When Devices Become Collaborative

Supporting Device Interoperability and Behaviour Reconfiguration Across Emergency Management Scenario

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WoO
web of objects

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7th of March 2014
INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

Introduction & Context Scenario

State of the Art

- IoT approaches to device data and service management

- Service Composition Approaches

- Data Formats for Emergency Management Situations
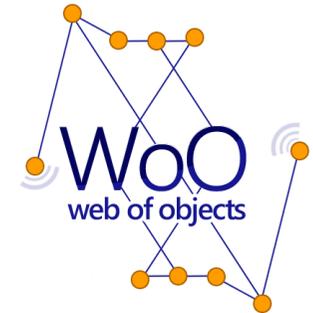
WoO Solution for Dynamic Devices Collaboration

- Web of Objects approach in Device Data Management

- Services Workflow for Device Cooperation

- Data exchange Model for Incident Management

Conclusions and Further Work

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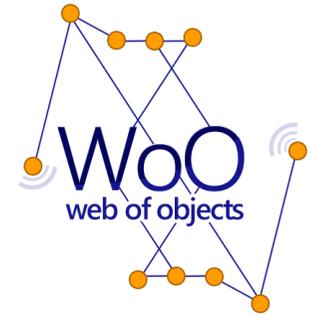
Introduction & Context Scenario

Emergency management is a highly critical domain

◆ Multiple stakeholders with **different missio**ns and who have **specific incident management procedures**

◆ Have to **share the same space and objects** and **to receive the suitable information in real time**

◆ **Real-time alarm processing leading to stakeholders coordination could save lives and resources**

Example of different stakeholders mission in a public area

◆ **Control center**: manage and supervise all the detection equipments;

◆ **Surveillance company** : detect intruders and assure the security;

◆ **Train/Air company:** communicate with the passenger about his trips;

◆ **Area Administration:** administer and keep up the shared space

◆ **Shops**: to sell goods and make publicity for their business offer;

◆ **Passengers**: to travel, relax, enjoy himself, buy;

◆ **First responders**: re-establish the normality after an incident;

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Objects Acting in an Emergency Scenario

Objects	Associated Services	Target Objects
Door	Door_intrusion-detected;	CC-Alarm-Manager
Emergency door (ED)	ED_Open_Notification; ED_Closed_Notification;	CC-Alarm-Manager
PTZC	PTZC_movement_detected; PTZC_photo_sending PTZC_orientation_confirmed;	CC-Alarm-Manager; CC-Video-Tracker; EE
Electrical Equipment (EE)	EE_autoMonitoring	CC-Alarm-Manager; PTZC;
Fire detector, Smoke detector, Temperature meter;	D-Fire_sendAlarm, D-Smoke_sendAlarm, M-Temperature_sendAlarm	CC-Alarm-Manager;
CC-Alarm-Manager	CC-AM_sendFireAlarm CC-AM_sendComplexAlarm CC-AM_openEmergencyDoor CC-AM_closeEmergencyDoor CC-AM_Evacuation-message	Fire-Agent-Smartphone; Security-Agent-Smartphone ED ED Publicity-display-monitor
CC-Video-Tracker	CC-VT-suspectSelection CC-VT-suspectLocalization CC-VT-closeEmergencyDoor	Surveillace-Camera-XYZ Security-Agent-Smartphone ED
CC-Access-Control	Open/close doors	ED

Objects	Associated Services	Target Objects
Surveillace-Camera-XYZ	SC-XYZ-videoStreaming	CC-Video-Tracker
Fire-Agent-Smartphone	Fire-Agent-Smartphone_Ack	CC-Alarm-Manager;
Security-Agent-Smartphone	Security-Agent-Smartphone_Ack Security-Agent-Smartphone_Success	CC-Alarm-Manager; CC-Alarm-Manager; Security-Agent-Smartphone; Police
Water-Plug	Water-Plug_Location Water-Plug_Unauthorized-usage-alarm Water-Plug_Distribution-ack	Fire-Agent-Smartphone CC-Alarm-Manager; CC-Objects-Manager??

Observation: a service could be « offered » based on the object behavior, or it should be demanded by an external object (that « discovered », or that have « registered » in order to be notified about it's status changing)

EE – PTZC => when an object feels itself damaged, ask the closest camera to turn and to record its scene

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M

Maintenance scenario**: devices (objects) to be first installed, dynamically configured and replaced in case of dysfunction:**

 ◆ **An IP address is assigned to the device, and it is registered in the network, together with its technical details and its localization**
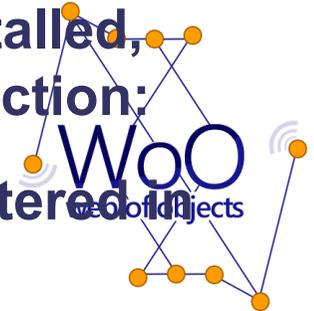
P

Public security scenario**: suspect person to be tracked further to a malicious action;**

I

Incident scenario **(e.g. fire) affecting the infrastructure and requiring first responders;**

C

Commercial scenario**: music band/VIP/publicity car to be tracked and accompanied by displaying publicity announces on the corresponding display monitors;**

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M C C
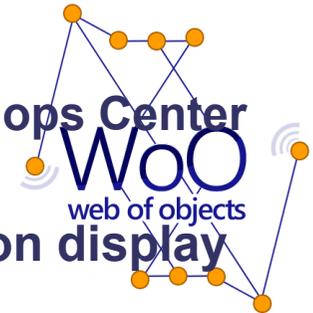
- ◆ **All the objects are installed and configured;**
- ◆ **A VIP is walking in the commercial area and is tracked by the Shops Center by using** CC-Video-Tracker**;**
- ◆ **The Publicity Display monitors around the VIP current location display a VIP presentation**

P P+I I I P

- ◆ **A person (the Suspect) enters into a restricted area and is detected by the Door and by the PTZ low quality camera;**
- ◆ **The suspect damages an electrical equipment (EE). The EE raise an alarm, while the PTZ camera turns to the EE scene.**
- ◆ **A fire is triggered further to the EE damage, and is detected by the Fire detector, Smoke detector, Temperature meter;**
- ◆ **Further to received alarms, the Control Center calls the Fire agency and send a broadcast alarm to security agents in the station area, calling two of them in the damaged restricted area.**
- ◆ **The fire agent and the security agent confirm the mission**
- ◆ **The Control Center initiates the video tracking process, having priority over the Shops Center, whose access to the** CC-Video-Tracker **will be interrupted;**

WoO
web of objects

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P

C

I

M+I

I

M
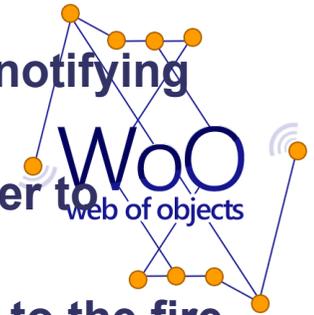
- ◆ The **security agent** catch the suspect and immobilize him, while notifying the **CC**

- ◆ The **Shop Center** re-gains access to the **CC-Video-Tracker** in order to continue the **VIP** tracking

- ◆ When the **fire agent** arrives in the station, the closest **Water plug** to the fire place notifies the agent about its position.

- ◆ During the water distribution, the **water plug** notifies about its action the **CC**, the **fire agent** (and eventually the security agents)

- ◆ Starting with the moment when the security alarm is validated, the **Publicity Display monitors** around the fire are used for displaying the security messages

- ◆ When the **repairman** arrives in the station, the location and technical details about the **Electrical Equipment** will be transmitted on his SmartPhone

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Camera: photo-based detection
Next camera: according location
Storage: further to alarm

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web of objects

Suspect tracked & captured

Agent Smartphone: suspect photo and current location

Intrusion: Hall-Effect Sensor & PTZ camera

Fire: ambient sensors
EE damaged: electricity sensor
Suspect photo: PTZ camera

RoomB8 – Suspect & fire detected

CRITICAL ALERT

CC-Video-Tracker:
-suspectSelection
-suspectLocalization

Publicity panel: Evacuation message
Fireman Smartphone: in-door guiding
Hydrant: notifying its location and status

Fire exit

Fireman & people coordinated

CC-Alarm-Manager:
-callFireAgency
-assignRightsFireman
-evacuationMessage

CC-Maintenance:
-equipmentFaultDetection
-assignRightsRepairman

Control Center

Repairman Smartphone
- in-door guiding
- technical details

Repairman guided and informed

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The Owners and the Business Workflows of the Objects

Objects	Owners	Business Workflow
Door	Area Administration (e.g. Airport, Shopping Mall)	Maintenance, Incident
Emergency door (ED)	Area Administration	Maintenance, Incident
PTZC	Surveillance company	Public security, Commercial
Electrical Equipment (EE)	Area Administration	Maintenance, Incident
Fire detector, Smoke detector, Temperature meter;	Area Administration, Control Center	Maintenance, Incident
CC-Alarm-Manager	Control Center	
CC-Video-Tracker	Surveillance company	
CC-Access-Control	Control Center	
Surveillace-Camera-XYZ	Surveillance company	
Fire-Agent-Smartphone	First Responders	
Security-Agent-Smartphone	First Responders	
Water-Plug	Area Administration	

Modify or Hide in the header / footer properties :   Date

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Important issues of the scenario

- ◆ Maintenance workflow: devices have to be configured and managed

- ◆ All business workflows: devices' services have to be executed in specific sequences

- ◆ Messages transmitted between devices should automatically exploitable by all Emergency Management procedures

State of the Art

- ◆ **IoT approaches to device data and service management**

- ◆ **Service Composition Approaches**

- ◆ **Data Formats for Emergency Management Situations**

WoO Solution for Dynamic Devices Collaboration

- ◆ **Web of Objects approach in Device Data Management**

- ◆ **Services Workflow for Device Cooperation**

- ◆ **Data exchange Model for Incident Management**

State of the Art & WoO Contribution

Device management

Open/close the station! Update infos in real-time

I have 7 possible variants

Locate a men with red hat descending from the Paris train

5 minutes until London train 5 platforms distance

Line changed for Paris train

Go to line 8
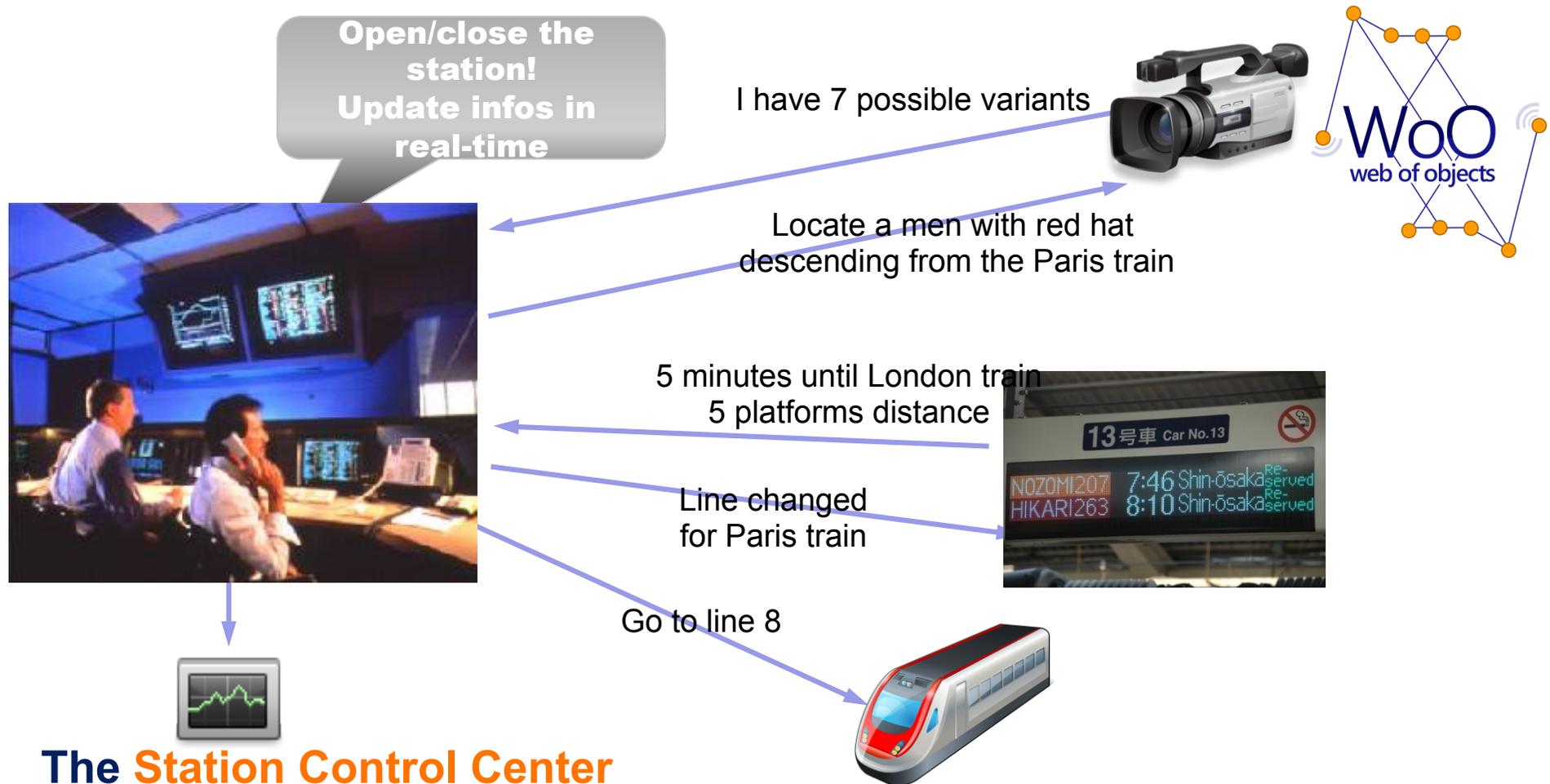
The Station Control Center
communicate via an integrated protocol with each object:

- ◆ **Transmit commands,**
- ◆ **modify certain object properties,**
- ◆ **ask for information.**

WoO web of objects

13号車 Car No.13
NOZOMI207 7:46 Shin-ōsaka Reserved
HIKARI263 8:10 Shin-ōsaka Reserved

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Device technologies in the Internet of things

IoT: Autonomy, adaptability, reactivity

Schema	UPnP	DPWS	ONVIF
Addressing	DHCP, AutoIP	DHCP, AutoIP	WS-Addressing
Discovery	SSDP	WS-Discovery	WS-Discovery
Description	UDA Schema	WSDL	WS-I Basic Profile 2.0
Control	SOAP 0.9, 1.1	SOAP 1.2	ONVIF DM WSDL
Eventing	GENA	WS-Eventing	WS-Base Notification WS-Topics
Presentation	HTTP, HTML	HTTP, HTML	

Probe: ticket
(discovery approach)

ProbeMatch: ticket

My **name** is: iP@M
My **properties** are:
My **services** are:
My **operating context** :
my journey

Event: 15 min to destination
Message: Wake up!

Control: GoTo Platform 8

## Control (device management) means to implement:
◆ **software and firmware provisioning** *(install, update, uninstall)*
◆ **software control** *(start/stop)*
◆ **management** *(get, set, create, delete)*
◆ **diagnostics** *(self-test, ping, tracert, nslookup)*

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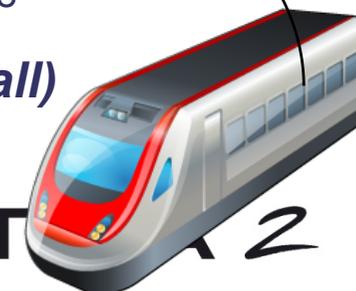
❑ **Control Point**: a client that discover and control the servers UPnP

❑ **Device**: the server (that receive demands)

❑ **The same object** could be **CP** and **Device**

❑Very poplar in industry
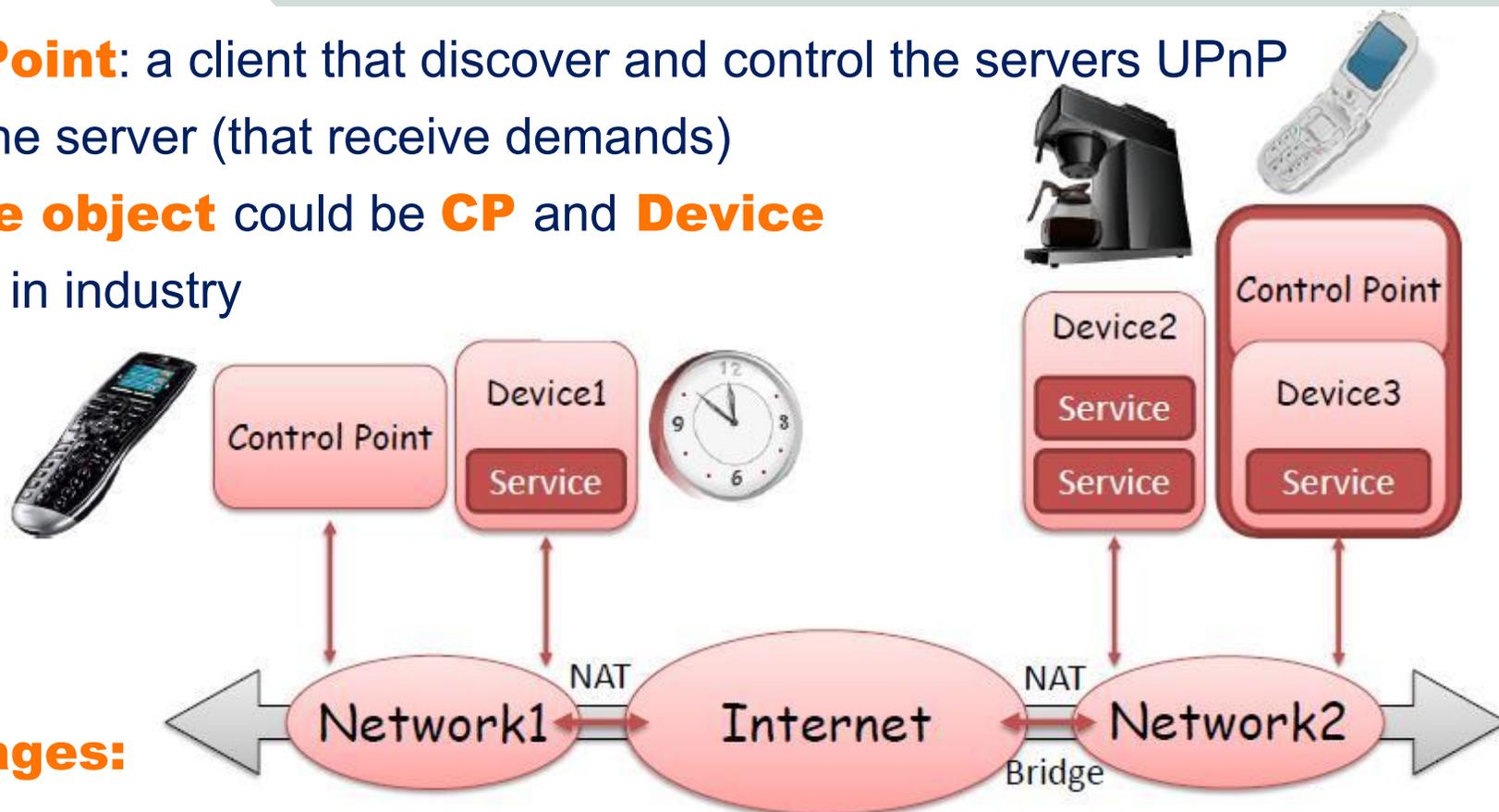
Disadvantages:

◆ **Require multiple resources at object level:**
Web server + xml parser + soap + …

◆ **Based on non-standard protocols:**
– Discovery: SSDP on top of HTTPU, HTTPMU
– Description: dialect XML
– Events: GENA

◆ **No authentication protocol (no security)**

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Standard OASIS since juin 2009,

Exclusivelly based on standards across all the layers:

WoO
web of objects

DPWS metadata	
WS-Discovery WS-Transfer WS-MetadataExchange	WS-Eventing
WS-Addressing	
SOAP 1.2 WSDL 1.1, XML Schema	
UDP	HTTP 1.1
	TCP
IPv4/IPv6	

DPWS extensions | *Web Services*
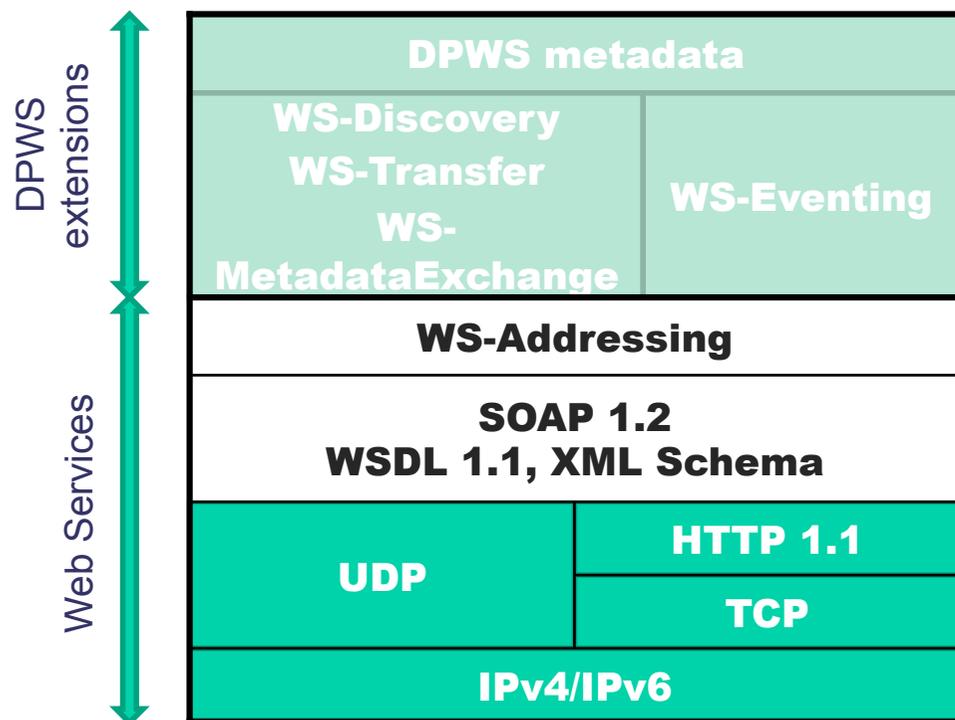
DPWS provides particular approches (extensible) for:

- Discovery
  => Dynamic reconfiguration
  - Dynamic view of available devices
- Metadata exchange
  => Semantic reasoning
- Eventing
  => Monitoring and reasoning

Advantages:

- The existing implementations interoperables

Disadvantages:

- Weak compatibility

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WoO solution: management plugin for DPWS communication stack to allow device management through web services protocol

DPWS & management plugin can be used at every level: from IT down to devices:

◆ Forge website (open source code): https://forge.soa4d.org

◆ DPWS project: https://forge.soa4d.org/projects/dpwscore/
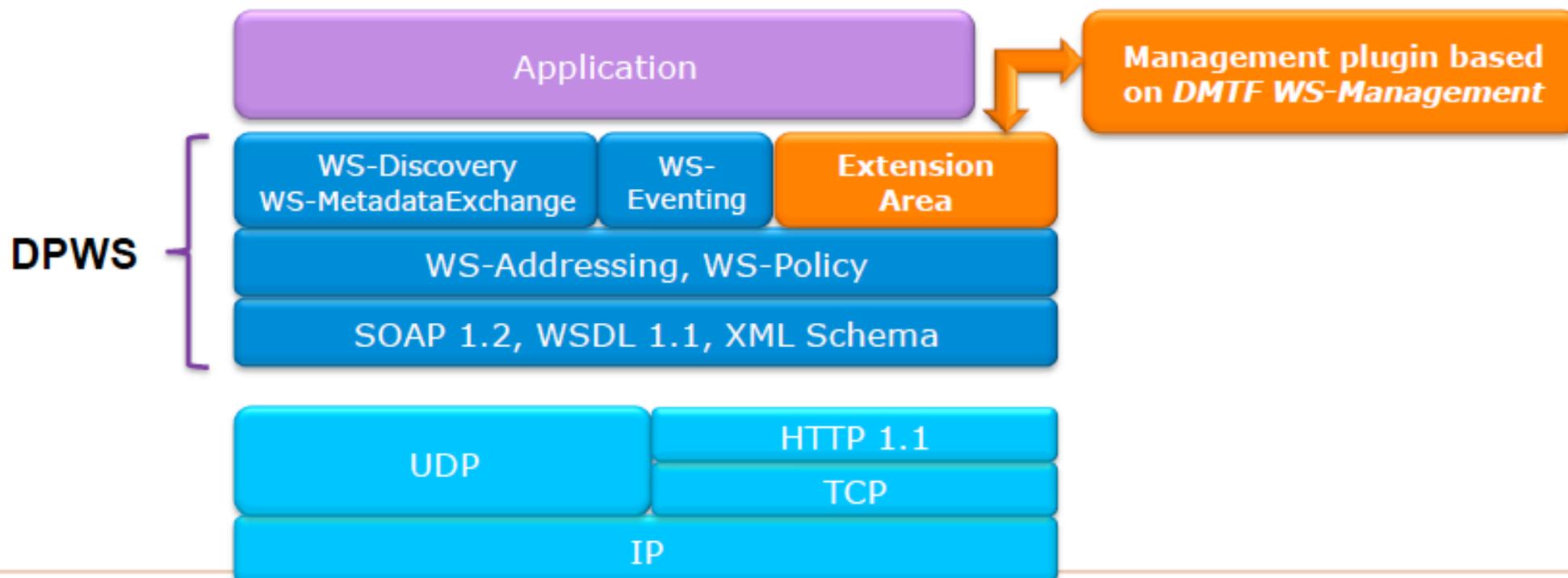
Main generic WS-Management plugin features:

◆ **Device management with XML-based description of managed sensors/devices (a.k.a resources).**

◆ **Management Operations, using WS-* specifications :**

- ○ DISCOVERY : Discover managed resources (WS-Discovery).

- ○ GET, PUT, CREATE, et DELETE : read, modify, create, or delete (portion of) resources (WS-Transfer). (Hey, looks like REST operations ;-)).

- ○ ENUMERATE : Enumerating « resources » (WS-Enumeration).

- ○ (UN)SUBSCRIBE : Subscribe/ Unsubscribe management events sent by resources through DPWS Heartbeat and also available (WS-Eventing).

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OUTPUT plugins (High Level)

INPUT plugins (Low-Lev

eObjects

ThingSpeak

THINGS CHQT

xively
by LogMeIn

sense

Any other HTTP
servers/apps

HTTP(S)

Windows Azure

MESSAGE

Scrolling
LED panel

Jabber   BE3

REST

Vocal
synthesis

Any other protocol
which is able to
send data/events
(remotely or locally)
(remote clients/
servers, actuators,
other industrial
devices)

XMPP

AMQP

Web services
DPWS

Mail sender
(SMTP)

SMS
sender

Stomp

MQTT

MySQL

FTP

Audible
alarm

Sogeti HighTech
embedded smart engine

USB

XBee

DPWS

ZigBee

UPnP dlna

gemalto   libelium

Z wave

N

REST

Green. Smart. Wireless.
enocean

Any other protocol
which is able to
provide data/events
(remotely or locally)
(sensors, actuators,
other industrial
devices)

Toradex
Swiss. Embedded. Computing.

EVERSPRING

2

Connect everything, everywhere, easily.

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Adding specific local behavior to plugins

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

Remote device/app

MQTT

Specific Behaviour
Embed local behaviour (state machine, IA...) to fit clients needs

Sogeti HighTech

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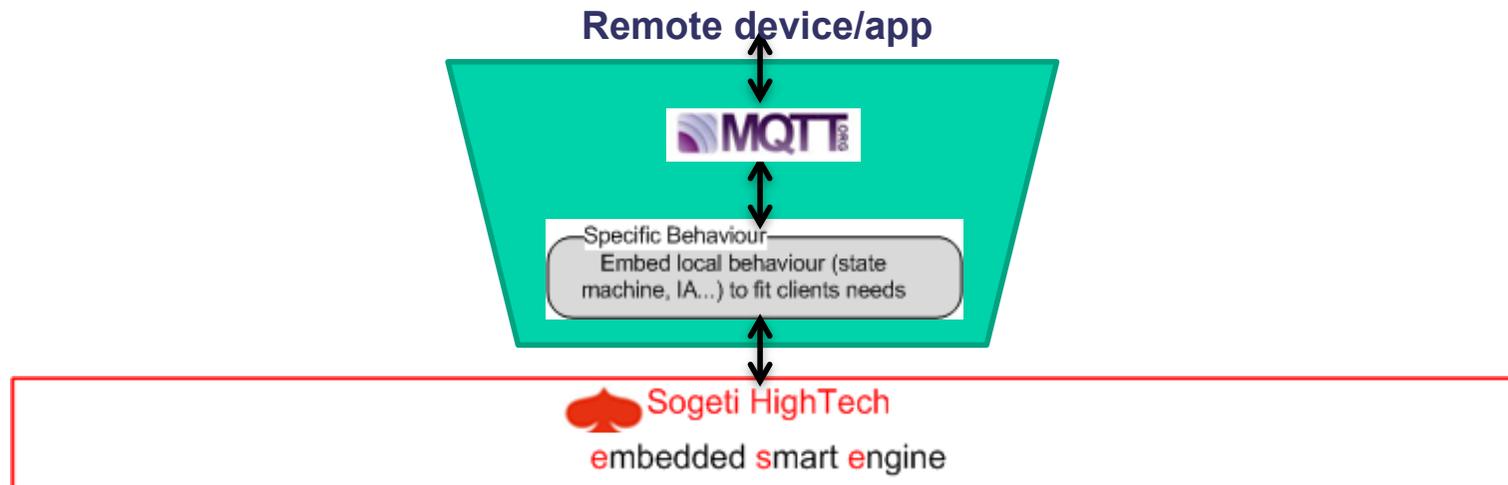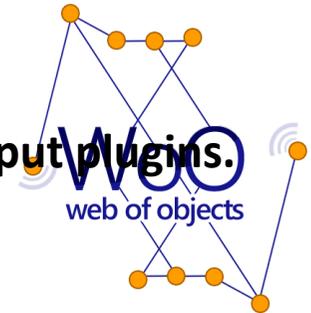
For example, adding a behavior to take into account data coming from different kind of sensors, and correlate them in real-time to output new higher-level events.

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.

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Application Creation

WoO Frontend

| Access Tools | Representation Tools | Composition Tools | Sharing Tools | Admin Tools |

web of objects

WoO Backend

Registry
- Devices
- Services

Domains

Data

WoO Apps

Apps Runtime

Open Data

WAN

Device Exposure / Description / Gateways-based interoperability

LAN

Devices | Services | Apps Runtime

Dashboard

72

Devices | Services | Apps Runtime

Local WoO Devices + Gateway   **WoO Connected Devices**   **Local Autonomous WoO Devices**   **Public / Open Autonomous WoO devices**

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SmartM2M SDK

Application Creation

DPWSim
9

WS toolkit

Dlite smartphone App

Elevator panel

Smartphone Emergencies App

SmartMeter

WoO Frontend

Access Tools

Composition Tools

Sharing Tools

Admin Tools

Surveillance App
12

web of objects

Bec3

WoO Backend

SmartM2M Engine
6

Registry

Emergencies Mgt Sys
8

Domains

WoO Apps

Open Data

Services

Apps

SmartMeter Backend

Dlight

5

YouTube

flickr

WS

amazon

talk

WAN

Device Exposure / Description

6

Dlight
4

7

Smart{Home/Shopping} Gateway

Gateway
2

Gateway
1

Gateway(UPV)
3

13

M2M gateway

DPWS/REST Gateway
10

SmartM2M Engine

Smartphone + app

IPTV

Dashboard

Smartphone

WSN

Camera

Arduino

SmartMeter

Dlight
4

SmartSteaming

SETHA

Dlight

Building sensors
11

SmartM2M Engine
6

Camera + analysis
9

Local WoO Devices + Gateway

Local Autonomous WoO Devices

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WAN

LAN

WoO – Business Workflows are employed to define choreographies
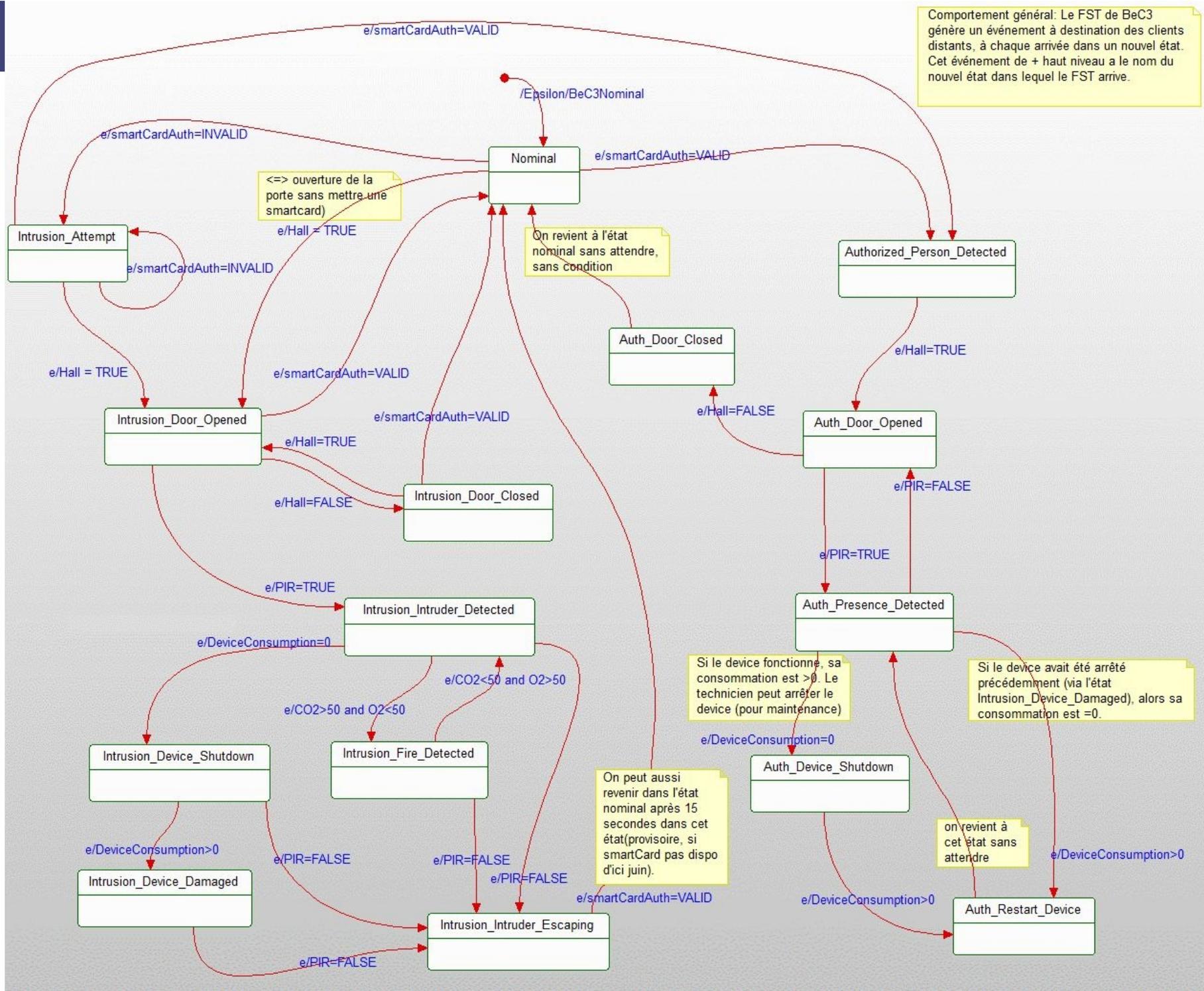
State of the Art & WoO Contribution

Services Workflow for Device Cooperation

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Orchestration vs composition

- **Business Process Execution Language (WS-BPEL)**

- **Web services Choreography Description Language (WS-CDL)**
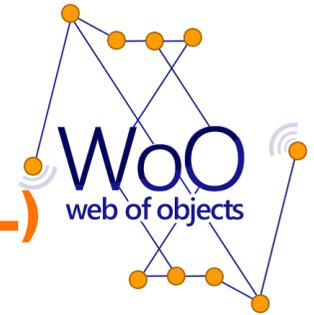
IoT Application Creation

- Allows the design and execution of versatile IoT apps granting a wide panel of modular and incremental interactions for a wide variety of devices.
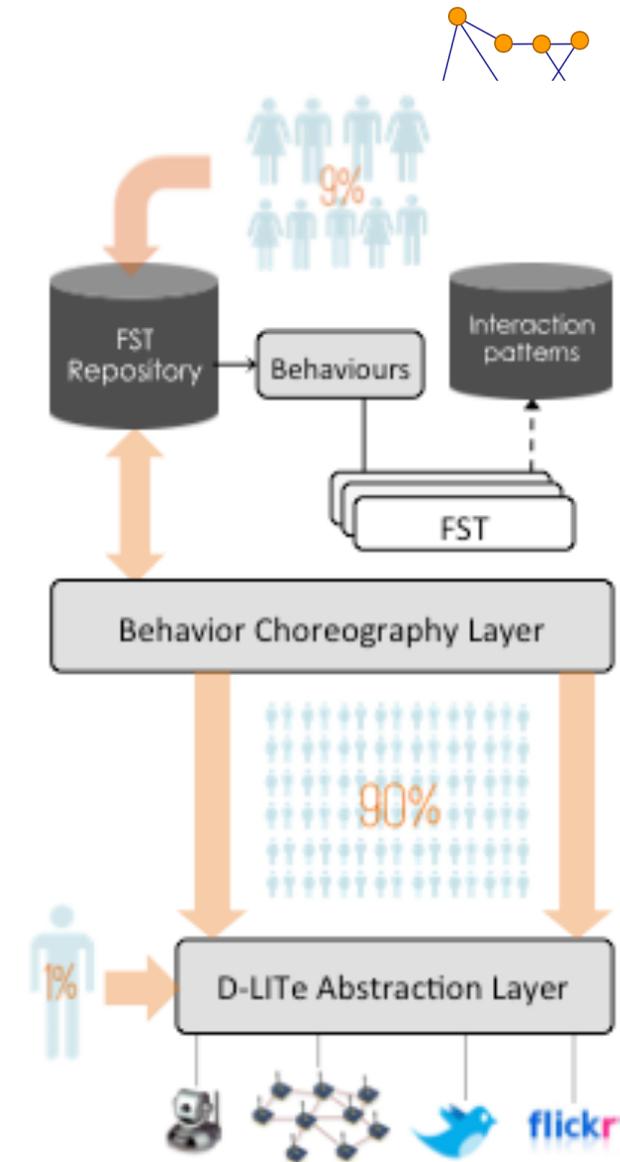
Dlite API for Your Devices

How does it work ?

Java/Internet Capable Device

No Java/Internet Device
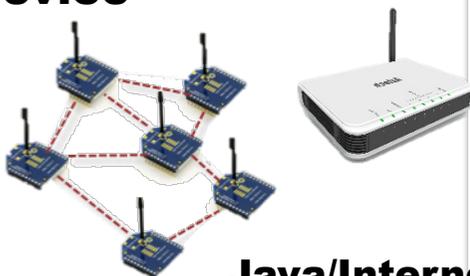
Java/Internet capable Gateway

Dlite APi

DOOR	×
door intrusion detected	

PTZ	×
mouvement detect	

FIRE DETECTOR	×
send alarm	

SENSOR GW	×
Send unified Alarm	

ALARM MGR	×
Valid Alarm - Broadcst	

FIRE AGT PHONE	×
Confirm-mission	

SCRTY AGT PHONE	
Confirm-mission	

FIRE AGT PHONE	×
refresh current location	

VIDEO TRACKER	×
Suspect Localization	

MAINTENANCE	×
Assign repairman	
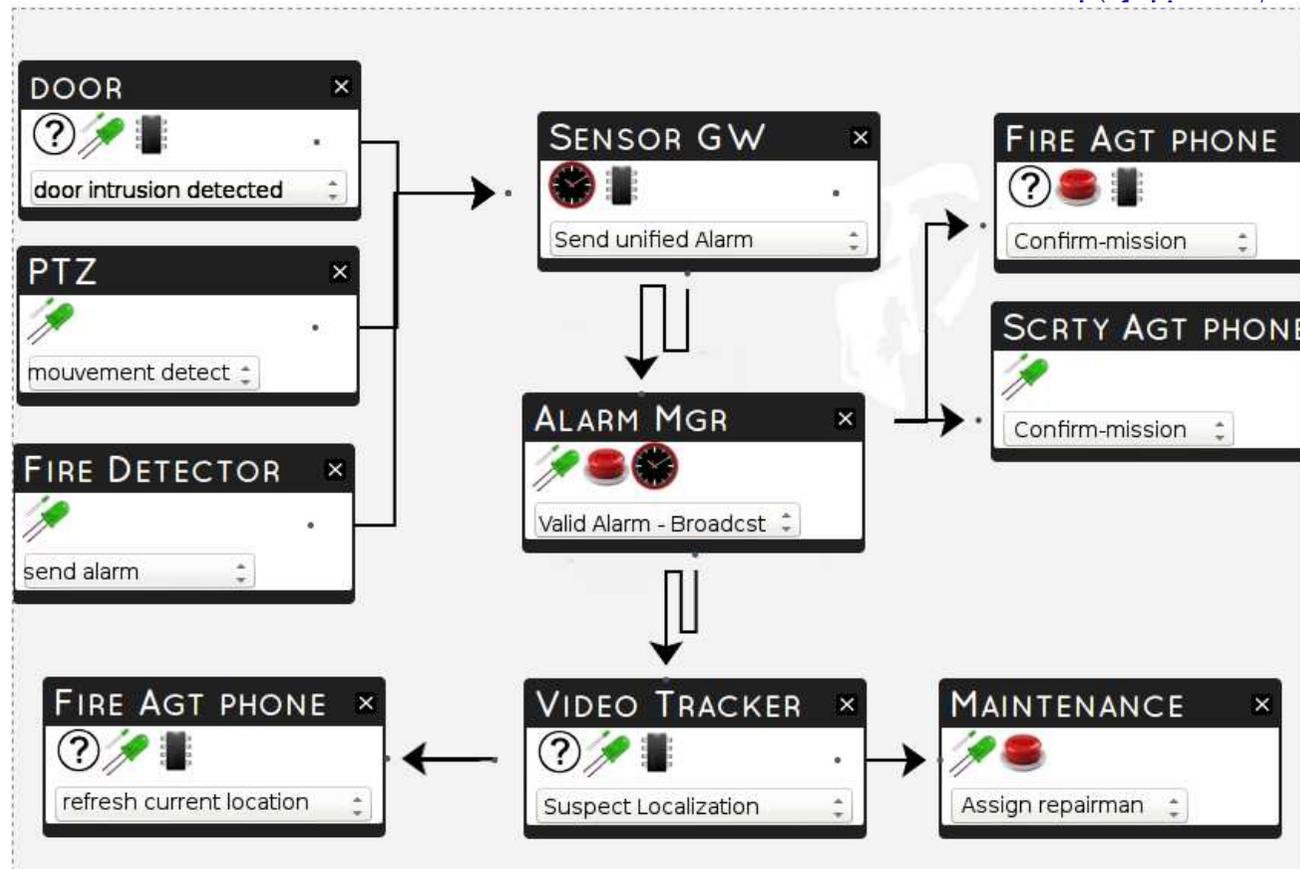
Abstracted View of Devices on BEC3

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2) D-LITe: Choreography
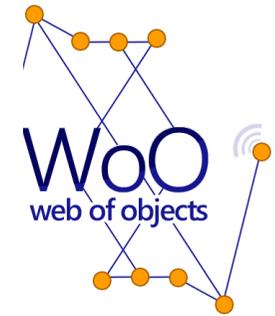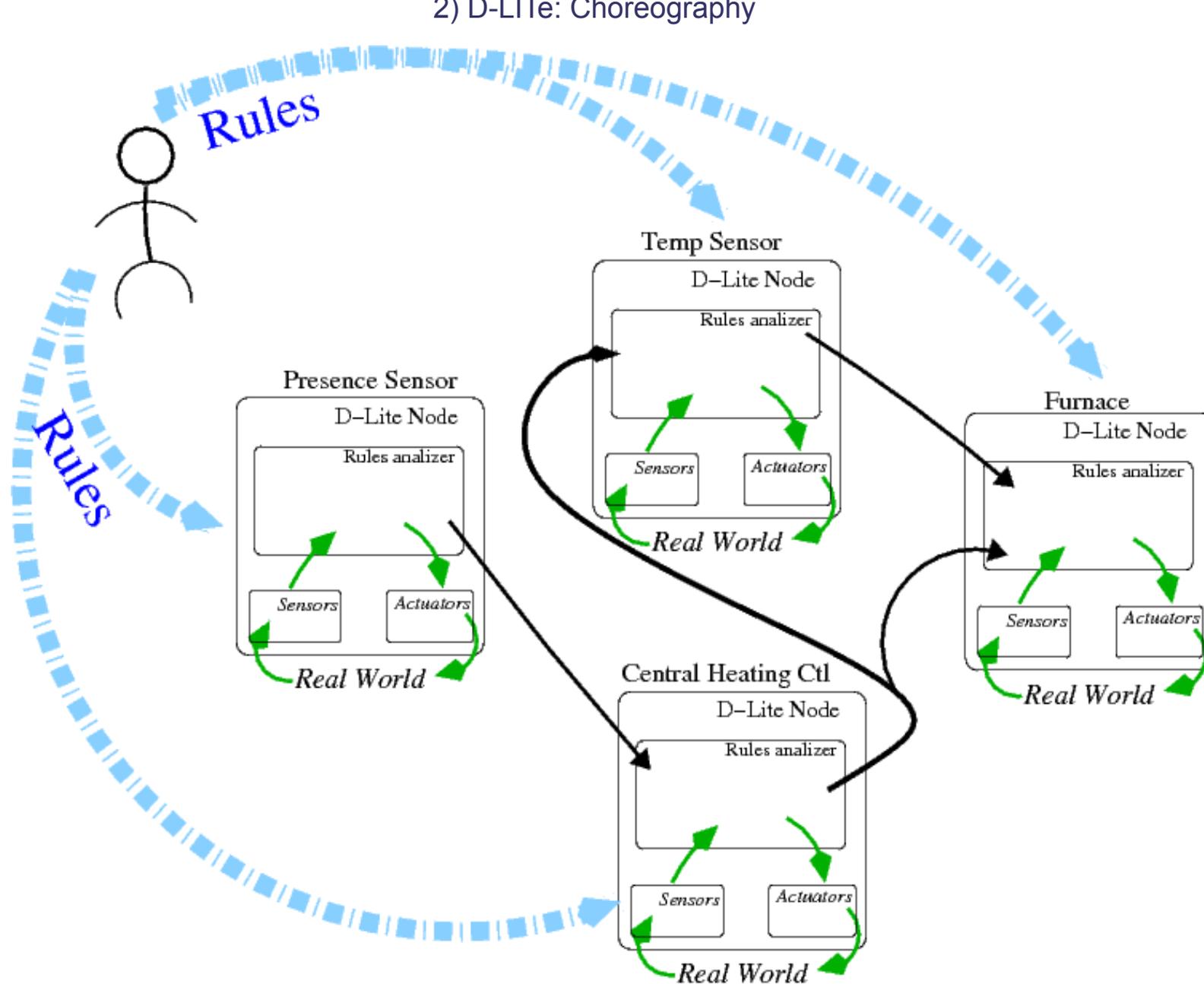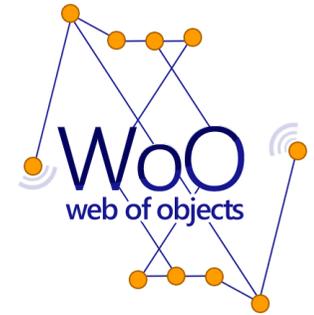
Message exchange in Incident Management

Current ontologies or vocabularies specialized in message exchanging between different stakeholders

- - example, Nepomuk Message ontology - http://www.semanticdesktop.org/ontologies/2007/03/22/nmo/
- - based on the e-mails and instant messages structure and functioning principles
- support for identifying the sender, the recipient(s), their address, the subject of a message, etc.

Emergency Data Exchange Language (EDXL)

- standards family developed by OASIS
- follows the same principle, but adding support to describe:
  - the content of an alarm
  - the conditions under which an information control could be yield to an external authority such the police.

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EDXL-DE (Distribution Element)

- designed to package and deliver any OASIS EM Standard or other data message;
- may be thought as a "container" that carries a "payload" of formatted message sets (such as Alerts or Resource Messages).
- Messages may be distributed to specific recipients, to a geographic area, or to an agency type (police, fire, etc.).

EDXL-CAP (The Common Alerting Protocol)

- provides support for multiple alert messages types, such as:
- Warnings, Acknowledgements, Expirations and cancellations, Updates and amendments;

EDXL-RM (Resource Messaging)

- describes a set of pre-defined messages for requesting/sharing resources
- (e.g. emergency equipment, supplies, people);

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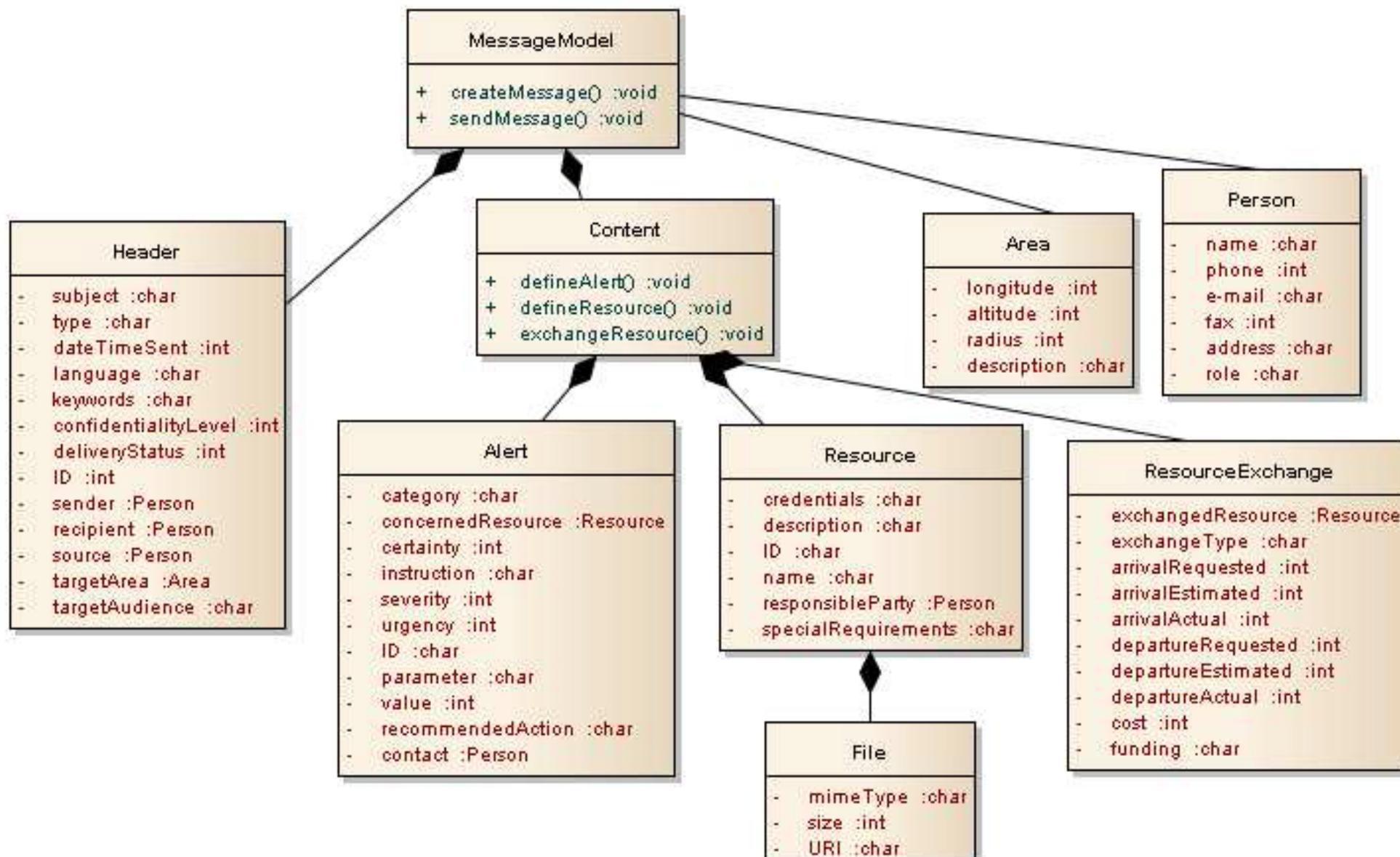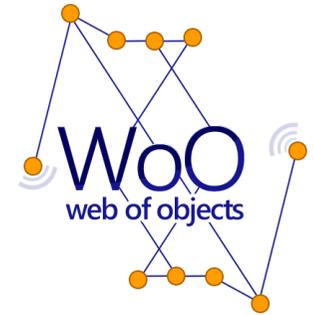
Conclusions

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
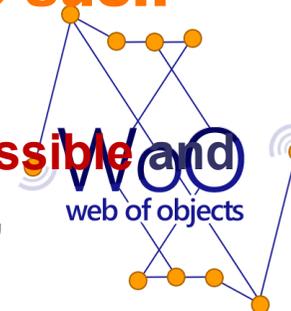
Further work

- Develop a semantic alternative of the BEC3 approach, where the composition is based on ontology

Further Steps towards finalizing the WoO solution:

- Standardization of the proposed framework for the IoT

- Validating the solution through all the project demonstrators

Further collaboration perspective

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