Towards Ambient Assisted Cities and Citizens

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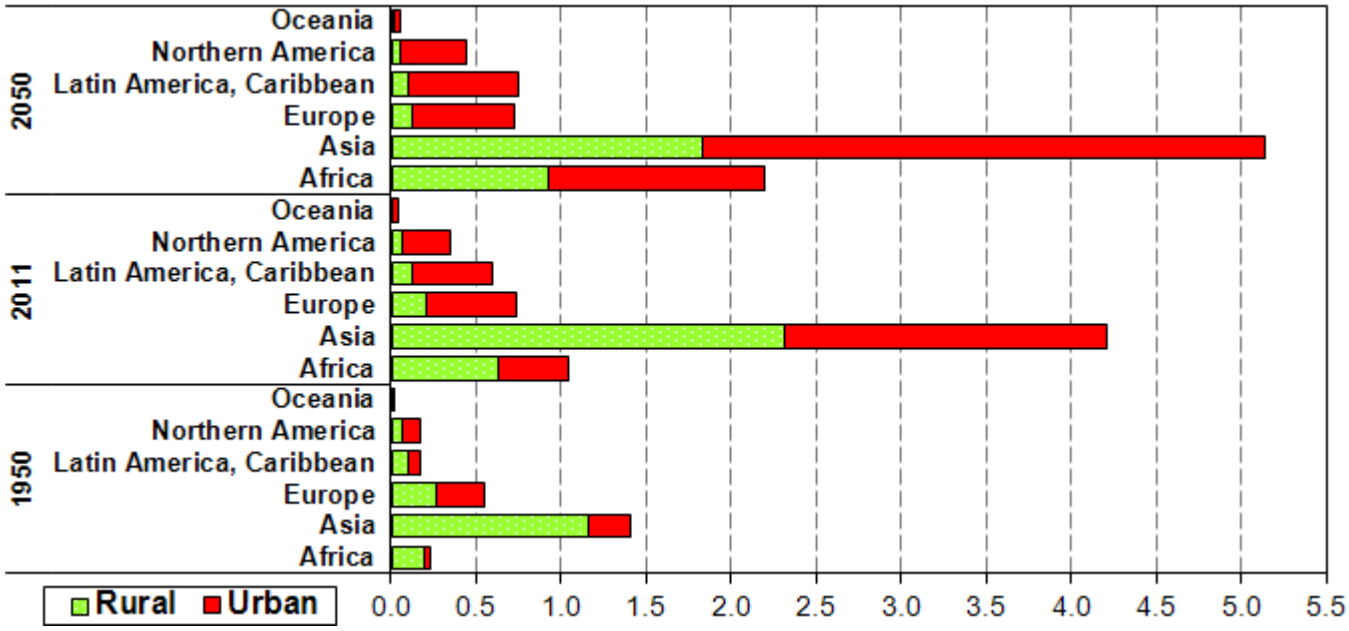
Society Urbanisation

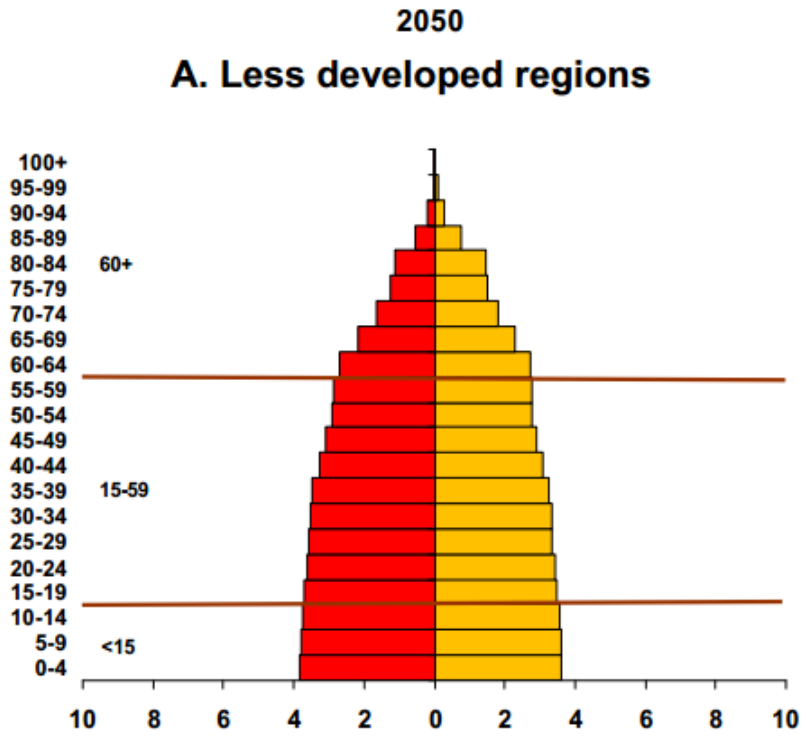
- Urban populations will **grow by an estimated 2.3 billion over the next 40 years**, and as much as **70% of the world's population will live in cities by 2050**

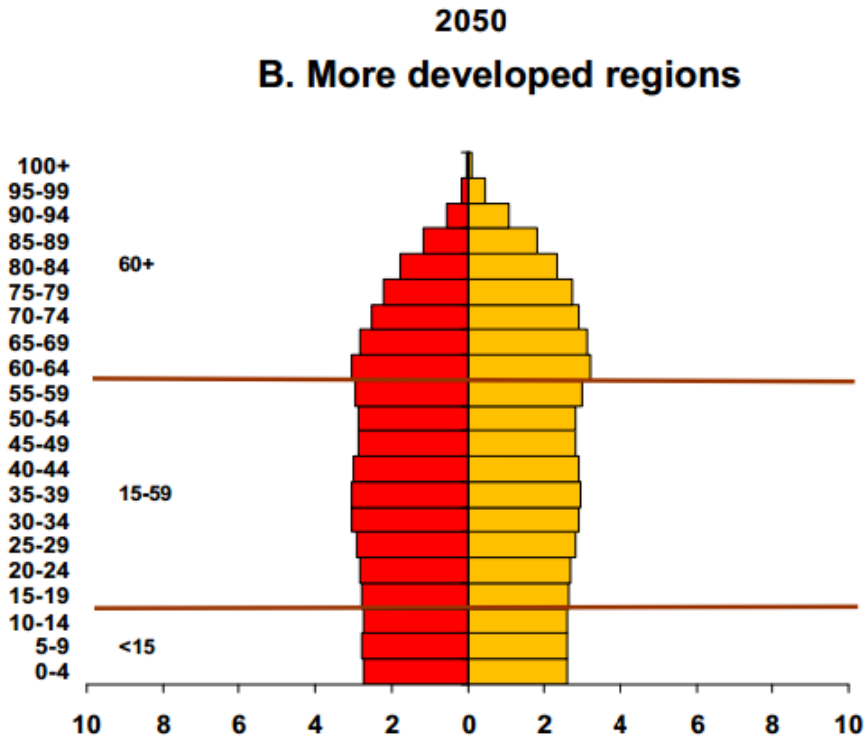
[World Urbanization Prospects, United Nations, 2011]



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

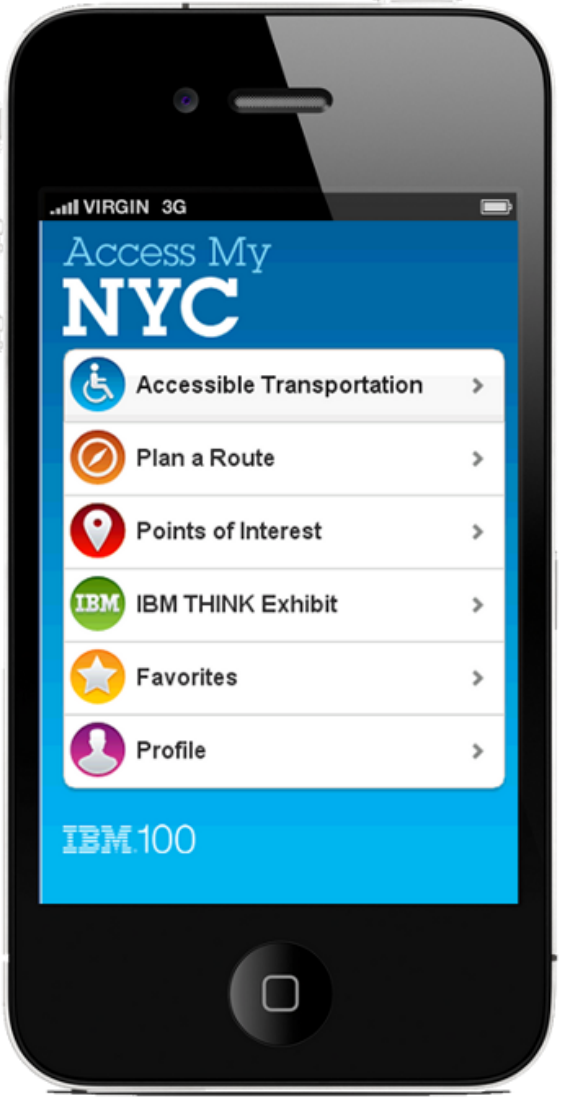
- The main attribute of a **Smart City** is **efficiency**
- An **Age-friendly city** is an inclusive and accessible urban environment that promotes active ageing
- The **main attributes of an Ambient Assisted (Smarter) City** are:
  - **Livable**
  - **Accessible**
  - **Healthy**
  - **Inclusive**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

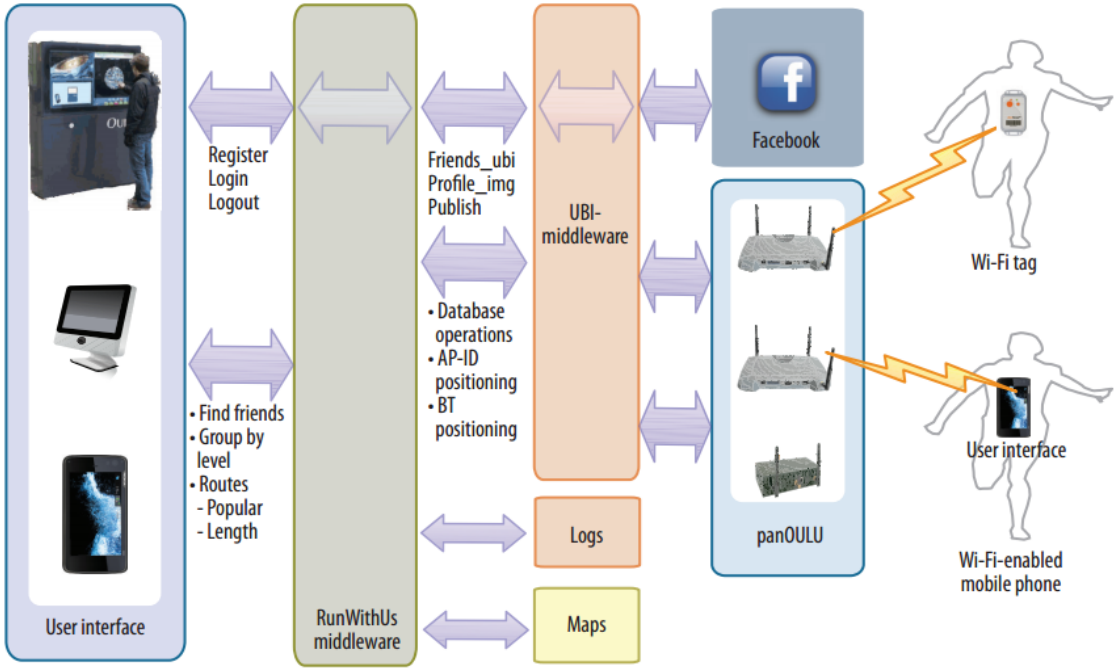


AccessMyNYC

- **AccessMyNYC** is an app designed to help define requirements for more inclusive Smarter Cities
  - Brings together **geo-location and mapping technologies, transportation data, and publicly available accessibility information** to help N.Y.C. residents and visitors
    - **Find** information about accessible public and private transportation and plan a public transit or walking route
    - **Identify** accessibility information about points of interest citywide, including restaurants, hotels and most commonly visited attractions
    - **Customize** search criteria to filter accessibility information by personal needs and preferences
    - **Rate** and **tweet** about the accessibility of city systems and points of interest.

Run with Us

- Smart cities should **promote healthier lifestyles** by using their urban wireless infrastructures to implement mechanisms that encourage residents to play sports and exercise
  - RunWithUs was an early attempt deployed in Oulu to motivate city residents to exercise
    - Defines as social network of residents that can challenge each other
      - http://www.ubioulu.fi/en/UBI-summer-school-2011-workshops



Physical and Digital Barriers

- Some Spanish initiatives have tackled how to **overcome architectural barriers**:
  - VIABLE project aims to offer real-time information about the status of the public ways in a place

  - LibreDeBarreras promotes citizen participation through mobile app:
    - http://libredebarreras.es/informacion

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

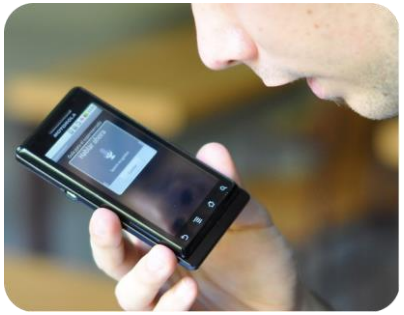
- Smartphones
  - Increasing computing, communication and sensing capabilities
  - Sensorial complement for visually impaired

BlindShopping Platform

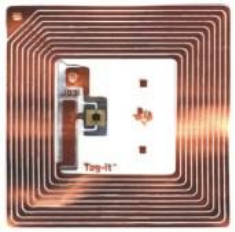
- **Goal**: A platform that enables blind people to shop autonomously in a supermarket
- What does it contribute with?
  - A **navigation system**
  - A **product browsing mechanism**
- Directly applicable to the Smart City domain:
  - Enabling blind people to navigate and browse through the real-world's 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



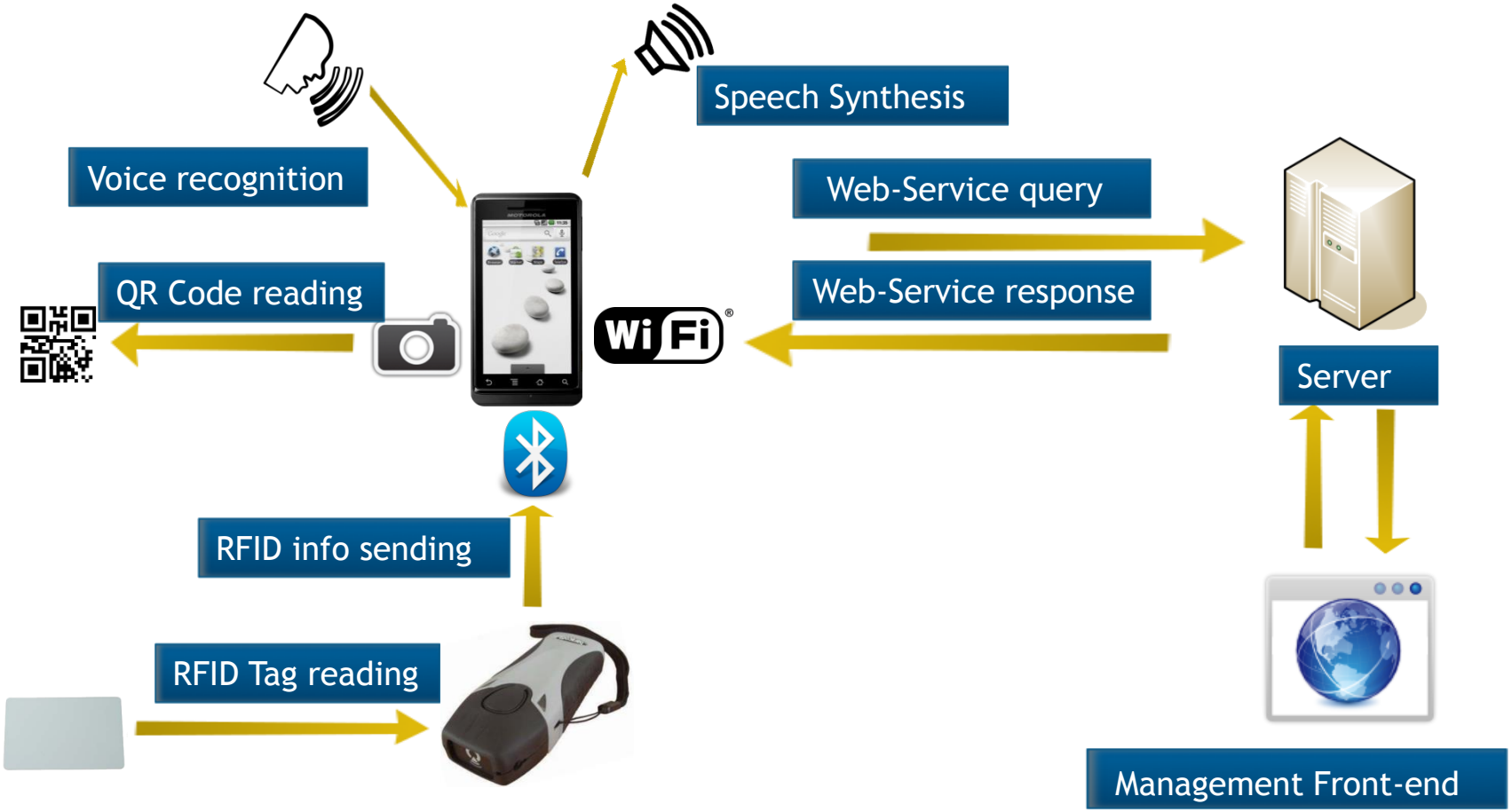
Product Recognition System

- 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

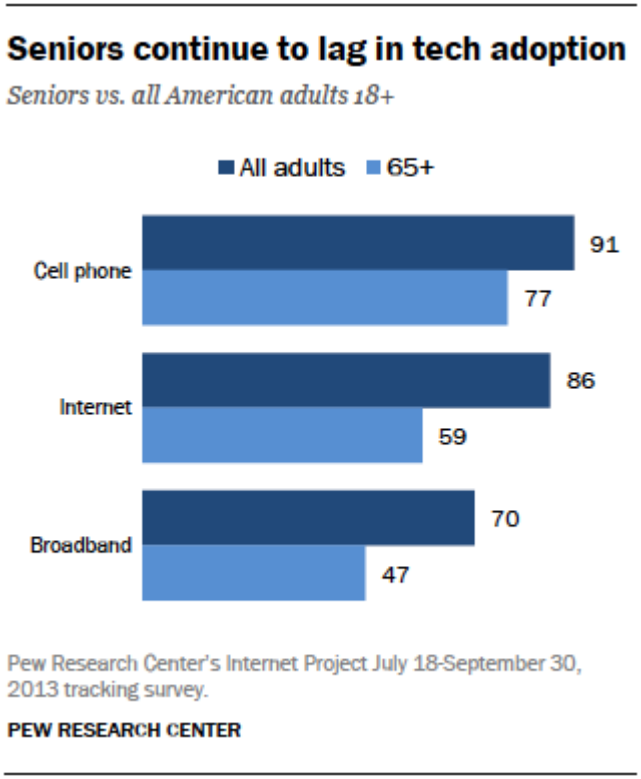


BlindShopping + iPavement = Accessible Tourism

- 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.

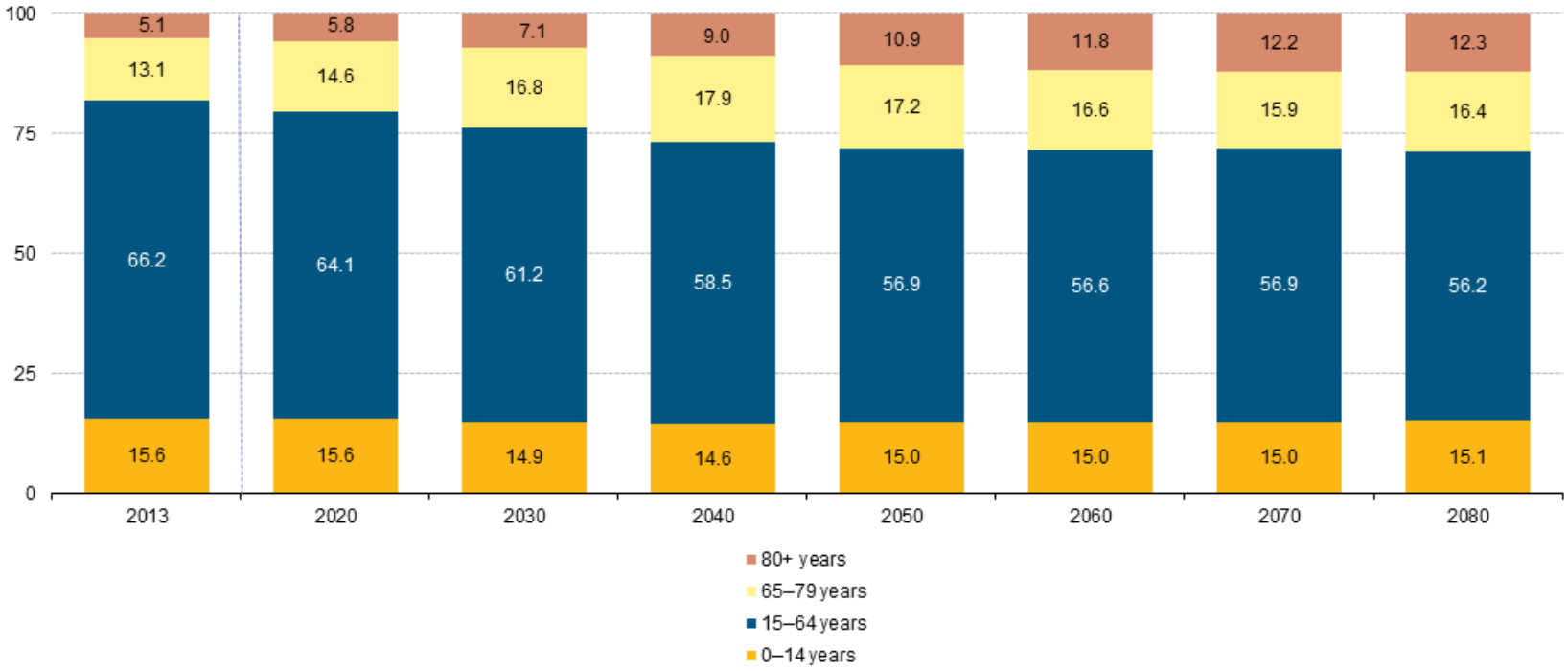
Imhotep: User-conscious adaptable mobile interfaces

- Fewer technology users among elderly and people with disabilities

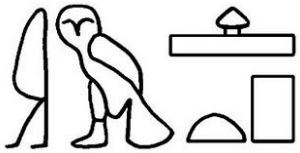


Need for adaptive interfaces

- This **user base is going to grow** even more with the increasing of average age in Europe.



(1) 2020–80: projections (EUROPOP2013).
Source: Eurostat (online data codes: demo_pjangroup and proj_13npms)



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envisioning future internet

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**

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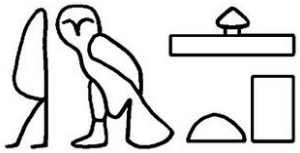

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Imhotep

- Aim → ***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

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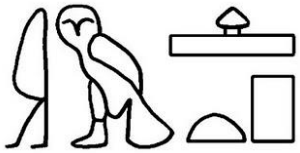
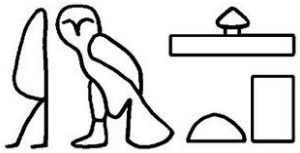


Framework architecture

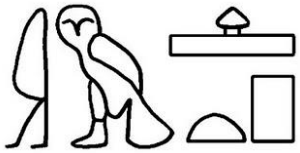
- Composed by three main elements:
  - The **pre-processor directives**
  - The **adaptation server**
    - Aware of user and device capabilities
  - The **fuzzy knowledge-eliciting reasoner** (integrated in the adaptation server)



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.

```
//#if defined (${piramide.capabilities.user.sight.dioptres})
    //#if ${piramide.capabilities.user.sight.dioptres} > 10
        addTextToSpeech();
    //$else
        addGraphicInterface();
    //#endif
//$else
        addGraphicInterfaceAndTextToSpeech();
//#endif
```

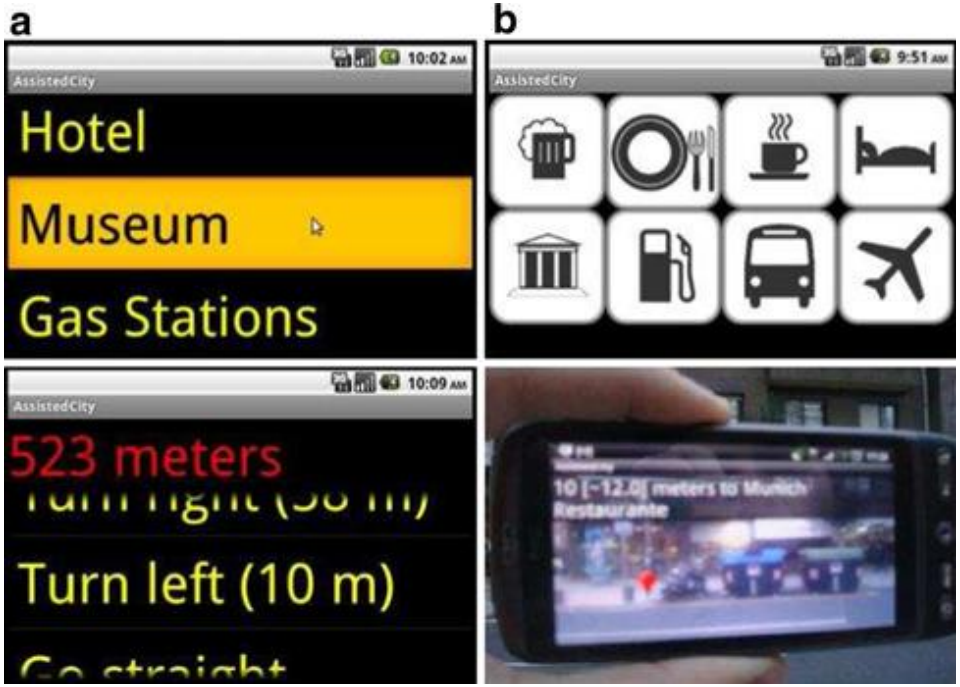


Fuzzy Knowledge-Eliciting Reasoner

- 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 easy 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

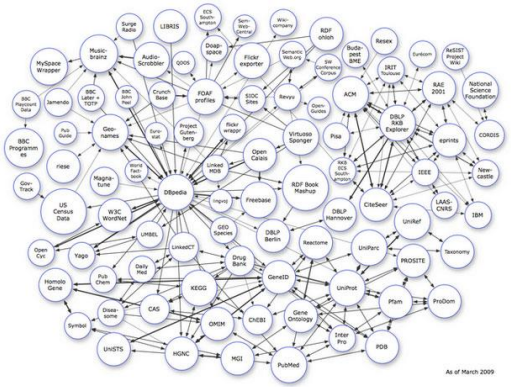
- The main stakeholders of the resulting **urban apps ecosystem** by IES Cities envisaged smart city-enabling platform are:
  - Mainly the **citizens** as final users and app idea innovators
  - **SMEs and public administration** of different cities who satisfy the social and economic needs detected

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/

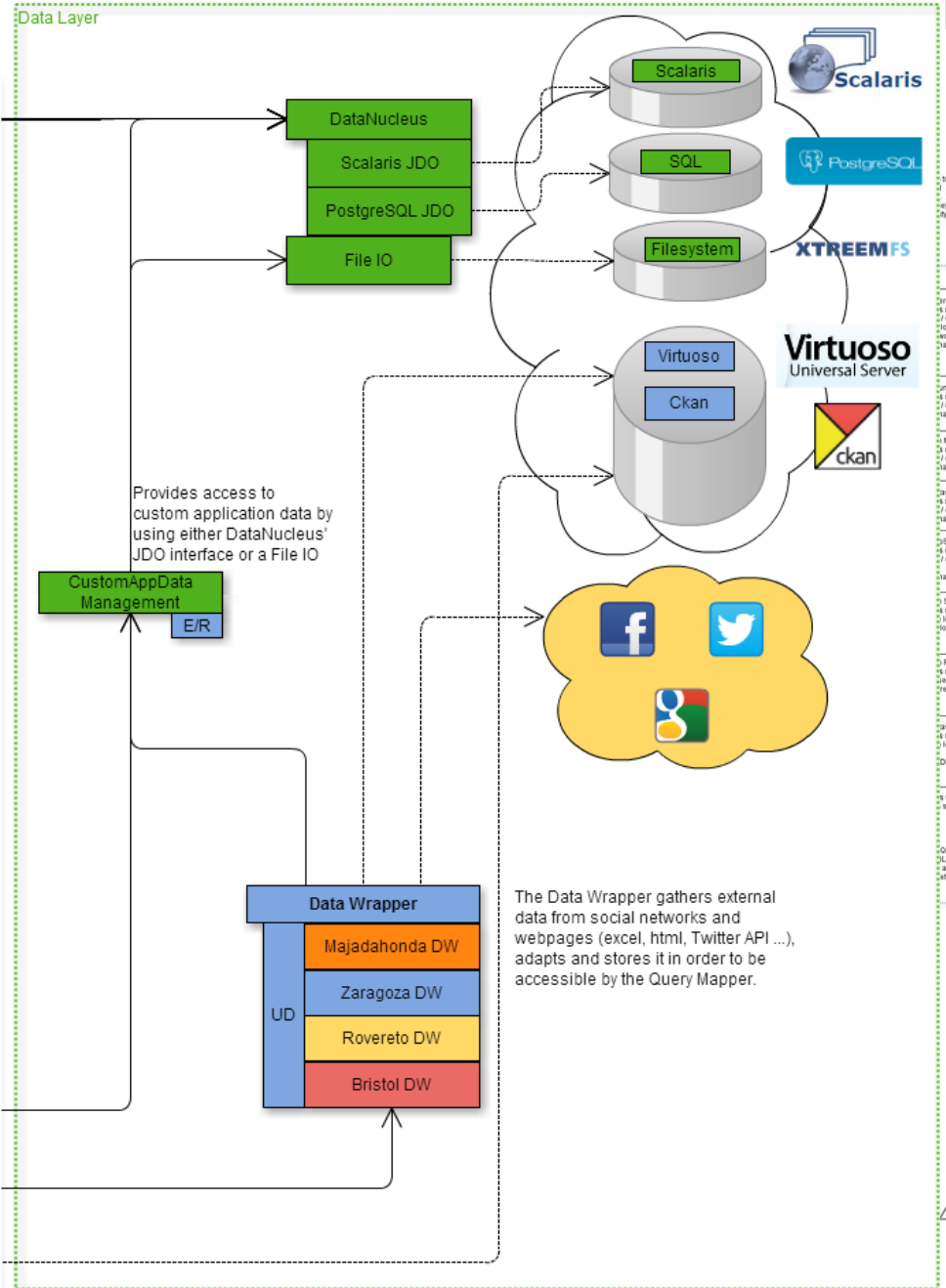


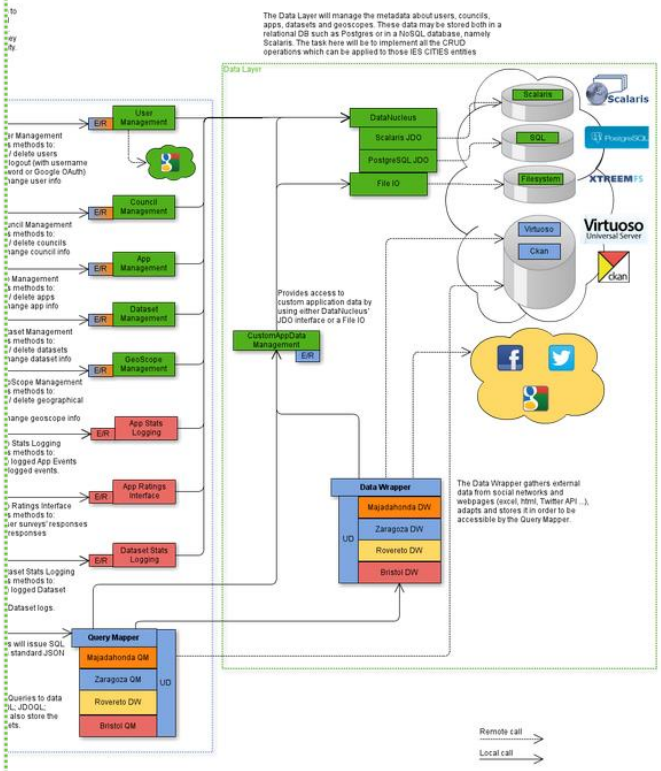
Mechanisms for Supporting Citizens & Developers

- **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 geoscopes. These data may be stored both in a relational DB such as Postgres 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

rchitecture





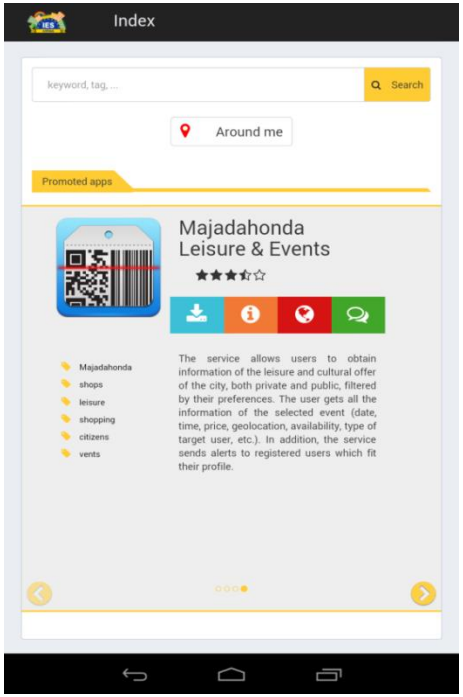
User-provided Data

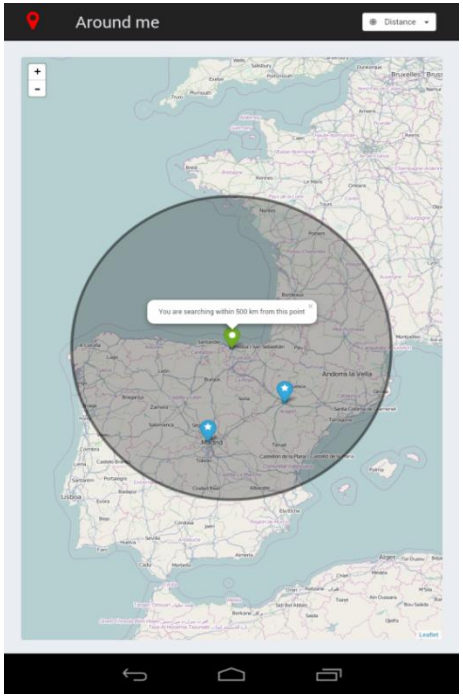
- Smart Cities seek **the participation of citizens**:
  - To **enrich the knowledge gathered about a city** not only with **government-**provided or **networked sensors'** provided data, but also with **high quality and trustable data**
    - **BUT, how can we know if a given user and, consequently, the data generated by him/her can be trusted?**
      - W3C has created the PROV Data Model, for provenance interchange

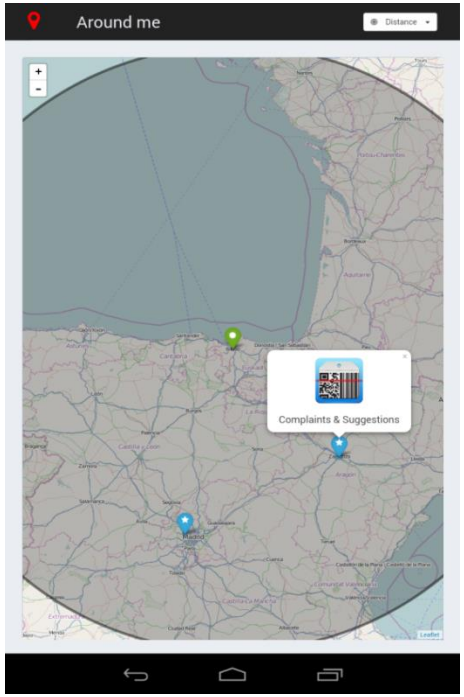
Problems associated to User-provided Data

- 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

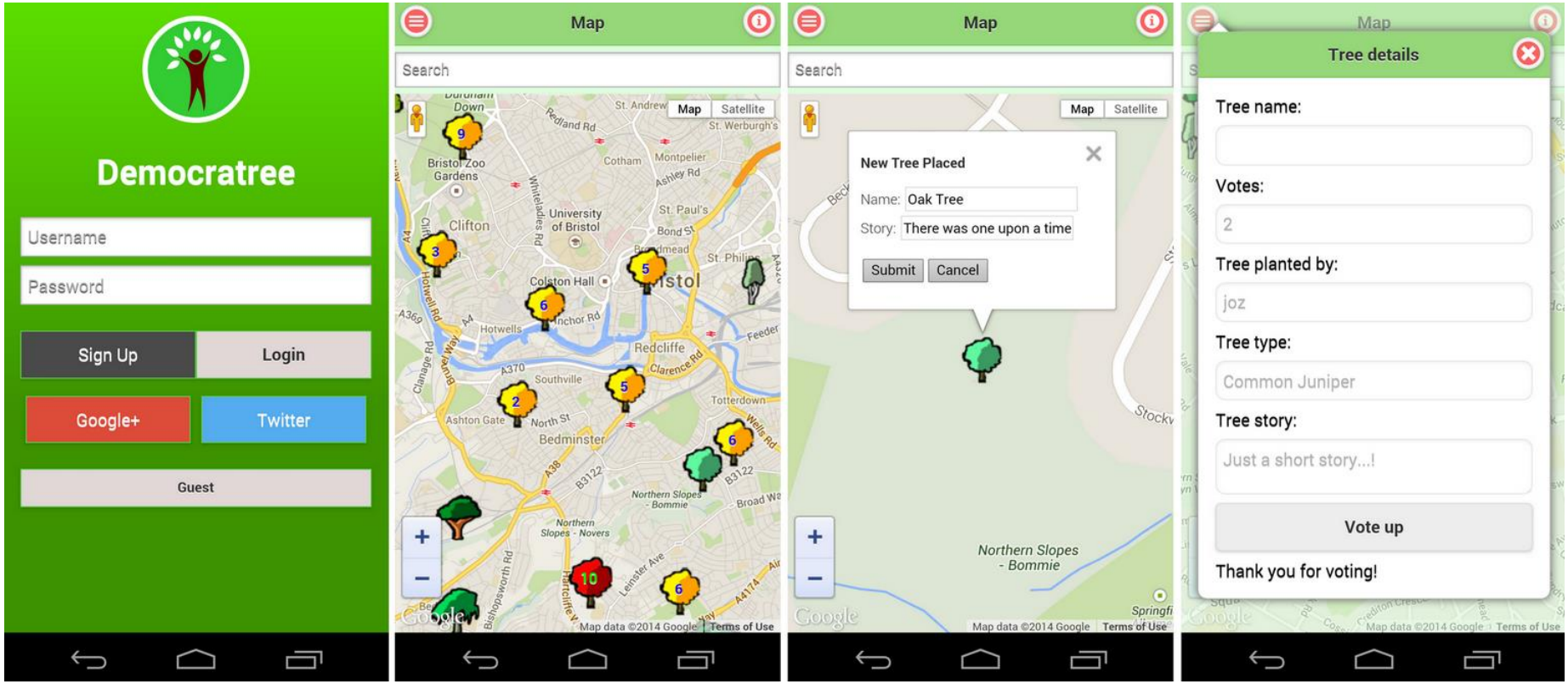
IES Cities Player



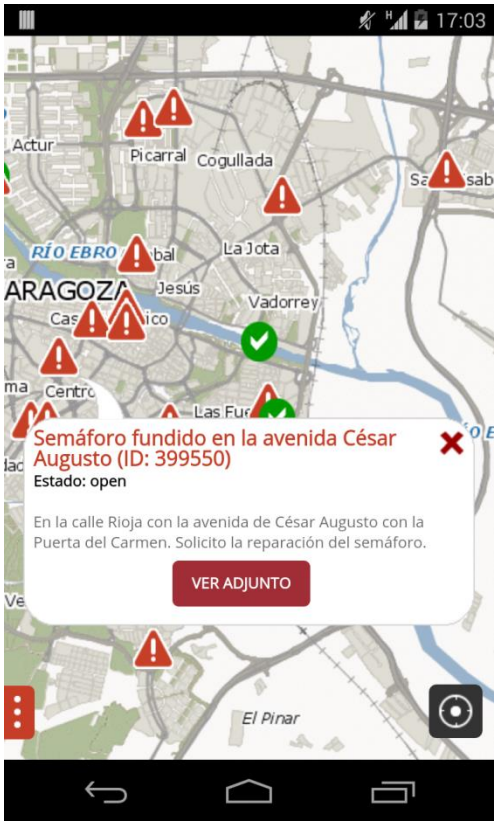


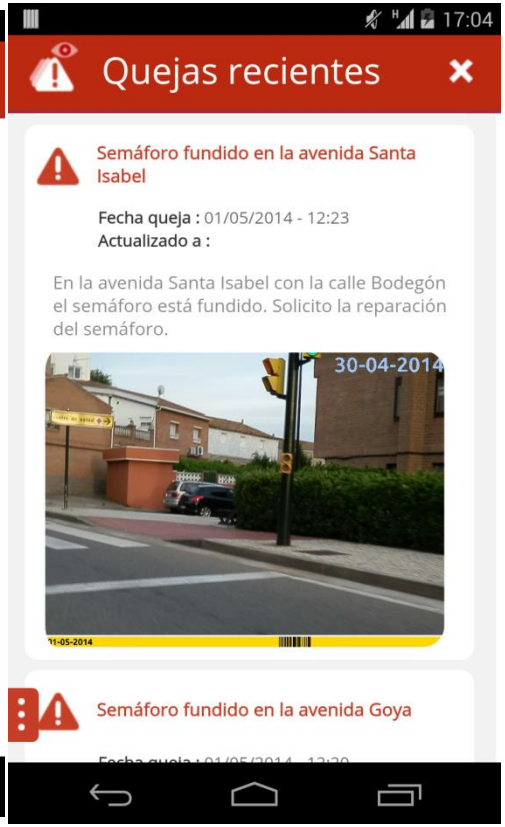


Bristol's Democratree App



Zaragoza's Your Opinion Matters



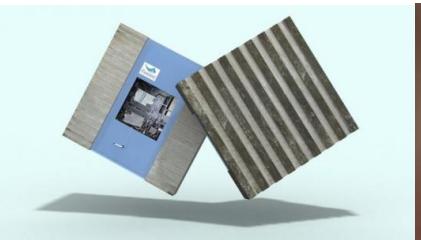


Conclusions IES Cities

- 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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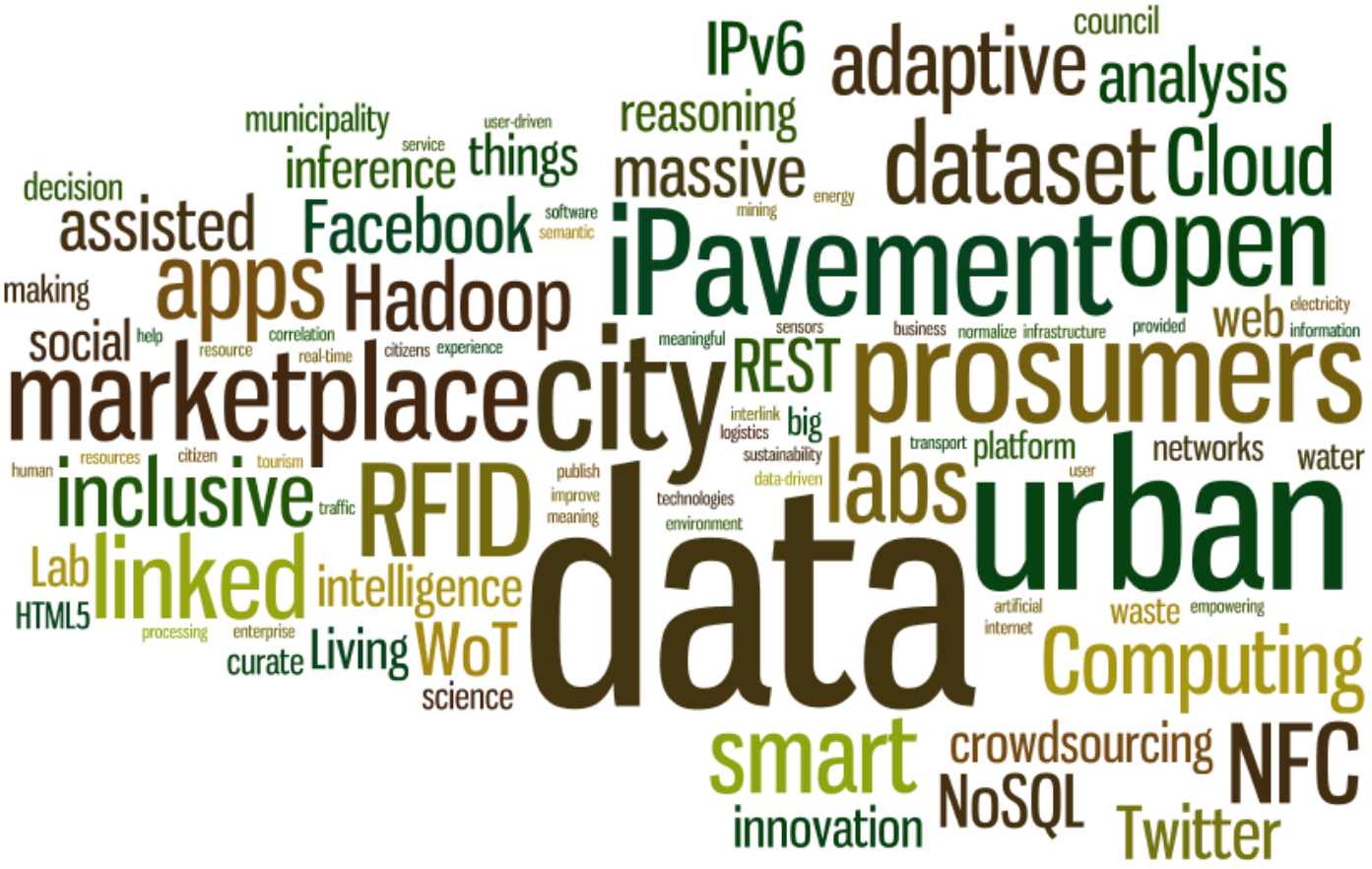

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