WoO Approach General Overview

WF-IoT 2014

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6th Of March 2014

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Scientific and Business Context

Context – IoT and WoT gather more and more devices

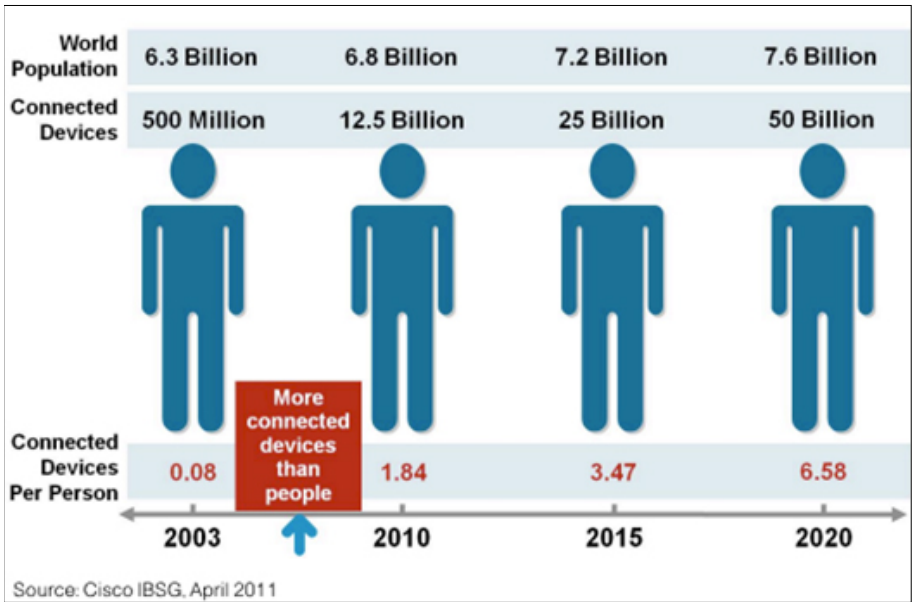
IoT boom:

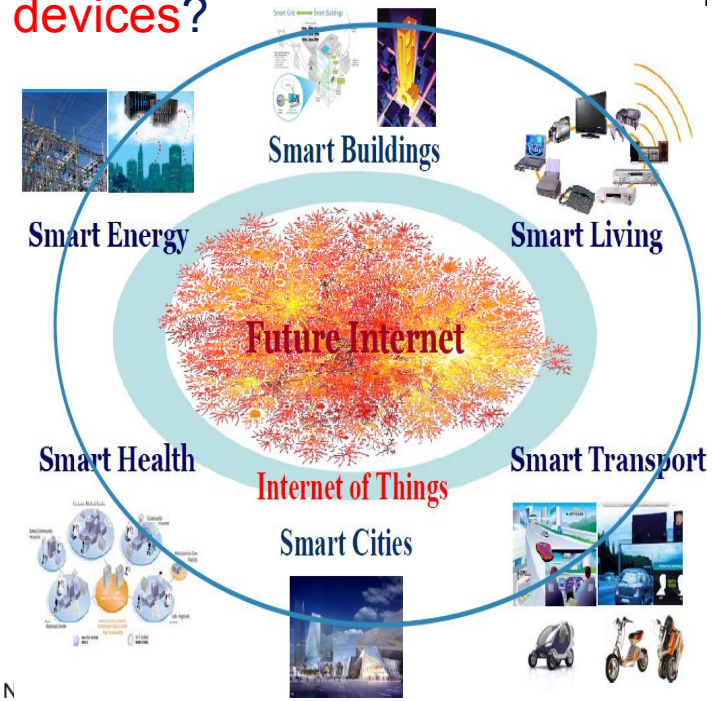
- **Since 2007: more devices than people are connected to Internet** (Cisco IoT IBSG, 2011)
- **In 2020: 50 billions devices will be connected to Internet** (Ericsson, 2011)
- In 2020: the global M2M business (large industry, solution providers, connectivity providers) will reach 260 milliards Euros (Machina Research, 2012);
- By 2020: IoT will add $1,9 trillion to the global economy (Gartner, 2013)

=> huge business application development (WoT & Future Internet boom)

People connected to Internet resulted in Web 1.0, 2.0, 3.0 … applications

What can we imagine about the future of the connected devices?





Context – status of IoT and WoT business

Huge deployment of smart devices and sensors, resulting in huge amount of data collected, not exploited in real-time, nor outside a closed system:

- **Smart metering => filtered data is selected for billing purposes, and various statistic analysis are accomplished**
  - If a third party (e.g. insurance company) is interested in specific data, no legal framework and no technical support
- **Smart homes**: each equipment is able to switch in secure mode, and to send information or alarm messages, eventually to receive remote control commands
  - France: government investment in “sensing” the elder people homes

Example of « Sensor Map » type platforms:

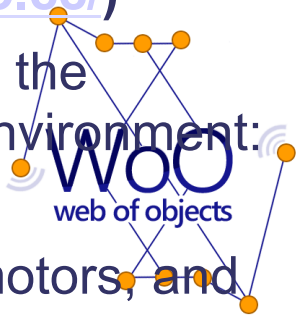
- Citysense (by Sense Networks): http://www.citysense.net/
- Sensor Map (by Microsoft): http://atom.research.microsoft.com/sensewebv3/sensormap/
- **QEO (byTechnicolor)** http://www.i-speak-qeo.com/events.php

→ **Integrated solutions requiring that the proprietary bricks are adopted by all parties: service providers, device providers, application developers**

→ **involve network connectivity providers, such as the SIGFOX dedicated M2M/IoT network: btw objects, SI, Internet**

Controlling devices: open-source Solutions (hw&sw)

Arduino electronics prototyping platform (http://www.arduino.cc/)



- A board with a microcontroller , that could be programmed using the Arduino programming language and the Arduino development environment: free software available
- receives input from a variety of sensors and can control lights, motors, and other actuators
- can be stand-alone or they can communicate with software running on a computer (e.g. Flash, Processing, MaxMSP).

Phidgets - http://www.phidgets.com/

- A box (in various assembling formulas) connecting USB sensors & devices to be controlled from a PC
- Applications for controlling devices could be quickly developed in various languages based on the provided **APIs**

Sense Mother, with **Motion Cookies** for connecting every day objects

!!! The Internet and Web aspects are not considered

Ninja Block and Twine: sensor box connected and controlled via Web

Controlling devices: proprietary solutions

Device producers adopt proprietary solutions:

Siemens

- https://www.siemens.be/cmc/ccmi/smarthome/fr/particulier/

Schneider

- http://www.schneider-electric.com/products/ww/en/

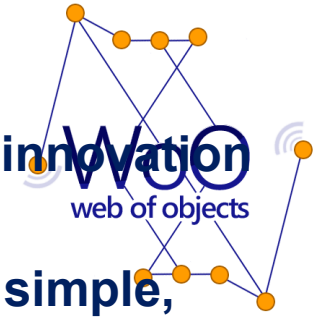
Some specific APIs are provided to public:

Philips Hue API: intelligent lighting

- together with this **API**, Philips provided a **software development kit** (SDK) **for iOS developers** who want to make their own mobile apps to turn off, dim, time or sync their Hue bulbs
- communication between the device (light bulb) and iPhone is done via the ZigBee Light Link low-power wireless protocol.
- Application examples:
  - app that syncs the light bulbs with music
  - app that uses the iPhone's calendar to schedule when the lights should be on
- See http://iotevent.eu/philips-offers-ios-sdk-for-hue-the-connected-lightbulb-

Common efforts towards a business expansion of IoT

Allseen Alliance - https://allseenalliance.org/



- the broadest cross-consortium to advance the adoption and innovation in the "Internet of Everything" in homes and industry
- The idea: devices, objects and systems can be connected in simple, transparent way to enable seamless sharing of information and coordinated and intelligent operations across all of them
- Devices and services become able to discover, connect and interact
- Pave the way to consumer oriented applications development
- Initial framework is based on AllJoyn open source project
  - the products, applications and services created with AllJoyn can communicate over multiple transport layers (Wi-Fi, power line or Ethernet) regardless the manufacturer or operating system and without the need for Internet access
  - Versions available for Linux, Android, iOS and Windows

=> Adoption of open-source as fundamental approach

WoO Project Focus at a Glance

Web of Objects project focus

WoO focus: building application layer over the IoT infrastructure

⇒ Providing support to business players to involve heterogeneous objects in complex applications for improving our quality of life

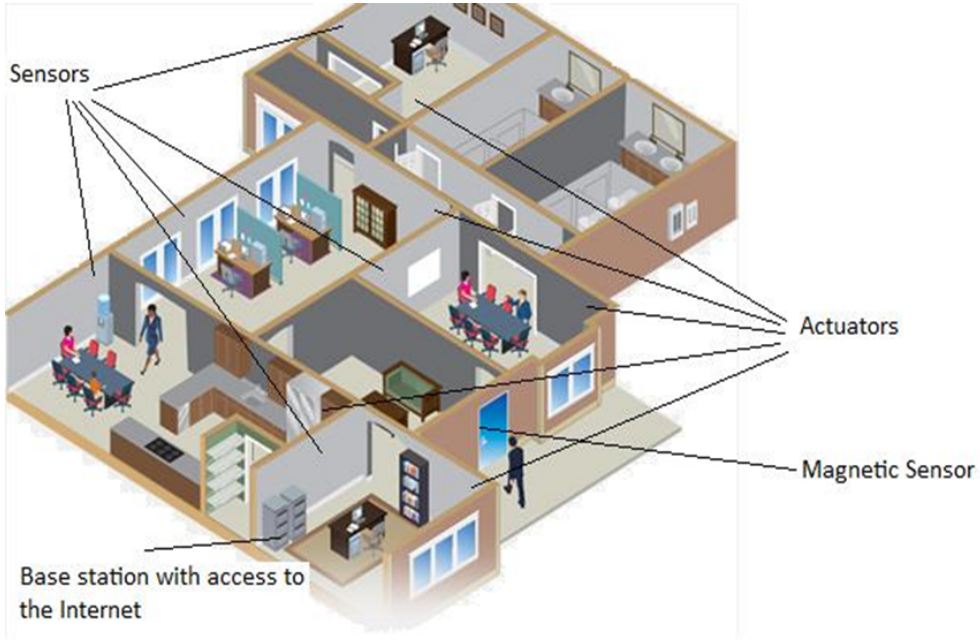
Ex 01: incident management

- real-time alarm processing leading to stakeholders coordination could **save lives and resources**
- **Objects are active players:**
  cameras turns to the scene
  and
  notifies security agent,
  door closes,
  electrical equipment
  asks for being rescued,
  water plug notify its
  presence to fireman, etc;

Web of Objects project focus

Ex 02: communicate with the environmental objects

- Instead having a lot of “cards” that duplicate your profile
- Use your NFC-enhanced Smartphone for communicate with: your home, your car, mall parking, restaurants or shops



Ex 03: climate control and energy saving

- By exploiting occupancy information in building

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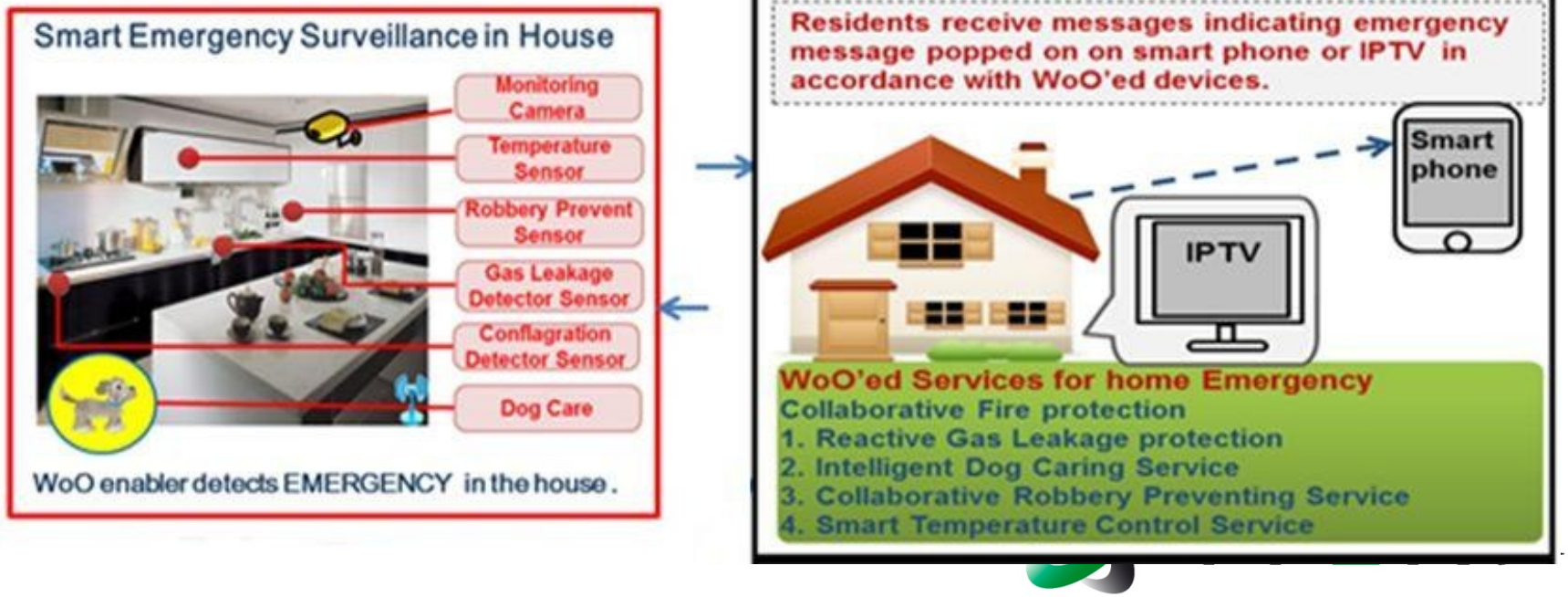
Web of Objects project focus

Ex 04: smart emergency services

- Multiple types of objects in Home and Shopping Mall collaborate to provide customer-centered emergency service capabilities through semantic ontology and context awareness mechanism
- Dynamic creation of device/user community for customer-centric service features (e.g., for normal persons, handicapped persons, children, etc.)



WoO Approach – Innovative Solutions for Critical Issues

Semantics is a key enabler for a common language such as:

- A device (belonging to a particular or to a institution) is accessible and to third parties applications (government, police, fire agency, hospitals, shops, restaurants)
- A complex application for smart city integrate as actors devices from multiple stakeholders

Service composition is a strong requirement since:

- Complex business applications are based on complex service workflows

Interoperabilty

- The number and diversity of communication protocols between these devices are for any industrial system a real Babel tower

Security is a strong requirement since:

- Exposing a device on the Internet increase its security vulnerability

Key Enablers for the WoO approach

Better exploiting the Smartphone Sensors

- Gloo platform: Integrating the smartphone capabilities in the Web of Things

Standardization efforts was seriously considered:

- IoT solution can be adopted by Business world if based on standards

WoO Project Structure

Project Consortium

- 25 Partners:

- **Large companies (6)**
- **SMEs (7)**
- **Universities (7)**
- **Research institutes (5)**

Canada

Spain (7)

France (7)

Egypt (3)

Korea (7)

WP7: Exploitation of Results

The main project result:

service infrastructure for IoT business applications

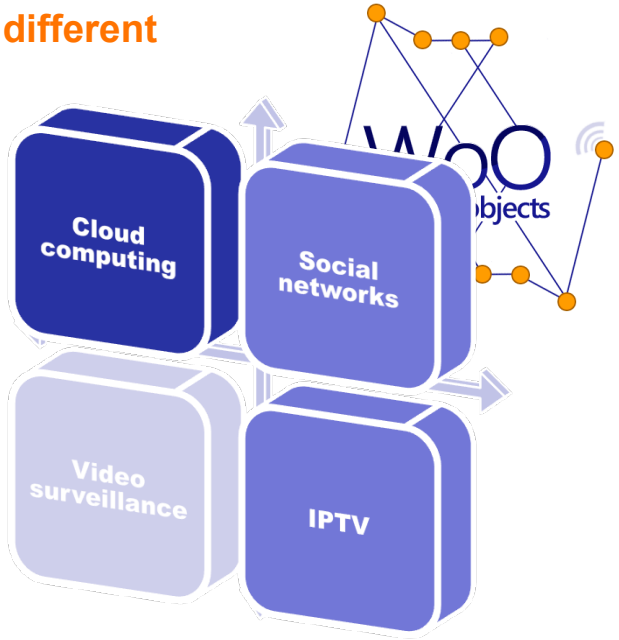
based on standardized protocols enabling:

- Multi-tenancy of devices & services
- interoperability sensor services,
- service discovery and composition,
- dynamic configuration

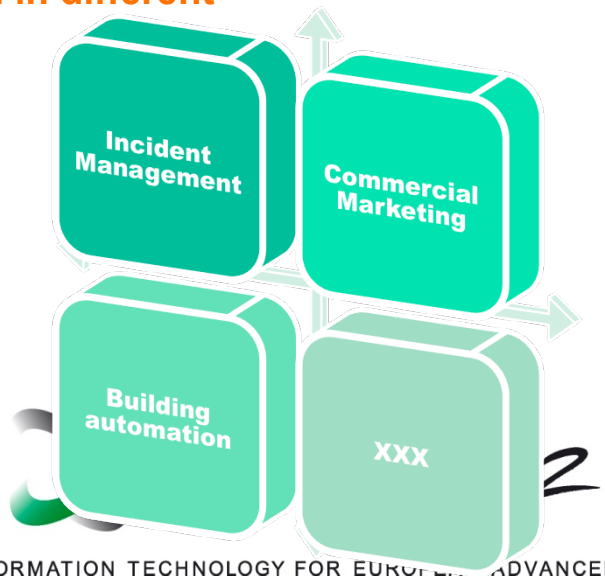
and including:

- Semantic annotation tools
- Semantic service orchestration framework

Integrated with different Technologies:



Instantiated in different domains:



WoO Architecture

Application Creation

WoO Frontend

- Access Tools
- Representation Tools
- Composition Tools
- Sharing Tools
- Admin Tools

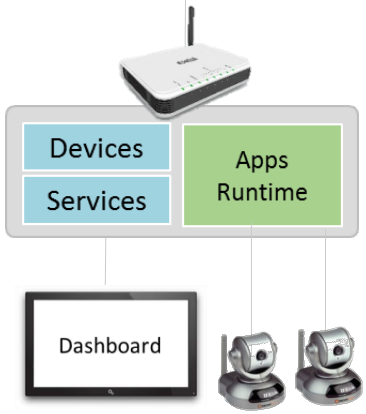
WoO Backend

- Registry
  - Devices
  - Services
- Domains
- Data
- WoO Apps
- Apps Runtime

WAN

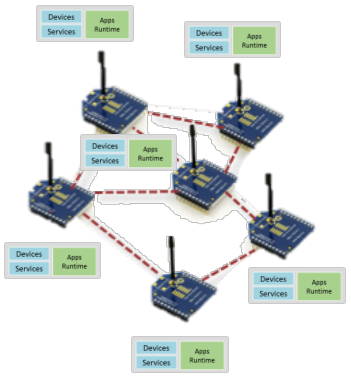
LAN

Device Exposure / Description / Gateways-based interoperability

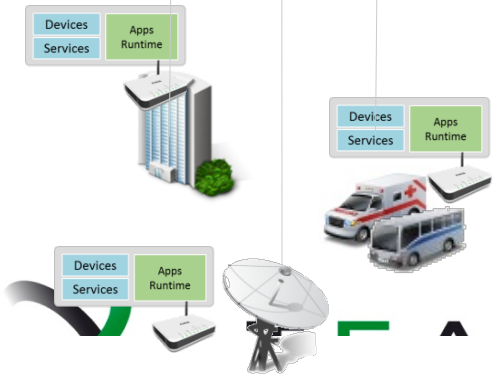


Local WoO Devices + Gateway

WoO Connected Devices

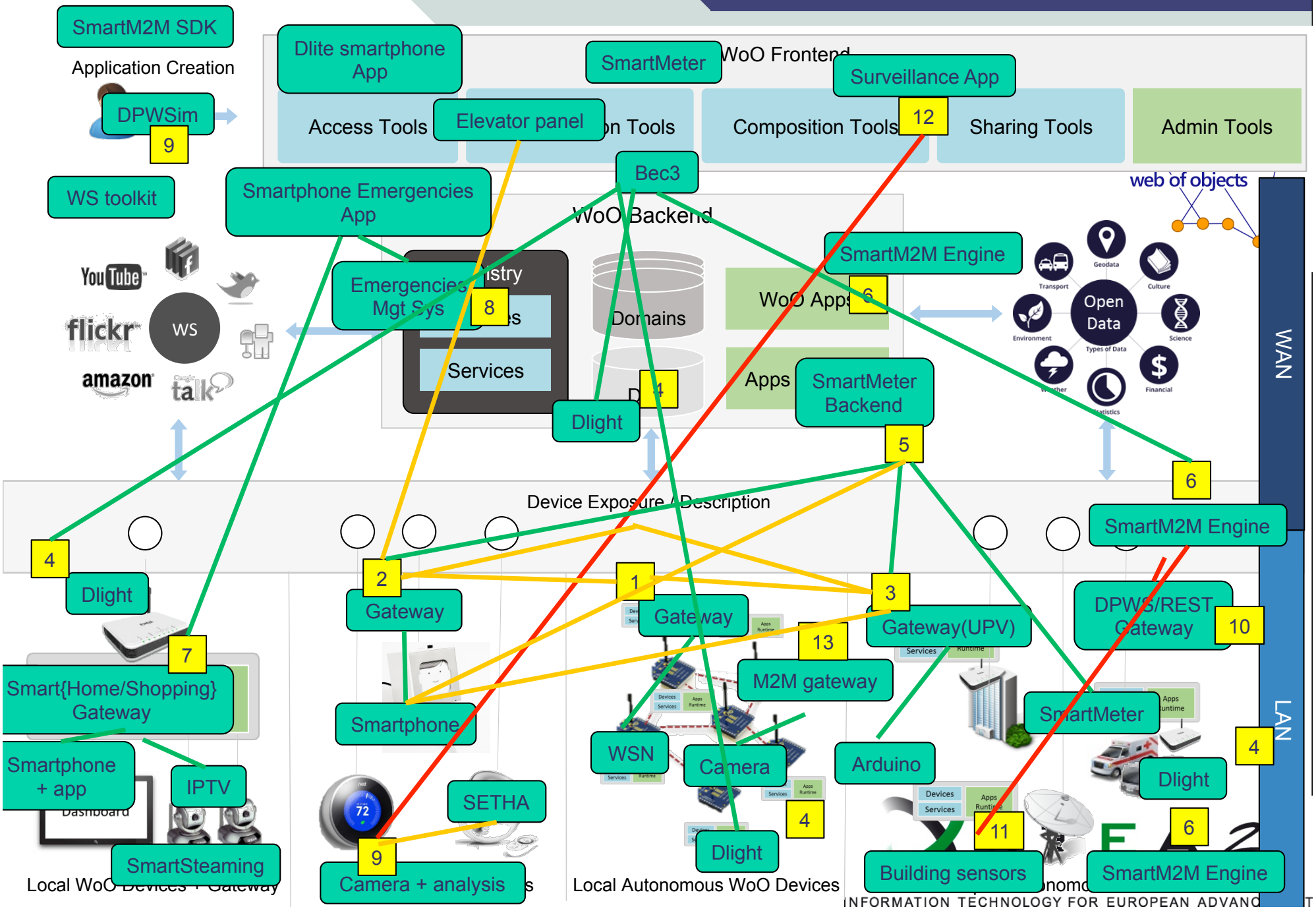


Local Autonomous WoO Devices



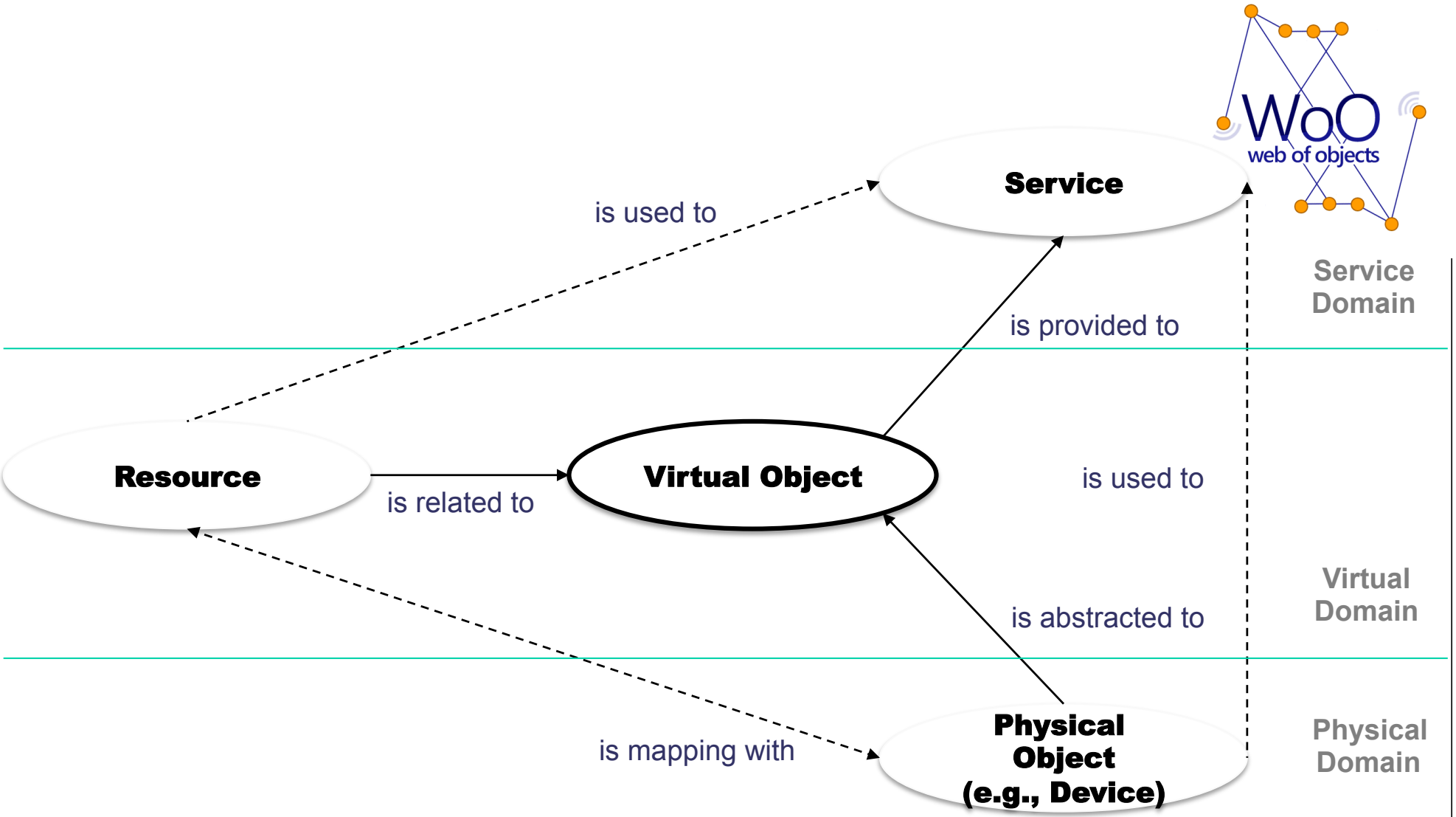
Public / Open Autonomous WoO devices

La carte des composantes et de leur dependences



WoO Innovative Approaches

WoO Semantic Approach



Main advantages:

- **Reusing of the objects and their services**
- **Matching with a cloud computing integration**

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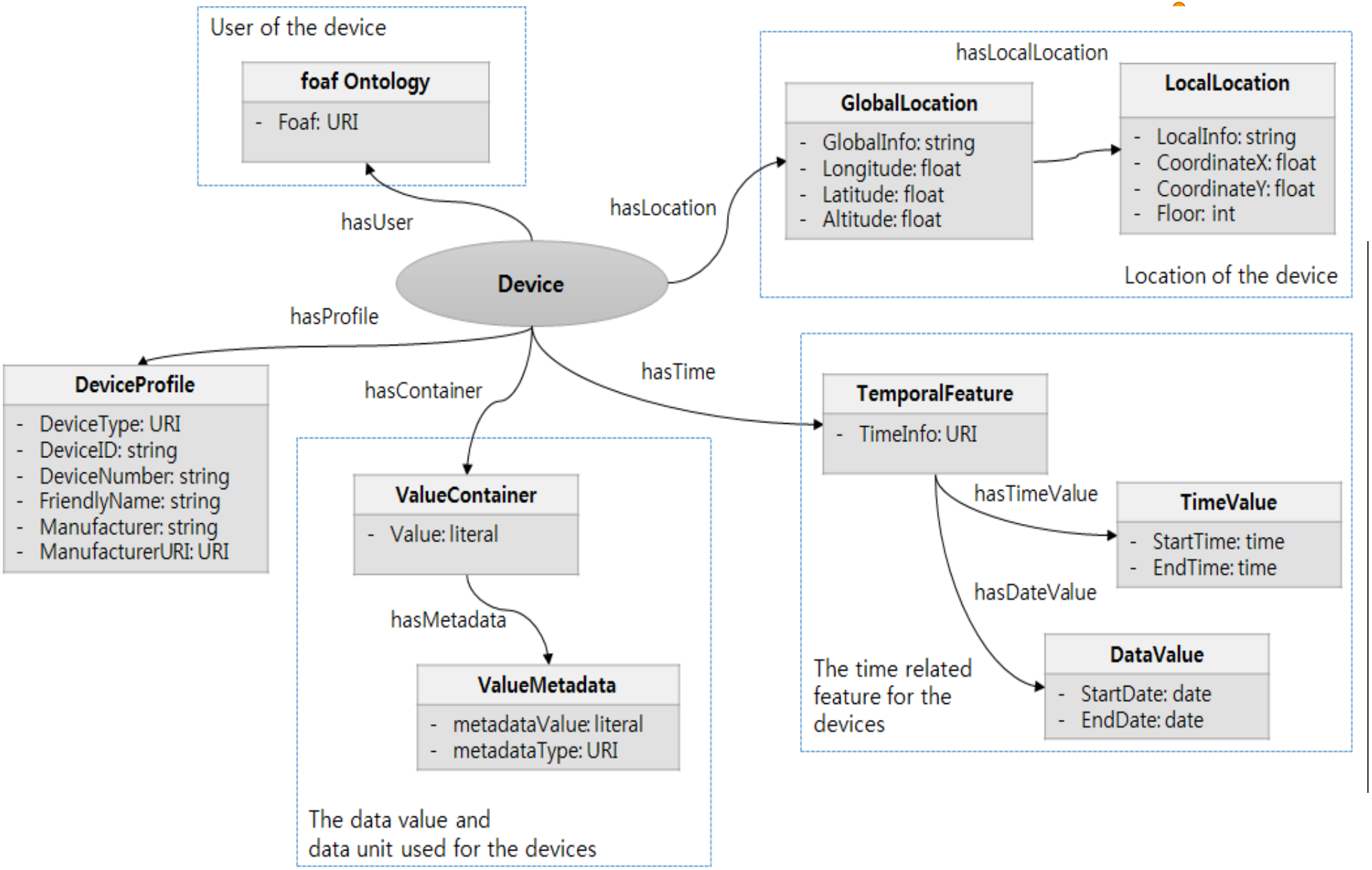
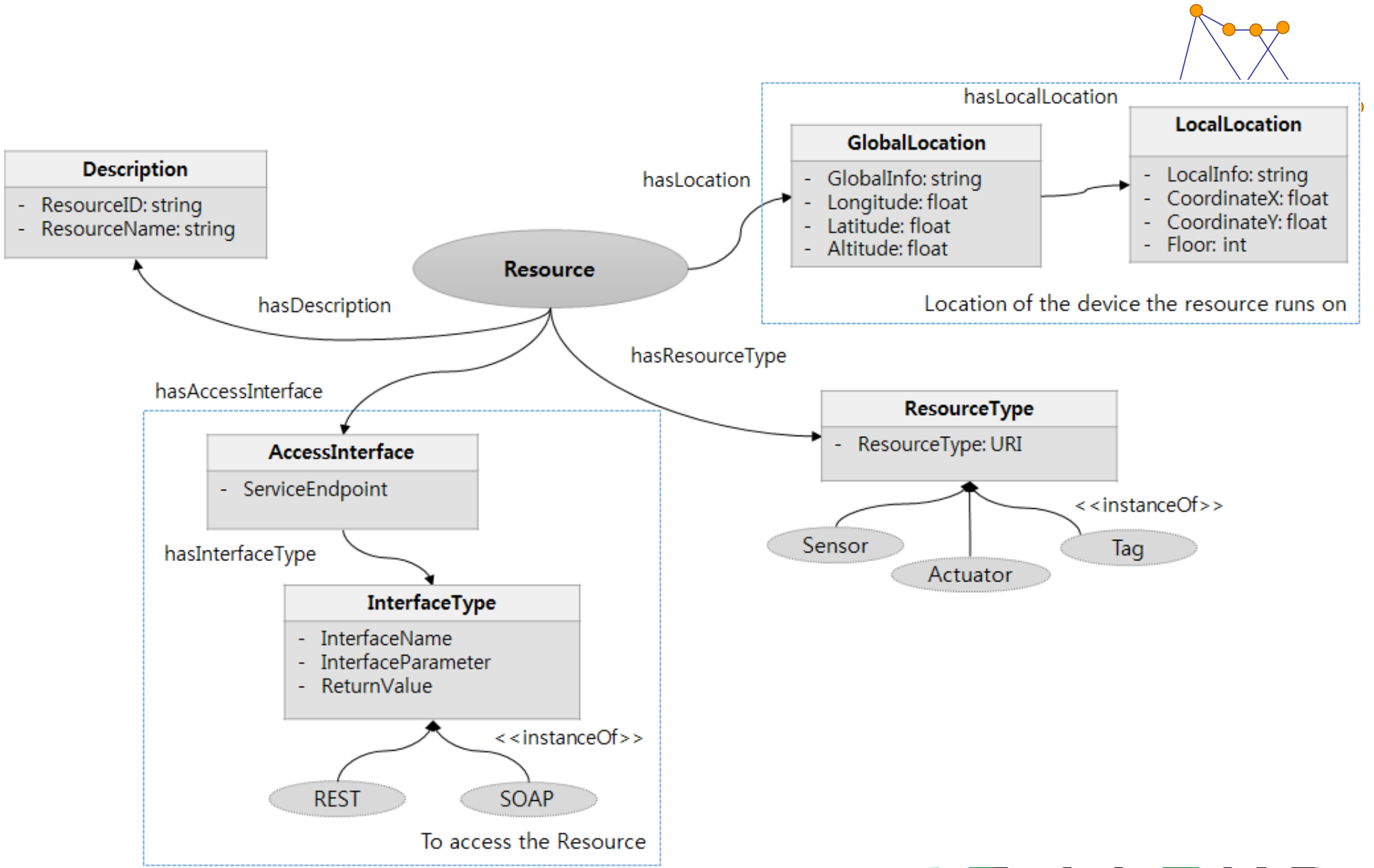
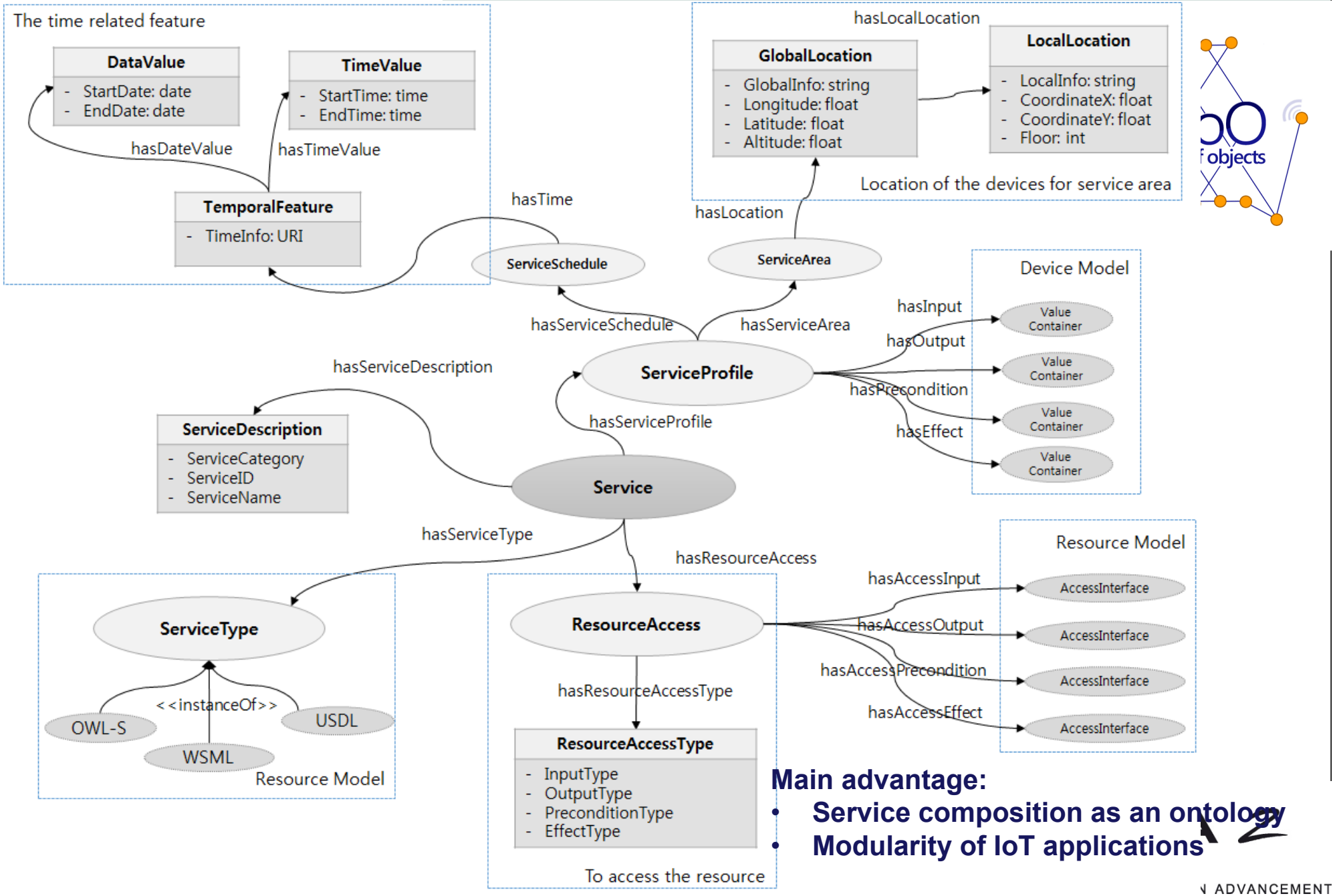
WoO Semantic Approach: Device Model



WoO Semantic Approach: Resource Model



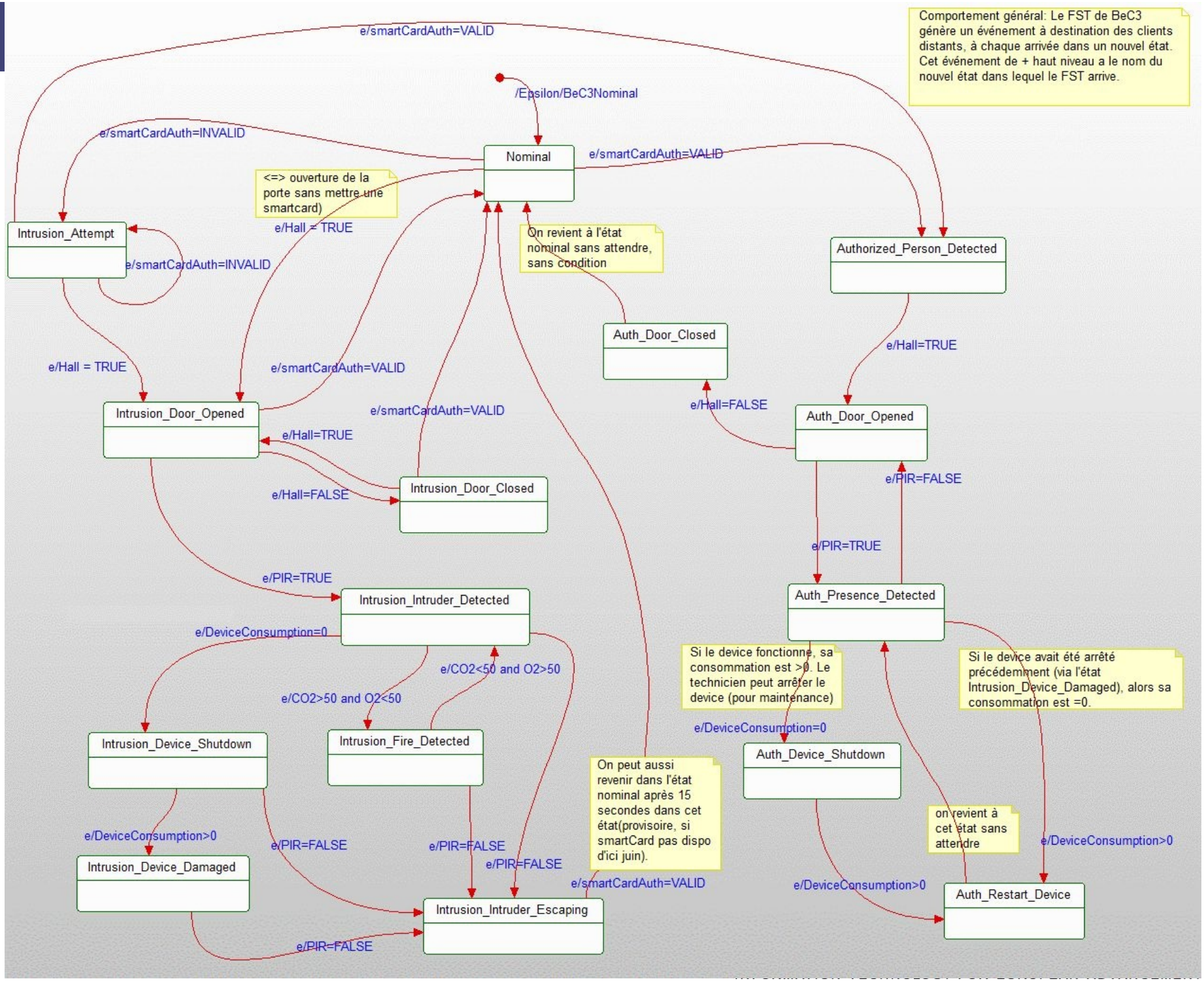
WoO Semantic Aproach: Service Model



Main advantage:

- **Service composition as an ontology**
- **Modularity of IoT applications**

WoO – Business Workflows are employed to define choreographies

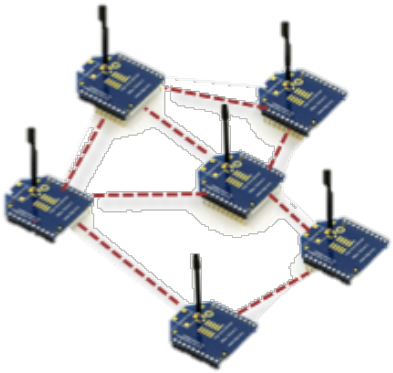


Dlite API for Your Devices

How does it work ?

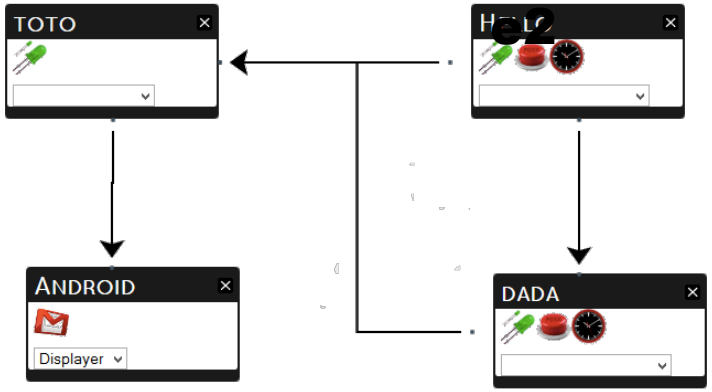
Java/Internet Capable Device

No Java/ Internet Device



Java/Internet capable Gateway

Dlite API



Abstracted View of Devices on BEC3

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WoO Interoperability solution - SHT smart engine

Objects interoperability issue

Today connected-objects (sensors, actuators, industrial devices/system) « are talking » amongst themselves (M2M / Internet of Things), but often in different languages.

The number and diversity of communication protocols between these devices are for any industrial system a real Babel tower:

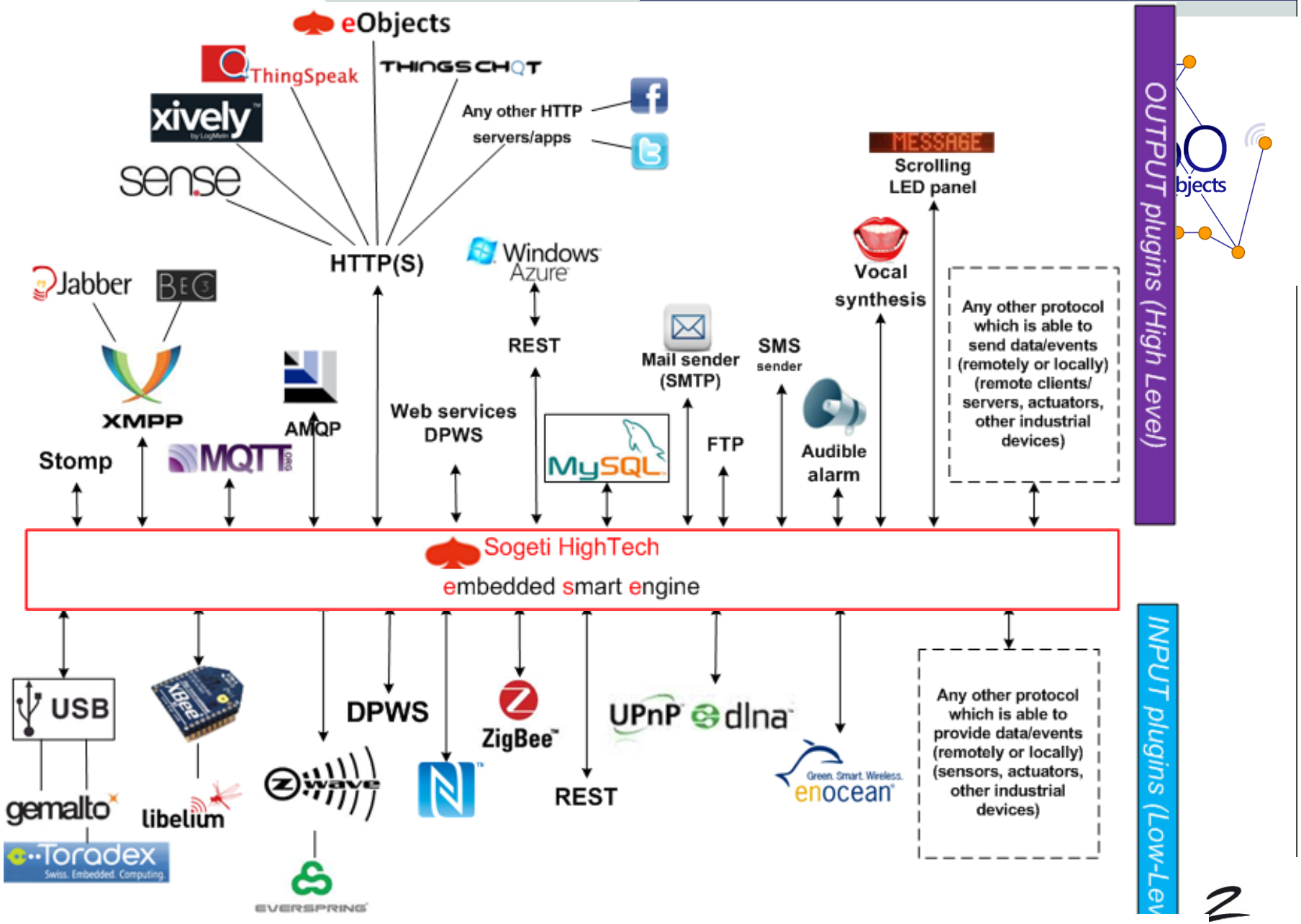
ZigBee	Z-Wave	1-Wire	PLCBUS	KNX
xPL	DMX	DALI	BACnet	6LowPAN
MODBUS	PROFIBUS	CAN	IRDA	WS-*
RFID	NFC	Teleinfo	XBEE	GPRS
GSM	Ethernet	Wifi	TCP/IP	UDP
SNMP	SOAP	HTTP	FTP	SMTP
Bluetooth	RS232	RS485	I2C	USB
REST	and many others…			

Our clients need a solution to :

➔Provide communication between heterogeneous devices with or without local/remote management system

➔Get heterogeneous data and events / Configure devices remotely / Call services.

WoO Interoperability: SHT smart engine – Big picture

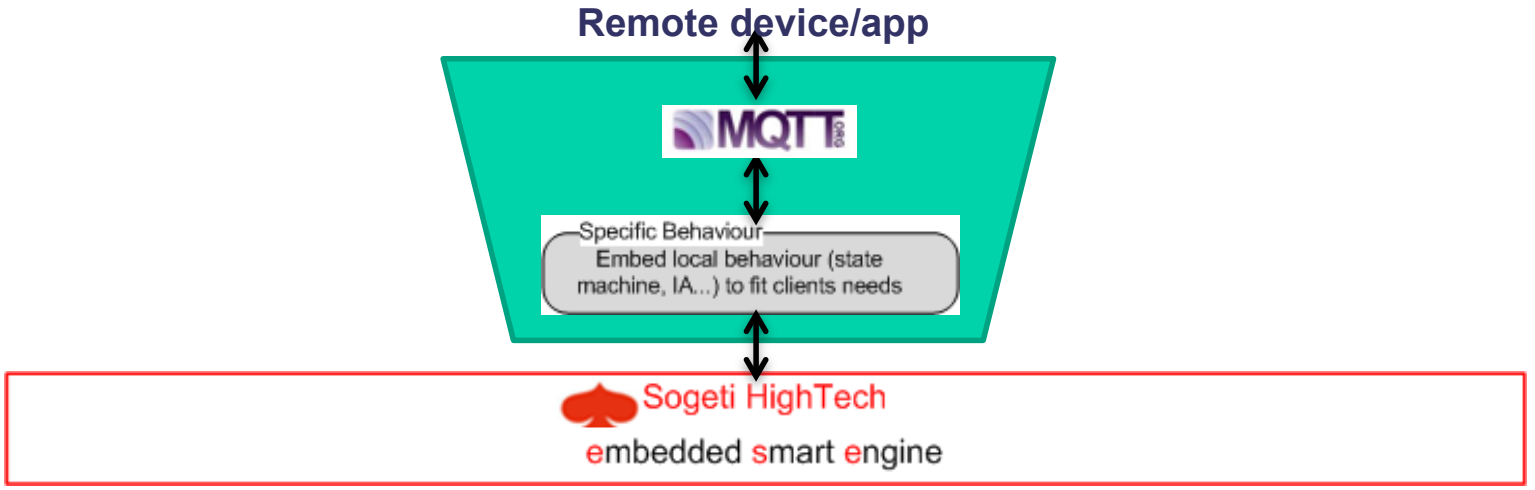


Connect everything, everywhere, easily.

WoO Interoperability solution - SHT smart engine

Adding specific local behavior to plugins

Specific local behavior, specific intelligence**, can be added to any input /output plugins.**



For example, adding a behavior to take into account data coming from different kind of sensors, and correlate them in real-time to output new higher-level events.

This behavior can be a simple embedded state chart, or a bigger intelligence artificial engine if needed.

This optional behavior, specific to each plug in, allow the implementation any kind of scenarios and business cases.

Web of Object Security challenge

Exposing a device on the Internet increase its security vulnerability:

- Hacking IoT devices is a trend in security conferences
- a Mozilla software developer demonstrated how to gain access to hotel rooms protected by key card locks made by Onity
- As for computers, new worms are able to infect home routers, set-top boxes, security cameras, and other consumer devices
- Real life incidents:
  - web-based vehicle-immobilization system disabled more than 100 vehicles in Austin (Texas);
  - a hacker gained access to a baby monitor;

WoO efforts towards increased WoT security (semantic-based approach):

- Considering all security parameters
- Ensuring security at multiple levels
- Deploying multiple security mechanisms

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Security aspects of the WoO

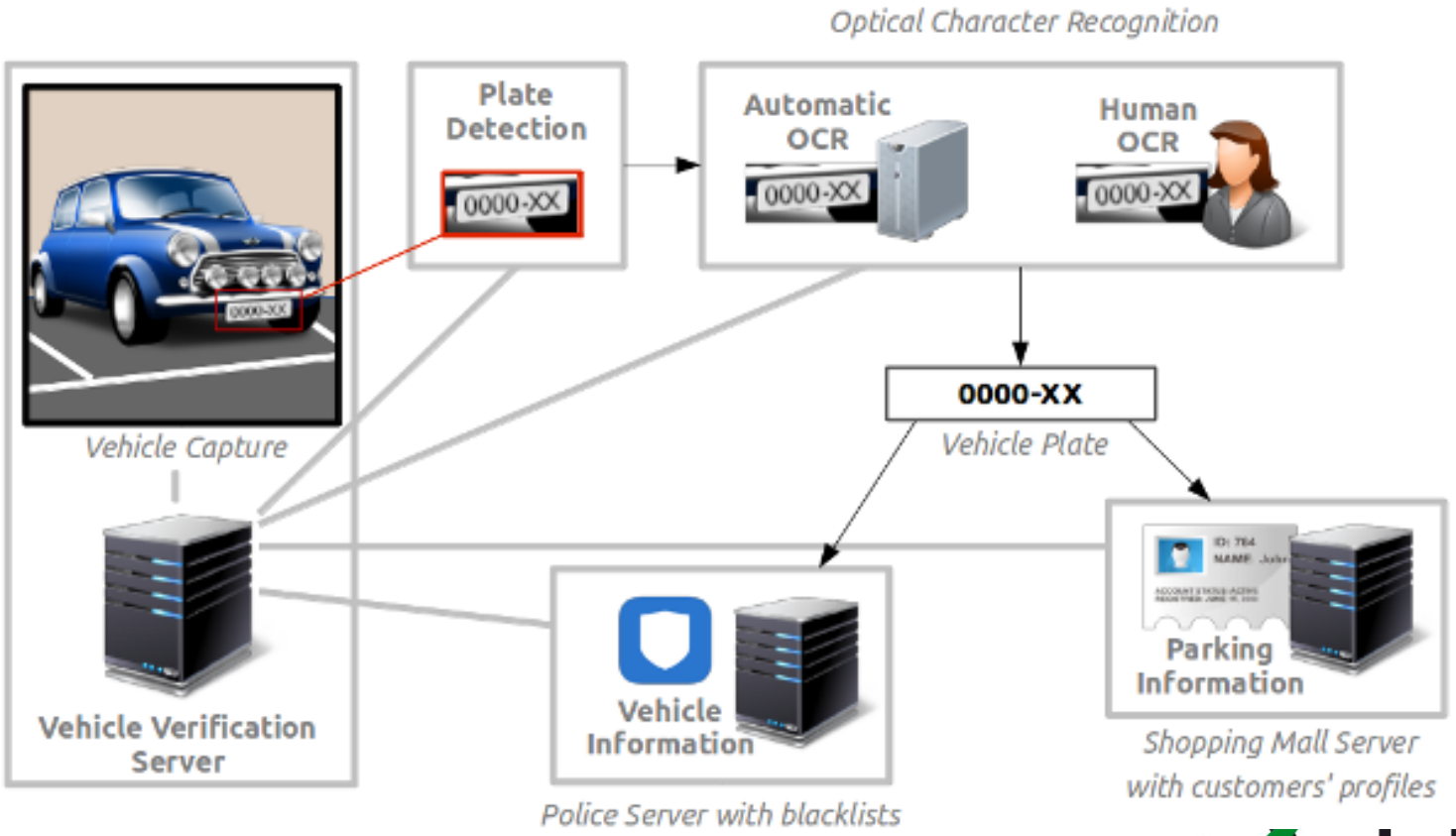
Contributions of WoO

- **Context management and security policies**
  - Decentralized management of the user's profile
  - Different view of the profile according to the current context
  - Group management and key distribution
- **Privacy of the user's profile**
  - Hiding sensitive information
  - Distortion of the user's profile
- **Accessing services**
  - Traditional security: object authentication, user authorization
  - New secure services: oblivious databases
- **Recommending objects, services and content**
  - Search for content and objects w/o leaking preferences

Security aspects of the WoO

Step in the WoO demonstrator

- **Private authorization of location-based services**
  - Demonstrates the use of homomorphic encryption to provide oblivious databases



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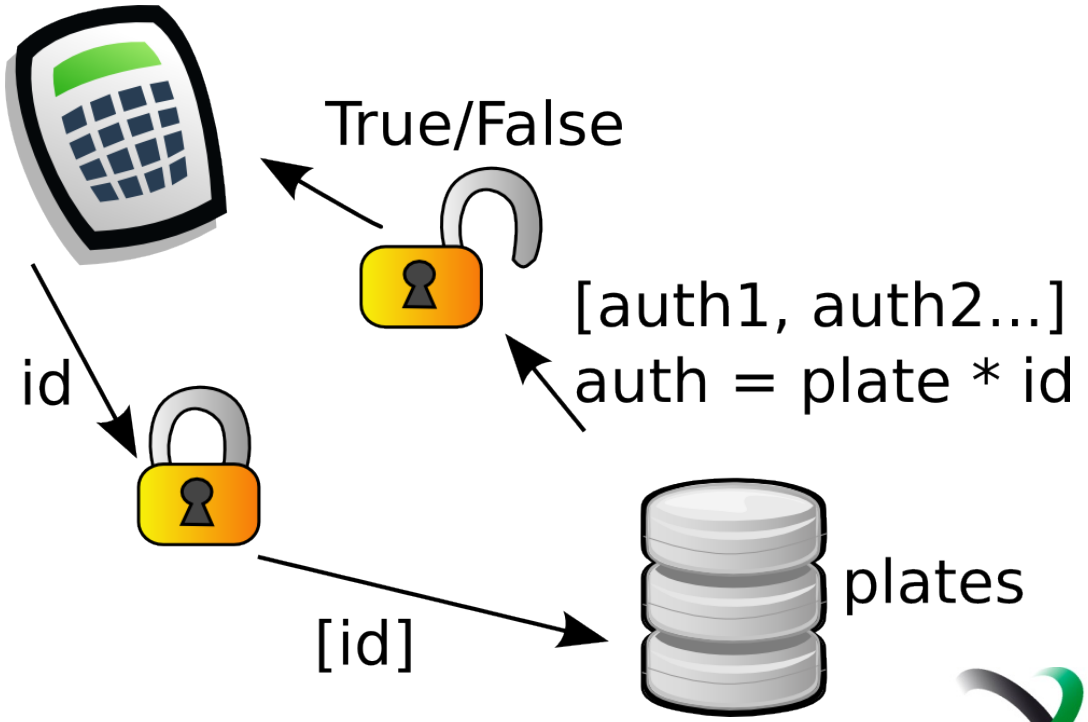
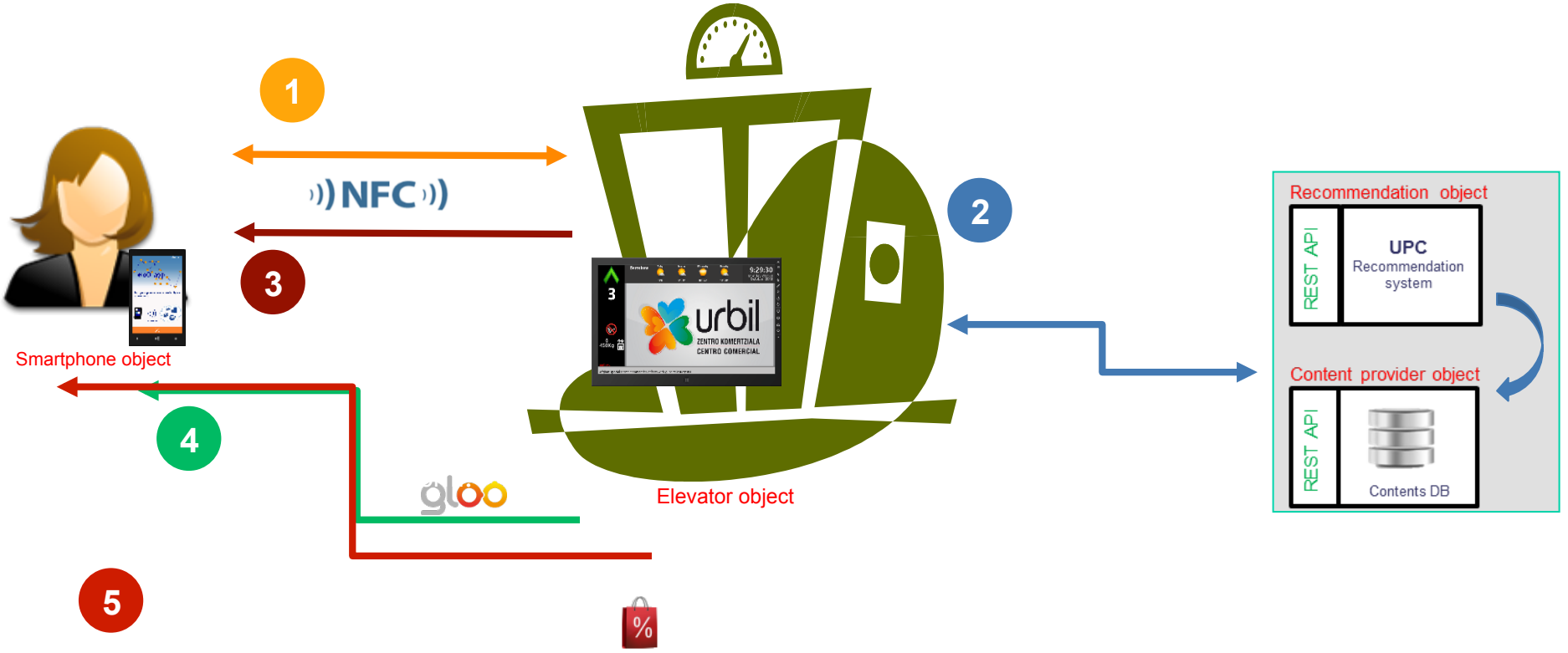


Security aspects of the WoO

Step in the WoO demonstrator

- **Secure recommendations and privacy protection**
  - Demonstrates the use of profile distortion to protect the user privacy



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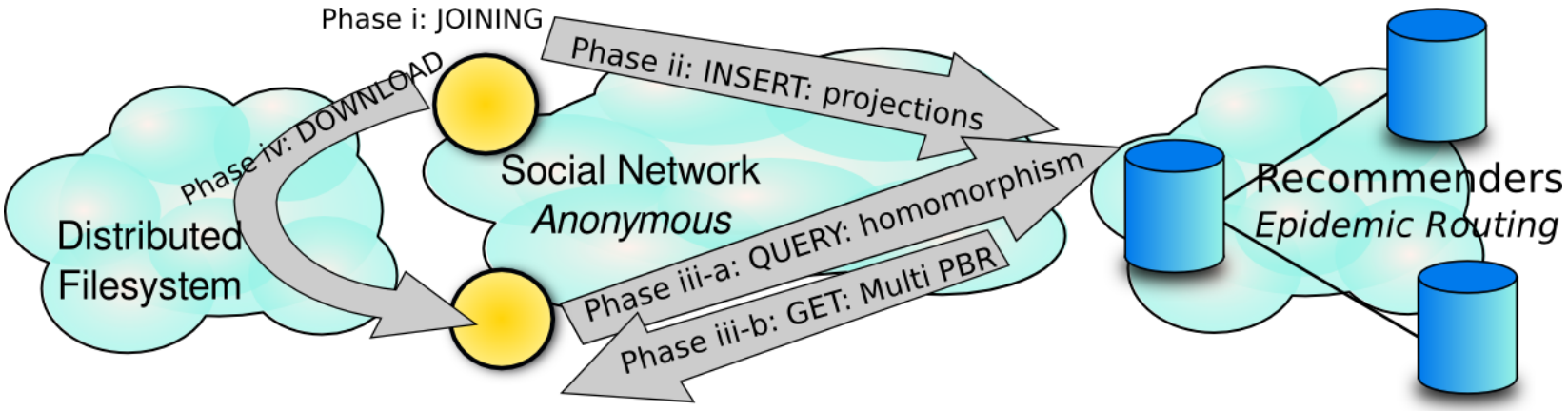


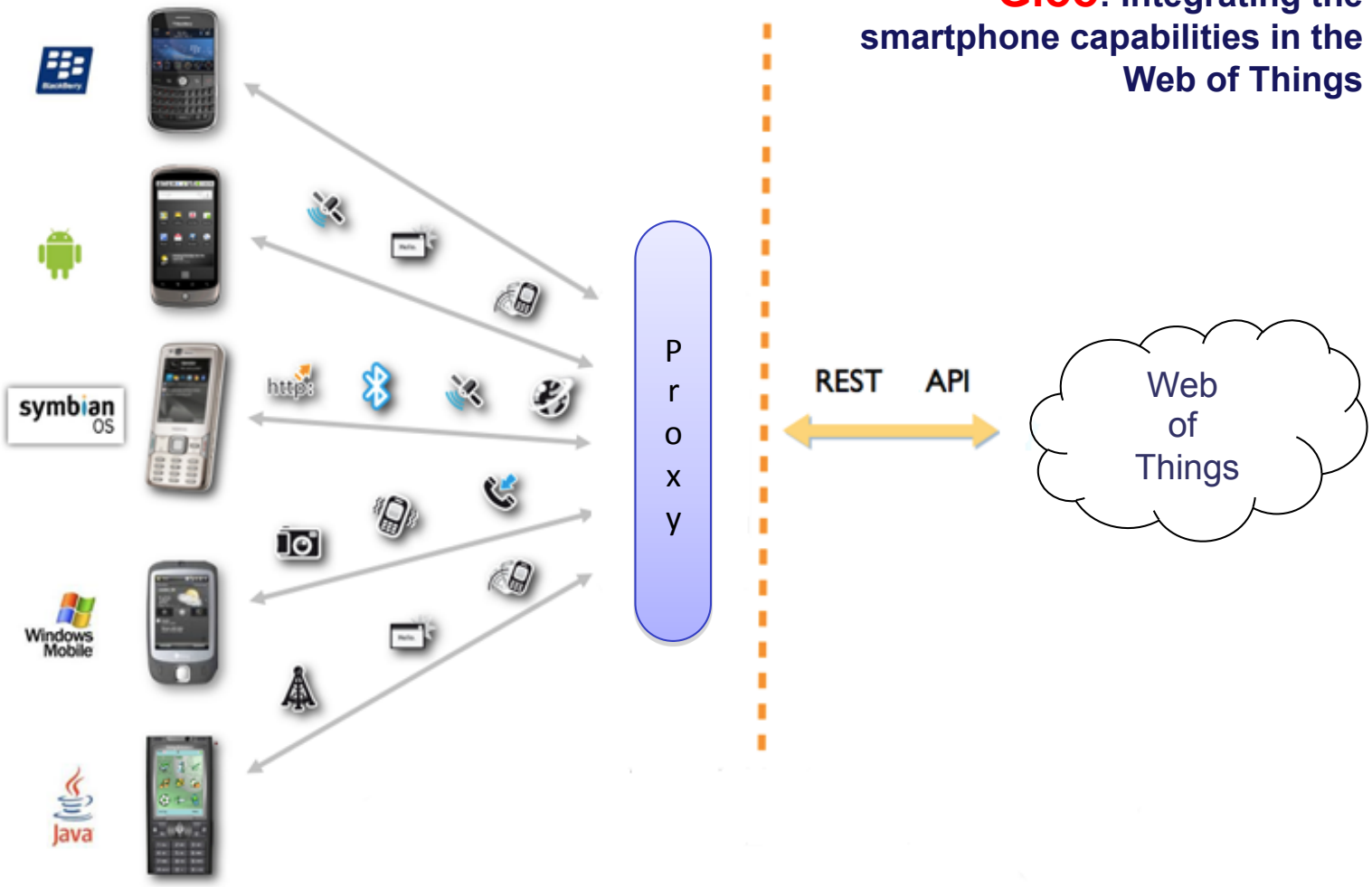
WoO Project Enablers

WoO for Smartphone

The smartphone:
A device full of sensors, actuators and capabilities

WoO for Smartphone

Gloo: Integrating the smartphone capabilities in the Web of Things

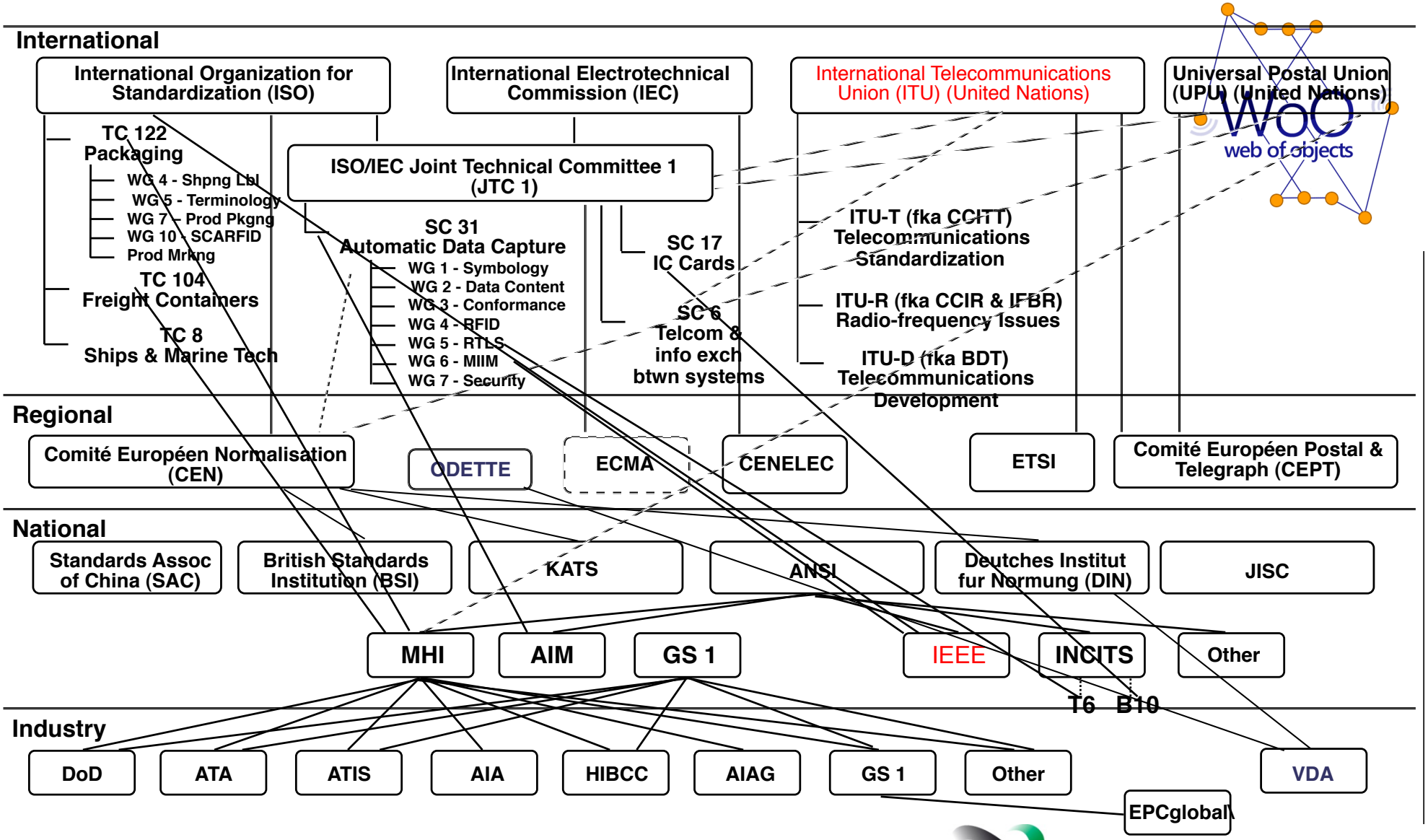


WoO for Smartphone

GLOO current Capabilities:

- Accelerometer
- A/GPS
- Bluetooth (near devices)
- Tower Cell
- Camera
- Browser
- NFC
- Phone call
- Contacts
- Messages and Polls (Human interaction)
- User Profile

IoT - International Standards Activities picture



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WoO - ITU-T SG13 IoT/WoT standardization

- **2012: 12 contributions to different standardization bodies:**
- **2013: 16 contributions to different standardization bodies:**
  - ITU-T SG13: Future networks including cloud computing, mobile and next-generation networks

Published Recommendations

- **Y.2060: Overview of the Internet of things**
- **Y.2061: Requirements for the support of machine-oriented communication applications in the next generation network environment**
- **Y.2062: Framework of object-to-object communication for ubiquitous networking in next generation networks**
- **Y.2063: Framework of the Web of Things**
- **Y.2064: Energy saving using smart objects in home networks**
- **Y.2069: Terms and definitions the Internet of Things**

On-going draft recommendations

- **Y.sfem-WoO (energy management – Web of Objects)**
- **Y.sms-WoO (smart media services – Web of Objects)**
- **Y.social-device (social device networking)**

WoO Conclusions

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WoO Approach – Innovative Solutions for Critical Issues

Semantics

- Enables a device to be accessible and act as actor in multiple applications (government, police, fire agency, hospitals, shops)

Service composition

- Enable to define complex service workflows for complex business applications

Interoperability

- Enable devices based on heterogeneous communication protocols to be part of complex applications

Security

- Enable to filter the device exposure to Internet for avoiding the security vulnerability

Better exploiting the Smartphone Sensors

- Gloo platform: Integrating the smartphone capabilities in the Web of Things

Standardization efforts

- IoT solution can be adopted by Business world if based on standards

Next Steps for the WoO approach

Further Steps towards finalizing the WoO solution:

- Standardization of the proposed framework for the IoT for making an business IoT solution as modular as possible
- Validating the solution through all the project demonstrators

Further collaboration perspective

- object virtualization : integrating semantic approach with the cloud computing technologies