The impact of Internet of Things in Big Data approach and Future Internet

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Agenda

IoT and Future Internet

Smart Cities: a challenge for Big Data

Technology Integration Needs

Examples of application

Conclusions

Today's Internet trends

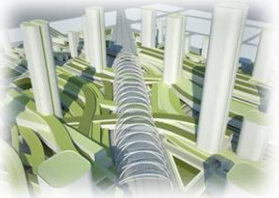
- Current Internet is a collection of rather uniform devices
- Mobile device becoming a key player in service race
- Mobile service is a key word
  - Social networking or Web 2.0 – Facebook, Twitter, LinkedIn etc
  - Location determination – location-enabled services – Gowalla, Google Latitude, Foursquare etc.
  - Video content retrieval – YouTube
  - Mobile payments – no killer app so far
  - Combined apps
    - E.g. social networking + location
  - App, app, thousands of apps – Ovi store, App store
    - Most apps are narrow, focused and stand-alone
    - Future trend – cloud service
- Human to machine (H2M) vs. Machine to Machine (M2M)
  - One of the major trend leading to change of Internet paradigm

Future Internet challenges

- Health industry
  - Ageing, assisted living
  - Real-time health tracking
  - [Autonomic] robotic surgery
- Government and city
  - Operation optimization including energy consumption
  - Emissions, wastes and other green issues
- Automotive industry
  - Car manufacturers etc.
- Smart living
  - Web 3.0, less footprint







Future Internet devices

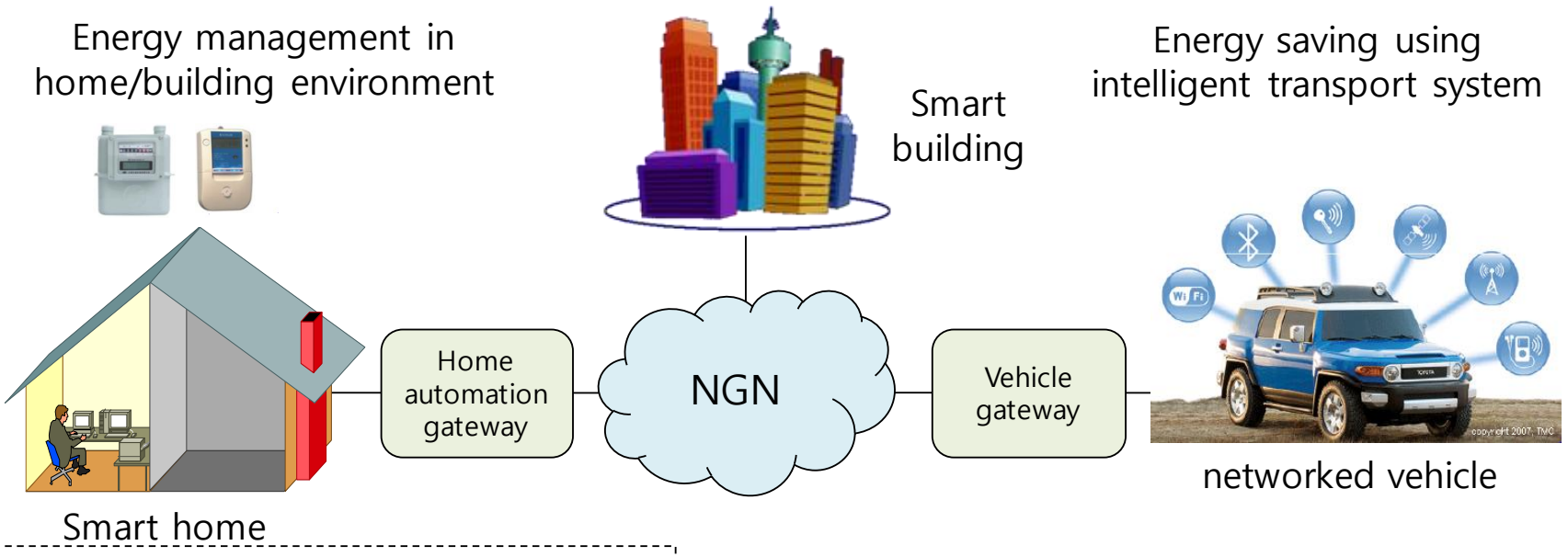


- The Wireless World Research Forum (WWRF) predicted recently that there will be 5-7 trillion wireless devices serving 5-7 billion people, i.e. around a thousand devices per person, by 2020
- What types of devices are expected to be among this vast number?
  - Personal devices, like wireless sensors – wearable, in-home and in-car devices, electronic home appliances
  - Devices of autonomic flavor like robots with communication abilities
  - Medium-specific devices like underwater wireless (acoustic) sensors, health in-body sensors and nano-machines
  - Flying devices like manned/unmanned terrestrial and [micro, bio] aerial vehicles
  - All other devices of mixed type forming an environment possibly with unique highly dynamic and agile requirements
- Every object will be integrated onto the network and regarded as a networking device generating, relaying and/or absorbing data

Future Internet

- Future Internet will feature omnipresent heterogeneous smart devices wirelessly communicating over hybrid and ad-hoc networks of devices, sensors and actuators working in a synergy to improve the quality of our lives, optimizing energy consumption and consistently reducing the ecological impact of a mankind

A Future Internet vision



Objects in a home/building (fixed smart environment)
- Energy saving system (ESS)
- Smart Meter /Home automation controller
- Home appliances/ storage/
- Communication equipments
- Surveillance cameras/ Personal devices

Objects in a vehicle (mobile smart environment)
- Passenger devices: mobile phone, PDA, etc
- OEM devices: vehicle dedicated devices for safety, maintenance, power/fleet management, etc
- Vehicle equipped devices: navigation, monitor, etc
- Asset: moving products

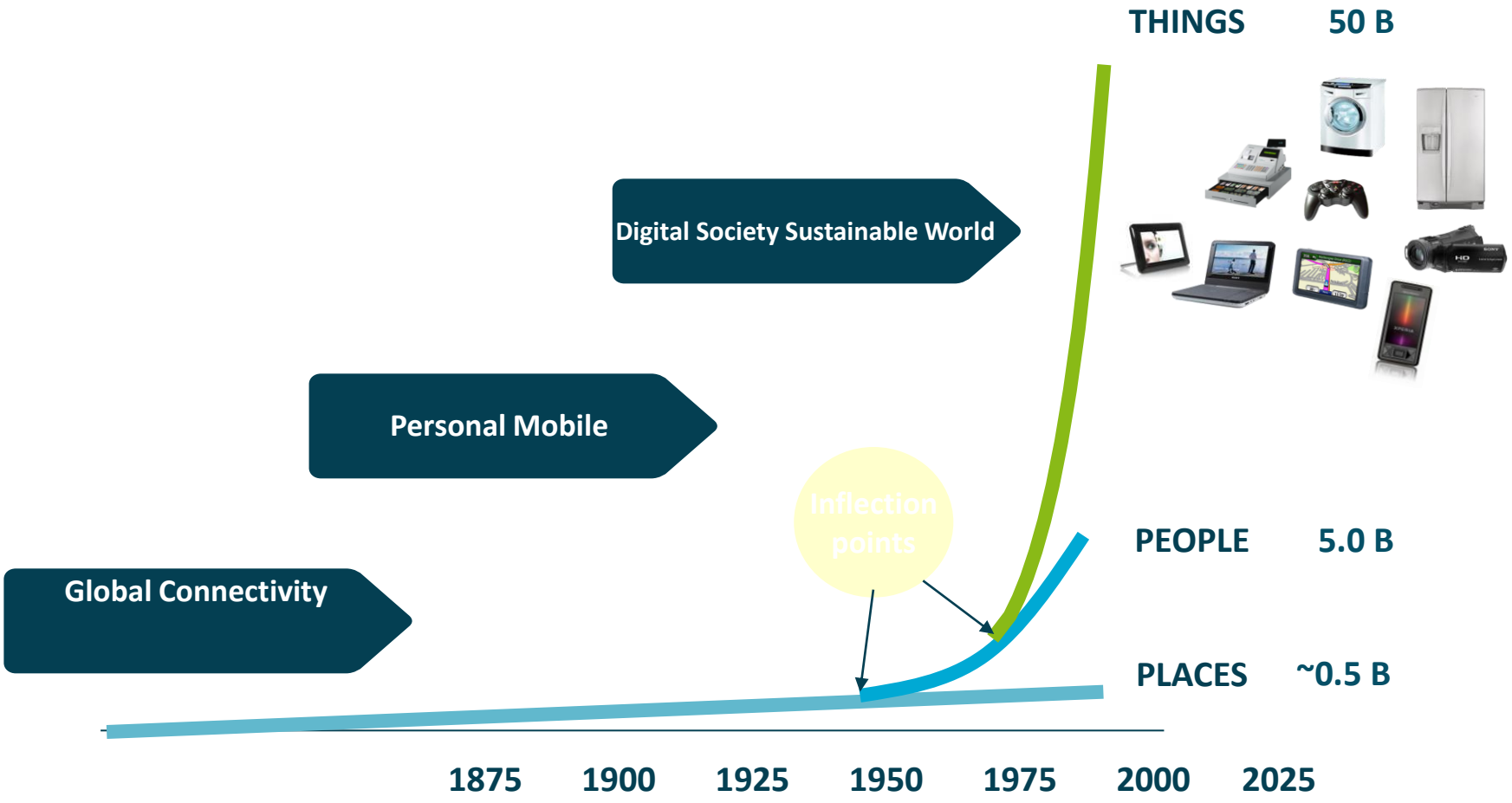
Future Internet: Towards a 'smarter' World

- **Supporting applications of high socio-economic value, such as in the areas**

  - **Smart energy grids -** Energy grids will increasingly face risks of congestion and blackout. Internet connectivity, computing power, digital sensors and remote control of the transmission and distribution system will help to make grids smarter, greener and more efficient,
  - **Smart environmental information systems -** the use of sensor networks for collecting real or near real time environmental data is a growing field of application. It requires Internet connectivity for data management, dissemination and integration in complex information systems,
  - **Smart systems for transport and mobility -** Putting 'intelligence' into the roads and cars with Intelligent Transport Systems (ITS)– with e.g. sensor networks, radio frequency tags, and positioning systems offer a promising alternative. The internet provides a solution to interconnect these diverse technologies and bring more efficiency to mobility through real-time management of public and private transport resources, traveller information and decision-making tools, way beyond the capability of current solutions,
  - **Smart healthcare systems -** Current research experiments aim to develop technologies for 'ambient' environments capable of assisting patients and satisfying their information and communication needs. These technologies combine devices (sensors, actuators, special hardware and equipment), networks and service platforms to harness information about medical conditions, patient records, allergies and illnesses.

➲**Towards the future "internet-enabled" infrastructures**

Internet of Things (IoT)



Source: Ericsson

Hiding behind the Net!

- The Internet scales because IP assumes almost nothing!

ON THE INTERNET NOBODY KNOWS YOU'RE A DOG!

Borrowed from N. Gershenfeld

Now, what's up?

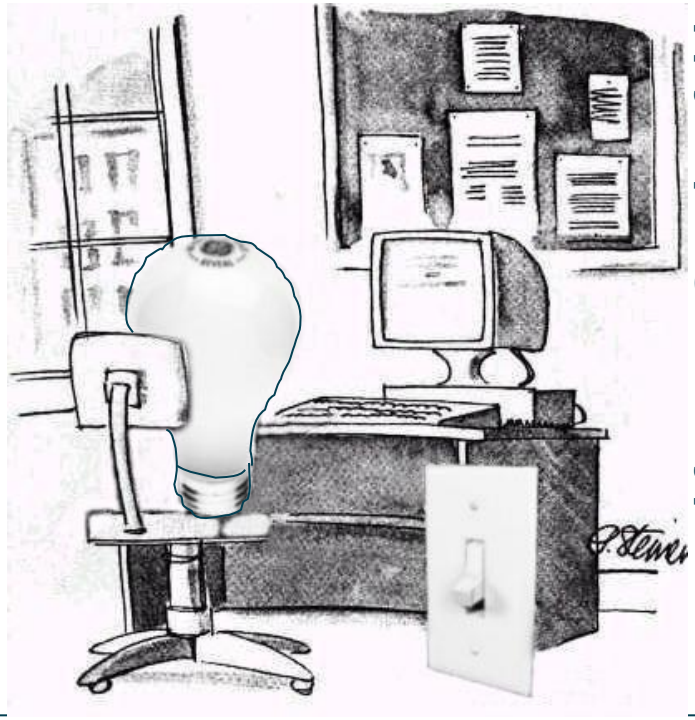
Internet-1

Internet-2

Internet-~~3~~

0

Internet-0: the Internet of Things

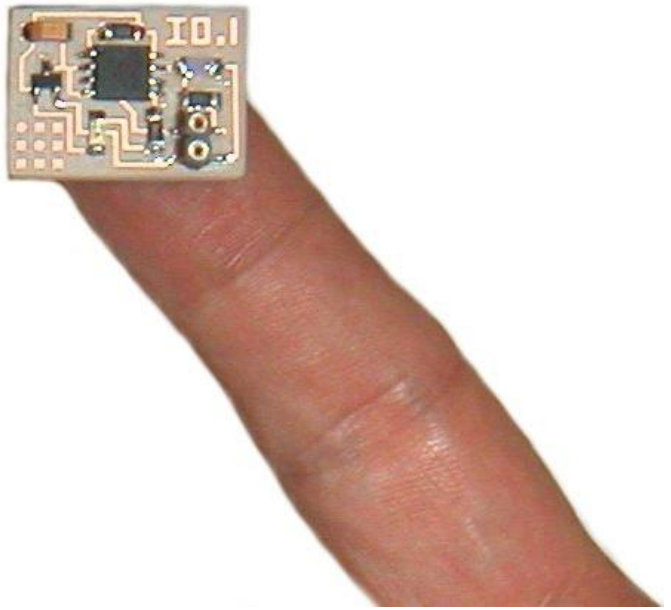


Borrowed from N. Gershenfeld

ON THE INTERNET NOBODY KNOWS YOU'RE A LIGHT BULB!

Internet Hosts

1974



2004

Borrowed from N. Gershenfeld

IoT: Smart Objects

This device is embedded into objects (to make them "Smart")

A Tiny computer that may contain:

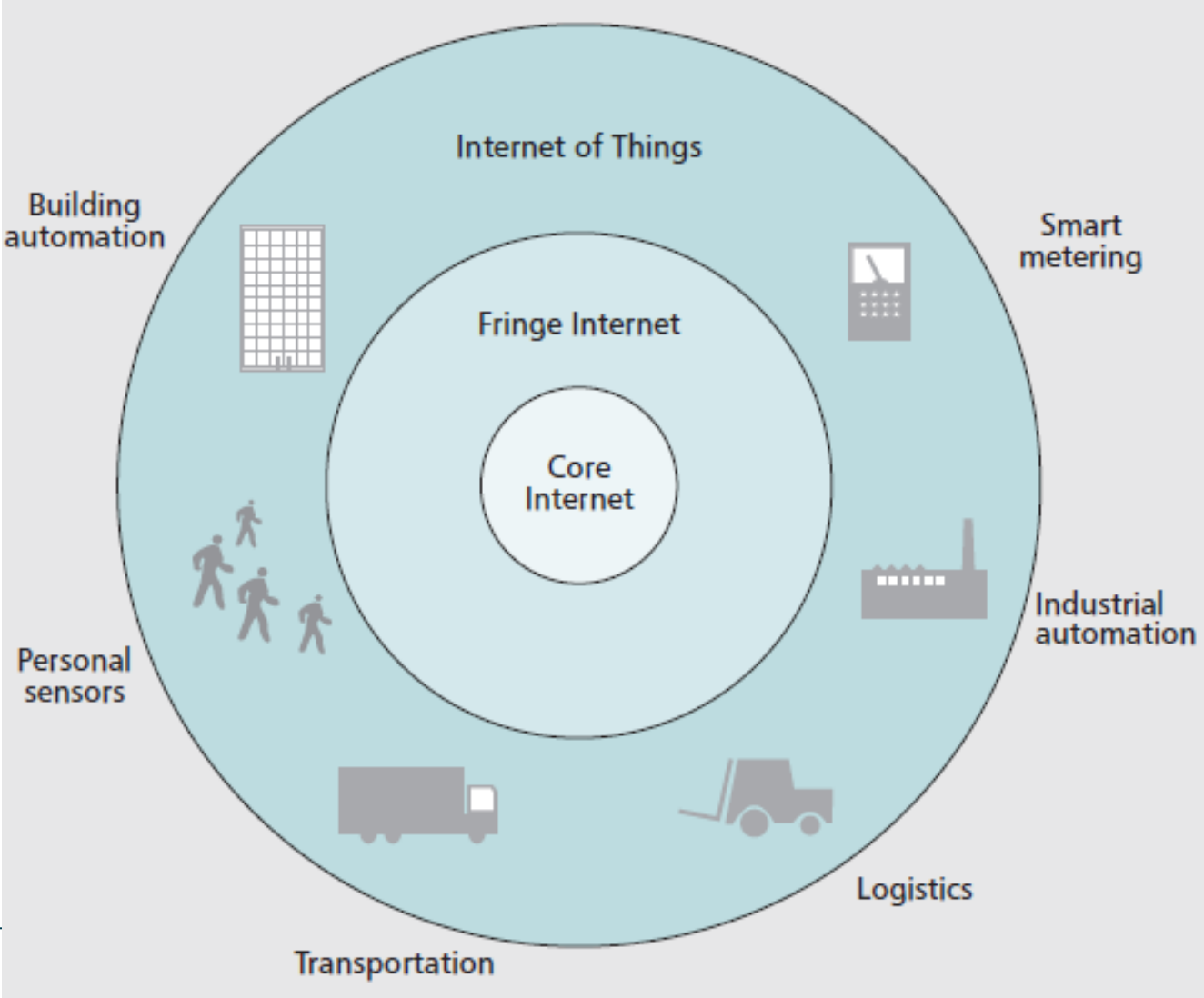
Sensors & Actuators (GPIO)

Communication Device (Transceiver)

CPU + Memory
(Data: 10KB/Code: 100KB)

Power supply
Battery or Harvesting (solar panel)

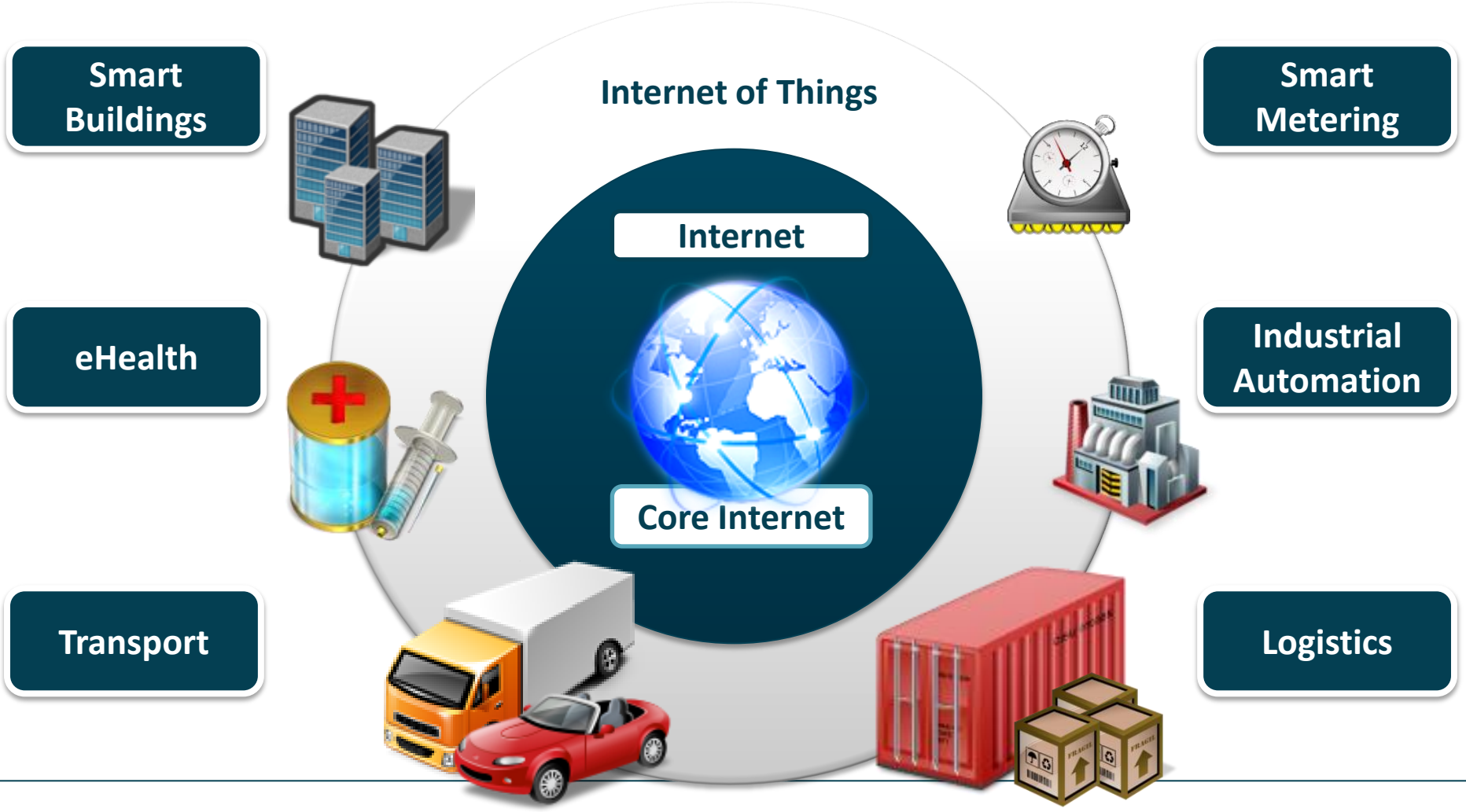
IoT onion model



Challenges of IoT

- Super large scale (anything, anytime, anywhere, by anybody)
- Interconnection of Heterogeneous devices, OS, and subnets
- Openness and Security
- Dependability and Reliability
- ……
- Doubt 1: Is it possible to connect anything to the Internet?
- Doubt 2: Do we want to connect everything to the Internet?
  - Business protection
  - Security and Privacy
  - Trustworthy

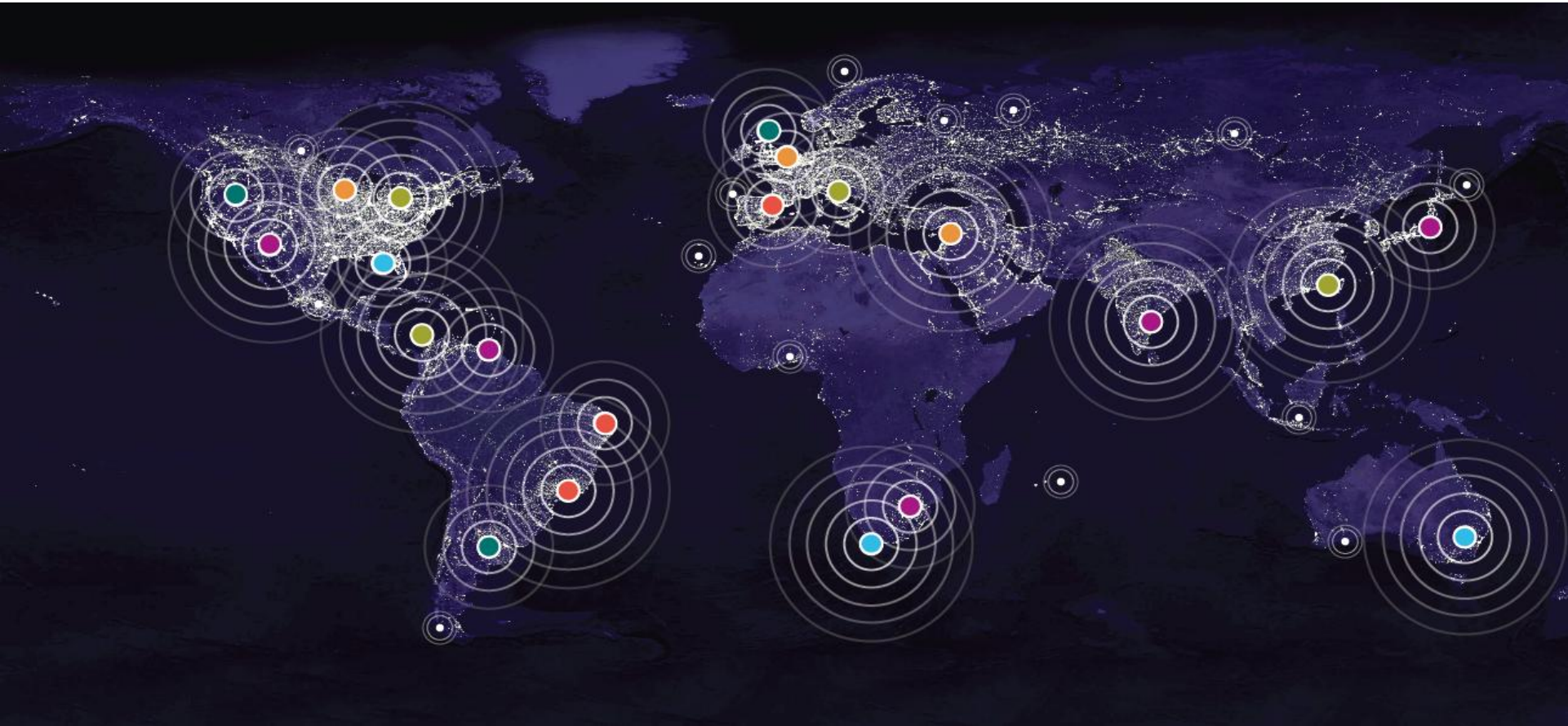
Internet of Things applications



Big Data and Smart Cities

A planet of cities

In 2007, for the first time in history, the majority of the world's population — 3.3 billion people — lived in cities. By 2050, city dwellers are expected to make up 70% of Earth's total population, or 6.4 billion people.




WE ARE LONDONERS

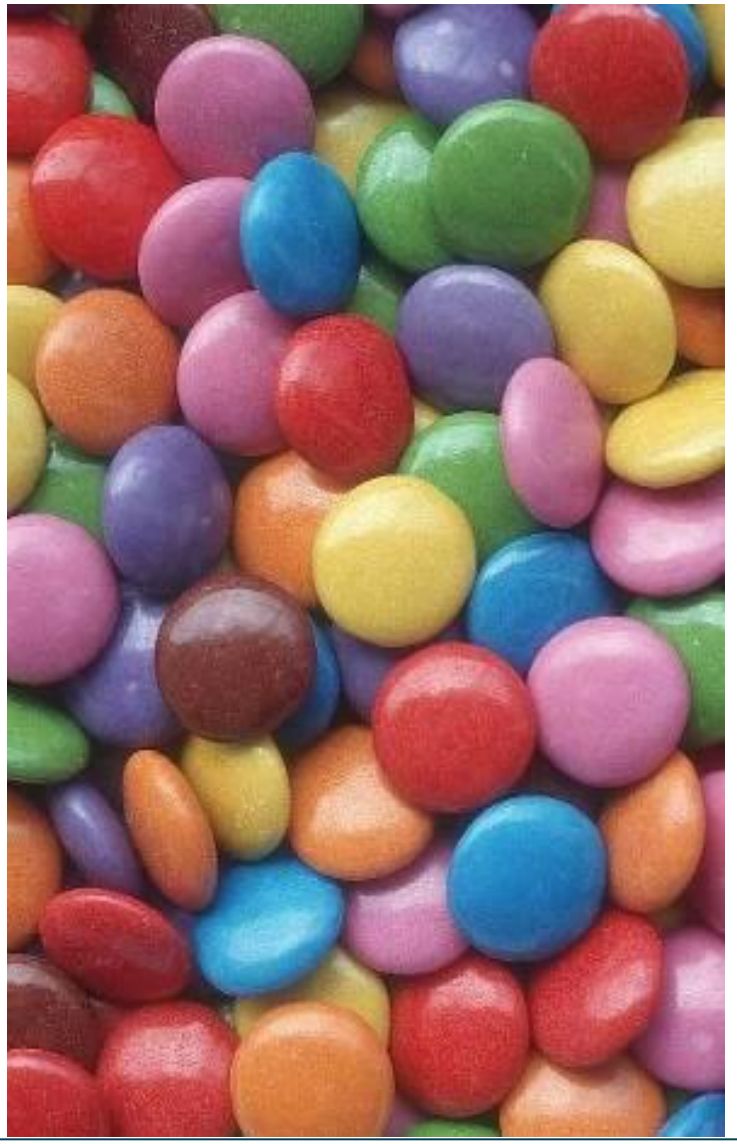

Hercul
U.P. CYCL


Victorian Technology in the 21st Century

Smart cities

- **Today:**
  - **Slowing mesh networks development**
  - **Few applications**
    - **video-surveillance, municipal info**

- **Potential services:**
  - **Automation (watering)**
  - **Monitoring (pollution)**
  - **Energy/Water savings**
  - **Water leak detection**
  - **Traffic Regulation**
  - **Physical Security**



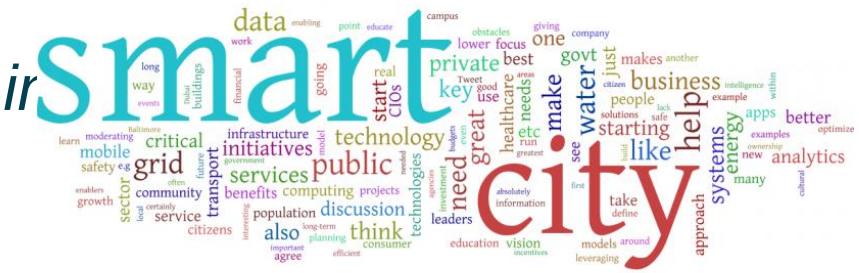
Smart city 2020…

Our cities are fast transforming into artificial ecosystems of interconnected, interdependent intelligent digital "organisms"

- **Emerging technologies (ICT) are poised to reshape our urban environments**

William J. Mitchell (MIT, smart city Lab)

"Our cities are fast transforming into artificial ecosystems of interconnected, interdependent intelligent digital organisms. This is the fundamentally new technological condition confronting architects and product ir

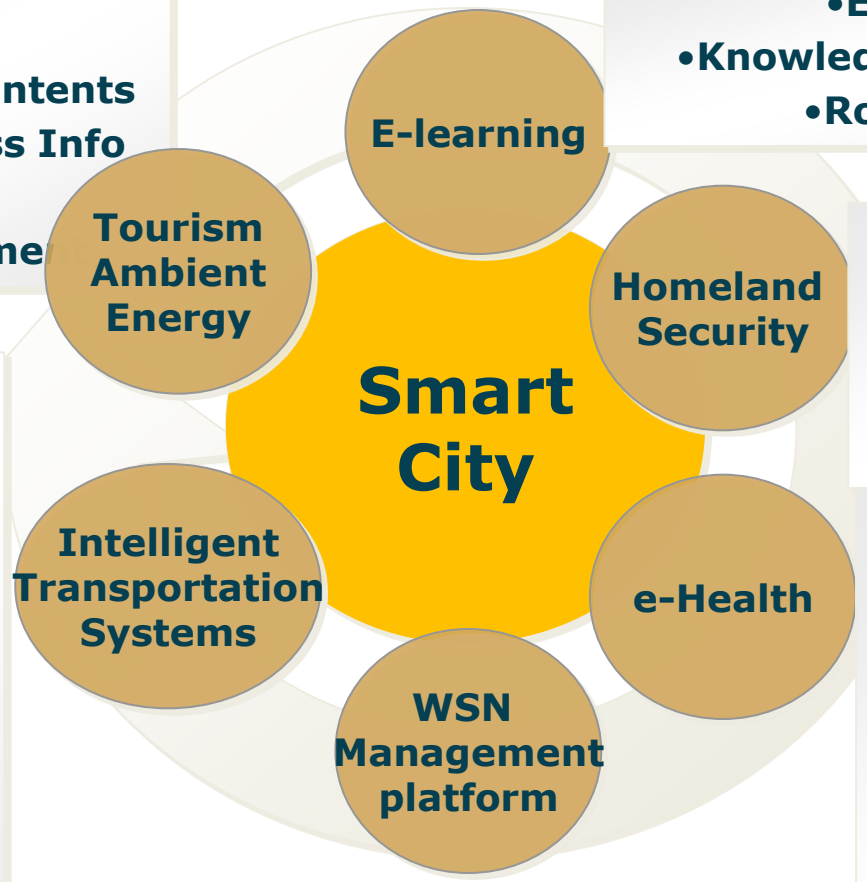


Smart city: Main functional Architecture

The smart city is the Information & communication Infrastructure

- e-Tourism web 2.0 approach
- User Generated Contents
- Context Awareness Info Push
- Energy Manageme

- Traffic information
- Fleet management
- Access Control
- Road Charging
- Emergency Call
- Mobile Payments
- Parking Management
- Pay As You Drive
- City Logistics
- Vehicle Tracking
- Work Force Managem.



- E-learning
- Knowledge Management
- Role gaming

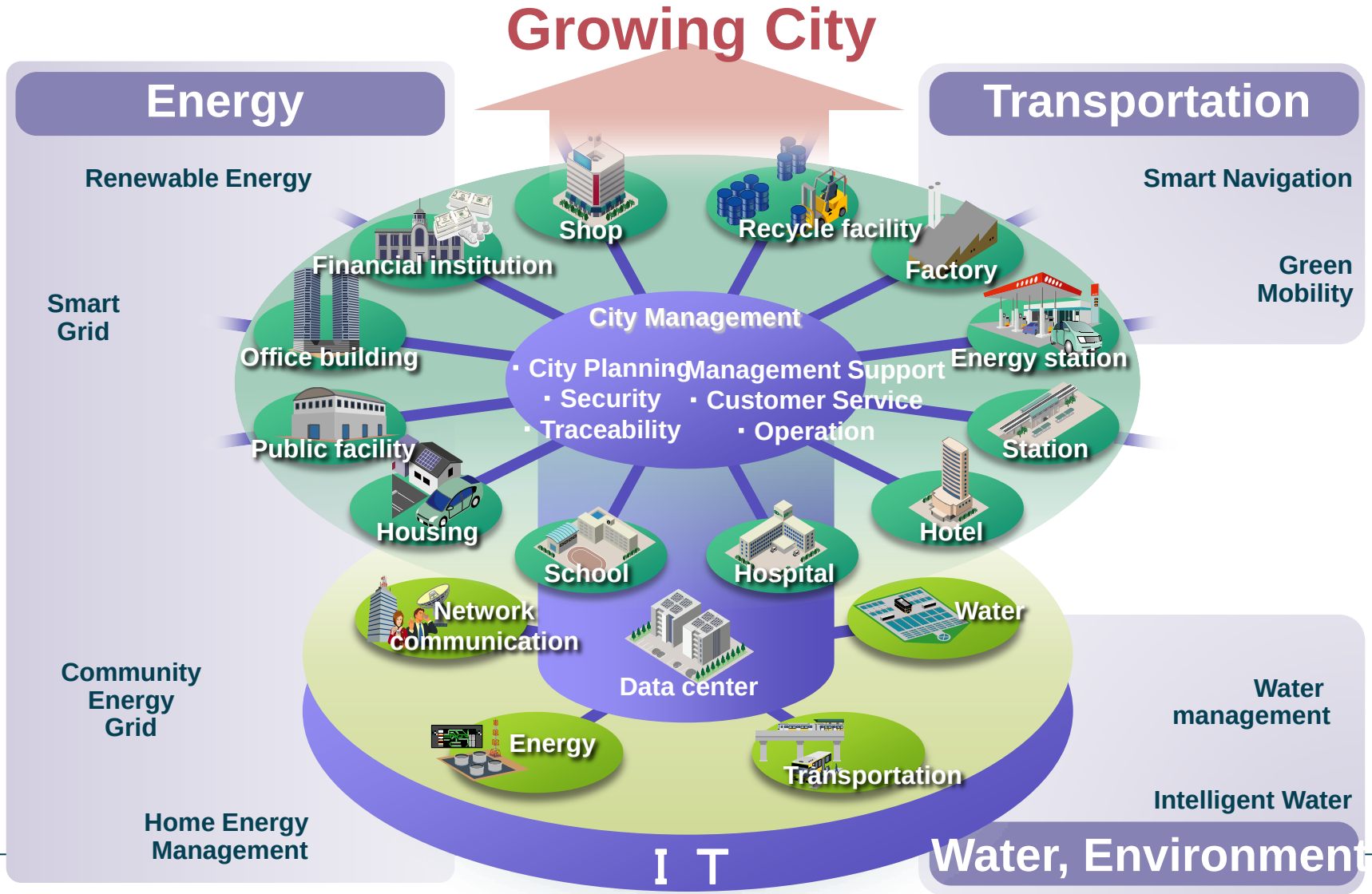
- Video surveillance
- Sensor networks integration
- Video semantic capabilities

- Electronic Patient Record
- Therapy management
- Biomedical parameters monitoring
- Second Opinion Management
- Pharmaceutical risk mgmt

- ICT platform for Wireless Sensor Networks management and control

Smart City Vision

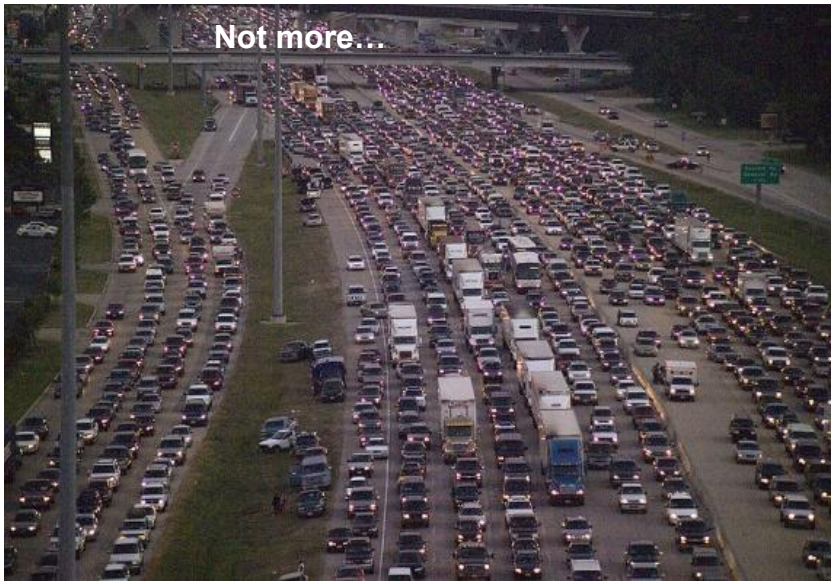
Connect our life with social infrastructure and make the life comfortable, safer, eco friendly



IERC documents: http://www.internet-of-things-research.eu/documents.htm

Cities require smarter solutions

- The systems are under increasing environmental, social and economic pressures
  - For sustainable prosperity, the systems need to be managed optimally
    - The systems need to become smarter!



‘Smart’ solutions are instrumented, interconnected and intelligent

Instrumented + **Interconnected** + **Intelligent**

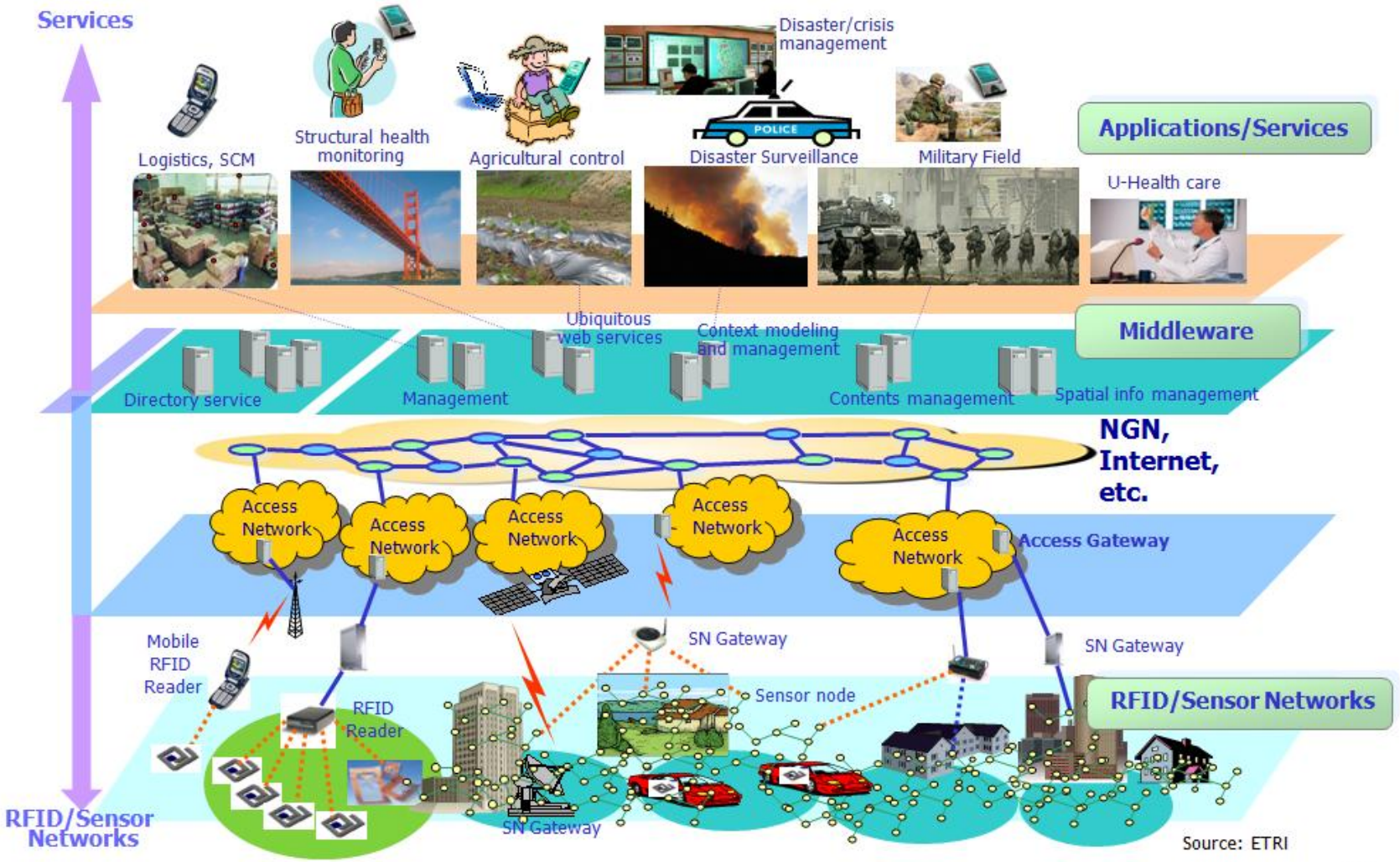
Event capture and filtering for timely response

Any to any linkage of people, process, and systems

Deep discovery, analysis and forecasting

= 

Global Services for Citizens



The problem – Smart City Use Case

RFID tags utility and limitations

Home, Office, Meeting Rooms

Conferences

Theaters

Concerts

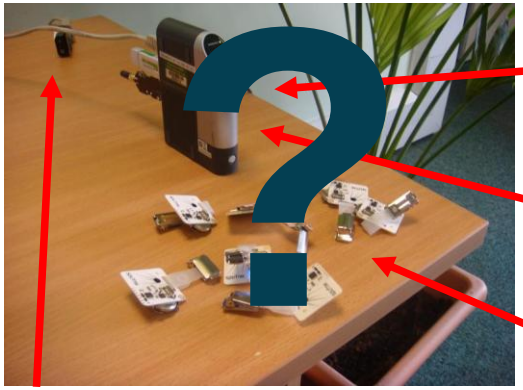
Stadiums

Cities

An Approach – Smart City Use Case

Smart Crowds Monitoring

Traditional RFID tracking system



RFID base station
Connected via USB
[illegible]SN [illegible]urce

[illegible]SN b[illegible]e sta[illegible]on
• Connected via USB
• GS[illegible]sour[illegible]

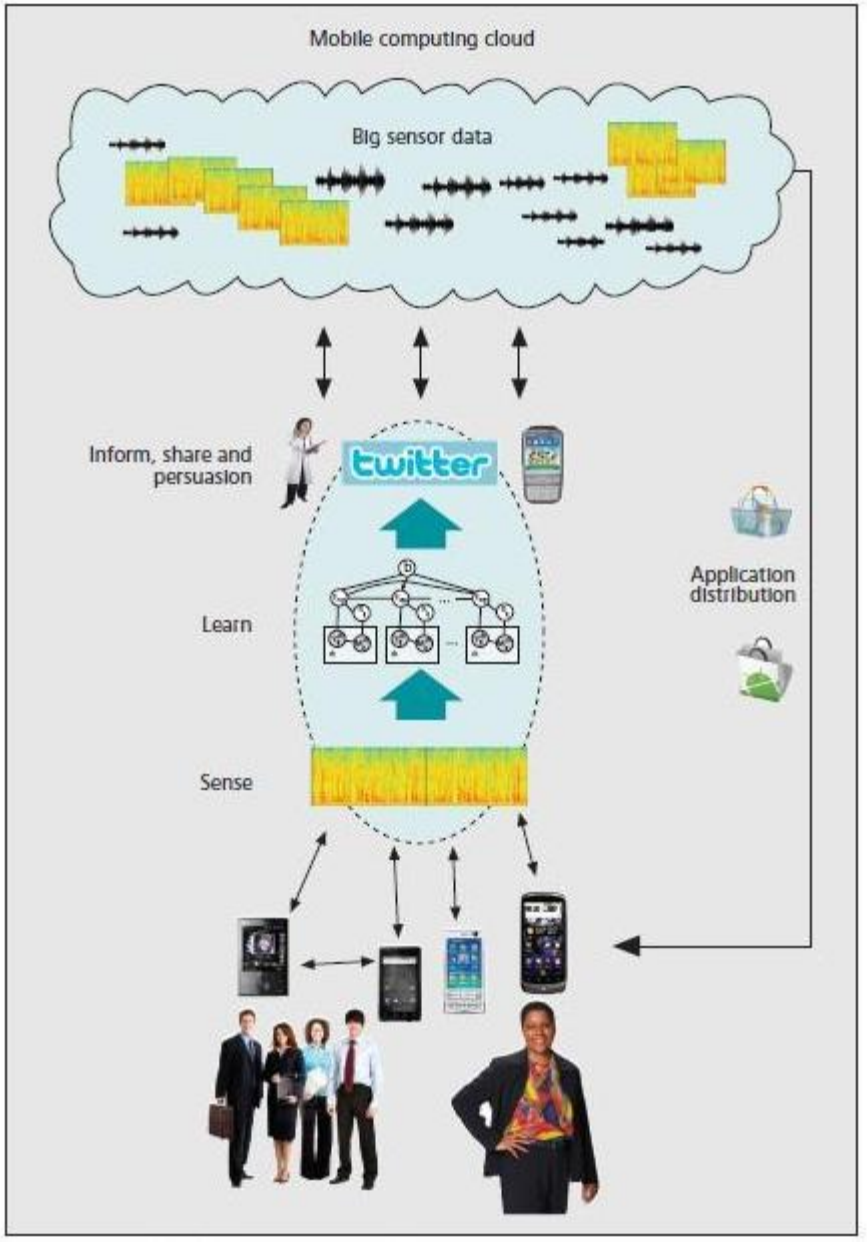
RFID Tag
• Sends beacons to bas

Sensor
• TMoteSky and TMoteInvent
• Distinguish between low power (proximity) and higher power (localization) packets

Big Cities = $$$$

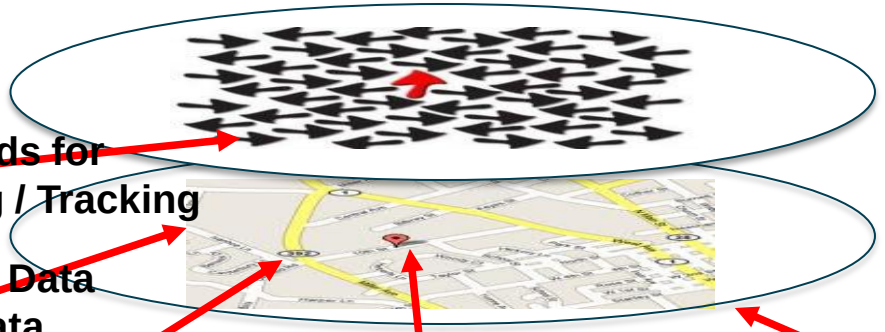
Almost everybody has a smart phone

MOBILE PHONE SENSING ARCHITECTURE



Smart City Use Case – Demonstrator

Smart Crowds Monitoring

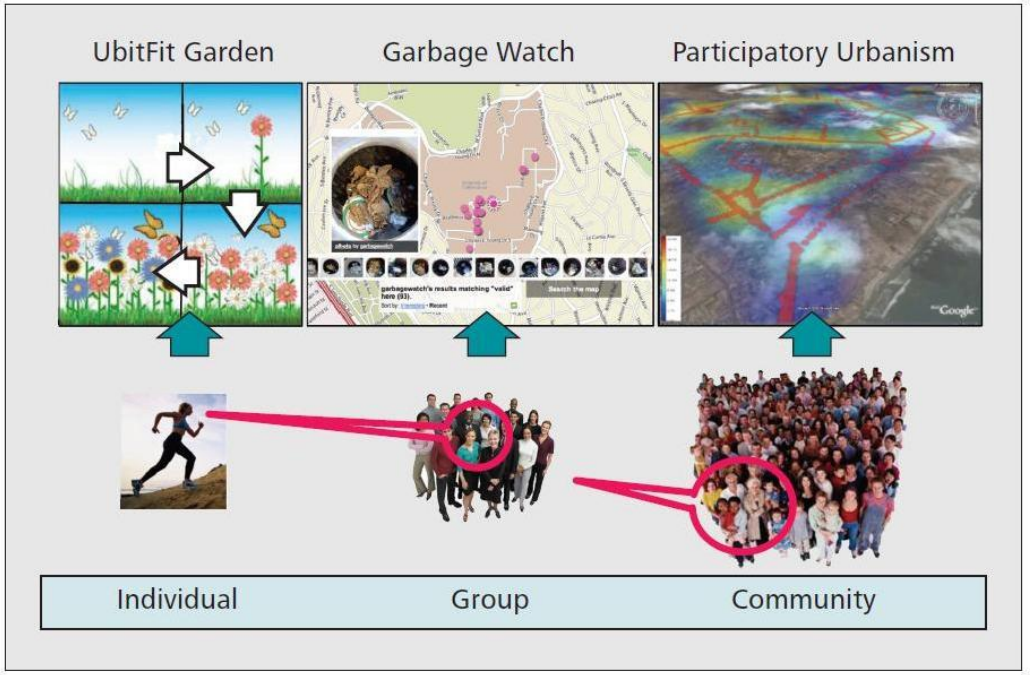


Crowds for Monitoring / Tracking

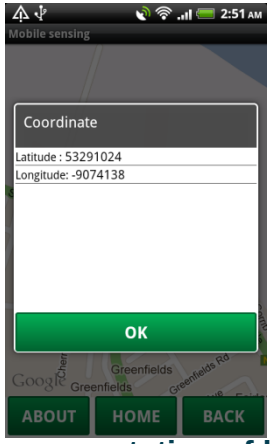
Geographical Data
• Linked Data

Clustering Algorithms

Virtual Infrastructure & Global Sensor Network



Sensors
• Specific Locations

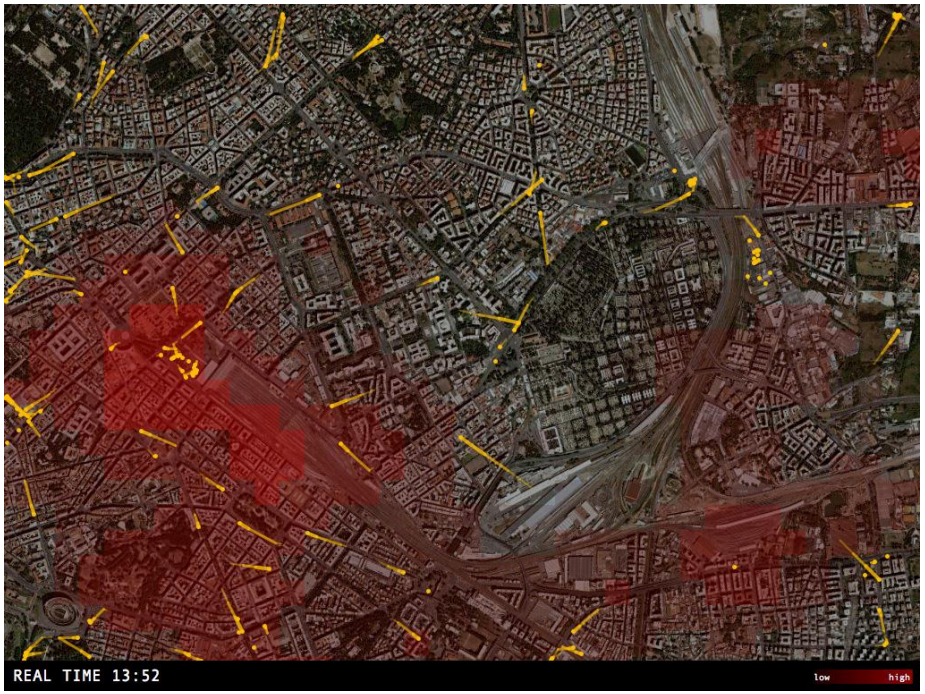


Real-time graphical representation of location data collected from other users mobile phones

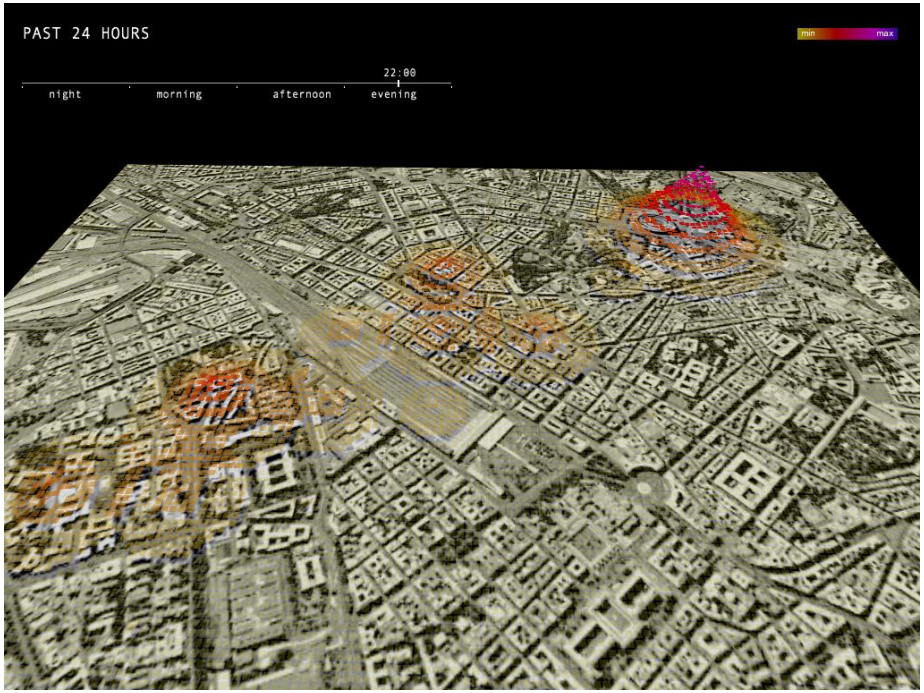
IoT platforms: http://postscapes.com/internet-of-things-platforms

Example, Smart Mobility Applications

“Real Time Rome”, the power of “Crowd-sourcing”



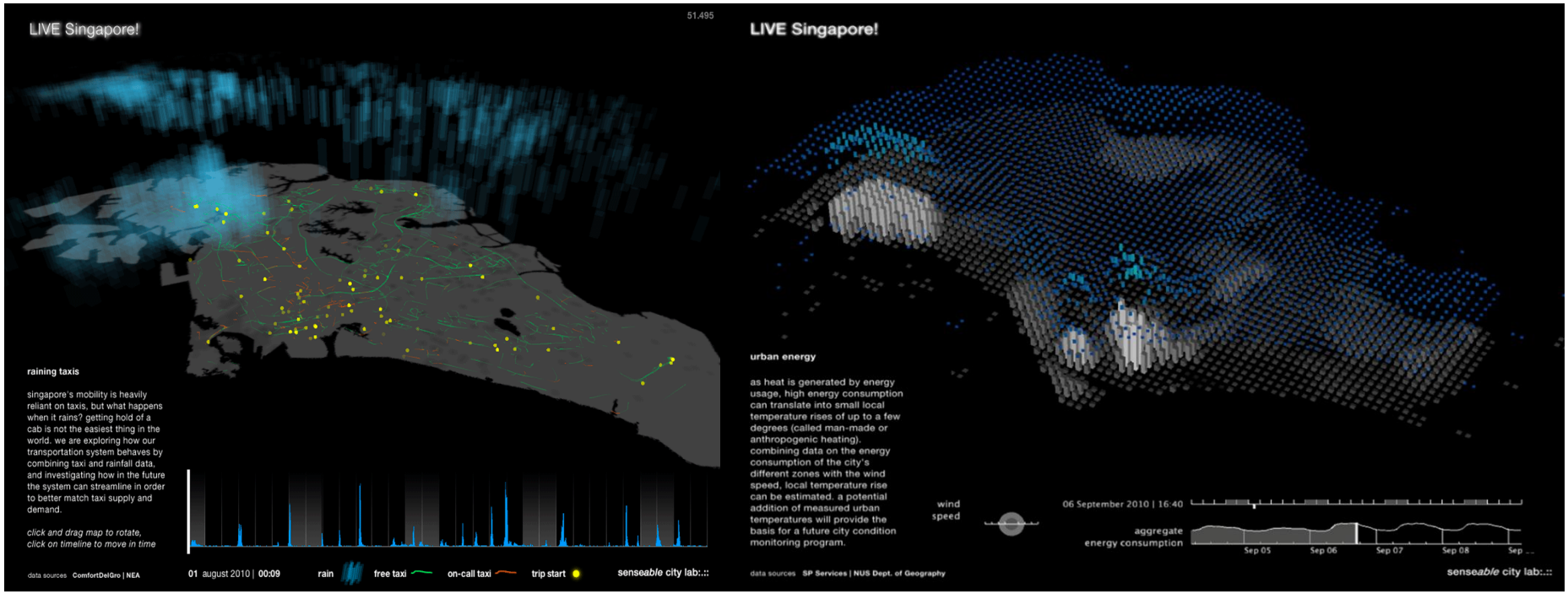
Rome, bus traffic vs. population distribution



Rome, density of tourists vs. location (3D)

Example, Smart Mobility Applications

“Live Singapore”, the power of “Crowd-sourcing”



http://www.youtube.com/watch?feature=player_embedded&v=2aEPkyOBtRo

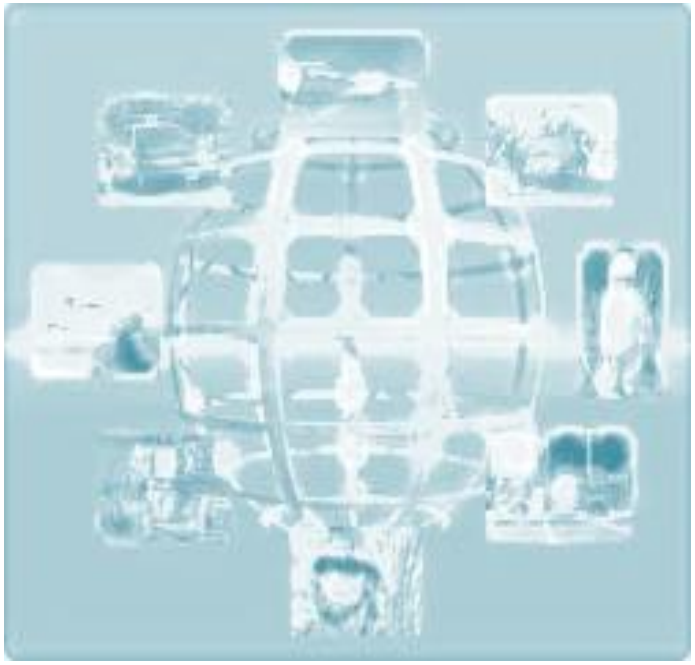

Scared?

Technology Integration

Three main architectural components:

- Sense: data collection, integration and discovery
- Learn: extract knowledge
- Inform, share and persuasion

Why IP ?



Open Standards vs. proprietary

- COTS* suppliers drive costs down but
- Reliability, Availability and Security up

IP abstraction vs. per MAC/App

› 802.11, 802.15.4 (e), Sat, 3G, UWB

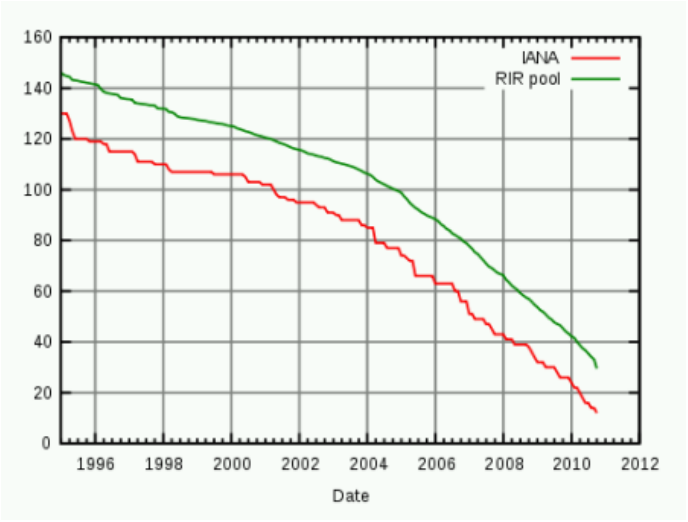
› Keep L2 topology simple

To Infinity and Beyond… But End-to-End.

- No intermediate gateway, tunnel, middle boxes & other trick

- * *Commercial, off-the-shelf*

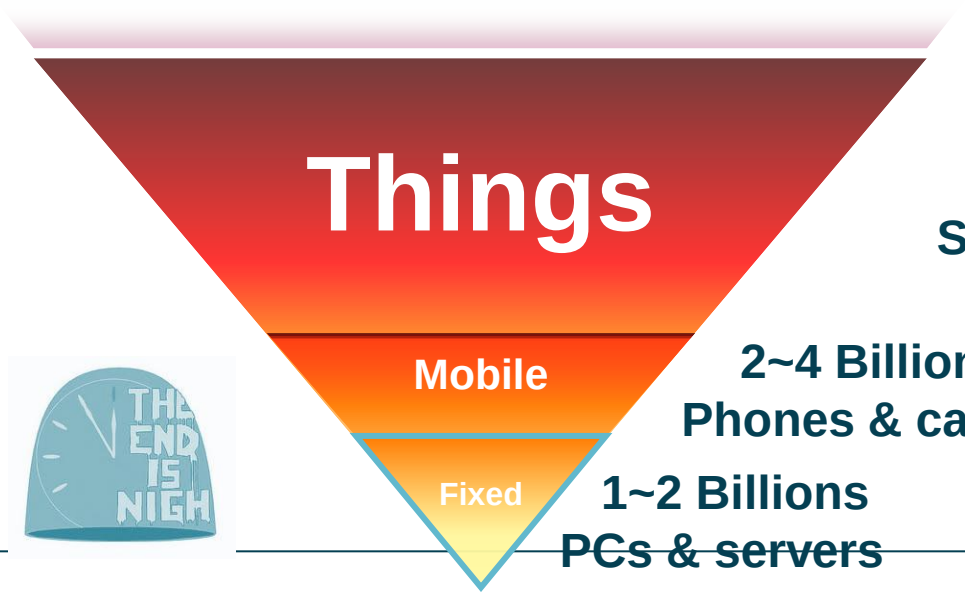
Which IP version ?



The current Internet comprises several billion devices

Smart Objects will add tens of billions of additional devices

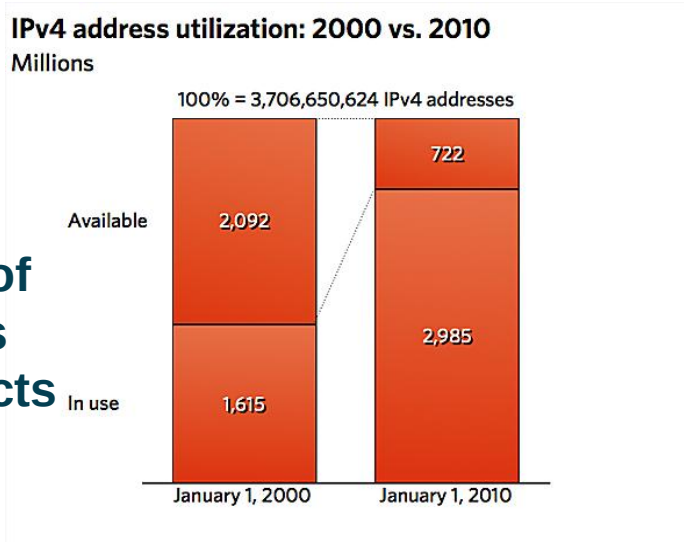
IPv6 is the only viable way forward



Tens of Billions Smart Objects

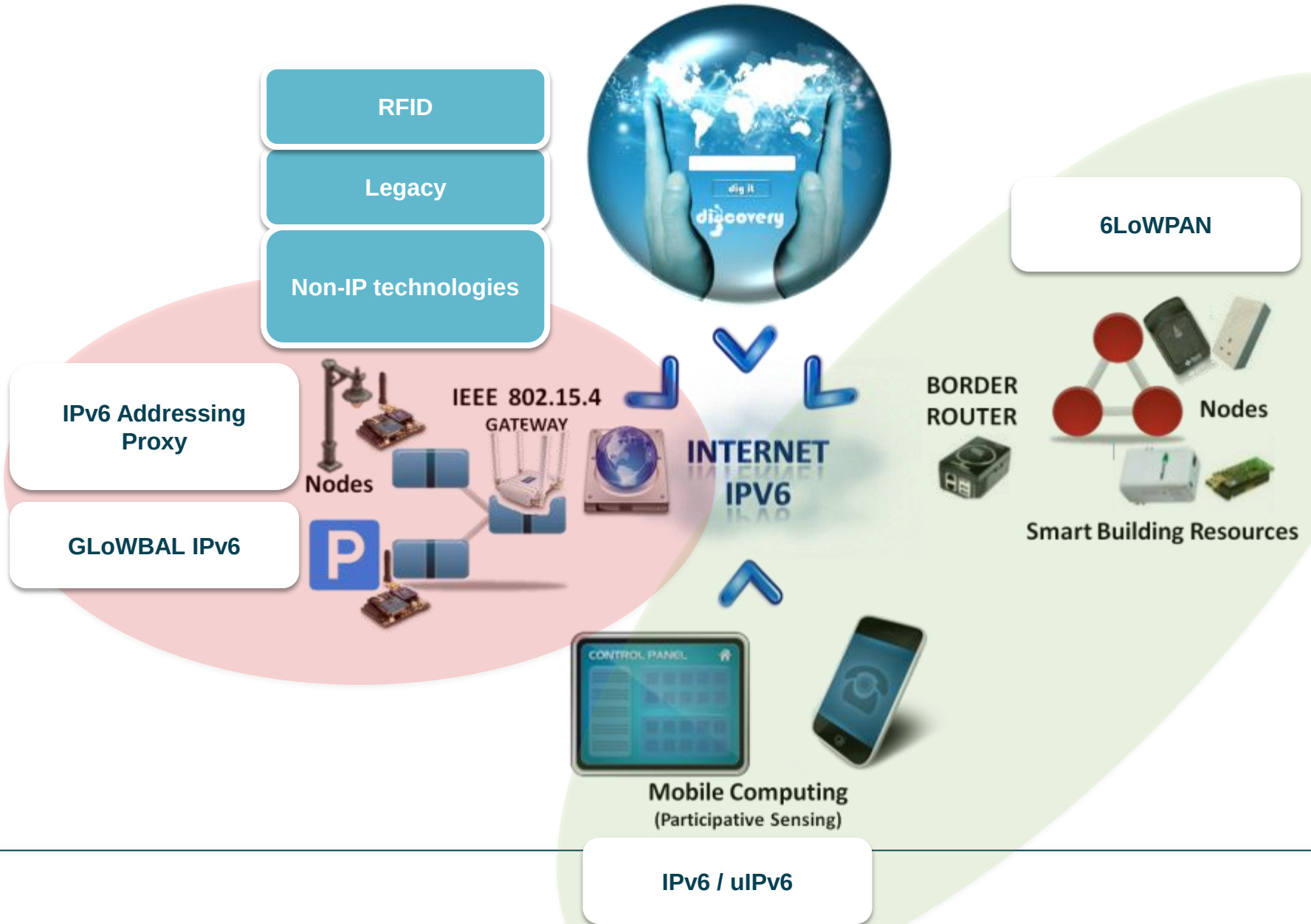
2~4 Billions Phones & cars

1~2 Billions PCs & servers



IPv4 Unallocated pool to exhausted March 2011 !
RIRs pools to exhaust late 2011 and through 2012

Global Vision



Global Connectivity: IPv6

IPv6 Technology

Addressing space

- Address space of 128 bit is a pure necessity for the *Internet of Things and Services*

Global capabilities

- Efficient support for global communications is required to embrace the machine to machine (M2M) communications in Internet of Things.
- Able to sense and affect surrondings

High scalability

- Every square millimeter on the face of the earth has a possible of $1.7x10^{17}$ addresses on an area the size of the tip of your pen.

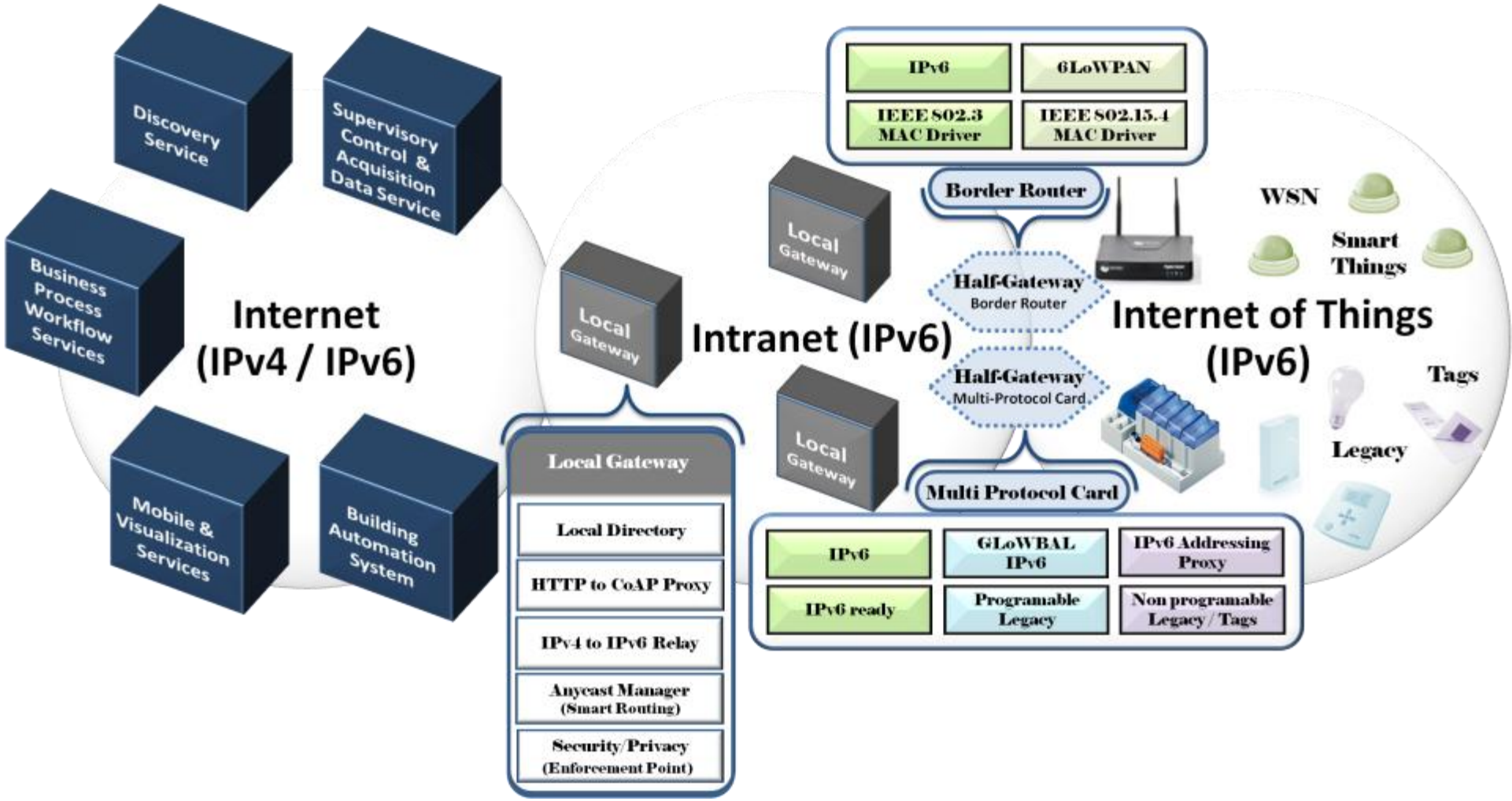
Available and tested

- It is an already existing and extended architecture, with available services/protocols for discovery, WebServices and security.

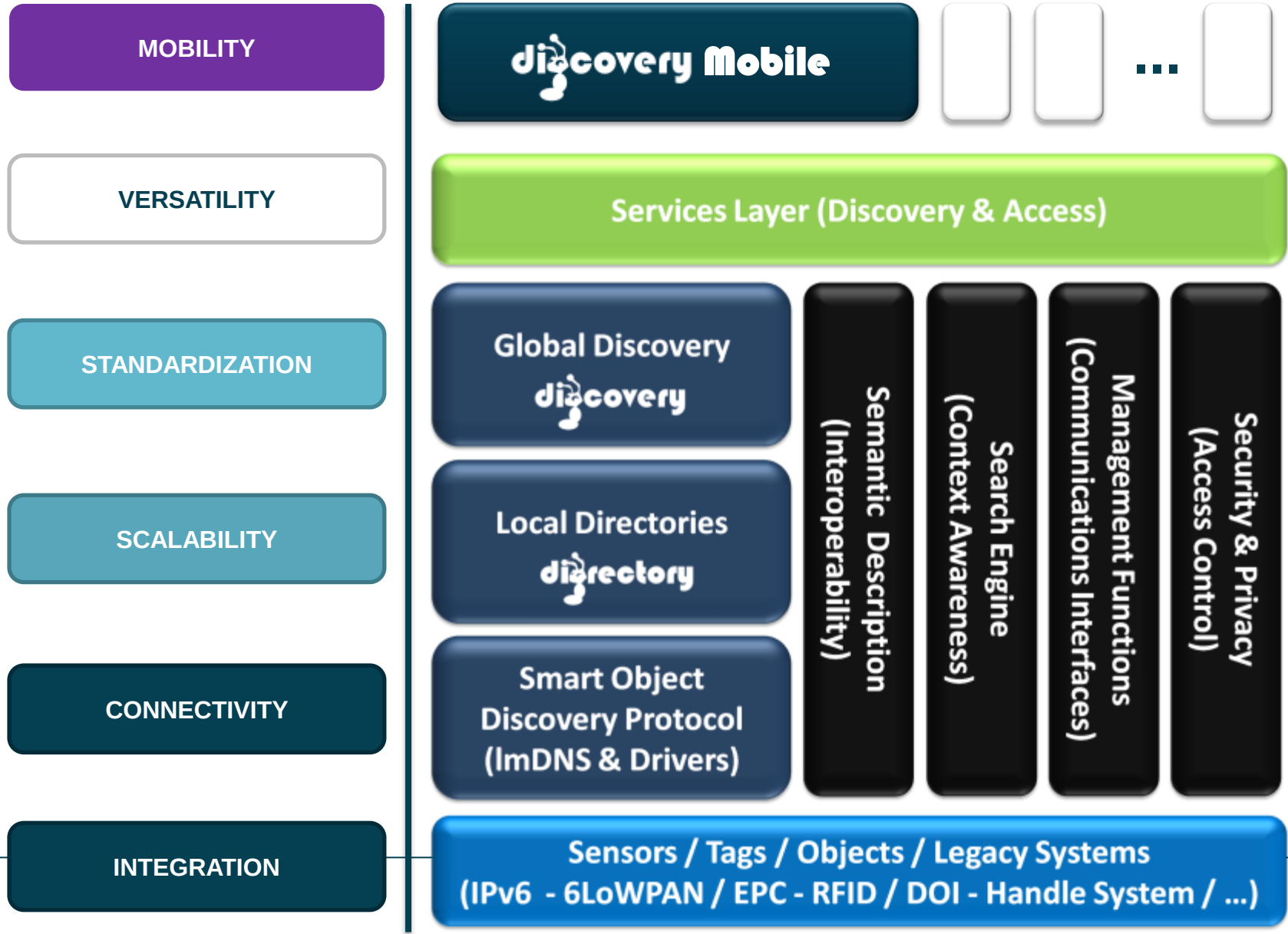
Additional reasons for IPv6 are:

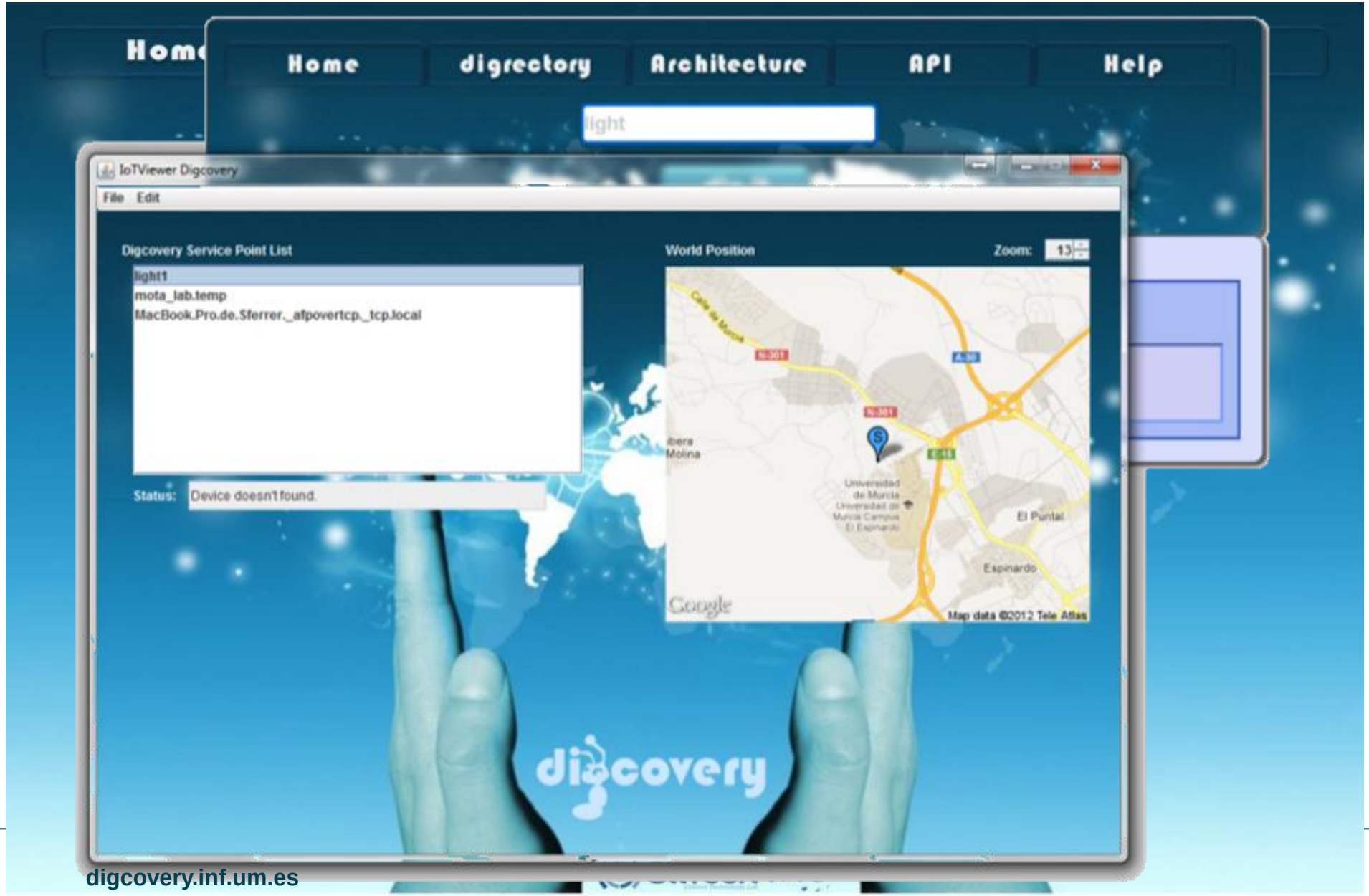
- **Mobile IP support**
- Auto configuration techniques
- Security features of IPSec.
- Anycast and multicast
- Network management facilities

Connectivity and Integration



Digcovery


MOBILITY
VERSATILITY
STANDARDIZATION
SCALABILITY
CONNECTIVITY
INTEGRATION
digcovery Mobile
...
Services Layer (Discovery & Access)
Global Discovery
digcovery
Local Directories
digrectory
Smart Object Discovery Protocol (ImDNS & Drivers)
Semantic Description (Interoperability)
Search Engine (Context Awareness)
Management Functions (Communications Interfaces)
Security & Privacy (Access Control)
Sensors / Tags / Objects / Legacy Systems
(IPv6 - 6LoWPAN / EPC - RFID / DOI - Handle System / ...)


Home
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Architecture
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Help
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IoTViewer Digcovery
File Edit
Digcovery Service Point List
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MacBook.Pro.de.Sferrer._afpovertcp._tcp.local
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13
Status:
Device doesn't found.
Universidad de Murcia
El Puntal
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Google
Map data ©2012 Tele Atlas
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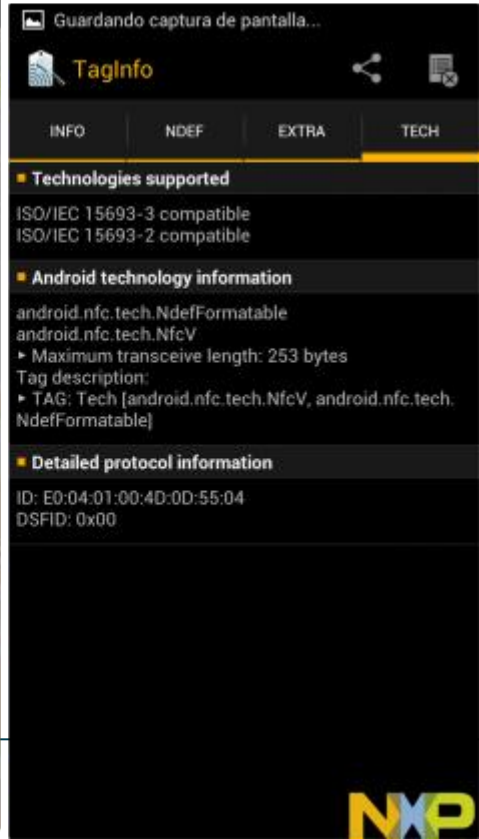
Digcovery Mobile

Interacting through RFID/NFC

Tags from Technical Unit

Identification (digcovery)

Tag Type Information

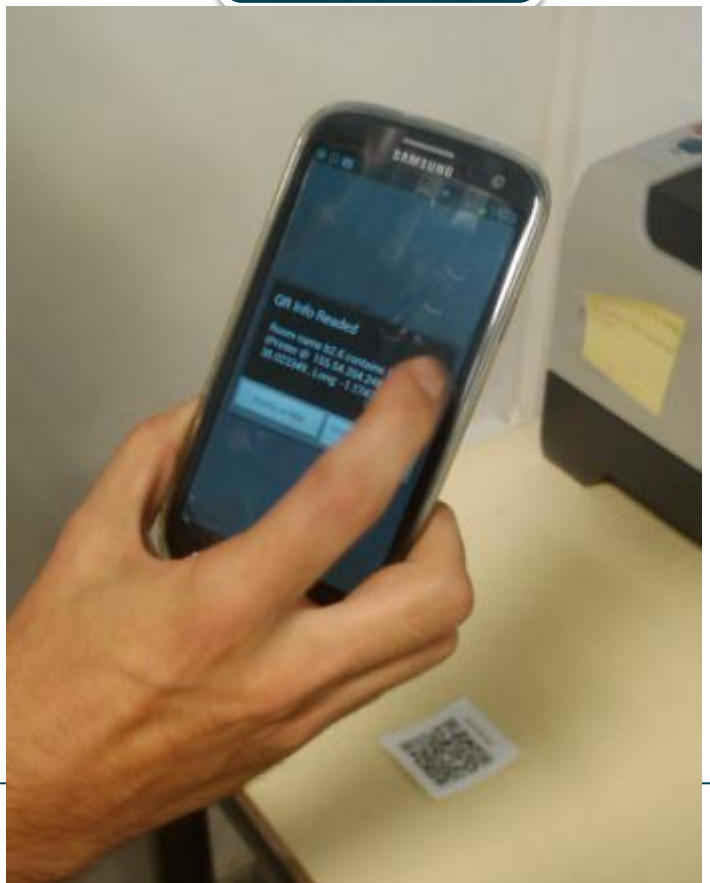


Digcovery QR

Interacting through QR Codes

Read QR Code

Printer (ipp) Services

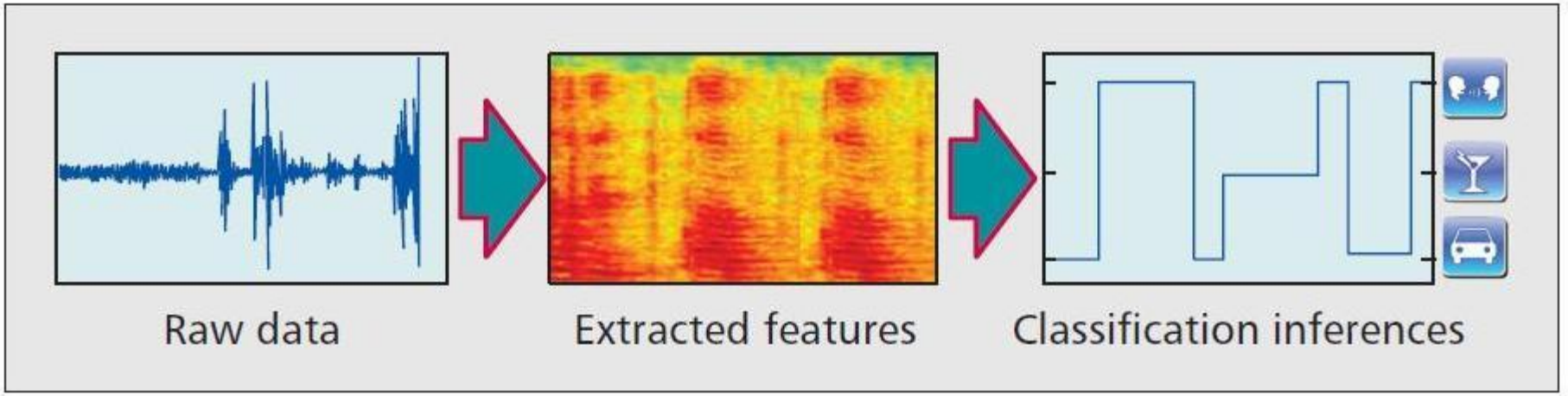


LEARN: INTERPRETING SENSOR DATA

Key challenges in interpreting sensor data:

- *human behavior*

- *context modeling*

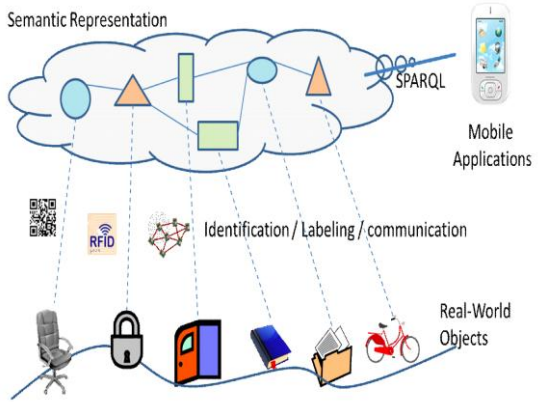


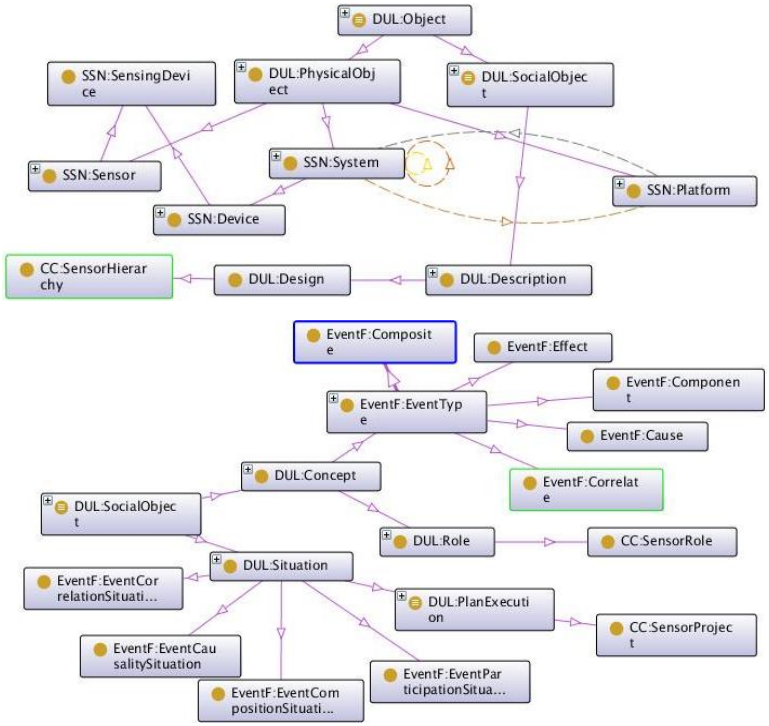
Detecting the meaningful changing points in a trajectory

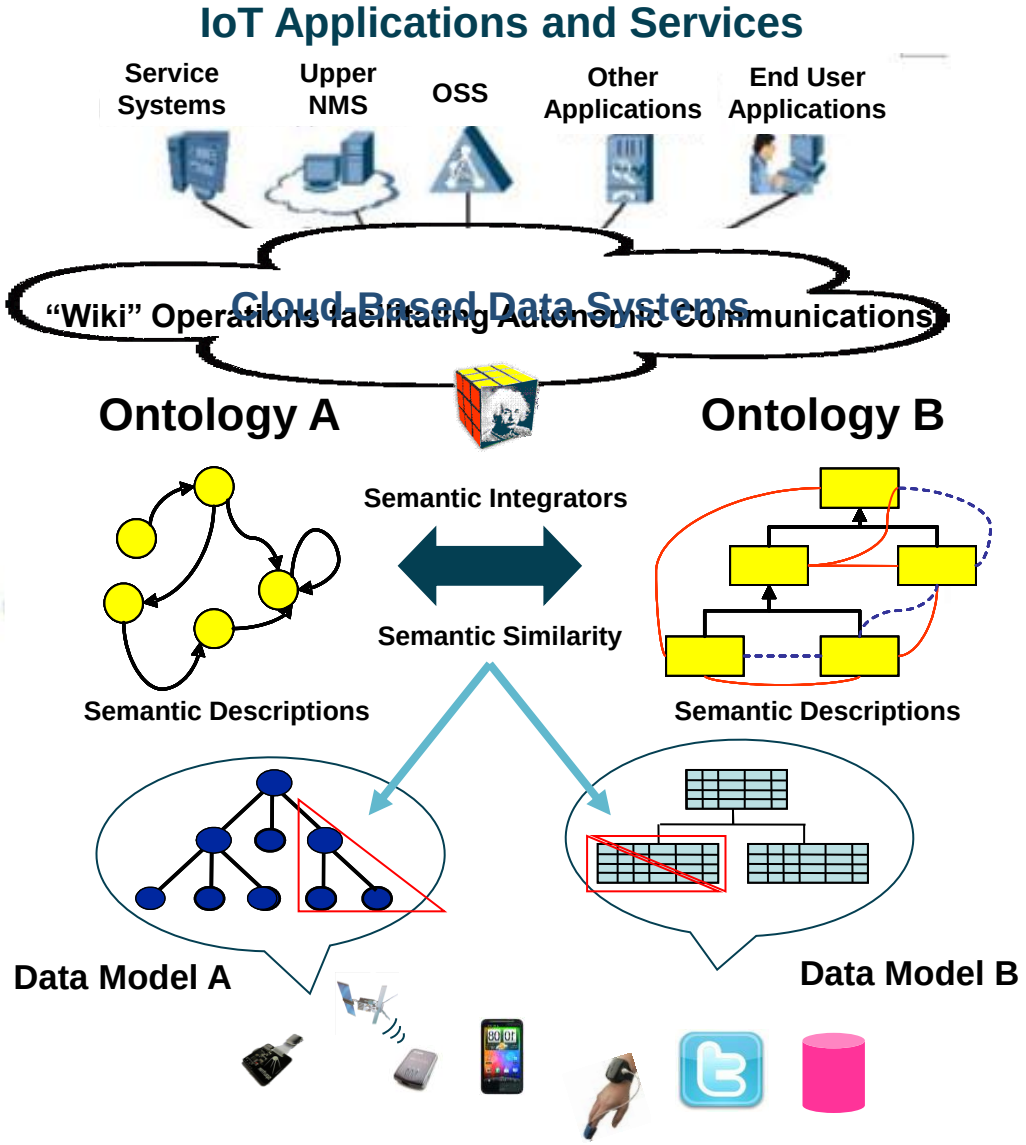
http://www.seabilla.eu)

- to detect vessel's abnormal behaviour fron their tracks.
- CEP (Complex Even Processing), clusterin algorithms, Marko techniques to models t detect pattern c behaviours based o basic events

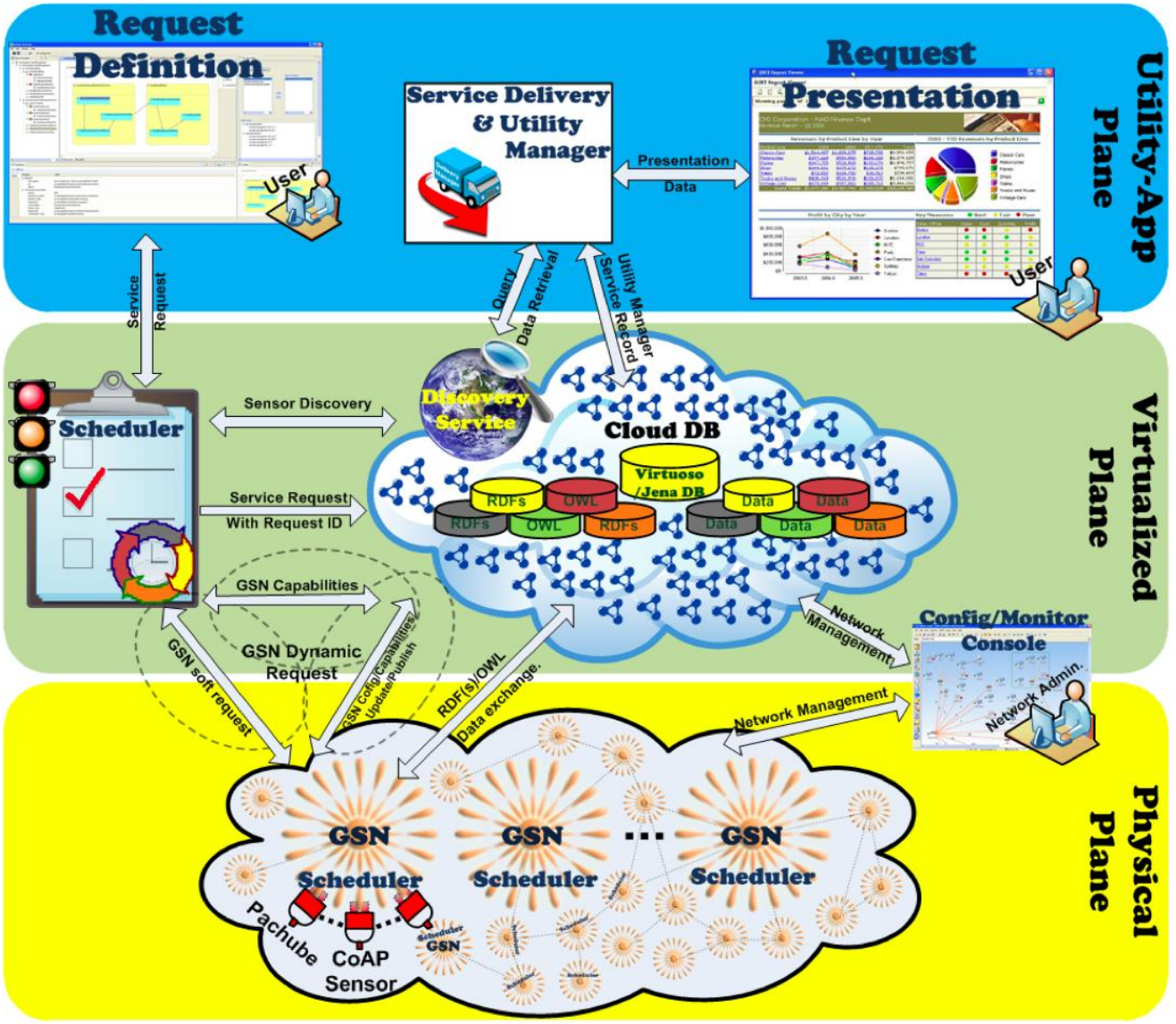
Extensions towards Interoperability







OpenIoT Design Principle

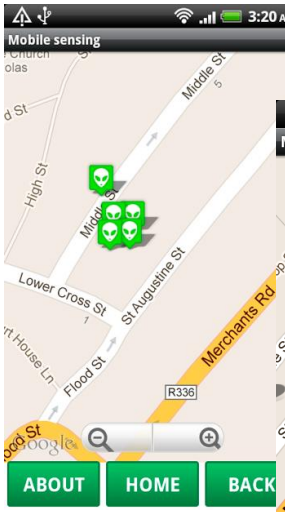


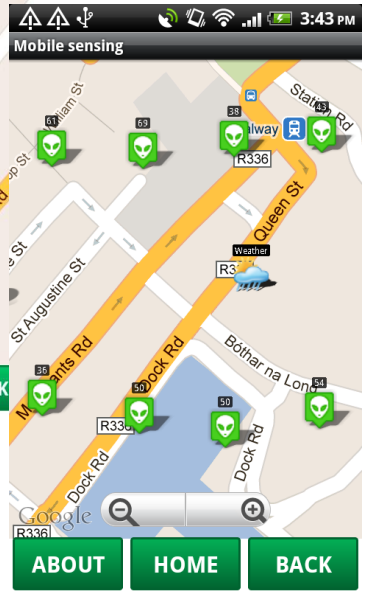
INFORM, SHARE, AND PERSUASION: CLOSING THE SENSING LOOP

- *Sharing*
- *Personalized Sensing*
- *Persuasion*
- *Privacy*

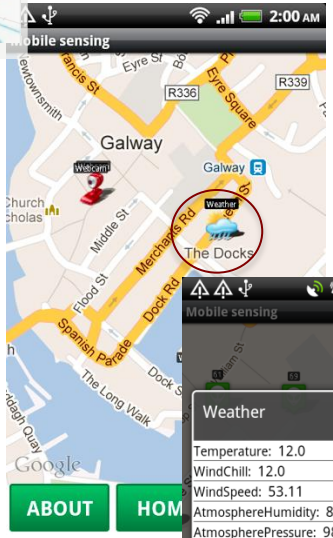
Smart City Use Case – Global Sensors Network

Smart Crowds Monitoring

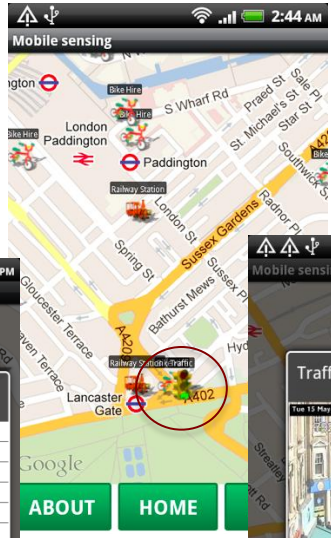


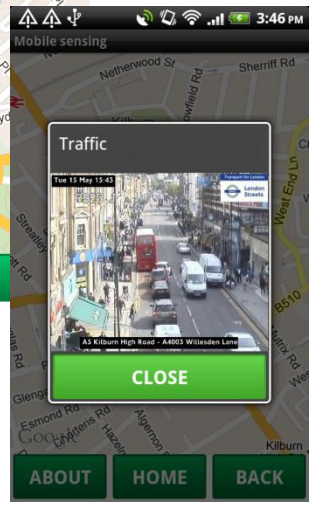


Clustering algorithm simplifying visualization about big groups of people



Real-time data collected from weather sensors





Real-time data collected from traffic cams

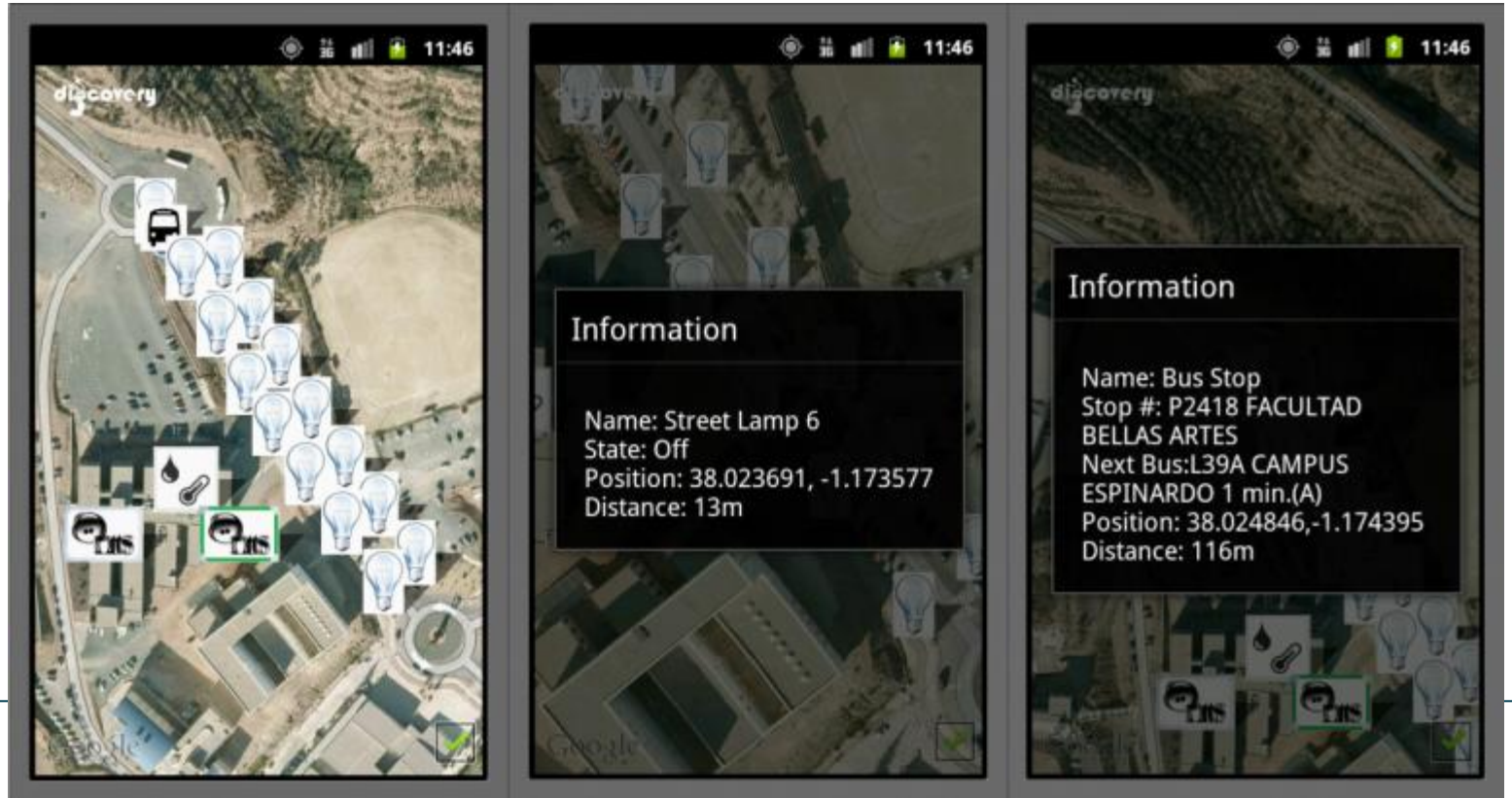
Digcovery Mobile

Interacting through WebServices

Map Visualization

Street Lights

Bus Stop



Smart City: Main challenges

- Smart cities
  - **Extended communication** (Home, travels, WIFI, G3….) for users and city operators
  - **Mobility (Public Transport and virtual collaboration)**
  - **Transportation**
    - Intelligence Transportation systems
    - Inter modality – new added value services for users (attractively)
- Environment
  - Energy saving – C02 reduction
- Impact on systems (Physical and IT)
  - **Exchange of data**
  - **Open Architecture (platform)**
  - **Interoperability**
  - Extended supervision capabilities
  - Complexity management

Applications

Monitoring and Automation

Energy Efficiency

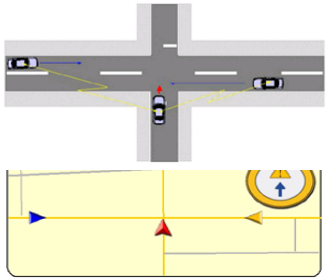
Predictive maintenance

Healthcare

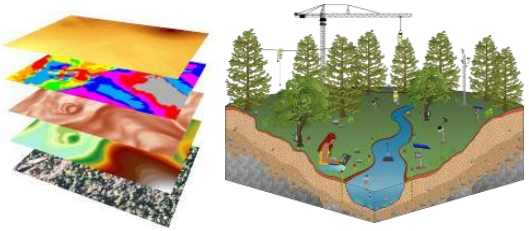
Defense

Asset tracking

Industrial Automation



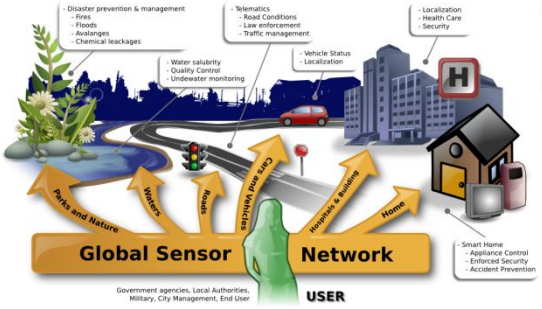
Car 2 Car



Research & Discovery

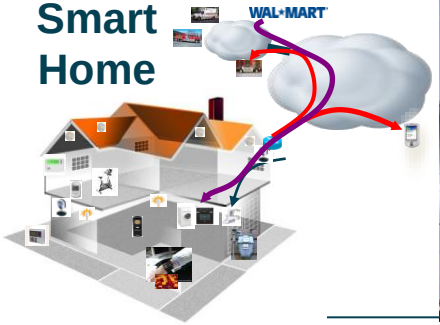
Agriculture

Smart Cities



Smart Grid

Smart Home



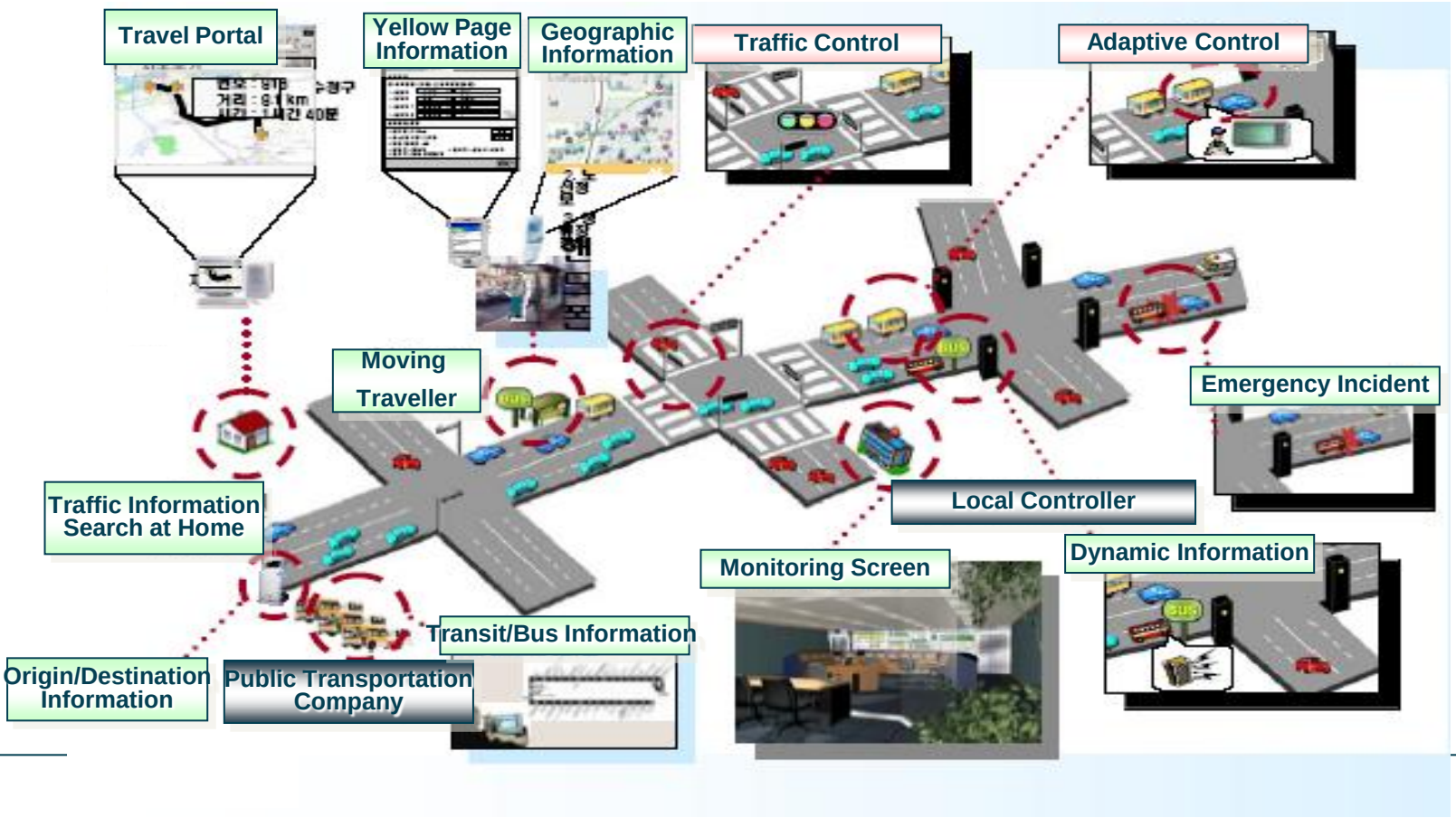
Intelligent Building

City Target Services : ITS

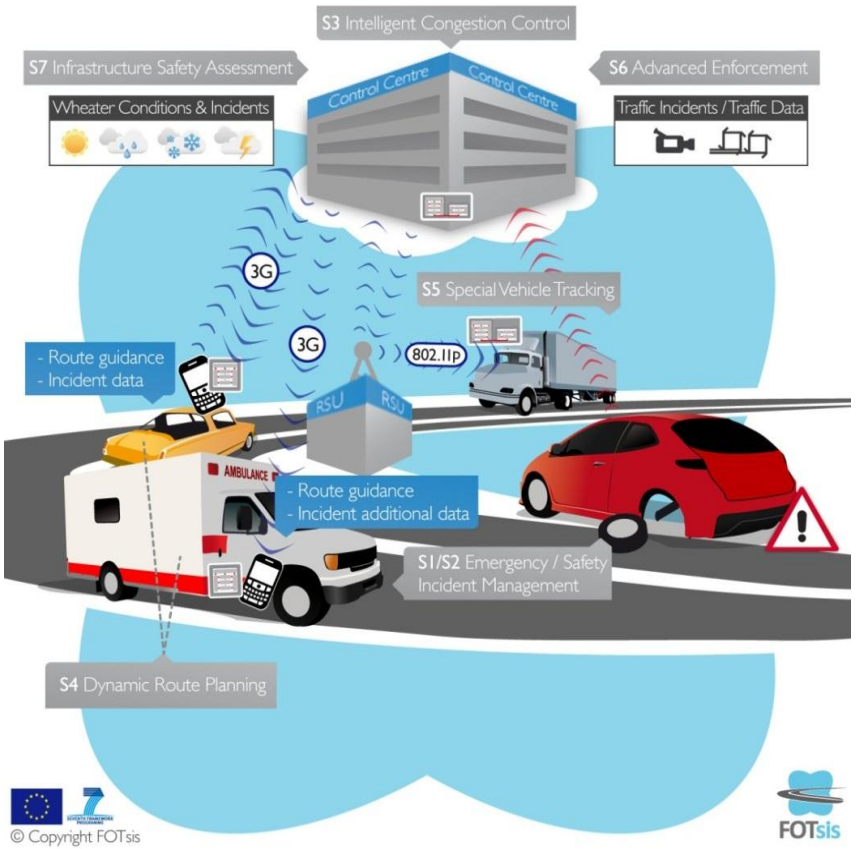
ITS

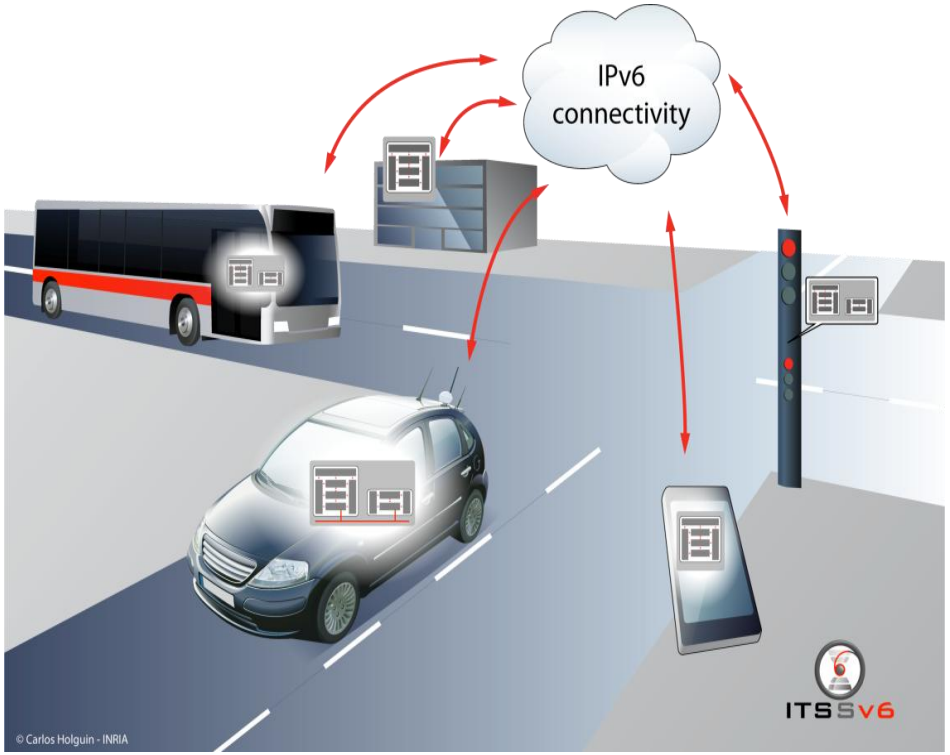
- To efficiently provide services for solving various traffic problems using ubiquitous technologies in the road

such as Real-time traffic information system, Traffic Management System, Electronic Toll Collection System, etc.



Sensors and ITS

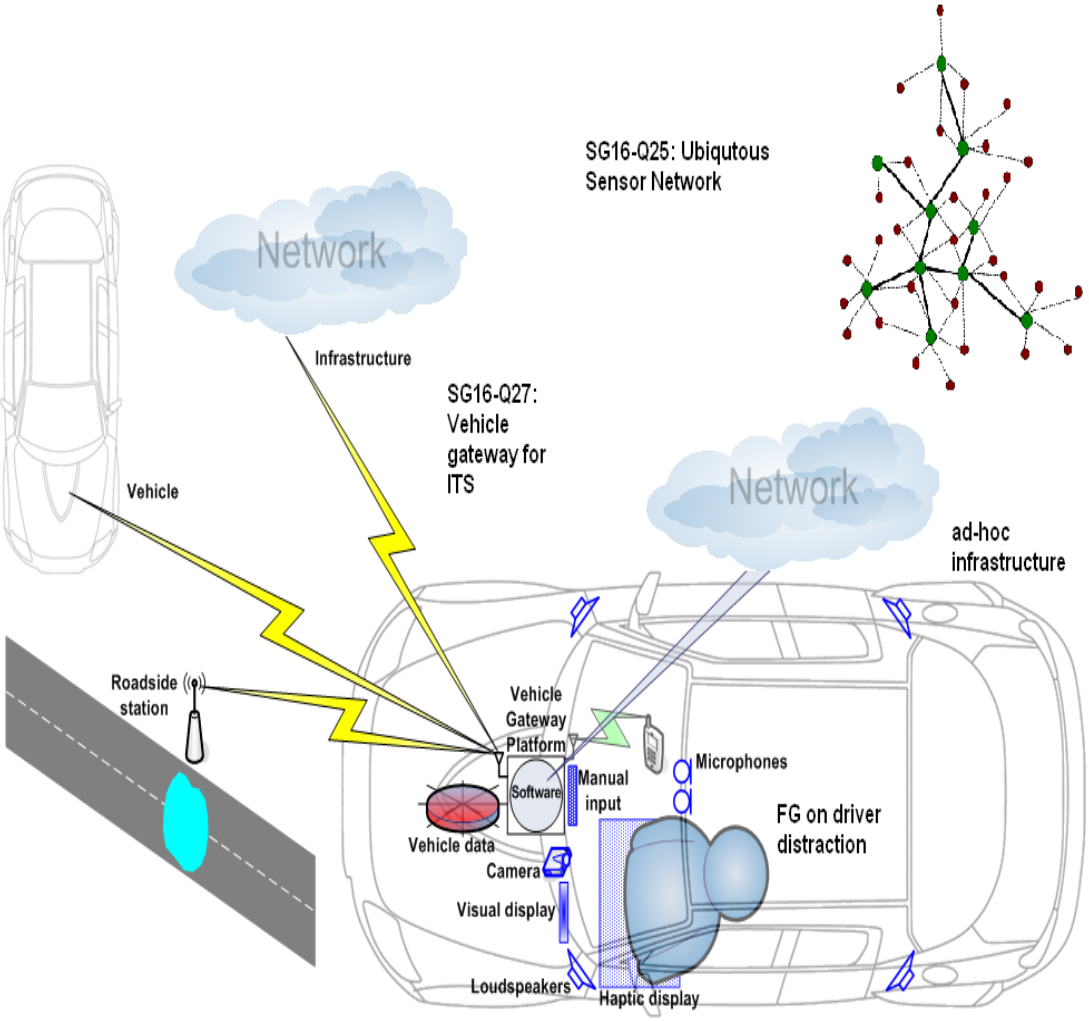




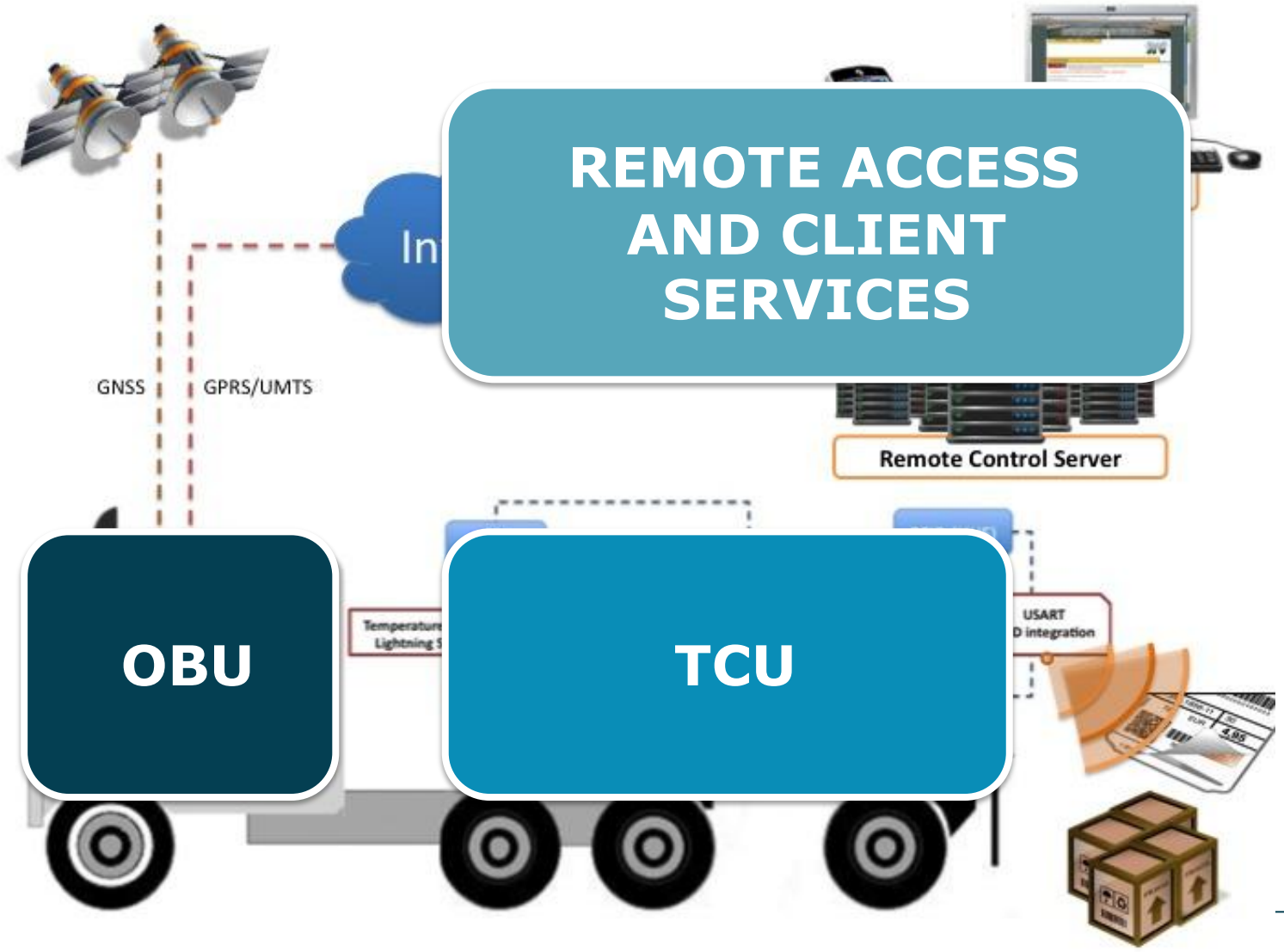
- Fully networked cars and roads exchange information w/ roadside equipment (V2I) and other cars (V2V);

Sensors and ITS

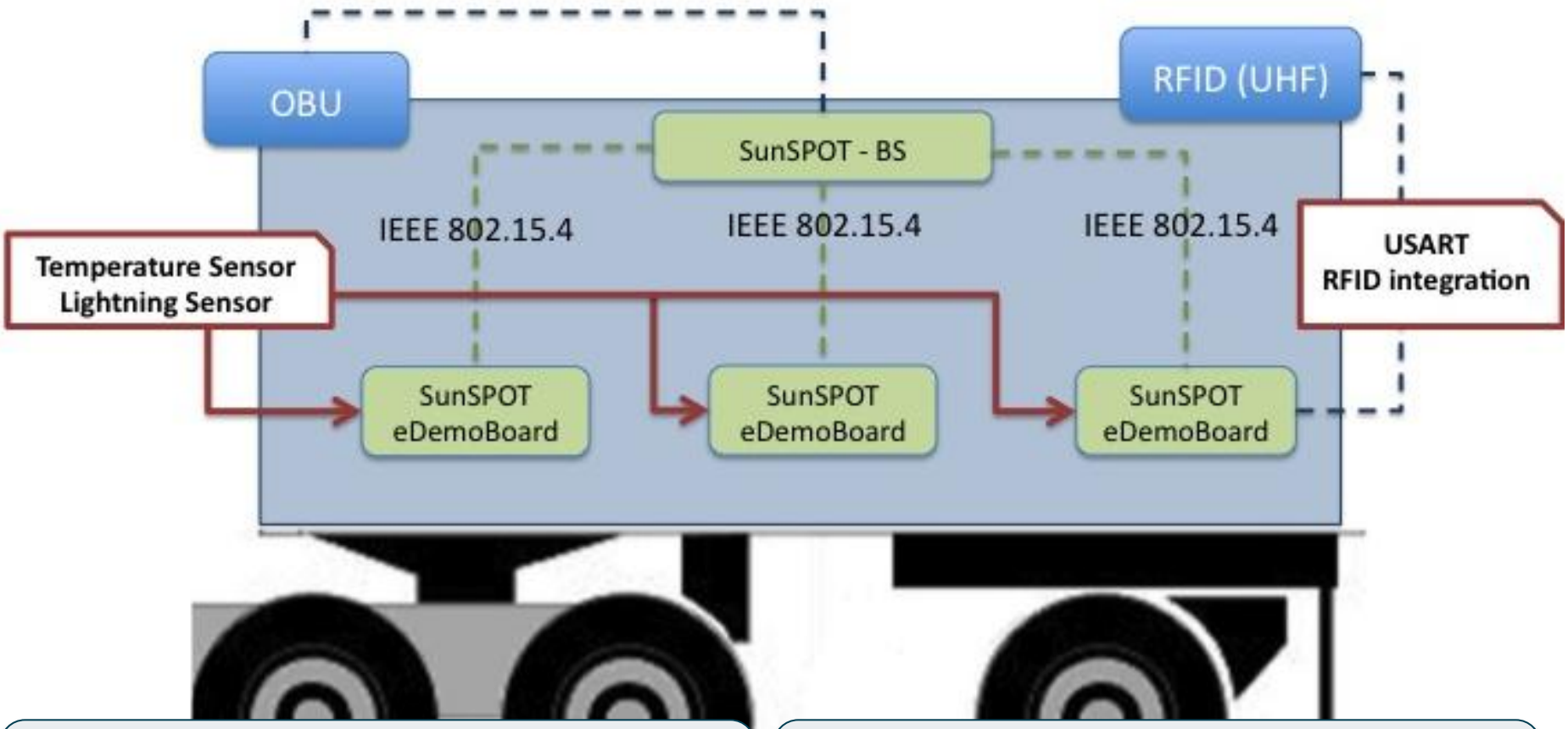
- IPv6 based sensor is part of the IoT scenario and with hightly impact on ITS
- Sensor can be at roadside or within the car network
- Sensor are needed to be treated as first order object



Applicability to goods tracking



Sensors in the Trailers



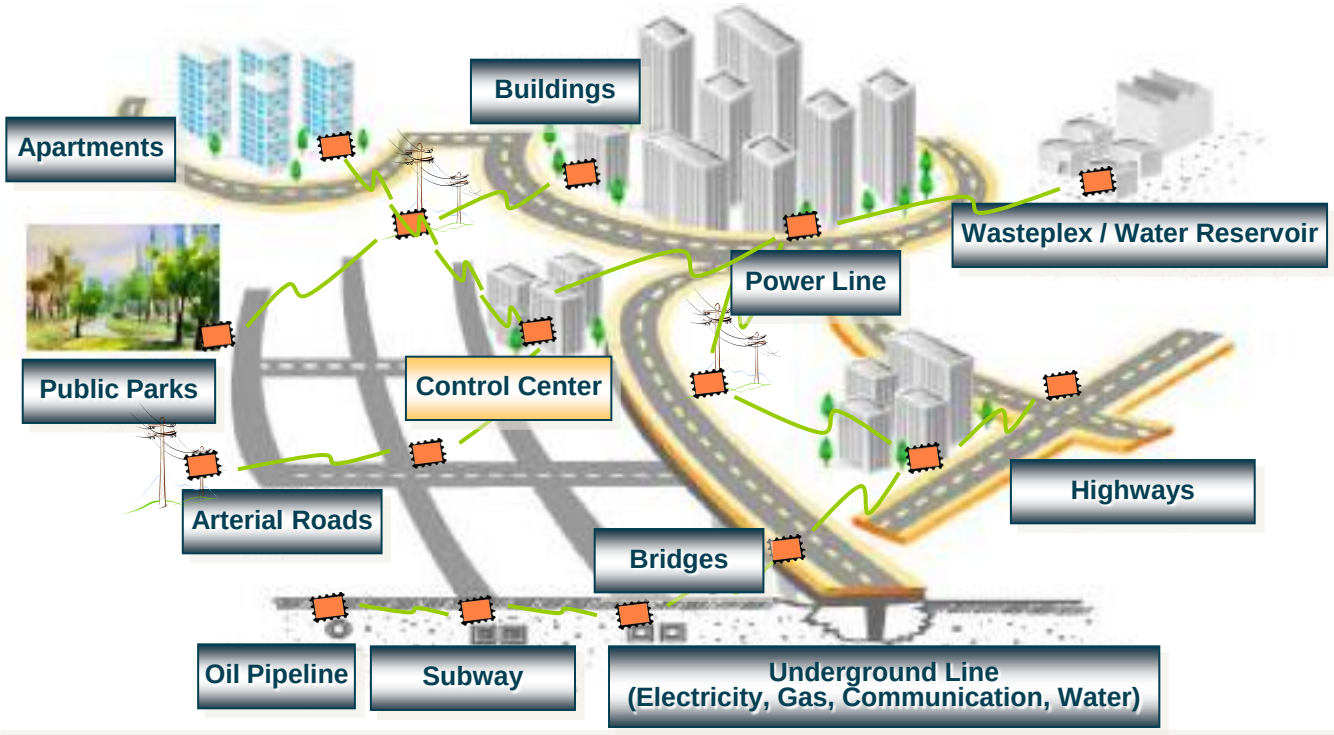
IPv6 connectivity over IEEE 802.15.4

RFID Integrated Directly over the deployed nodes.

City Target Services: FMS

FMS

- Ubiquitous Facility Monitoring information system: to efficiently use the SOC facility and building, the subsidiary facilities (the street lights, and a park) including the road within a u-City, the bridge, a harbors, etc.
- Ubiquitous-based FMS: Building GIS and carrying out the real time monitoring, maintenance and management



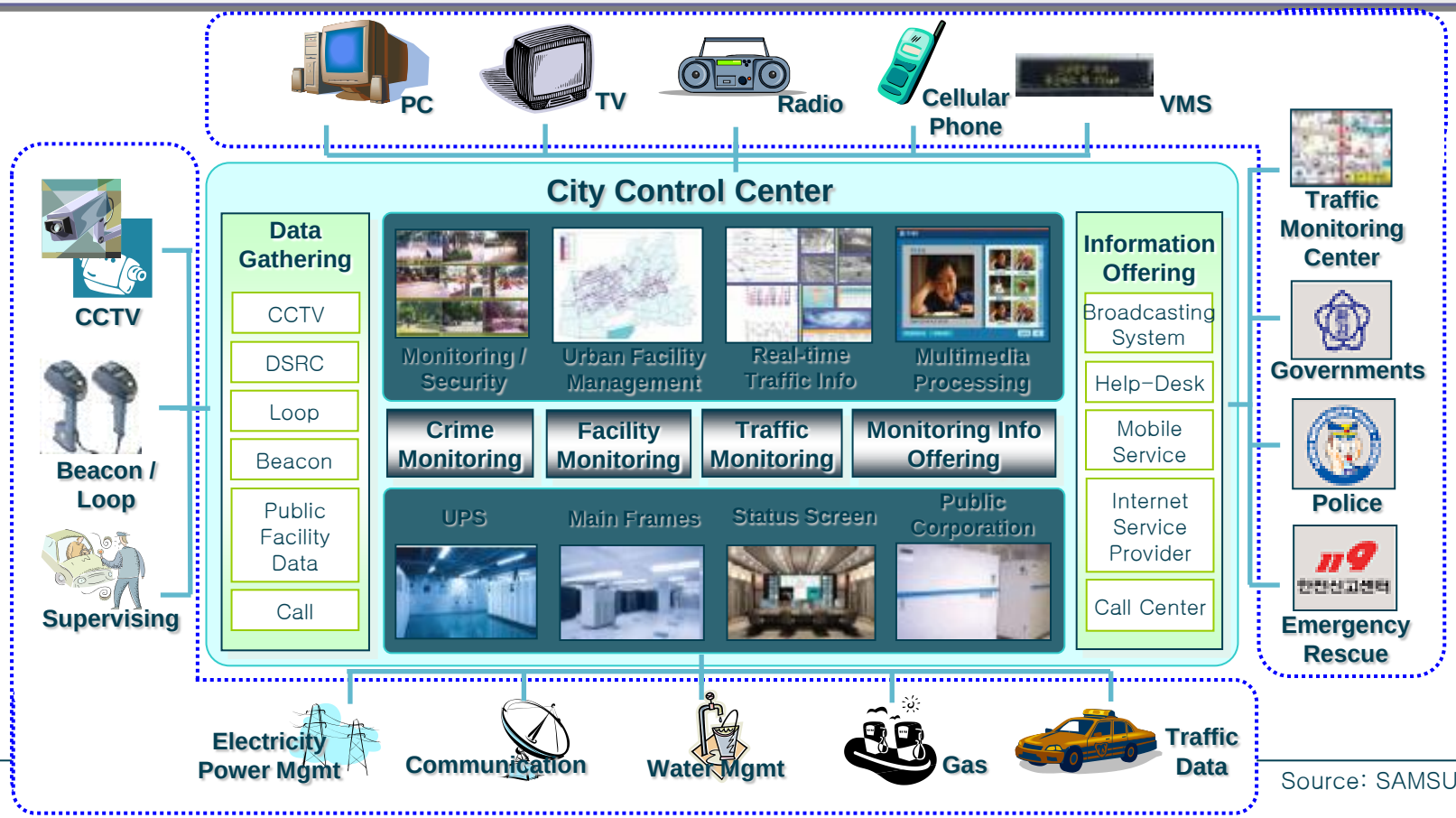
- Remote Inspection of a Meter
- Positioning Waterworks
- Positioning Power/Comm. Line
- Remote Diagnostic of Facilities
- Status Monitoring
- History Management
- Statistics Management
- Real-time Information Gathering

*FMS: Facility Management System

City Target Services: City Control

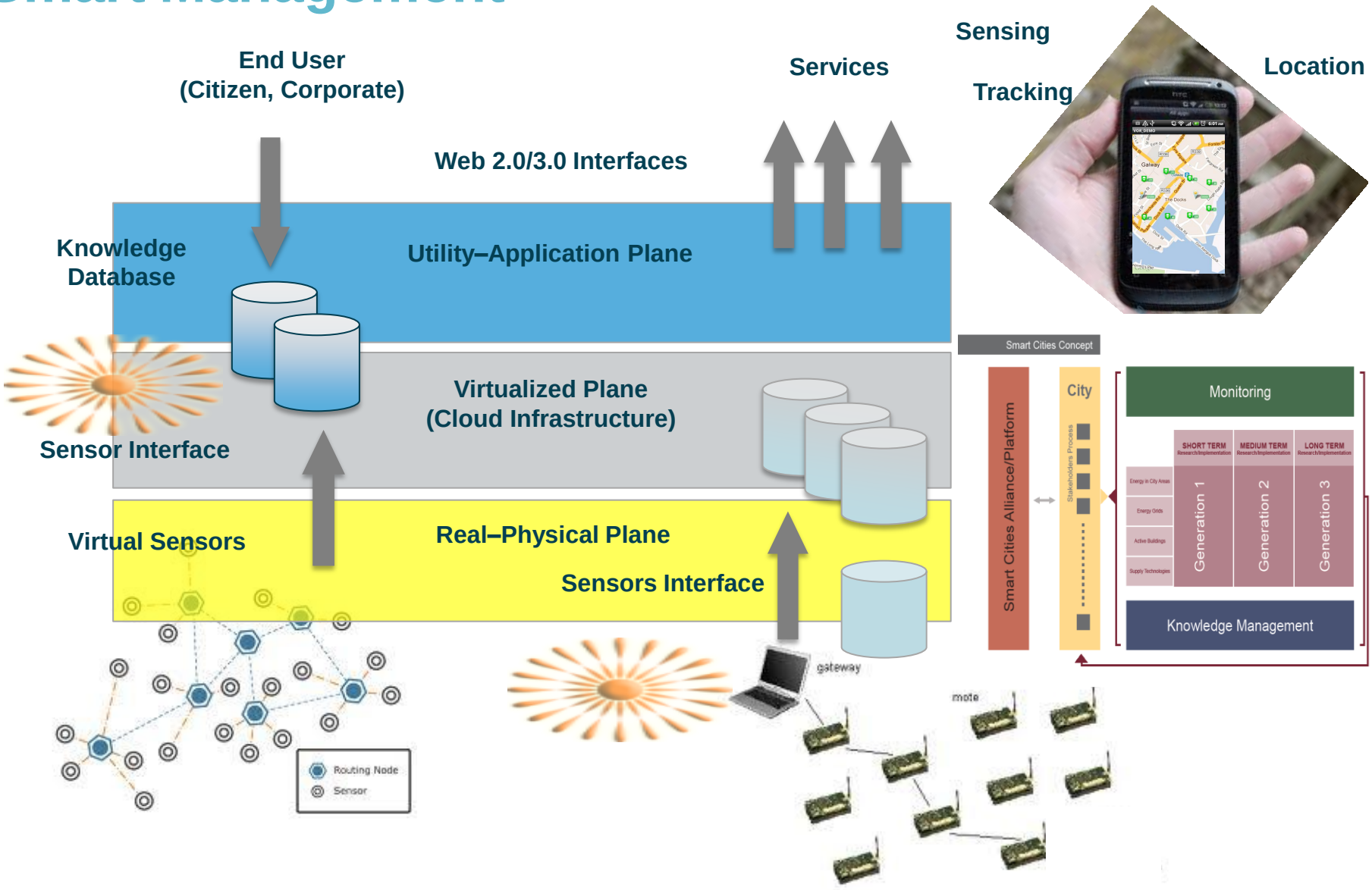
City Control Service

- Collecting city management information from communication systems, road networks and other facilities, and analyzing the information
- Operating and managing all related events systematically in a city
- Providing real-time information for the management of a city



Source: SAMSUNG SDS

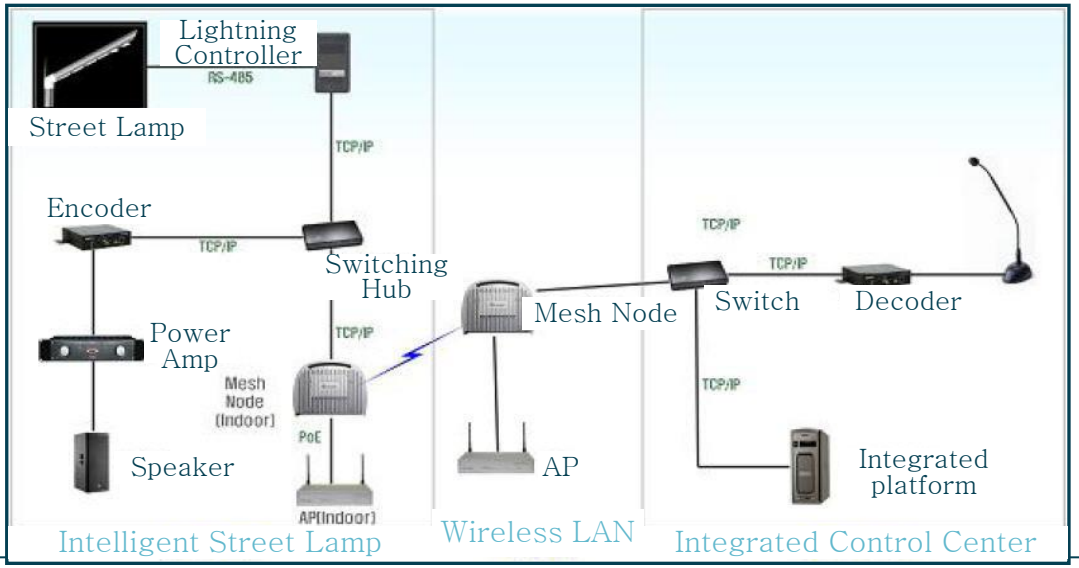
Smart Management



Sample Case : City Construction Infrastructure

❑ **Intelligent street lamp (Seoul, u-Street lamp of Cheonggye stream)**

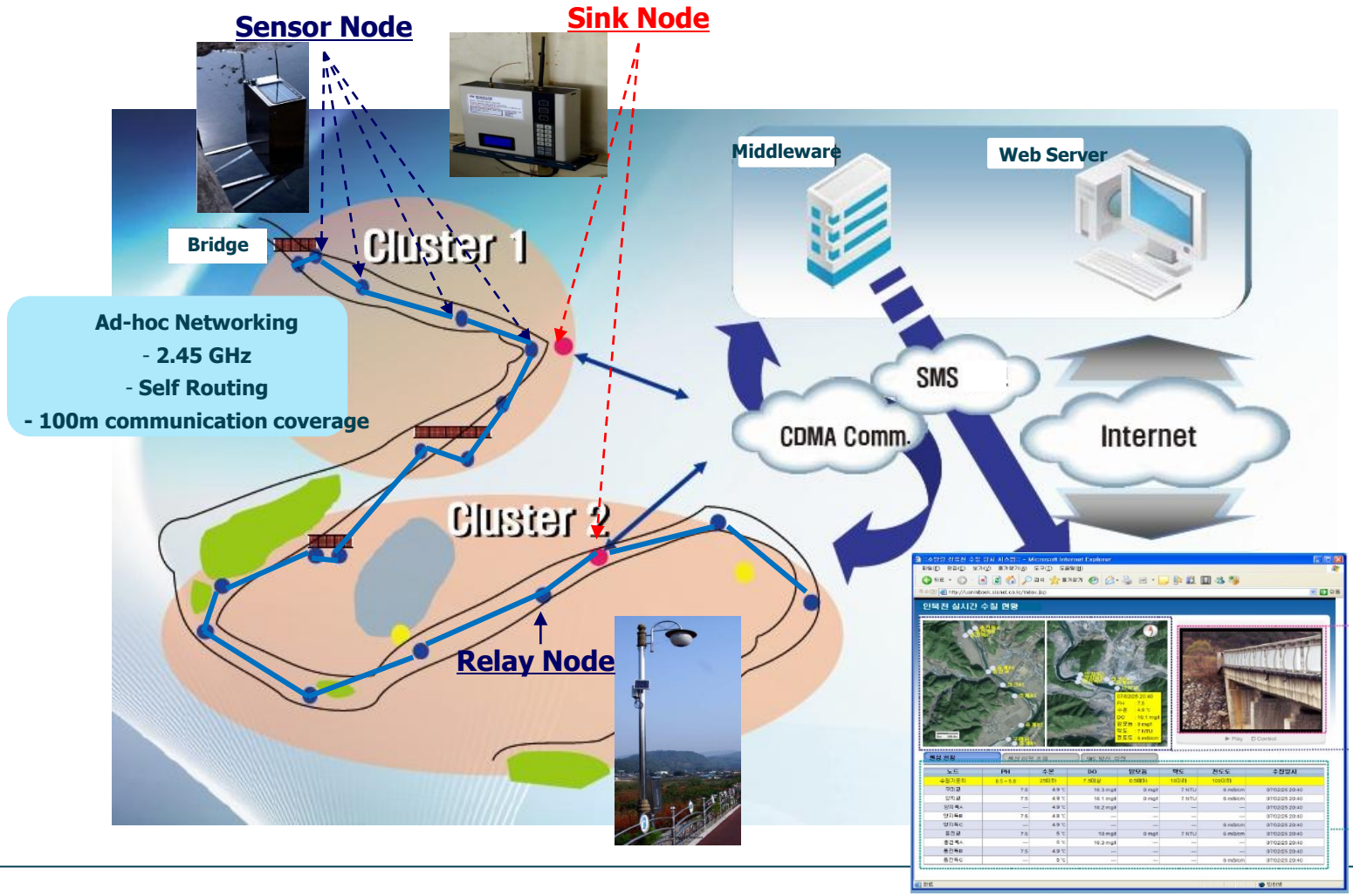
Names of goods	Specification
Intelligent Street Lamp	242× 7000× 194
Pedestrian Lamp	280× 154, Metal halide lamps 150W
Event Lamp	270× 186.5× 112, LED 132W
Mood Lamp	270× 186.5× 112, LED 132W
Lightning Controller	240× 160× 80
Encoder	200× 155× 50, MPEG-4
Power Amp	180× 300× 70, 100W
Speaker	180× 300× 70, 100W
Switching Hub	178× 30.2× 108, 10/100 Base-T, 8Port



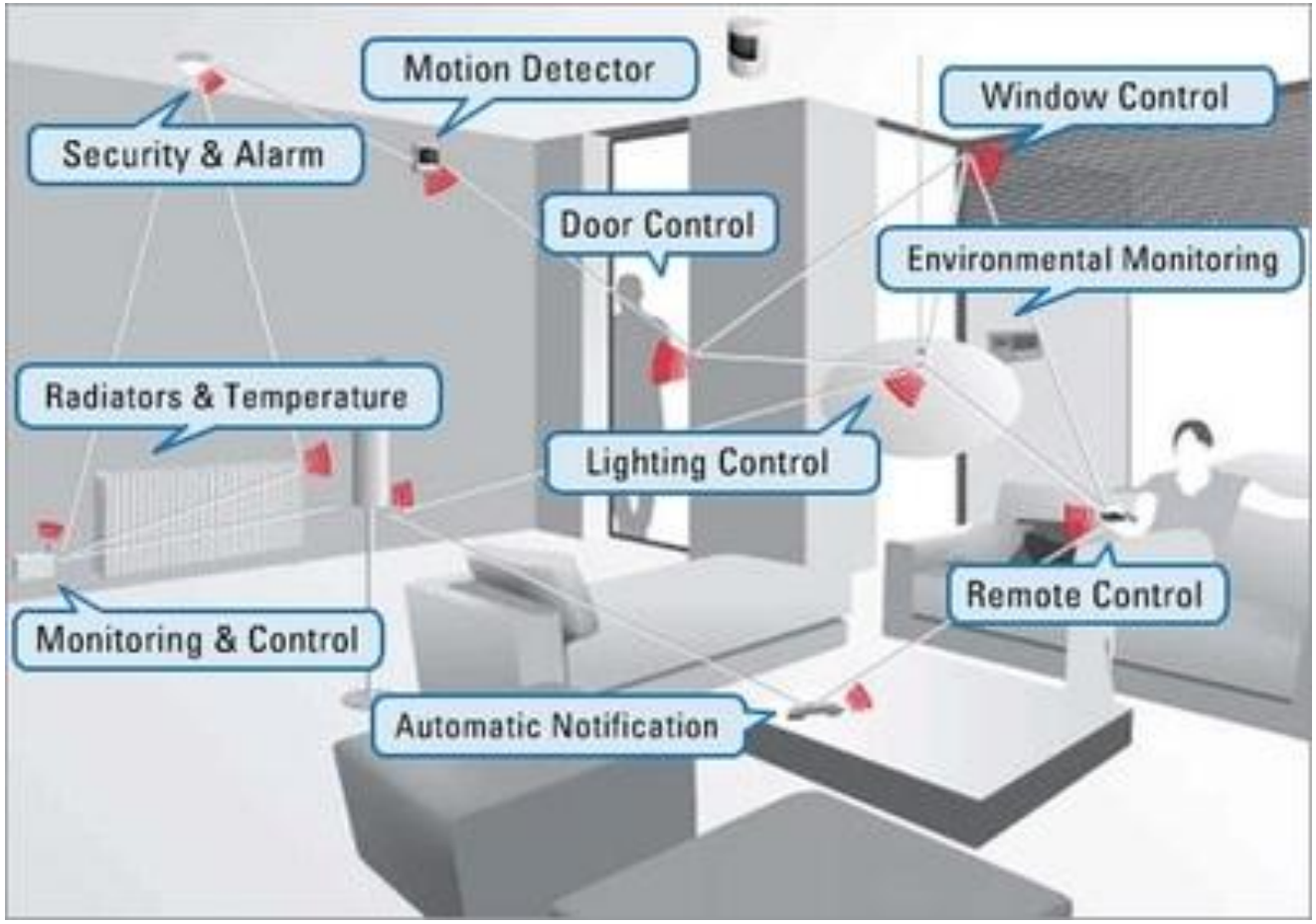
Source: Seoul City

Sample Case : City Sensor Networks

❑ Monitoring water quality



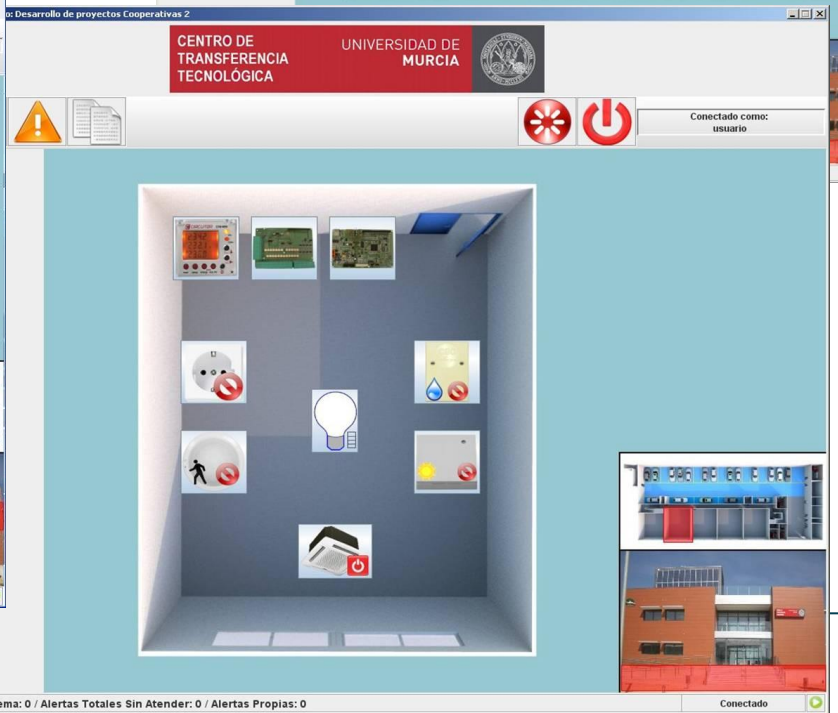
Smart Homes



http://www.orble.com/the-smart-home-how-building-management-systems-integrate-technology-to-increase-energy-efficiency/

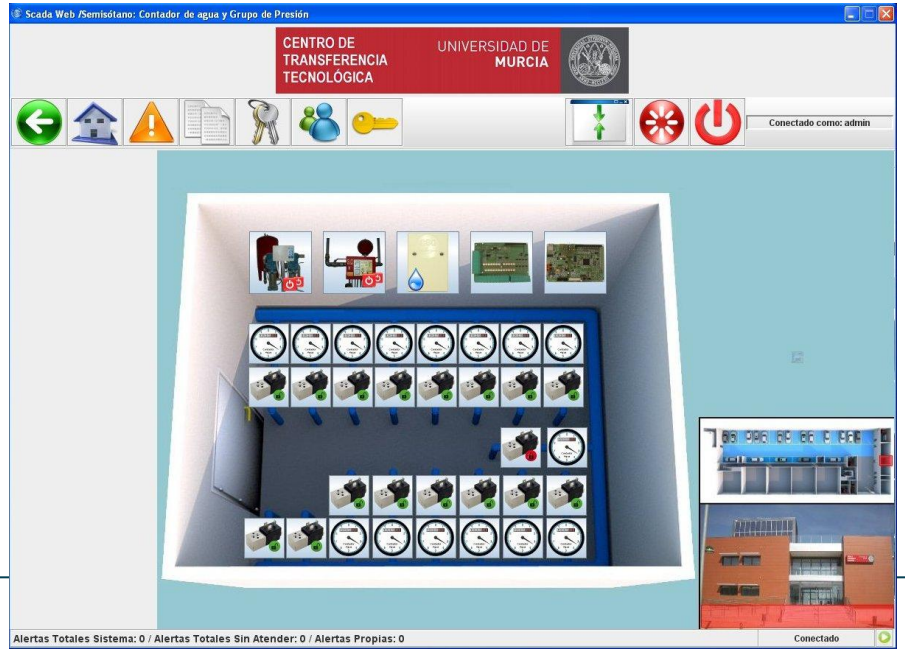
Smart Buildings
Domosec Architecture Smart – Human Interface

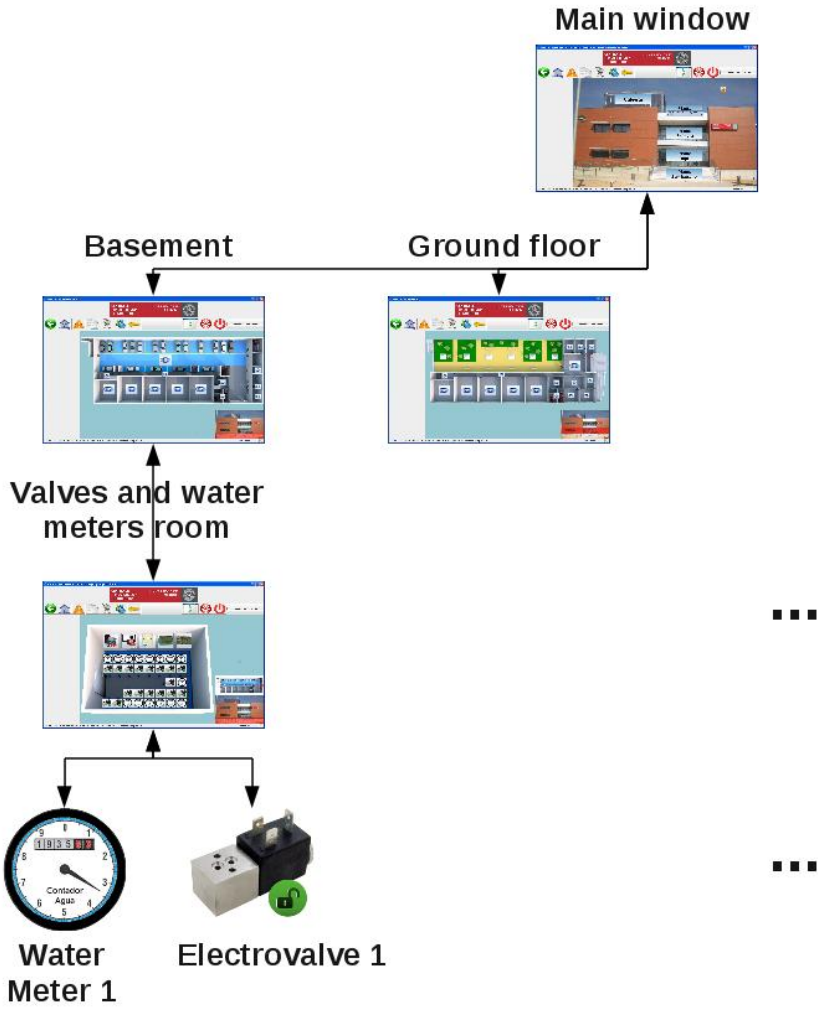
- SCADA web can be operated from any computer with a web server and JVM.



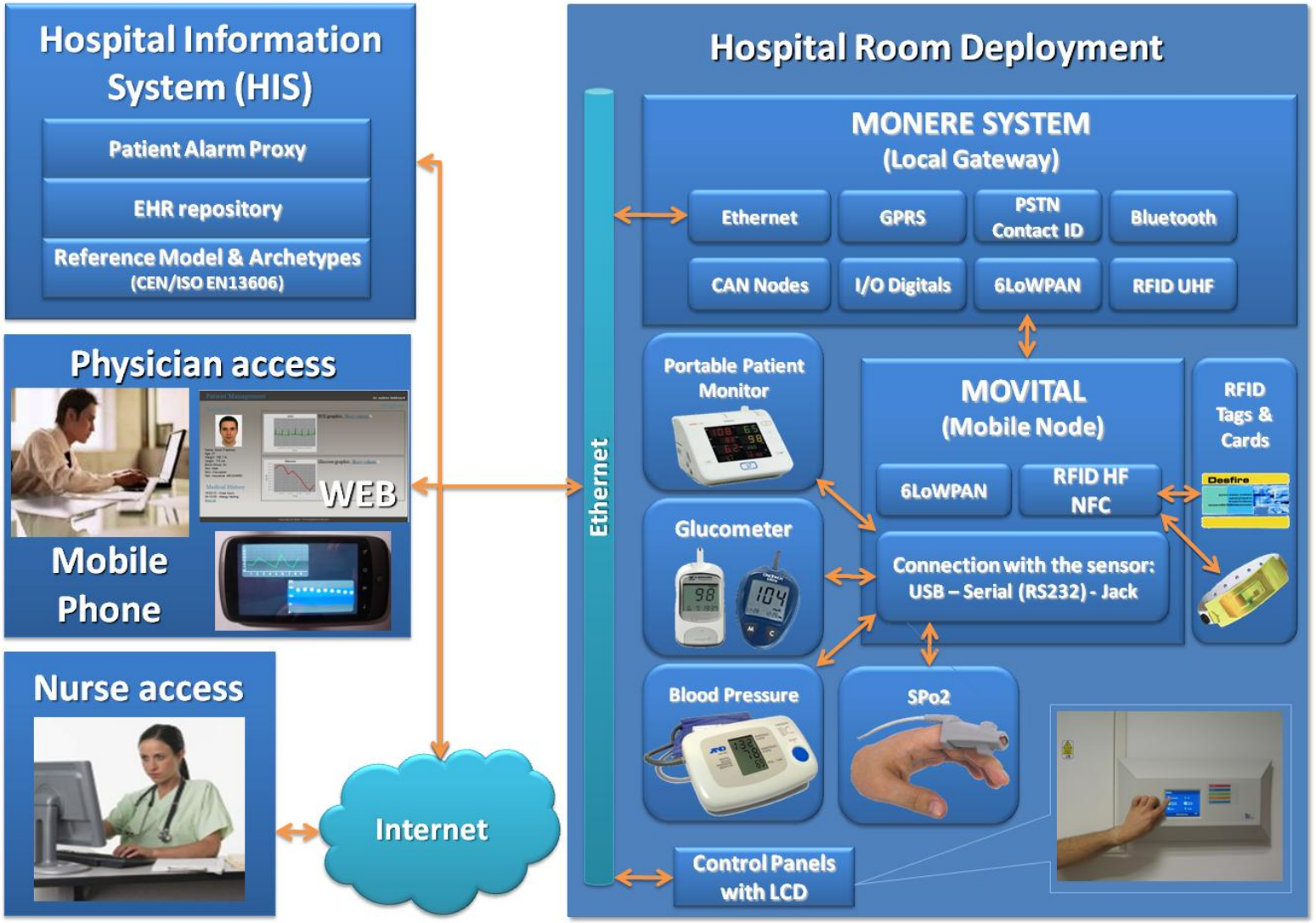
Smart Buildings
Domosec Architecture – Human Interface

- Visual and Layered design





eHealth: Internet of Things platform



A new world of data

Drawing made by primary class children for the Paradiso contest "the Internet of the future seen by the children of today"

Conclusion

- IoT are becoming a first class-object of the Internet
- Their integration in the real-world of users has a relevant potential for new applications and services
  - SmartCities as one of the key area as an umbrella for citizen services like Mobility, Transport. Etc
  - Smartphones as a sensor platform
- The availability of these sources of new data brings new opportunities to exploit it and define user centric services
- Still several challenges:
  - Security and Privacy
  - Discovery and naming
  - Heteregenous integration of legacy systems

References

- General
  - IoT Comic Book: http://www.alexandra.dk/uk/services/Publications/Documents/IOT_Comic_Book.pdf
  - IERC documents: http://www.internet-of-things-research.eu/documents.htm
  - IoT Council: http://www.theinternetofthings.eu/
  - IoT platforms: http://postscapes.com/internet-of-things-platforms
  - http://senseable.mit.edu/
- Videos
  - Internet of Things
  - http://www.youtube.com/watch?v=I5Rba7c6RwQ
  - http://www.youtube.com/playlist?list=PLD4B1B7AB8011CFB7 (EU)
  - Vint Cerf http://www.youtube.com/watch?v=ZYAJaOVuyxI
  - Smart buildings
  - http://www.youtube.com/watch?v=gCuPx9shWT0&feature=related
  - Smart Cities
  - https://www.youtube.com/watch?v=ncV2mrveIlM
  - http://www.youtube.com/watch?v=DnyINyyZvkg