Towards Ambient Assisted Cities

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Abstract

• This talk will give an overview of the progress achieved and actions undertaken by the MORElab research group, belonging to University of Deusto in Bilbao, SPAIN, in the area of Future Internet and Ambient Intelligence. Over the last 8 years this research group has been working in the areas of Ambient Intelligence, Ambient Assisted Living, Linked Data, Social Media Analysis and Internet of Things. A summary of the most relevant research projects and results developed by the group will be given. A total of 8 PhD theses and the participation in more than 20 projects have taken place in this period. After an overall overview the talk will focus on highlighting the concept of Ambient Assisted Cities, i.e. cities which are more accessible, inclusive and participative. The different contributions carried out by MORElab in this area will be highlighted and the research challenges to be addressed in order to fully encompass this vision will be identified.
University of Deusto
University of Deusto

- 997 staff
- > 12 K students (15% international)
- 125 anniversary in 2012
- 2 campus: Bilbao & San Sebastian
DeustoTech – Deusto Institute of Technology

• Associated to Faculty of Engineering, it belongs to Fundación Deusto
• 150 people divided in 7 research units
  – We represent DeustoTech-INTERNET, a.k.a. MORElab – envisioning future internet research group
    • http://www.morelab.deusto.es
DeustoTech-INTERNET

• Motto: “User-centred Intelligent Services for Anything, Anywhere at Anytime”

• Areas of research:
  – Context-aware Mobile Computing for Enhanced User-Environment Interaction
  – Semantic Middleware for Embedded Wirelessly-connected Devices
  – Smart Environments of Augmented Internet-connected Objects
  – Ambient Assisted Living (AAL): adaptive accessible interfaces and social robotics.
  – Future Internet: Internet of Services, Internet/Web of Things and Web of Data
DeustoTech-INTERNET Unit

• Principal researcher:
  – Dr. Diego López-de-Ipiña,
    http://paginaspersonales.deusto.es/dipina/

• It comprises
  (http://www.morelab.deusto.es/labman/people/members/unit/deustotech-internet/):
    – 4 lecturers (3 PhD holders)
    – 4 PostDoc
    – 4 Research Assistants
    – 2 Research Interns
    – 9 PhD grant holders

• 23 people
DeustoTech-INTERNET Performance

MORElab total incomes

MORElab incomes in 2014

Geographical scope

Europe
Spain
Europe
DeustoTech-INTERNET Performance

Breakdown for Europe in 2014

Breakdown for Spain in 2014

Breakdown for Euskadi in 2020
Active projects
(as of October 2014)

• European projects:
  1. Go-Lab: Global Online Science Labs for Inquiry Learning at School (FP7-ICT-2011-8, Nr. 317601, IP project)
  2. IES CITIES: Internet-Enabled Services for the Cities across Europe, FP7, Comisión Europea, CIP-ICT-PSP-2012-6, Pilot Type B - CIP-ICT-PSP-P
  3. SONOPA: SOcial Networks for Older adults to Promote an Active life (AAL-2012-5-187 and AAL-010000-2013-13), AAL call 5
  4. MOVESMART: Renewable Mobility Services in Smart Cities, FP7, European Commission, ICT-2013.6.6, Pr. 609026
  5. WeLive: A neW concept of pubLic administration based on citizen co-created mobile urban services, H2020-INSO-2014, 645845

• Spanish projects (mostly applied research)
  1. Migration towards the Cloud - mCLOUD, IPT-2011-1558-430000
  2. FRASEWARE - Mecanismos de Razonamiento Evolutivo y Personalizable con Gestión de Ambigüedad para Entornos Asistidos, TIN2013-47152-C3-3-R , Basic Research project

• Basque projects (mostly basic research)
  1. DYNUI: Capability and Context-aware Dynamic Adaptation of User Interfaces for Ambient Assisted Living (PC2012-73A)
  2. SUDMERK: Scalable User-generated Dataset Mining for Extracting Reliable Knowledge, S-PE13FD007
  3. SmarTUR: Tourism in Smart Intelligent Environments
  4. DEUSTEK3: Research group recognized by the Basque University system (IT745-13)
What do we actually do?

• Remote Labs & Internet-connected Objects:
  – GO-LAB – federation of remote labs to enable cross-organisation remote experiments
  – WebLab-Deusto – open platform to ease the deployment of remote labs

• Enabling Smart Assistive Environments:
  – SONOPA – activity-aware social networks to promote social interaction among elderlies
  – FRASEware – enhancing activity recognition by mixing knowledge- and data-driven approaches obtaining dynamic and personalized models
  – DYNUI – user interfaces adaptable to user context, capabilities and devices
What do we actually do?

• Social Data Mining & CrowdSourcing:
  – **SABESS** – extracting structured knowledge about emergencies from social networks
  – **MOVESMART** – enhancing routing algorithms for Electric Vehicles taking into account user generated data

• Linked Data Prosuming, Visualizations & Apps:
  – **IES Cities** – urban app ecosystems based on council and government open data where users prosume data
  – **WeLive** – enabling a holistic LinkedData-based Open Services platform to enable co-creation and open innovation of urban services for open government
  – **SmarTUR** – tourism related LinkedData Apps (LinkedQR)
  – **SUDMERK** – applying visualization to enhanced understanding of open datasets
What do we actually do?

• **Semantic Embedded Middleware:**
  – **SUDMERK** – coordination of distributed embedded objects through Triple Spaces
  – **Sustainable IoT** – persuasive interfaces and cooperation among smart connected objects to foster sustainability

• **Cloud Computing:**
  – **mCLOUD** – migration of enterprise applications to the Cloud

• **Mobile Computing for Enhanced User-Environment Interaction:**
  – **Q-Apps** - Quality-in-use assessment framework for mobile apps
  – **KONTATU** - Context-Aware Communication Means Recommendation
  – **LaguNFC** - Enabling access to the digital world to the elderly
IES Cities is the last iteration in a chain of inter-related projects promoting user-centric and user-supplied mobile services that exploit open data and user-supplied data. The technical components and achievements of several former European projects will be integrated to assemble an open Linked Data apps-enabling technological platform. Such platform will be deployed in different cities across Europe, allowing the citizens to produce and consume Internet-based services (apps) based on their own and external open data related to the cities. Something specially remarkable about IES Cities is that no project before has considered so much the extent of the impact that the users may have on improving the open data in which services are usually based. The user-centred approach is a must for the success of the project. The target groups of the project will be citizens, SMEs, ICT-developing companies and public administration. IES Cities will provide a user-centric urban apps enabling platform for users in four cities across Europe. Each city will initially test the functionalities of the platform with completely independent services.
Web of Data: MORElab Dataset

- All group related data is searchable, browse-able by humans and machines:
  - SPARQL endpoint MORElab labman: [http://apps.morelab.deusto.es/labman/sparql](http://apps.morelab.deusto.es/labman/sparql)

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<tr>
<th>journal_article</th>
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<th>abstract</th>
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<tr>
<td><a href="http://apps.morelab.deusto.es/labman/resource/publications/webtag-web-browsing-into-sensor-tags-over-nfc">http://apps.morelab.deusto.es/labman/resource/publications/webtag-web-browsing-into-sensor-tags-over-nfc</a></td>
<td>&quot;WebTag: Web Browsing into Sensor Tags over NFC&quot;</td>
<td>&quot;Information and Communication Technologies (ICTs) continue to overcome many of the challenges related to wireless sensor monitoring, such as for example the design of smarter embedded processors, the improvement of the network architectures, the development of efficient communication protocols or the maximization of the life cycle autonomy. This work tries to improve the communication link of the data transmission in wireless sensor monitoring. The upstream communication link is usually based on standard IP technologies, but the downstream side is often mediated with proprietary protocols used for the wireless link (like ZigBee, Bluetooth, RFID, etc.). This work presents a novel solution (WebTag) for a direct IP based access to a sensor tag over the Near Field Communication (NFC) technology for secure applications. WebTag allows a direct web access to the sensor tag by means of a standard web browser. It reads the sensor data, configures the sampling rate and implements IP based security policies. It is, definitely, a new step towards the evolution of the Internet of Things paradigm.&quot;</td>
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| [http://apps.morelab.deusto.es/labman/resource/publications/wuh-staircase-profile-printed-monopole-design](http://apps.morelab.deusto.es/labman/resource/publications/wuh-staircase-profile-printed-monopole-design) | "UWB Staircase-Profile Printed Monopole Design" | "In printed monopoles, the current distribution along the lower monopole sheet and upper groundplane edges can be made analogous to a transmission line distribution by an appropriate antenna feed design. Accordingly, the VSWR < 2 impedance bandwidth upper frequency limit can be estimated for staircase-profile printed 2-D ultrawideband (UWB) monopoles. Following this guideline, three tailored-bandwidth prototypes are designed, implemented and measured. They retain their length and width while multiplying their upper frequency (4.87, 8.7, and 15.15 GHz) by the number of monopole profile steps (1, 2, and 3). The deviation is found mainly below 13% in relation to the reference formula. The concept of angular range based on pattern stability factor (PSF) is introduced to compare the solid angle of UWB pattern stability operation when increasing the bandwidth. The angular range degradation versus impedance bandwidth improvement shows all the possible performance levels of the antennas. Thus, the design of UWB printed monopoles is approached from both points of view, i.e., impedance bandwidth and pattern stability."

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Converting to and Visualizing Open Data

- **euwomen**: visualization about women politician and voters in EU elections:
  - [http://apps.morelab.deusto.es/euwomen/](http://apps.morelab.deusto.es/euwomen/)

- **euro e-lecciones**, social data mining in Twitter to visualize trends for the last European elections
  - [http://apps.morelab.deusto.es/eu_elections](http://apps.morelab.deusto.es/eu_elections)

- **teseo**, conversion and visualization of the distribution by genre and topics of PhD dissertations in Spain. These data was extracted from site [https://www.educacion.gob.es/tseo/irGestionarConsulta.do](https://www.educacion.gob.es/tseo/irGestionarConsulta.do)
  - [http://apps.morelab.deusto.es/tseo](http://apps.morelab.deusto.es/tseo)

- **Dbpedia.eu**, we are maintainers of DBPedia in Basque language
  - [http://eu.dbpedia.org](http://eu.dbpedia.org)

- **intelldata**, bank transaction analysis in different streets and neighborhoods in Madrid and Barcelona
  - [http://apps.morelab.deusto.es/intellidata/](http://apps.morelab.deusto.es/intellidata/)
Converting to and Visualizing Open Data

Heatmap of waste generation in Biscay

This heatmap shows the generated waste mass by person and day for each municipality in Biscay, with a range of 0-2 kg per person and day.
Internet of Things: SmartVase
Internet of Things: EcoSoul-ed Things & Behaviour Change
Web of Things: OtsoPack Semantic Middleware

Triple Spaces solution for heterogeneous devices

https://code.google.com/p/otsopack//
Federating Labs for Remote Experimentation using the Web

Scalable, web-based and experiment-agnostic remote laboratory management system:

https://github.com/weblabdeusto/weblabdeusto/
SABESS: Social Data Mining for Emergy Detection

Crowdsourcing for verification and enhancement:
* Access emergency sufferers or witnesses
* Access to domain/geographic area experts

Reactive Social Media Crawler:
* Proactive detection
* Focused search

Social media entry enrichment:
* Linkage among entries
* Linkage with LOD resources

Social media entry filtering:
* Author reputation
* Social entry credibility
* Spam and rumour detection

Event centered social media clustering:
* Semantic analysis (NERC and SA)
* Spatio-temporal aggregation

Event clustering

Crowd Sourcing

Actionable Emergency Knowledge
PhDs defended in the group

1. “CONCERT: A new framework for contextual computing in tourism to support human mobility”, by Carlos Lamsfus, supervised by Diego López-de-Ipiña y Aukrène Alzua, 29/10/2010

2. “Middleware Framework for the Configuration and Personalisation of Ubiquitous Environments by the Final User” by Aitor Uribarren, supervised by Diego López-de-Ipiña and Rosa Iglesias, 01/07/2011

3. “The web as a suitable execution platform to precisely represent audio-visual contents and registering user interaction” by Pablo Garaizar, supervised by Dr. Diego López-de-Ipiña y Dr. Miguel Ángel Vadillo, 29/04/2013

4. “New protocols for the discovery and automatic composition of services in ad hoc mobile networks”, by Unai Aguilera, supervised by Dr. Diego López-de-Ipiña, 3/05/2013

5. “Transitive and Scalable Federation Model for Remote Laboratories” by Pablo Orduña Fernández, supervised by Dr. Javier García Zubia, 31/05/2013

6. “Plataforma web y metodología para el desarrollo de sistemas sensibles al contexto basada en la colaboración entre programadores y expertos en el dominio” by David Martín del Canto, supervised by Dr. Diego López-de-Ipiña y Dra. Aukrène Alzua, 7/6/2013

7. “Towards more Reliable and Efficient Intelligent Environments: Uncertainty, Vagueness and Reasoning Distribution” by Aitor Almeida Escondrillas, supervised by Dr. Diego López-de-Ipiña, 10/06/2013

8. “Semantic Tuple Spaces for Constrained Devices: a Web-compliant Vision ” by Aitor Gómez-Goiri, supervised by Dr. Diego López-de-Ipiña, 16/06/2014
Some Selected Publications


Some Selected Publications


Some Selected Publications

DeustoTech INTERNET + TELECOM units

<table>
<thead>
<tr>
<th>Title</th>
<th>Year</th>
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<tbody>
<tr>
<td>Visual Analysis of a Research Group's Performance thanks to Linked Open Data</td>
<td>2014</td>
<td>Conference paper</td>
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<tr>
<td>Oscar Peña, Jon Lázaro, Altor Almeida, Pablo Orduña, Unai Aguilera, Diego López-de-Ipiña</td>
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<tr>
<td>Towards federated interoperable bridges for sharing educational remote laboratories</td>
<td>2014</td>
<td>Journal article</td>
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<tr>
<td>Pablo Orduña, Philip H. Bailey, Kimberly DeLong, Diego López-de-Ipiña, Javier García-Zubia</td>
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<td>Towards a microRLMS approach for shared development of remote laboratories</td>
<td>2014</td>
<td>Conference paper</td>
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<td>Pablo Orduña, Luis Rodríguez-Gil, Ignacio Angulo, Olga Dziubenko, Unai Hernández-Jayo, Diego López-de-Ipiña, Javier García-Zubia</td>
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<td>To switch off the coffee-maker or not, that is the question to be energy efficient at work</td>
<td>2014</td>
<td>Conference paper</td>
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Other achievements

- 1 spin-off came up from the research group, [http://www.symplio.com/](http://www.symplio.com/)

- Open source contributions:
  - WebLabDeusto – [https://www.weblab.deusto.es/web/](https://www.weblab.deusto.es/web/)
  - labman_ud research group management system – [https://github.com/OscarPDR/labman_ud](https://github.com/OscarPDR/labman_ud)

- Open dataset released in CKAN about MORElab’s people, projects and publications:
  - [http://ckan.linkeddata.es/dataset/morelab](http://ckan.linkeddata.es/dataset/morelab)
  - Our datasets are scheduled to appear in next [http://lod-cloud.net/](http://lod-cloud.net/)

- MORElab researcher Pablo Orduña was nominated MIT’s TR35 SPAIN in 2012
Activities Organized @ MORElab

• Bilbao Sustainability Jam, 22-24 November 2013
  – http://susjam.morelab.deusto.es/

• Open Hack Day 2013:
  – http://dev.morelab.deusto.es/hackathon/index.php/P%C3%A1gina_principal#Resultados

• Random Hacks for Kindness @Bilbao

• AppCircus in Bilbao

• Apps4BetterWorld
Towards Ambient Assisted Cities
Society Urbanisation

- Urban populations will grow by an estimated 2.3 billion over the next 40 years, and as much as 70% of the world’s population will live in cities by 2050

[World Urbanization Prospects, United Nations, 2011]
The Society is Aging

- Dramatic shift in demographics
  - By 2050 the number of people over the age of 60 is expected to triple, and will outnumber children under 15 for the first time in human history [World Population Ageing 2013 (Report), UN]
What is a Smart City?

• A means of making available all the services and applications enabled by ICT to citizens, companies and authorities that are part of a city’s system
  – It aims to increase ALL citizens’ quality of life and improve the efficiency and quality of the services provided by governing entities and businesses
What is an Ambient Assisted City?

- A city aware of the special needs of ALL its citizens, particularly those with disabilities or about to lose their autonomy:
  - Elderly people
    - The "Young Old" 65-74
    - The "Old" 75-84
    - The "Oldest-Old" 85+
  - People with disabilities
    - Physical
    - Sensory (visual, hearing)
    - Intellectual
Age-friendly Smarter Cities

• The main attribute of a **Smart City** is **efficiency**
• An **Age-friendly city** is an inclusive and accessible urban environment that promotes active ageing
• The **main attributes of an Ambient Assisted (Smarter) City** are:
  – Livable
  – Accessible
  – Healthy
  – Inclusive
  – Participative

[WHO Global Network of Age-friendly Cities]
Accessible & Inclusive Cities

• According to the World Health Organization, **people with disabilities make up about 15% (about 1 billion people) of the world’s population**

• Many cities have been investing on becoming **more accessible**, i.e. enabling the mobility and access to services to any person
  - Many **public spaces have been transformed and instrumented**:
    • Pedestrian ways’ barriers have been eliminated
    • Traffic lights use sound
    • Networks of sensors have been spread throughout the cities

• On the other hand **Urban Poverty** is a phenomenon in many emerging countries’ cities.

• **How do we truly progress towards smarter fully inclusive cities?**
  - We need to adapt not only the infrastructure but the services offered
Our work eliminating barriers: Accessibility in Public Spaces

• **BlindShopping**: Enabling Accessible Shopping for Visually Impaired People through Mobile Technologies
  – How to translate this to the Smart Cities domain?

• **Imhotep**: User-conscious adaptable mobile interfaces
  – How to apply it to Urban Apps?
BlindShopping – Motivation

• Blind people
  – 285 millions worldwide (WHO, 2014)
  – Difficulties in their daily life tasks

• Smartphones
  – Increasing computing, communication and sensing capabilities
  – Sensorial complement for visually impaired
BlindShopping Platform

- **Goal**: A platform that enables blind people to shop autonomously in a supermarket

- What does it contribute with?
  - A navigation system
  - A product browsing mechanism

- Directly applicable to the Smart City domain:
  - Enabling blind people to navigate and browse through the real-world’s objects and services
Navigation System

• Guides the blind user inside the supermarket
  – Verbal interaction

• Location defined by:
  – RFID tags distributed throughout the corridors
  – RFID reader attached to the white cane
Product Recognition System

• Tells the user information about products
• Based on QR Codes
  – recognized by camera
  – one per product on the shelf
• Verbal description
Dairy products

Puleva brand milkshake price 3 euros
Platform Architecture

Voice recognition
QR Code reading
RFID Tag reading
RFID info sending
Web-Service query
Web-Service response
Speech Synthesis
Server
Management Front-end

DeustoTech
BlindShopping + iPavement = Accessible Tourism

- What about if the pavement (tactile paving) of some core parts in a city could be enriched with RFID tags or iBeacons?

- What about if the tips of white canes were instrumented with an RFID or BTLE reader?
  - Accessible tourism would be enabled
    - It would ease navigation to POIs (Points of Interest)
    - Such POIs (statues, buildings, and so on) could be annotated with embossed QR codes or RFID tags readable through NFC.
Imhotep: User-conscious adaptable mobile interfaces

- Fewer technology users among elderly and people with disabilities

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**Seniors continue to lag in tech adoption**

*Seniors vs. all American adults 18+*

<table>
<thead>
<tr>
<th>Technology</th>
<th>All adults</th>
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<td>Cell phone</td>
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<td>Internet</td>
<td>86</td>
<td>59</td>
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<tr>
<td>Broadband</td>
<td>70</td>
<td>47</td>
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Pew Research Center's Internet Project July 18-September 30, 2013 tracking survey.

PEW RESEARCH CENTER
Need for adaptive interfaces

- This user base is going to grow even more with the increasing of average age in Europe.
Need for adaptive interfaces

• Developers traditionally tend to ignore or neglect this user base
  – The individual user groups (each disability have different requirements) may not be big enough to justify the additional development costs
  – Developing accessible applications can be difficult and error-prone

• Need to progress from device responsive apps to age & sensor-disability friendly apps
Imhotep

• Aim \( \rightarrow \) *Provide tools that ease the development of adaptive, user-centric accessible applications*

• Design objectives:
  – Make the framework platform independent
  – Reduce the adoption costs
  – Help AAL programmers without expertise in accessible applications
  – Practical down-to-earth approach
Framework architecture

• Composed by three main elements:
  – The **pre-processor directives**
  – The **adaptation server**
    • Aware of user and device capabilities
  – The **fuzzy knowledge-eliciting reasoner**
    (integrated in the adaptation server)
Preprocessor Directives

• **Conditional** directives can be used to avoid the compilation of fragments of code if certain conditions are matched. These conditions can include calls to functions provided by the framework.

```cpp
//if defined (${piramid.capabilities.user.sight.dioptries})
//if ${piramid.capabilities.user.sight.dioptries} > 10
    addTextToSpeech();
//else
    addGraphicInterface();
//endif
//else
    addGraphicInterfaceAndTextToSpeech();
//endif
```
Fuzzy Knowledge-Eliciting Reasoner

• Objectives
  – To infer new user and device capabilities from those specified in the profiles.
  – To enable the AAL developers to abstract from the crisp values (*the user has less than 3 dioptres*) in favour of more natural concepts (*the user can see without a significant problem*).
Assisted City

- Imhotep-powered app to search nearby interesting locations (bars, restaurants, hotels, etc.), adapted to the user requirements and capabilities.
  a. **Adapted to blind users.** Uses the Android TextToSpeech API to communicate and a graphic interface with different colors and font sizes to ease the reading.
  b. **Adapted to regular users.** Users are driven to the selected point by using the augmented reality. As you can see in the image below, the distance to the point and a marker indicating its position is shown using the device camera.
Citizen Participation

- Smart Cities improve the efficiency and quality of the services provided by governing entities and business and *(are supposed to)* increase citizens’ quality of life within a city
  - Do they really address the user needs?

- *“The city must become like the Internet, i.e. enabling creative development and easy deployment of applications which aim to empower the citizen”* - **THE APPS FOR SMART CITIES MANIFESTO**
  - This view can be achieved by leveraging:
    - **Available infrastructure** such as Open Government Data and deployed sensor networks in cities
    - **Citizens’ participation through apps** in their smartphones
Why Participative Cities?

• Not enough with the traditional resource efficiency approach of Smart City initiatives
  • “City appeal” will be key to attract and retain citizens, companies and tourists
  • Only possible by user-driven and centric innovation:
    -- The citizen should be heard, EMPOWERED!
      » Urban apps to enhance the experience and interactions of the citizen, by taking advantage of the city infrastructure
    -- The information generated by cities and citizens must be linked and processed
      » How do we correlate, link and exploit such humongous data for all stakeholders’ benefit?
        • We should start talking about Big (Linked) Data
IES Cities Project

• The IES Cities project *promotes user-centric mobile micro-services that exploit open data and generate user-supplied data*

  – **Hypothesis**: *Users may help on improving, extending and enriching the open data in which micro-services are based*

• Its *platform aims to*:

  – *Enable user supplied data to complement, enrich and enhance existing datasets* about a city

  – *Facilitate the generation of citizen-centric apps* that exploit urban data in different domains
IES Cities Research Aim

• “To create a multi-device dataset and application ecosystem based on standard web technologies, that exploits the data shared by councils and their citizens, and provides to citizens, tourists and workers an enhanced experience in a municipality”
IES Cities Stakeholders

• The main stakeholders of the resulting urban apps ecosystem by IES Cities envisaged smart city-enabling platform are:
  – Mainly the citizens as final users and app idea innovators
  – SMEs and public administration of different cities who satisfy the social and economic needs detected
**LinkedData**

- “A term used to describe a recommended best practice for exposing, sharing, and connecting pieces of data, information, and knowledge on the Semantic Web using URIs and RDF”

- Allows to **discover, connect, describe and reuse all types of data**
  - Enables to pass from a Web of Documents to a Web of Data
    - In September 2011, it had 31 billion RDF triples linked by 505 million links

- Thought to open and connect diverse vocabularies and semantic instances, to be used by the semantic community

- URL: [http://linkeddata.org/](http://linkeddata.org/)
Mechanisms for Supporting Citizens & Developers

• **Provenance tracking mechanisms** to assess and qualify user-provided data, thus promoting valuable and trustable information and decrementing and eventually discarding lower quality data
  – W3C PROV Data Model for provenance exchange on Web

• **Human Computation** enables to leverage human intelligence to carry out tasks that otherwise would be difficult to accomplish by a machine
  – Gamification can also be used to incentivize citizen participation

• **JSON schema and query languages** to facilitate urban apps development
  – Structured and non-structured data in the form of RDF, CSV or even HTML pages can be easily mapped into JSON
The Data Layer will manage the metadata about users, councils, apps, datasets and geoservices. These data may be stored both in a relational DB such as PostgreSQL or in a NoSQL database, namely Scalaris. The task here will be to implement all the CRUD operations which can be applied to those IES CITIES entities.

Data Wrapper gathers external data from social networks and webpages (e.g., Excel, HTML, Twitter API...), adapts and stores it in order to be accessible by the Query Mapper.
User-provided Data

• Smart Cities seek the participation of citizens:
  – To enrich the knowledge gathered about a city not only with government-provided or networked sensors' provided data, but also with high quality and trustable data
  • BUT, how can we know if a given user and, consequently, the data generated by him/her can be trusted?
    – W3C has created the PROV Data Model, for provenance interchange
IES Cities wants to analyze the impact that citizens may have on improving, extending and enriching the data the IES Cities enabled services will be based upon.

- Quality of the provided data may vary from one citizen to another, not to mention the possibility of someone's interest in populating the system with fake data.
  - Duplication, miss-classification, mismatching and data enrichment issues
IES Cities Player
Bristol’s Democratree App
Zaragoza’s Your Opinion Matters
Conclusions IES Cities

• Capital to include citizens in the Smart City innovation loop and in the enrichment of the city knowledge with their data contribution
  – Only way to progress towards Smarter (Inclusive) Cities

• IES Cities aims to address this by offering:
  – Architecture enforcing usability, interoperability, modifiability, scalability and portability …
    • Added value for public bodies, developers and users
      – No need for republishing existing datasets
      – REST interfaces and generic queries (SQL-based) for intuitive development of IES Cities Services
      – Semantic technologies to support the generation and validation of Linked Open Data
I have a dream ... the user-empowered inclusive City

- **Smart Objects**, e.g. iPavement, an enabling technology for inclusive cities which allows to collect data, e.g. people transiting through a given area
- **Open data** from a given council should be linked to real-time data gathered by iPavement and other city sensors (physical) or prosumed by users (virtual sensors)
- **Smartphones running Location-aware Open Data apps** which recommend to surrounding citizens and visitors according to their profile and capabilities
  - User-conscious apps should adapt to the capabilities of different users, their devices and current context
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Towards Ambient Assisted Cities

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