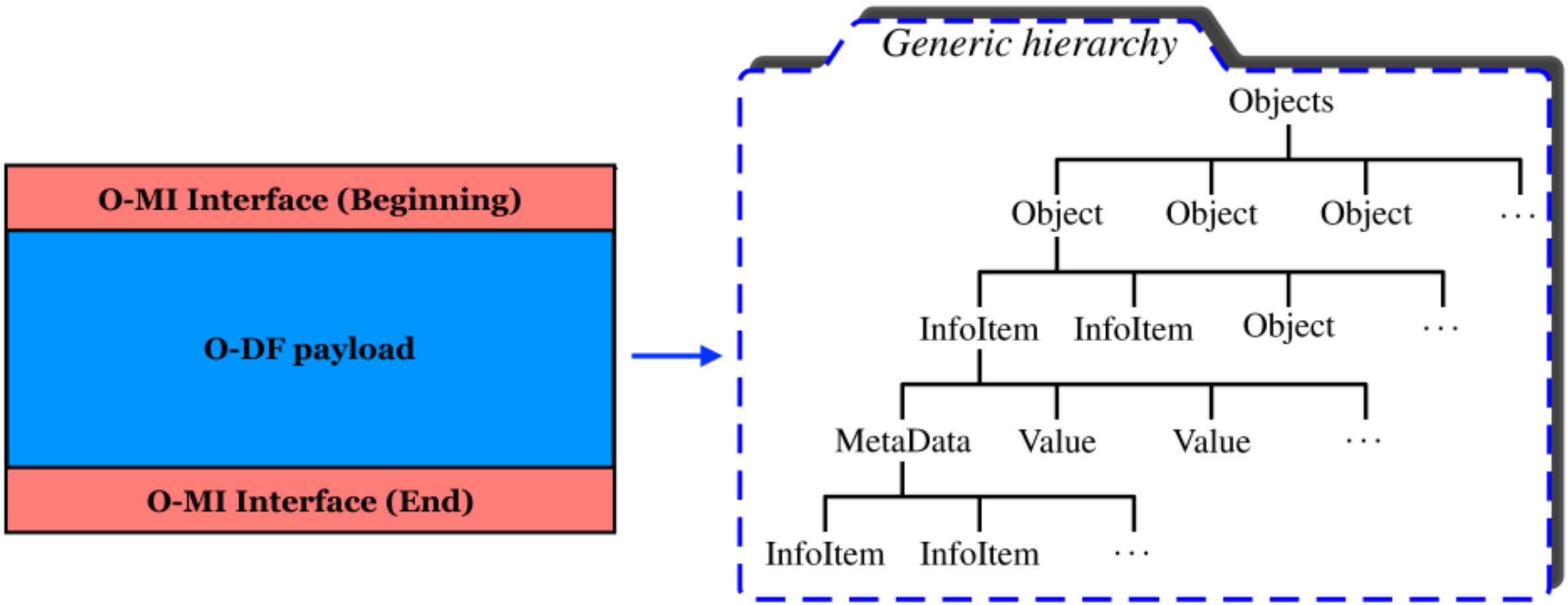
A High-level Introduction of the standard specifications



O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications

Generic enough for representing any object and information that is needed for information exchange in the IoT



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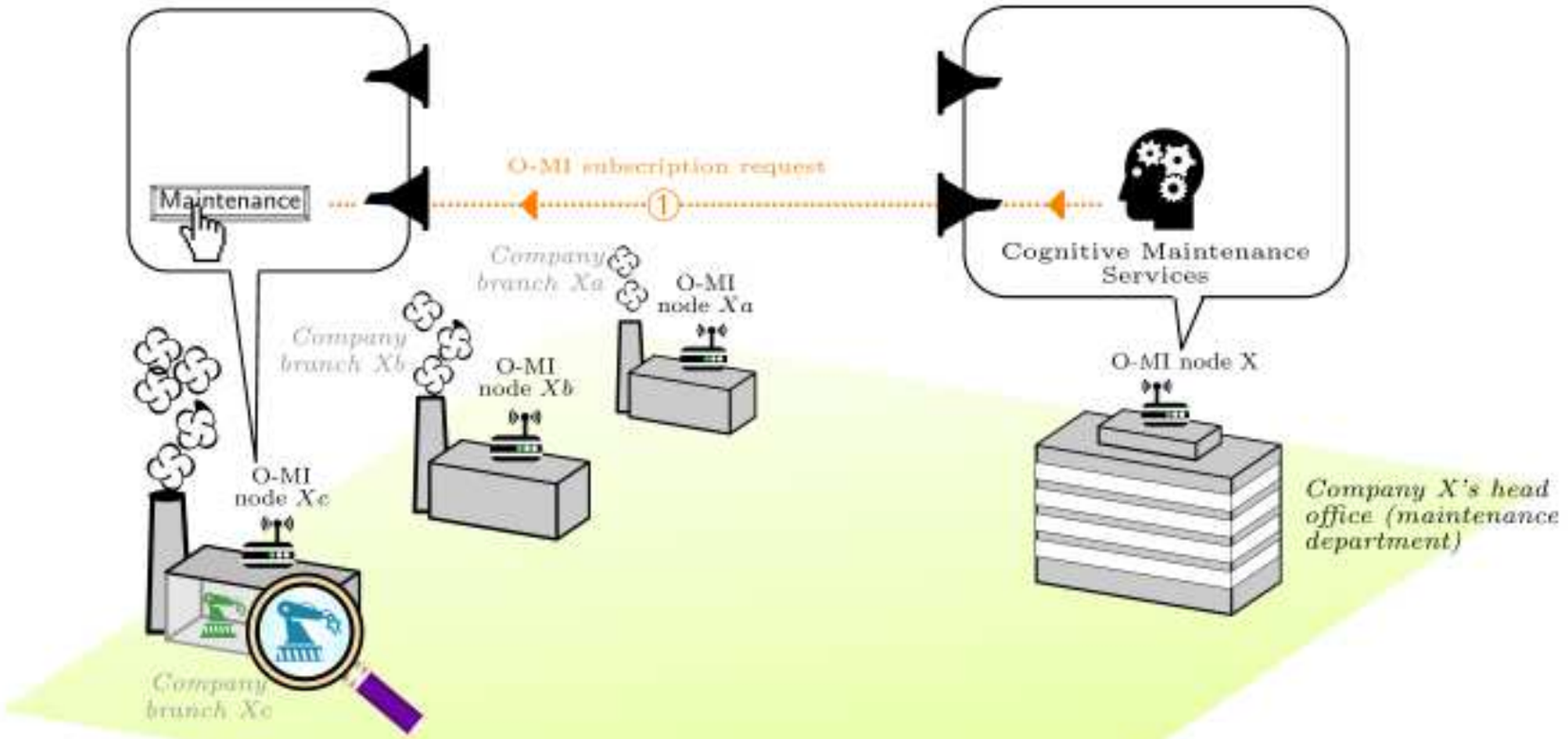


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11         </Object>
12       </Objects>
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14   </omi:read>
15 </omi:omiEnvelope>
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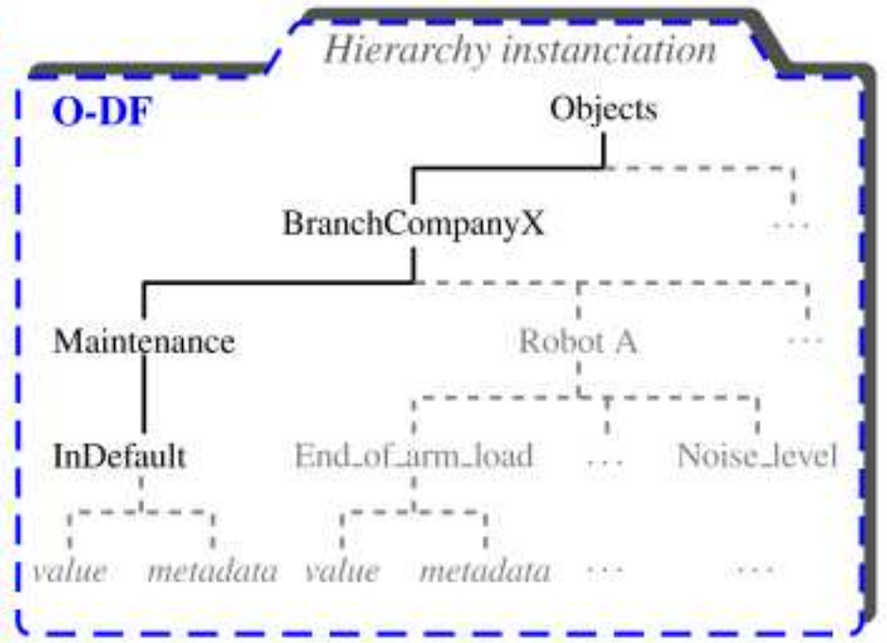
O-MI

O-MI



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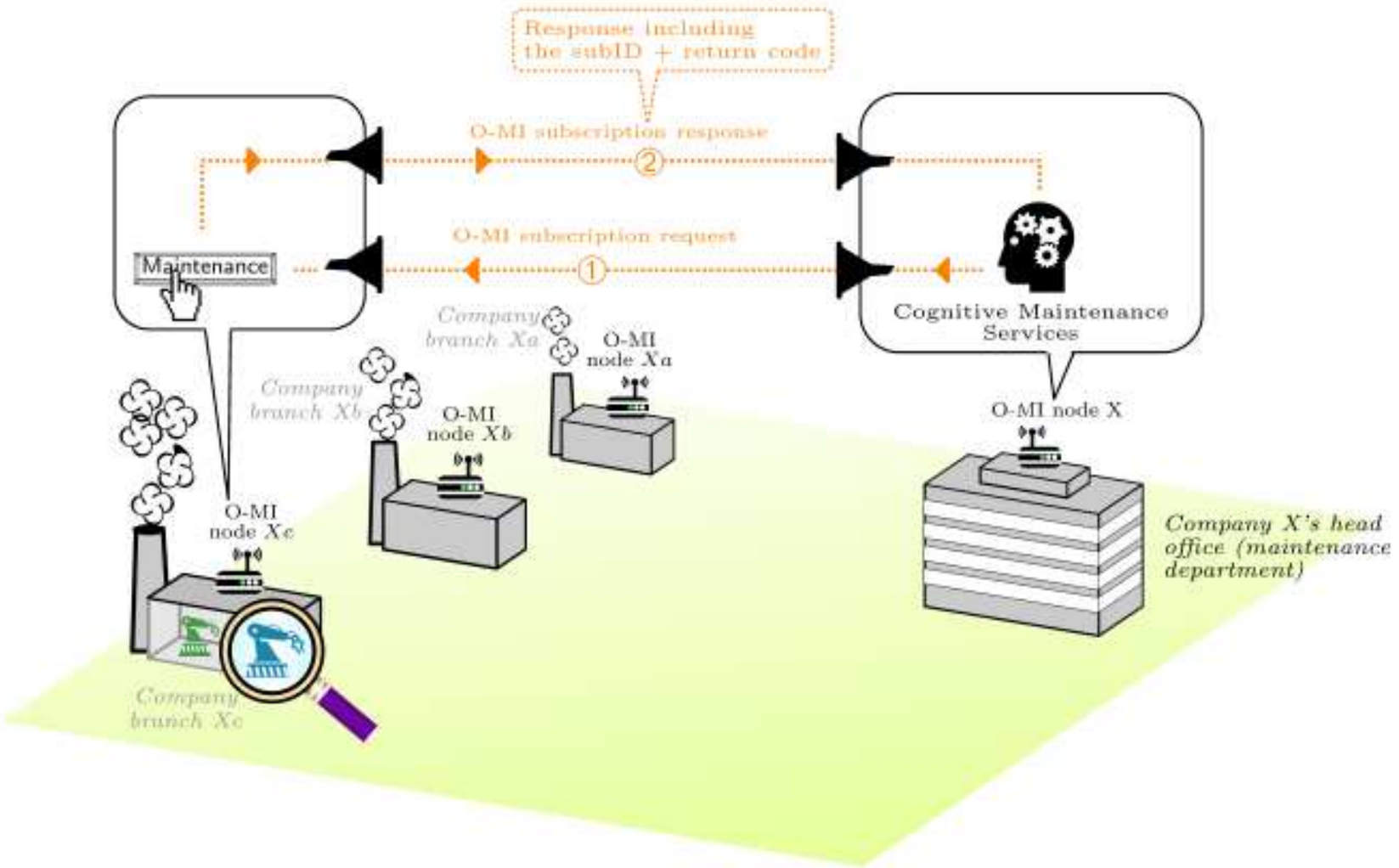


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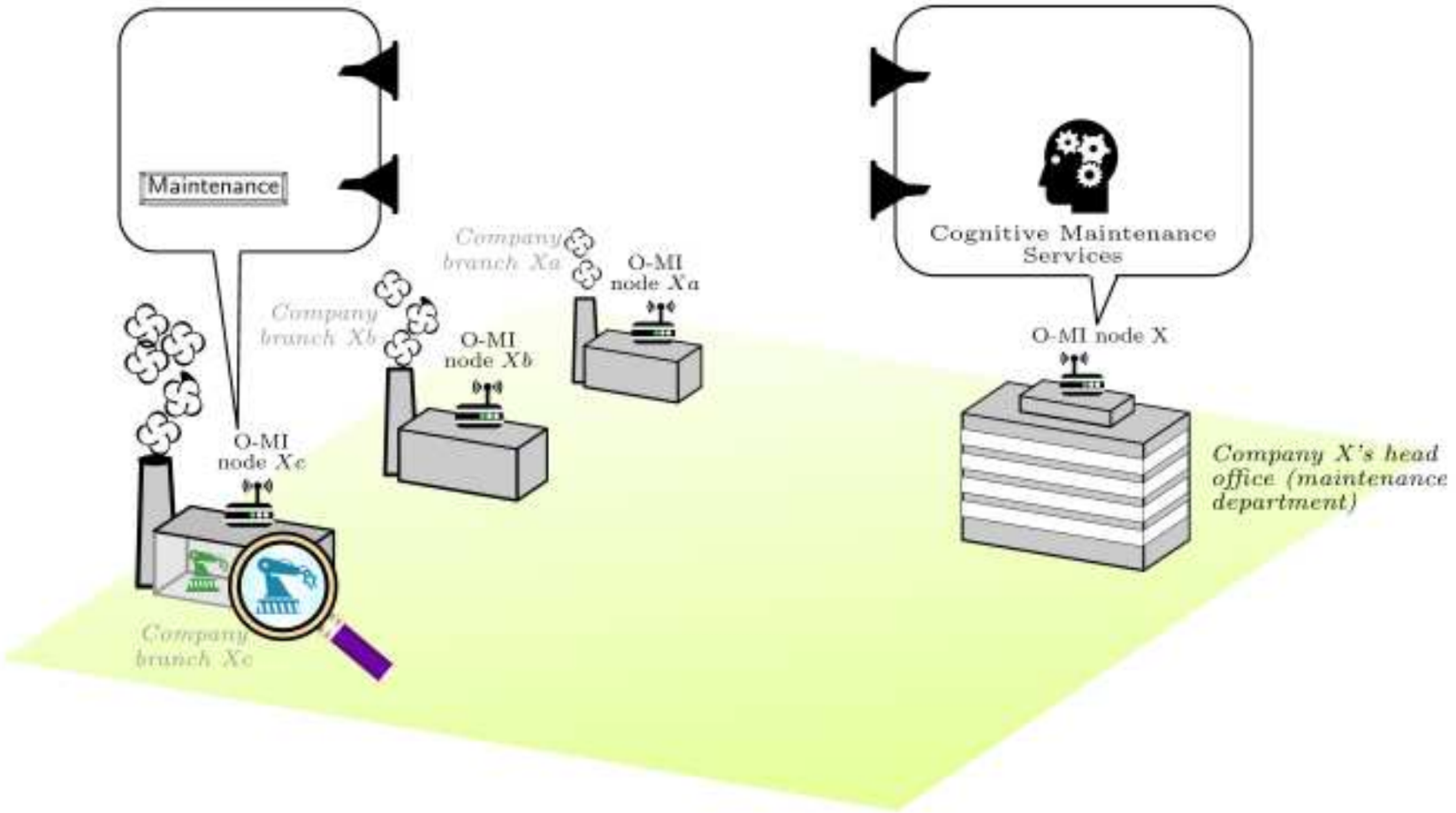

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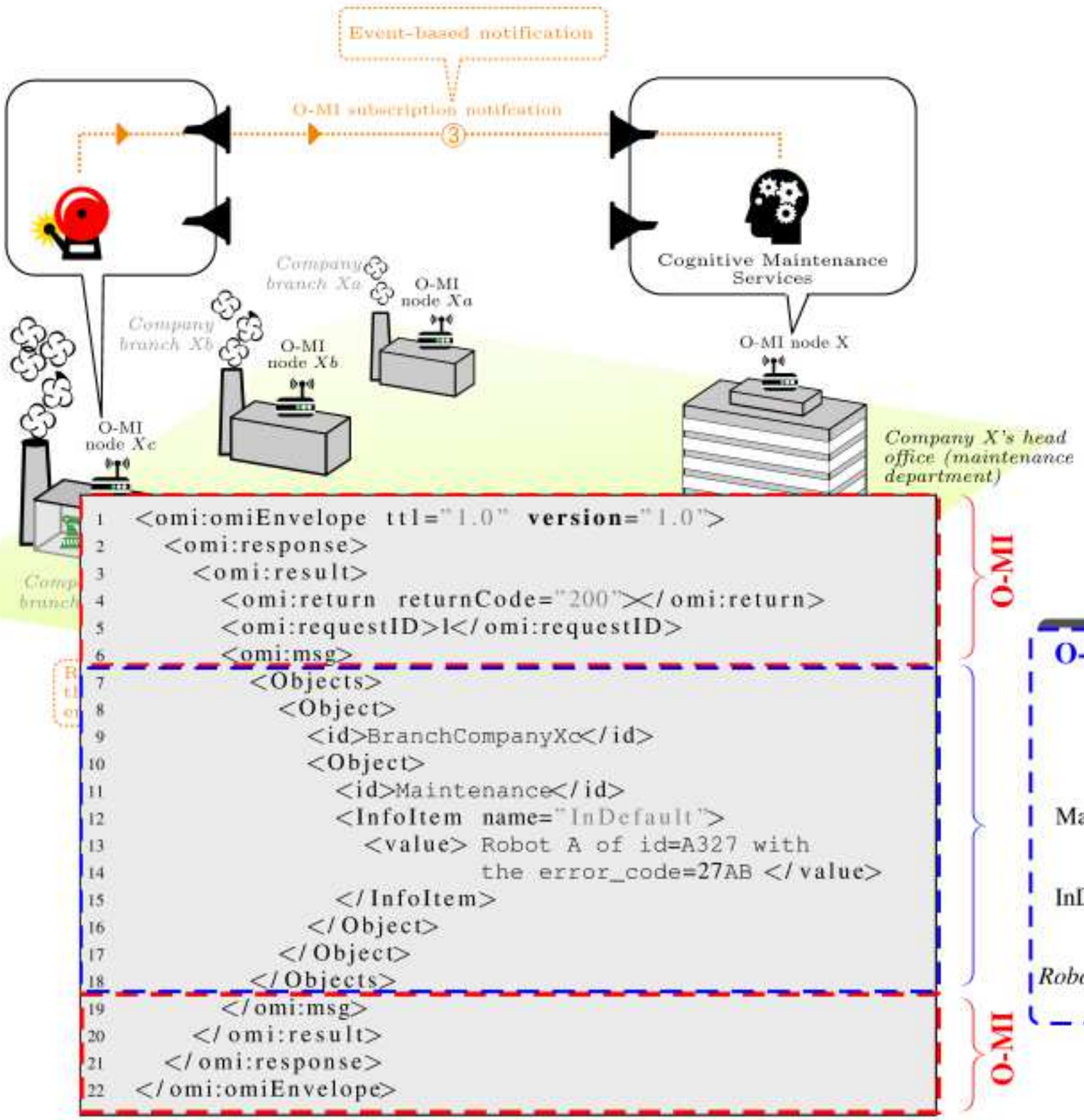


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18         </Objects>
19       </omi:msg>
20     </omi:result>
21   </omi:response>
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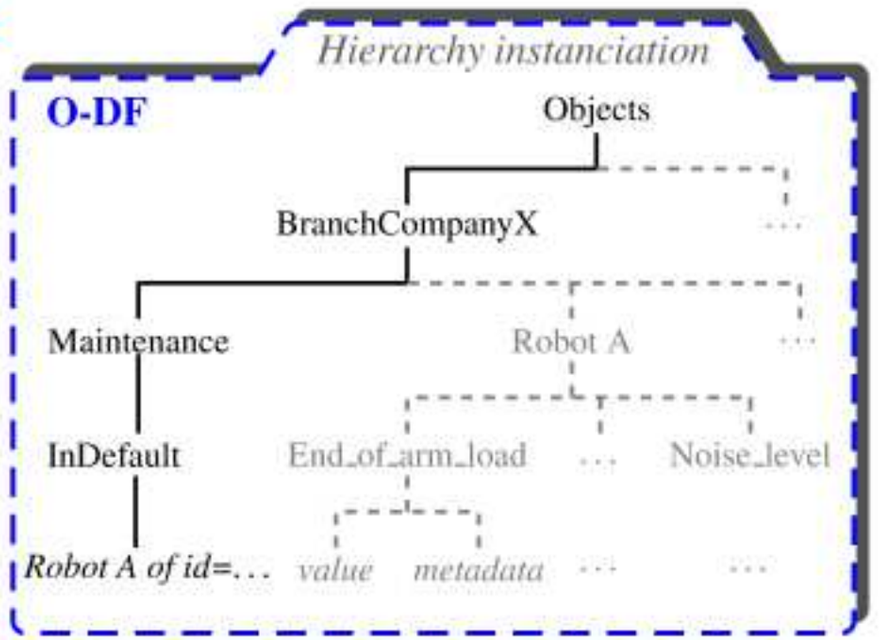
O-MI

O-MI



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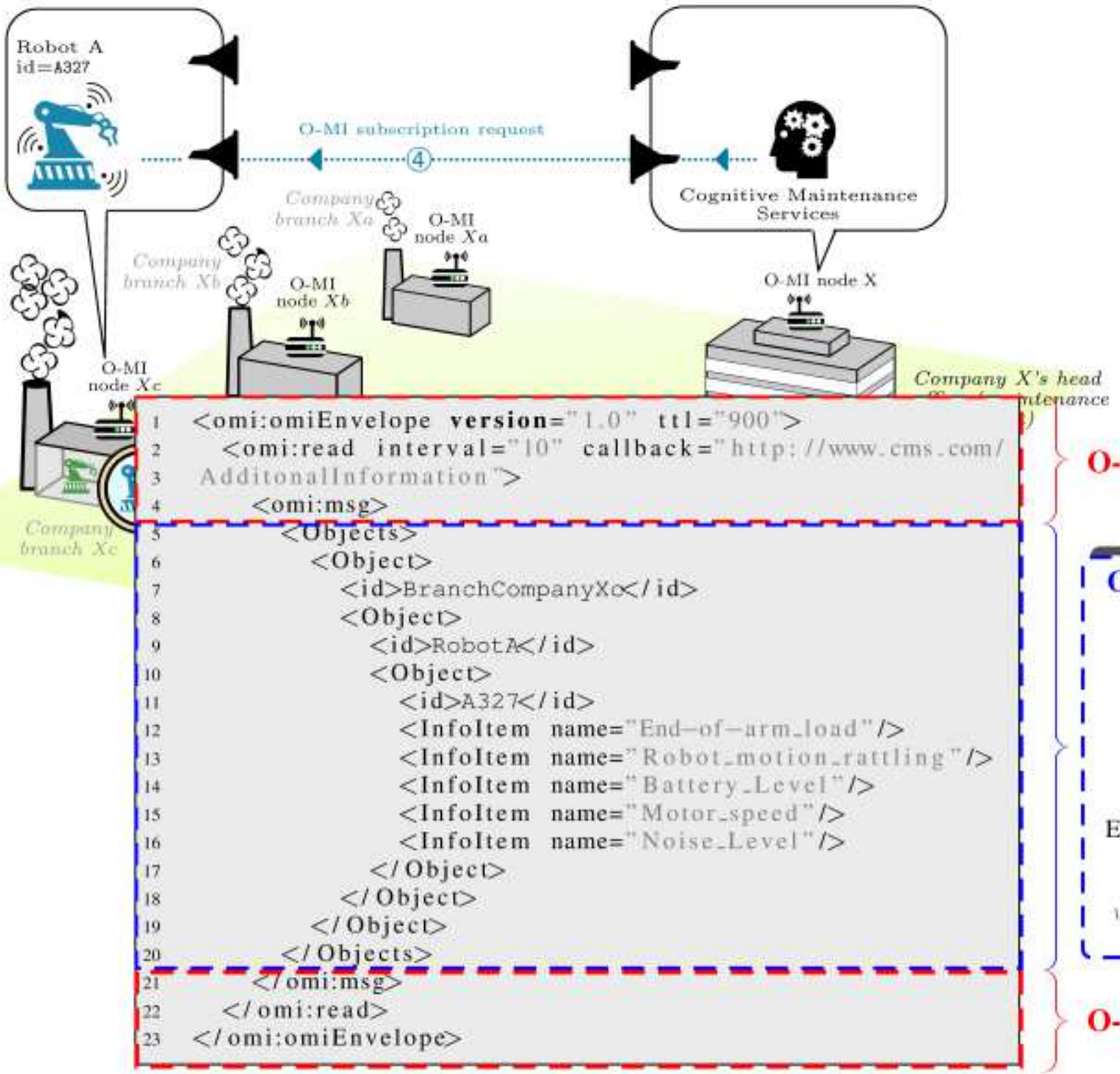


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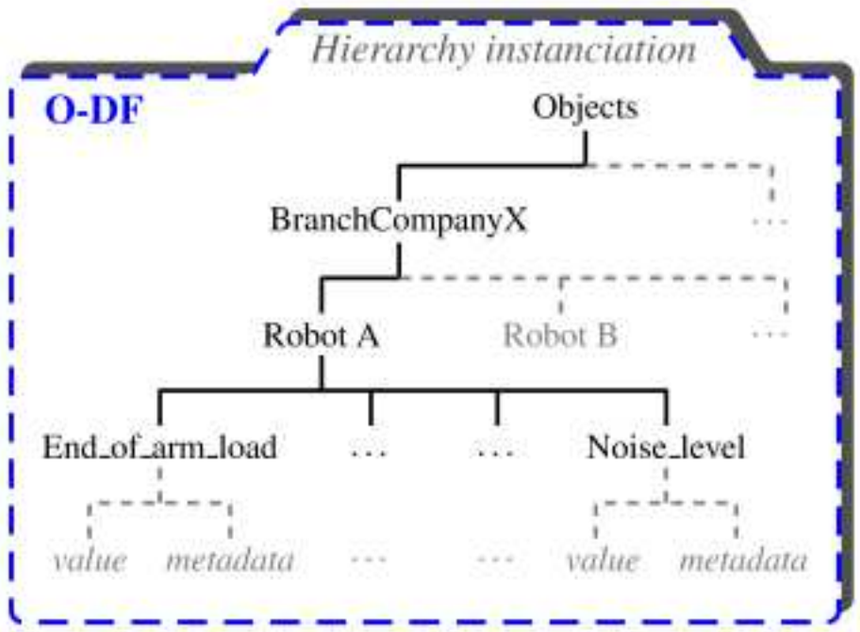
O-MI



O-MI

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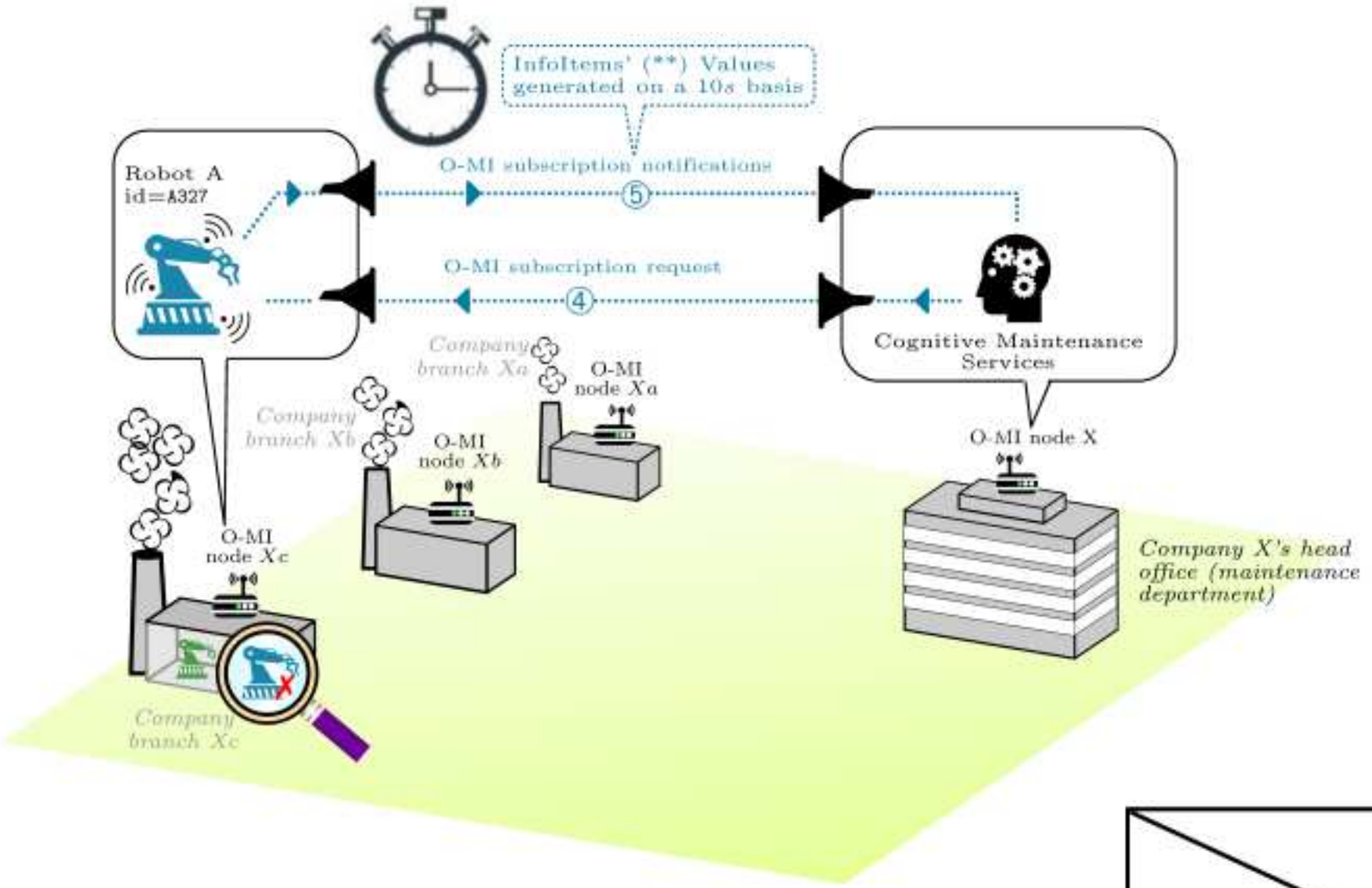
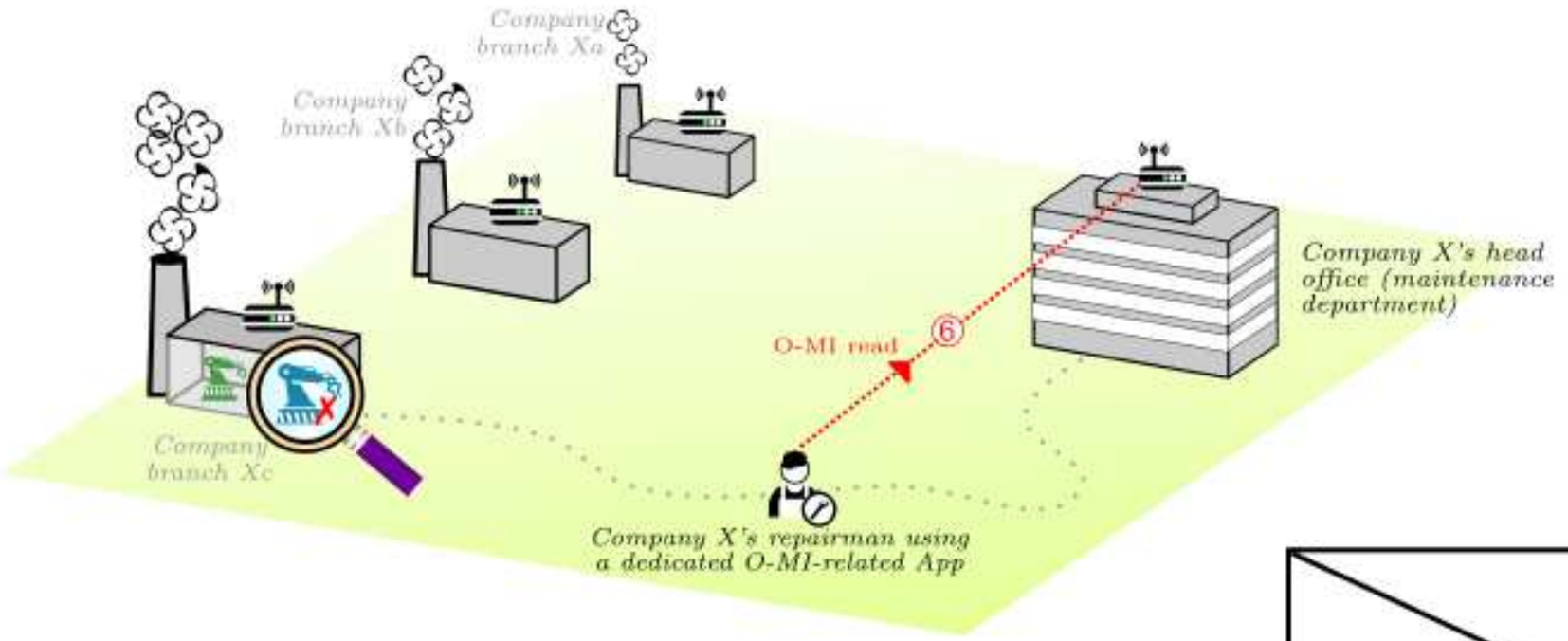


O-MI/O-DF notification responses

O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications

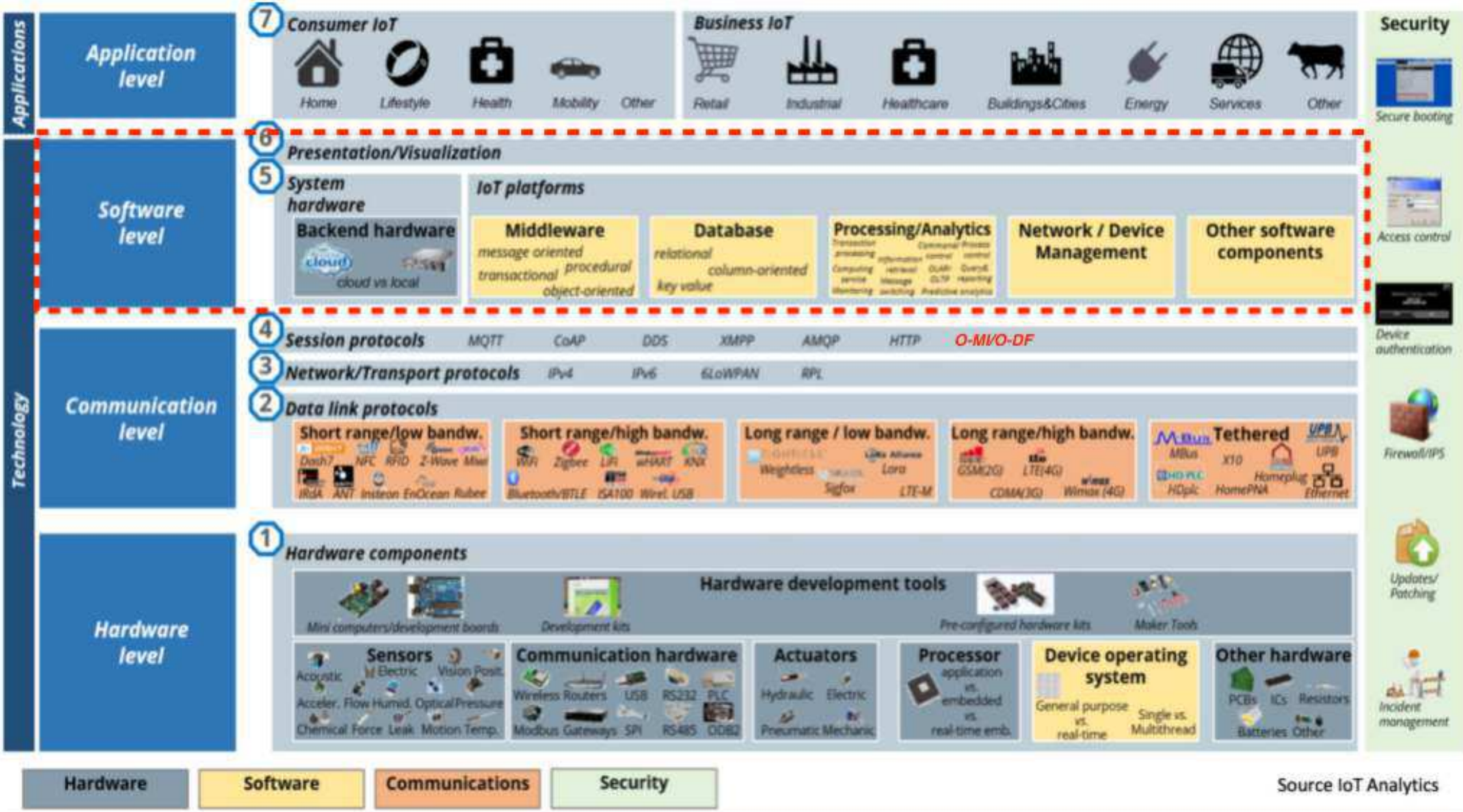


O-MI/O-DF Read request

...

O-MI & O-DF Messaging Standards

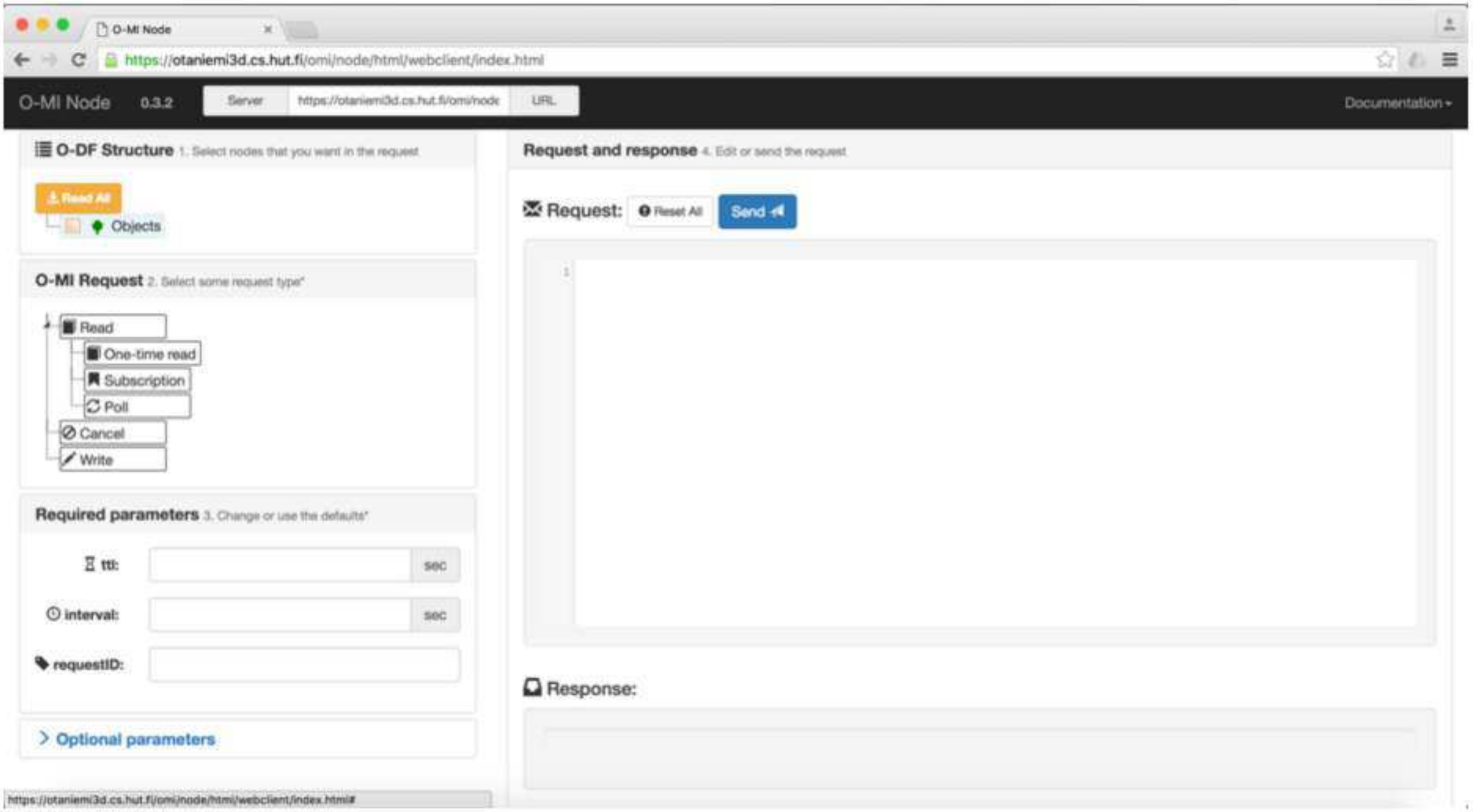
O-MI/O-DF based scenarios/proofs-of-concept



Source IoT Analytics

O-MI & O-DF Messaging Standards

First Standard Reference Implementation

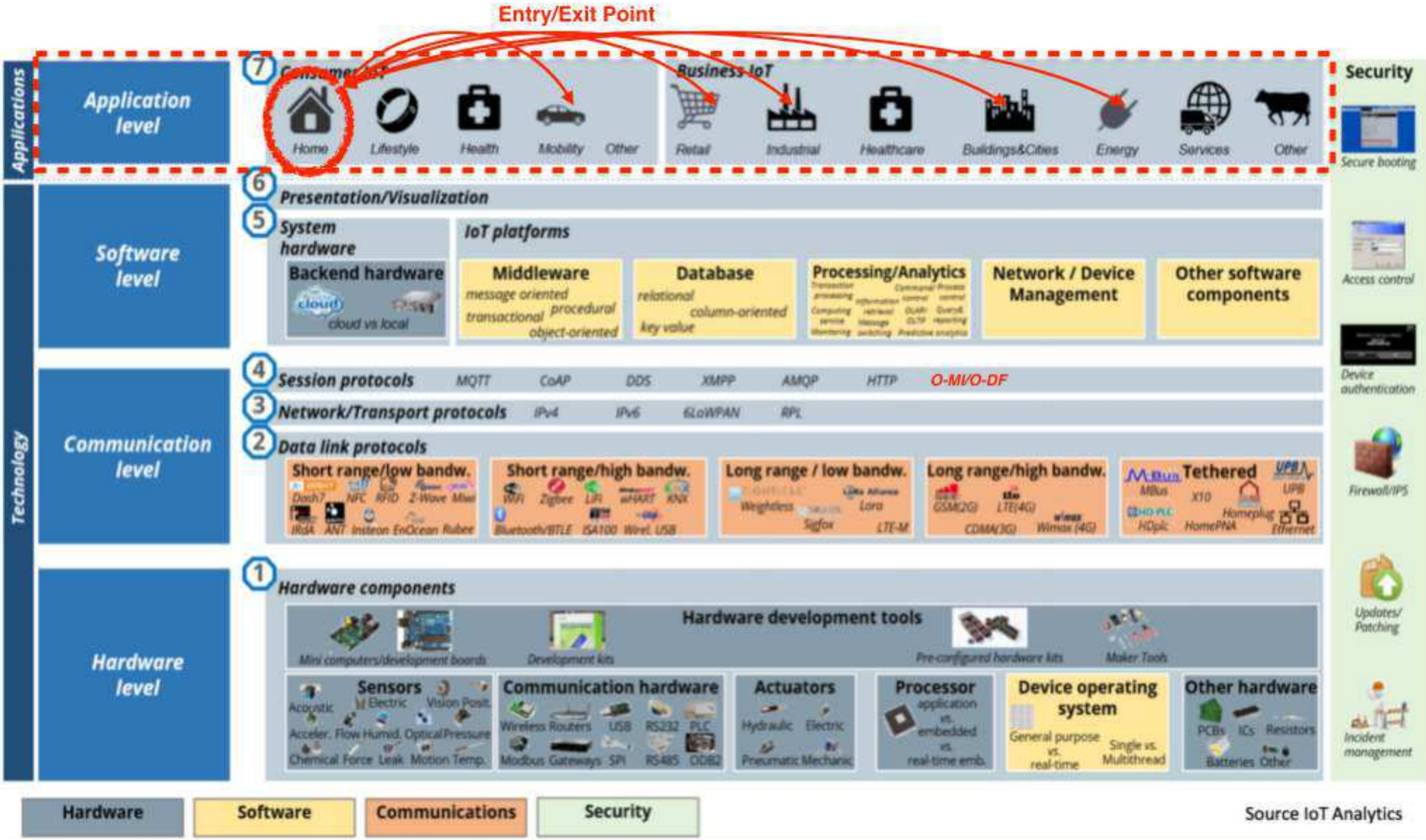


Reference Implementation (web-based UI): https://otaniemi3d.cs.hut.fi/omi/node/html/webclient/index.html
http://biotope.sntiotlab.lu:8080/html/webclient/index.html

Reference Implementation (source code): https://github.com/AaltoAsia/O-MI

O-MI & O-DF Messaging Standards

O-MI/O-DF based scenarios/proofs-of-concept



Source IoT Analytics

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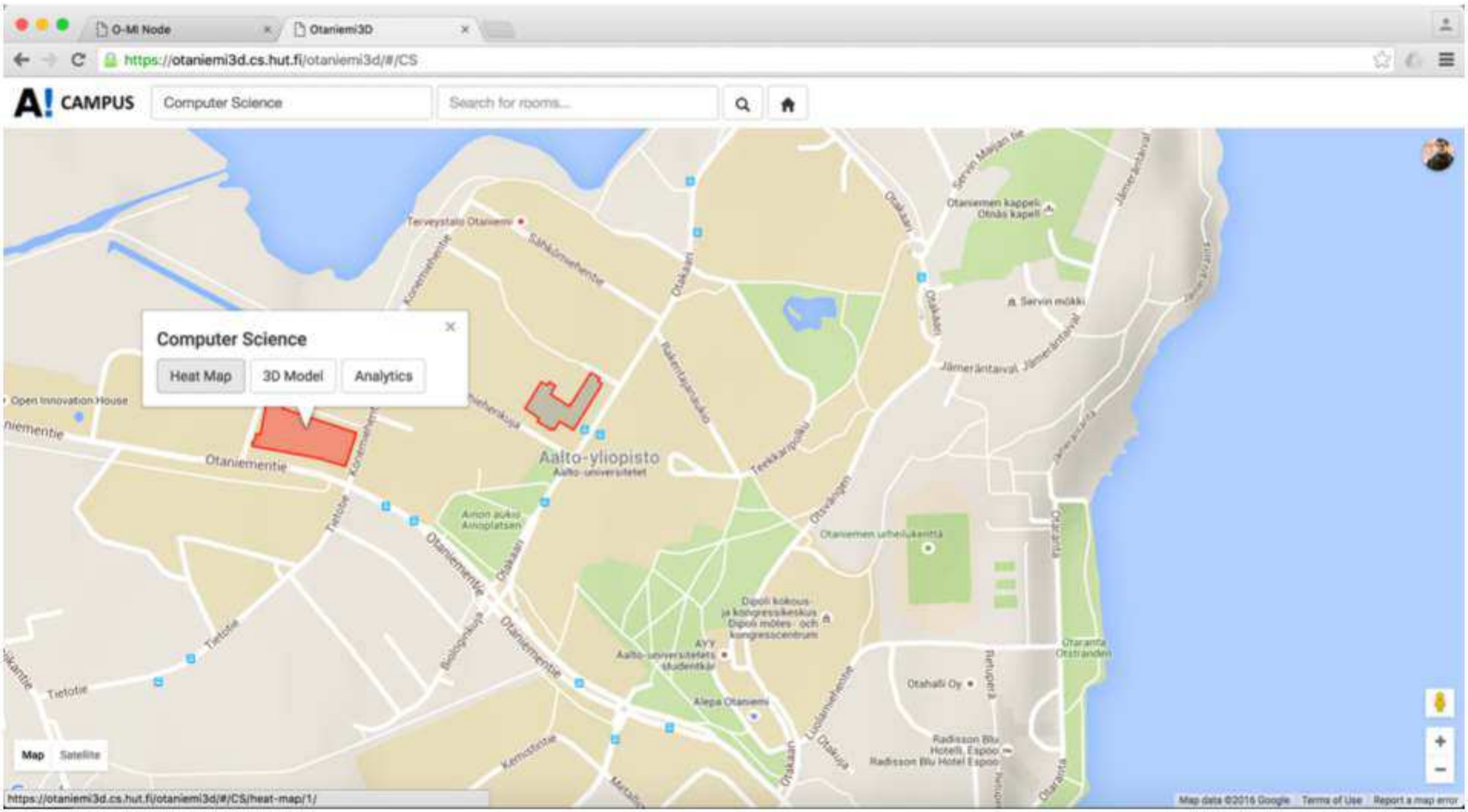
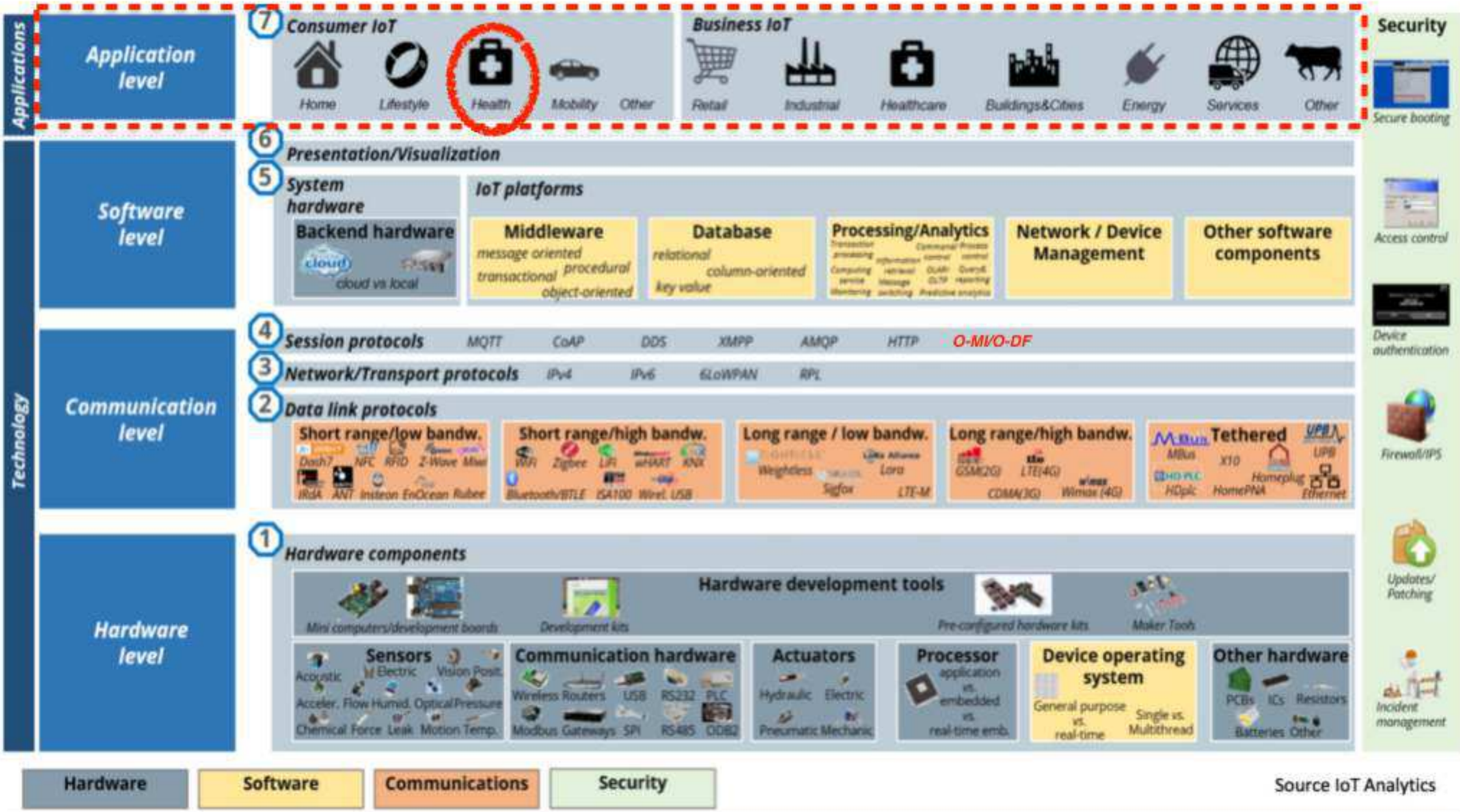


Smart Campus Application built on top of O-MI/O-DF: http://otaniemi3d.cs.hut.fi/otaniemi3d/#/
http://biotope.sntiotlab.lu:8080/html/snt3d/index.html#/

O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications



Hardware | Software | Communications | Security

Source IoT Analytics

O-MI & O-DF Messaging Standards

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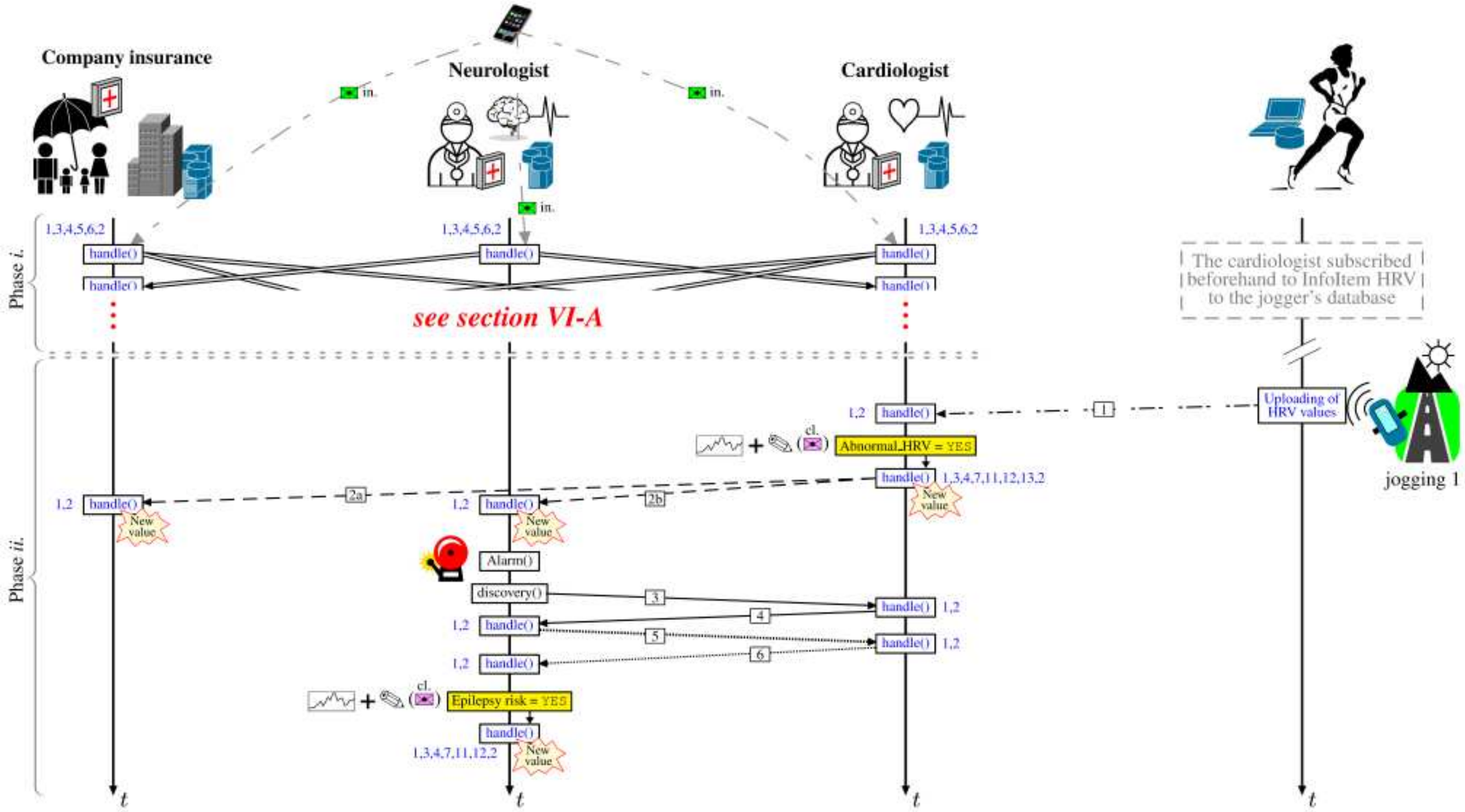

Kubler, S.; Främling, K.; Derigent, W. (2015) *P2P Data Synchronization for Product Lifecycle Management*", Computers in Industry, vol. 66, n°0, pp. 82-98.

O-MI & O-DF Messaging Standards

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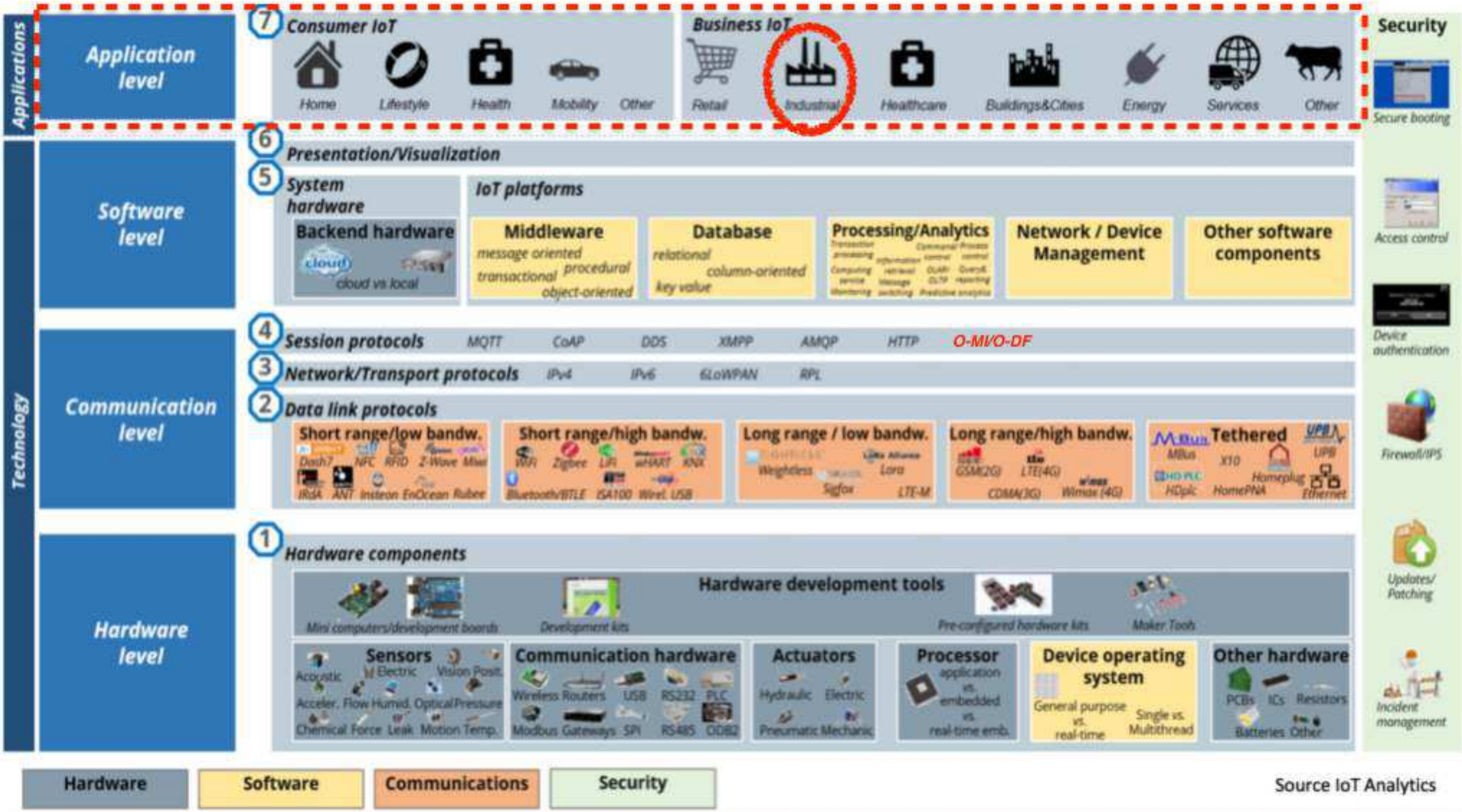

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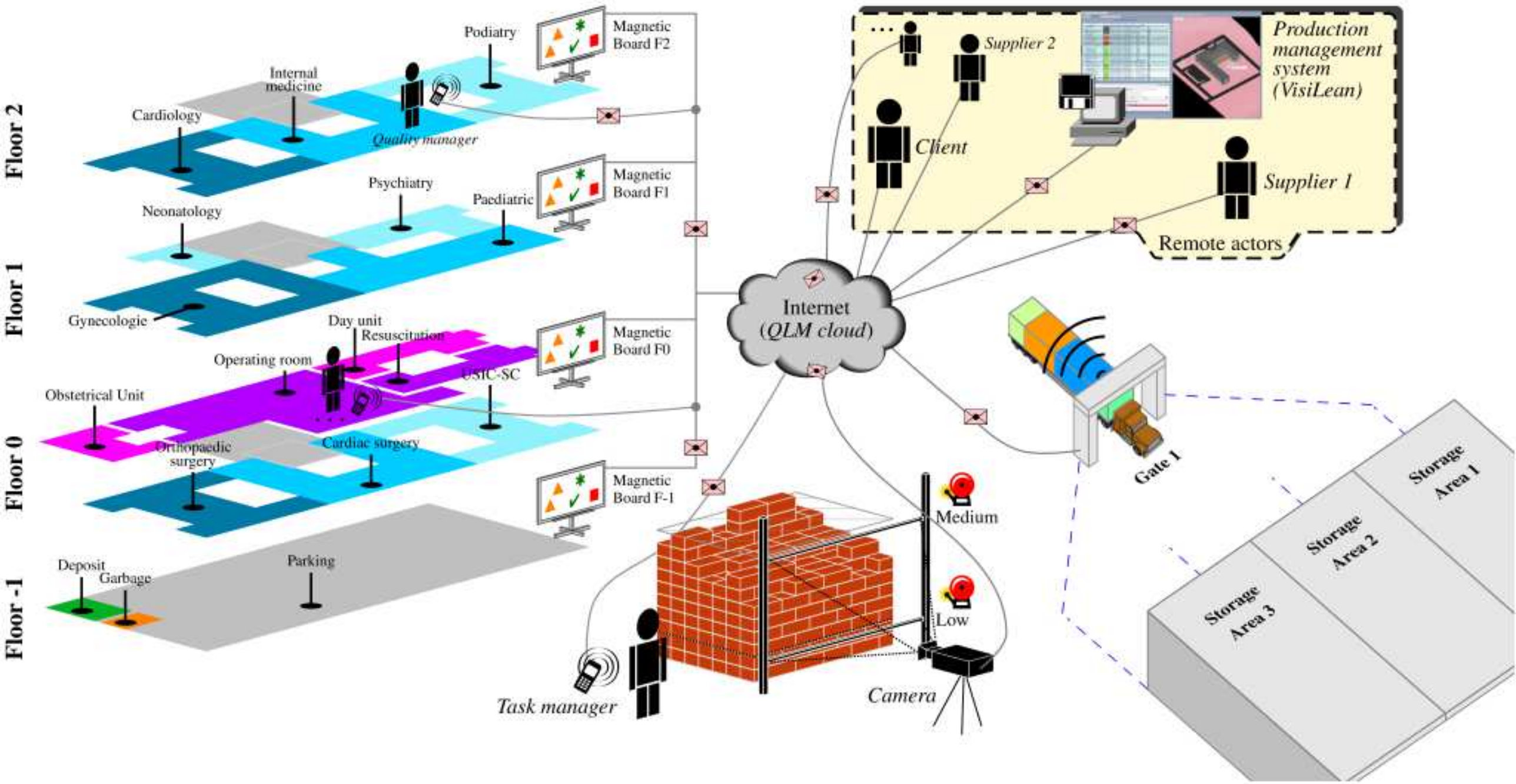

Dave, B., Kubler, S.; Främling, K.; Koskela, L. (2016) "*Opportunities for enhanced lean construction management using Internet of Things standards*", Automation in Construction, vol. 61, pp. 86-97.

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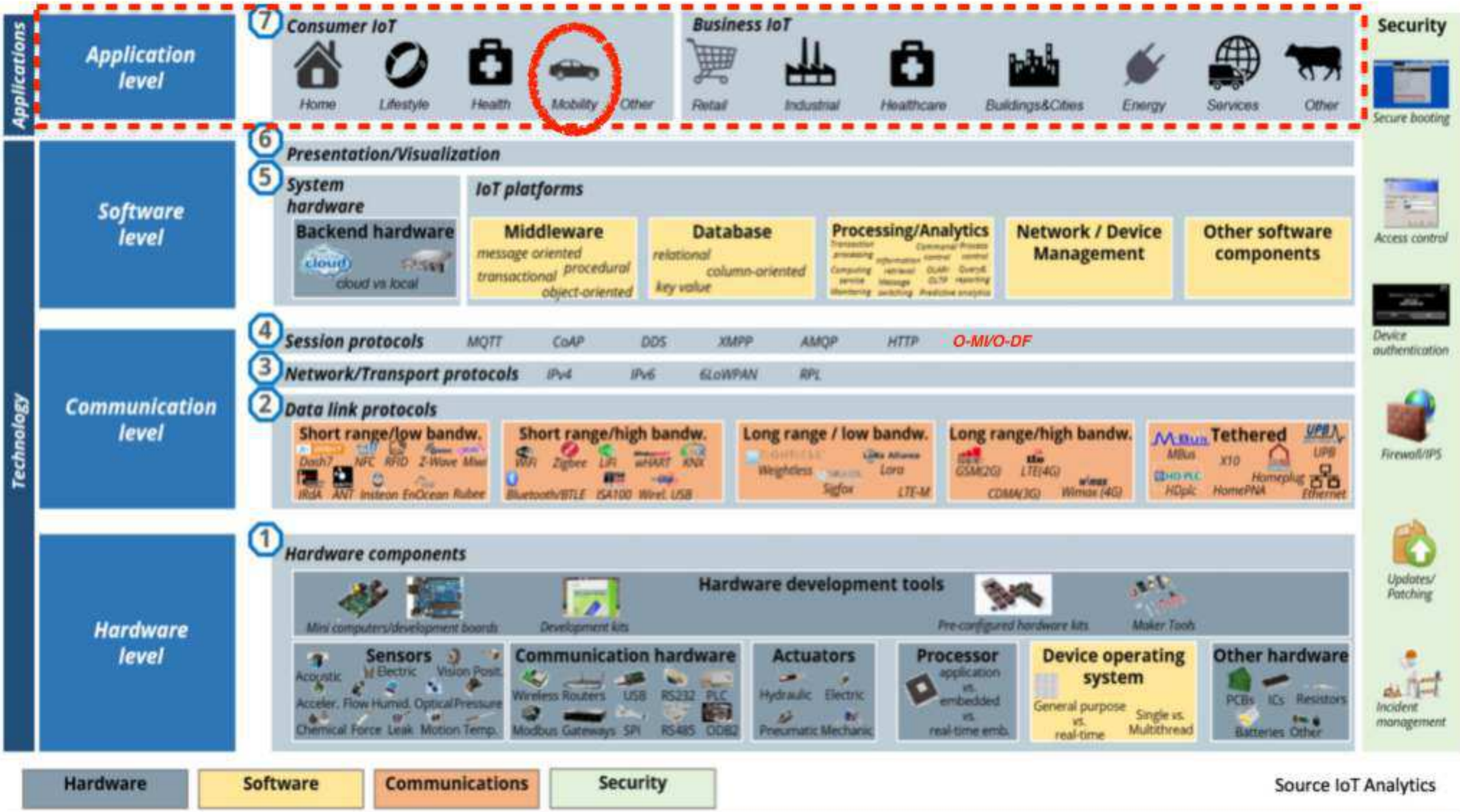
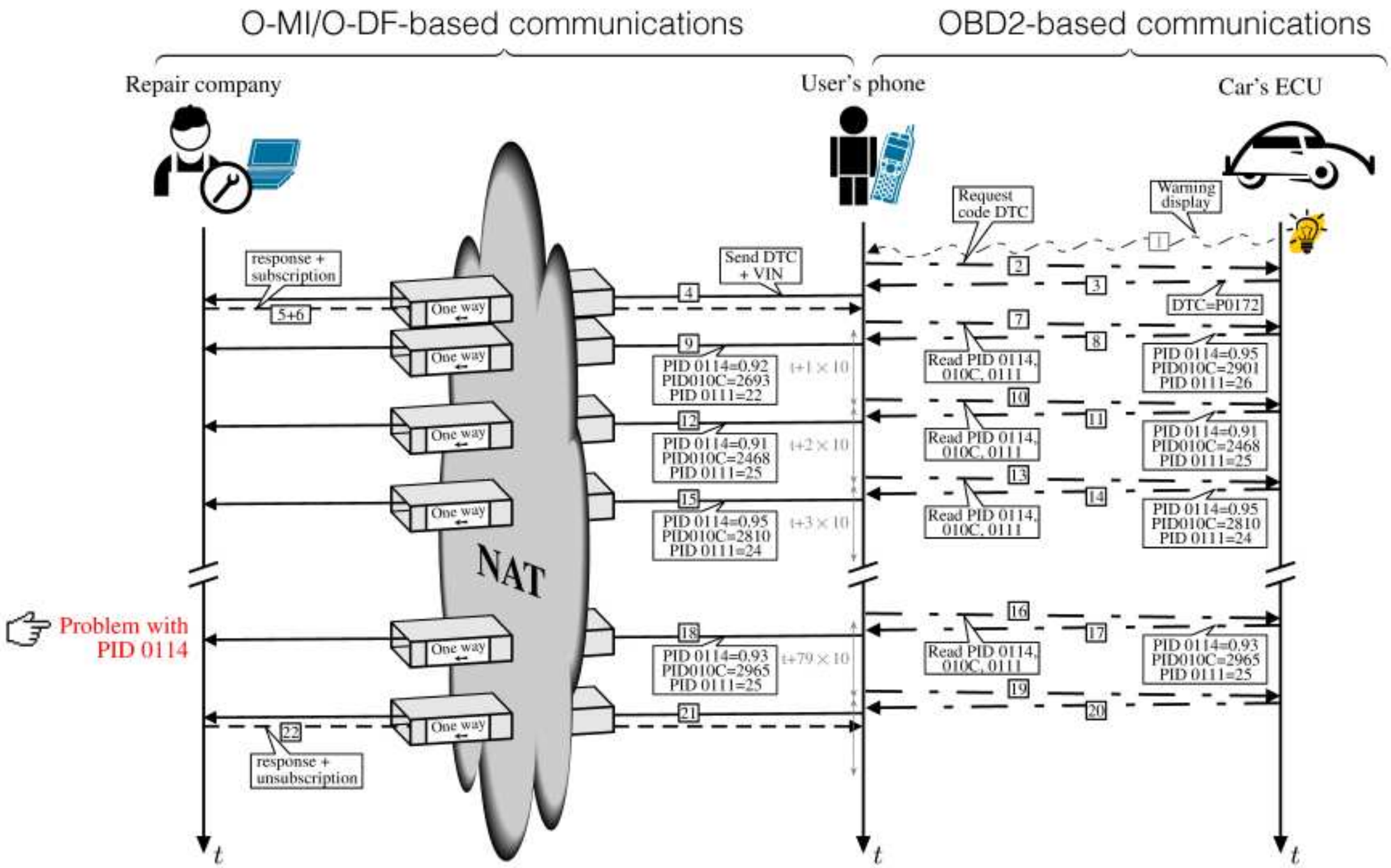


Source IoT Analytics

O-MI & O-DF Messaging Standards

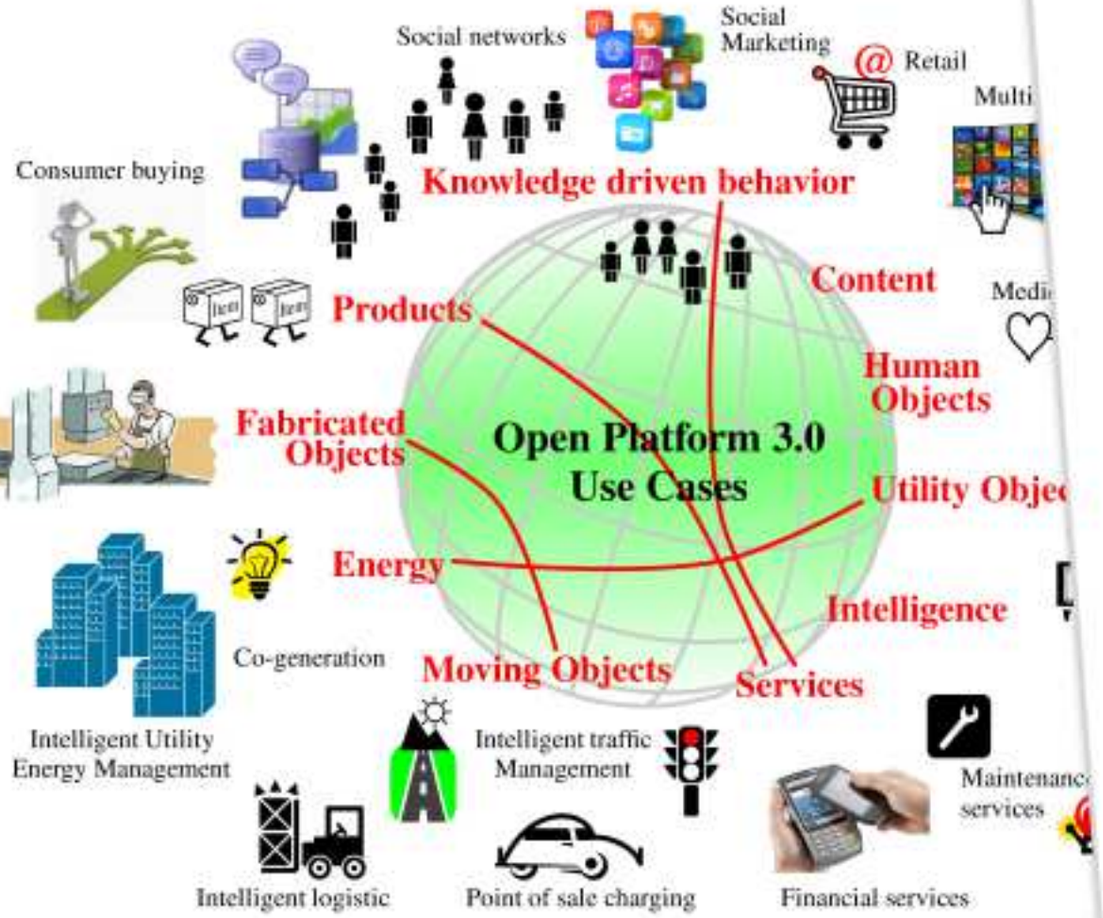


DTC: diagnostic trouble codes
PID: Parameter ID

Kubler, S.; Främling, K.; Buda, A. (2016) "*A standardized approach to deal with firewall and mobility policies in the IoT*", Pervasive and Mobile Computing, vol. 20, pp. 100-114.

The Open Platform 3.0™

22 Use Cases defined in the White Paper (Nexus in Force)

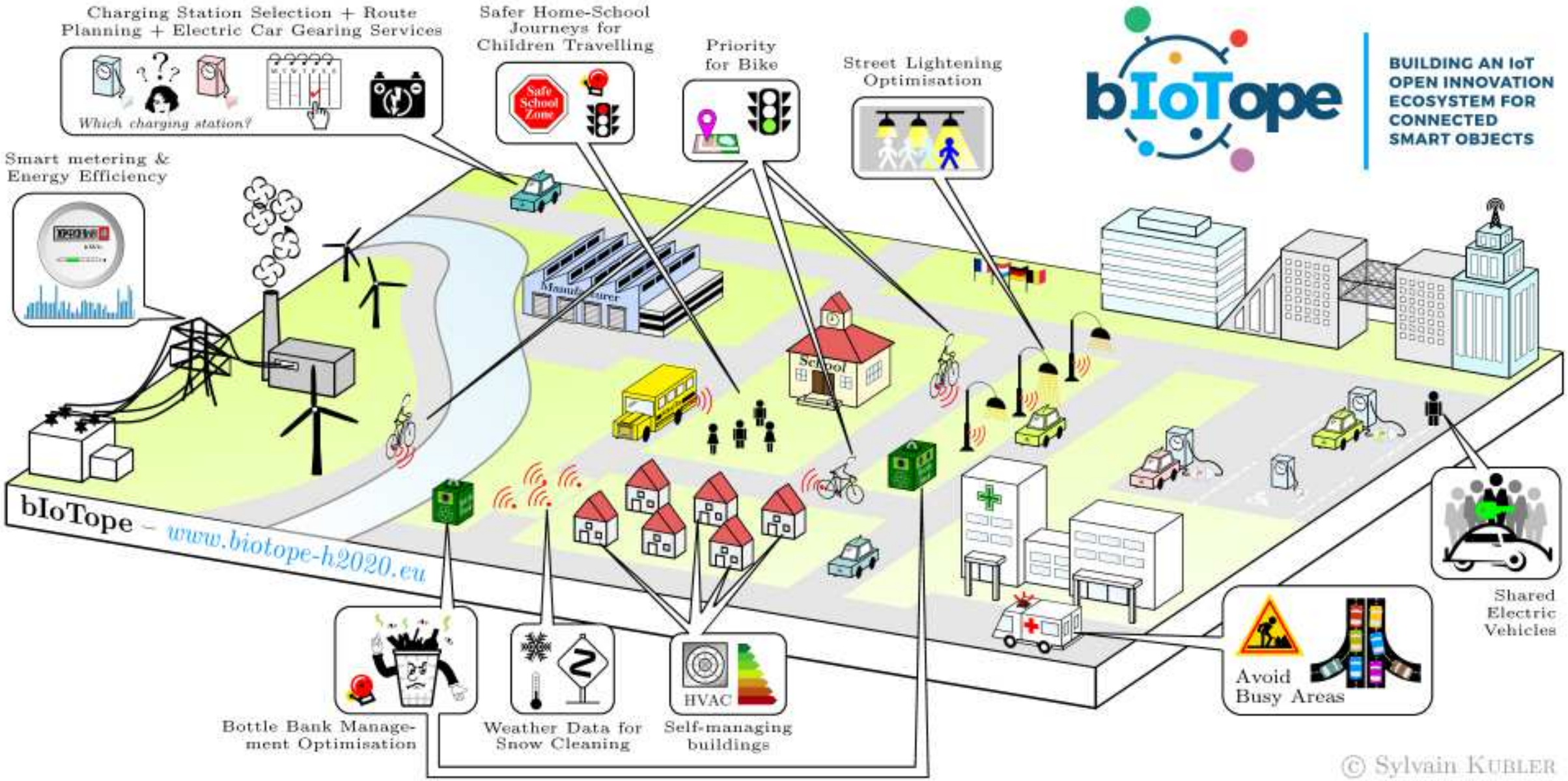


SUMMARY

- IoT (Internet of Things) — The road ahead
- EU's Vision & Ambition
- O-MI & O-DF Messaging Standards used as Foundation of the bIoTope (H2020 ICT30) project
- bIoTope Large-Scale Pilots
- Conclusion

bIoTope Large-Scale Pilots

Smart City Pilot overview



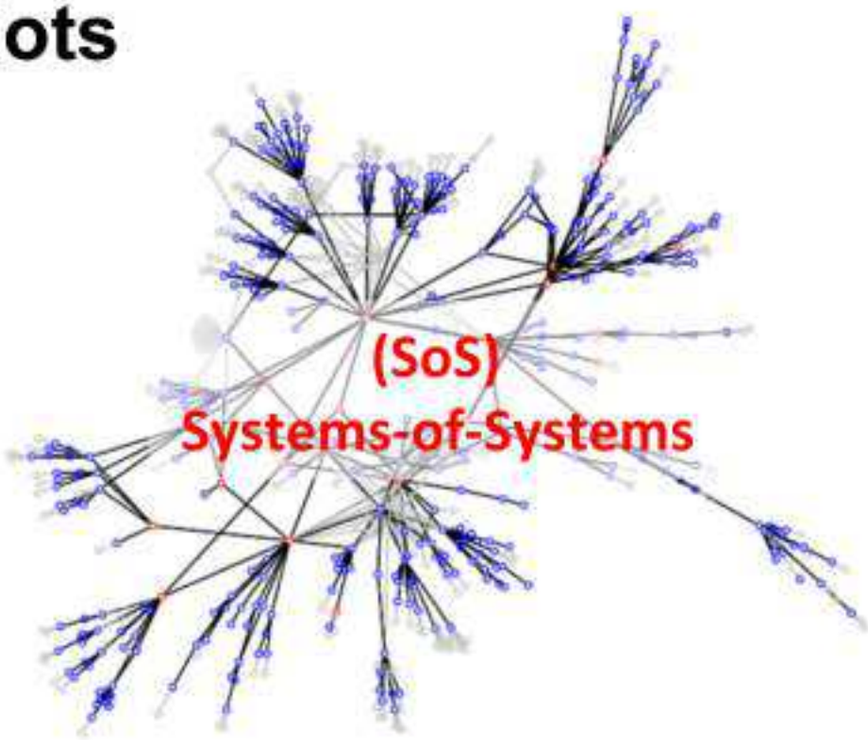
Helsinki City

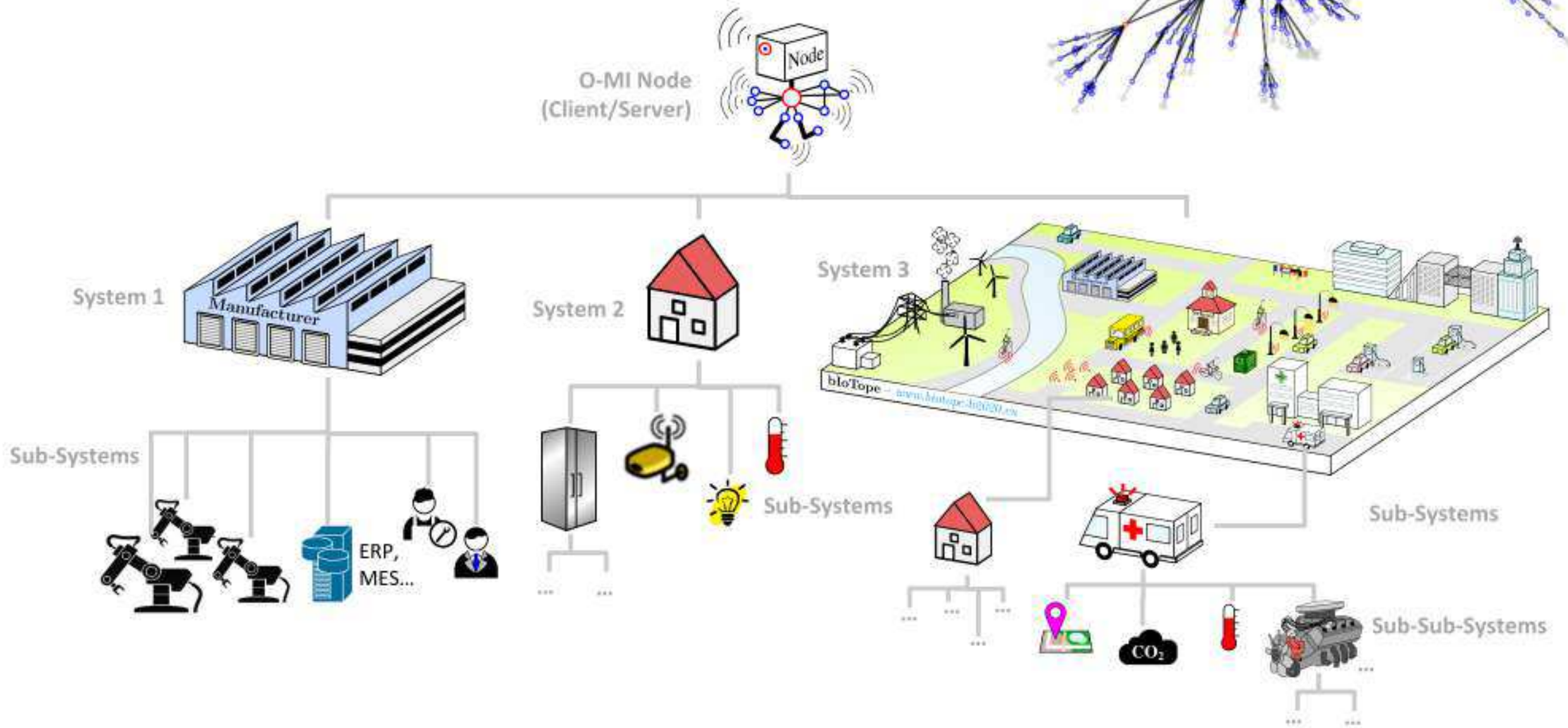
Grand Lyon (59 municipalities)

Brussels Region (19 municipalities)

bloTope Large-Scale Pilots

Micro-Billing Platform for IoT





bIoTope Large-Scale Pilots

Micro-Billing Platform for IoT

PRIVACY ...

XaaS
(*Privacy*-as-a-Service…)

Billing Framework
(Digital currency…)

ripple ...

Information Catalog

Find IoT information to benefit from

bIoTope

BUILDING AN IoT OPEN INNOVATION ECOSYSTEM FOR CONNECTED SMART OBJECTS

Information
Publication & Discovery

Information Quality
(Assessment & Management)

Like

Information
STAYS THERE

O-MI node-related Catalog

Info. Discovery/ Search (Visual)

Info. Discovery/ Search (Automated)

P2P data & Money transactions

bIoTope – www.biotope-h2020.eu

Potential Consumer

Potential Consumer

bloTope Large-Scale Pilots

Open Calls to engage local companies…

Open Calls — May 2017

750k€ in total (50-150K€ per open call)

http://biotope.cs.hut.fi/index.php/open-calls/

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Conclusion

- Creating Standards & getting them into widely use is not that easy.

NOT ONLY AN ENGINEERING TASK

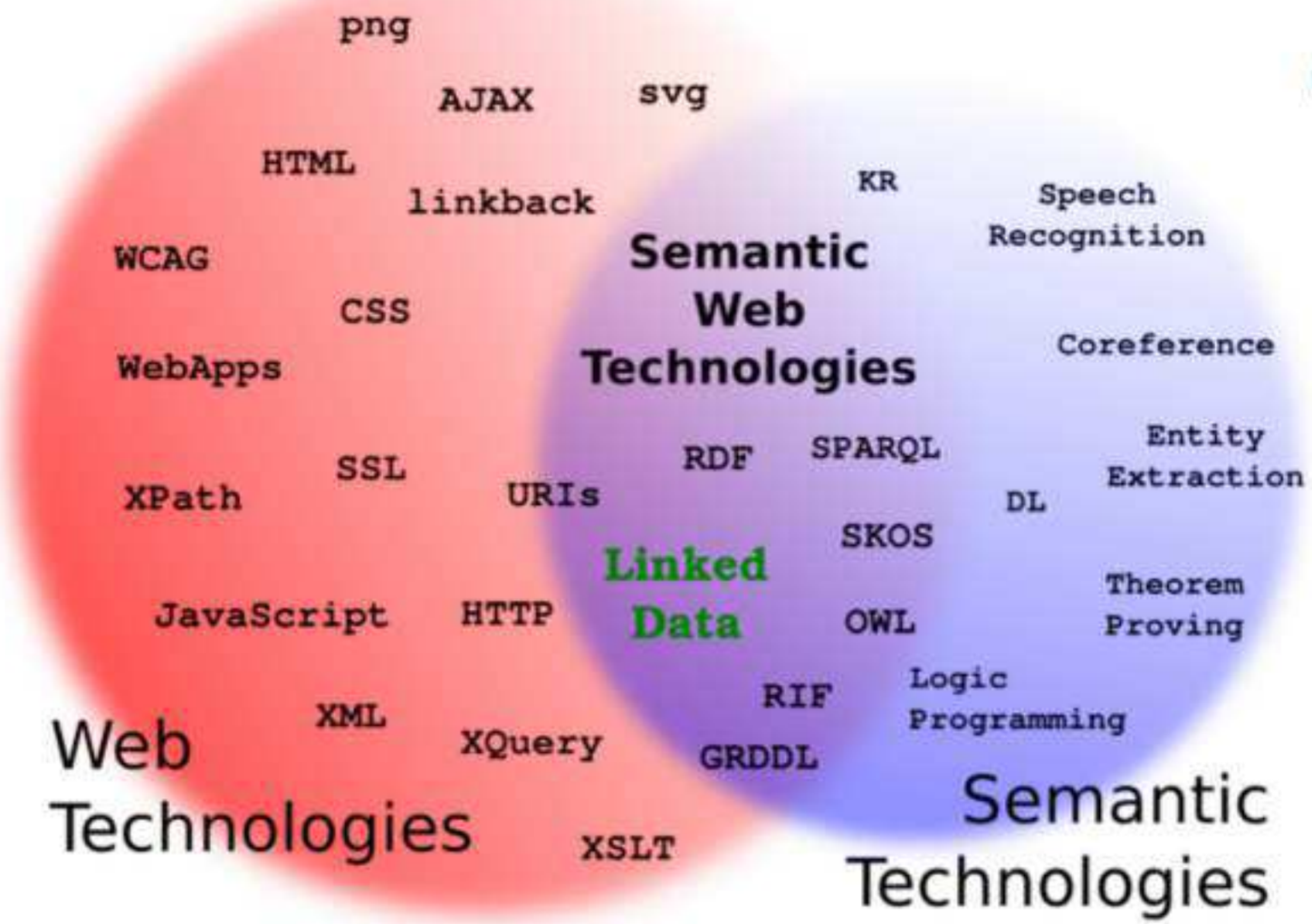
LONG & CHALLENGING PATH

Conclusion

- Creating Standards & getting them into widely use is not that easy.
- The success of the IoT strongly depends on (i) Vertical Silos (ii) User acceptance (iii) Information-as-an-Asset.

Conclusion

- Creating Standards & getting them into widely use is not that easy.
- The success of the IoT strongly depends on (i) Vertical Silos (ii) User acceptance (iii) Information-as-an-Asset.
- IoT Messaging Standards must be combined with Semantic Web Technologies



schema.org

securityandtrust.lu

Day 2 (April 20th): Data collection for Internet of Things

Data Publication & Discovery based on Open IoT Messaging Standards

Sylvain Kubler:
sylvain.kubler@uni.lu
Luxembourg University, Interdisciplinary Centre for Security, Reliability & Trust

UNIVERSITÉ DU LUXEMBOURG