H2020 project (ICT30)
http://www.biotope-project.eu

IoT-based Smart Parking System for Sporting Event Management

S. Kubler*, J. Robert*, A. Hefnawy#, C. Cherifi#, A. Bouras#, K. Främling+

* *University of Luxembourg, Interdisciplinary Centre for Security, Reliability & Trust*
# *Qatar University, DCSE, College of Engineering*
+ *Aalto University, Computer Science*

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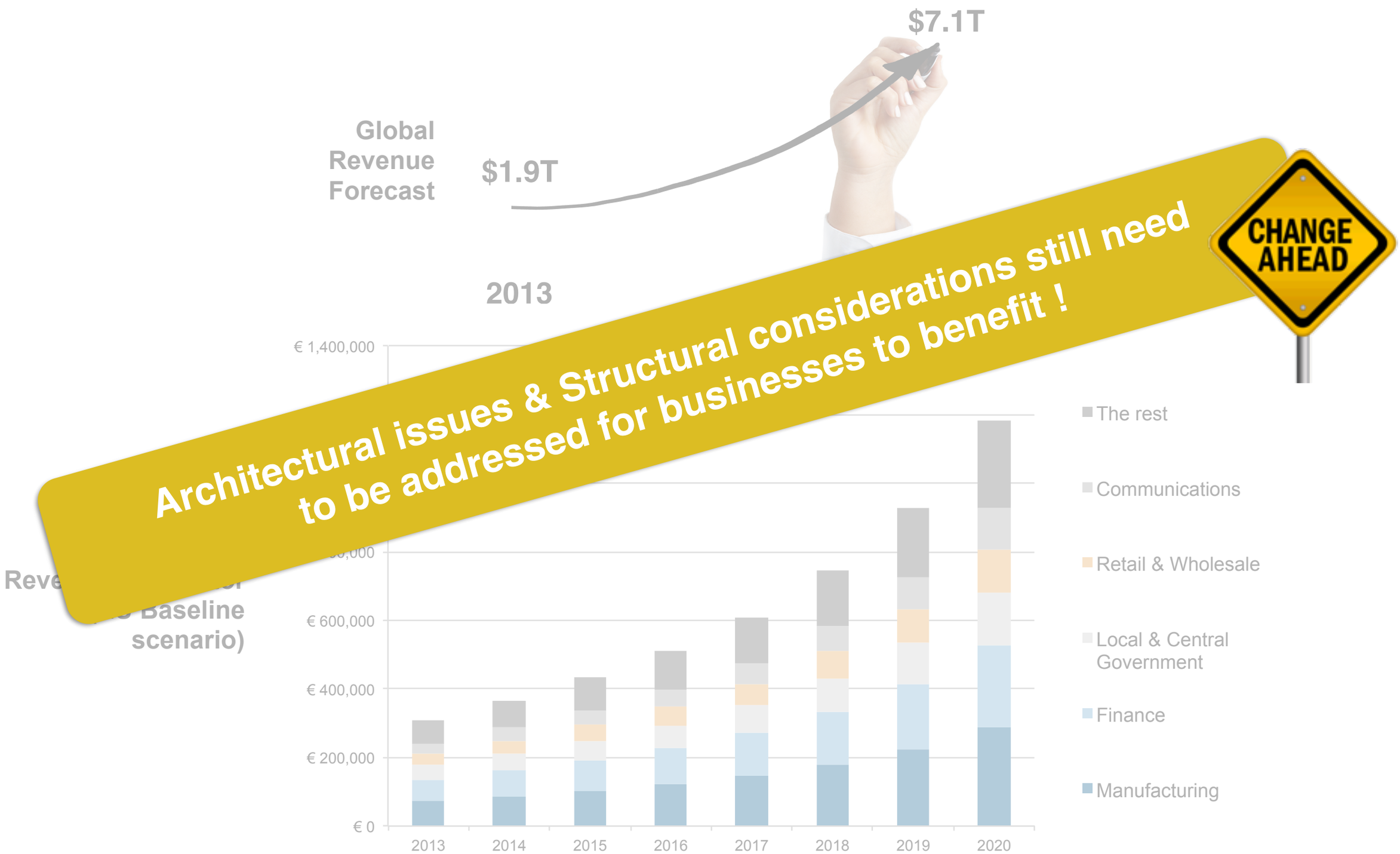
SUMMARY

- IoT (Internet of Things) — The road ahead
- EU's Vision & Ambition
- O-MI & O-DF Messaging Standards used as foundation of the (bIoTope) IoT ecosystem
- IoT-based Smart Parking Scenario
- Conclusion

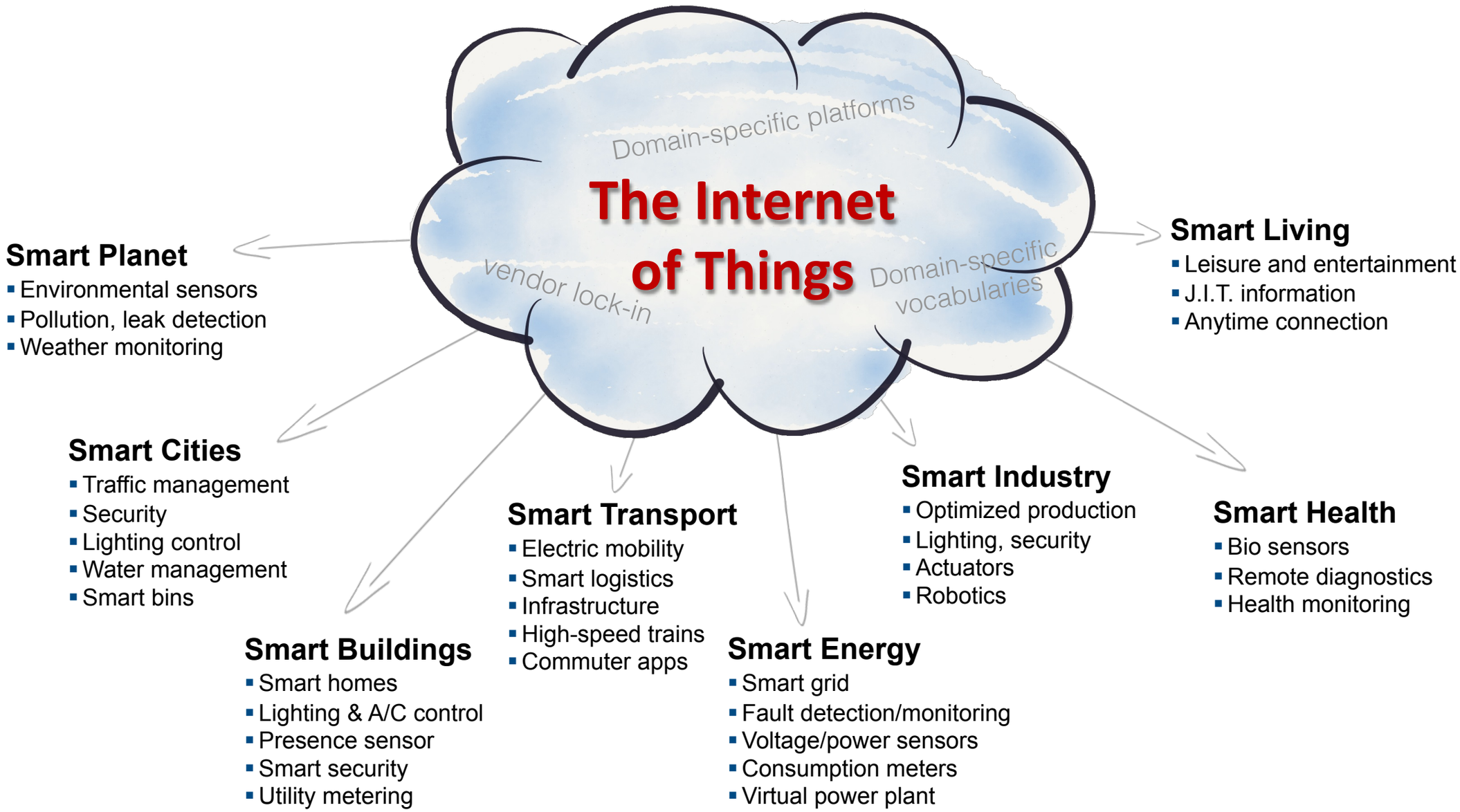
IoT— The road ahead



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— The road ahead



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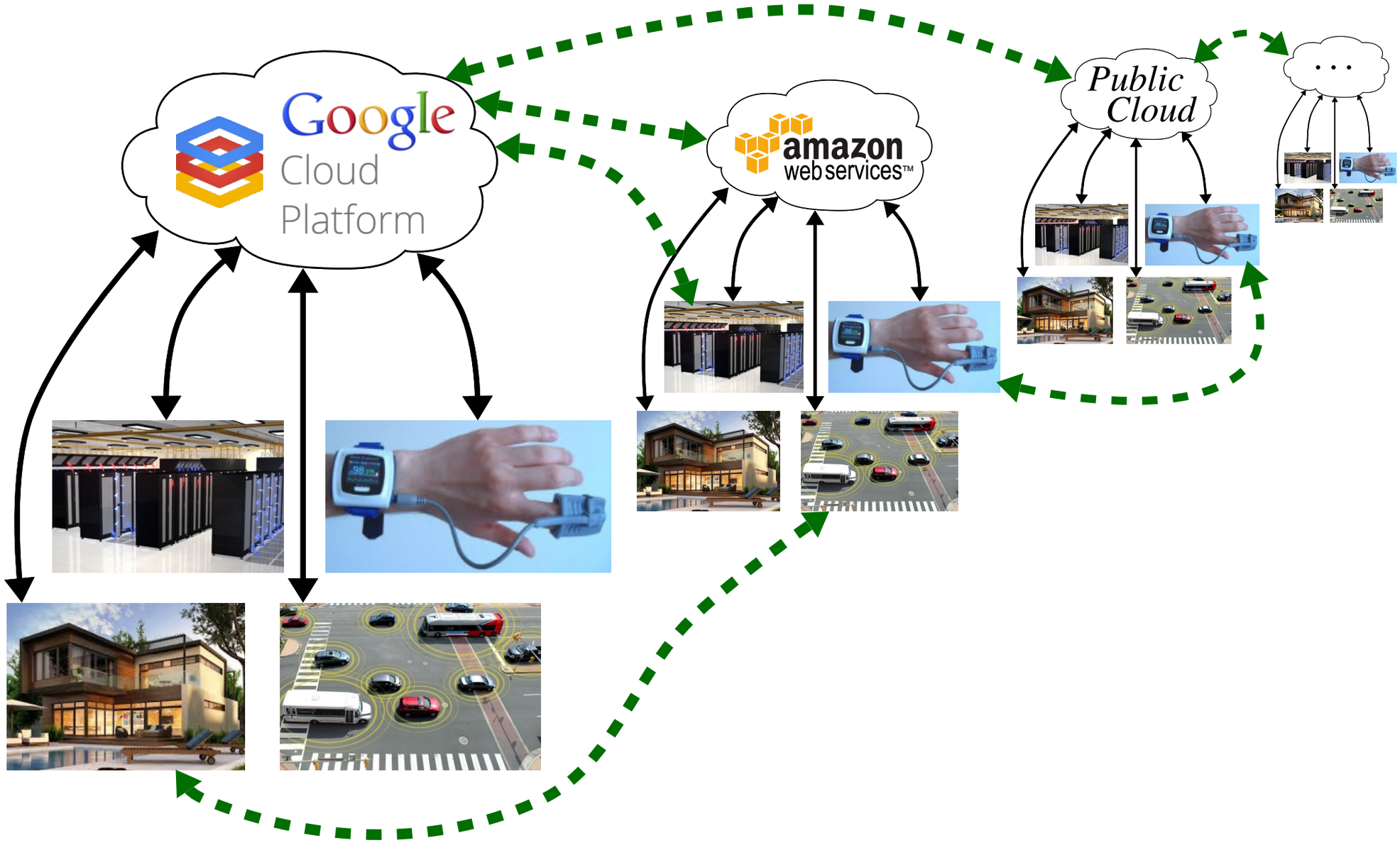
IoT— The road ahead



Legend

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

Ideal IoT : Communication allowed between vertically-oriented closed systems

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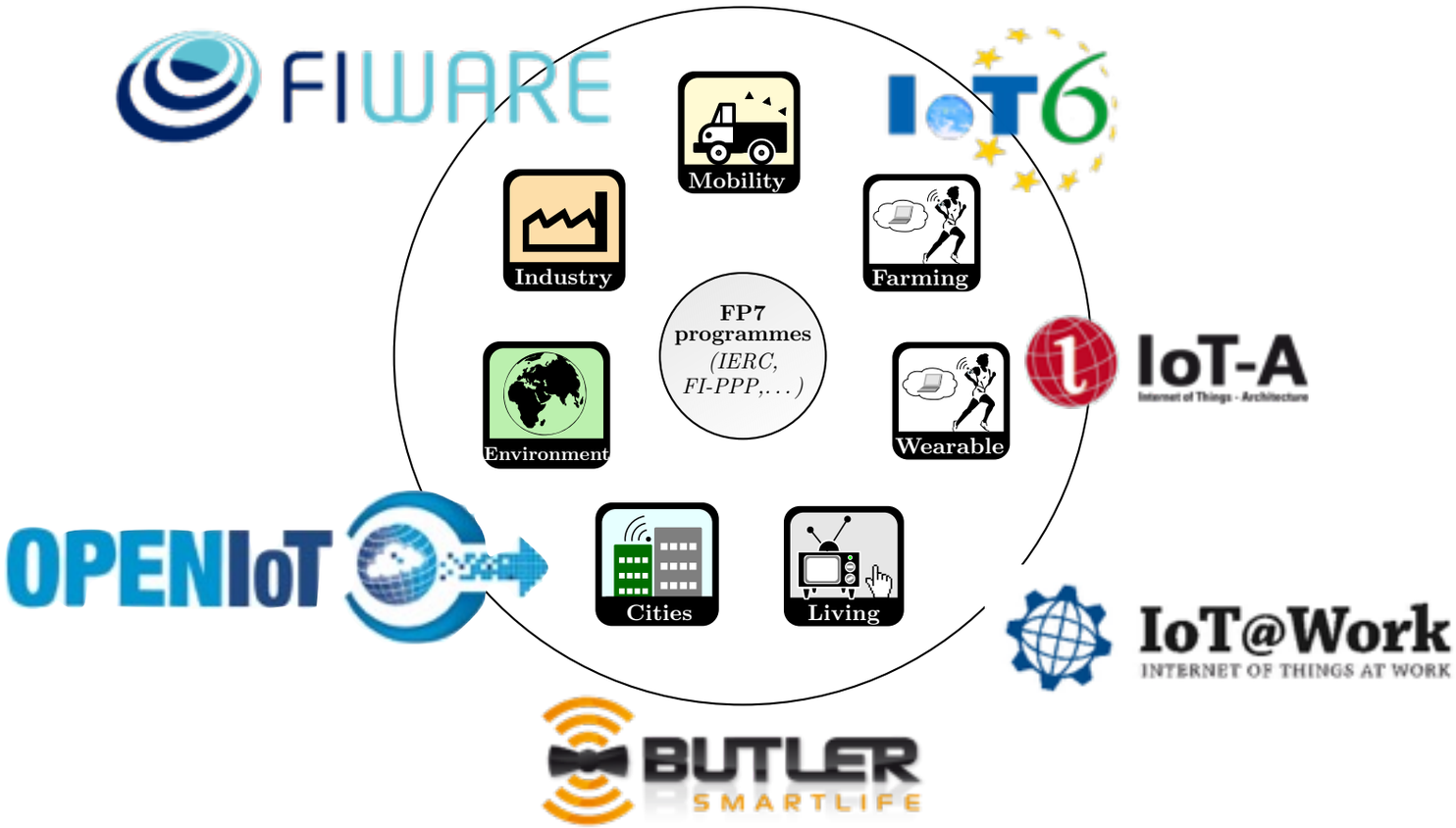
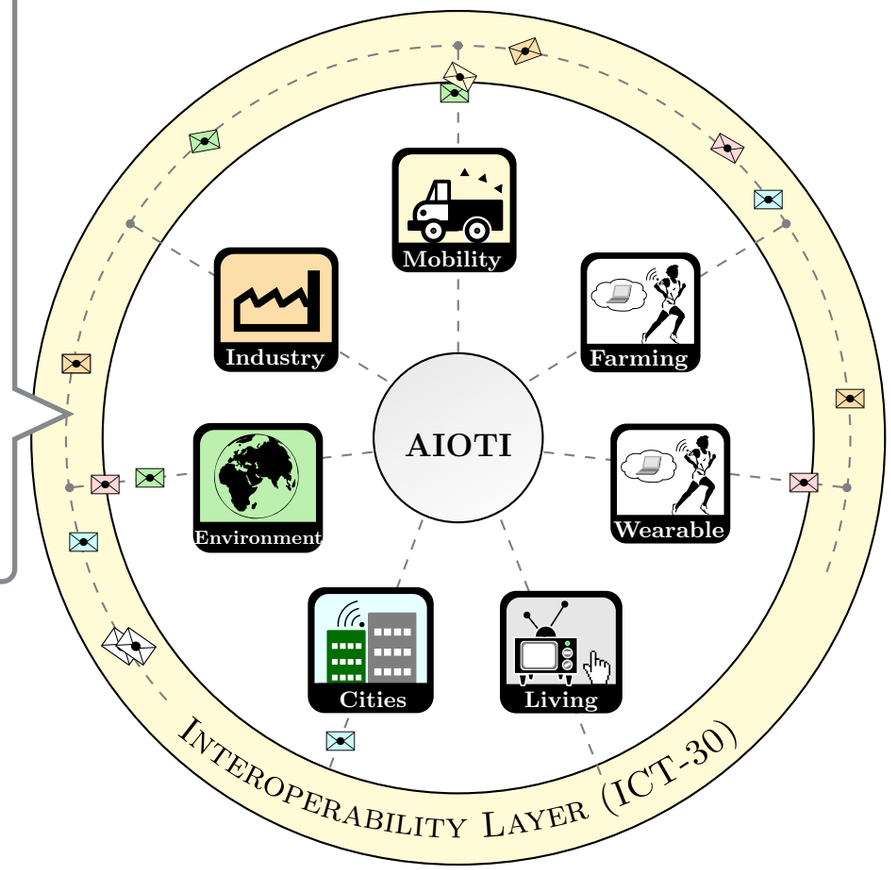
EU's Vision & Ambition



EU's Vision & Ambition

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	✗	✓	✓	✗

Project Coordinator

Aalto University (Finland)

Prof. Kary FRÄMLING
School of Science and Technology
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✉ kary.framling@aalto.fi

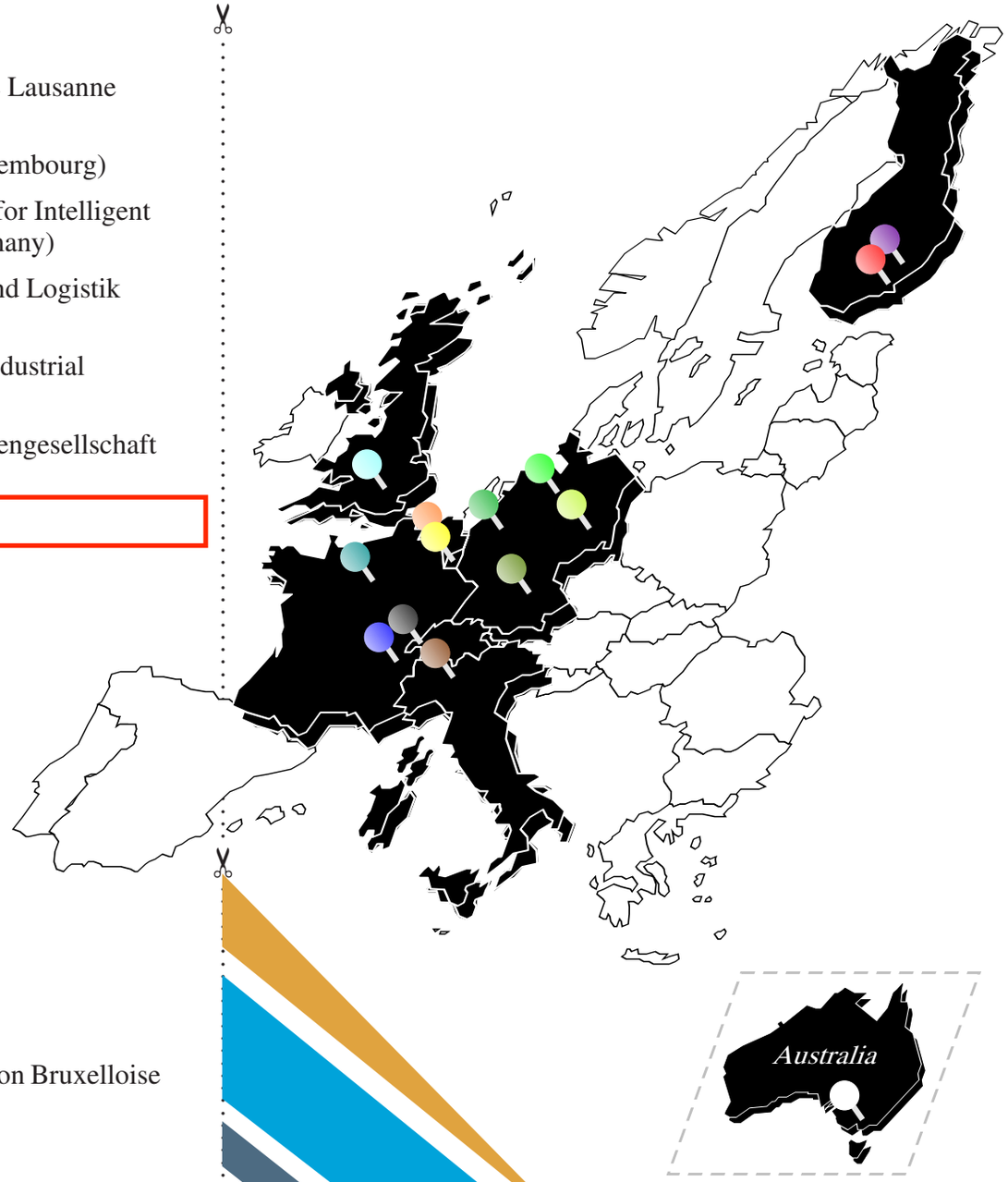
Project Consortium

- **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

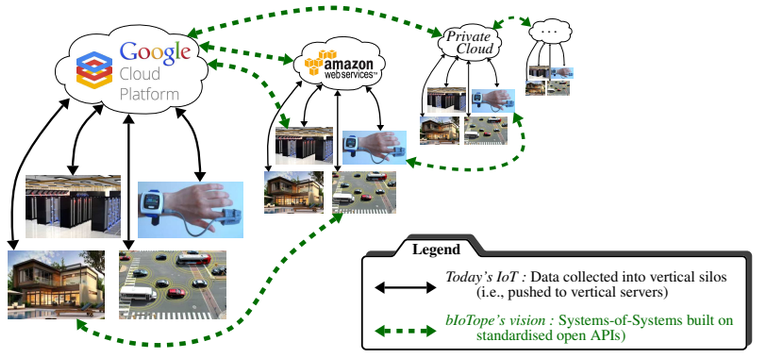
- www.bIoTope-project.eu
- Twitter: @bIoTope_project



Building an IoT Open Innovation Ecosystem for Connected Smart Objects

Scope & Objectives

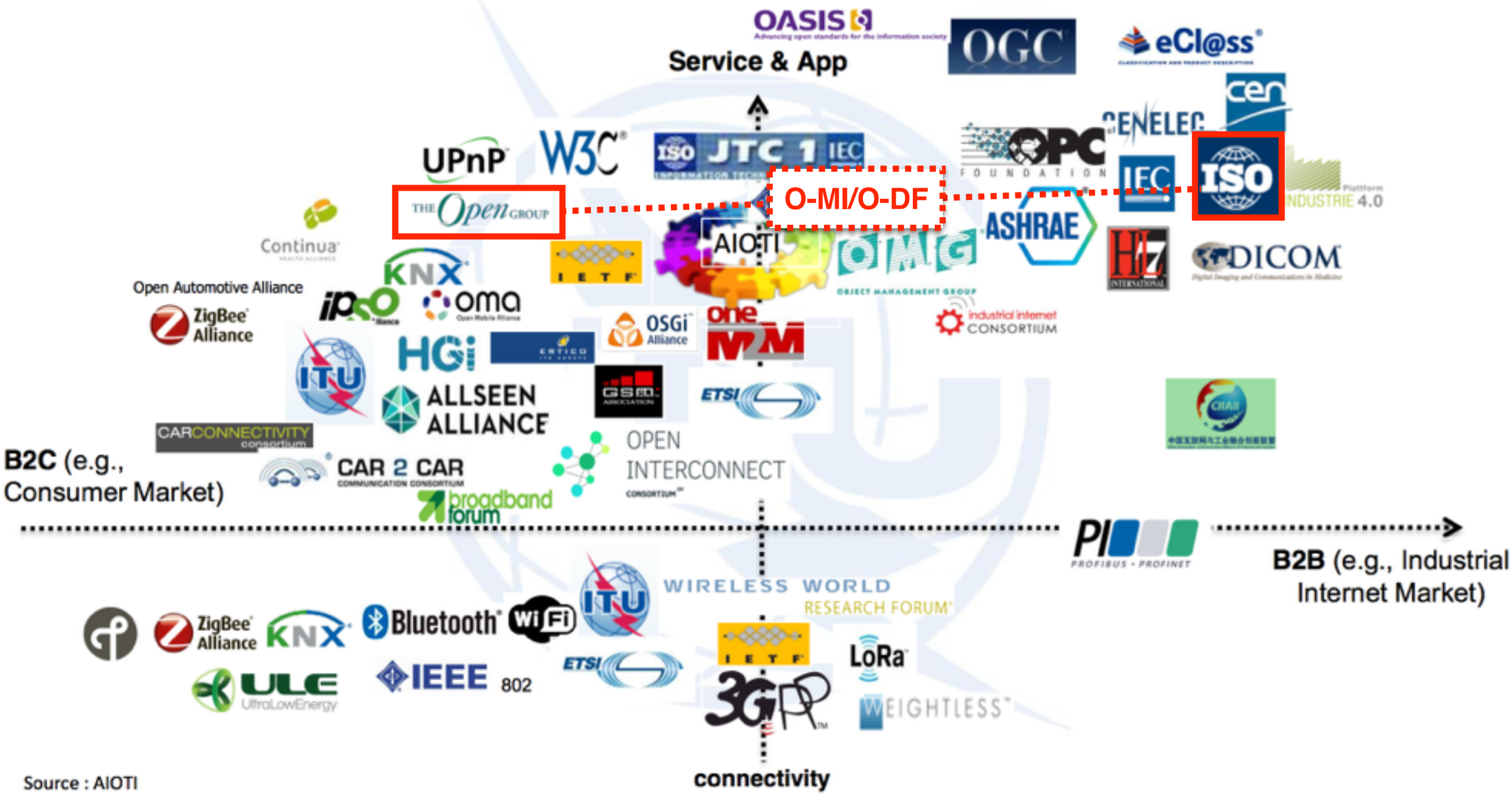
The Internet of Things (IoT) brings opportunities to create new services and products, reducing costs for societies, and changing how services are sold and consumed. A critical obstacle to further IoT innovation is the "vertical silos" that shape today's IoT landscape. These silos impede the creation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

© bIoTope Consortium

IoT— The road ahead



Source : AIOTI

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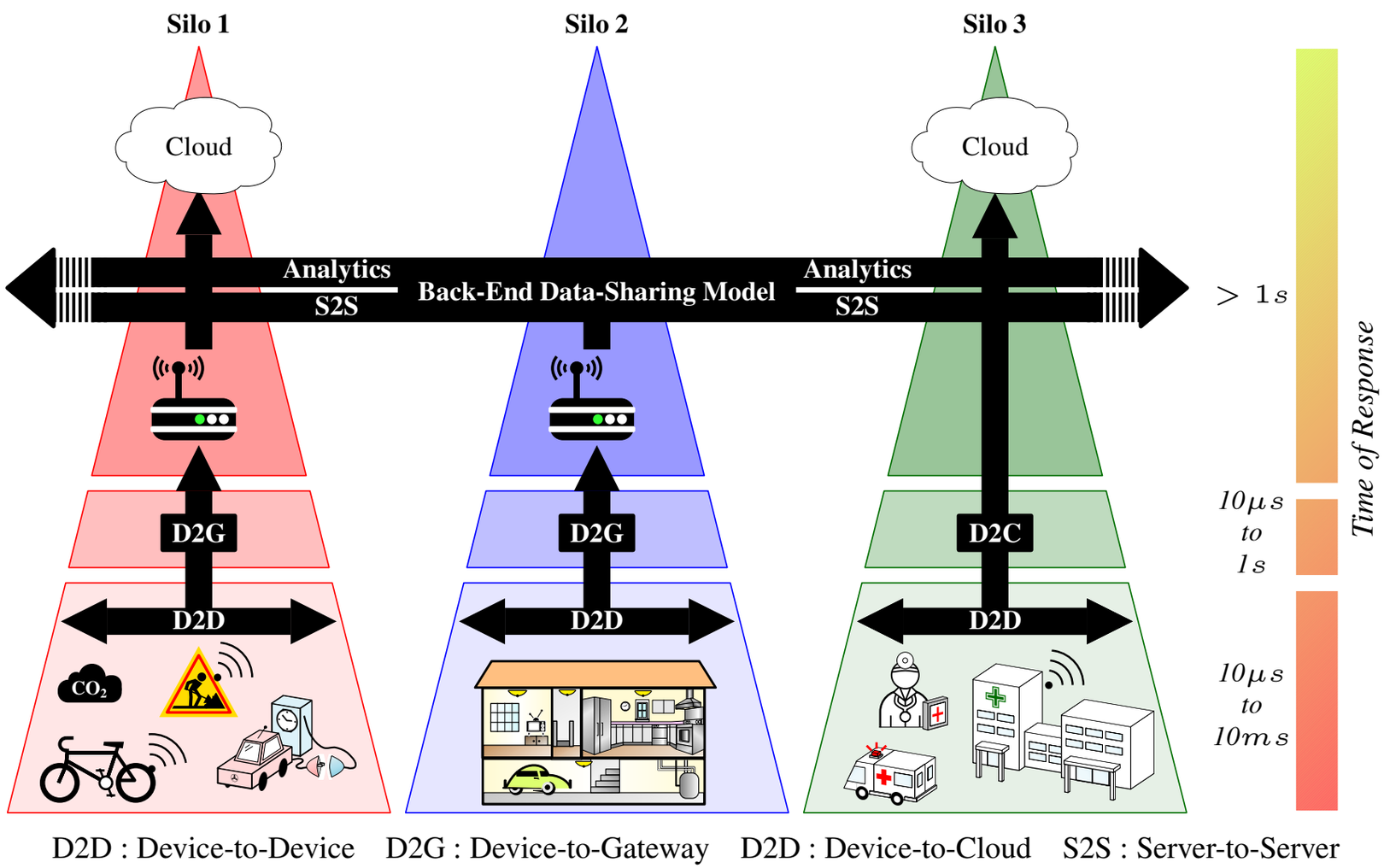
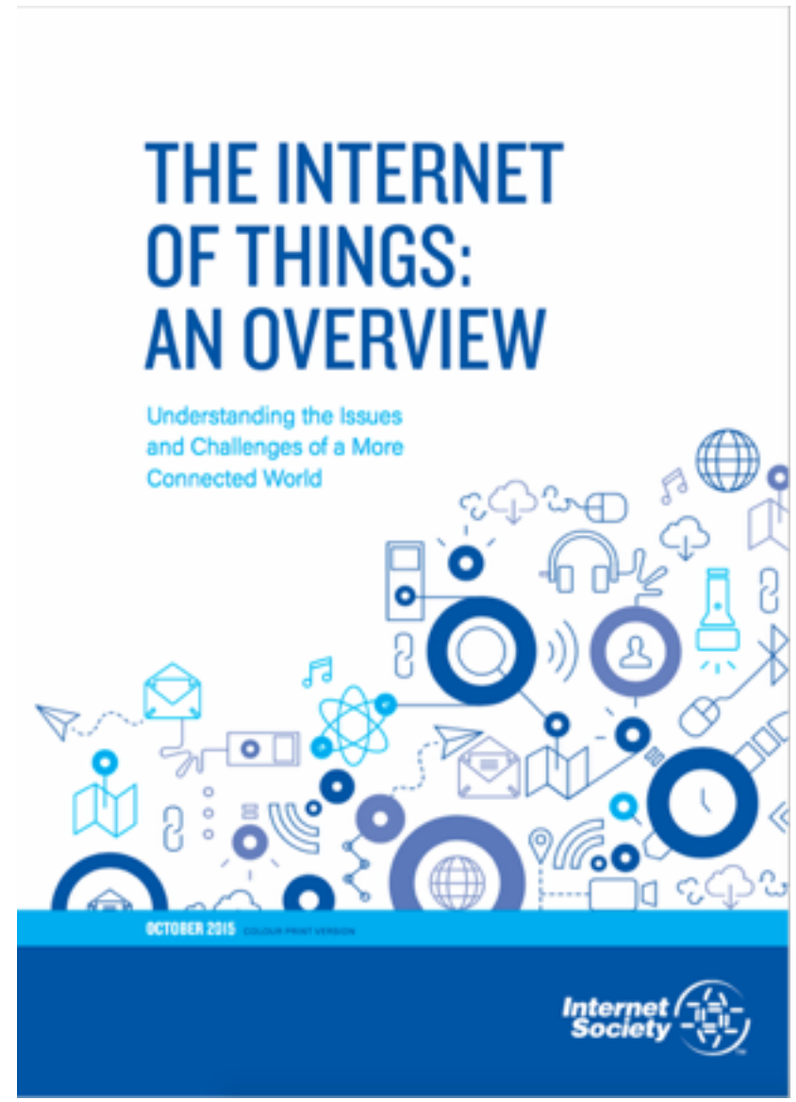
O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications



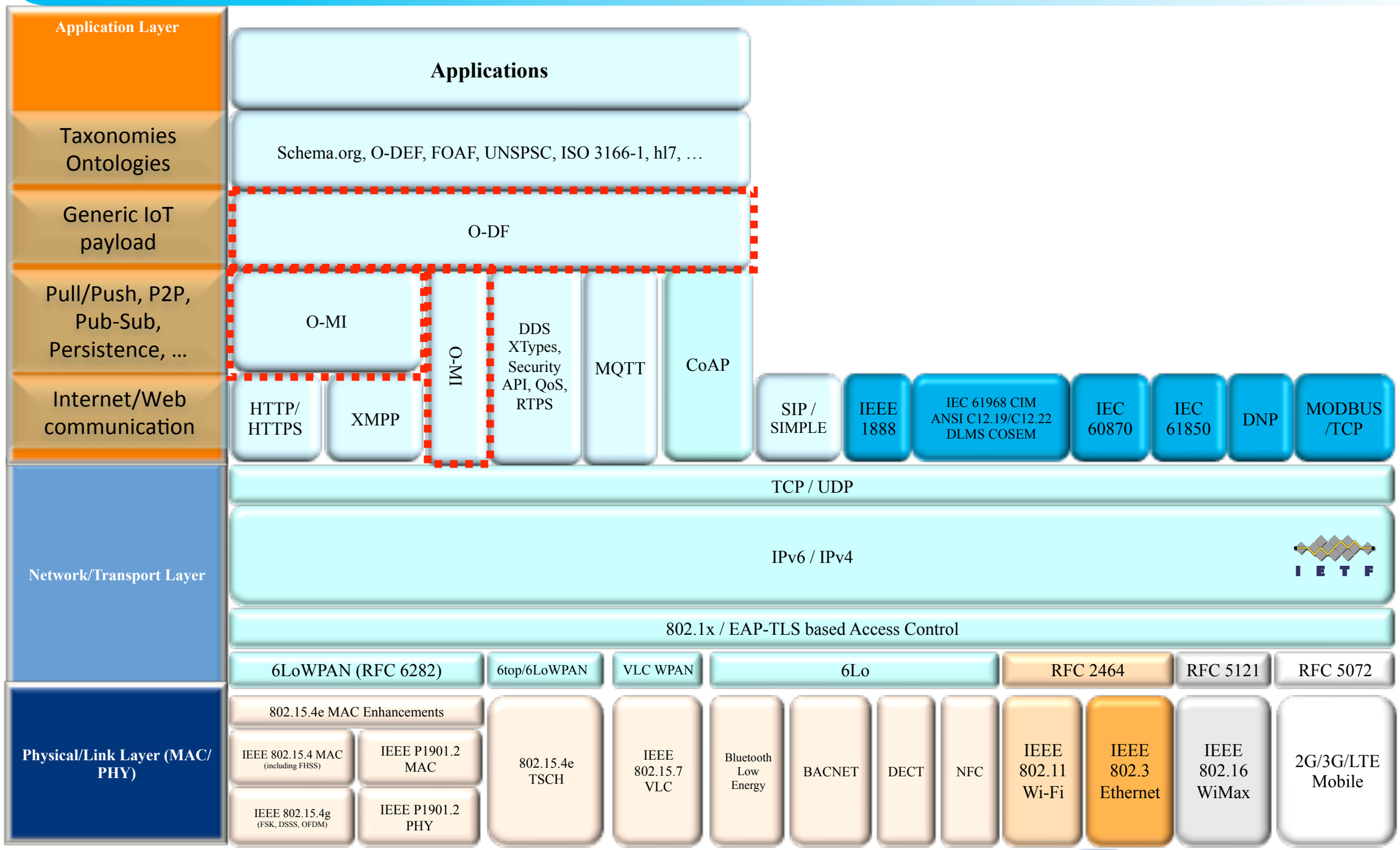


Four common **IoT communication models**:

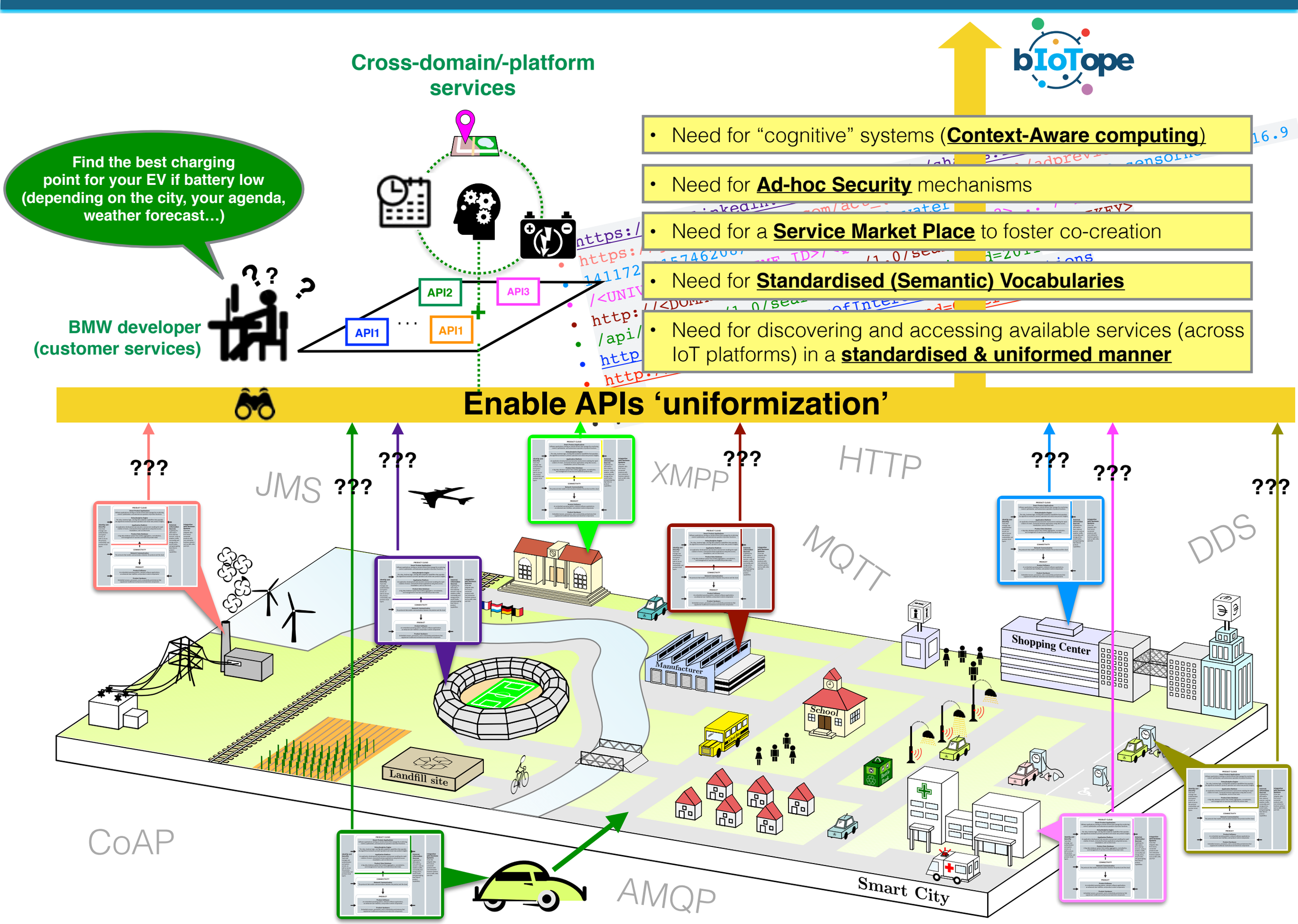
- Device-to-Device (D2D)
- Device-to-Gateway (D2G)
- Device-to-Cloud (D2C)
- Backend Data Sharing Model (S2S + Analytics)

O-MI & O-DF Messaging Standards

A High-level Introduction of the standard specifications



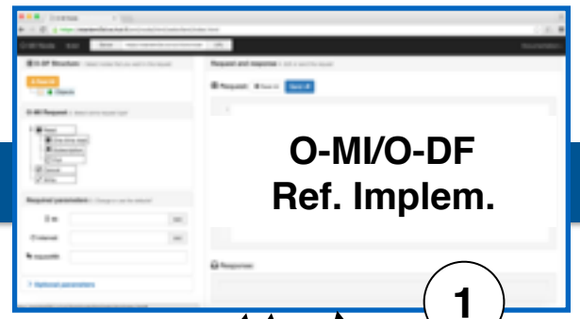
“bloTope is about platform federation for cross-domain innovation” (API economy)

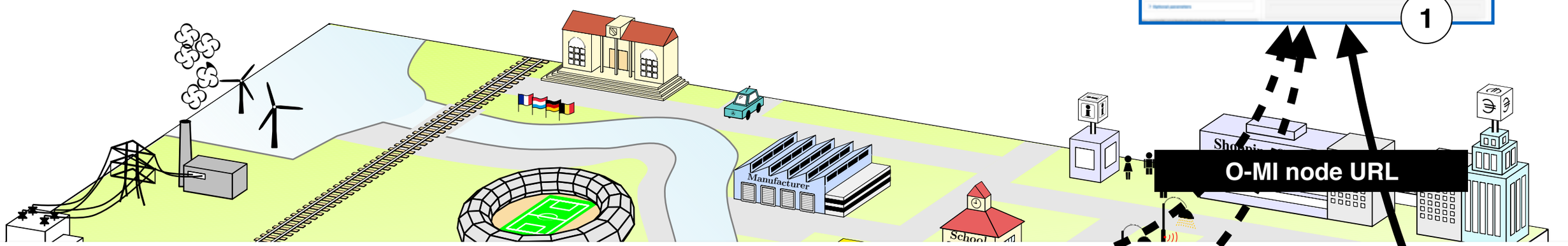

Cross-domain/-platform services
Find the best charging point for your EV if battery low (depending on the city, your agenda, weather forecast…)
BMW developer (customer services)
API1
API2
API3
API1
bIoTope
Need for "cognitive" systems (Context-Aware computing)
Need for Ad-hoc Security mechanisms
Need for a Service Market Place to foster co-creation
Need for Standardised (Semantic) Vocabularies
Need for discovering and accessing available services (across IoT platforms) in a standardised & uniformed manner
Enable APIs 'uniformization'
???
JMS
???
???
XMPP
???
HTTP
???
???
???
MQTT
DDS
CoAP
AMQP
Landfill site
Manufacturer
School
Shopping Center
Smart City

Use Case Providers

Aalto Smart Campus: https://otaniemi3d.cs.hut.fi/omi/node/html/webclient/index.html
Sophia-Antipolis Smart Campus: http://sparks-vm26.i3s.unice.fr:8080/html/webclient/index.html
Colleague Smart House: http://jeremyshouse.jeremy-robert.fr
University of Luxembourg: http://biotope.sntiotlab.lu:8080/html/webclient/index.html
…

Standardised Service Description & Messaging Interfaces (O-MI/O-DF)

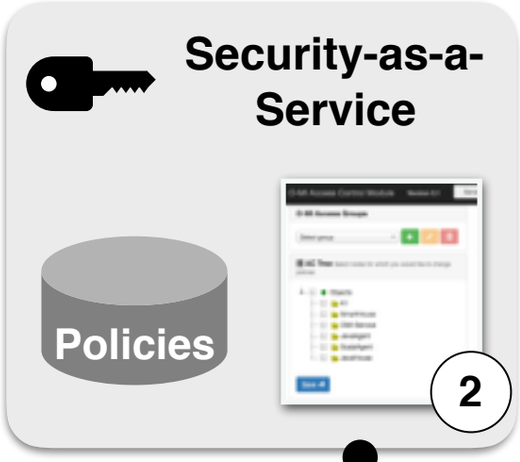




JCDecaux API | Other… | Other… | BMW API | Hue API | 0 Netatmo API

…

…



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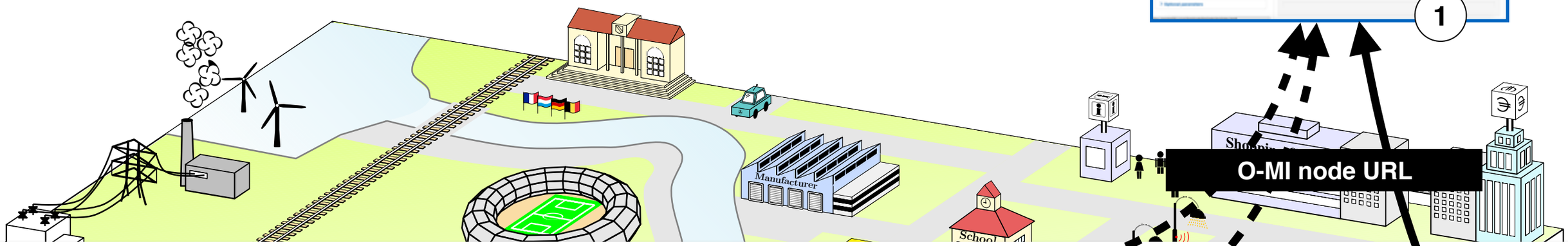

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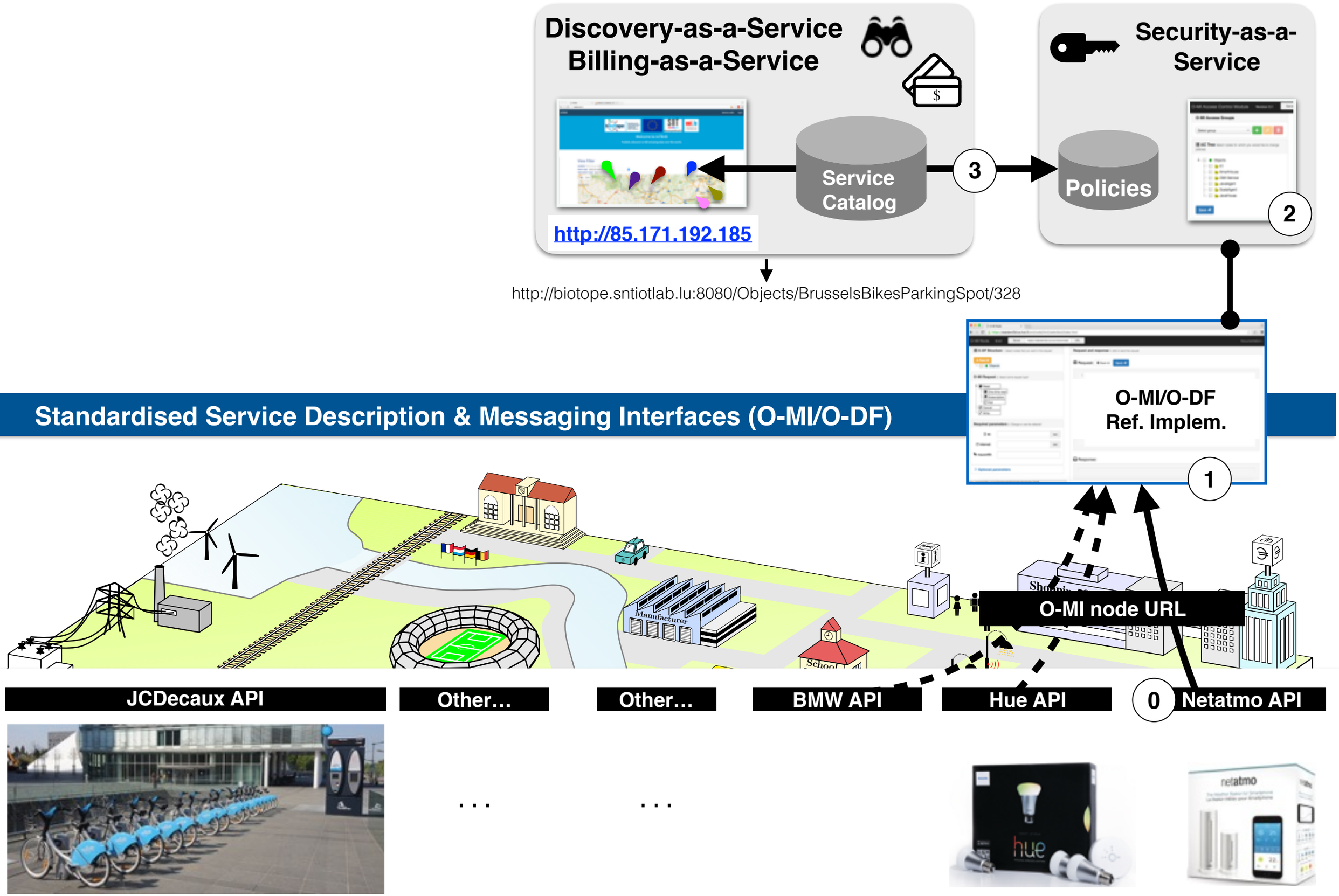
…


Discovery-as-a-Service
Billing-as-a-Service
Security-as-a-Service
Service Catalog
Policies
3
2
http://85.171.192.185
http://biotope.sntiotlab.lu:8080/Objects/BrusselsBikesParkingSpot/328
O-MI/O-DF
Ref. Implem.
1
Standardised Service Description & Messaging Interfaces (O-MI/O-DF)
O-MI node URL
Manufacturer
JCDecaux API
Other…
Other…
BMW API
Hue API
0
Netatmo API
...
...
hue
netatmo

Demo Part 1

Peer-to-Peer IoT data exchange (depending on access rights)

5

IoT Visual Programming Tools

4

Discovery-as-a-Service
Billing-as-a-Service

Security-as-a-Service

https://www.youtube.com/watch?v=gYdFOVXd25o

Service Catalog

3

Policies

2

http://85.171.192.185

http://biotope.sntiotlab.lu:8080/Objects/BrusselsBikesParkingSpot/328

6

IoT ecosystem end-users
(cities, citizens, SMEs, etc.)

O-MI/O-DF
Ref. Implem.

1

Standardised Service Description & Messaging Interfaces (O-MI/O-DF)

O-MI node URL

JCDecaux API | Other… | Other… | BMW API | Hue API | 0 Netatmo API

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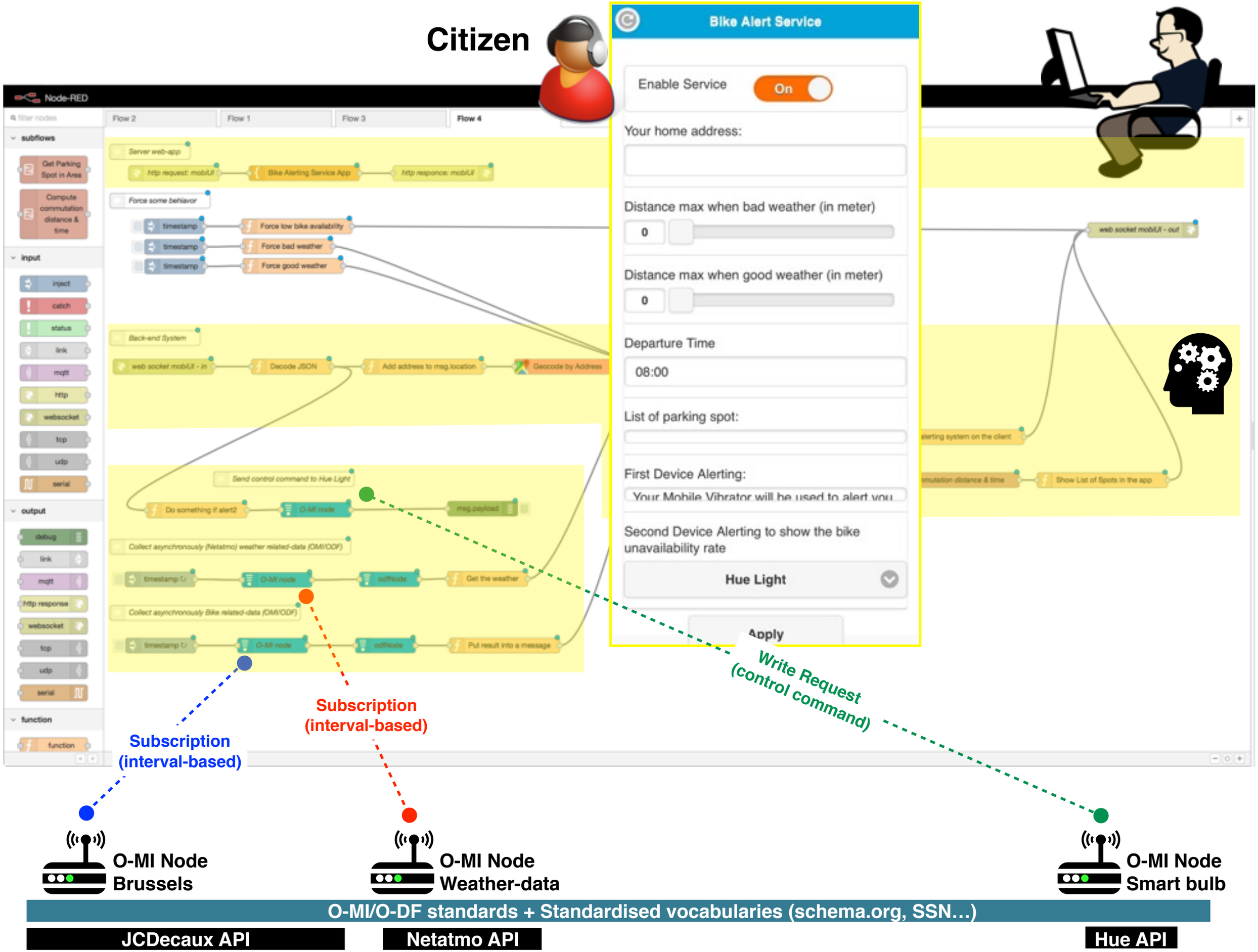
Citizen
Node-RED
Flow 2
Flow 1
Flow 3
Flow 4
subflows
Get Parking Spot in Area
Compute commutation distance & time
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
serial
output
debug
function
Server web-app
http request: mobiUI
Bike Alerting Service App
http responce: mobiUI
Force some behiavor
timestamp
Force low bike availability
Force bad weather
Force good weather
Back-end System
web socket mobiUI - in
Decode JSON
Add address to msg.location
Geocode by Address
Send control command to Hue Light
Do something if alert2
O-MI node
msg.payload
Collect asynchronously (Netatmo) weather related-data (OMI/ODF)
odfNode
Get the weather
Collect asynchronously Bike related-data (OMI/ODF)
Put result into a message
Bike Alert Service
Enable Service
On
Your home address:
Distance max when bad weather (in meter)
0
Distance max when good weather (in meter)
0
Departure Time
08:00
List of parking spot:
First Device Alerting:
Second Device Alerting to show the bike unavailability rate
Hue Light
Apply
web socket mobiUI - out
Show List of Spots in the app
Write Request
(control command)
Subscription
(interval-based)
Subscription
(interval-based)
O-MI Node
Brussels
O-MI Node
Weather-data
O-MI Node
Smart bulb
O-MI/O-DF standards + Standardised vocabularies (schema.org, SSN…)
JCDecaux API
Netatmo API
Hue API

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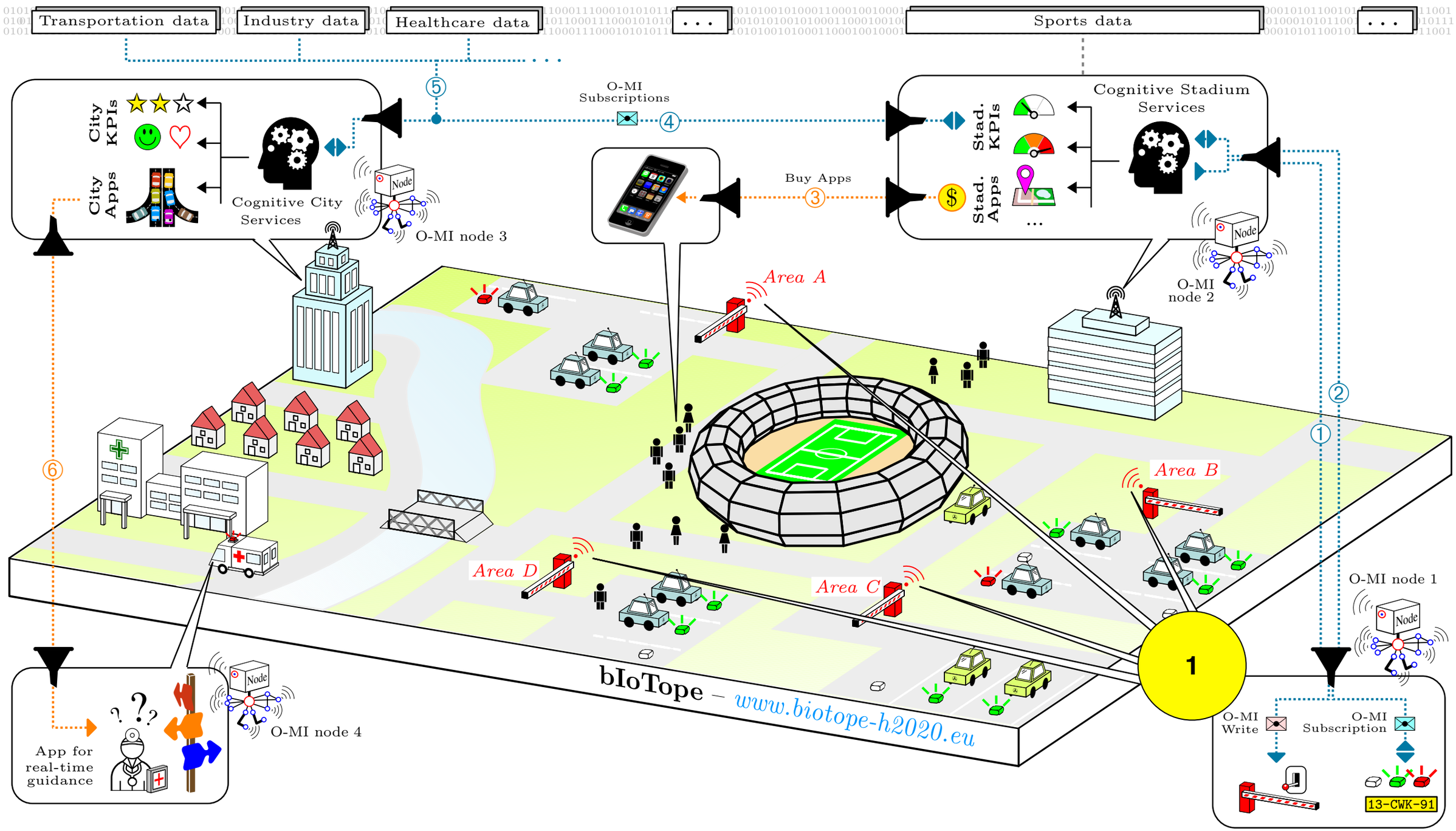
IoT-based Smart Parking
FIFA World Cup 2022 (Qatar)



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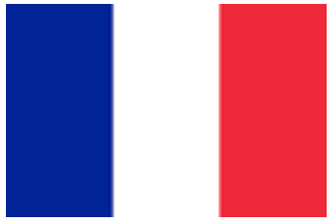
bIoTope City Pilots

Open Calls — May 2017

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

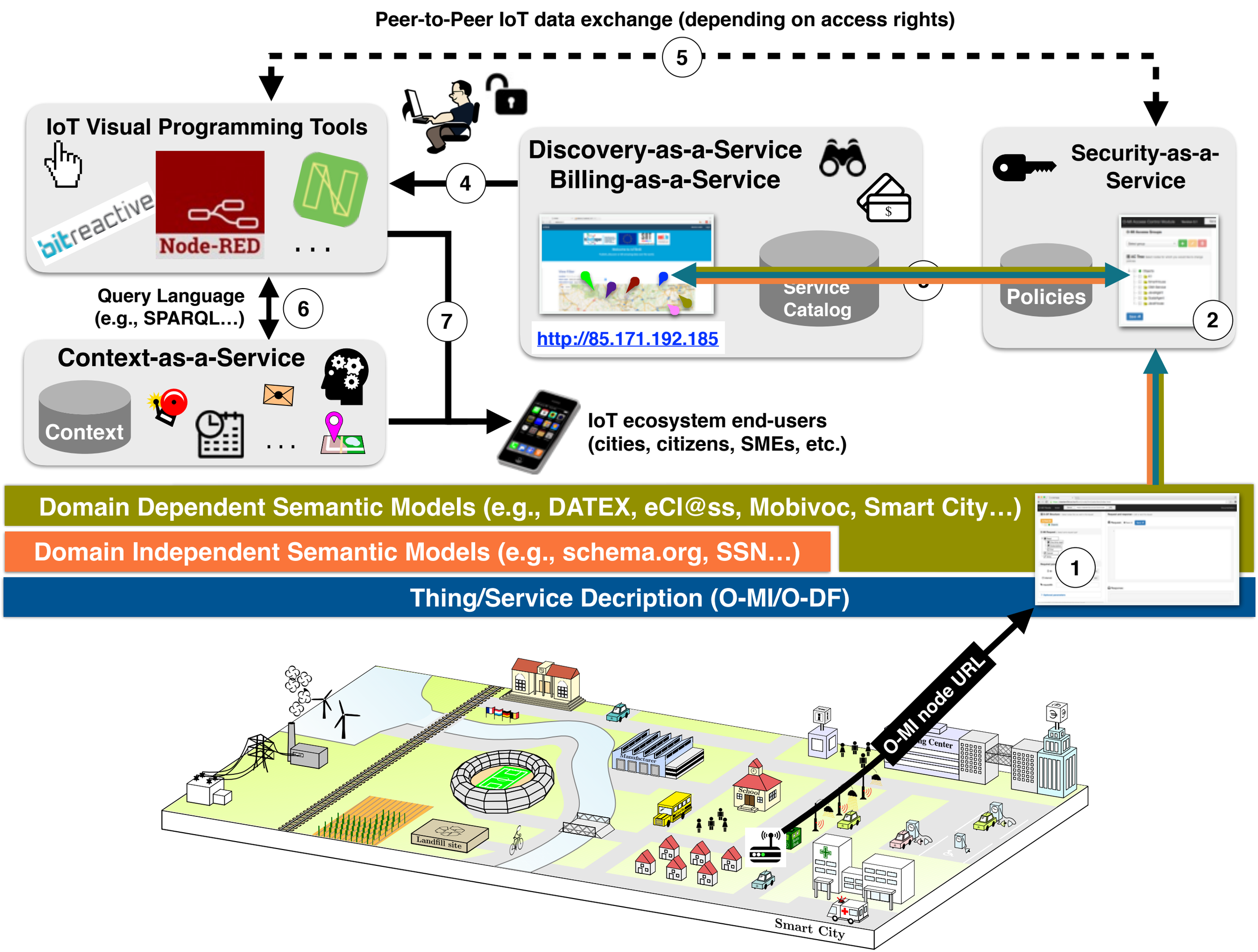
http://www.biotope-project.eu

Helsinki City



Grand Lyon (59 municipalities)

Brussels Region (19 municipalities)


Peer-to-Peer IoT data exchange (depending on access rights)
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IoT Visual Programming Tools
bitreactive
Node-RED
. . .
4
Discovery-as-a-Service
Billing-as-a-Service
http://85.171.192.185
Service Catalog
Security-as-a-Service
Policies
2
Query Language
(e.g., SPARQL…)
6
7
Context-as-a-Service
Context
. . .
IoT ecosystem end-users
(cities, citizens, SMEs, etc.)
Domain Dependent Semantic Models (e.g., DATEX, eCl@ss, Mobivoc, Smart City…)
Domain Independent Semantic Models (e.g., schema.org, SSN…)
Thing/Service Decription (O-MI/O-DF)
1
O-MI node URL
Manufacturer
School
Landfill site
Smart City

H2020 project (ICT30)
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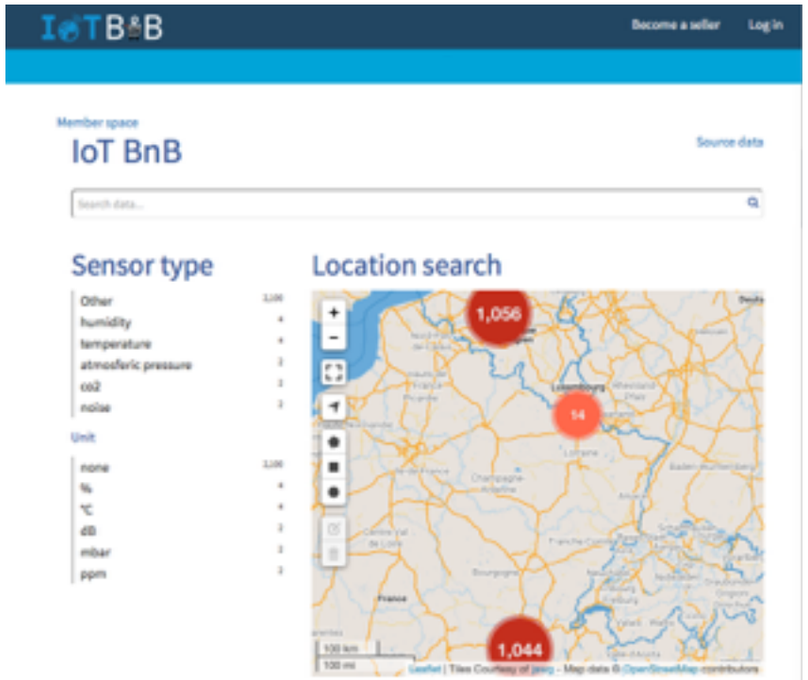
Development stages:

Search for data sources → Pay for accessing them (if needed) → Token generation → Re-Use Token in your IDE

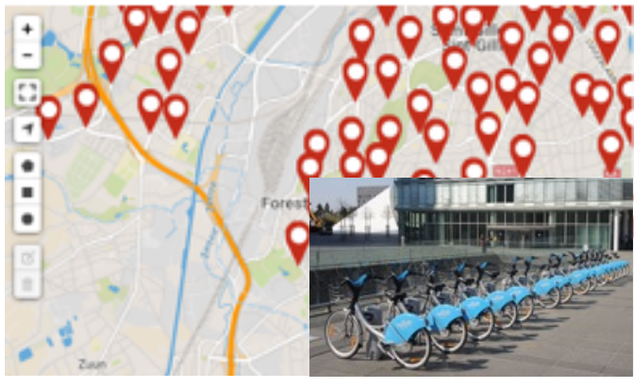
Jérémy

bIoTope Service Marketplace



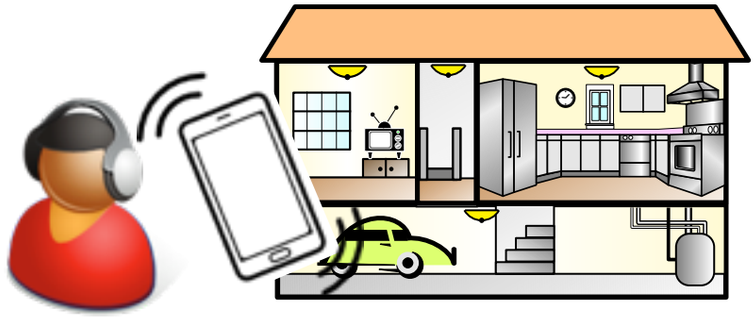
O-MI/O-DF standards + Standardised vocabularies (schema.org, SSN…)

JCDecaux API



Netatmo API

Hue API



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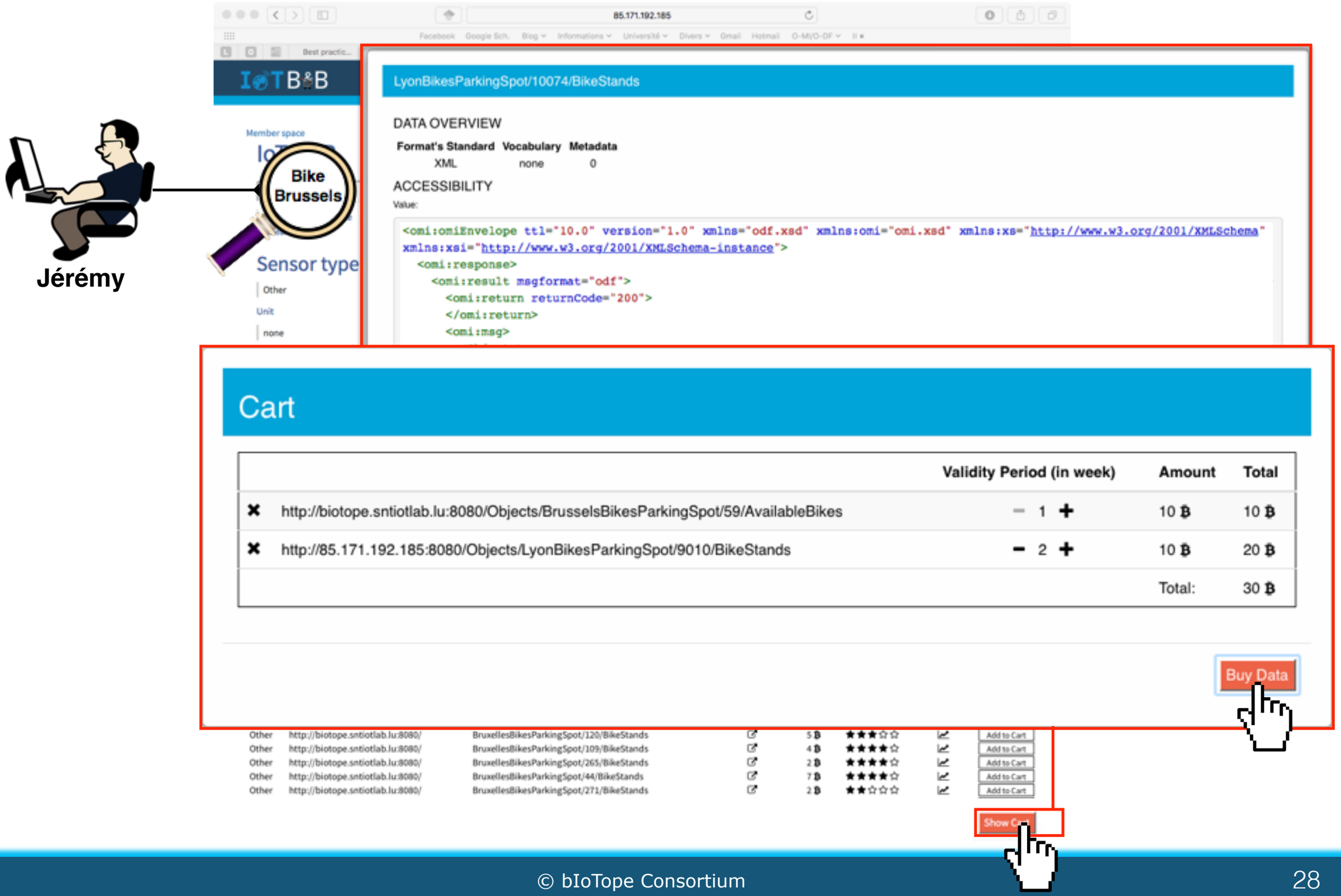

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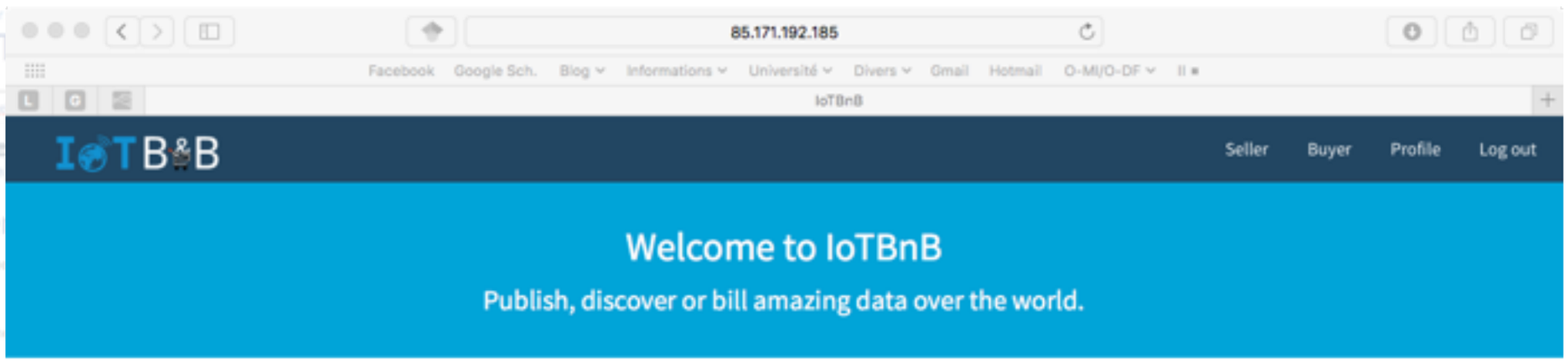
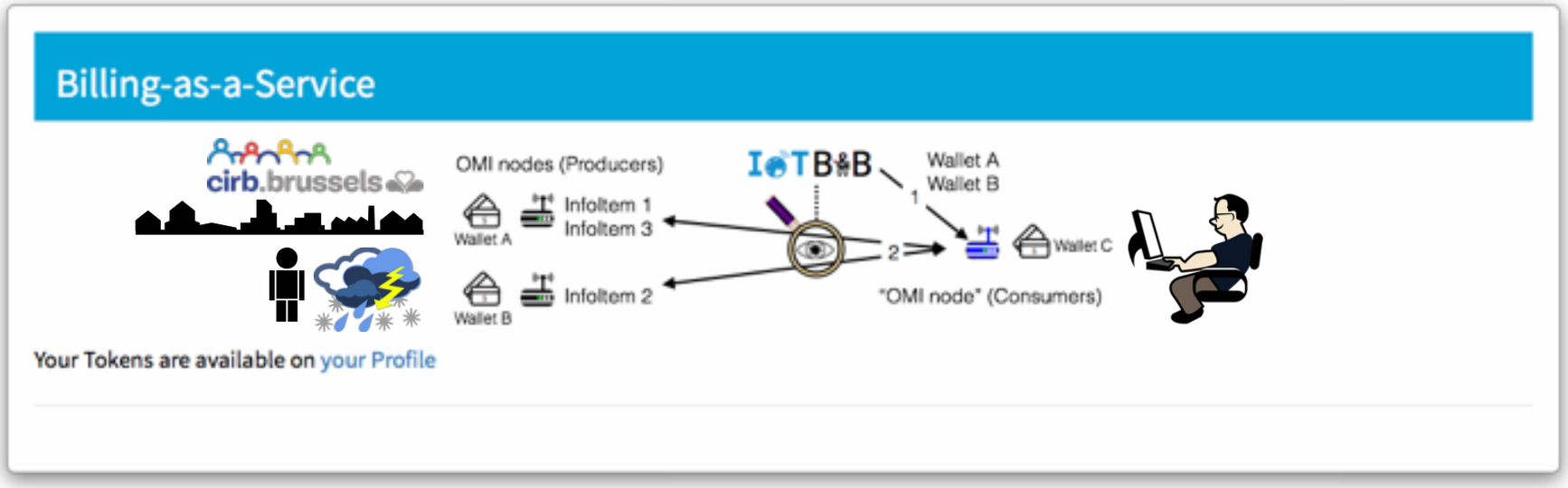
Jérémy





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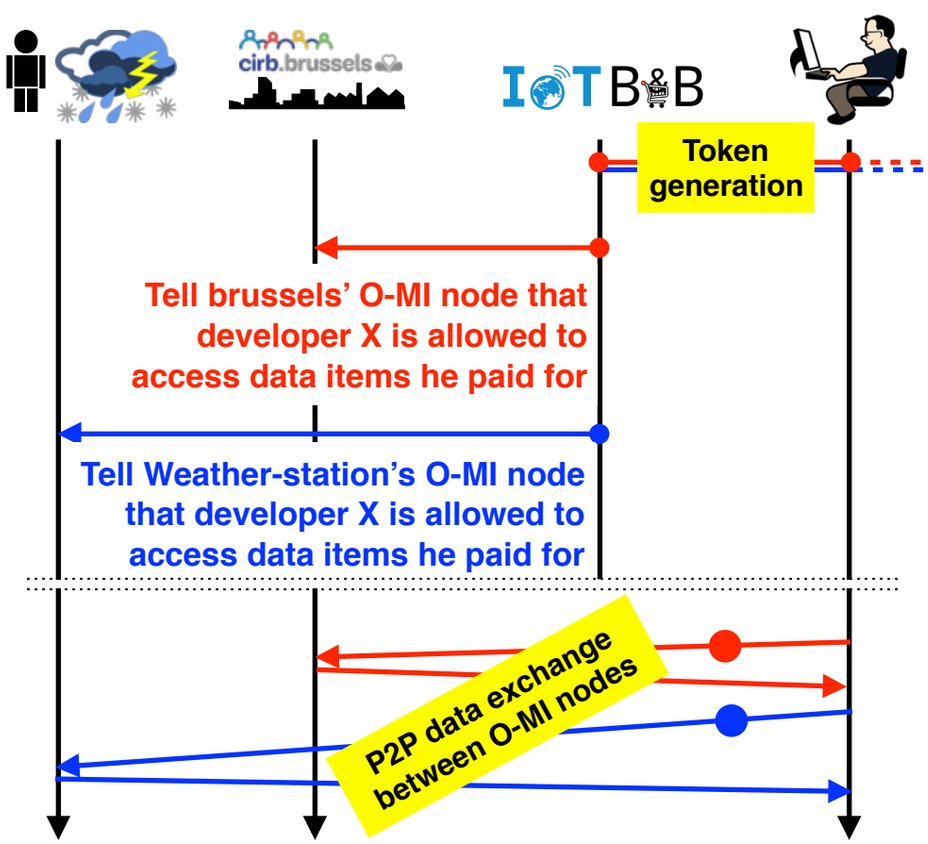
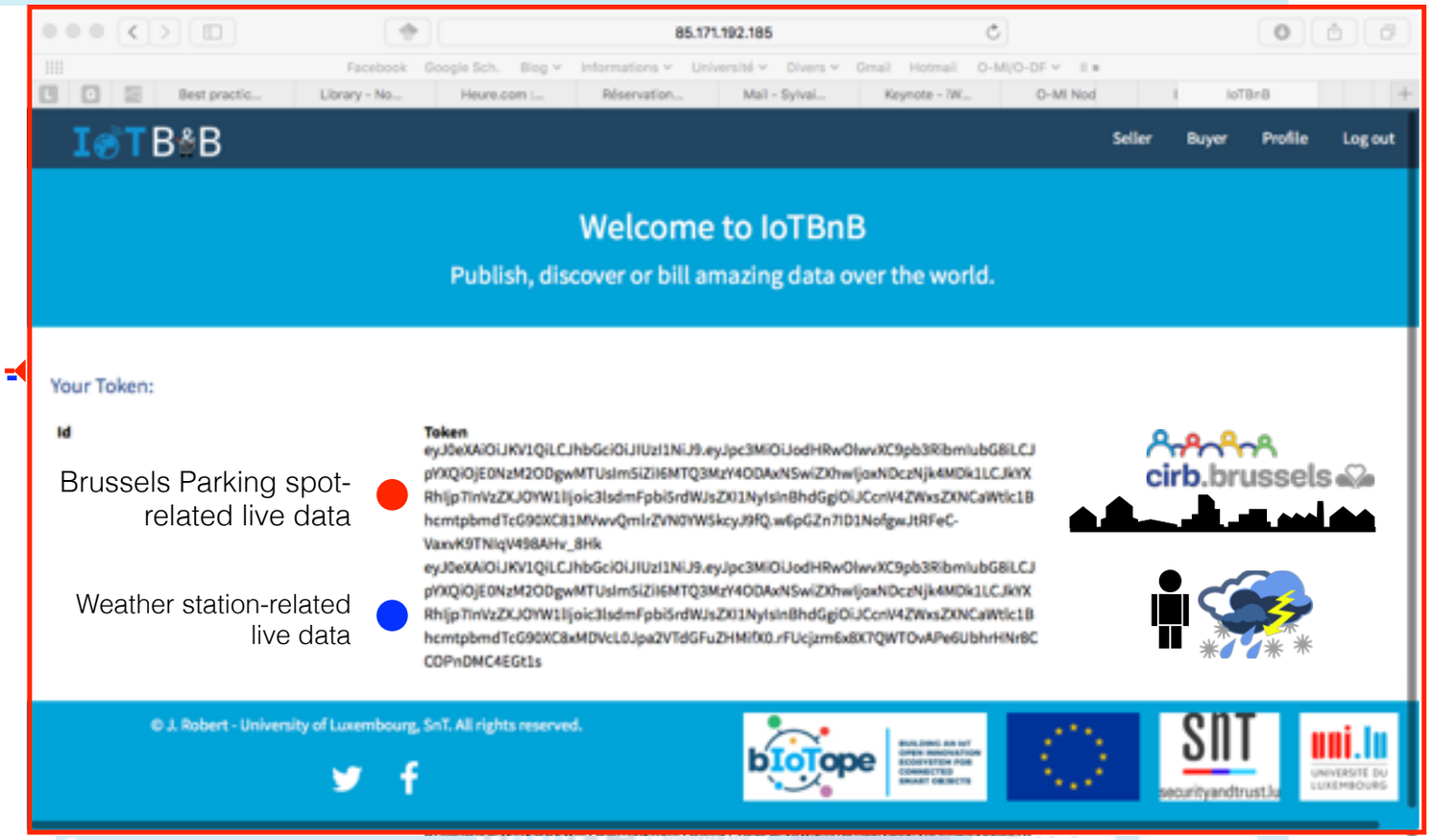
Jérémy





Development stages:

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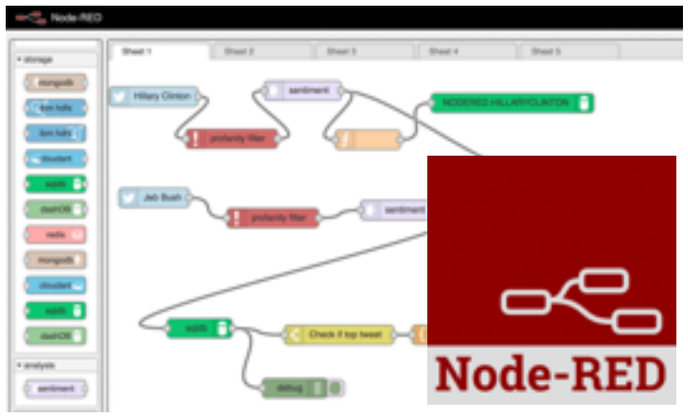
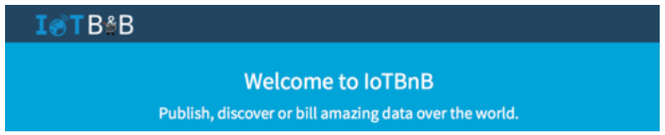
Jérémy

My favorite IDE



. . .

bIoTope Service Marketplace



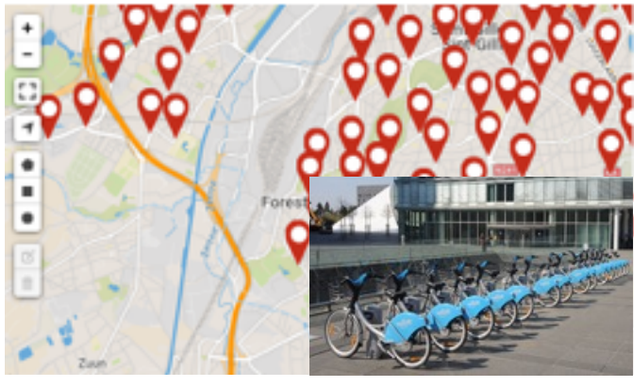
O-MI Node Brussels

O-MI Node Weather-data

O-MI Node Smart bulb

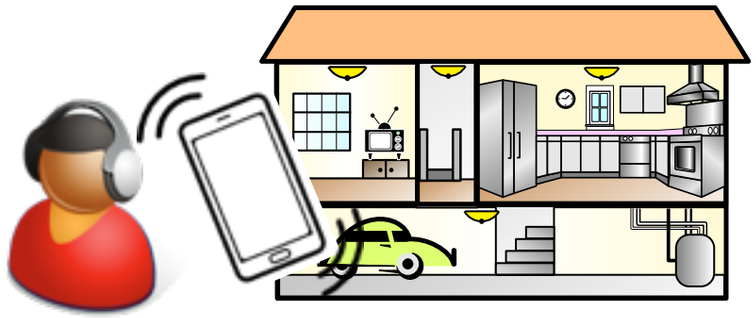
O-MI/O-DF standards + Standardised vocabularies (schema.org, SSN…)

JCDecaux API



Netatmo API

Hue API



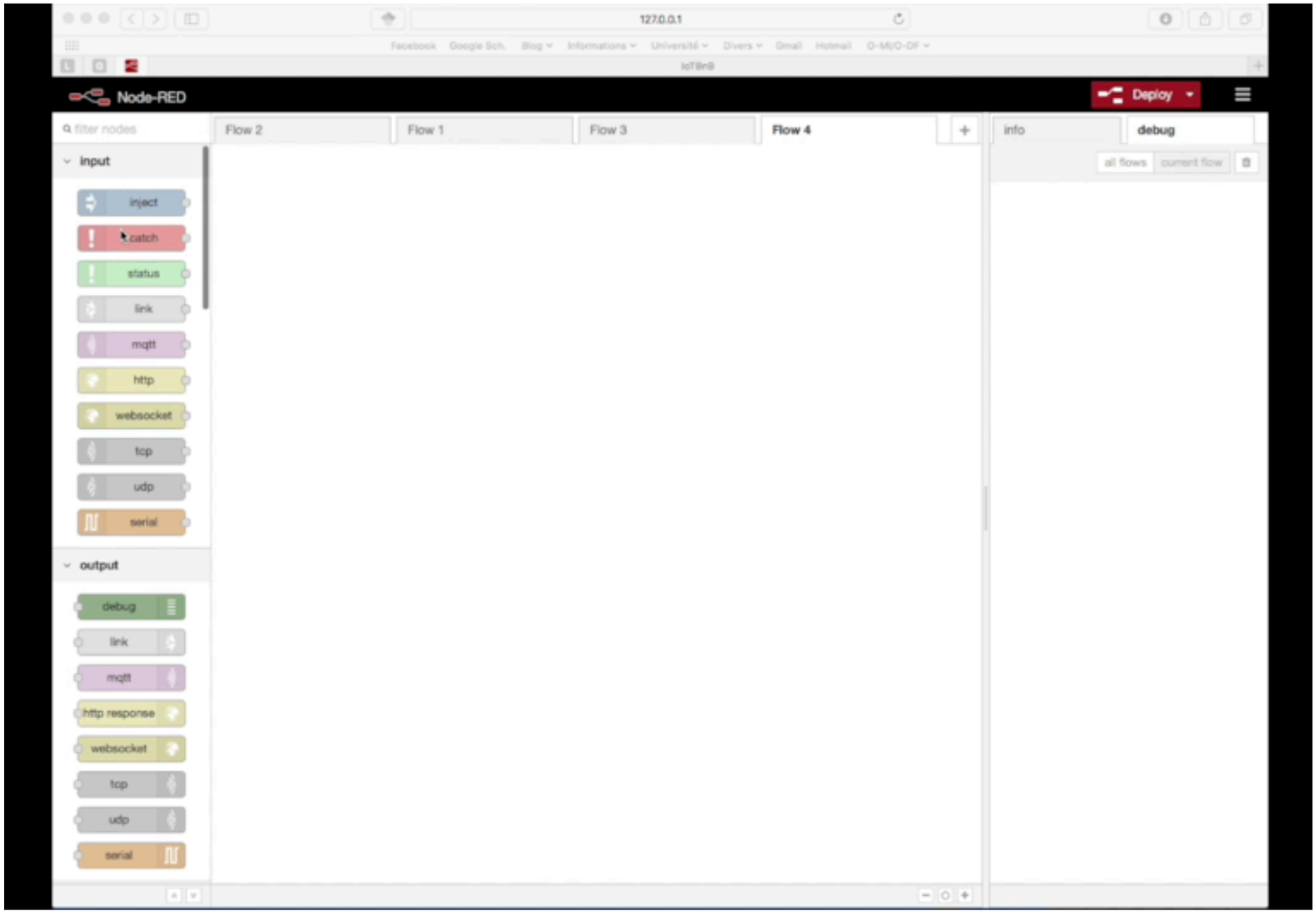
Development stages:

Search for data sources → Pay for accessing them (if needed) → Token generation → Re-Use Token in your IDE

Jérémy

Node-RED

My favorite IDE



Peer-to-Peer IoT data exchange (depending on access rights)

Demo Part 1

4

IoT Visual Programming Tools

bitreactive

Node-RED

. . .

3

Discovery-as-a-Service
Billing-as-a-Service

Service Catalog

2

Check the following Video clip (Demo):
https://www.youtube.com/watch?v=OueY3o-Rf_4

Information-as-a-Service

Standardised Service Description & Messaging Interfaces (O-MI/O-DF)

O-MI O-DF

Internal Agent

Java
Scala
https://github.com/AaltoAsia/O-MI

External Agents

Node-Red
Shell-script
...

http://www.slideshare.net/skubler/how-to-publish-iot-dataservices-from-your-own-iot-environment-nodered

www.slideshare.net/skubler/how-to-publish-iot-dataservices-from-your-own-iot-environment-scriptshell

Objective 5:
Towards more cognitive IoT applications

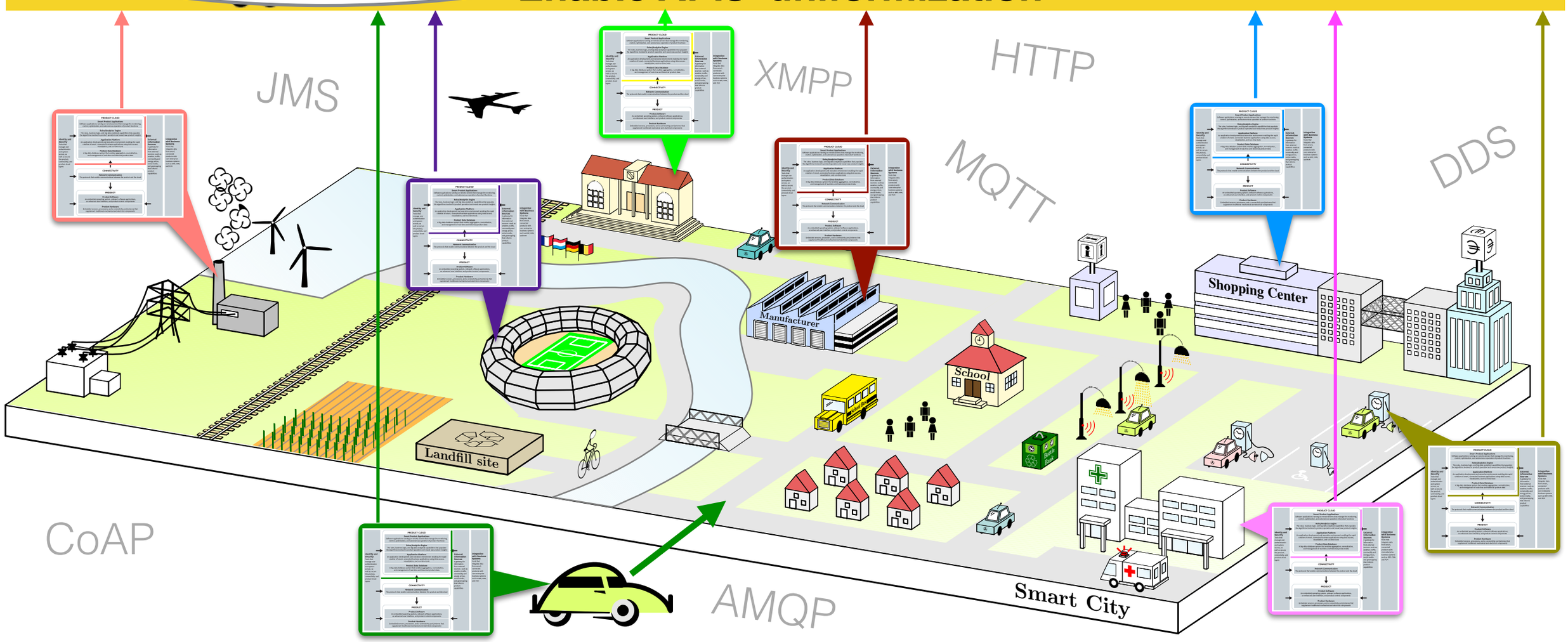
Investigate and develop more autonomous and cognitive IoT systems

Investigate and develop more efficient P2P Identity & security management in the IoT

Enable IoT developers to both publish and discover — *in an efficient manner* — relevant services for their own business

Extend [illegible] and -independent vocabularies for enhanced service description

subscription…) to enable P2P data exchange between smart systems

- Need for "cognitive" systems (**Context-Aware computing**)
- Need for **Ad-hoc Security** mechanisms
- Need for a **Service Market Place** to foster co-creation
- Need for **Standardised (Semantic) Vocabularies**
- Need for discovering and accessing available services (across IoT platforms) in a **standardised & uniformed manner**

Enable APIs 'uniformization'