FROM RESEARCH TO INDUSTRY

cea tech

ClouT: Cloud of Things for empowering the citizen clout in smart cities

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Séminaire ASPROM
Objets communiquants connectés industriels, M2M, réseaux

Vendredi 13 Juin
Paris

Agenda

- From embedded systems to Internet of Things
- European IoT Research Priorities
- sensiNact - Service-oriented approach for IoT application development and deployment
- Applications in smart cities
  - ClouT project, Cloud of Things for empowering the citizen clout in smart cities
  - BUTLER project, uBiquitous, secUre inTernet-of-things with Location and contExt-awaReness
  - OUTSMART project, Provisioning of urban/regional smart services and business models enabled by the Future Internet
- Summary

Internet of Things

- Personal Computers were revolutionary!
- But the real revolution was when we inter-connected them!

  => Internet

Internet of Things

- Personal Computers were revolutionary!
- But the real revolution was when we inter-connected them!

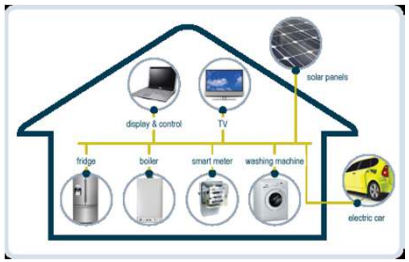
  => Internet

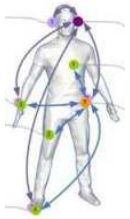
- Embedded devices are revolutionary!
- But the real revolution will be when we will inter-connect them!

=> Internet of Things

From embedded systems to Internet of Things (IoT)

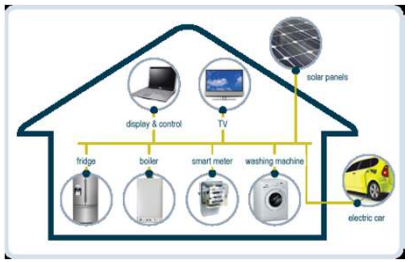
- Traditional embedded systems: dedicated to a specific task in a given application domain.

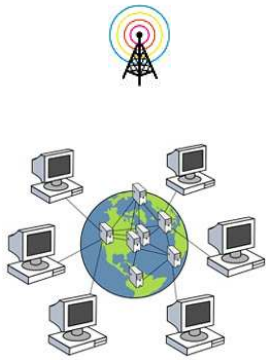


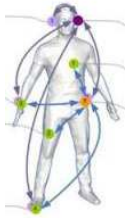


From embedded systems to Internet of Things (IoT)

- Traditional embedded systems: dedicated to a specific task in a given application domain.
- Internet of things: communicating and collaborating embedded systems that are massively deployed, that can perform universal tasks across domains



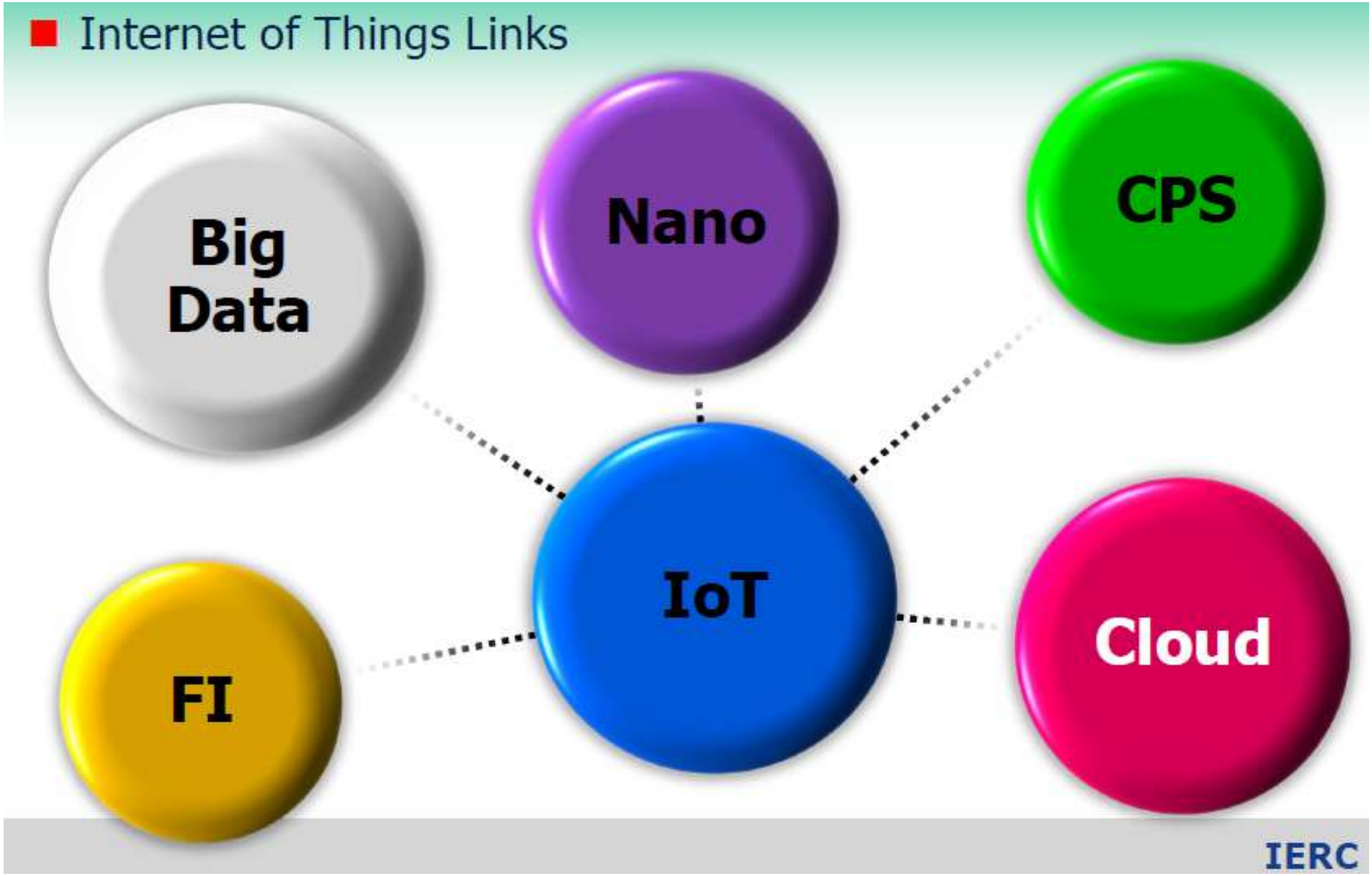




Many application areas

- environmental monitoring,
- ambient intelligence for smart places (homes, buildings, cities, shops, transportation),
- critical physical infrastructures (e.g. bridges, tunnels) monitoring,
- homeland security,
- smart utilities (e.g. electrical, gas, water, oil),
- factory automation and process control,
- disaster management
- health care,
- etc.

European Research Cluster on the Internet of Things (IERC)



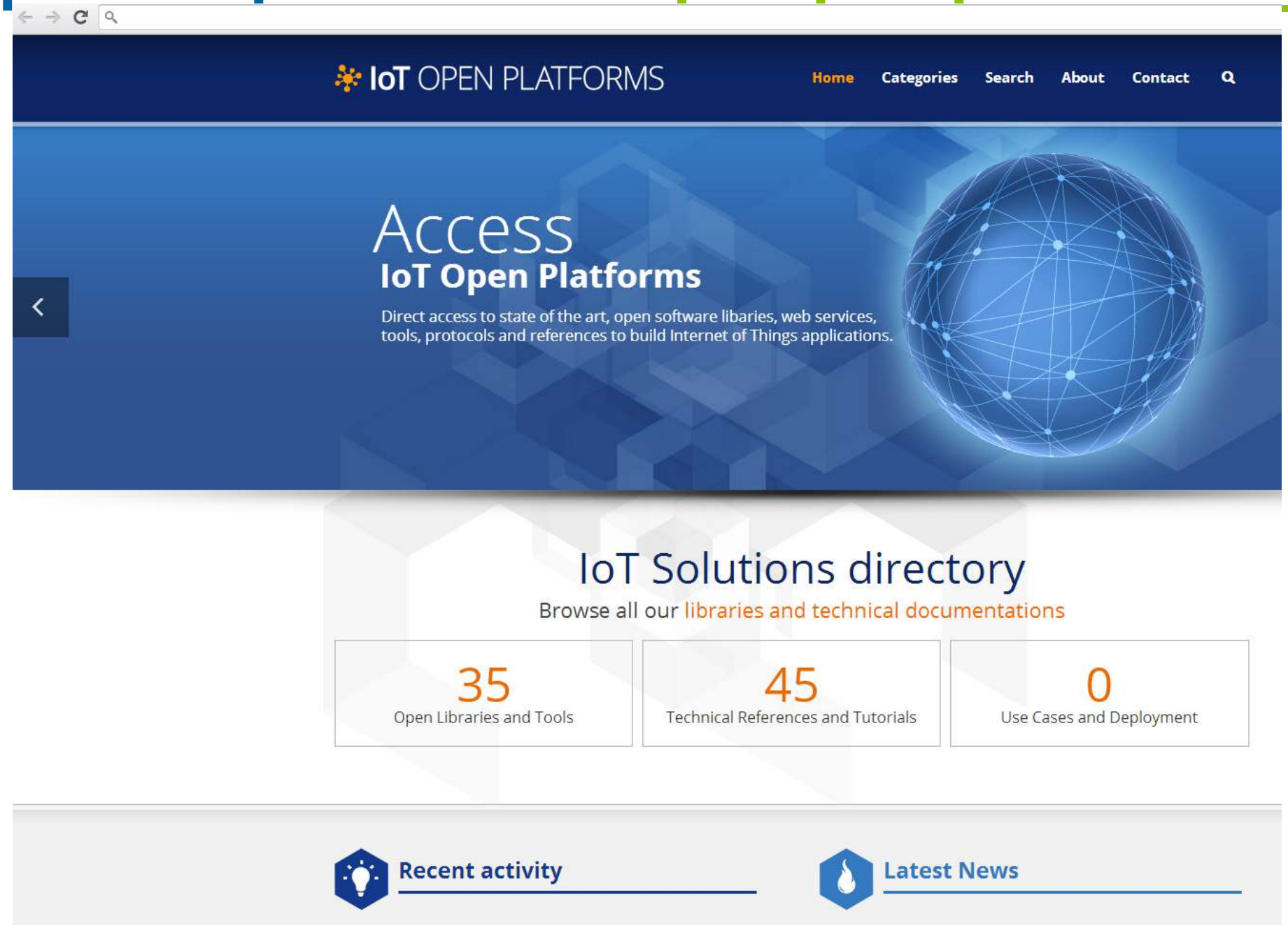
IERC main goals

- Create communities for open IoT platforms
- Contribution to pre-normative activities / standardisation, development of business models, innovation activities which aim at stimulating platform adoption
- Networking of IoT technology stakeholders
- Activities to increase societal acceptance and foster specific education

IERC Transversal activity chains

IERC Transversal activity chains

Open IoT platforms: http://open-platforms.eu



An open IoT platform

sensiNact - Service-oriented approach for IoT application development and deployment

Today: Domain-centric smart solutions

SmartHome

- Monitoring and controlling
- Saving energy comfortably
- Interacting with appliances
-…

SmartHealth

- Monitoring medicine intake
- Personalized diabetes assistance
- Providing training tips
- …

SmartTransport

- Promoting carpooling
- Minimizing taxi delays
- Avoiding traffic jams
- …

SmartCity

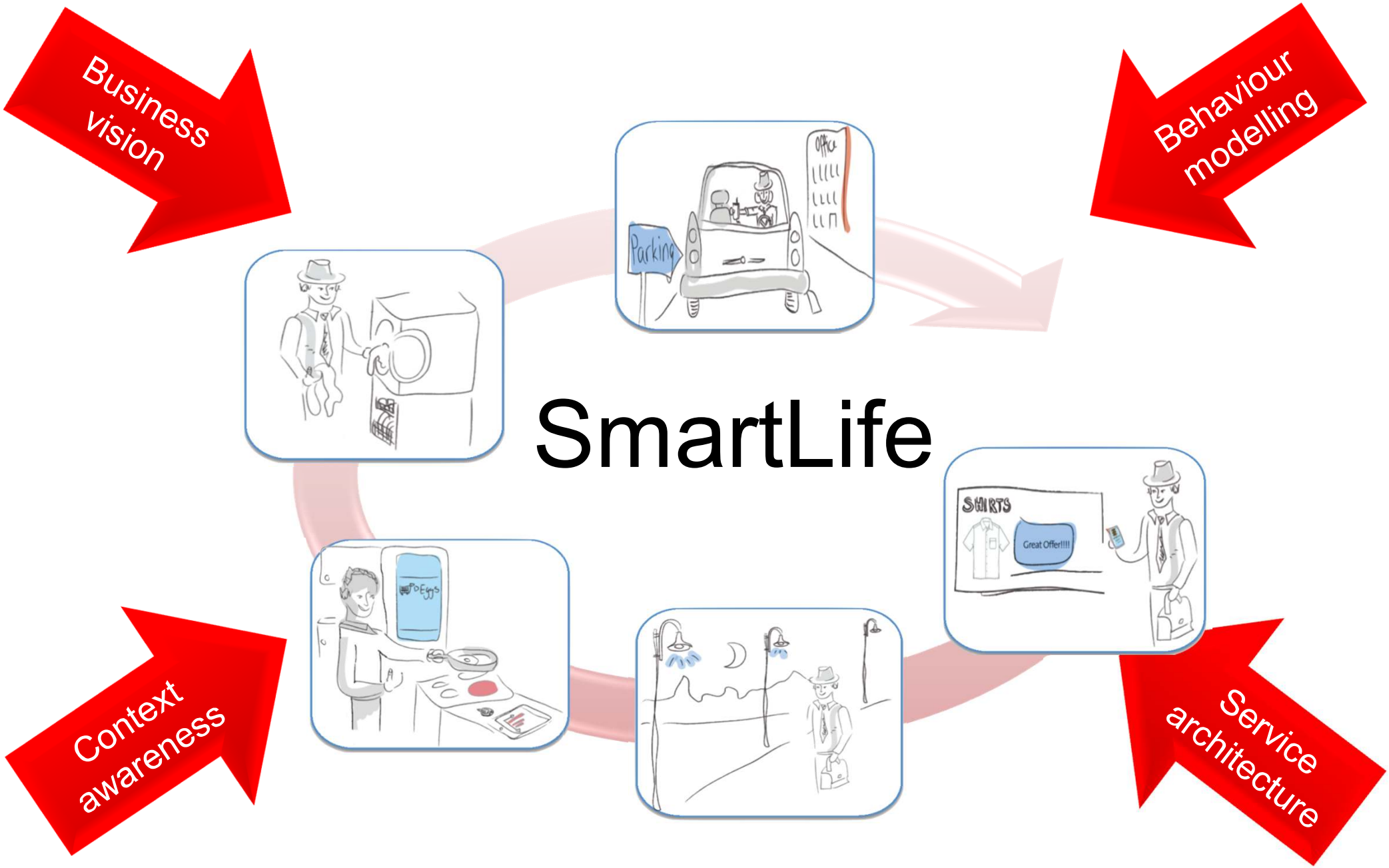
- Managing parking space
- Lighting up a city efficiently
- Monitoring Air Quality
- …

SmartShopping

- Managing sparkdeals
- Getting advice on buying goods
- Retrieving discount
- …

Illustrations from the EU FP7 BUTLER project

Tomorrow: horizontal smart solutions



Illustrations from the EU FP7 BUTLER project

Tomorrow: horizontal smart solutions

Business vision

Behaviour modelling

Execution Environment

Hardware Platform

sensiNact middleware for integrated smart life

Context awareness

Service architecture

Illustrations from the EU FP7 BUTLER project

Heterogeneous IoT Devices

Various application domains

Smart Parking

Home-automation

Energy monitoring

Media Follow-me

Secure access

Personalized coupons

sensiNact horizontal platform

Smart Parking

Home-automation

Energy monitoring

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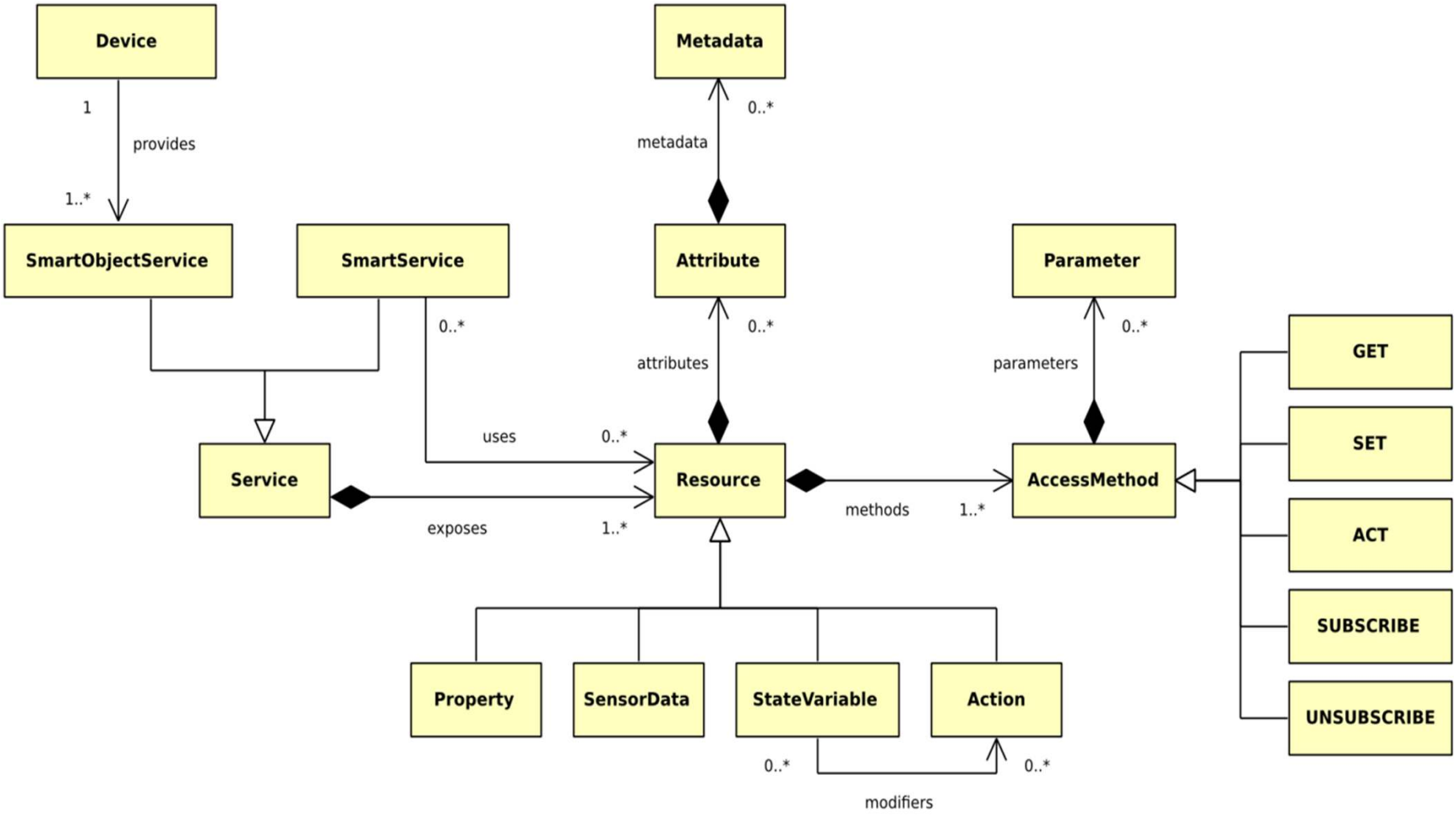
Personalized coupons

APIs, Data as a Service, user portal, service management portal

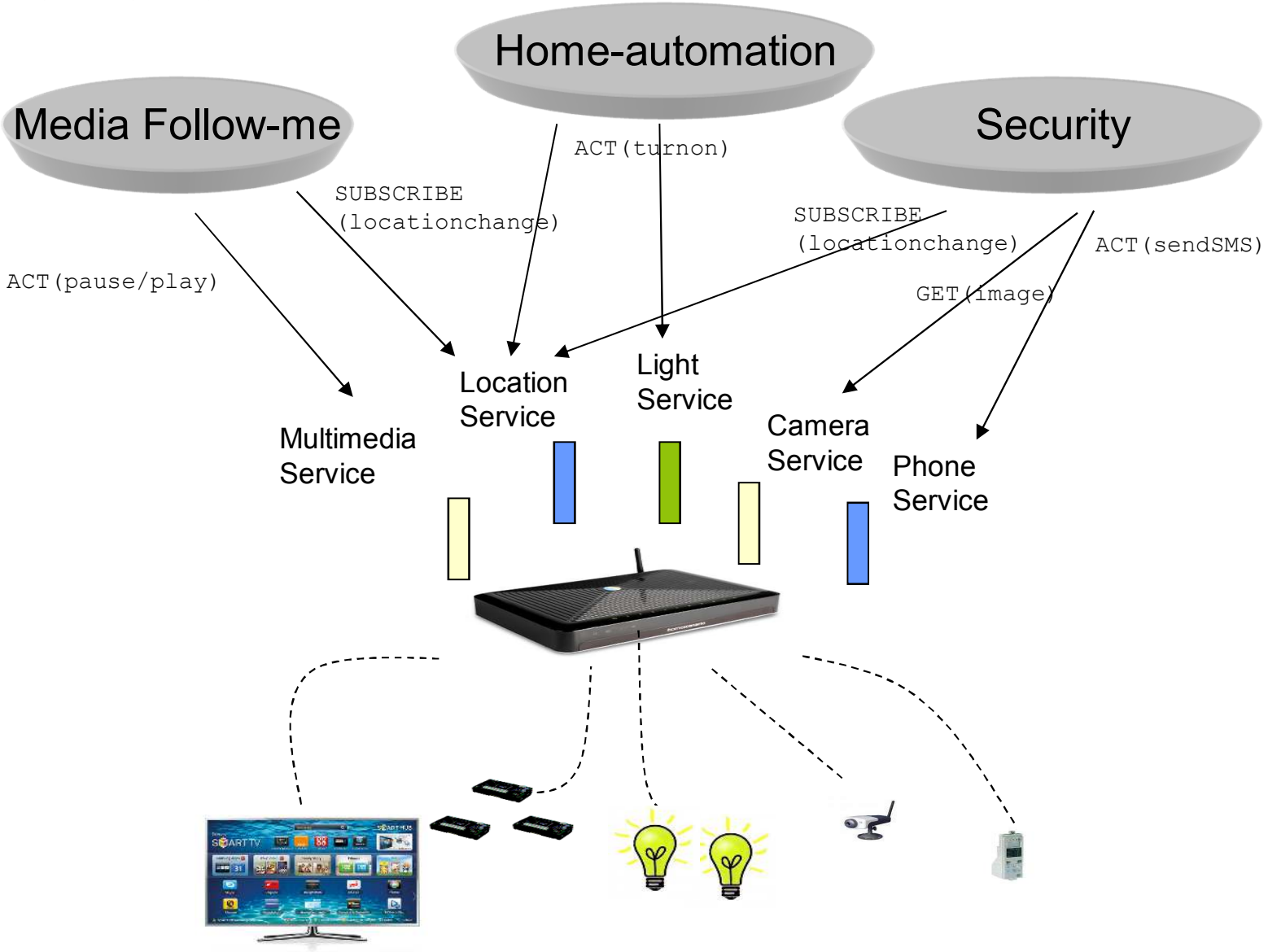
user context | environmental context | user future behaviour | user preferences | user location

Device as a Service; device/service discovery, generic APIs for resource access

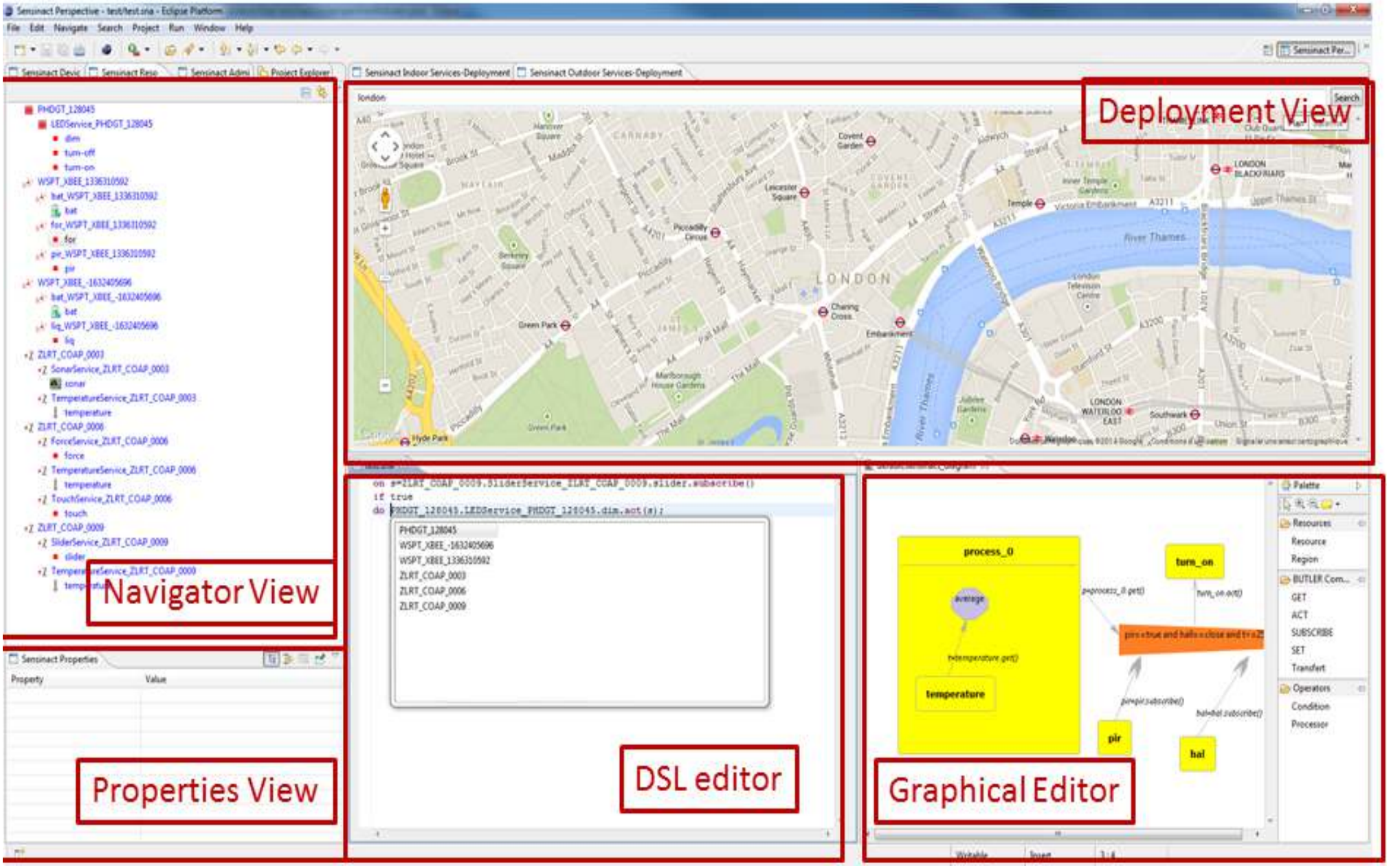
sensiNact Service/Resource Model



IoT Device as a Service: reuse of devices by different applications



sensiNact Studio: tool for IoT application development and deployment



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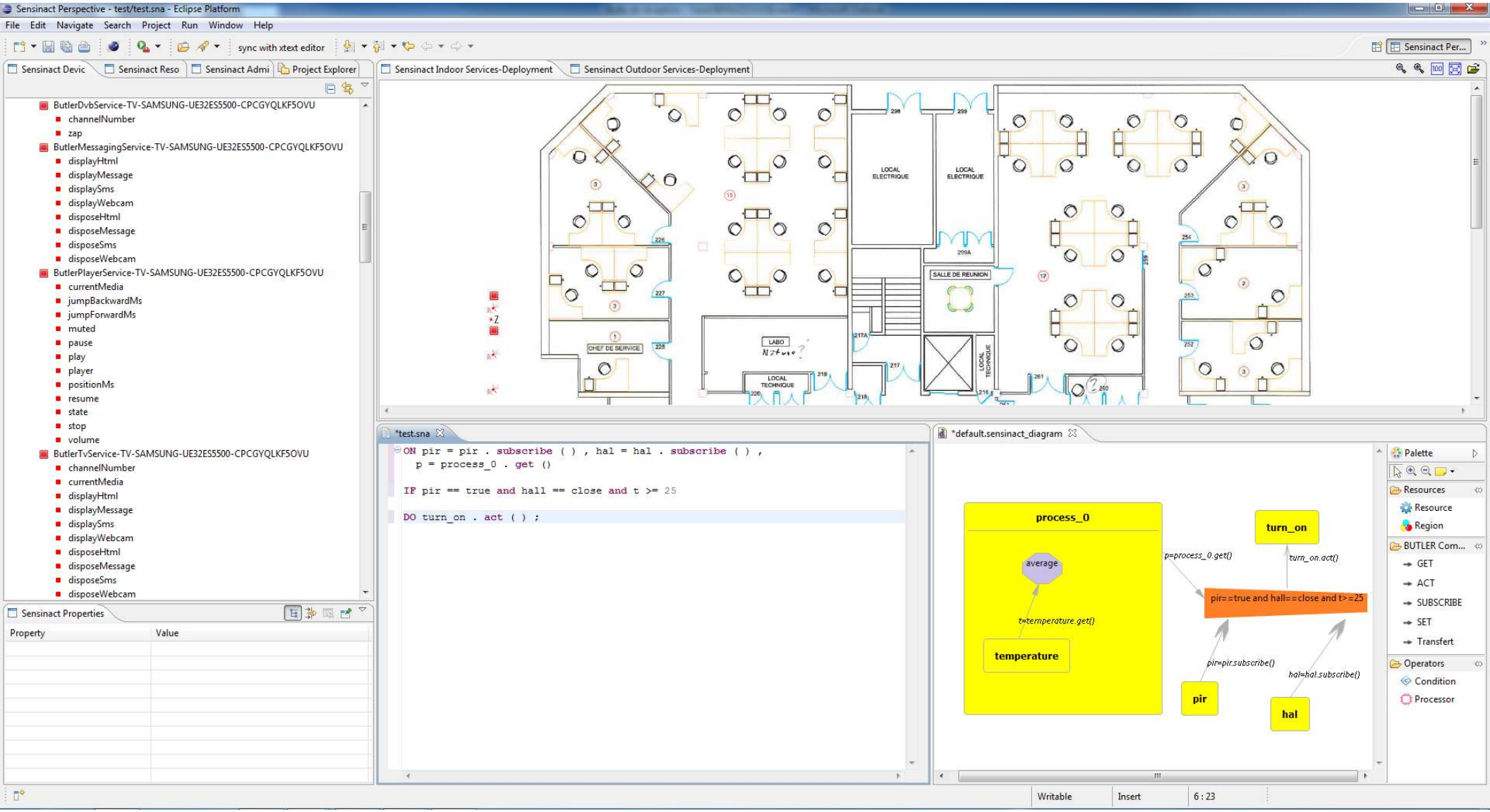

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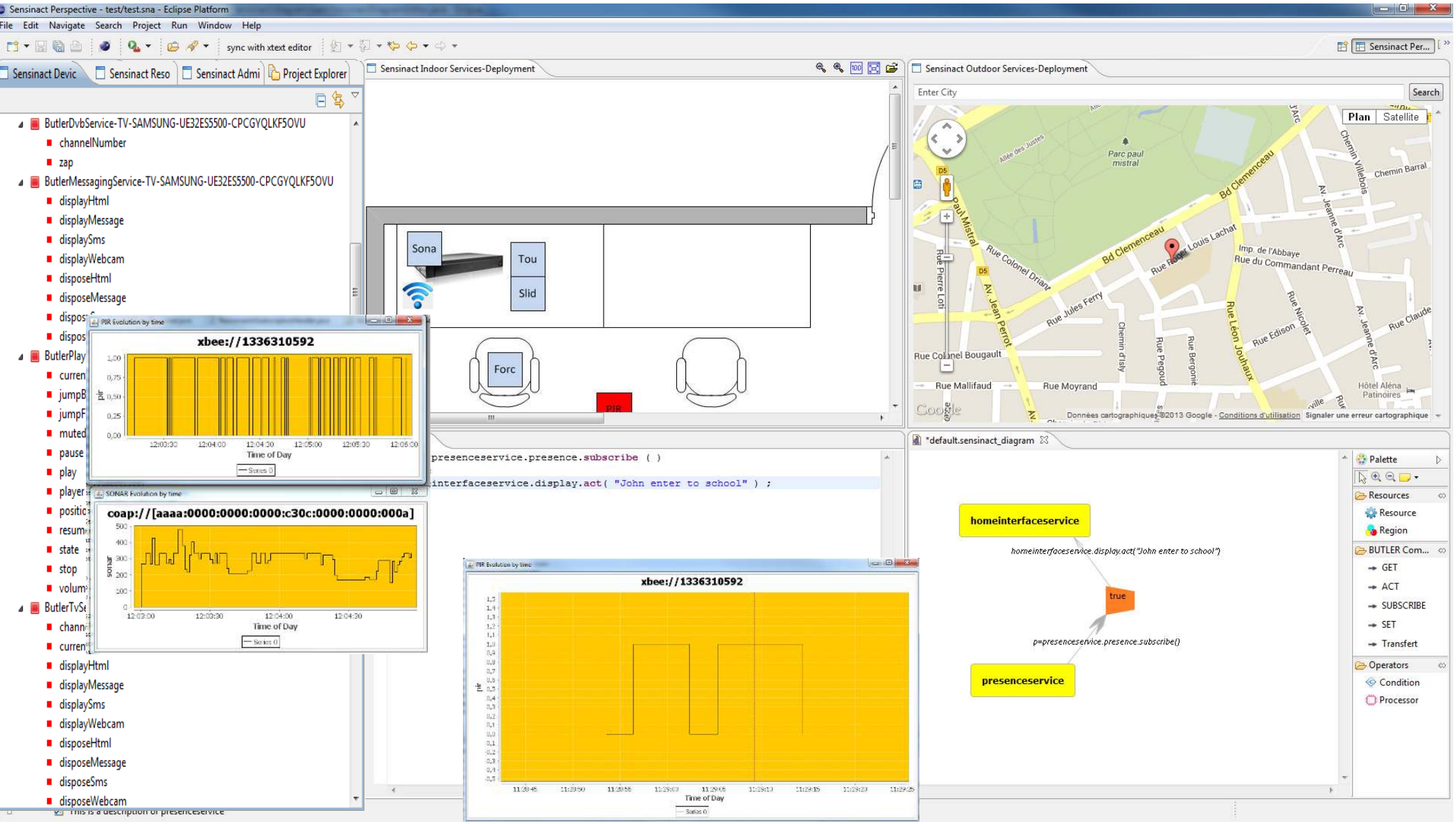

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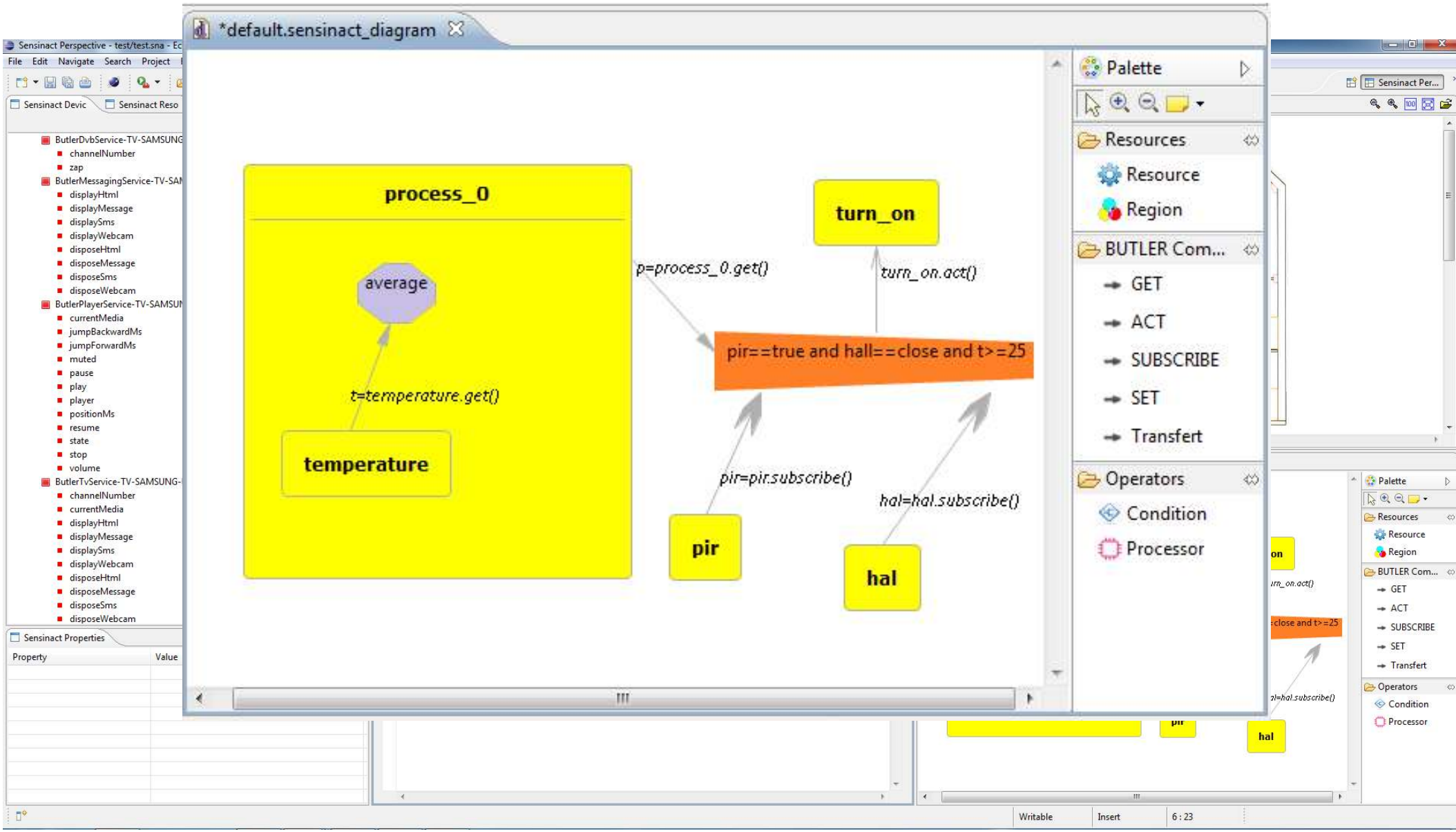
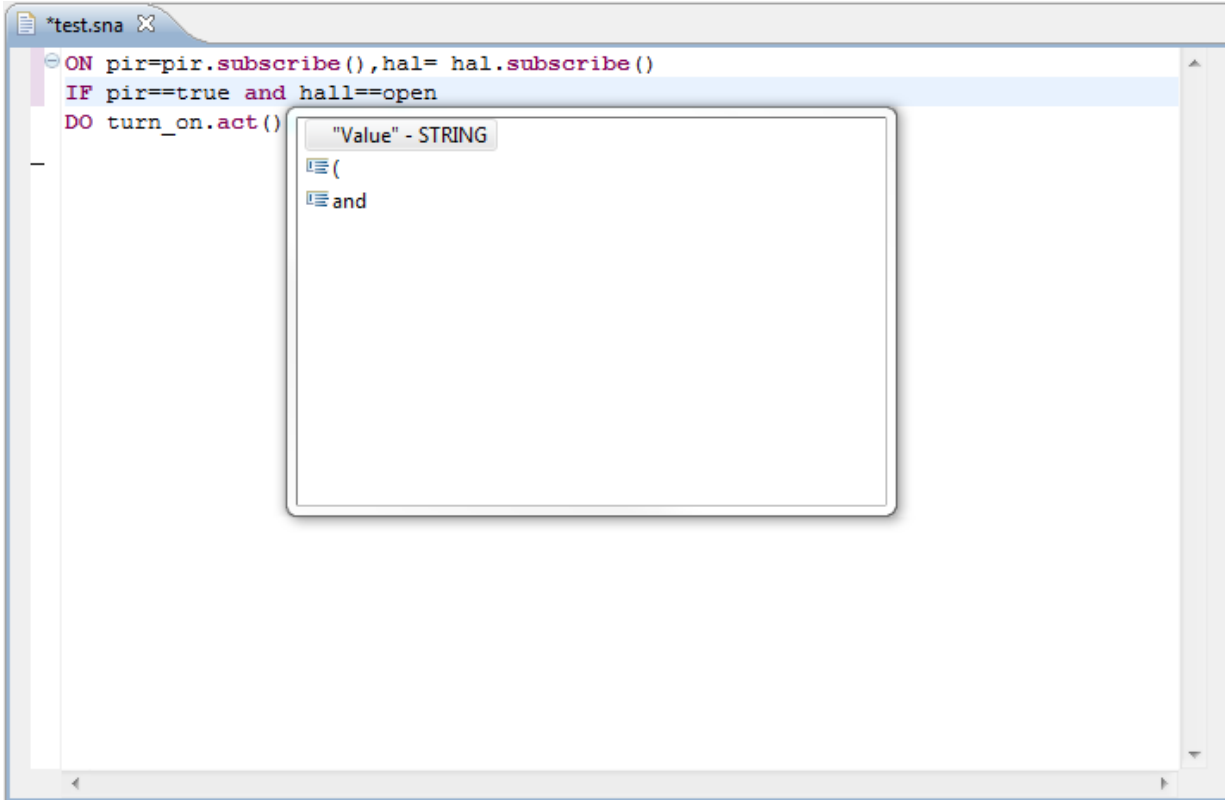
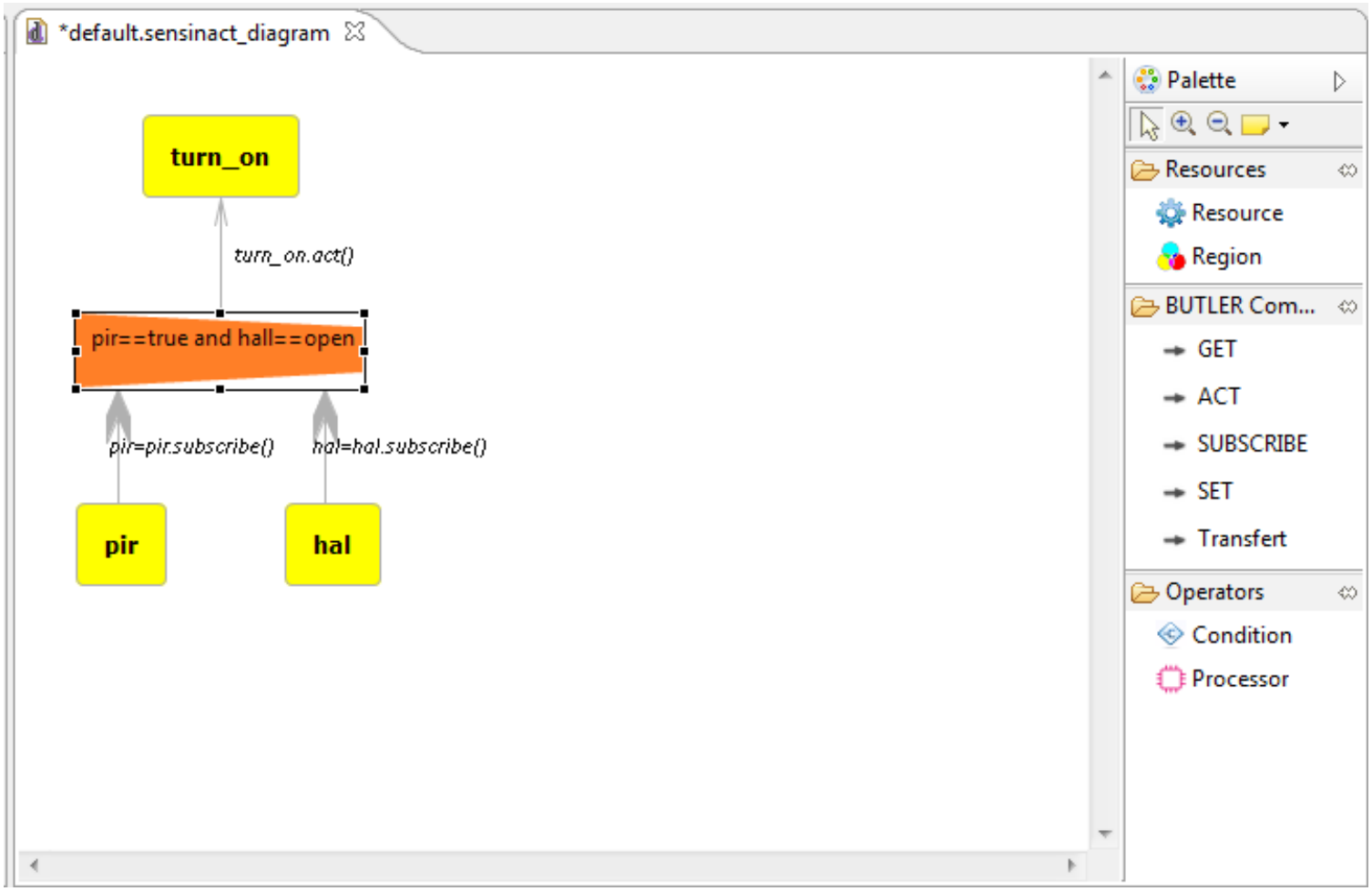


- A DSL for building IoT applications based on Event Condition Action rules
- **ON** Event **IF** Condition **DO** Action

ON presence=PIRService.PIR.**subscribe**()
IF presence==true
DO LightService.lightOn.**act**();
IF presence==false
DO LightService.lightOff.**act**();



Graphical equivalence of the rule with GMF

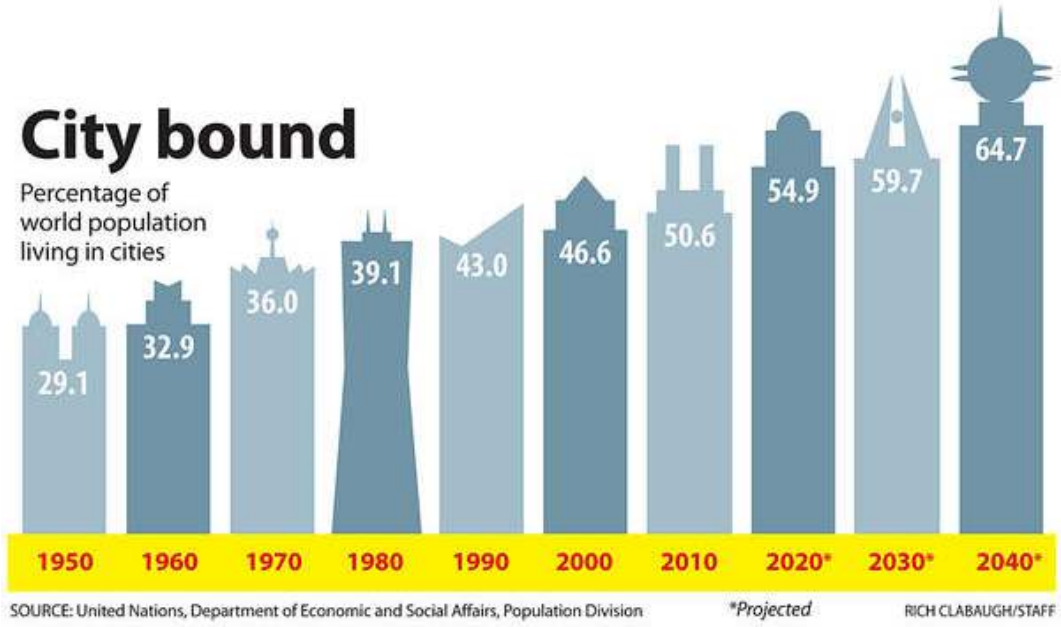


IoT and smart city experience in European Projects

BUTLER
ClouT
OUTSMART

Context and motivation

Cities have been facing emerging challenges such as efficient energy management, economic growth and development, security and quality of life of its habitants



- More than half of the world population lives in cities
- On 2% of the earth's surface, cities use 75% of the world resources
- Urban areas of the world are expected to absorb all the population growth expected over the next four decades while at the same time drawing in some of the rural population.
- Urban population percentage is around 75% in Europe

Europe should take immediate measures in order to transform cities into "smart cities" that better manage their resources, keep (and increase) the quality of life and security of their citizens

EU FP7 BUTLER Project

uBiquitous, secUre inTernet-of-things with Location and contExt-awaReness

FP7 call: FP7-ICT-2011-7

Integrated Project

October 2011 – September 2014

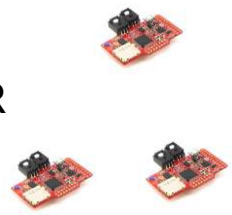
15 M€

1234 man-months

From BUTLER project presentation

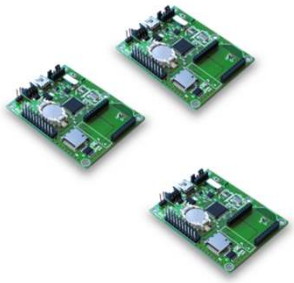
BUTLER Gateway – overall architecture

BUTLER Devices



Zolertia (CoAP)

Waspmote (Zigbee,)



TST Motes (multi-protocol, proprietary API)

Zigpos (Zigbee, proprietary API)

SunSPOT (802.15.4, JAVA APIs)

Smart TV (UPnP or proprietary API)

BUTLER Gateway – overall architecture

BUTLER Gateway

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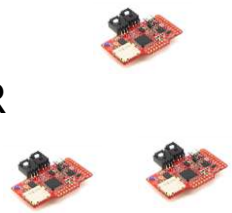

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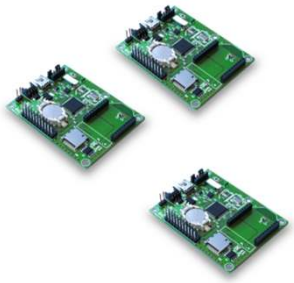

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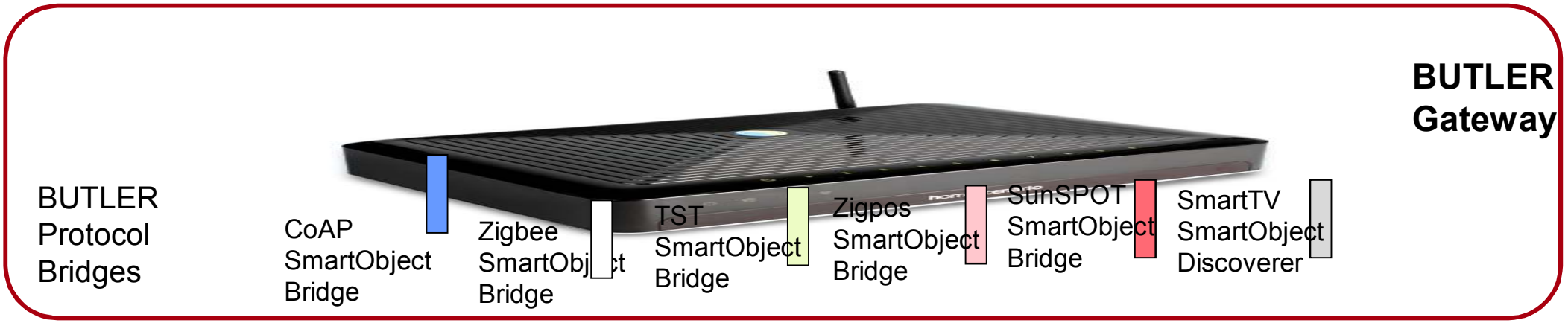

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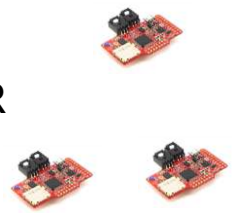

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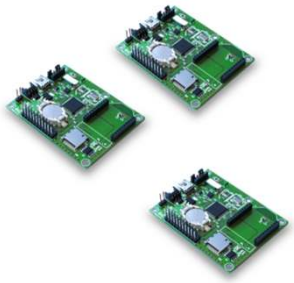

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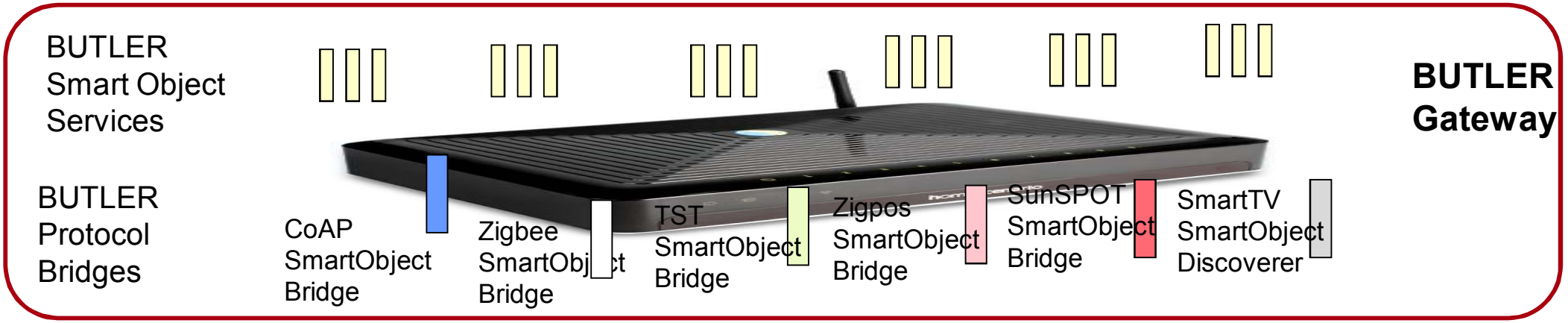

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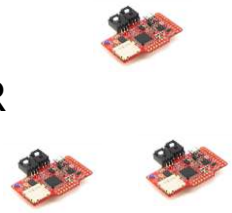

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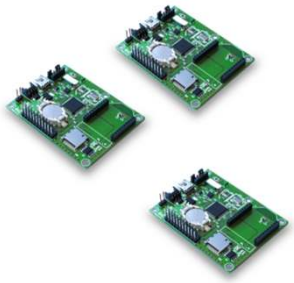

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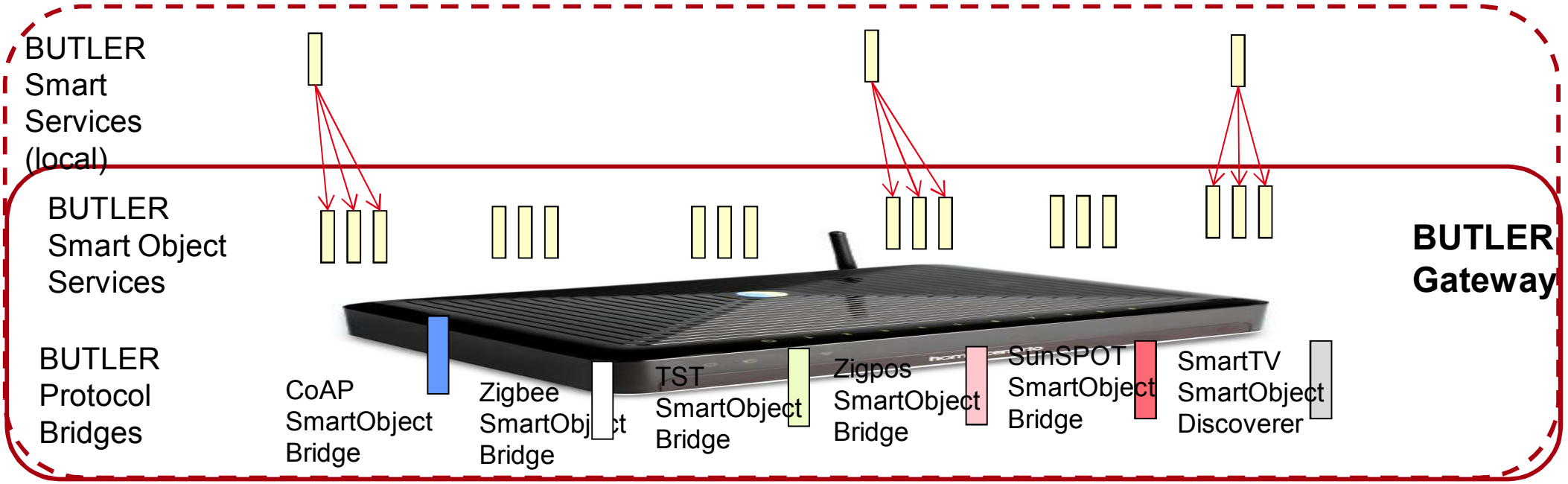

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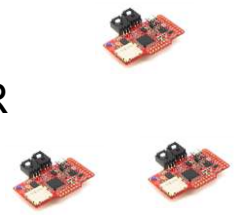

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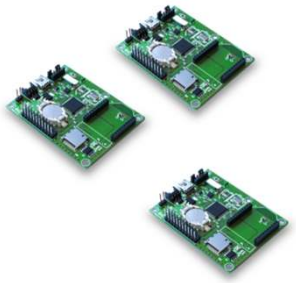

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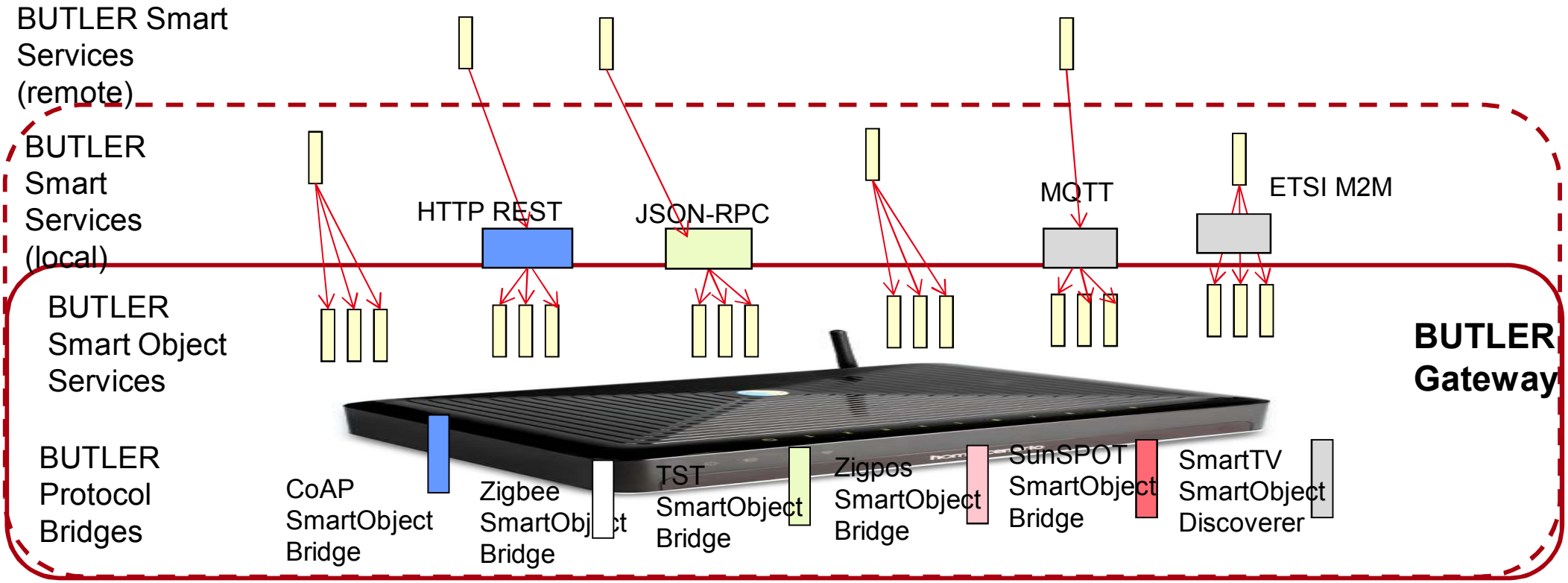

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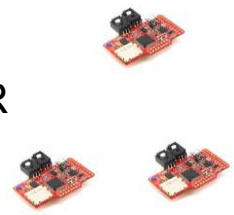

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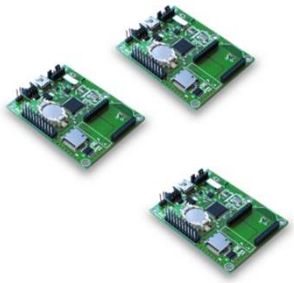

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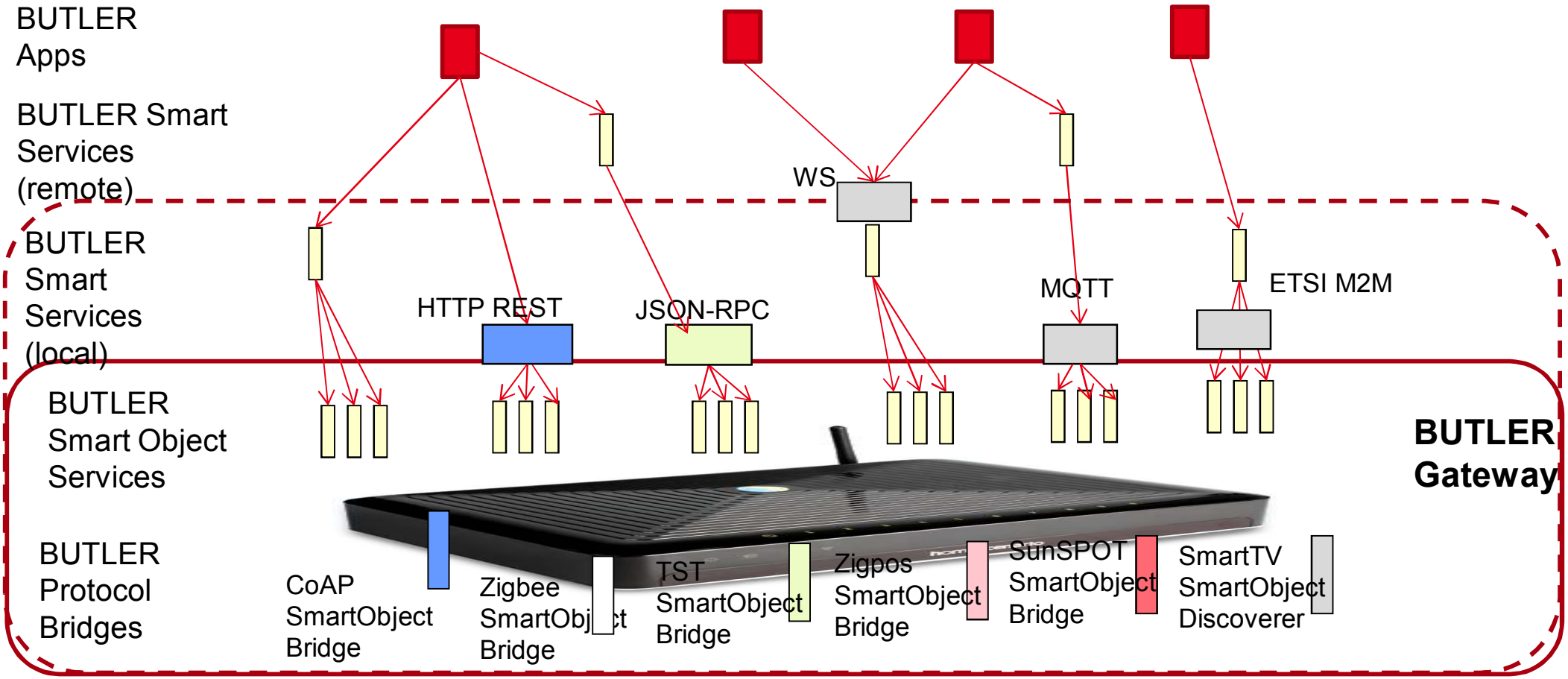
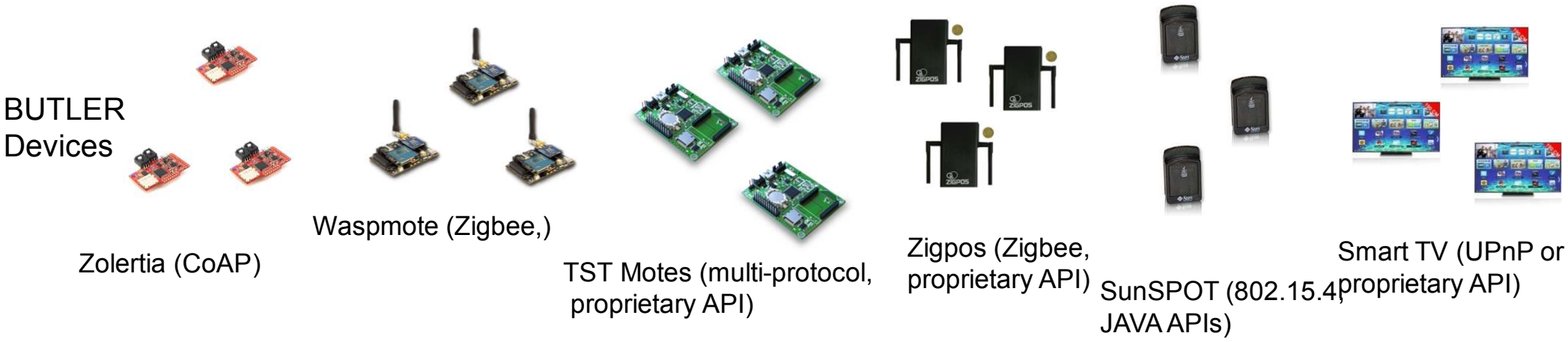
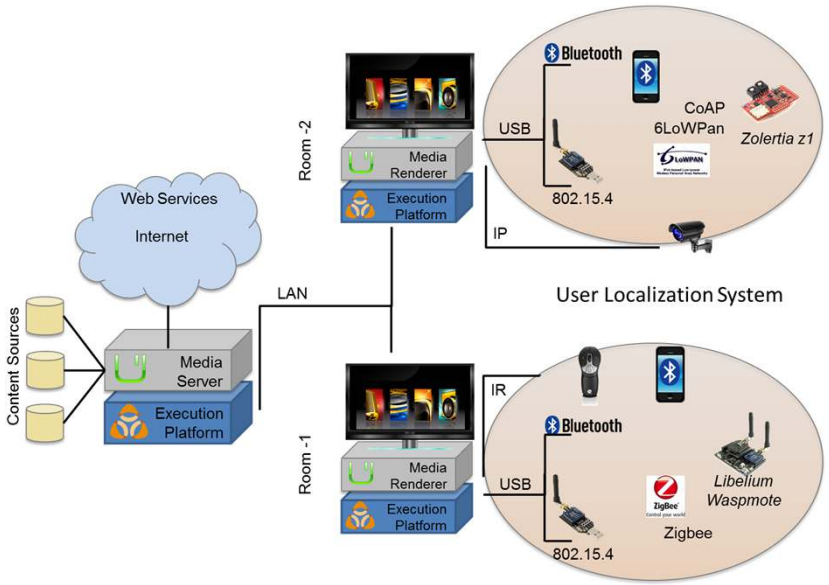
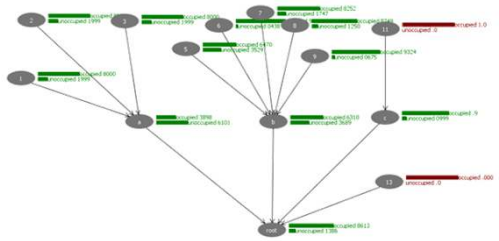
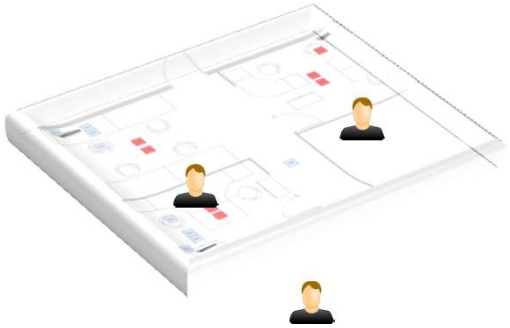




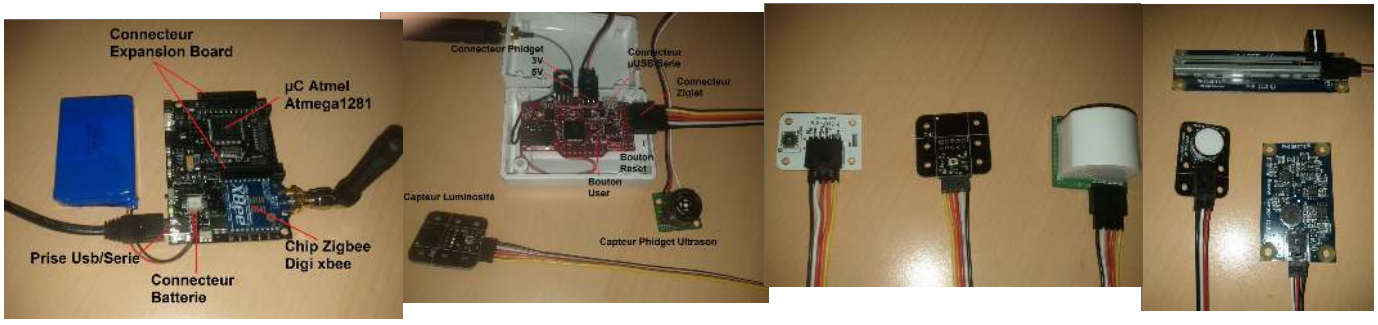
Smart Home – multimedia follow me and pick me





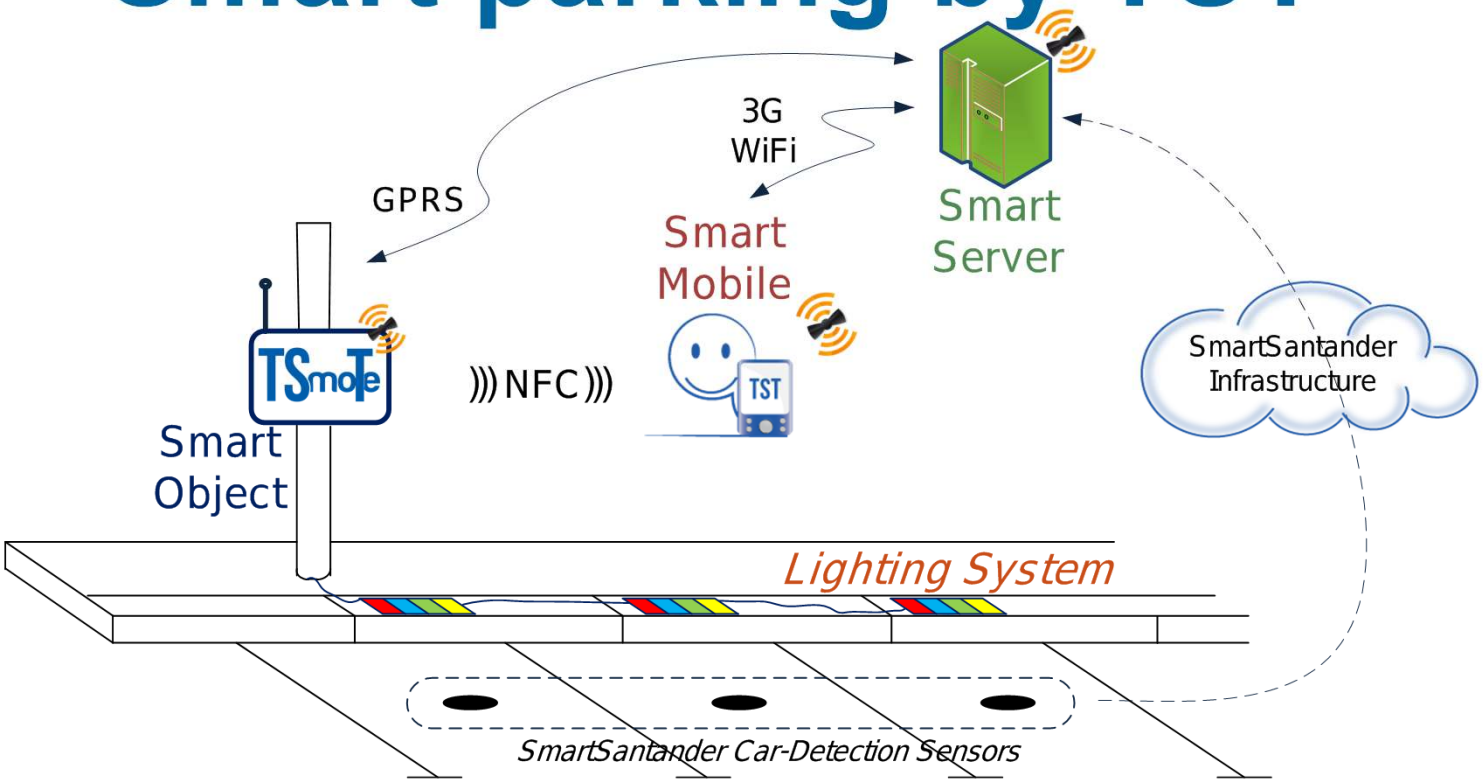


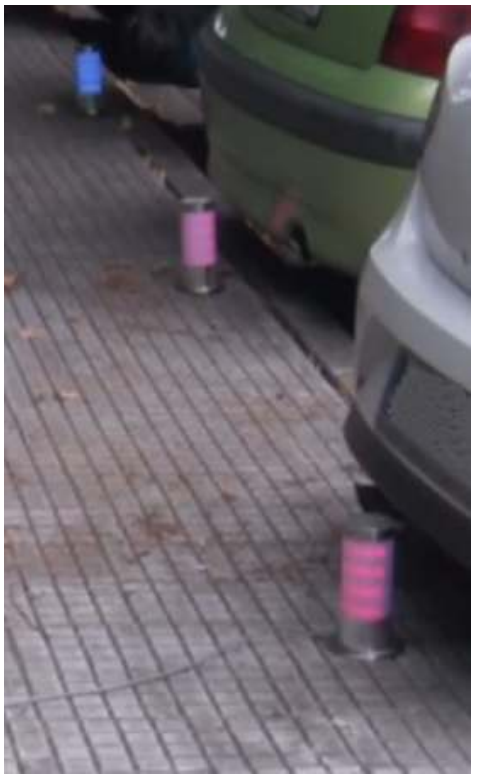
6LoWPAN and Zigbee based sensors for localisation

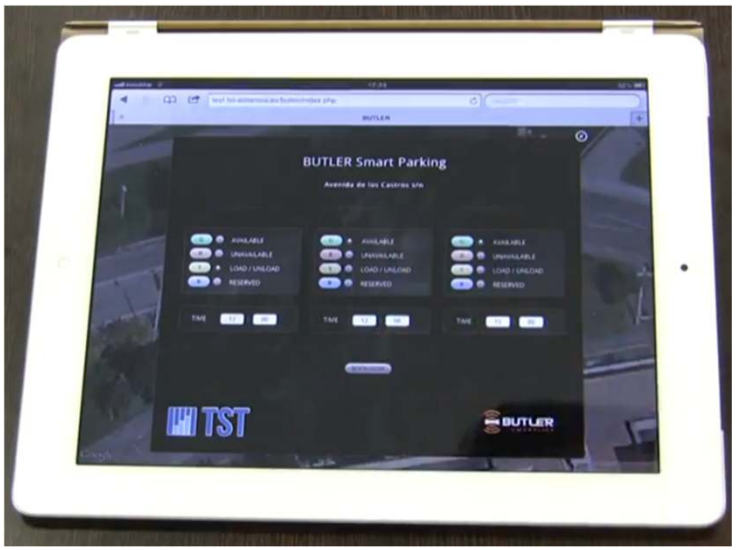


UPnP for media service

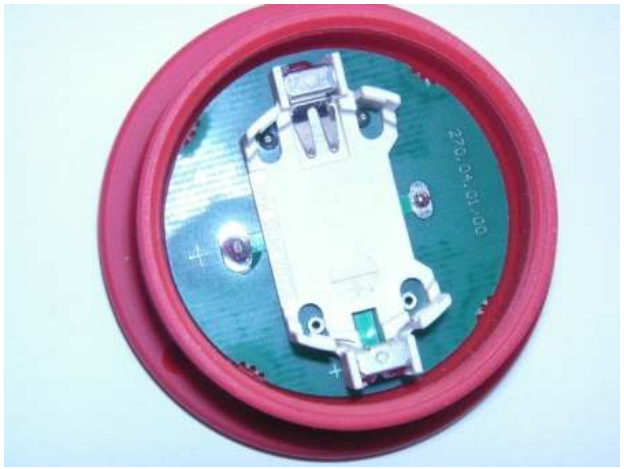
Smart parking by TST



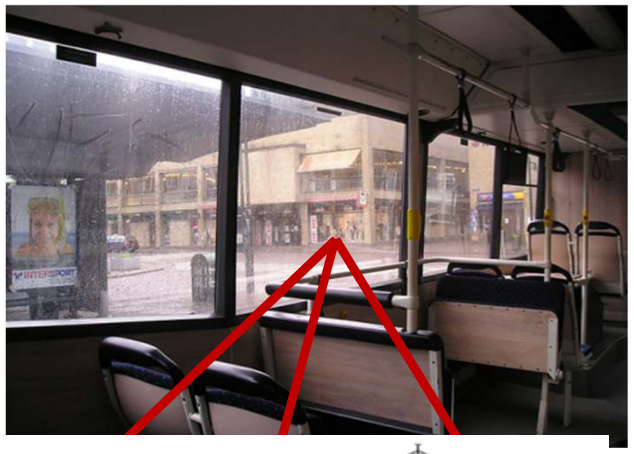


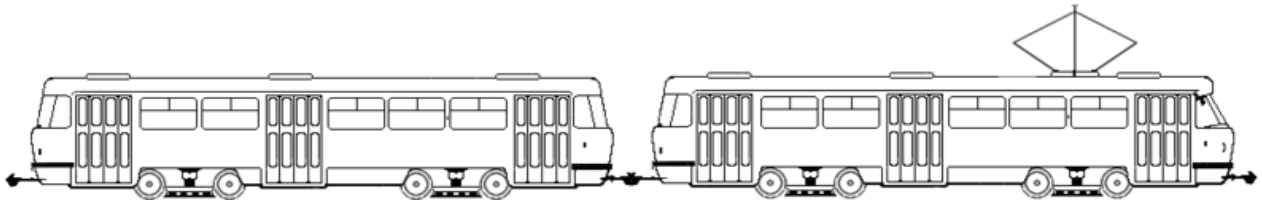


Smart transport, Zigpos in Glacier Express (access right management for staff)



Smart transport, passenger localisation





ClouT: Cloud of Things for empowering the citizen clout in smart cities

AT A GLANCE

Project coordinator :

Clout-EU: **Levent Gürgen, CEA-LETI, France**

ClouT-JP: **Yoshio Saito, NTT East, Japan**

Partners:

ClouT-EU

Engineering, Italy
Universidad de Cantabria, Spain
ST Microelectronics SRL, Italy
Ayuntamiento de Santander, Spain
Comune di Genova, Italy

ClouT-JP

NTT East
NTT R&D
Keio University
Panasonic System Solution
National Institute of Informatics

Duration: **36 months**

Total cost: **€2,32M for ClouT-EU**
€1 ,5M for ClouT-JP, funded by NICT

Programme: **FP7-ICT-2013- EU-Japan**

Further information:

http://clout-project.eu
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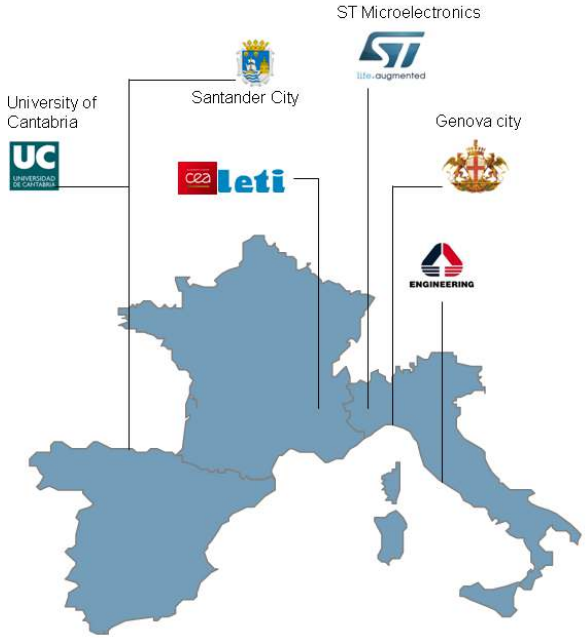
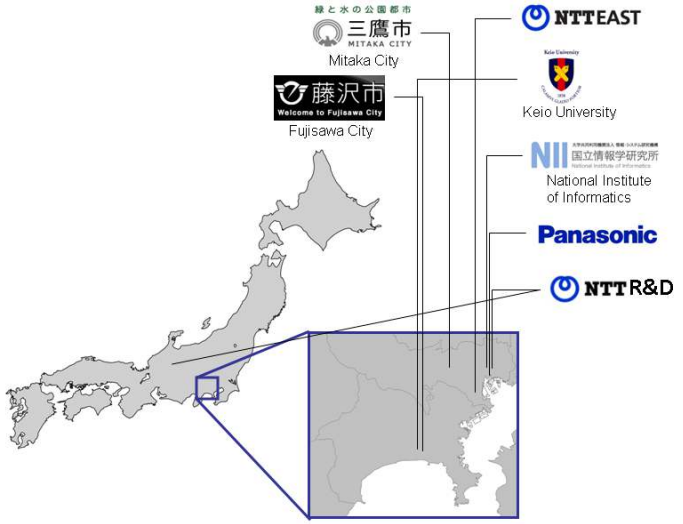
Levent.gurgen@cea.fr
+33 4 38 78 97 57





ClouT Objectives

1. Bridging Internet of Things and Internet of People by exploiting the Cloud paradigm, enabling end to end business and social scenarios *(Cloud+IoT = ClouT)*

- Extend the IoT with Cloud capabilities
- Enable secure and easy access to city resources via services
- Support mash-up and integration of city services

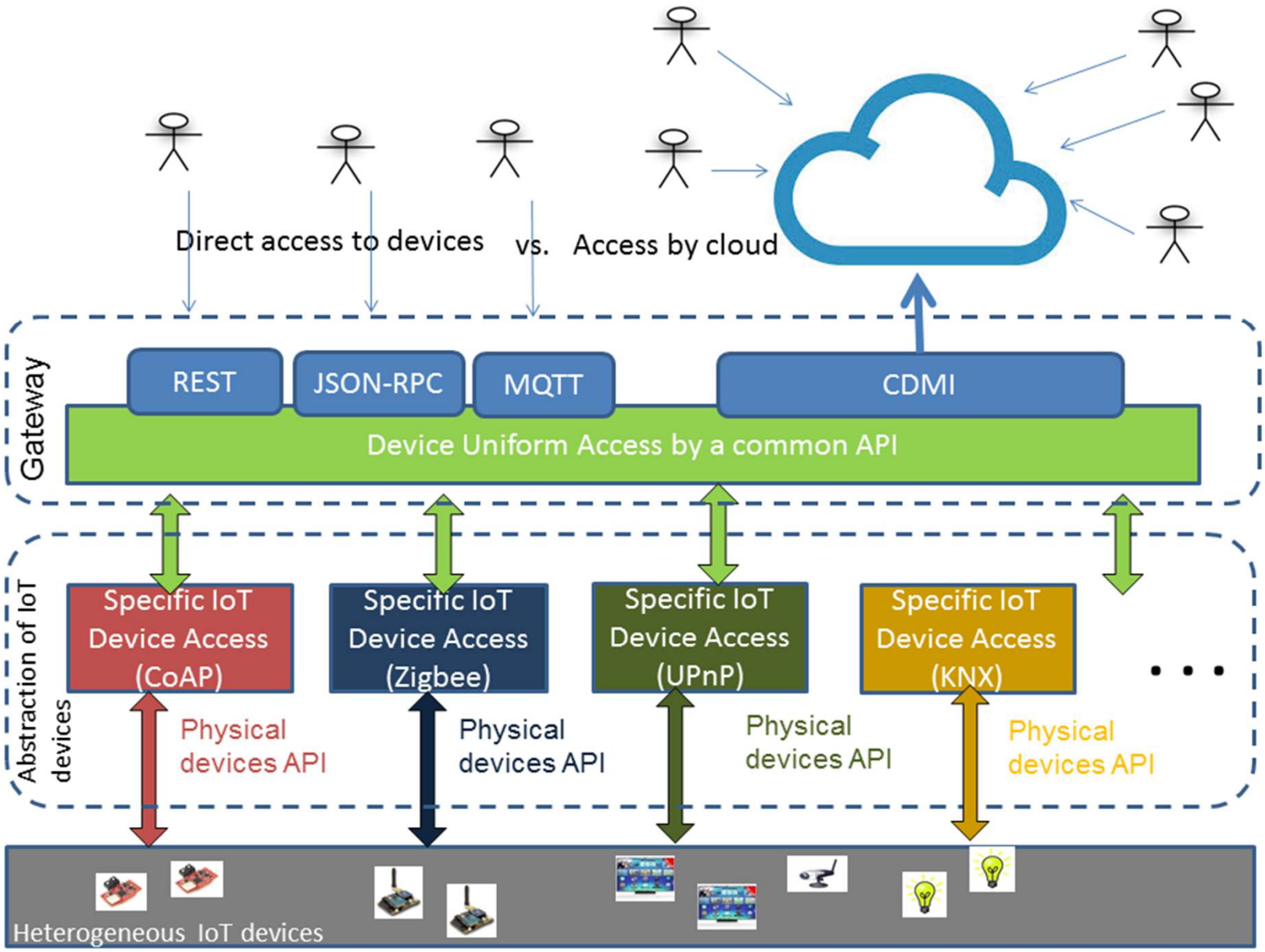
2. Prototyping and validating the ClouT Reference Architecture to enable Smart City ecosystems

- Support development and execution of apps for cities
- Deployments on 4 pilot cities
- Show feasibility of new business models

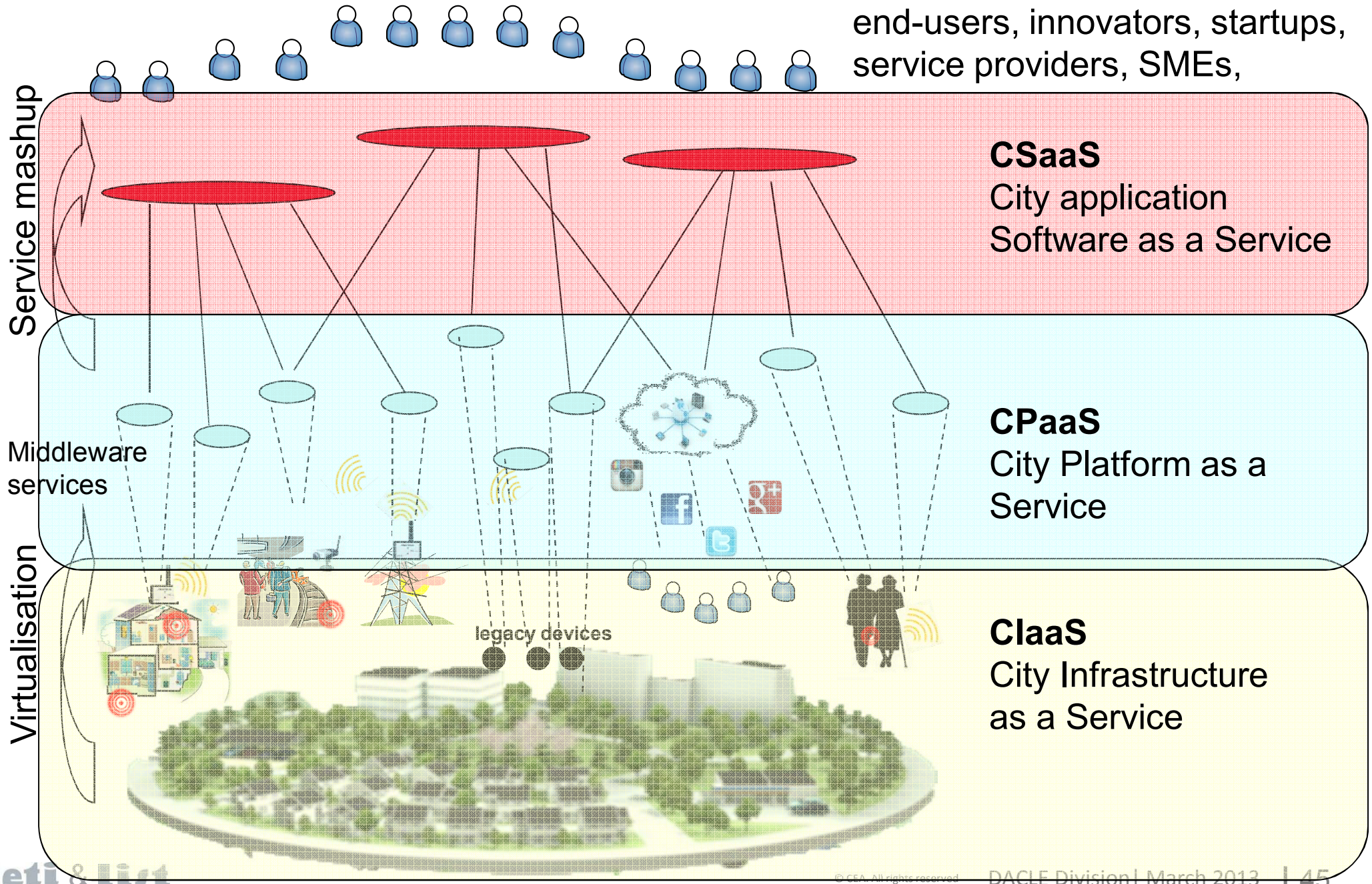
3. Join the forces and create a long lasting synergy for Smart City initiatives between Europe and Japan

- Exchange of best practices and lessons learned
- Joint development of sustainable solutions
- Establish mutual understanding and trust

From IoT to Cloud



Cloud model for IoT Services



ClouT Architecture

Use cases and field trials in 4 pilot cities

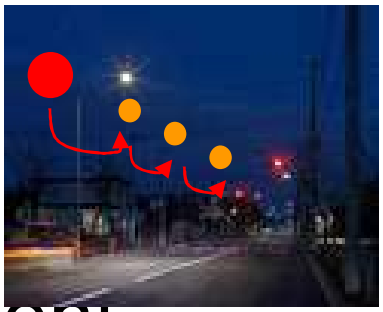
- Participatory sensing
  - Participatory citizen
  - Sensing loop citizens

- Urban context-aware
  - Multi-modal transportation
  - Event perception support
  - Interactive city infrastructures
  - Sharing IoT devices in the Clou
  - Augmented mobility

Santander **Fujisawa**

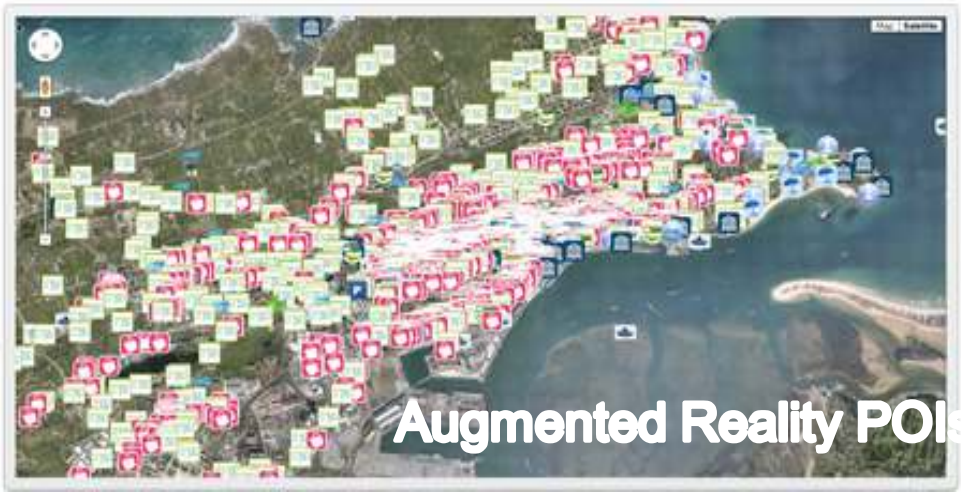
ClouT

Genova **Mitaka**



- Safety, emergency and health management
  - Risk warning and management
  - Caring of elderly people
  - Health and active walking support

Santander



maps.smartsantander.eu

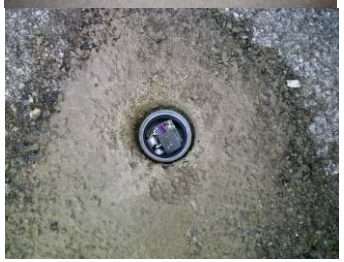
Santander, existing infrastructure

Environmental monitoring

Smart irrigation

mobile nodes on city buses and taxis

Parking sensors



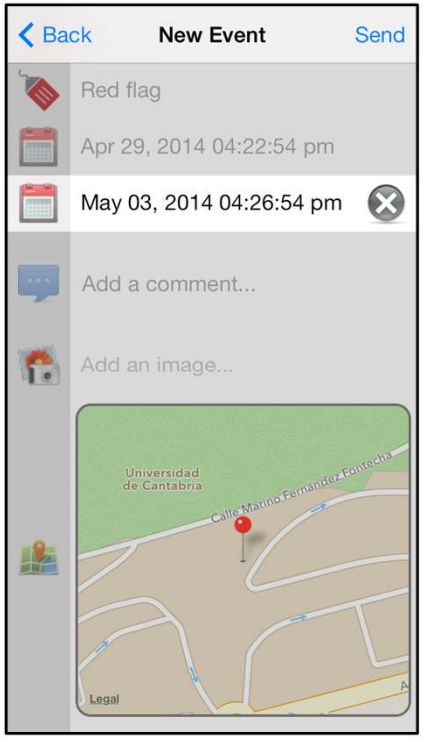
Guiding drivers

Trafic sensors

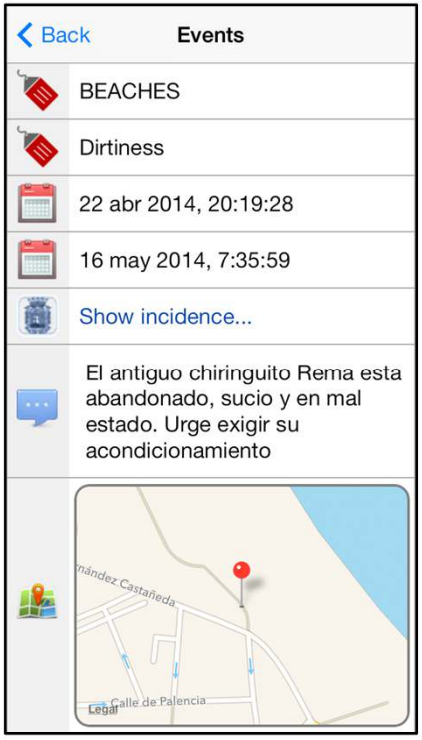
Participatory sensing in Santander

1. Reported events

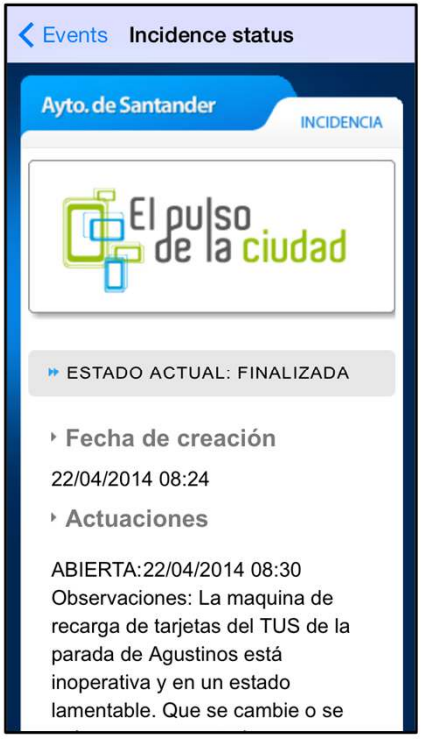
2. New event



3. Event information

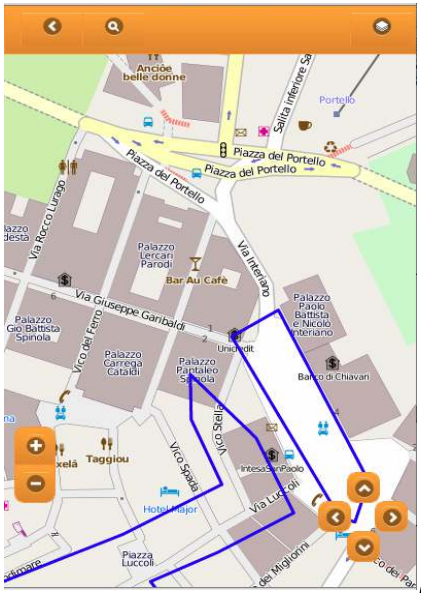


4. Incidence status



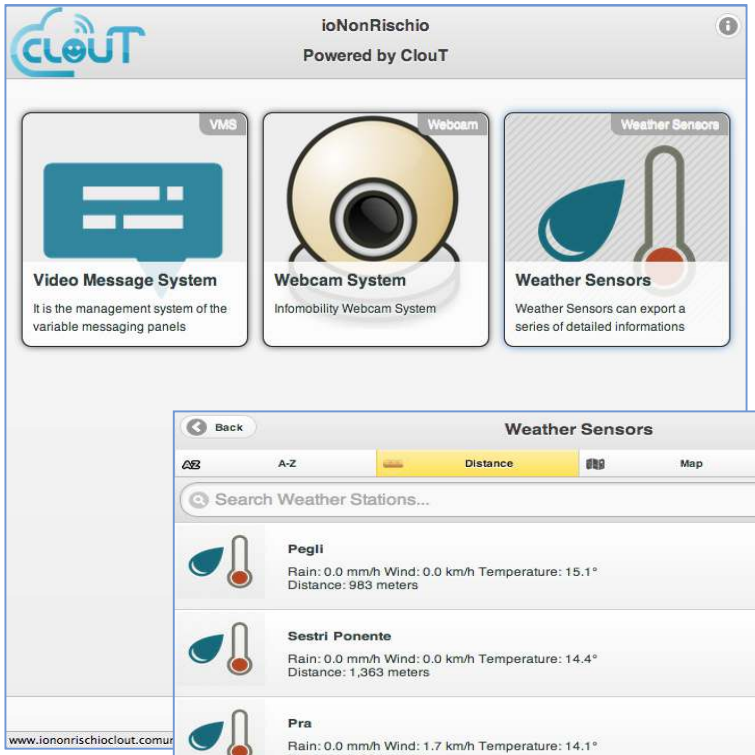
Genova

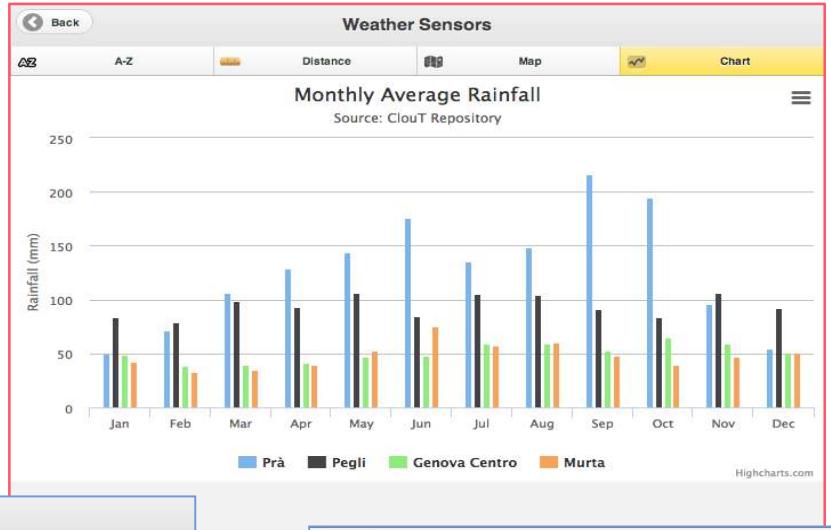
Smart port

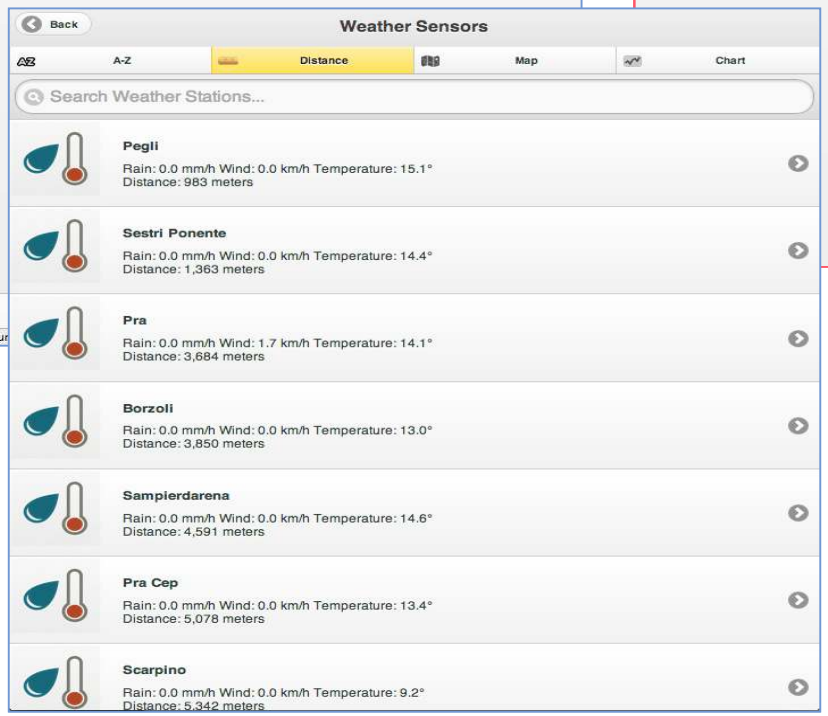


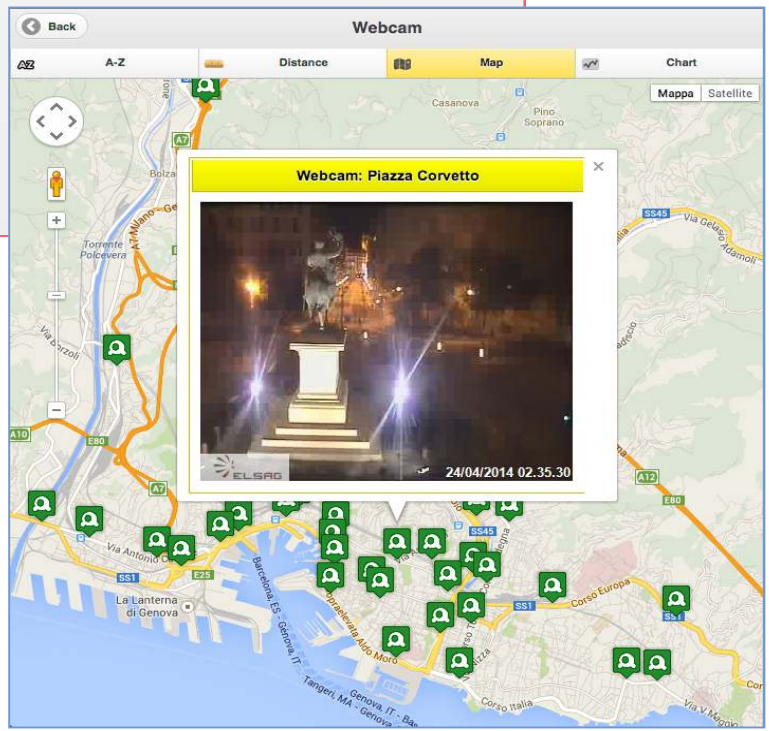
Flooding detection and alerts

Genova environmental data in the Cloud



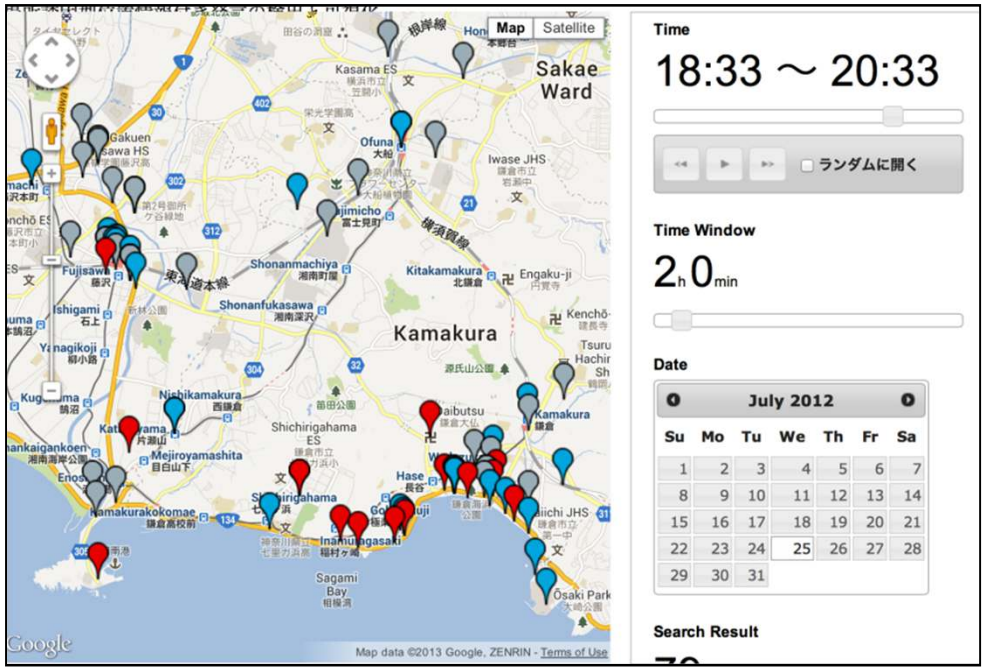




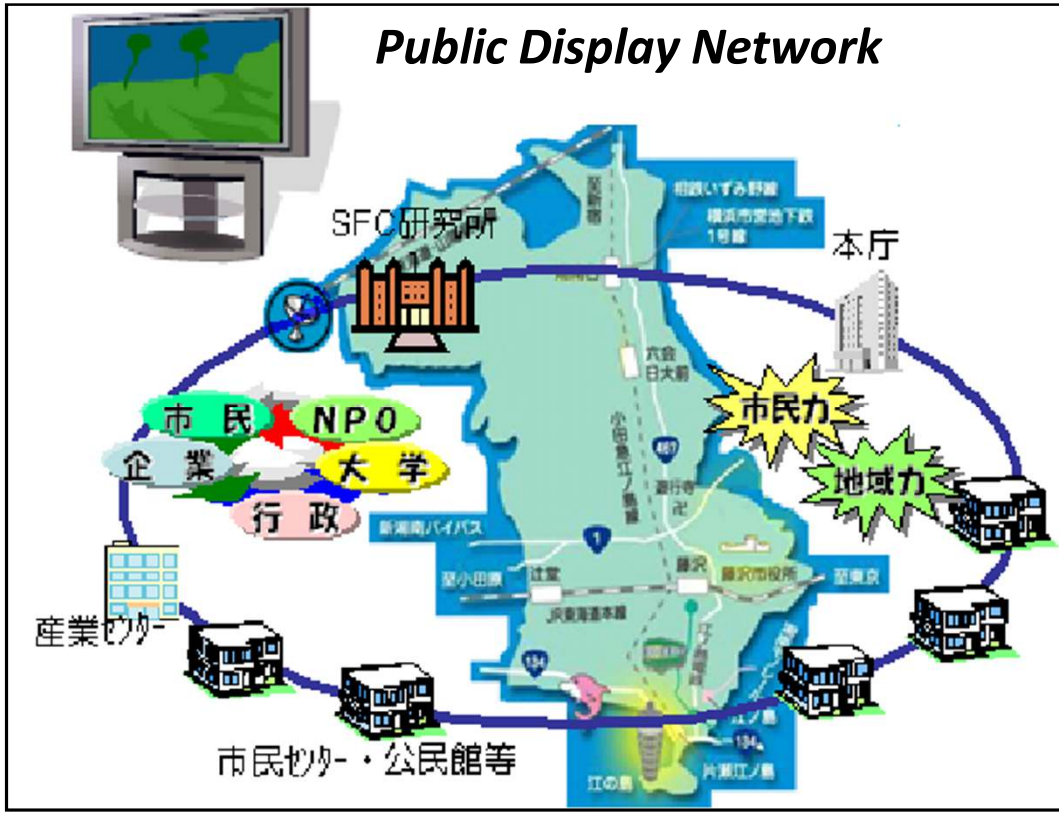


Fujisawa

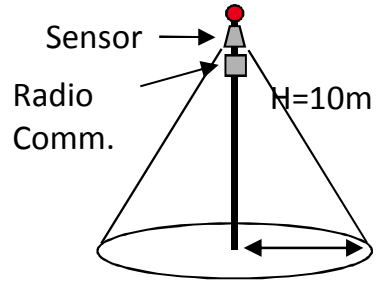
Event analysis

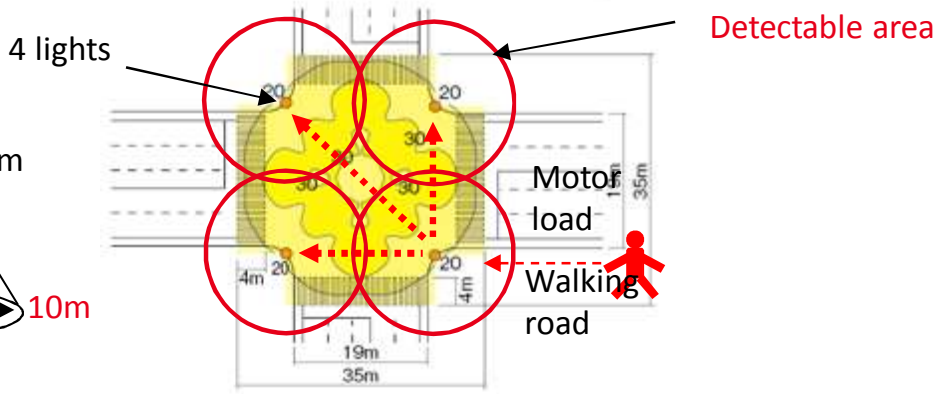


Public Display Network



Smart light and camera system





New lighting which integrated with visual projection by Panasonic

Create new space value
by fusion of visual projection & lighting

Projection Lighting

Fujisawaoooo! -Interactive Street @ Subana-

Public

- **City Database**
  - Map
  - Tourism
  - Citizen Participation
- **City Related Company Database**
  - NPO HP
  - Event Info.
- **Sensor Info.**
  - Camera
  - Camera Database

Private

- **Public API**
  - Restaurant Info.
- **SNS**
  - Local SNS
  - Twitter
- **Store Info.**
  - Coupon
  - Time Sales
- **Sensor Info.**
  - Interactive Street Santander
  - Illumination Sensor
  - Train Info.

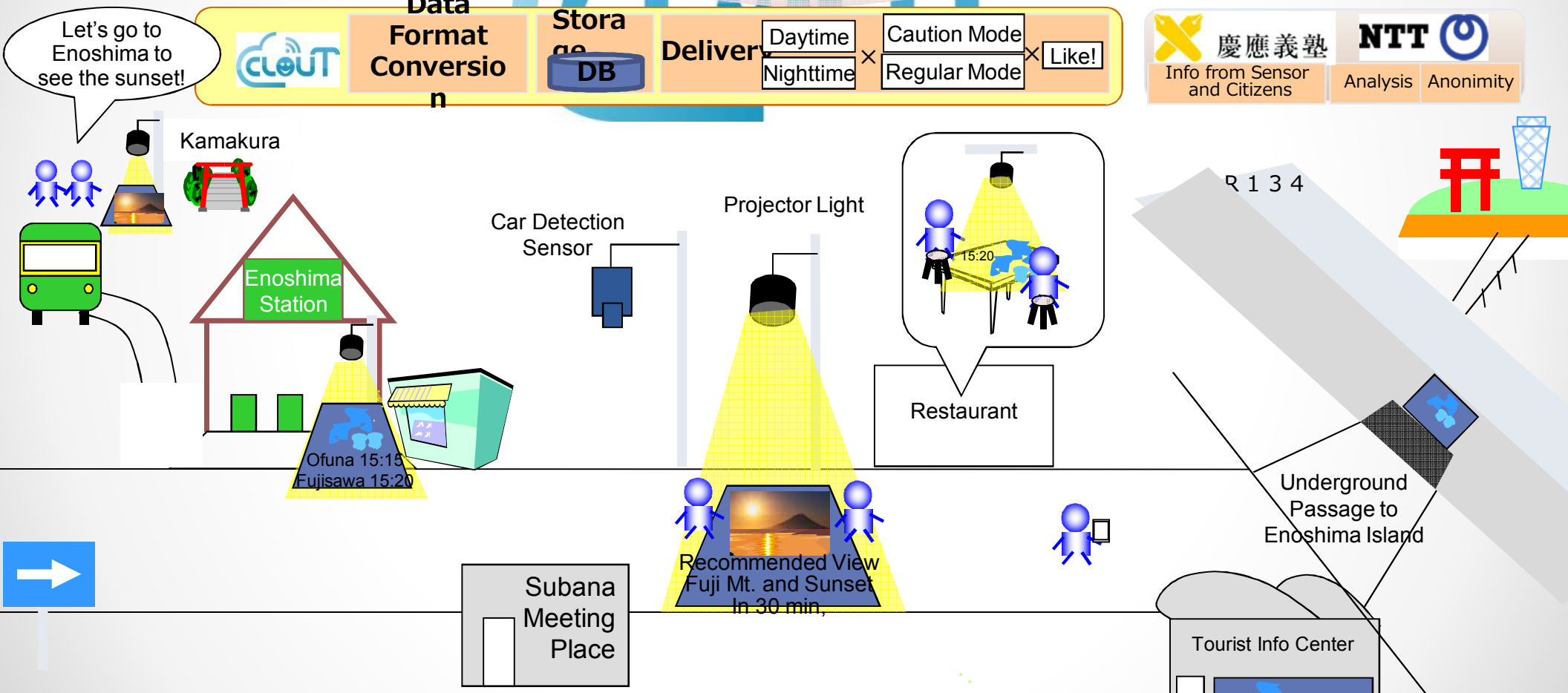
Input Data from Sensor or Database

CLOUT

Data Format Conversion → **Storage DB** → **Delivery**: Daytime / Nighttime × Caution Mode / Regular Mode × Like!

慶應義塾 NTT

Info from Sensor and Citizens | Analysis | Anonimity



【Regular Mode】

- Shop/Tourism Info.
- Info from Citizens
- Train/Station Info.

Fujisawaoooo! -Interactive Street @ Subana-

Public

- **City Database**
  - Map
  - Tourism
  - Citizen Participation
- **City Related Company Database**
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Input Data from Sensor or Database

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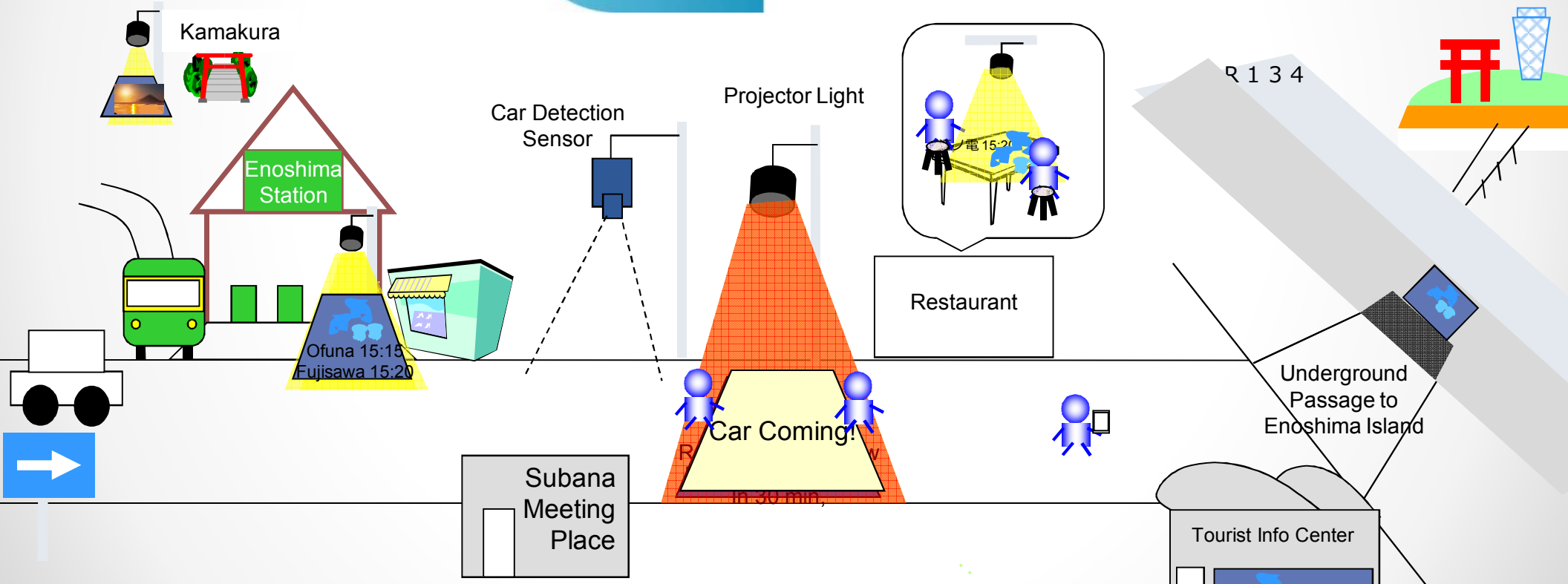
慶應義塾 | NTT

Info from Sensor and Citizens | Analysis | Anonimity



【Caution Mode】

①Detect Car Coming → Talk → ②Caution (Change the color, brightness or message)

Fujisawaoooo! -Interactive Street @ Subana-

目指せ！
東京オリンピック採用
CodeName:おもてなし

Public

- City Database
  - Map
  - Tourism
  - Citizen Participation
- City Related Company Database
  - NPO HP
  - Event Info.
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  - Restaurant Info.
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  - Santander
  - Illumination Sensor
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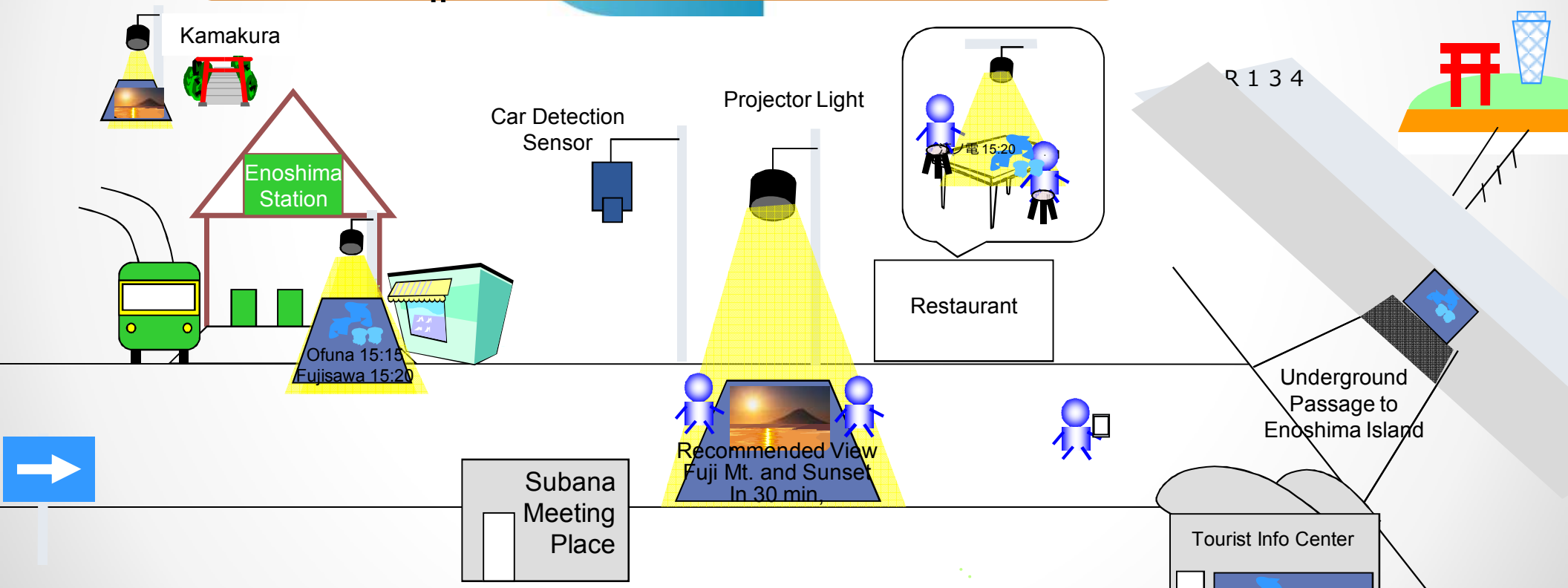
Input Data from Sensor or Database

CLOUT | Data Format Conversion | Storage DB | Delivery: Daytime / Nighttime × Caution Mode / Regular Mode × Like!

慶應義塾 Info from Sensor and Citizens | NTT Analysis | Anonimity



【Emergency Mode】

Fujisawaoooo! -Interactive Street @ Subana-

目指せ！
東京オリンピック採用
CodeName:おもてなし

Public

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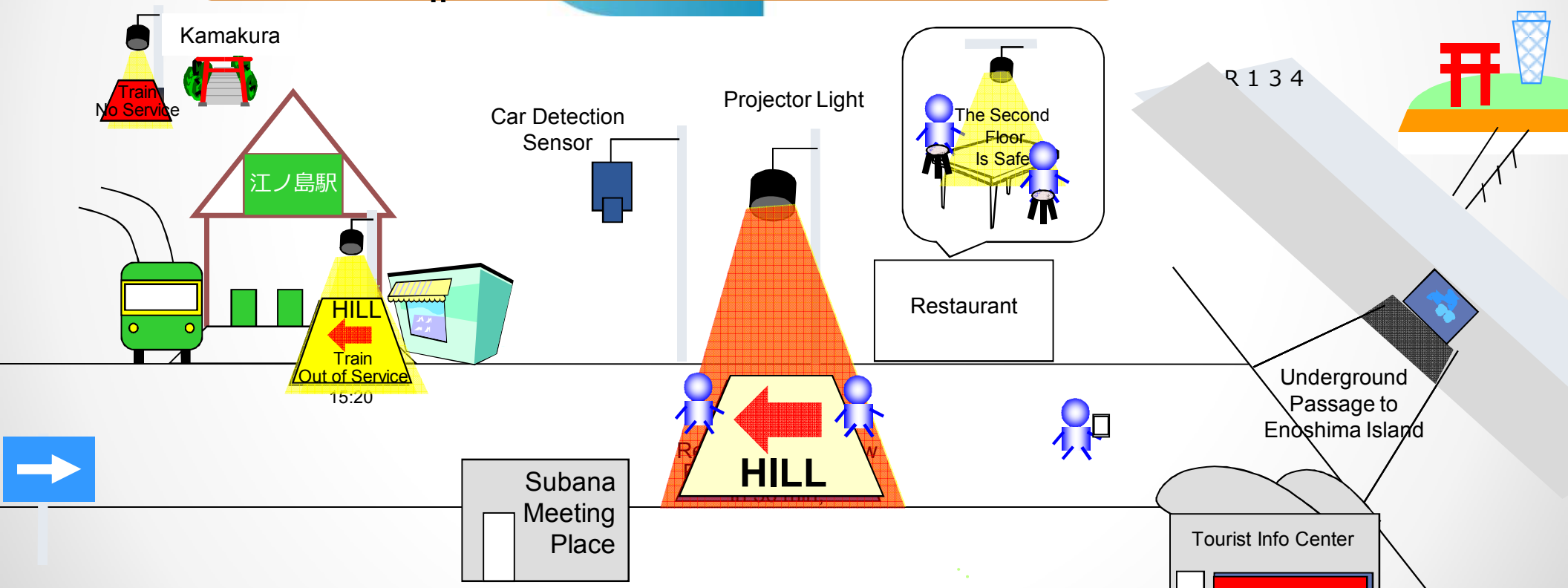
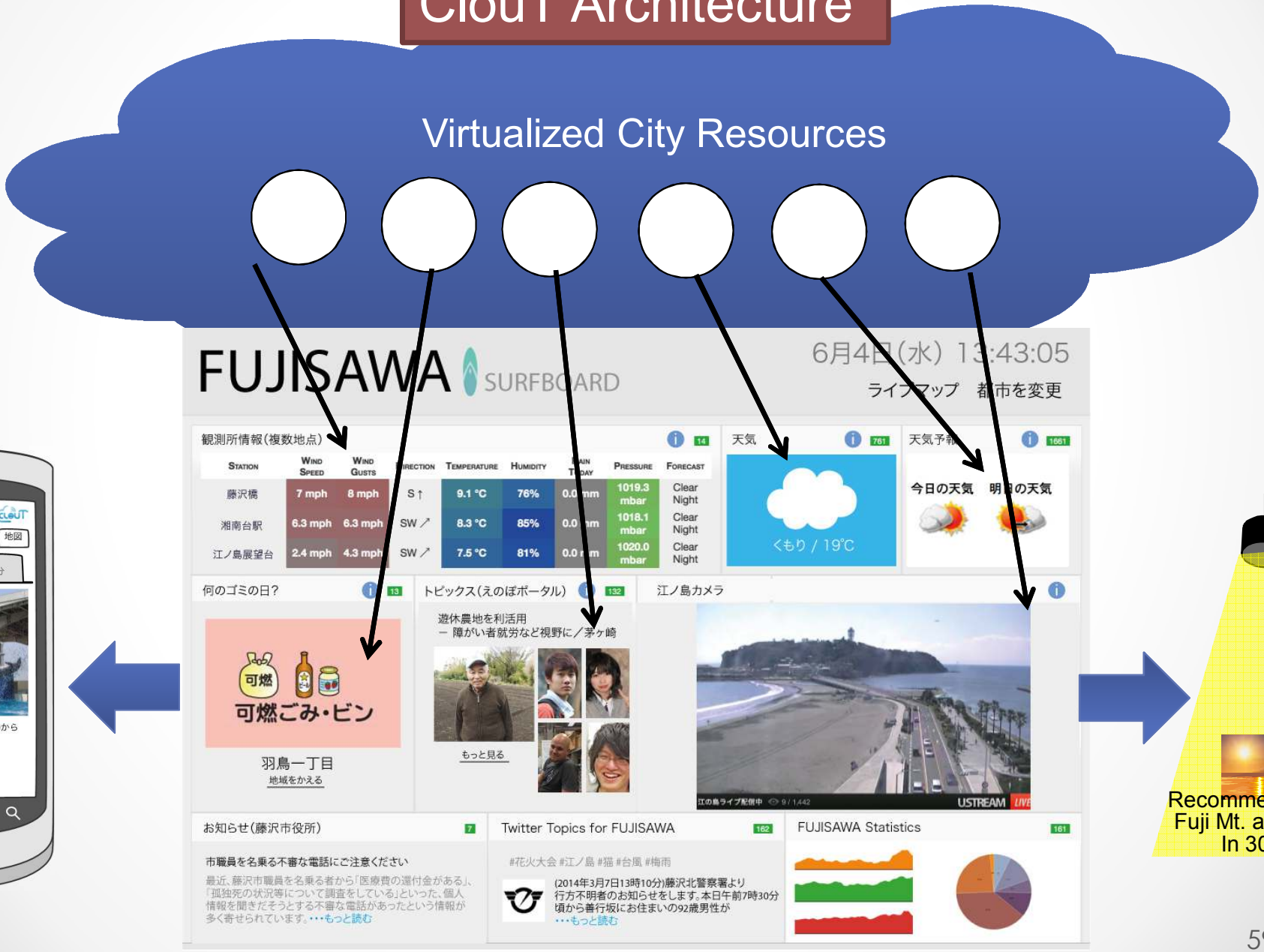


【Emergency Mode】

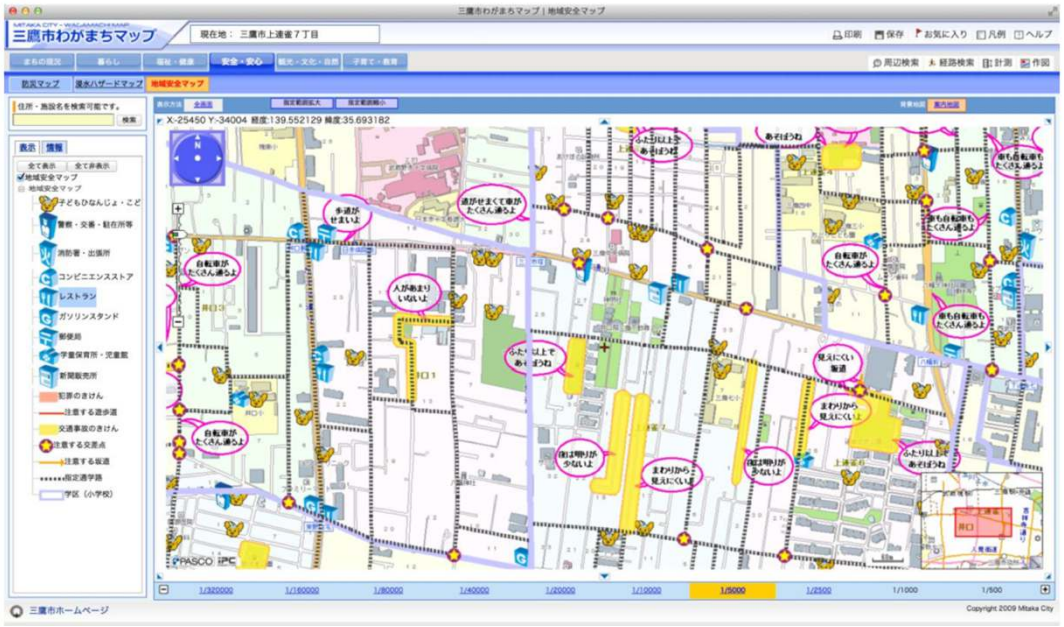
Fujisawa Dashboard

ClouT Architecture

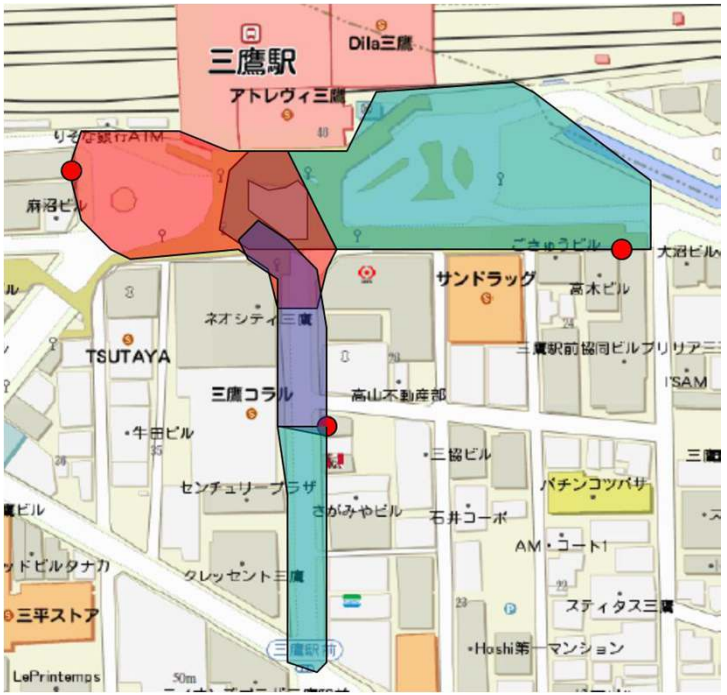


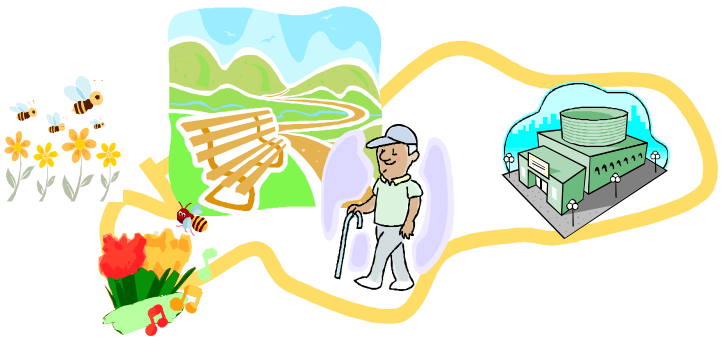
Mitaka

Mitaka GIS System



Station WiFi System

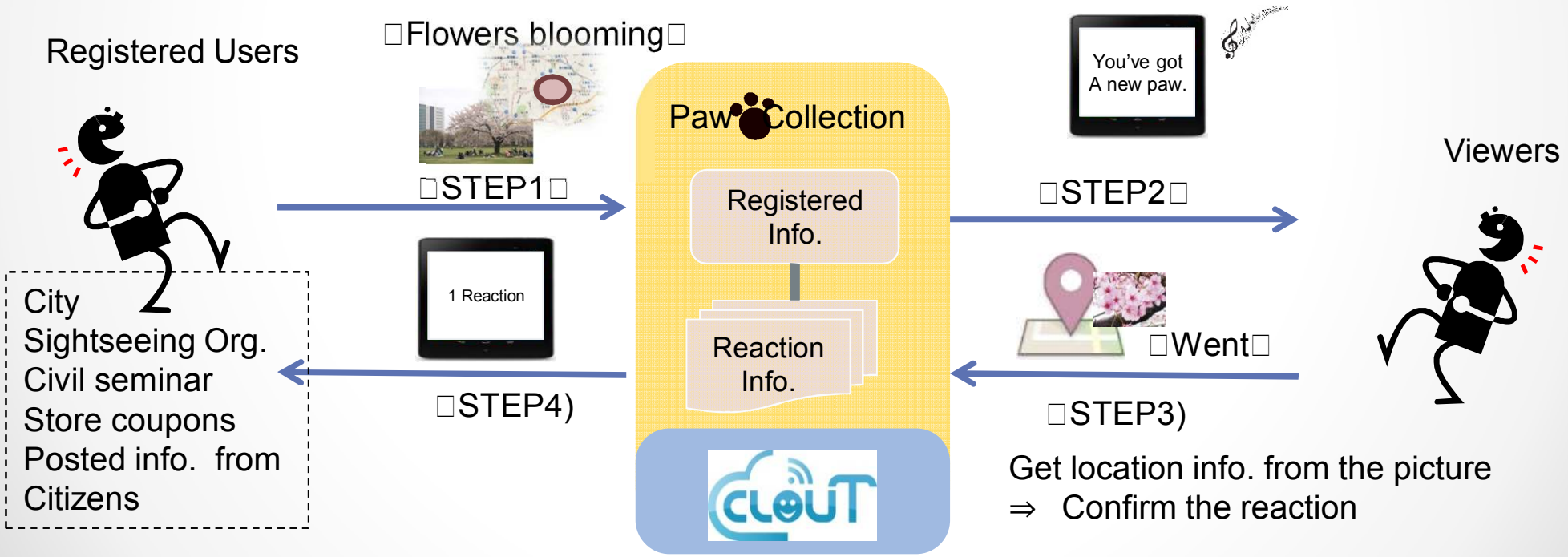




Going Out Support

Care giving with participatory sensing and city data

- Going out support for active seniors
  - Motivate them to go walking and participate community events for preventing elderly people's isolation, vitalizing stores or promoting health.
- Exchange information by smartphones and tablets



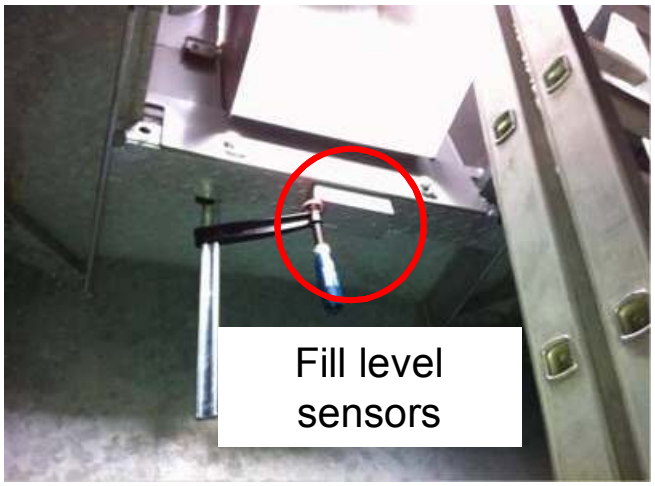
OUTSMART, FP7 FI-PPP Usage area project

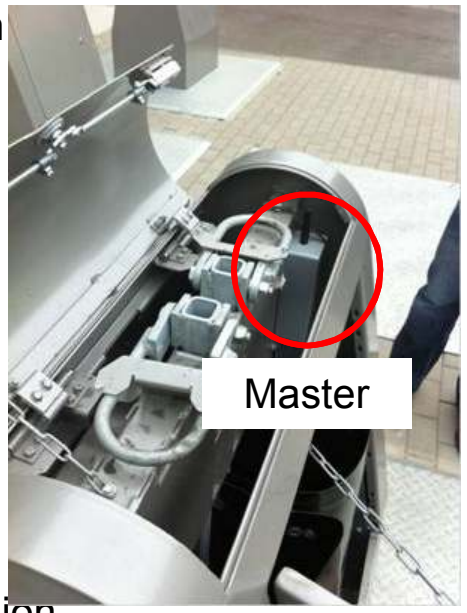
OUTSMART addresses five essential Smart City services:

- Water and Sewage – Aarhus DK
- Street Lighting – Santander ES
- Waste Management – Berlin DE
- Water and Environment – Trento IT
- Sustainable Urban Transport – Birmingham UK

Smart Waste Basket and Subsurface Containers (BERLIN)

- Ad hoc **fill level** measurements; data transmission to the collection vehicle when it approaches
- Develop assisted application for maintenance and fill level visualisation

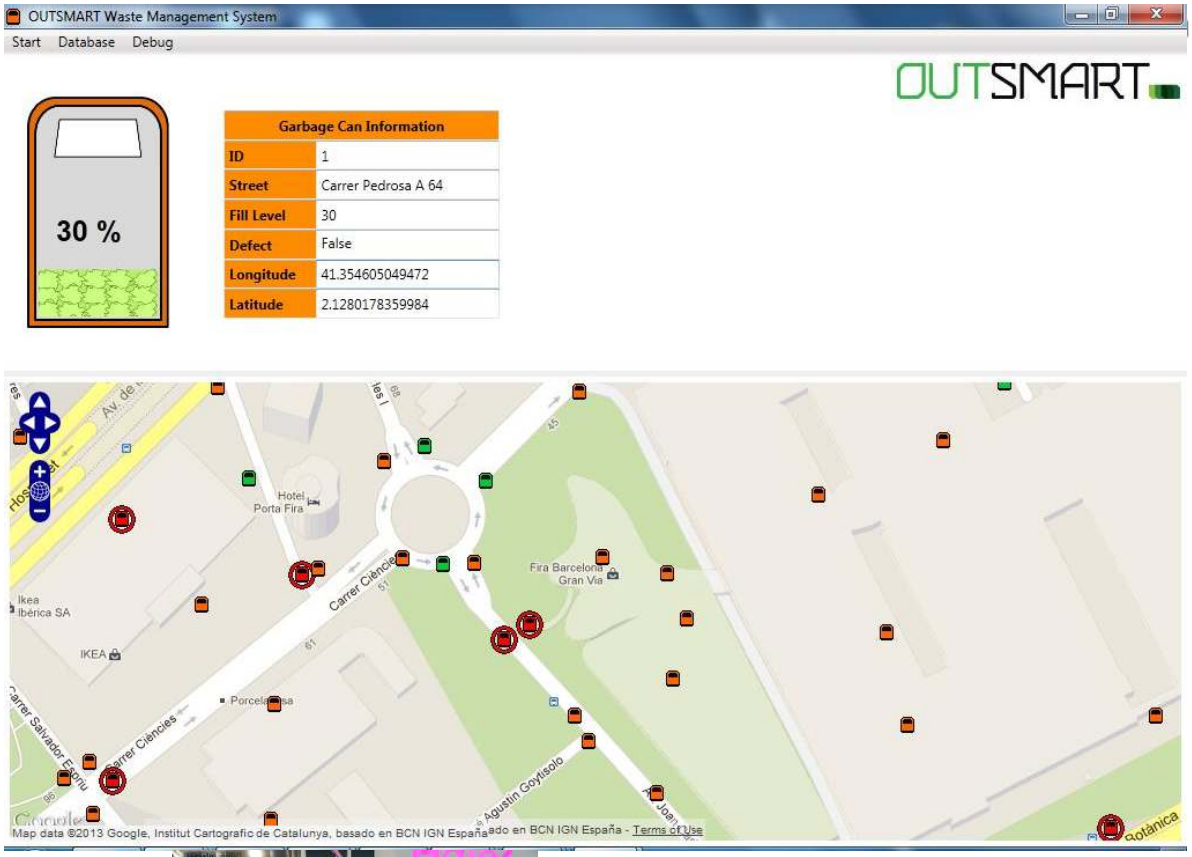




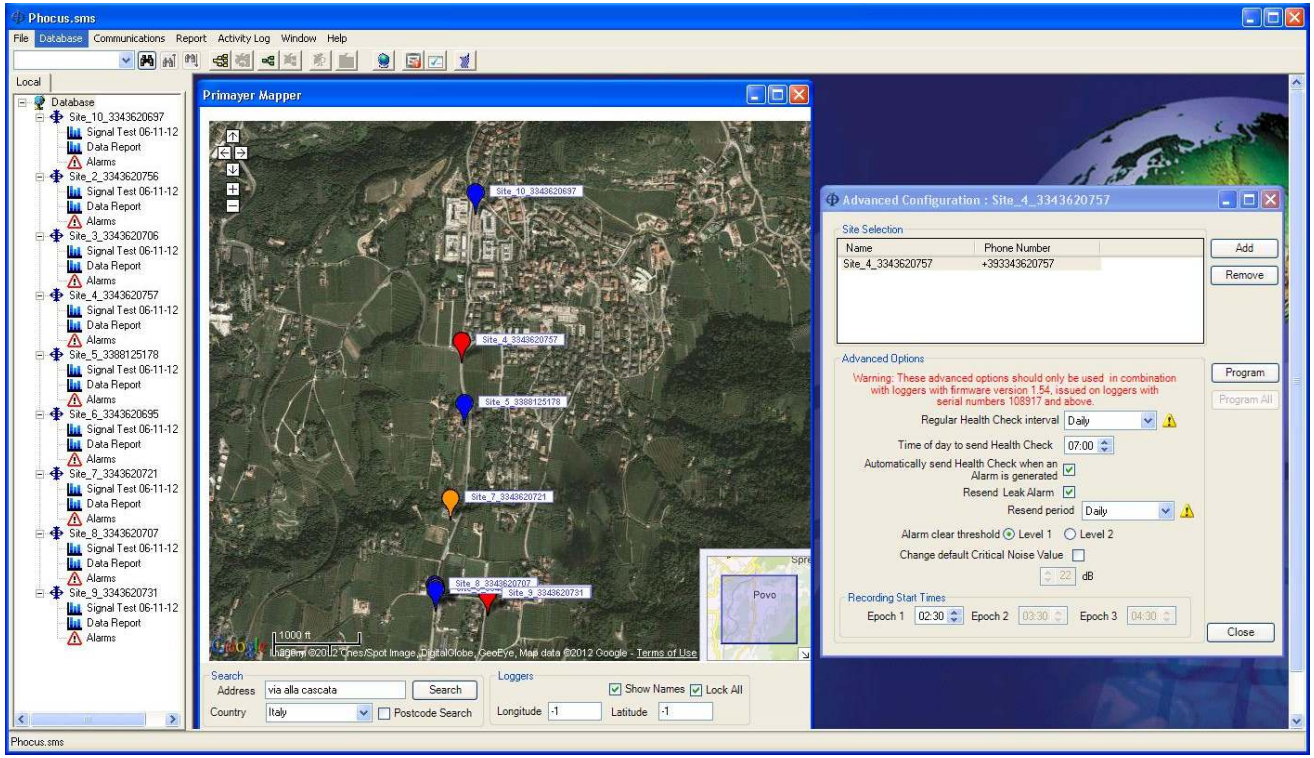
- **Continuous fill level measurement** every 30 min. and data transmission once or twice a day to the utility network
- Additional notification of the fill level data when an **alarm fill level** has been reached
- **Historical fill level data analysis** for fill level prognosis and optimization of logistics.

Seen at MWC!

GSMA MOBILE WORLD CONGRESS | 25 – 28 February 2013



ACTIVE LEAK DETECTION SERVICE (TRENTO)



- **Location detection of leakages;** integration of flow sensors to detect variations in the minimum level at night in a sector and a leakage identification system that progressively scales down the area.

CITY MAPS, LIGHT & POWER CONSUMPTION (SANTANDER)

AMM System (**Eon-Spain**)

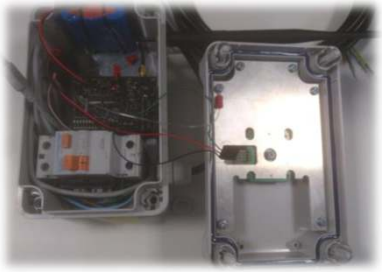
Light Sensor Nodes

Power Regulator's Intelligent Module (**Ingequr**)

- **Estimated light level**: obtained from real power consumption data and the kind of lamps installed from Utility resources (AMMS) and Authority devices (power regulators). Generate the *power consumption city map*.
- **Real light level** measurements, collected from a light level sensors network deployed all over the city (or areas that want to be covered), and will show the current status of city illumination.

- **Authority system power regulators:** controls the power provided to lamp post lines

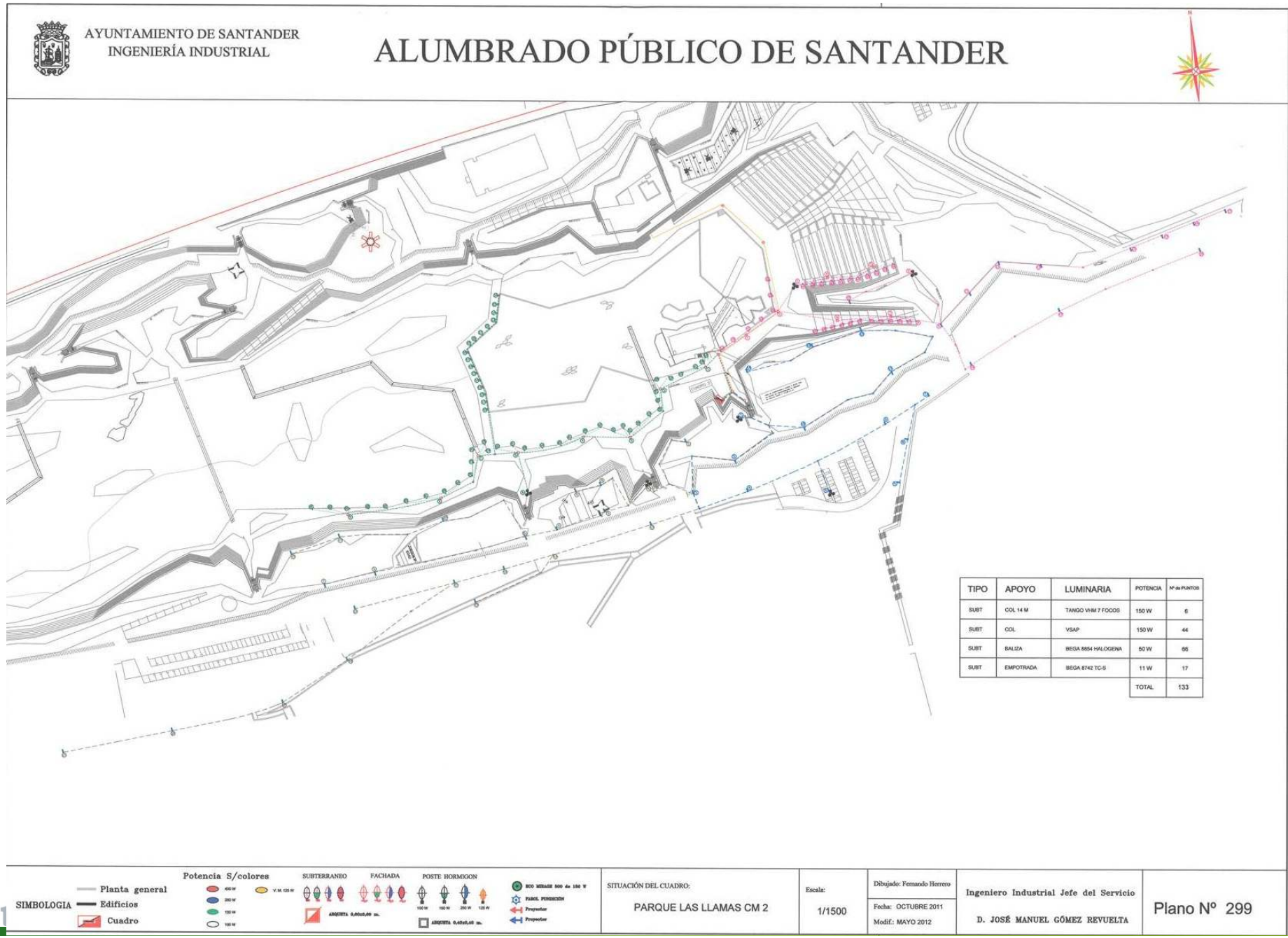
- **Pedestrian flow sensors network:** based on radar technology. Detect people presence on a specific area (city centre street or square)



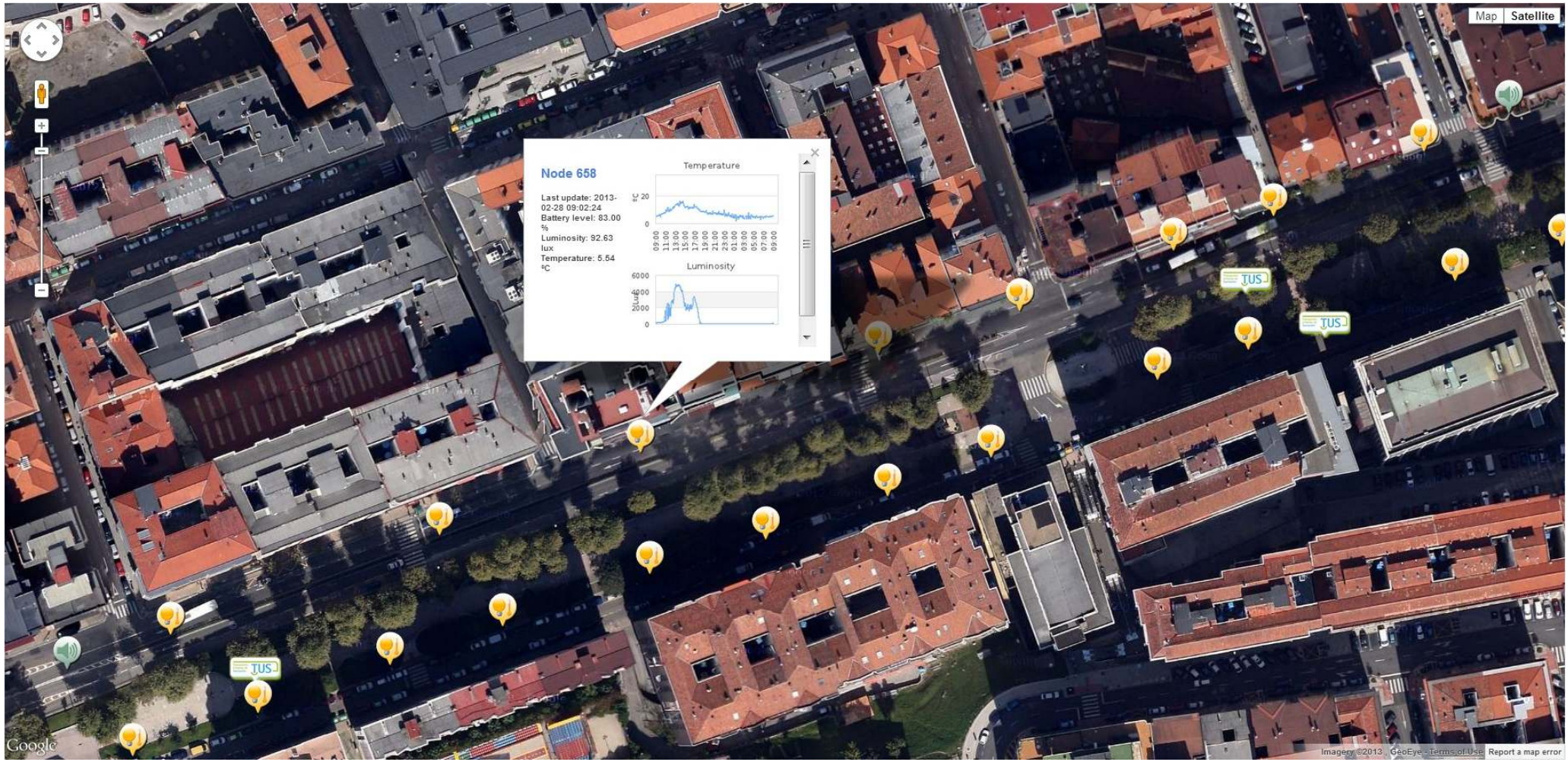
RADAR sensor node

*Power Regulator (**Ingequr**)*

Public Street lighting Map



Visualization on Google Maps



Summary

- The ICT has the potential of turning the cities into smarter ones.
- Key Technologies: IoT (Internet of Things) + Cloud
  - IoT for collecting real-world information in real-time
  - Cloud for storing/processing the information with elasticity, reliability and agility
- Efficient communication and collaboration mechanisms are needed to exploit all information sources to make the cities smarter
- Open platforms for creating a synergy between various stakeholders (citizens, municipalities, utilities, service providers, application developers, etc.)
- Service oriented approach for handling heterogeneity and dynamicity of the internet of Things
  - Easy creation and maintenance of dynamic IoT applications.
  - Middleware services for virtualization, data processing, device management, etc.
- Tools to design, deploy and supervise robust and dependable IoT applications

Internet of Things - Convergence of the physical and the virtual world

Service providers/ Operators

Networked applications

Middleware

Integrated device

CEA-LETI, from conception to integration (from hardware to middleware!)

Internet of Things

Thanks!

Special thanks to sensiNact contributors: Ozan Günalp, Mathieu Gallissot, Thomas Genet, Etienne Sorel, Yazid Benazzouz, Youssouf Zatout, Diana Moreno Garcia, Christophe Munilla

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