BARCELONA SMART CITY

The vision, focus and projects of the City of Barcelona in the context of Smart Cities 2007-2015. How evolution creates new paradigms

Ajuntament de Barcelona

Major Cities of Europe Summit
Florence, 31th May 2016

Mariano Lamarca Lorente
Innovation & Smart Cities Department.
E-mail: mlamarca@bcn.cat; mariano@ieee.org

1. Vision

The city of people

Technology as an enabler for:

- ✓ *Urban mobility more efficient and sustainable*
- ✓ *Environmental sustainability*
- ✓ *Business-friendly and attracting capital*
- ✓ *Integration and social cohesion*
- ✓ *Communication and proximity with people*
- ✓ *Knowledge, creativity and innovation*
- ✓ *Transparency and democratic culture*
- ✓ *Universal access to culture, education and health care*

Improve citizens' welfare and quality of life

Economic progress

2. Reference framework: Global Strategic framework

Barcelona is facing big economic development opportunities related to mobility & Smart Cities

European Union

Strategy EU 2020

- Innovation union
- An industrial policy for the globalization era
- Schedule for new skills and tasks
- A Europe that use its resources efficiently
- Youth on the move
- A digital agenda for Europe
- European platform against poverty

Ajuntament de Barcelona

Strategic framework 2012-2016

Government Plan	City map
Management plans	40 strategic goals of management
Operational plans	Functional plans

ICT framework of reference in the Barcelona City Council MESSI Strategy (Mobility, E-Government, Smart City, Information Systems & Innovation)

MOBILE WORLD CAPITAL BARCELONA

CIDEU

OpenData BCN

CITY PROTOCOL

smartcity barcelona

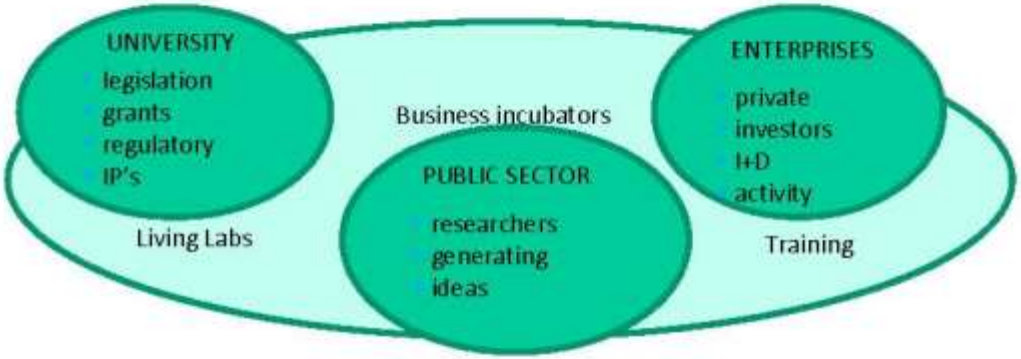
smart city expo

Private sector collaboration program

3. Smart city campus, clúster smart cities and Urban Lab

Barcelona seeks PPP's promotion for the provision of services and the smart management of the urban habitat.

1) Barcelona created **the Smart City Campus**, located in the 22@ innovation district. In order to further strengthen the strategy of the city, urban innovation, Barcelona wants to offer the city a storefront for companies to develop and test pilot.



2) The **cluster of smart cities**, that will be developed around Smart City Campus, wants to work and to agglutinate diverse sectors like ICT, energy, mobility... for the creation of an ecosystem that integrates not only companies (multinationals and SMEs), but also to institutions, research centres, technology transfer centers, and universities and the academic sector.

3) The goals of the **Urban Lab** are to use the city as a laboratory to approach the new solutions to market municipal services, and also, that companies can use it as a space for testing, facilitating market access and promoting competitiveness and finally to test research lines from universities and research centers.

Private sector collaboration program

3. Agreements: Collaboration with research centres

Collaboration with the Catalan research centers for RDI projects in Europe to promote, together with the "Generalitat" of Catalonia, the creation of a **cluster of smart cities** to incorporate companies in Barcelona / Catalonia .

bdigital

CITCLOPS
Wat ERP

SENSORDROID
Urbiotic transfer

i2cat

BDIC BARCELONA DESIGN INNOVATION CLUSTER

BCD Barcelona Centre de Disseny

Initiative
DIPOLIS

Microgrids and electric vehicle
Lighting
Building (NZEB) and industry

IREC

MOBILE WORLD LAB

CTTC

Private sector collaboration program

3. International Collaboration

Horizon2020 and European projects

- ***European Projects***
  - FIREBALL
  - OPENCITIES
  - iCity
  - Commons4EU
  - CitySDK
  - Growsmarter
  - Open-DAI
  - EUNOIA
  - Arrowhead
  - BESOS
  - D4Cities
  - …

- ***Working with the most advanced cities in the world***
  - METROPOLIS
  - CIDEU
  - Red Española de Ciudades Inteligentes
  - UCLG
  - EUROCITIES
  - Covenant of Mayors
  - World eGovernment Organization
  - Major Cities of Europe

Private sector collaboration program

4.- Urban Lab & H2020 Strategy: IOT Related Initiatives

100% Pilot WIFI Outdoor

100% FEIL: WIFI Via Publica

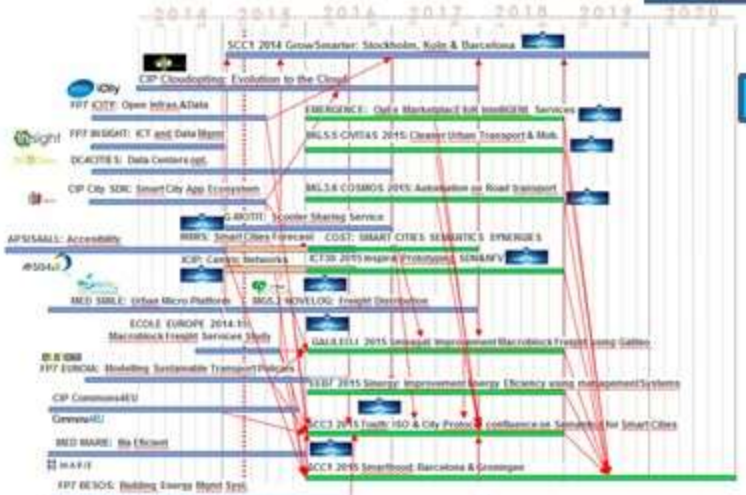
Indra Tradia

100% FEOSL: Smart Cities

libelium ARELSA urbiótica zolertia

100% 22 Urban Lab

world sensing



100% infoRegió de Catalunya

UPC aventia i2cat CISCO

95% EC Projects: Open Cities, iCity, Growsmarter

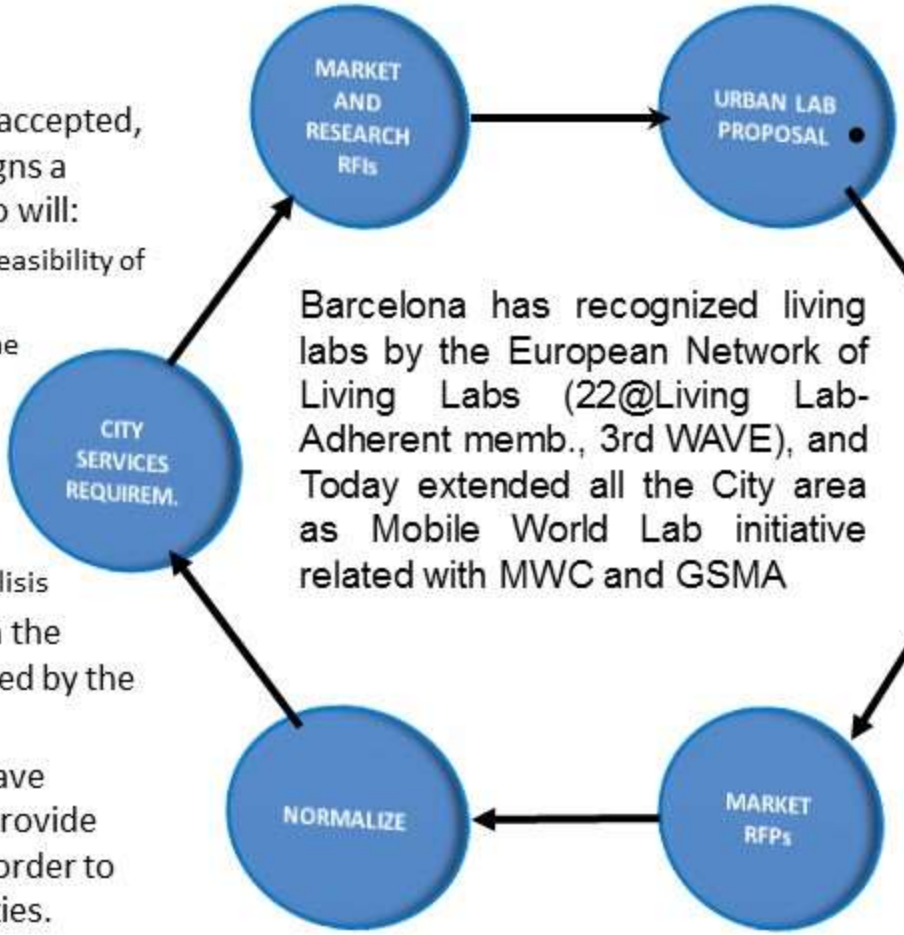
Mobile World Lab

2007 2009 2011 2013 2015 2017

Private sector collaboration program

4. Urban lab: How Works and City Objectives

- How works:
  - Once the proposal is accepted, the municipality assigns a project manager, who will:
    - ✓ Study and agree on the feasibility of the proposed project.
    - ✓ Facilitate the access to the infrastructures
    - ✓ Negotiate with local contractors installation and maintenance for proposed living lab.
    - ✓ Participate in results analisis
  - Costs associated with the project are not covered by the municipality.
  - However, if project have interest for BCN we provide funding programs in order to collaborate with entities.



Barcelona has recognized living labs by the European Network of Living Labs (22@Living Lab- Adherent memb., 3rd WAVE), and Today extended all the City area as Mobile World Lab initiative related with MWC and GSMA

Benefits

- Involvement of city-knowledge in the development of new products and research actions.
- Possibility of generating patents on state-of-the-art products already tested in a city.
- Creation of economical activity based in these actions

Private sector collaboration program

4. Urban lab: the city as a lab

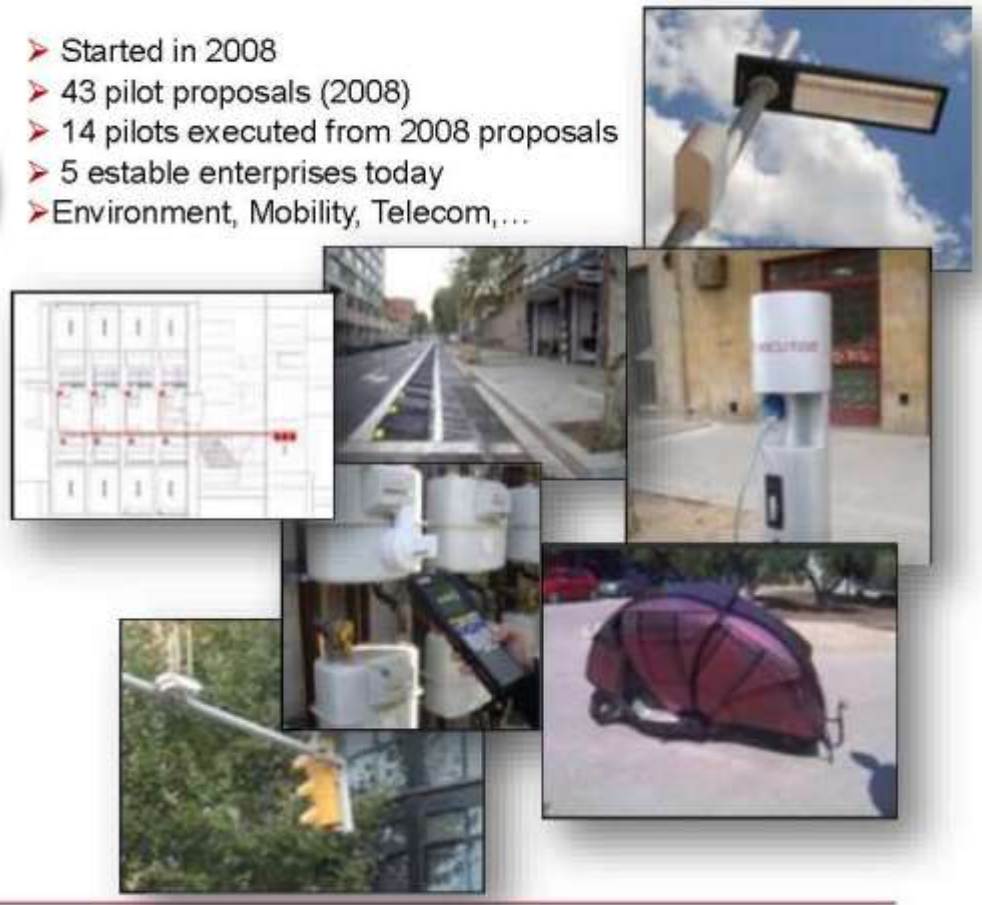
Local pilots for a global market

Some pilot projects:

- Lighting street poles -Eco Digital- with LED technology
- Electric vehicle charging points
- Electric solar-energy powered bikes
- Traffic control cameras
- Smart measurement of electricity and water
- FTTH
- Bike lanes
- Public parking sensors
- Noise sensors

Key information:

- Started in 2008
- 43 pilot proposals (2008)
- 14 pilots executed from 2008 proposals
- 5 estable enterprises today
- Environment, Mobility, Telecom,…



4. Urban lab: an Example→ Worldsensing (2010)

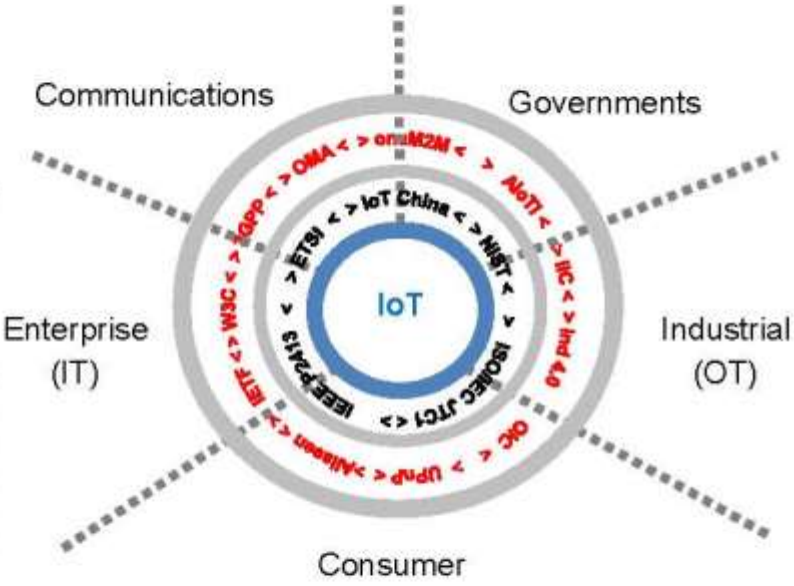
Today thousands of sensors installed worldwide

Private sector collaboration program

4.-Standardization Efforts of BCN City Council

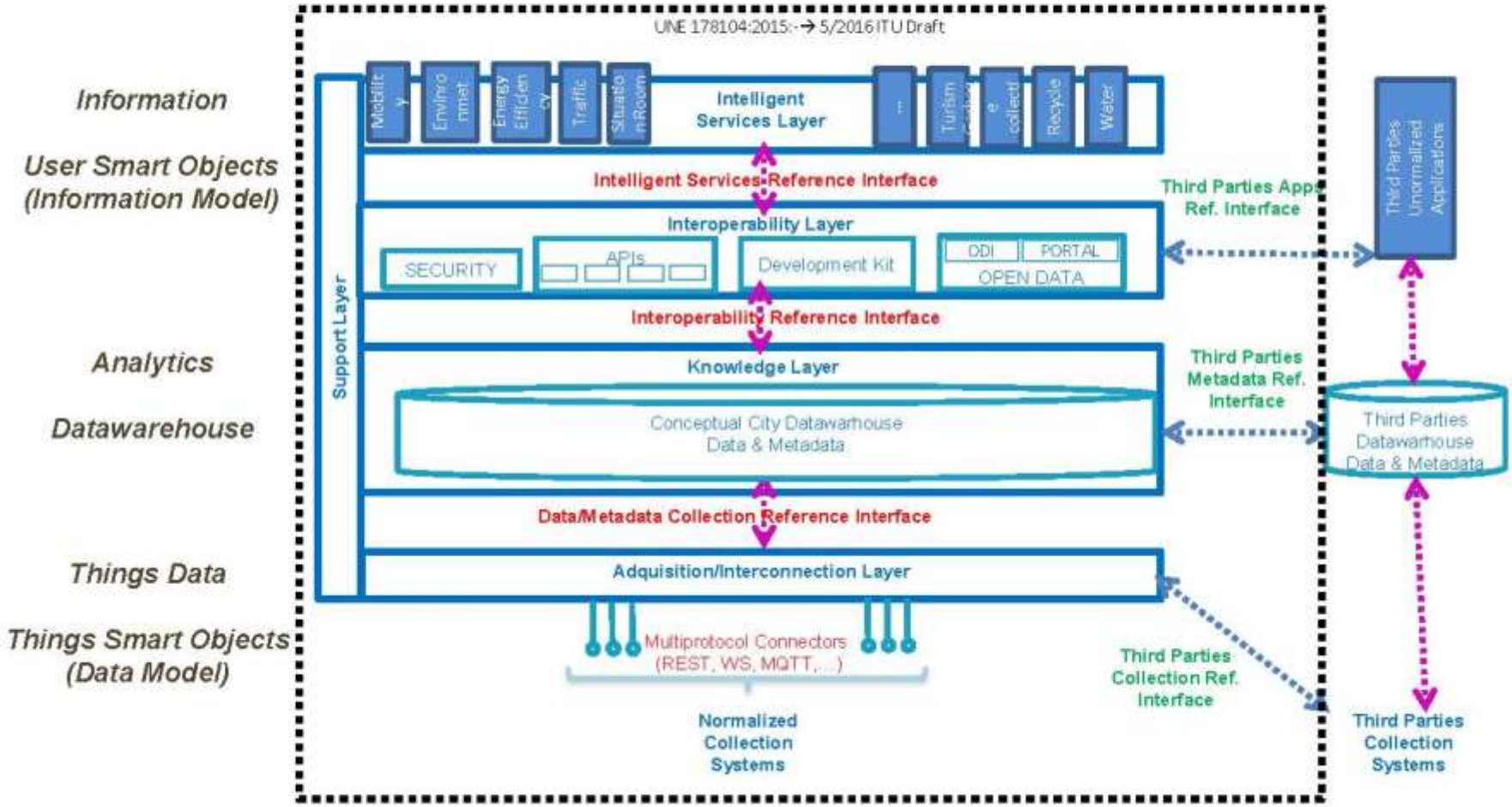
Standards Environment – I
Relation with IoT Efforts: ISO, IEEE, ITU-T, NIST,…

- Standards harmonization will even become very difficult if not impossible.
- *A single IoT Standard is not achievable due to legacy confluence.*
- Formal Standards from different bodies in all 5 Sectors are creating End to End IoT Architecture Frameworks to address the connection of Things to specific users sector.
  - ***Industrial: ISO-IEC-JTC1-WG10 and IEEE P2413***
  - ***Communications: 3GPP and 5G***
  - ***Government: ITU-T SG20 and NIST-CPS***



Smart Cities perspective is more advanced in City Protocol Society, ITU-T SG20 and ISO TC268 “Sustainable Communities”

Standards Environment – II
Relation with ITC Efforts: ITU-T SG20 and AENOR CTN 178



4.-Targets of Smart City Pilots for Barcelona

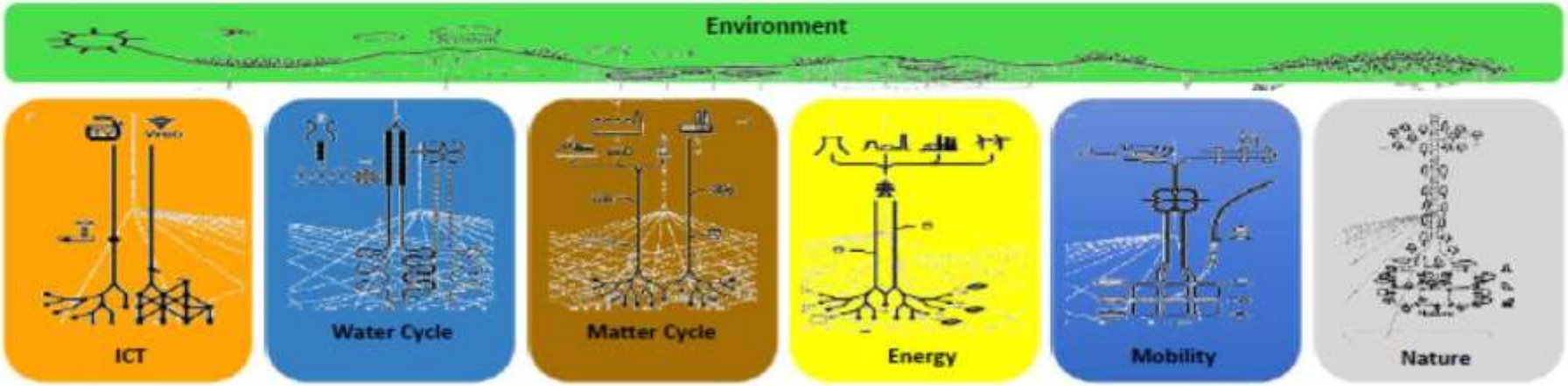
Create a **NORMALIZED Framework based in Standards at all levels** which permits an ordered masive construction of devices (transducers, sensors, actuators,...) in the streets and associate applications:

1. **Construction** Model: Powering & Housing
2. **Network** Model for Access & Transport
3. **Data Warehouse** Model
4. **User Access** Model based on **Open Data and other estandardized metodologies.**

Summary

Barcelona Local Program → Building Ideas

Conceptual model: anatomy of a Smart City



House / Building / Street / Neighbourhood / District

Social Impact / Citizens

Education | Health | Business | Culture | Security | Tourism | Sports | Gov

Monitoring

Plataform

Network

Government and citizenry (O-government)

5.- Barcelona Project – Macroblocks – Building Ideas

CONCEPT

The superblocks are defined theoretically as an "area of urban organization, from which a series of structured transformation strategies towards a new urban model, where mobility and reorganization of public space represent the first step".

Inside the macroblocks the traffic and the environmental pollution (noise and gas) are reduced.

POSSIBLE USE CASES

- Microdistribution system
- Buildings refurbishment
- Smart lighting
- Mobility services: Location & forecasting
- Sensors
- Improve air quality and reduce noise.
- Services for disabled people
- Taxi base services.

5.- Example Services on Macroblocks: "Puzzle Model"

USE CASE Microdistribution Macroblock Area[1]:

- Service 1: Electric vehicles for distribution[2]
- Service 2: Electrical charging points[3]
- Service 3: Parking zone to store packets
- Service 4: WIFI
- Service 5: Vehicle Location by WIFI

USE CASE Traffic Forecast Inside Macroblock[1]:

- Service 12: Bus Location Service
- Service 23: Taxi Location Service
- Service 5: Vehicle Location by WIFI
- Service 8: Vehicle location by IMEI
- Service 44: Correlation and Eliminate Repetition
- Service 29: Locate vehicles through cameras

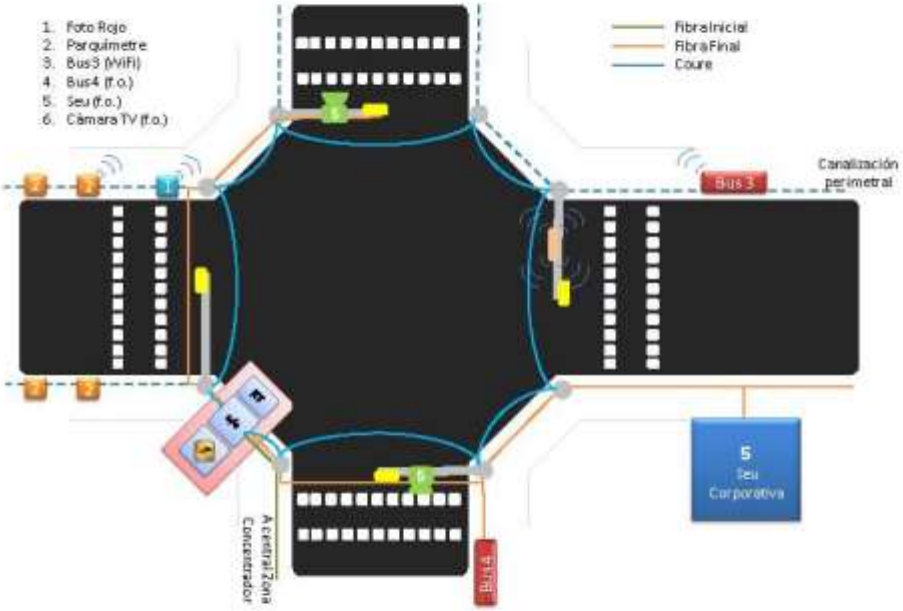
[1] Each city can decide which elements want to implement in its use case.

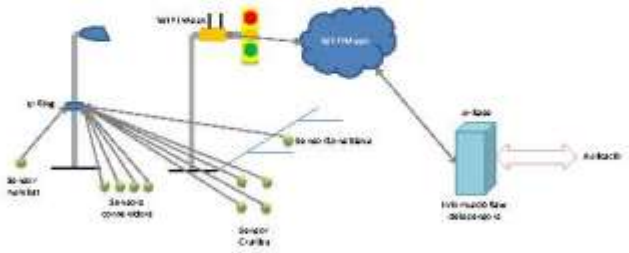
[2] It doesn't matter if one city uses small electric cars, bicycles, motorbikes for the distribution service.

[3] Each city can put a different model of charging point. The important thing is the service that it provides to the electrical vehicles and maybe the functionality to monitor its behavior.

6.- ICT Evolution: New Telecom Network

Optical & Wireless integration to enlarge capillarity
Barcelona City Council as own ICT Operator





GOAL

Maximum coverage to allow IoT and sensorization of City Services

6. ICT Evolution: Antecedents of Barcelona Local Program

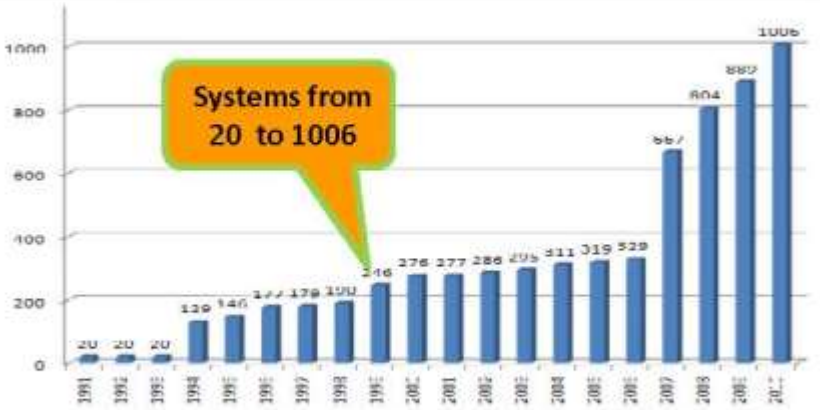
City Council in its Strategic Plans have identified several facts in ICT Applications Evolution in the City:

- Increase on new Telecommunications Services Demand,
- Increase of migration between fixed and mobile applications,
- Increase of Mobile Applications costs and need of guidelines on QoS,
- Availability and Security for new Telecommunications Services.

PROJECT	TARGET
Wi-Fi Outdoor	*Deploying a Wi-Fi / WIMAX Mesh network and enabling corporate services on the street for: police & firemen brigades, inspectors, sensors, etc., including Added Value Services for City Hall with higher bandwidth and availability*
Wi-Fi Indoor	*Enabling corporate users to seamlessly log in over wired/wireless corporate network WI-FI infrastructure available in corporate buildings interconnected over the municipal fibre optic network.*
Barcelona WIFI	*Bringing the Information Highway closer to the citizens and making a new way to provide on-line City Hall e-services.*

Today, all these wireless projects are fully integrated in our corporative network as a complement of fiber network and its are the main ICT basis for Smart City deployments.

However, another nightmare was detected for us:



What are our problems?: We need a Clear ICT Strategy Data

Machine to Machine World

Citizen Users

3rd: How provide the information to heteregeoneous users

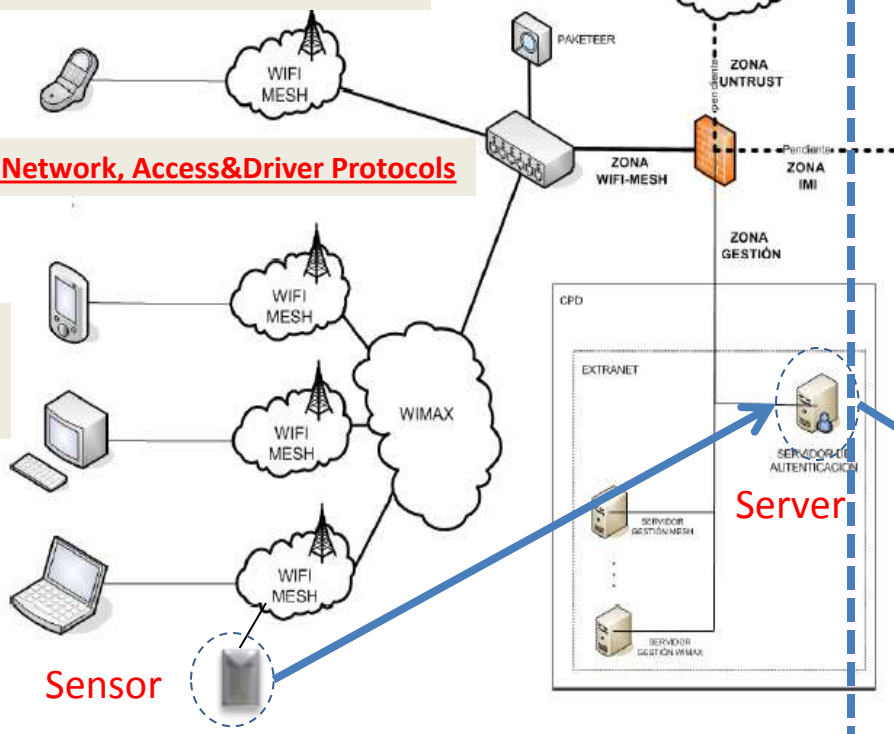
Corporative Users

User Access Platform

5th: Intelligence, Security, Privacy, Big Data, NFV, SDN, Where?

2nd: Nightmare of Network, Access&Driver Protocols

6th: How integrate our legacy systems?



Trusted third Parties Datawarehouse

City Council Datawarehouse

7th: How integrate our TTP? And others Third Parties?

4th: Client – Server Architecture, Who is the client? Who is the server? Where is the Cloud?

1st: Sensor Application Vertical Problem

8th: How Have We to Build It?: IoT?

6.-Some Concepts about IoT/M2M - I: Reality vs Hype

- **Internet of Things (IoT)**

is a self-configuring and adaptive system consisting on transducers (sensors and actuators) and smart objects whose purpose is to interconnect "all" things.

- **Machine to Machine (M2M)** represents the communication between"things"

- IoT will merge with other tecnologies: mixed reality, big data, data analítics,... to create the beginnings of a new concept of services.

- With the vast amount of data and available tools to extract actionable insights from it, data has become a critical issue.

As a consequence, we will to make independent data from services and things.

6.-Some Concepts about IoT/M2M - II: Reality vs Hype

- New Radio technologies that enable the Internet of Things (i.e.LPWA).
- First generation of IoT/M2M standards is mature to enable large-scale operational deployments.

- IoT offers new services that bridge physical and virtual worlds. However, imagine how you explain to a person from final last century these issue:
  - "I could access the entire knowledge through my phone but I use it to look at pictures and chat with strangers".

- This is our relationship to technology & data today. Most of applications are thought as silos.Technology is evolving so fast but we have still the same users.

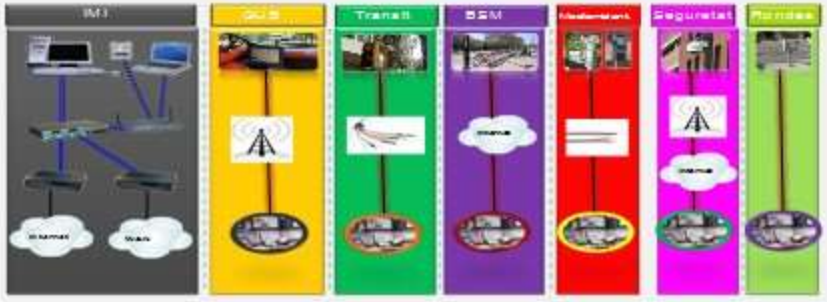
- IoT alone is not the solution, is only a part. We have to think global, we have to broke silos architecture.

7.-ICT Evolution: We need a New Public Space Management Model

From Nightmare...

Resources Vertical Management

Today: Vertical Aplications

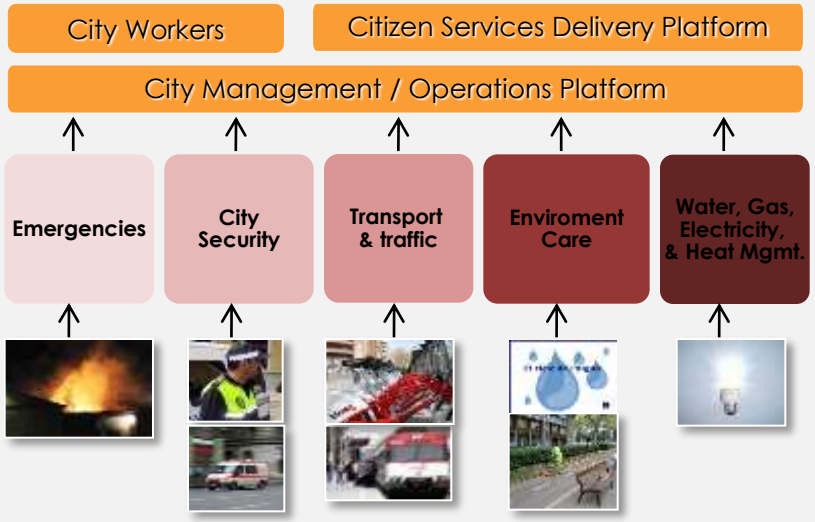


... To Paradise

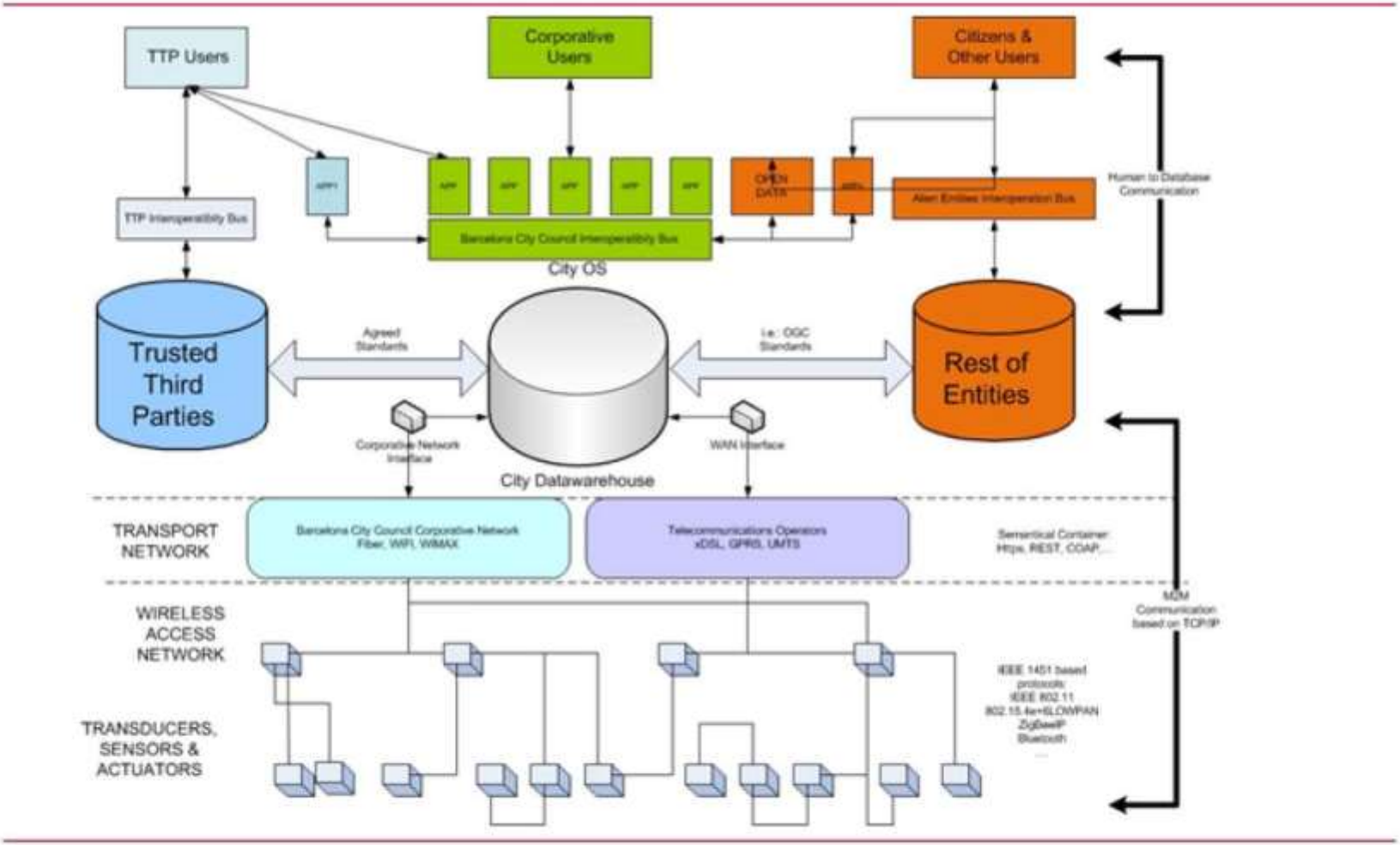
Dinamic Management of Services

Bidireccional Relationship between citizens and Administration

Common Data Warehousing & Use of Open Data



7.- Evolution: New Public Space Management Model (Concept)



10.- Example 1: Trash containers sensors (2010-Today)

Stores and business

- 12.000 RFID tagged containers
- For stores and offices trash collection
- Data protection standards (ENECSTI) compliant
- Future service "Pay as you through"

Citizens trash containers

- 27.000 RFID tagged (end of 2010) trash containers
- Amount of rubbish per day and container
- Geocoded information
- Cleaning trash-containers control

Pilot

- Ultrasonic sensors to provide load information for each trash container
- Smell sensors
- Future service of collection routes optimization

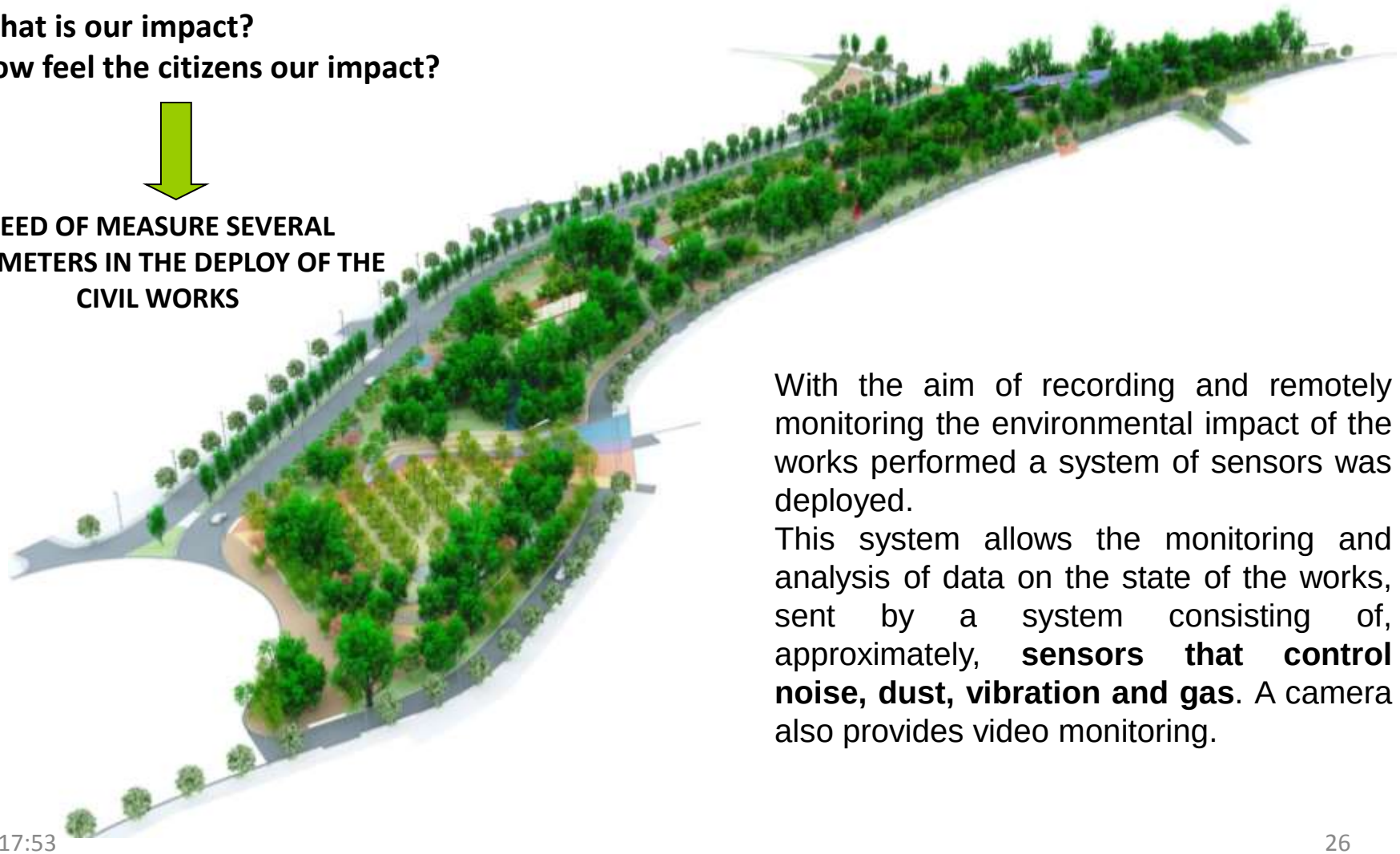
10.- Example 2: Civil Works Control & Monitoring:

Estatut Avenue (2011-2013), Glories Square (2014-Today),…

Good Practices in order to minimize ambient impact of civil works

What is our impact?
How feel the citizens our impact?

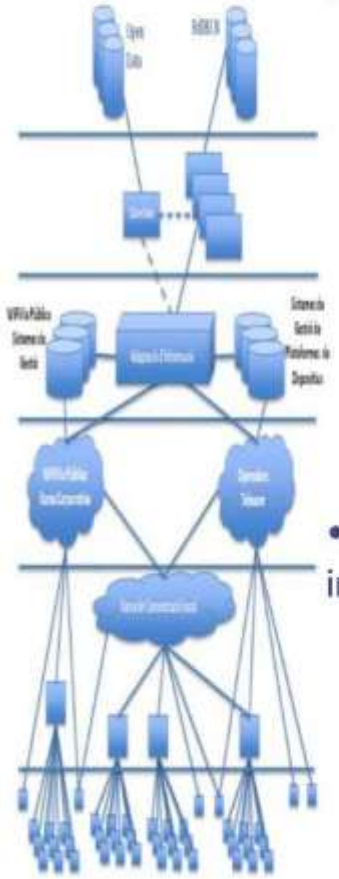
NEED OF MEASURE SEVERAL PARAMETERS IN THE DEPLOY OF THE CIVIL WORKS



With the aim of recording and remotely monitoring the environmental impact of the works performed a system of sensors was deployed.

This system allows the monitoring and analysis of data on the state of the works, sent by a system consisting of, approximately, **sensors that control noise, dust, vibration and gas**. A camera also provides video monitoring.

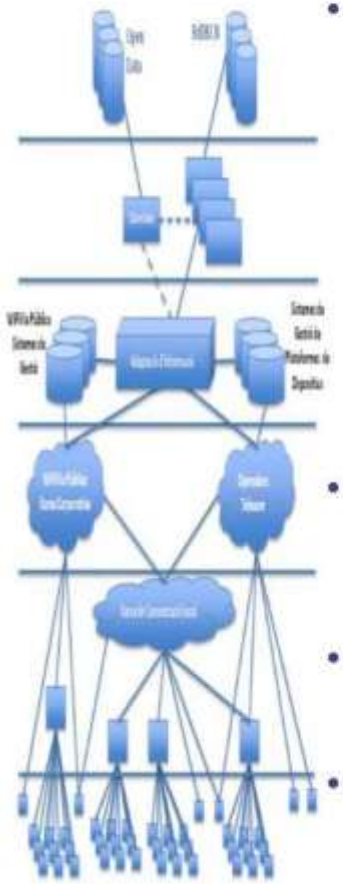
8.- A Openminded but Structured Vision-I



- First, It's necessary a clear internal organization at roles definition:
  - City Council Technical Users (Police, Fighfigter, Inspectors,..) define QoS:
    - physical parameters will be measured,
    - kind of devices will be used for a specific service,
    - how install these devices in the street
    - and how is the user interface
  - IT Department (IMI) define:
    - the adaptation layer in IoT Network to adapt data offered and actions permited to Dinamic User Interface desired by Users.
    - Intelligence, privacy, addressing and security issues (DHCP, wpa2, AES, VPN IPSec,...) and its location.

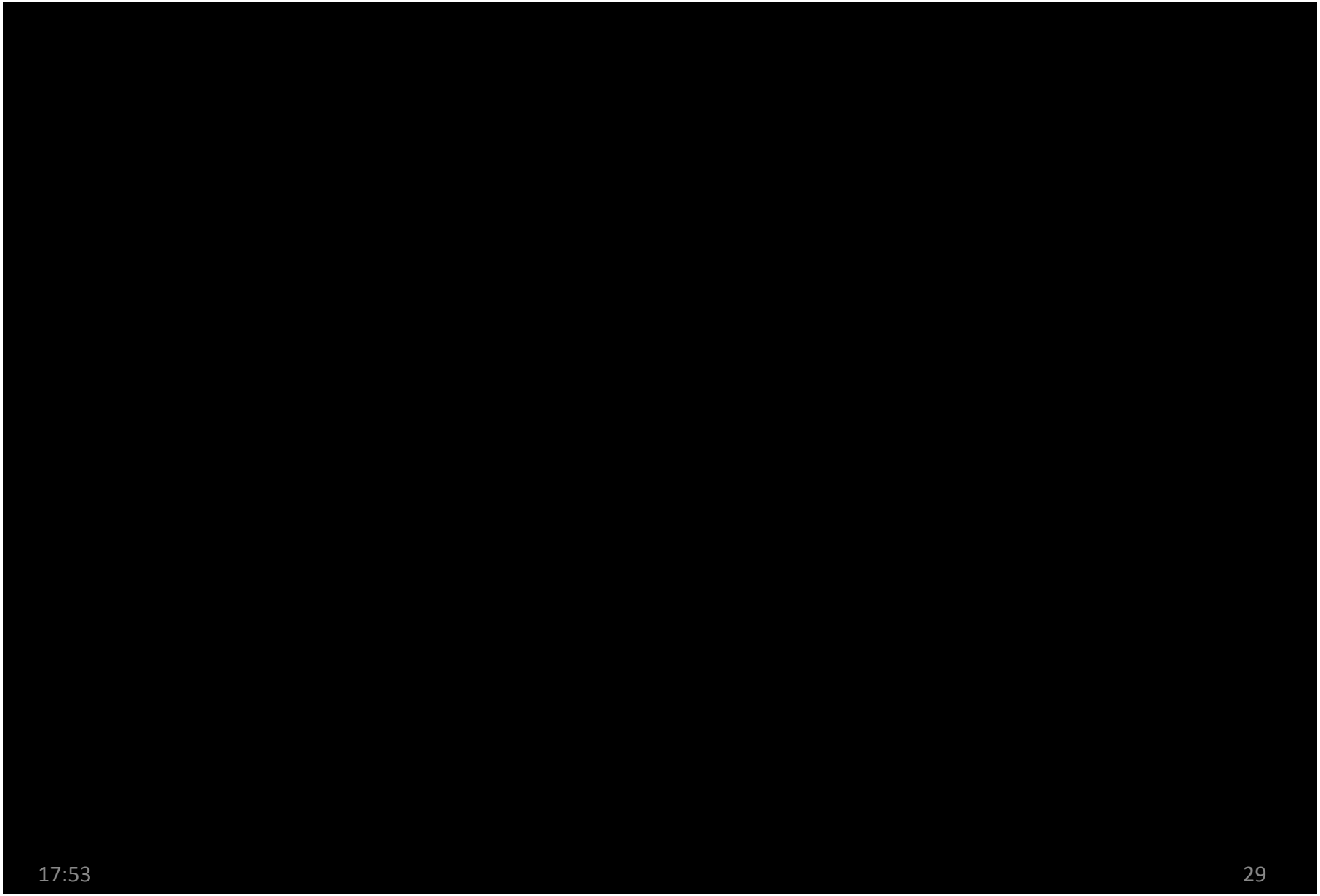
- Second, IMI has estabilised for RFP since 2013 key selections in order to normalize installation, access, transport network and datawarehouse:
  - Transport Network based in TCP/IP protocols over Telecom.Operator products.
  - Access Network which minimize latency and process working for each QoS defined. Ex.: WIFI, Bluetooth, ZigbeeIP SEP 2.0, 802.15.4e+ 6lowPAN,...
  - All the bateries will be based on lithium or similar enviroment impact.
  - All the elements will report position and will be controllable remotely.
  - Datawarehouse Access based on http+REST in M2M&applications segments.

8.- A Openminded but Structured Vision-II



- Third, Periodically we will evaluate if aproved standards could continue in the RFP processes. A commission evaluate the integration problems of new standards in terms of interoperability with existing elements and standards at the same level.
  - Define a normalized and flexible stack of standards that permits to integrate hetereogeneous sensor projects
  - **Standardization is the key requirement for communicating, comparing and combining information from different sensors.**
- **Fourth, All elements interact with Datawarehouse, never interact with users. Users applications interact with Datawarehouse.**
- Fifth, The aesthetic integration is an open question but we start to solve it.
- Sixth, IMI has started studies to acomplish for Smart Metering Aplications EU regulations and other market protocols (Lonmark,...) and to regulate all the elements semantically unregulated.

10.- Example 3: City OS Concept and New Paradigms



9.- Go On: From Basis to Complexity-I

New Public Space Management Model will be useful for most of Today Implemented Services. However, new services requires an improvement:

A.- We expect a big deployment of sensors and applications connected to Internet in next years.

B.- Only Deploy & Integrate Services has a good Business Case and/or a Social Benefit assumed by executive level.

C.- There are several questions solved for todays model, but for tomorrow model?

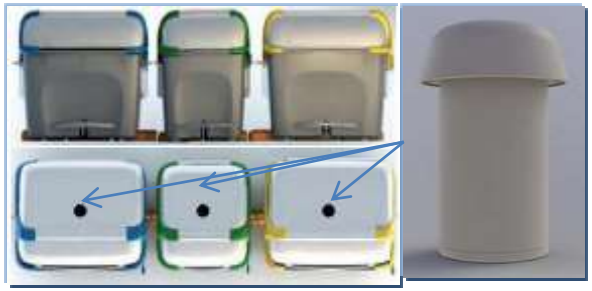
C.1.- How manage horizontal relationship

C.2.- Bussiness Intelligence and Big Data

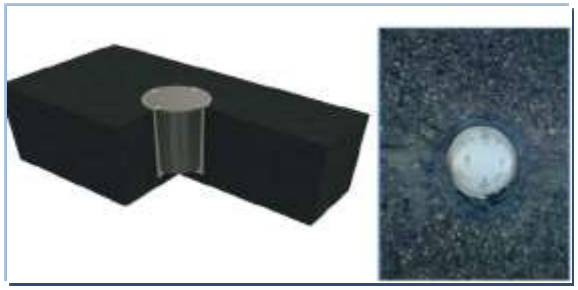
C.3.- Security, Privacy and Correlations

Barcelona Smart City projects

Containers



EM Earth Field



9.- Go On: From Basis to Complexity – II Horizontal Relationship

A.- In M2M Network the installation of a first set of sensors related with a specific service establish specific features. When you add new services who reuse your infrastructure the requirements associated to a specific device could change. Example: Temperature Sensor used for service 1 (ambient temperature) and service 44 (fire detection on containers).

B.- Transport Requirements could change if you use different telecommunications systems and/or operators. How bill it?

C.- Perhaps, applications functions could be distributed between common part and specific part. Examples: History and Math Modules

9.- Go On: From Basis to Complexity-III Business Intelligence and Big Data

A.- What Transmit? Data? Device Politics?

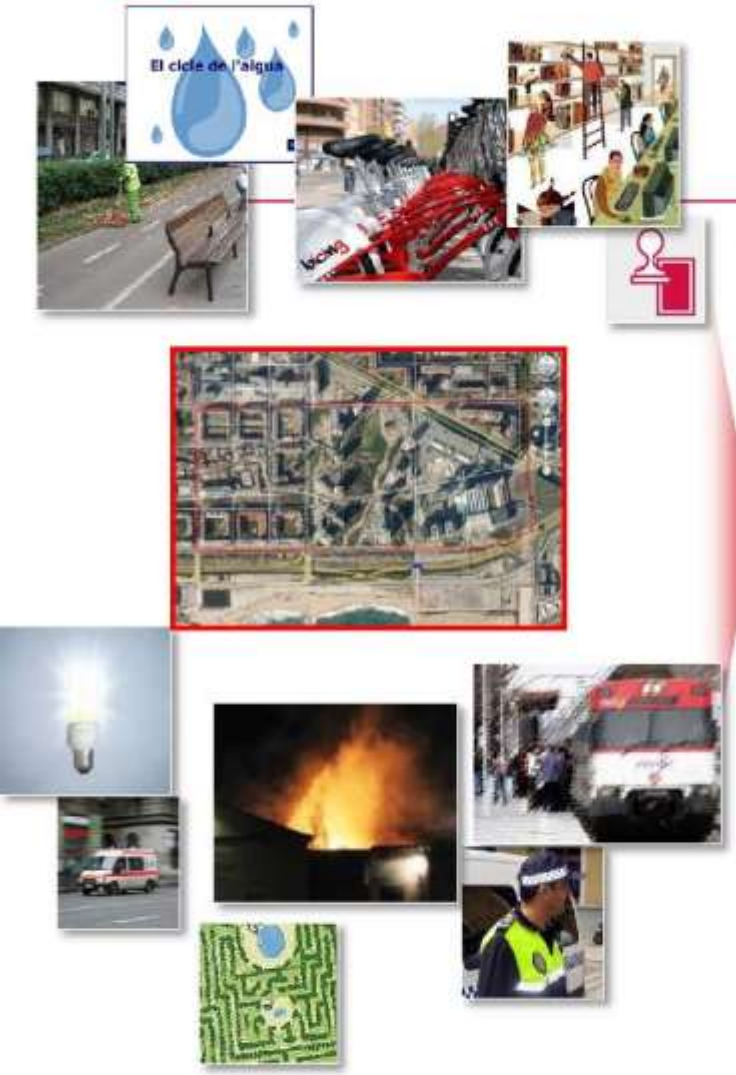
B.- We expect most of applications will have BI and Big Data Modules at Datawarehouse level and/or applications level.

C.- QoS requirements (mainly latency, security and privacy) can force to intall Big data modules and/or BI modules on field devices (mainly gateways on next future).

D.- Distributed Model versus centralized Model in Macroblocks Barcelona Model

E.- Trash Data Reuse

9.- Go On: From Basis to Complexity - IV Security and Privacy



A.-Our Security Concept is like a Onion or a Matryoshka

B.-First Level is the architecture-→M2M+DW+APPs

C.-2nd Level is the QoS definition of Services. Privacy is a part of this definition.

D.-3rd Level is Network QoS and Security Tools. In fact we have equivalent features than Operators.

E.- 4th Level is Standard Network Security Systems, mainly in APPs area.

F.- 5thLevel is Normalized M2M/IoT Network&Data Syst.

G.- 6th Level is Semantical Correlation

H.- Be Careful:

- Compromise Energy/Process/Data Content
- How secure are we? What cost?.
- Headen Privacy Issues

Security Issues: Key Topics – Next Big Bouble?

A question frequently asked by Boards after reading headline grabbing attacks is

"how secure are we?"

You have no way of answering it without first understanding your threat.

"What Threats?"

Security shouldn't be about marketing and sales. We will re-orient the discussion to how to architect defenses against the threats against your business.

You have to Understand what you can and cannot secure and at what cost.

What is cost?

9.- Go On: From Basis to Complexity - V
BE CAREFUL

A.- Update RFP process and service documentation.

B.- Diferenciate: internal/external customers and TTPs.

C.- Compromise Coverage/Energy/Intelligence

D.- Headen Privacy Issues

E.- Tecnology evolves fast and change Paradigms. M2M section needs incorporate time sensitive processes, security, privacy and Big Data.

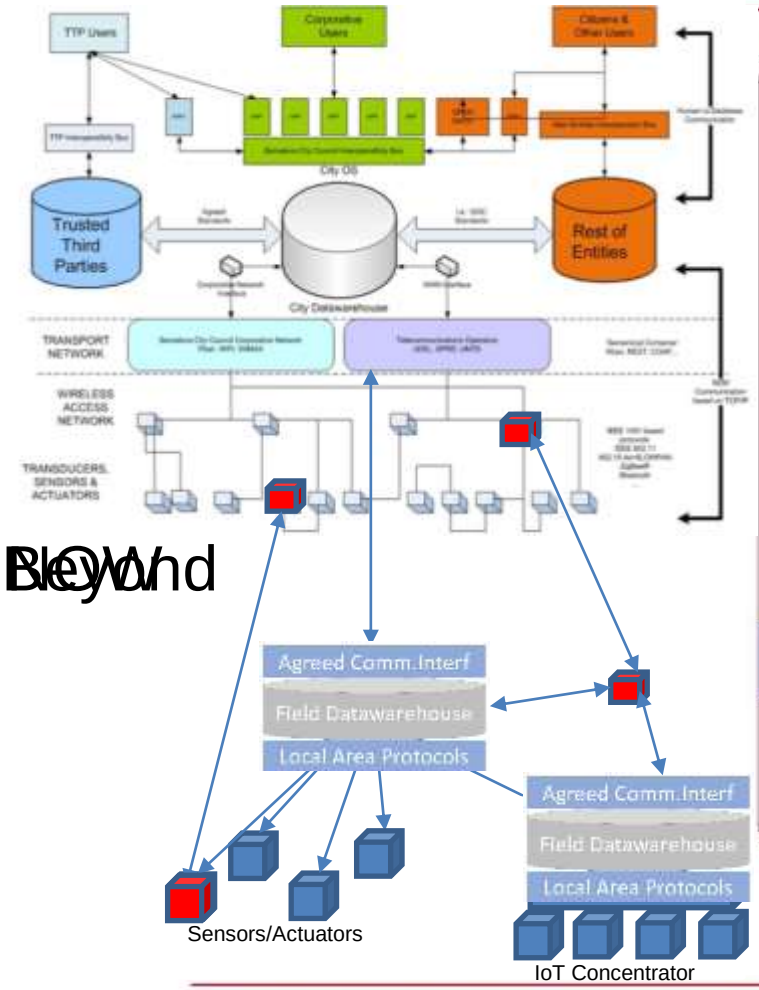
F.- IoT Systems are heterogeneous, large-scale, distributed and multi-vendor. Interoperability is key to keep cost low, reduce risk, spur innovation,...

G.- Interoperability in Semantical Levels: Data collected, Datawarehouse Southbound and Northbound, Application, Users and Tird Parties.

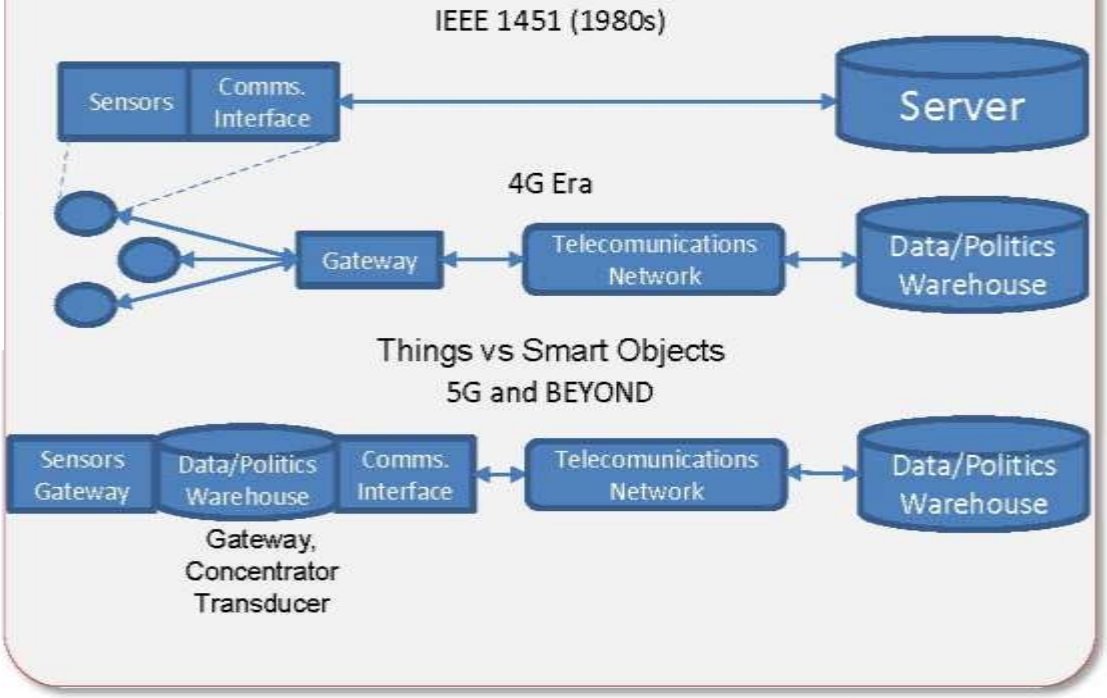
Ex: Chain supply – Suply Chain

H.- Compromise with Standardization at all levels

10.- Go On: From Basis to Complexity - VI
BE CAREFUL



Take a time to see evolution from IEEE 1451 to 5G and Beyond:



10.- Barcelona Desires

1.- Ease of Deployment:

- Ease installation in streetlights and utility poles,
- Different options of powering,
- Maximize remote operations (i.e. Reset),
- Provide autodiscovering option,
- Frequencies Flexibility, etc...

2.- Interoperability & Scalability:

- Ease to add capacity and expand coverage area,
- Integrate sensors of other vendors who follows standards aproved by Barcelona City Council (BCC),
- Integrate your devices over transport devices of other vendors who follows standards aproved by BCC,
- Ability to provide to Data Warehouse the data formats aproved by BCC (W3C/OGC),
- OpenData and Medata as a Service to Enterprises and Citizens, etc...

3.- Service & Suport:

- Supported by certified Local companies with a strong customer service ethic able to work productively in collaboration with the real customer and the vendor.

4.- Normalization: To have Normalized Standards at all levels

5.- PPP: Support Enterprises, Start-Ups, Researchers and Universities in projects can improve the organization of the City (Smart Cities Projects)

10.- Some Philosophy: We perform Smart Cities. Is it New?

- We detect a great number of services with possibilities of improvement if we use TIC in the process.
  - Some people says: We start the Smart City! We are the first Smart team in our City! Really, the idea would be good, BUT...
  - We have defined a model for TIC, IoT and Smart Cities. However, some others departments created services with a similar solution without contact with our team.
  - It's Magic! Or first may be we have to listen the world! First TOOL: LISTEN
  - LISTEN? WHO?→ Your team, the users, other cities, other industries (IIoT is no new),...
  - That is not new, two examples: Ildefons Cerda defines 150 years ago the urbanistic structure of actual Barcelona (Ensanche), and the romans create the first sewerage.
  - In fact, Smart Cities it's only a Marketing useful concept. In all the cities, you can find several teams working in improve city process.

4.-International Recognitions

Bloomberg Philanthropies

1st Mayors Challenge 2013-14

"Vincles BCN"

Co.EXIST

Top 10 Europe smart 2012:

1. Copenhagen
2. Stockholm

...

7. London
8. **Barcelona**

...

IDC Analyze the Future

Certification "Biosphere World Class Destination"

Barcelona iCapital 2014 - 2016

iCapital Capital of Innovation

24/01/2014

European Comission

Introducing the use of new technologies to bring the city closer to citizens

BIOSPHERE RESPONSIBLE TOURISM

Turisme Responsible UNESCO

Thank you!!

Barcelona is orienting its city evolution strategy towards to guarantee quality of life for its citizenry, social and urban improvement and added value in its neighbourhoods, fostering all its urban potential towards sustainable development and green economy, in favour of an energetically self-sufficient city and where

“Many slow cities inside a smart city”

Barcelona is orienting its city evolution strategy towards to guarantee quality of life for its citizenry, social and urban improvement and added value in its neighbourhoods, fostering all its urban potential towards sustainable development and green economy, in favour of an energetically self-sufficient city and where nature holds a prominent role for the balance of the city. A connected city with a high-speed interconnected Metropolitan Area.

Ajuntament de Barcelona

www.bcn.cat

Mariano Lamarca i Lorente
Innovation & Smart Cities Department.
E-mail: mlamarca@bcn.cat; mariano@ieee.org