

The quest for Ubiquitous Computing: from Ambient Intelligence to the combination of Internet of Things and Web of Data applied to Ambient Assisted Living and SmartCities

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Outline

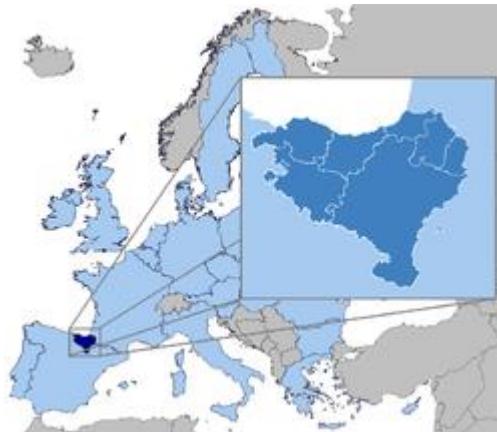
- My organization:
 - University of Deusto
 - DeustoTech
- Quest for making reality UbiComp
- The MORElab research group
 - Dissertations, publications and active projects
- Goal for my placement

University of Deusto



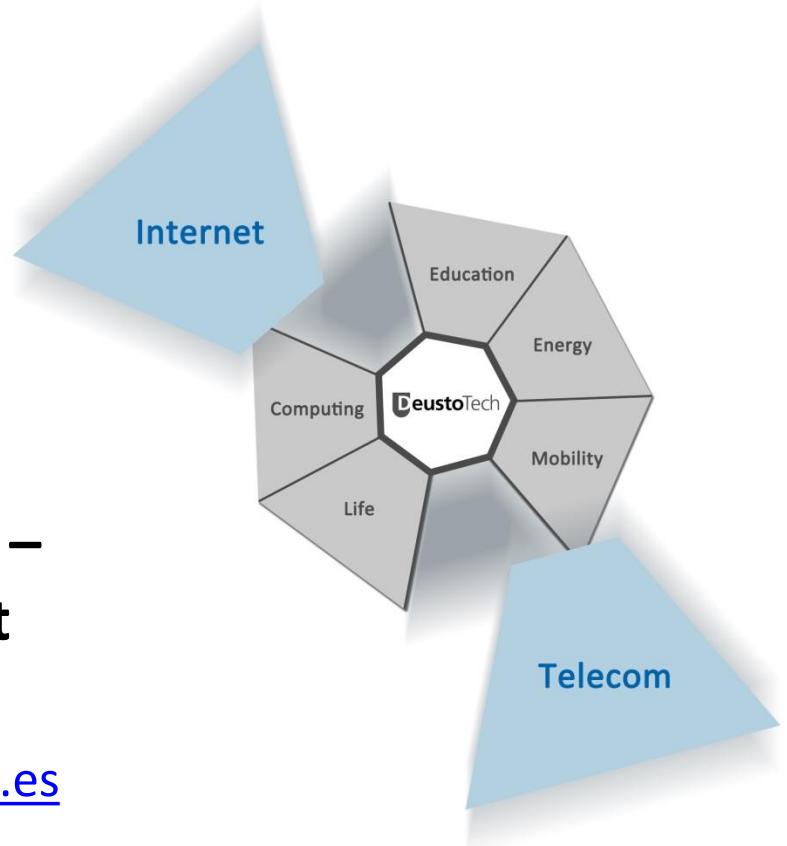
University of Deusto

- 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

Initial steps on UbiComp Research

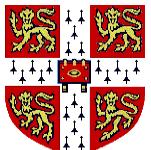
- What is the endemic problem(s) of Aml precluding its wider deployment?
 - Probably many factors but a very remarkable one is the ...
 - “unfortunate” **high demand on infrastructural support!!!**
 - Sensors
 - Actuators
 - Automation buses and protocols
 - Wireless communication links
 - Middleware
 - Context modelling and Reasoning engines
 - And so on and so forth ...

Research Motivation

- Given that Aml is not possible without infrastructure ...
 - **How do we alleviate this “unfortunate” need?**
- Our approach/research aim:
 - Use and adapt low-cost off-the-shelf hardware infrastructure and combine it with intelligent middleware and interaction techniques to make “any” environment appear “intelligent”
- **This talk describes several iterative research efforts addressing the infrastructure dependency issue pursued by Dr. Ipiña and his team:**
 - **Iteration 1: Build your own sensing and reasoning infrastructure**
 - **Iteration 2: Concentrate on explicit user-environment interaction**
 - **Iteration 3: Leverage from Web 2.0 principles and map them to Aml**
 - **Iteration 4: Enable Dynamic and Flexible Smart Environments applied to AAL**
 - **Iteration 5: Towards SmartCities through Web of Data and IoT**

Iteration 1: Build your own essential sensing and reasoning infrastructure (1998-2002)

- Goals:
 - build Sentient Spaces = computerised environments that sense & react
 - close gap between user and computer by using context
 - make ubiquitous computing reality through Sentient Computing
 - by **building your own low cost easily deployable infrastructure to make it feasible!!!**
- Developed during PhD research in University of Cambridge
 - <http://www.cl.cam.ac.uk/research/dtg/>
 - Supervised by Prof. Andy Hopper



Laboratory for Communications Engineering (LCE)
Cambridge University Engineering Department
England, UK



AT&T Laboratories
Cambridge



Basque Government
Education Department

Sentient Computing

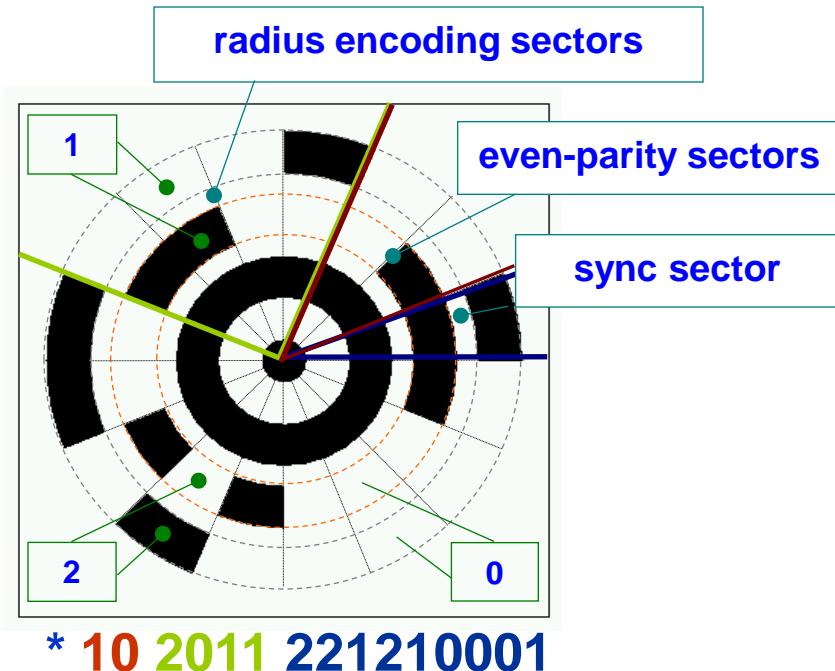
- **Sentient Computing = computers + sensors + rules:**
 - distributed sensors capture context, e.g. temperature, identity, location, etc
 - rules model how computers react to the stimuli provided by sensors
 - 3 phases: (1) context capture, (2) context interpretation and (3) action triggering
- **PhD aim:** to make viable widespread adoption of Sentient Computing through:
 - location sensor deployable everywhere and for everyone
 - middleware support for easier sentient application development:
 - rule-based monitoring of contextual events and associated reactions
 - user-bound service lifecycle control to assist in action triggering

TRIP: a Vision-based Location Sensor

“Develop an easily-deployable location sensor technology with minimum hardware requirements and a low price”

- TRIP (Target Recognition using Image Processing):
 - identifies and locates tagged objects in the field of view of a camera
- Requires:
 - off-the-shelf technology: cameras+PC+printer
 - specially designed 2-D circular markers
 - use of well-known Image Processing and Computer Vision algorithms
- Cheap, easily deployable → can tag everything:
 - e.g. people, computers, books, stapler, etc
- Provides accurate 3-D pose of objects within 3 cm and 2° error

TRIPcode 2-D Marker

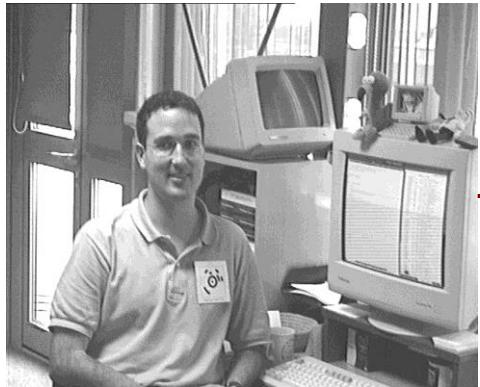


TRIPcode of radius **58mm** and ID
18,795

- 2-D barcode with ternary code
- Easy to identify bull's-eye:
 - invariant with respect to:
 - Rotation
 - Perspective
 - high contrast
- 2 16 bit code encoding rings:
 - 1 sector synchronisation
 - 2 for even parity checking
 - 4 for bull's-eye radius encoding
 - $3^9 = 19,683$ valid codes

Target Recognition Process

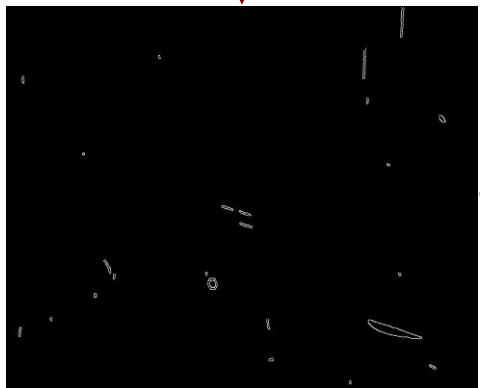
Stage 0: Grab Frame



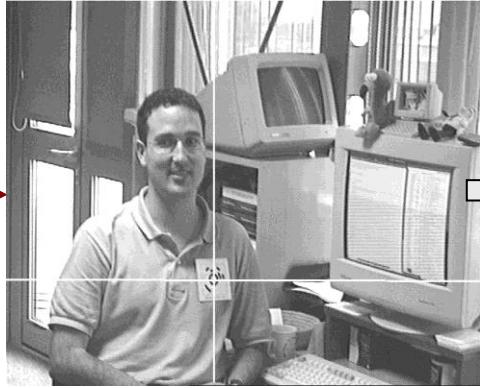
Stage 1: Binarization



Stage 2: Binary Edge Detection



Stage 3: Edge Following & Filtering



Stages 4-7: Ellipse Fitting, Ellipse Concentricity Test,
Code Deciphering and POSE_FROM_TRIPTAG
method

Ellipse params:
 x (335.432), y (416.361) pixel coords
 a (8.9977), b (7.47734) pixel coords
 θ (15.91) degrees

Bull's-eye radius: 0120 (15 mm)
TRIPcode: 002200000 (1,944)

Translation Vector (meters):
 $(T_x=0.0329608, T_y=0.043217, T_z=3.06935)$

Target Plane Orientation angles (degrees):
 $(\alpha=-7.9175, \beta=-32.1995, \gamma=-8.45592)$

d2Target: 3.06983 meters

A Rule Paradigm for Sentient Computing

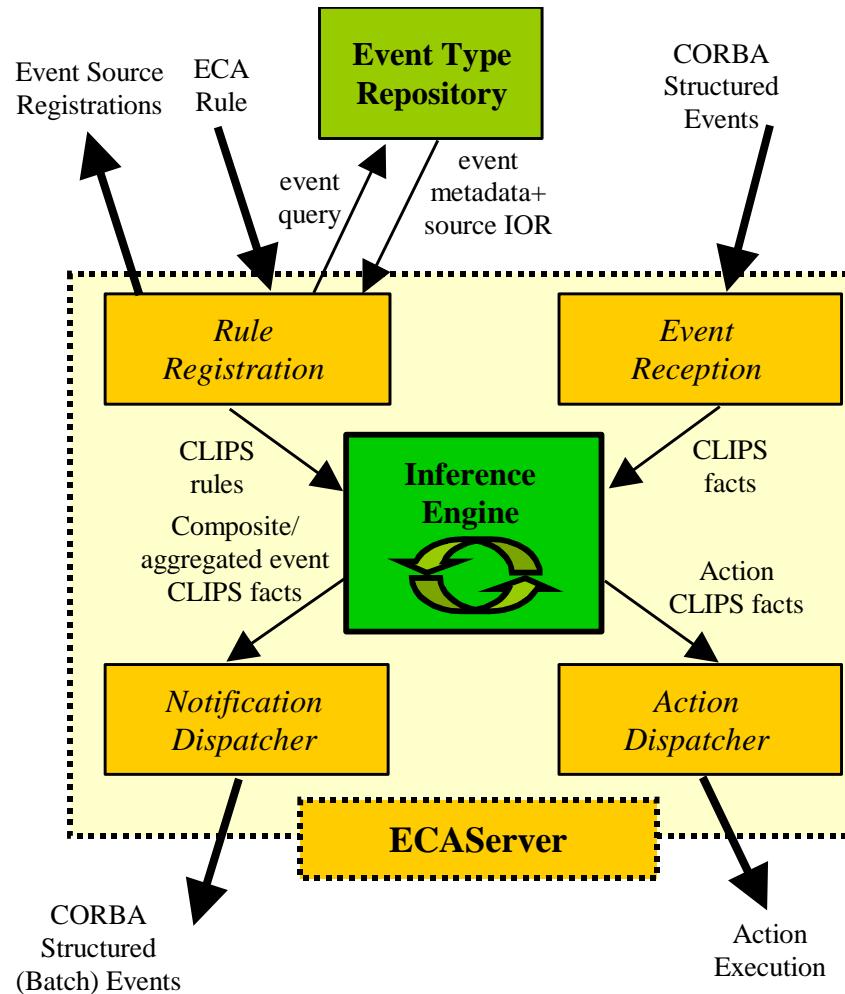
- **Sentient systems are reactive systems that perform actions in response to contextual events**
 - Respond to the stimuli provided by distributed sensors by triggering actions to satisfy the user's expectations based on their current context, e.g. their identity, location or current activity
- Issues:
 - Development of even simple sentient application usually involves the correlation of inputs provided from diverse context sources
- Observation:
 - ***Modus operandi* of sentient applications: Wait until a pre-defined situation (a composite event pattern) is matched to trigger an action**

ECA Rule Matching Engine

- Sentient Applications respond to an ECA model:
 - monitor contextual events coming from diverse sources
 - correlate events to determine when a contextual situation occurs:
 - e.g. IF two or more people in meeting room + sound level high THEN meeting on
 - ineffective to force every app to handle same behaviour separately
- Solution → **ECA Rule Matching Service**:
 - accepts rules specified by the user in the ECA language

```
<rule> ::= {<event-pattern-list> => <action-list> }
```
 - automatically registers with the necessary event sources
 - notifies clients with aggregated or composite events or executes actions when rules fire:
 - **aggregated event** = new event summarizing a situation
 - **composite event** = batch of events corresponding to a situation

ECA Service Architecture



Building a Sentient Jukebox with ECA Service

“If it is Monday, a lab member is logged in and either he is working or it is raining outside, then play some cheerful music to raise the user’s spirits”

```
within 15000 /* Enforce events occur in 15 secs time span*/
  query PCMonitor$logged_in(user ?userID, host ?hostID) and
  test(dayofweek = "Monday") and
  Location$presence(user ?userID) before
  /* a presence event must occur before any event on its RHS */
  ((PCMonitor$keyboard_activity(host ?hostID, intensity ?i) and
    test(?i > 0.3)) or
   (query WeatherMonitor$report(raining ?rainIntensity) and
    test(?rainIntensity > 0.2)))
=>
  notifyEvent(Jukebox$play_music(?userID, ?hostID, "ROCK"));
}
```

LocALE Framework

- Need to provide **support for reactive behaviour of sentient systems**:
 - e.g. user-bound service activation after aggregated event arrival
- **LocALE = CORBA-based solution to object lifecycle & location control**:
 - hybrid of CORBA's Object LifeCycle Service and Implementation Repository
 - addresses location-constrained service activation, deactivation and migration
 - adds mobility, fault-tolerance and load-balancing to objects in a location domain
 - generates permanent object references (independent of object network location)
 - undertakes transparent client request redirection upon object's location change
 - useful for third-party object location controllers:
 - e.g. "migrate the TRIP parser to another host when the used host owner logs in"

Bookmarks Go To: <http://www-lce.eng.cam.ac.uk/Library/cgi-bin/TRIPboardMonitorCtrl.py> What's New

The LCE Meeting Room's Active TRIPboard

The LCE Meeting Room's Active TRIPboard Monitor current status is: **ACTIVE**.
Click on the buttons below to activate/deactivate the service.

The TRIP frame parser is currently running at: **tetleys.eng.cam.ac.uk** host.

Activate Monitor | **Deactivate Monitor**

The last snapshot taken (Jan 21 08:53) of the LCE Meeting Room's whiteboard was:

Diagram description: The whiteboard displays a hand-drawn logic circuit. At the top, there are two AND gates, each with two inputs and one output. The outputs of these two AND gates are connected to the inputs of an OR gate. The output of the OR gate is labeled Q_2 . Below this, there is a NOT gate with its input connected to the output of the OR gate. The output of this NOT gate is labeled E . On the left side, there is a clock input labeled CLK_1 and two more AND gates, each with two inputs and one output. The outputs of these two AND gates are labeled D_1 and D_2 . Below D_1 and D_2 , there is another NOT gate with its input connected to the output of the AND gate D_1 . The output of this NOT gate is labeled Q_1 . There are several handwritten annotations: 'Clock' is written next to CLK_1 ; 'Setup' is written twice, once next to the connection between the OR gate's output and its own input, and once next to the connection between the NOT gate's output and its own input; 'Reset' is written twice, once next to the connection between the NOT gate's output and the AND gate D_2 's input, and once next to the connection between the NOT gate's output and the AND gate D_3 's input; 'Enable' is written next to the connection between the NOT gate's output and the AND gate D_3 's input.

Iteration 2: Concentrate on explicit user-environment interaction (2004-2006)

- Latest mobile devices used mainly for communication, entertainment or as electronic assistants
- However, their increasing:
 - Computational power
 - Storage
 - Communications (Wi-Fi, Bluetooth, GPRS)
 - Multimedia capabilities (Camera, RFID reader)
 - Extensibility
- Makes them ideal to act as intermediaries between us and environment:
 - Aware (Sentient) Devices
 - Powerful devices
 - Always with us anywhere at anytime
- **Our mobile devices can turn into our personal butlers!!!**

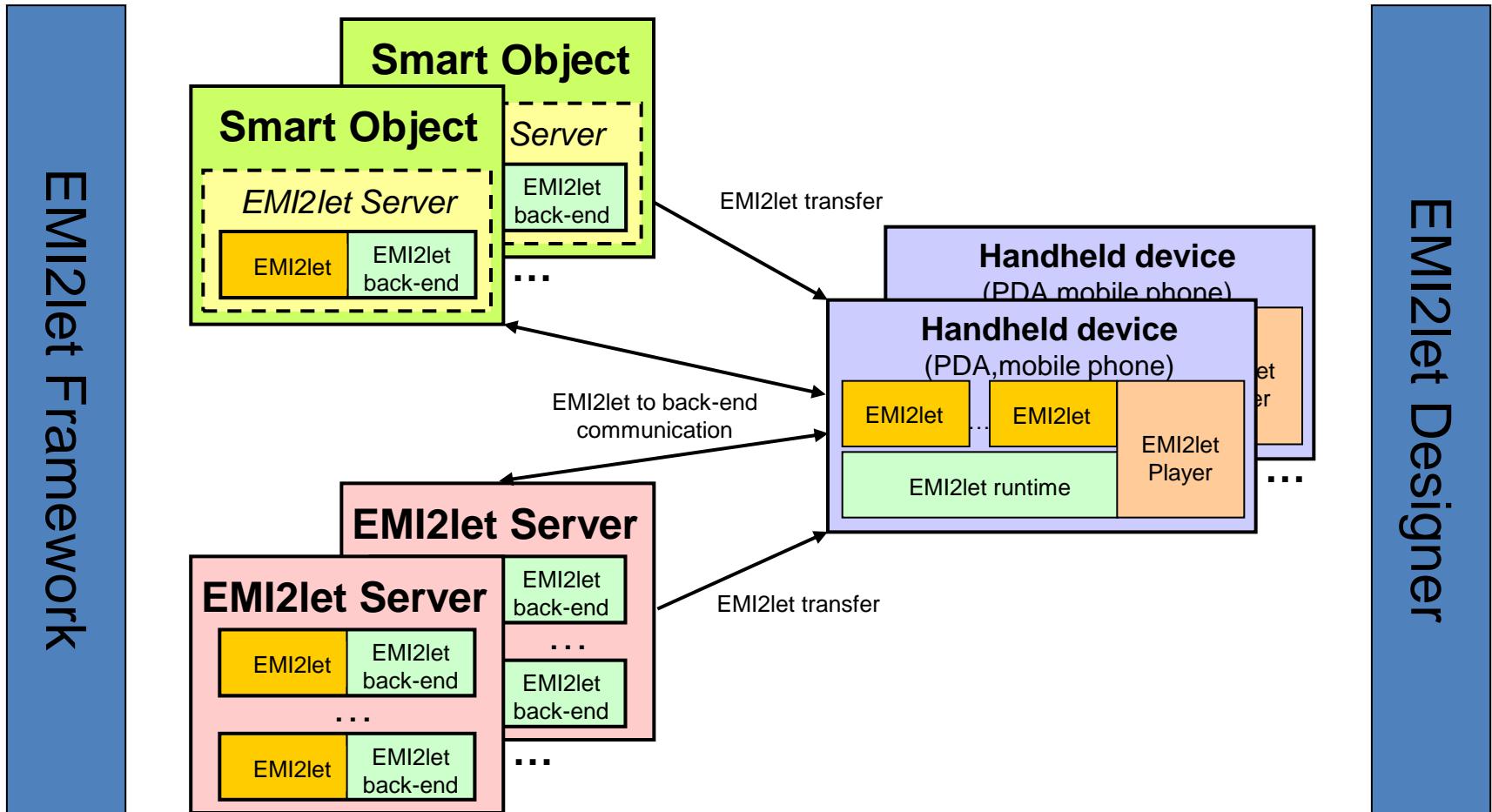
EMI²lets Platform I

- **EMI²lets** is a middleware to facilitate the development and deployment of mobile context-aware applications for Aml spaces.
- **Software platform** to:
 - convert physical environments into Aml spaces
 - augment daily life objects with computational services
 - transform mobile devices into Smart Object remote controllers

EMI²lets Platform II

- EMI²lets is an **Aml-enabling middleware**
 - addresses the **service discovery and interaction** aspects required for **active influence** on EMI²Objects
- Follows a Jini-like mechanism and Smart Client paradigm
 - once a service is discovered, a proxy of it (an EMI²let) is downloaded into the user's device (EMI²Proxy).
 - An **EMI²let** is a mobile component transferred from a Smart Object to a nearby handheld device, which offers a graphical interface for the user to interact over that Smart Object

EMI²lets Deployment





Does it work?

index - Microsoft Internet Explorer

Archivo Edición Ver Favoritos Herramientas Ayuda

Búsqueda Favoritos Búsqueda Ir Vínculos

Dirección: http://localhost/EMI2let.server.plugins.aspx/index.aspx

Google Buscar PageRank 0 bloqueado(s) Corrector ortográfico Opciones

Name : Airport
Description : EMI2let which allows you retrieve the information associated to a given flight
Play

EMI²
ENVIRONMENT MOBILE INTELLIGENT INTERACTION

Please insert your flight number:

Check

Destination : Destination
Time : Time
Flight : Flight
Gate : Gate

IBERIA

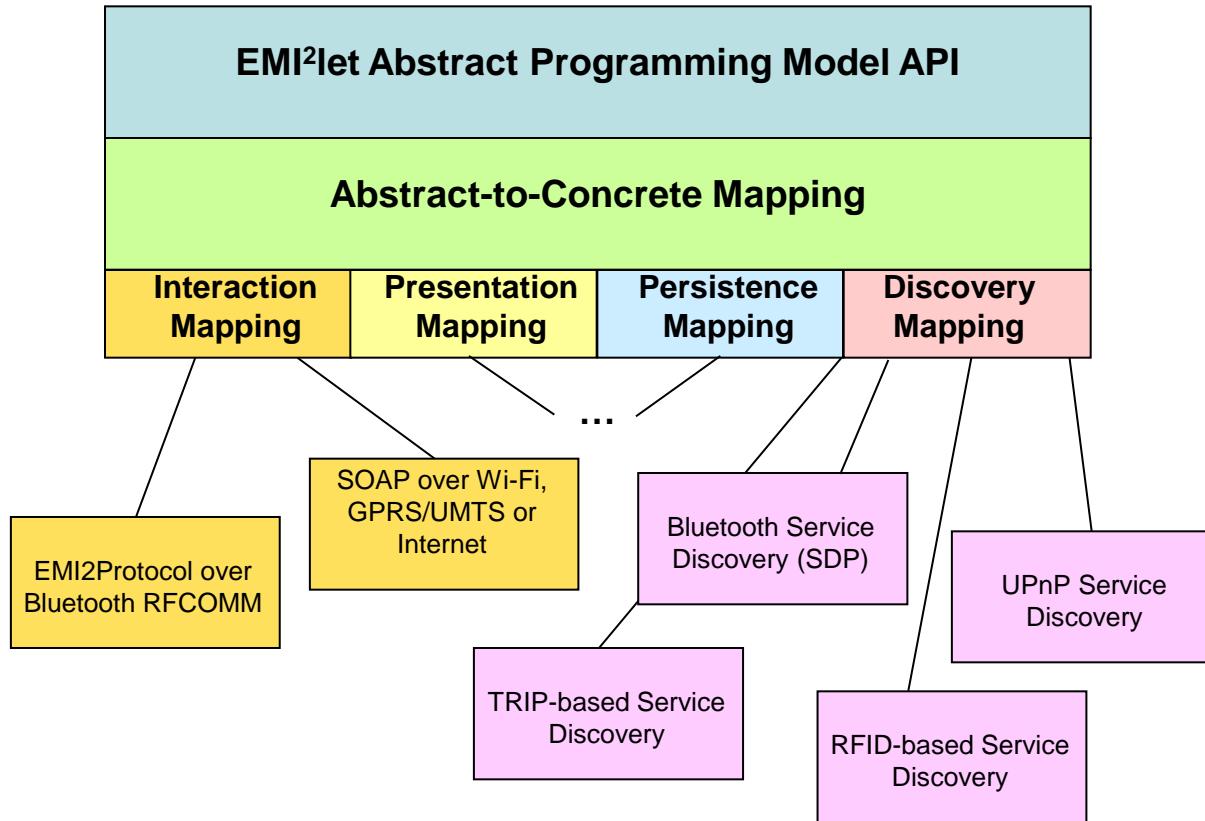
Intranet local

Inicio

Facultad de Ingeniería Ingeniaritzatza Fakultatea

D

EMI²lets Internal Architecture



The image shows a Windows desktop environment with four separate windows of the 'EMI2let Player' application running simultaneously. The desktop background is a blue and white graphic featuring the letters 'GEM2'.

- Top Row:**
 - Left: A log window showing system startup messages such as "Starting BLUETOOTH", "Starting WEBSERVICE", etc.
 - Middle: A menu window with the following options:
 - 1 Start Discovery
 - 2 Settings
 - 3 Log
 - 4 Services
 - 5 Actions
 - Right: A menu window with movement controls:
 - 1 Connect
 - 2 Request
 - 3 Normal
 - 4 Forward
 - 5 Stop
 - 6 Backward
 - 7 Left
 - 8 Right
 - 9 Slow
 - 0 Fast
- Bottom Row:**
 - Left: A camera view showing a close-up of a robotic arm or sensor.
 - Middle: A menu window with device control options:
 - 1 Refresh
 - 2 Up
 - 3 Down
 - 4 ->
 - 5 Less
 - 6 More
 - 7 <-
 - Right: A light control interface with a preview window showing a lamp and a menu window:
 - 1 Domotic Light

At the bottom of the screen, there is a horizontal toolbar with various icons and labels, including 'Log', 'Player', 'Options', 'COMMBOTS', 'Lampara', and 'Movement'. There are also buttons for 'Welcome', 'Start search', 'Unload service', and directional arrows.

Iteration 3: Easing Aml! Leverage from Web 2.0 principles (2007-08)

- **Issues impending Aml wide deployment remain:**
 - Aml is possible if and only if:
 - Environments are heavily instrumented with sensors and actuators
 - Besides, to develop Aml apps continues being very hard!
- Still, mobile devices enable interaction anywhere at anytime
 - User-controlled (explicit) & system-controlled (implicit)
- **Is Aml possible without heavy and difficult instrumentation (or infrastructure-less)?**
 - YES, IT SHOULD if we want to increase Aml adoption!!!

Research Aim

- **Aim**
 - Lower the barrier of developing and deploying context-aware applications in ***uncontrolled global environments***
 - Not only my office, home, but what about my city, other companies, shopping centres, and so on
- **HOW?**
 - Converging mobile and ubiquitous computing with Web 2.0 into **Mobile Ubiquitous Web 2.0**
 - Adding context-aware social annotation to physical objects and locations in order to achieve Aml

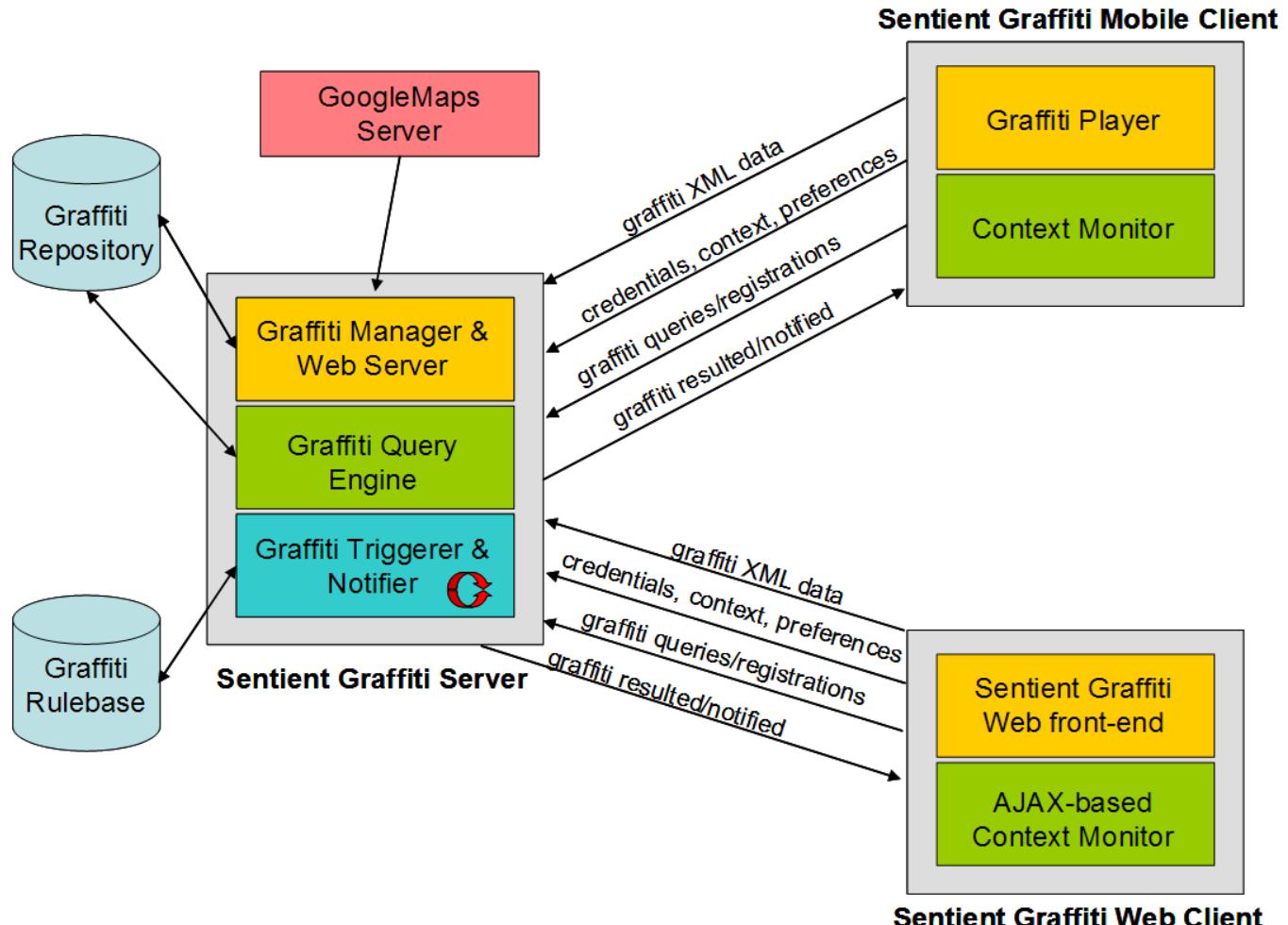
Sentient Graffiti

- **What does it do?**
 - Annotate every physical object or spatial region with info or services
 - Both indoors and outdoors
 - Filter annotations associated to surrounding resources based on user context and keyword filtering
 - Enable user interaction with the smart object and spatial regions both in a PUSH and PULL manner
- **Requirement**
 - Participation in a community of users interested in publishing and consuming context-aware empowered annotations and services

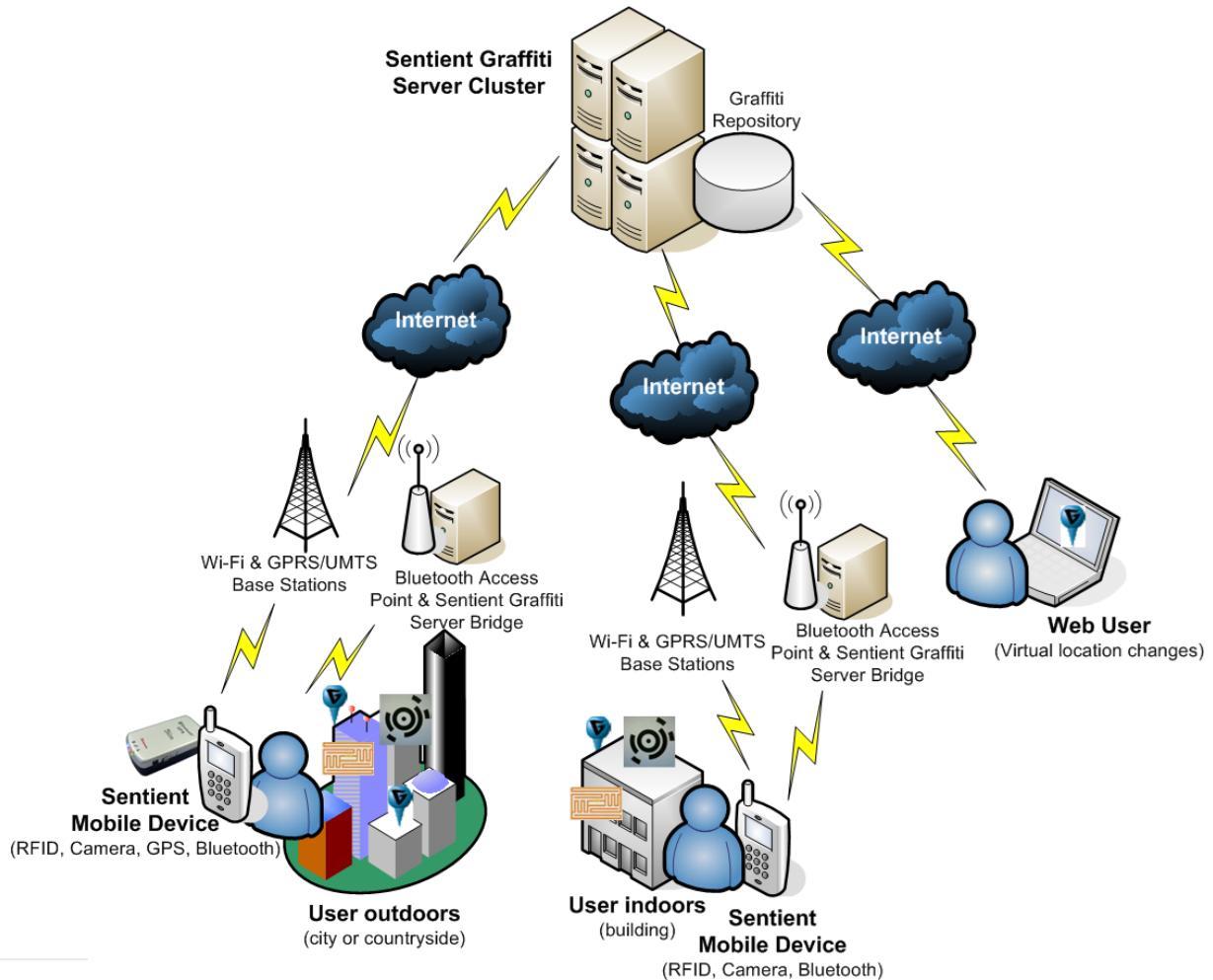
Functionality

- **User's view**
 - Graffiti annotation
 - Descriptions, keywords, contextual attributes
 - Graffiti discovery and consumption
 - TRIP, RFID, NFC, GPS
- **System's view**
 - Context-Aware Folksonomy
 - Tag/keyword-based
 - Context-Aware Mash-up
 - GoogleMaps + our server back-end

Architecture



Deployment Scenarios



Multi-modal Interaction



- Sentient Graffiti simplifies human-to-environment interaction through **four mobile mediated interaction modes**:
 - **Pointing** – the user points his camera phone to a bi-dimensional visual marker and obtains all the graffitis associated with it
 - **Touching** – the user touches an RFID tag with a mobile RFID reader bound to a mobile through Bluetooth (or NFC mobile) and obtains the relevant graffitis
 - **Location-aware** – mobiles equipped with a GPS in outdoor environments obtain the relevant nearby graffitis in a certain location range
 - **Proximity-aware** – the device retrieves all the graffitis published in nearby accessible Bluetooth servers when it is in Bluetooth range

Sentient Graffiti Web Client



Deusto Sentient Graffiti

Main Menu Edit Profile Tag List Administration Logout

Graffiti Information

Title * Football match

Description

Current Date 18/6/2006

Time Restrictions

Tags championship

Domains

Available	Selected
ESIDE	Sports

Visibility * Public Restrict Access

Allow my Contacts to see the Graffiti

Allowed Users

Logged in as: System Admin



Deusto Sentient Graffiti

Main Menu Edit Profile Tag List Administration Logout

Graffiti Information

Title * Football match

Description

Current Date 18/6/2006

Time Restrictions

Tags championship

Domains

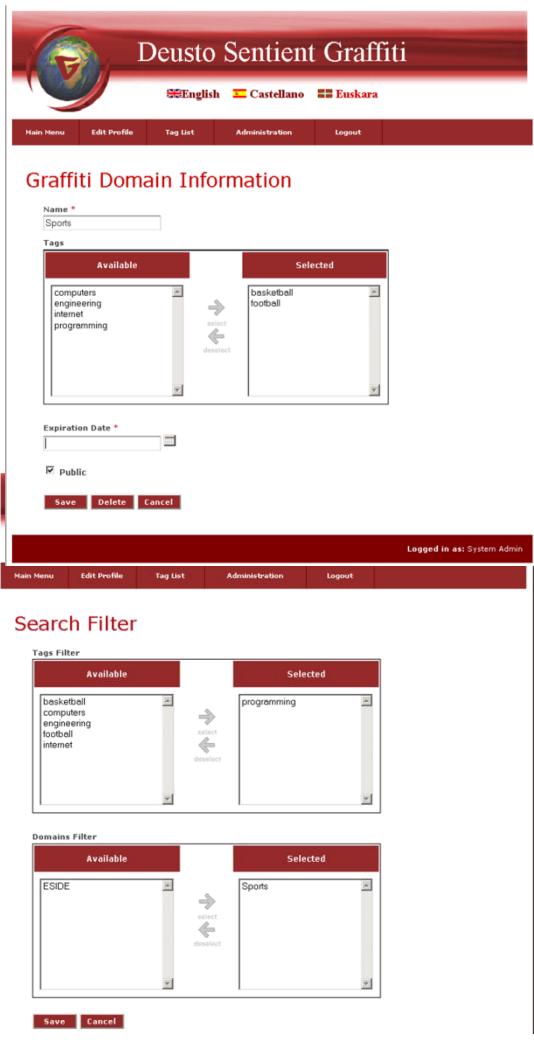
Available	Selected
ESIDE	Sports

Visibility * Public Restrict Access

Allow my Contacts to see the Graffiti

Allowed Users

Logged in as: System Admin



Deusto Sentient Graffiti

Main Menu Edit Profile Tag List Administration Logout

Graffiti Domain Information

Name * Spots

Tags

Available	Selected
computers engineering internet programming	basketball football

Expiration Date *

Public

Logged in as: System Admin

Main Menu Edit Profile Tag List Administration Logout

Search Filter

Tags Filter

Available	Selected
basketball computers engineering football internet	programming

Domains Filter

Available	Selected
ESIDE	Sports

Logged in as: System Admin

Application Types & Examples

- **Available prototypes:**
 - **Marker-associated Graffitis:** Virtual Notice Board
 - Public/private graffitis, expiration time, remote review, user participation
 - **Bluetooth-range Graffitis:** University Services Booth
 - Individual, group and private graffitis, tag-based (OPEN_DAY)
 - **Location-range Graffitis:** Bus Alerter
 - Third-party SG clientes
- **Other possible applications:**
 - City Tour: Bilbao_tourism Graffiti Domain
 - Conference: AmI-07 → feedback, expiration after conference
 - Publicity: Graffiti expiration after N times
 - Friend meetings
 - Disco/stadium/office blogs

Marker-associated Graffitis: Virtual Notice Board



Graffiti List

- By Position
- By TRIP
- By RFID
- By BT Bridge

Select Back Take Photo Back Get Graffitis Back

Graffiti List

Diego's Public Announcements

Note for Raúl de Benito

I am at SmartLab, I will be back in my office between 10am and 1pm.

Web Service

Options Back Open Back Options Back Back

Diego's Public Announcements

Note for Raúl de Benito

Raul, I had to go, if you need to talk to me urgently call to +3465432458

Sorry

Back

Bluetooth-range Graffitis: University Booth

	<p>Graffiti List</p> <p>By Position By RFID By TRIP By BT Bridge</p> <p>Select Back</p>	<p>Graffiti List</p> <p>Digital Informatio Booth We're at the Cafeteria</p> <p>Options Back</p>	<p>Digital Informatio Booth</p> <p>Here you can access services and information relative to the Faculty of Engineering Web Service</p> <p>Open Back</p>
<p>3G UD</p> <p>Universidad de Deusto Entrar</p>	<p>3G Menú</p> <p>Menú: Inf.General Consulta de notas e-mail Noticias Cátedra Telefónica Móviles Ayuda </p> <p>Options Back</p>	<p>Graffiti List</p> <p>Digital Informatio Booth We're at the Cafeteria</p> <p>Options Back</p>	<p>We're at the Cafeteria</p> <p>Join us Koldo, we will be there till 5pm</p>  <p>Back</p>

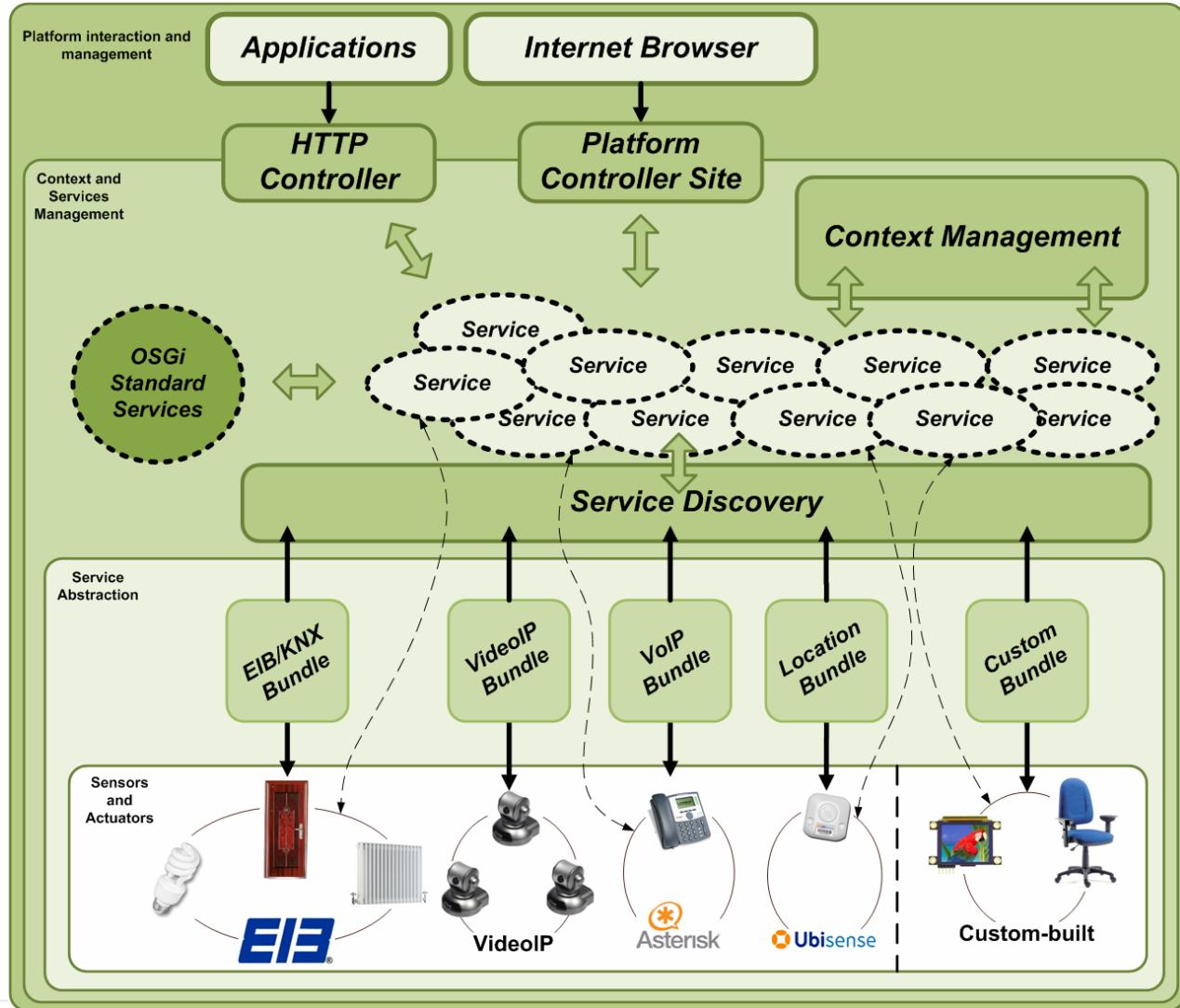
Iteration 4: Enable Dynamic and Flexible Smart Environments applied to AAL

SmartLab: Semantically Dynamic Infrastructure for Intelligent Environments
ElderCare: An Interactive TV-based Ambient Assisted Living Platform
(2008-10)



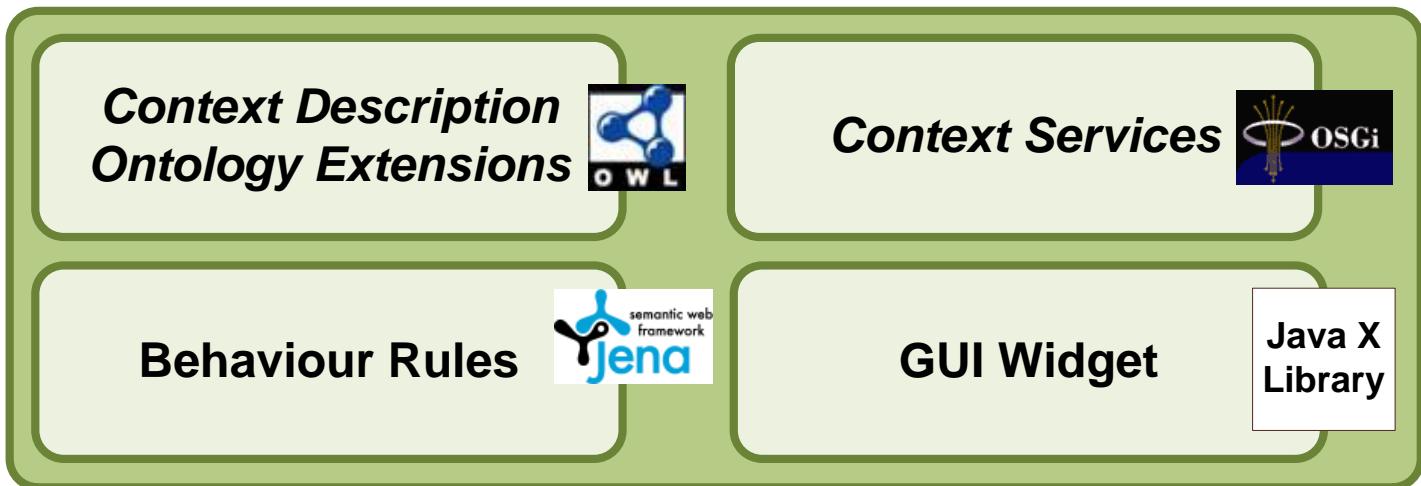
Universidad de Deusto
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SmartLab Architecture



Layer 2: Semantically-enhanced OSGi Bundles

Chair_v1.0.0.jar



Layer 3: Context Management

- Context information modelled with an ontology
 - Base core
 - Time and space relations
 - Events
- **New services might extend the knowledge base**
 - Classes and instances
 - Behaviour rules
- Converts inferred information into OSGi events to which the different services can register.
 - React accordingly to specific events.

Context Management

- Two knowledge generation methods in SmartLab:
 - **Ontological reasoning**
 - Makes use of RDF (`rdf:domain`), RFS (`rdfs:subPropertyOf`) and OWL (`owl:TransitiveProperty`) predicates
 - Allows to infer implicit knowledge
 - **Rule-based reasoning**
 - Allows defining relationship among entities in ontology
- Three types of inference:
 - **Semantic rules** – enable making ontological reasoning based on RDF and OWL theoretical models
 - **Knowledge extraction rules** – extract new knowledge from ontology's implicit one
 - **Event-inferring rules** – generate aggregated events from the context in the knowledge base

Contribution

- **Several extensions to the OSGi framework to support intelligent and evolvable environment instrumentation** have been presented:
 - Devices or environment services expose a special **semantic control bundle**.
 - OSGi bundles are discovered and act as a proxy providing semantic enhanced services.
 - These services populate the system with new context information in order to infer new knowledge and generate events.
 - Different services can register to receive context events and react to them accordingly.
 - The platform knowledge has been modelled using ontologies and rules that can be extended and updated dynamically.
 - For explicit interaction we have a HTTP interface or a Dashboard GUI based on widgets that can be used to interact with the platform.
 - **Semantic reasoning is powerful but costly computationally!!**

Dynamic AAL Environments

- AAL offers ICT support towards a more autonomous living of elderly and dependant people
- However, there are **several issues preventing a wider adoption of AAL:**
 - ICT support is usually **expensive and too complex** to deploy
 - **Collectives** such as care staff and relatives have often been **neglected**
 - **Care data management is often inadequate** and out of time
 - **Offered interfaces are not suitable** for elderly people
 - TV is the most universal and accessible device to any elderly person!!
- Our goal:
 - **Devise a low-cost, easily deployable, usable, evolvable ICT infrastructure leading towards AAL for All**

ElderCare Platform

- So, **are we ready to provide the AAL Kit?**
 - ElderCare = a minimum but sufficient set of off-the-shelf hardware and software infrastructure, which is:
 - **Affordable**: uses mass produced hardware. Our kit costs around 250€
 - **Unobtrusive**: seamlessly integrated with furniture, elderly people are only required to wear silicon RFID tags
 - **Easily deployable** both at homes and residences
 - **Usable and accessible** by any user collective through iTV, RIA, NFC
 - **Evolvable** – thanks to the adoption of OSGi, it copes with sensing and acting infrastructure and protocols (Zigbee, ANT, KNX and so on).

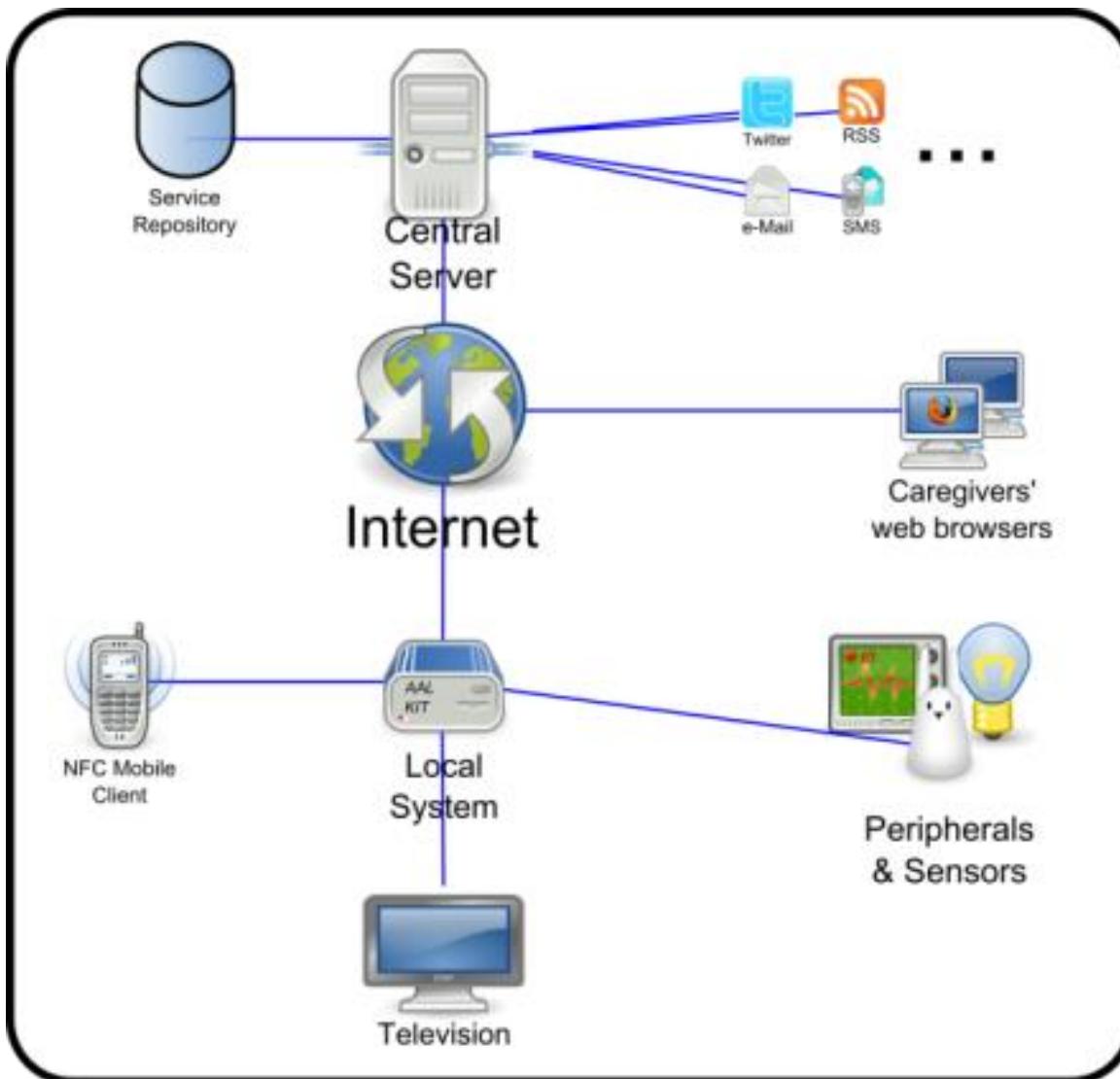
ElderCare Interfaces

- ElderCare offers interfaces for three core collectives in AAL:
 - **Elderly people** – by means of an interactive TV interface, a remote control or seamlessly integrated web objects
 - **Caretaking staff** – request and register info through NFC mobiles and touch screens and access a RIA interface
 - **Relatives** – follow elderly people's life logs through RSS and microblogging, or access it through a RIA interface

ElderCare Architecture

- Presents a distributed architecture with the following three types of components:
 1. **Local Systems** – AAL Kit instances deployed in residence rooms or houses
 2. **Mobile Clients** – allow recording care logs on wristband like RFID tags through NFC mobiles
 3. **Central Server** for remote management and service provisioning of remote local systems

ElderCare Architecture



ElderCare's Local Systems

- Governed by an Equinox OSGi server managing services such as:
 - TV tuner and widget manager (based on Mplayer)
 - Home automation manager
 - Alert manager
 - Elderly vital sign monitor (Zephyr HxM biometric vest)
 - Service Manager on top of BundleContext class
- Offers **TV, IoT and RIA interfaces** to control and manage accessibility services

Local System's TV Interface



Clamoxyl

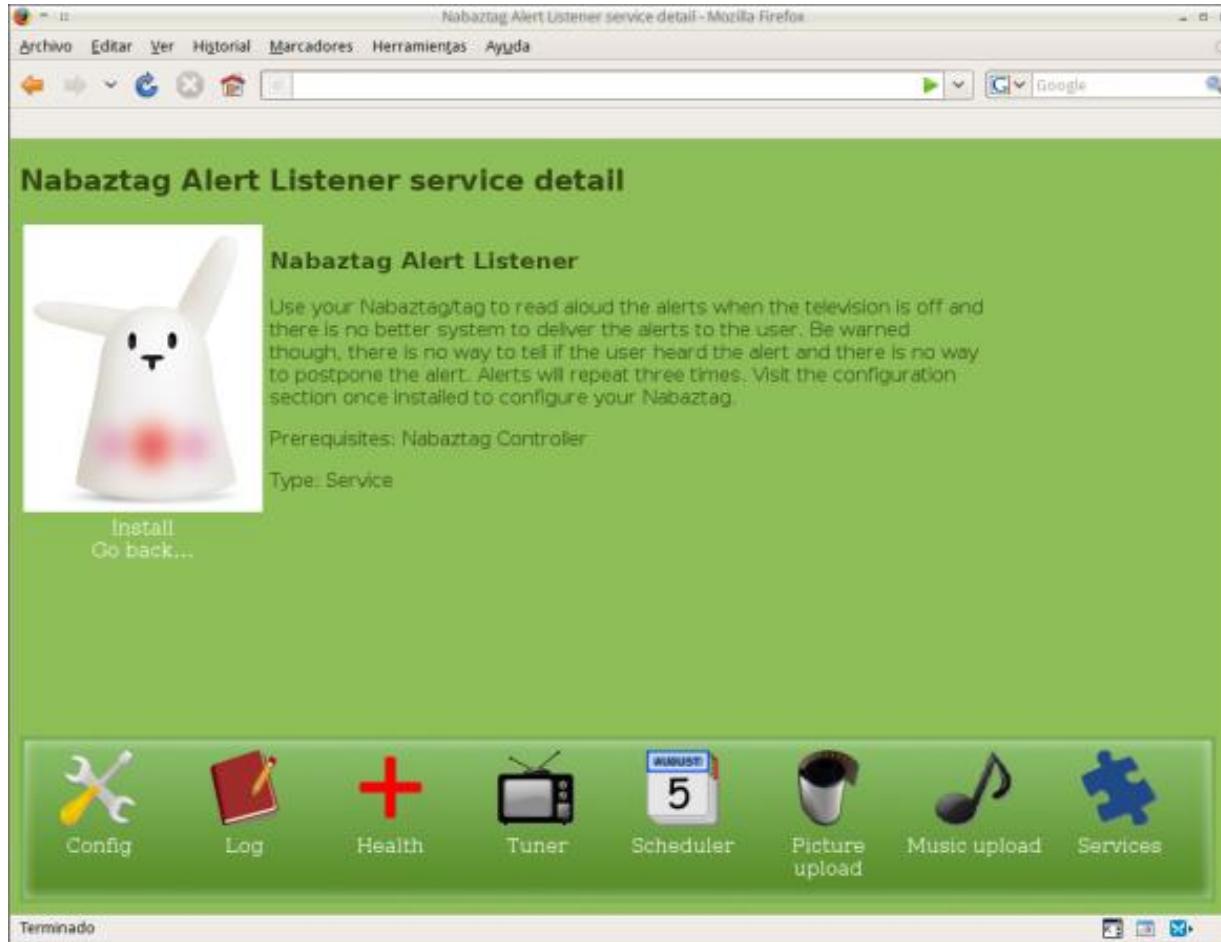
It's time to have some Clamoxyl

Clamoxyl
1g
6 comprimidos disperables

0 Accept

1 Postpone

Local System's RIA interface



ElderCare's Central Server

- **Unique façade to control a set of Local Systems** through a RIA interface developed with GWT which allows **configuration and control of a set of deployed Local Systems**
- **Responsible of managing changing connection details** of Local Systems
 - Caches current IP address and status of every local system
- **Reacts autonomously to state changes** reported by Local Systems
 - A rule-based system supporting different type rule engines associated to independent knowledge bases.
- Offers a **service repository (AAL store)** to deploy new services in remote Local Systems
- **Forwards collected (non-private) patient data** through RSS or micro-blogging services

Central Server's Front-end

ElderCare

Making aging better

Patients Staff Profiles & Permissions Configuration Care Logs and Reports **Services**

Remote client to manage:

Remote Patient 102 (Evarista Paredes) ▾

Available Services	<<	Installed Services
Nabaztag Alert System	Remove	DVB-T
Internet Browser		Media Gallery
RSS Reader	>>	

Upload a new service:

[Browse...](#)



Mobile Client



- **Care data management is inadequate:**
 - Relatives often do not have Internet access
 - Staff report care details off-line, late and incompletely
 - Residents do not always stay at the care centre
- We propose to **record care logs in situ through an NFC mobile on an RFID tag**
 - The most recent and **relevant care information**, and **medical profile** remains **with the patient at all time**
 - 164 messages can be stored in an 4K RFID wristband which may be enough for storing logs in a day

Mobile Client's User Interface



Publishing Care Logs

- The **ElderCare** platform does not only record custom data to enhance the daily activities in a care centre but ...
 - It also **exports non privacy-invasive data to external services such as Twitter** from which authorised followers can **follow the *lifelog* of residents**

Publishing Care Logs

The screenshot shows a Twitter profile page for the user `ignaciosarralde`. The profile picture is a blue cross with a green bird in the center. The timeline displays several tweets, all of which are care logs from a residence. The tweets are as follows:

- 2009/10/08T13:42:07:39832321 @Residence:Food 10:16 AM Oct 10th from JTtwitter
- 2009/10/08T13:27:35.38122311 @Residence:Received visit from Cousin Paco 10:10 AM Oct 10th from JTtwitter
- 2009/10/08T13:07:48.40223112 @Residence:Visited WC 10:04 AM Oct 10th from JTtwitter
- 2009/10/08T13:02:13.40223112 @Residence:Leisure- Playing cards 9:56 AM Oct 10th from JTtwitter
- 2009/10/08T12:48:20.40223112 @Residence:Incident- Hit another patient 9:49 AM Oct 10th from JTtwitter
- 2009/10/08T12:34:40.38122311 @Residence:Incident- Fell asleep 9:44 AM Oct 10th from JTtwitter
- 2009/10/08T12:10:18.38122311 @Residence:Leisure- Watching TV 9:37 AM Oct 10th from JTtwitter
- 2009/10/08T11:52:39.40223112 @Residence:Visited WC 9:32 AM Oct 10th from JTtwitter

Iteration 5: Towards SmartCities through Web of Data and IoT

MUGGES: Mobile User Generated Geo Services
Internet Enabled Services for cities across Europe
(2010-13)



Universidad de Deusto
Deustuko Unibertsitatea

Society estimations by 2050

- Urban populations will grow by 2.3 billion
 - **70% of world's population will live in cities**
 - **People with disabilities make up about 15% (\approx 1 billion people)**, according to the World Health Organization
 - People over the age of 60 is expected to triple, outnumbering children under 15 for the first time in human history

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.**
- Smart cities should not only enable **more efficient and effective management of the city resources**.
 - The aim is to **increase comfort and satisfaction from all population sectors**, without neglecting elderly and disabled people.

What is an Ambient Assisted City?

- A city aware of the special needs of all its citizens, particularly those with disabilities (physical, sensorial, intellectual...) or about to lose their autonomy (young old, old and oldest old)
- A both economical and technological **feasible** approach:
 1. Leverage the **open data initiatives**
 2. Use the **extensive sensor networks already deployed**
 3. Benefit from the **increasing number of smartphones** among citizens

Requirements for more inclusive and accessible AAC

- Seamless, low-cost and feasible city instrumentation
- Accessible user interfaces for applications
- User participation and contribution
- Exploitation of currently existing ICT infrastructure within cities

BlindShopping ⚒

- A platform that enables blind people to shop autonomously in a supermarket
- Motivation:
 - More than 70k blind people in Spain (ONCE, 2009)
 - Increasing computing, communication and sensing capabilities in smartphones
- Provides:
 - A navigation system (verbal interaction + RFID tags)
 - A product browsing mechanism

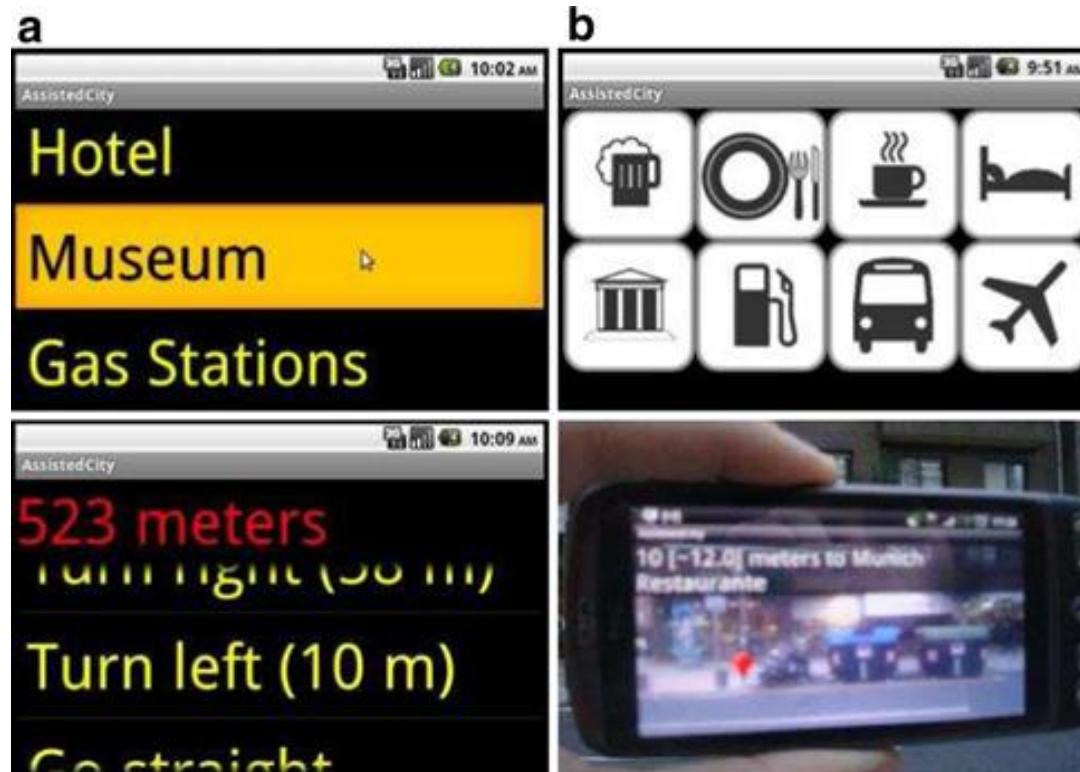


Imhotep

- **User-conscious interface adaptation**
- **Motivation:**
 - Increasing the number of apps suitable for number of elderly and disabled people
 - Developers tend to ignore or neglect this user base
- **Provides:**
 - Framework that eases the development of adaptive, user-centric accessible mobile applications

Imhotep > Assisted City app

- Imhotep powered app to search nearby interesting locations, adapted to the user requirements and capabilities



MUGGES

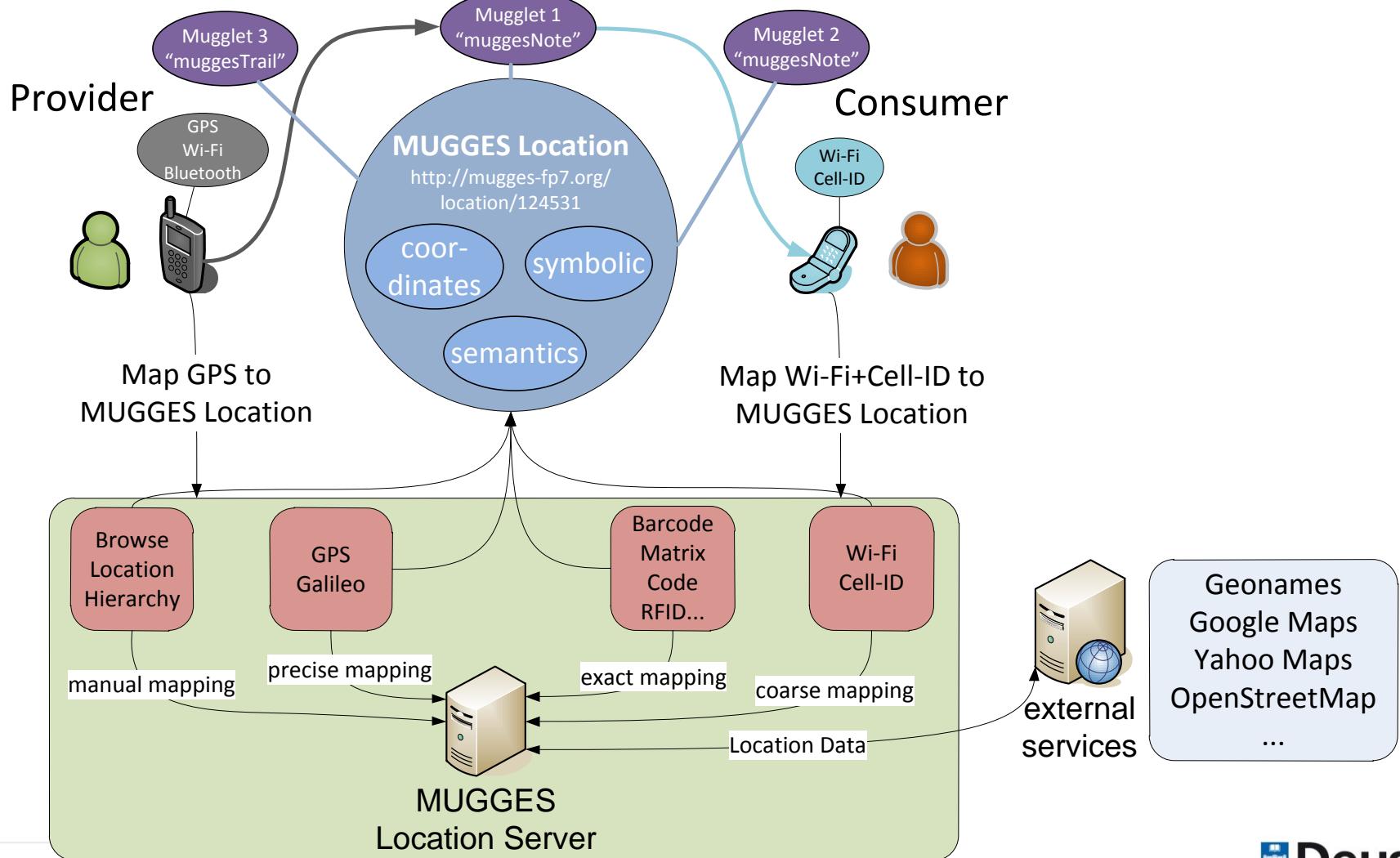
- **Mobile User Generated Geo Services**
- **Motivation:**
 - Users can develop their own services
 - Evolution of paradigm: from consumer to prosumer
- **Provides:**



The figure displays five mobile application screens for the 'mugges' platform, each illustrating a different type of user-generated geo service:

- muggesNote:** A note-taking feature where users can add text, images, and locations. It includes a map view with a green marker and a photo of a historical monument.
- muggesJournal:** A journal entry feature showing a list of three entries with dates and times.
- muggesTrail:** A trail mapping feature showing a green line on a map connecting several points, with a small character icon running along it.
- muggesRace:** A race tracking feature showing a map with a green line and numbered points (1, 2, 3, 4), indicating a race route or path.

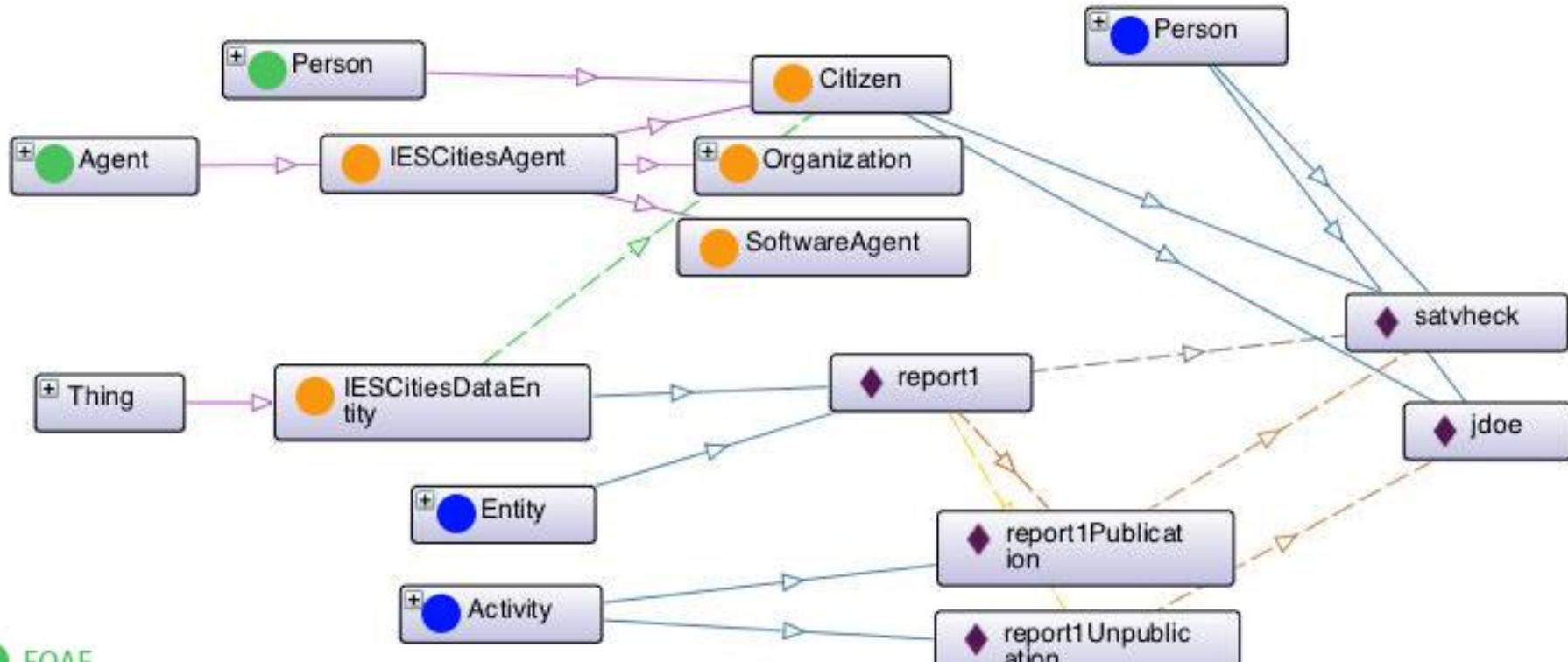
MUGGES Location Model



IES CITIES

- **Internet Enabled Services for cities across Europe**
- **Motivation:**
 - Citizens must be heard & empowered
 - The information gathered and provided by both cities and citizens must be linked and processed
- **Goals:**
 - Create a **multi-device dataset and application marketplace** based on standard and accessible web technologies, **exploiting data shared between citizens and councils**, and providing an enhanced experience to municipalities.

IES CITIES Ontologies



FOAF

W3C PROV

IES CITIES

Instantiation

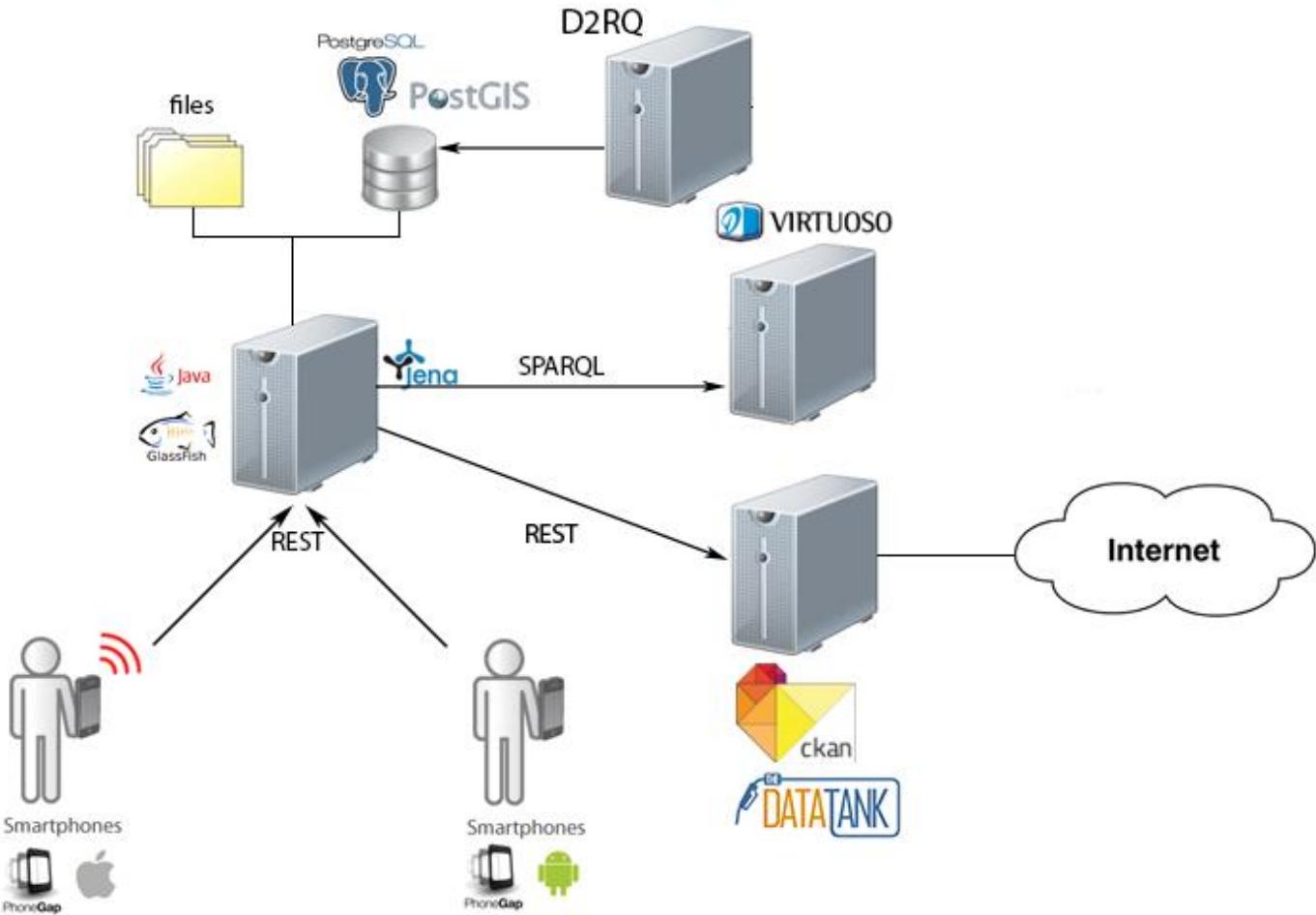
JSON-based Queries

- JSON formatted query, based on RDF triple pattern

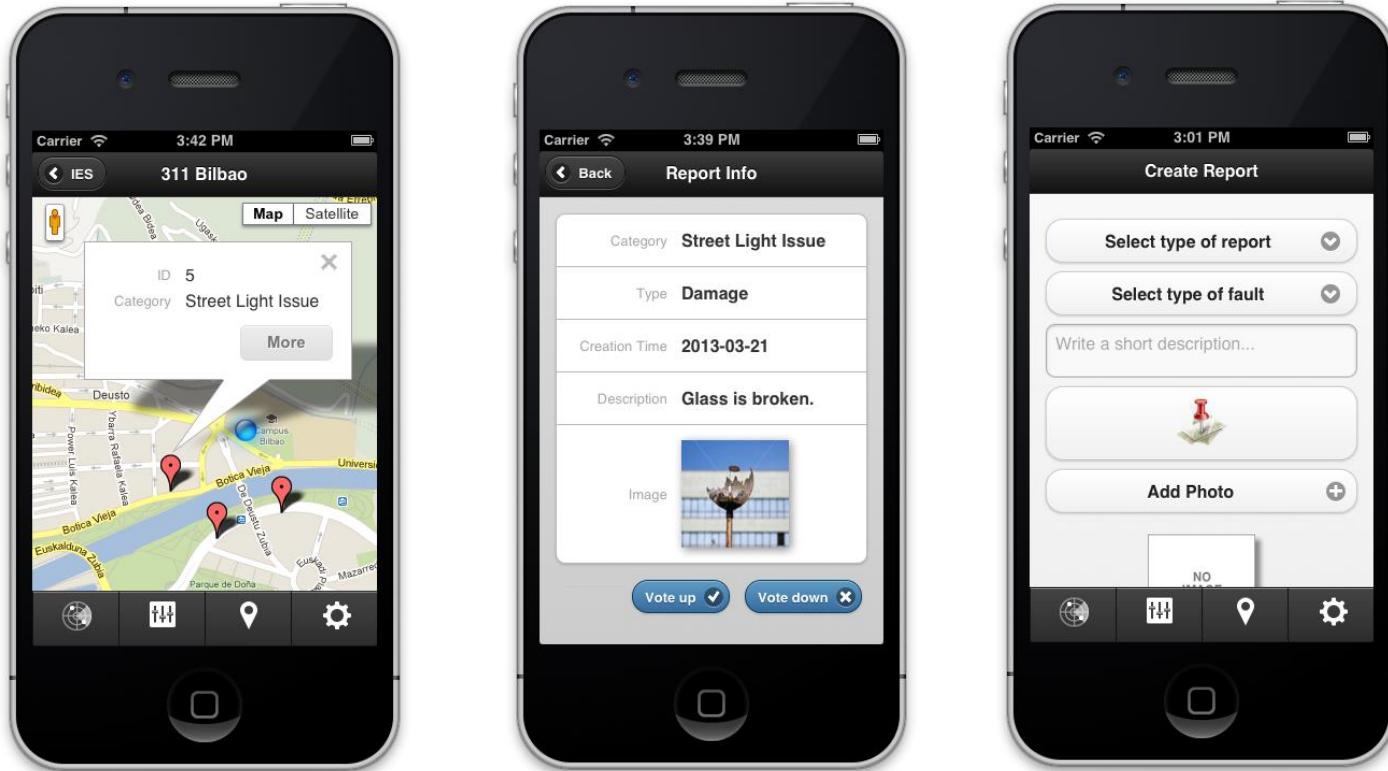
```
{  
  "type": "data",  
  "requested": { "predicate1": "object1",  
                 "predicate2": "object2" },  
  "optional" : { "predicate3": "object3" },  
  "given"    : { "predicate2": { "type": "string",  
                               "value": "object2_value" } }  
}
```

- Translated to corresponding technology
 - SPARQL
 - SPECTQL

Implementation



Exemplary application: 311 Bilbao



DeustoTech-INTERNET Unit

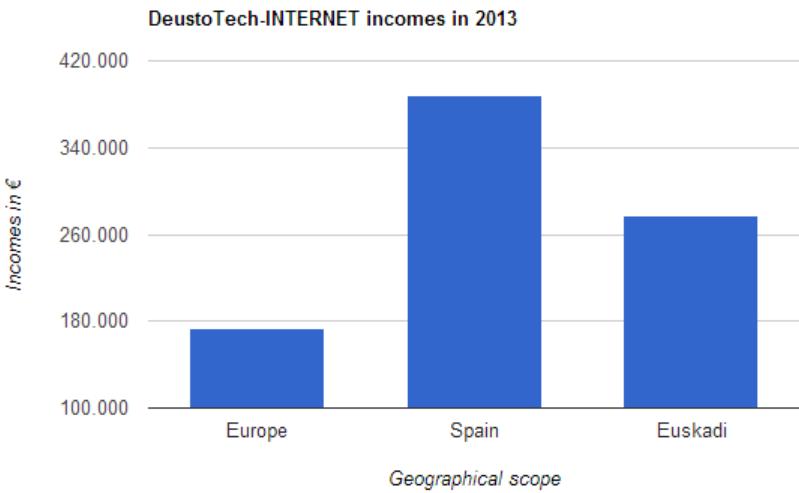
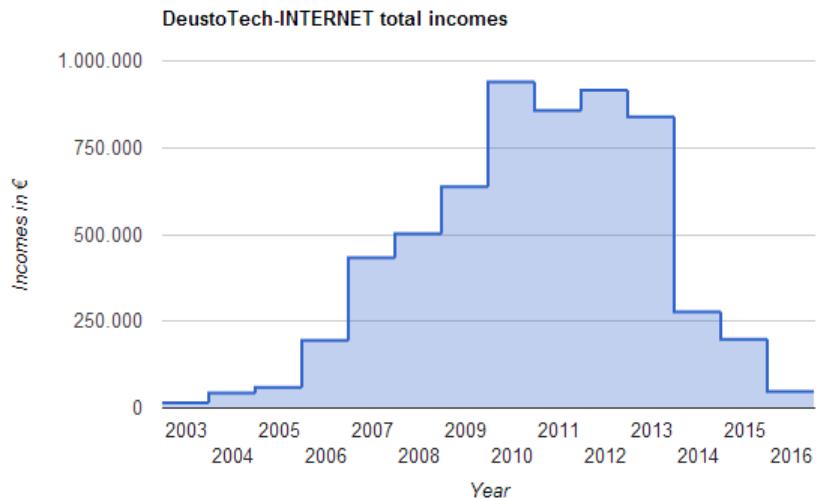
- Principal researcher:
 - Dr. Diego López-de-Ipiña,
<http://paginaspersonales.deusto.es/dipina/>
- It comprises:
 - 4 lecturers
 - 2 PostDoc
 - 9 full-time researchers
 - 5 PhD grant holders
 - 2 MSc grant holders
- **22 people**

Performance

- Scientific:
 - **2012: 66 publications**
 - 8 JCRs, 12 book chapters, 33 indexed conferences, 13 other publications
 - **2011: 48 publications**
 - 8 JCRs, 13 book chapters, 3 indexed conferences, 24 other publications
- Economic:
 - **2012: > 915K €**
 - **2011: > 850K €**

DeustoTech-INTERNET

Performance



Active projects (as of May 2013)

- **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
- **Spanish projects (mostly applied research)**
 1. THOFU: Future Hotel Technologies, CENIT 2010, Spanish IP-like project
 2. ADAPTA. Adapting, validating and integrating open data for governments and companies, IPT-2011-0949-430000
 3. Social Awareness Based Emergency Situation Solver. SABESS, IPT-2011-1052-390000
 4. Migration towards the Cloud - mCLOUD, IPT-2011-1558-430000
 5. TALIS+ENGINE: Hybrid Cooperative and Semantic Reasoning for Service Orchestration in Assistive Environments (TIN2010-20510-C04-03), 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. UCADAMI: User and Context-aware Dynamically Adaptable Mobile Interfaces (S-PE12FD006)
 3. SmarTUR: Tourism in Smart Intelligent Environments
 4. DEUSTEK3: Research group recognized by the Basque University system (IT745-13)
 5. ... upto 8

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:**
 - **THOFU** – creating the ICT infrastructure for next generation hotels and tourism including smart objects and sentiment analysis
 - **SONOPA** – activity-aware social networks to promote social interaction among elderlyies
 - **TALIS+ENGINE** – fostering personal autonomy by ambiguous context modelling, reasoning and services coordination through triple spaces
 - **DYNUI** – user interfaces adaptable to user context, capabilities and devices

What do we actually do?

- **Social Data Mining & Opinion Mining:**
 - **SABESS** – extracting structured knowledge about emergencies from social networks
 - **THOFU** – analysing information about hotel reviews to perform sentiment analysis
- **Linked Data & Linked Data Apps:**
 - **IES CITIES** – urban app ecosystems based on council and government open data where users prosume data
 - **ADAPTA** – enabling a holistic LinkedData platform to adapt, validate and exploit open data (dataset recommendation)
 - **SmarTUR** – tourism related LinkedData Apps (LinkedQR)

What do we actually do?

- **Semantic Embedded Middleware:**
 - **TALIS+ENGINE** – 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
- More info about our projects:
 - Projects page: <http://www.morelab.deusto.es/index.php/projects-701358149>

Web of Data:

MORElab Research Projects' Dataset

IES Cities: Internet Enabled Services for the Cities across Europe

Resource URI: <http://dev.morelab.deusto.es/sourceplanet/d2r/resource/project/IES-Cities>

[Home](#) | [All Project](#)

Property	Value
dc:description	IES Cities is the last iteration in a chain of inter-related projects promoting user-centric and user-provided 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, different at each location, in order to allow the cities and their citizens covering different needs under a common platform. Users will be able to continuously enrich the consumed services with their own data and to have a voice in the proposal and selection of new services to be developed. The set of pre-defined urban services defined is specific to the cities where they will be deployed since not all cities count with the same data and the same needs for their citizens. These services will target different strategic topics in a city such as mobility, environment, health, culture, knowledge of the cities and so on. The project comprises partners from five different European countries who will deploy and validate the integrated open platform for enabling Linked Data urban apps in cities from three different countries in Europe. The cities involved will be Zaragoza (ES), Bristol (UK), Rovereto (IT) and Majadahonda (ES).
swrcfe:hasConsortiumMember	< http://dev.morelab.deusto.es/sourceplanet/d2r/resource/organization/amis-doo >
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swrcfe:hasConsortiumMember	< http://dev.morelab.deusto.es/sourceplanet/d2r/resource/organization/ayuntamiento-de-zaragoza >
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swrcfe:hasProjectLeader	< http://dev.morelab.deusto.es/sourceplanet/d2r/resource/organization/european-union >
swrcfe:hasProjectLogo	< http://dev.morelab.deusto.es/sourceplanet/media/ >
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swrcfe:hasStatus	In development
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IES Cities: Internet Enabled Services for the Cities across Europe

www.morelab.deusto.es/projects-funding

Font size Bigger Reset Smaller

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MORE lab envisioning future internet DeustoTech

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DeustoTech total incomes

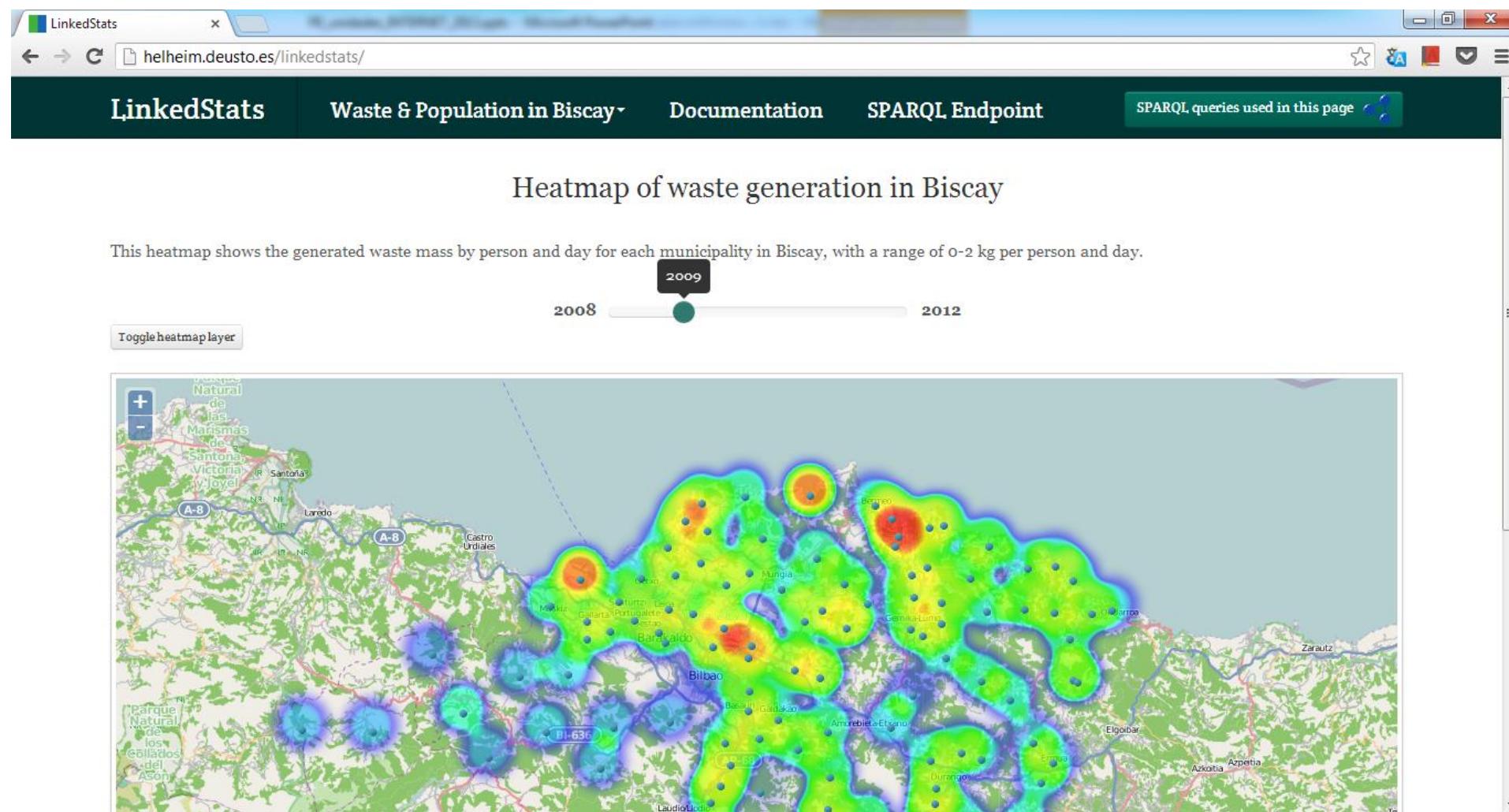
Incomes in €

Year

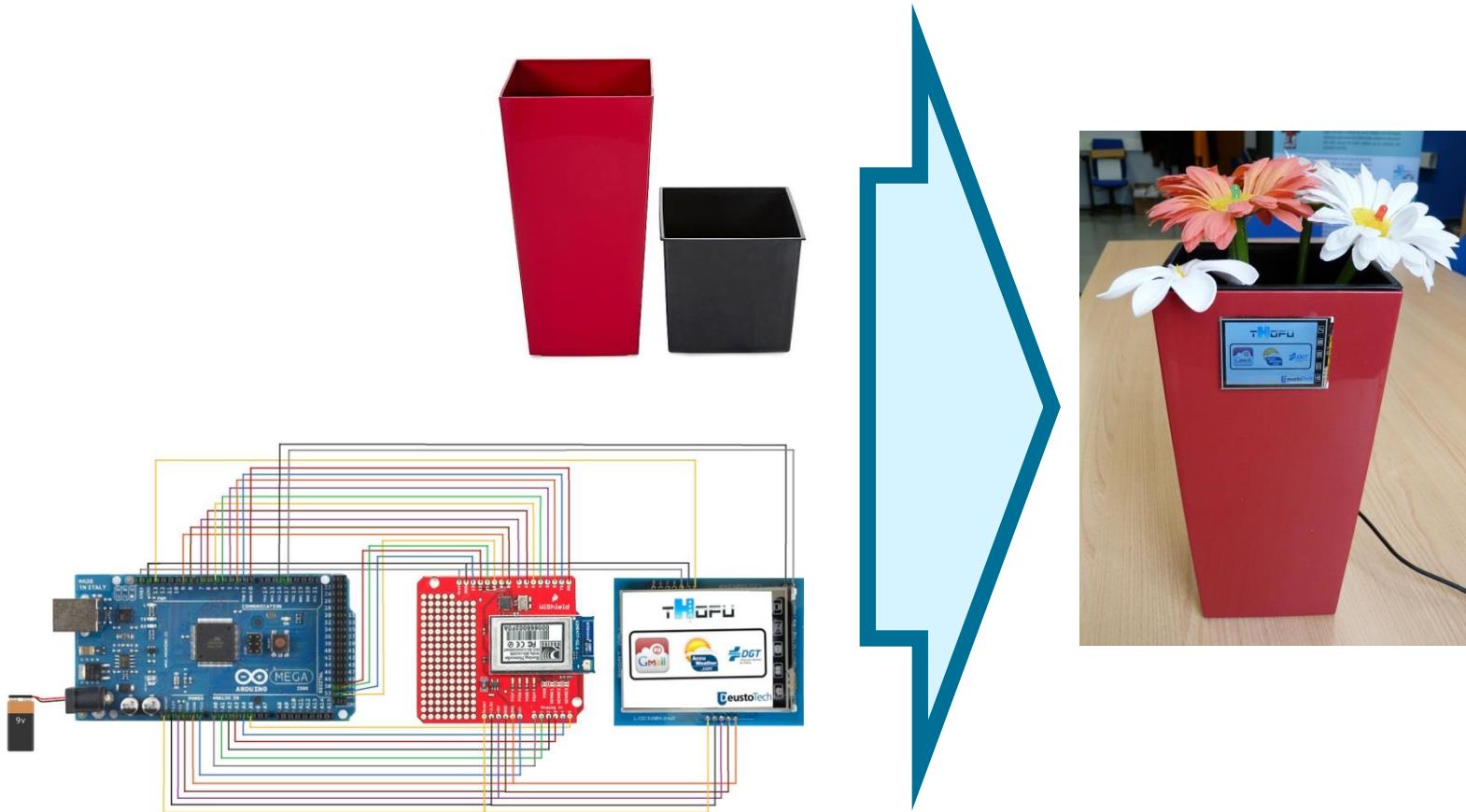
DeustoTech

Web of Data:

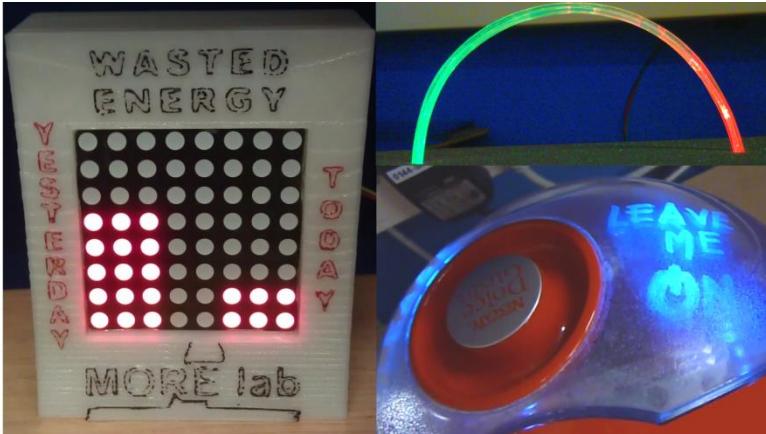
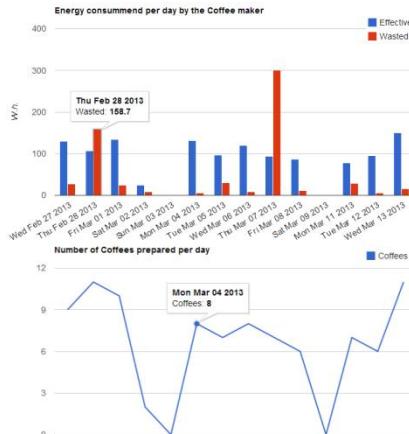
Waste-related LinkedStats



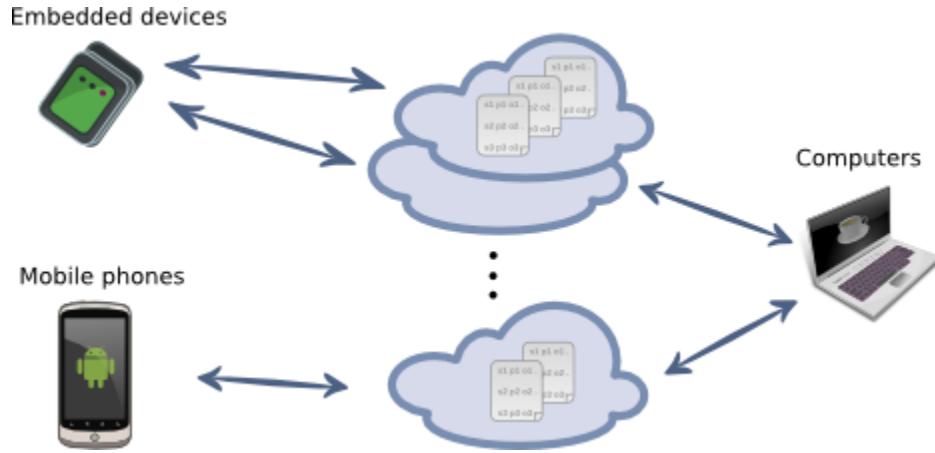
Internet of Things: SmartVase



Internet of Things: Social Sustainable Coffee Machine

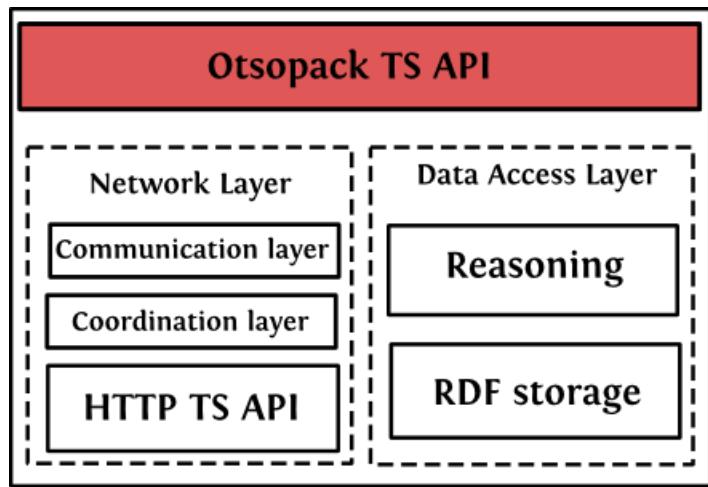


Web of Things: OtsoPack Semantic Middleware



Triple Spaces solution for heterogeneous devices

<https://code.google.com/p/otsopack/>



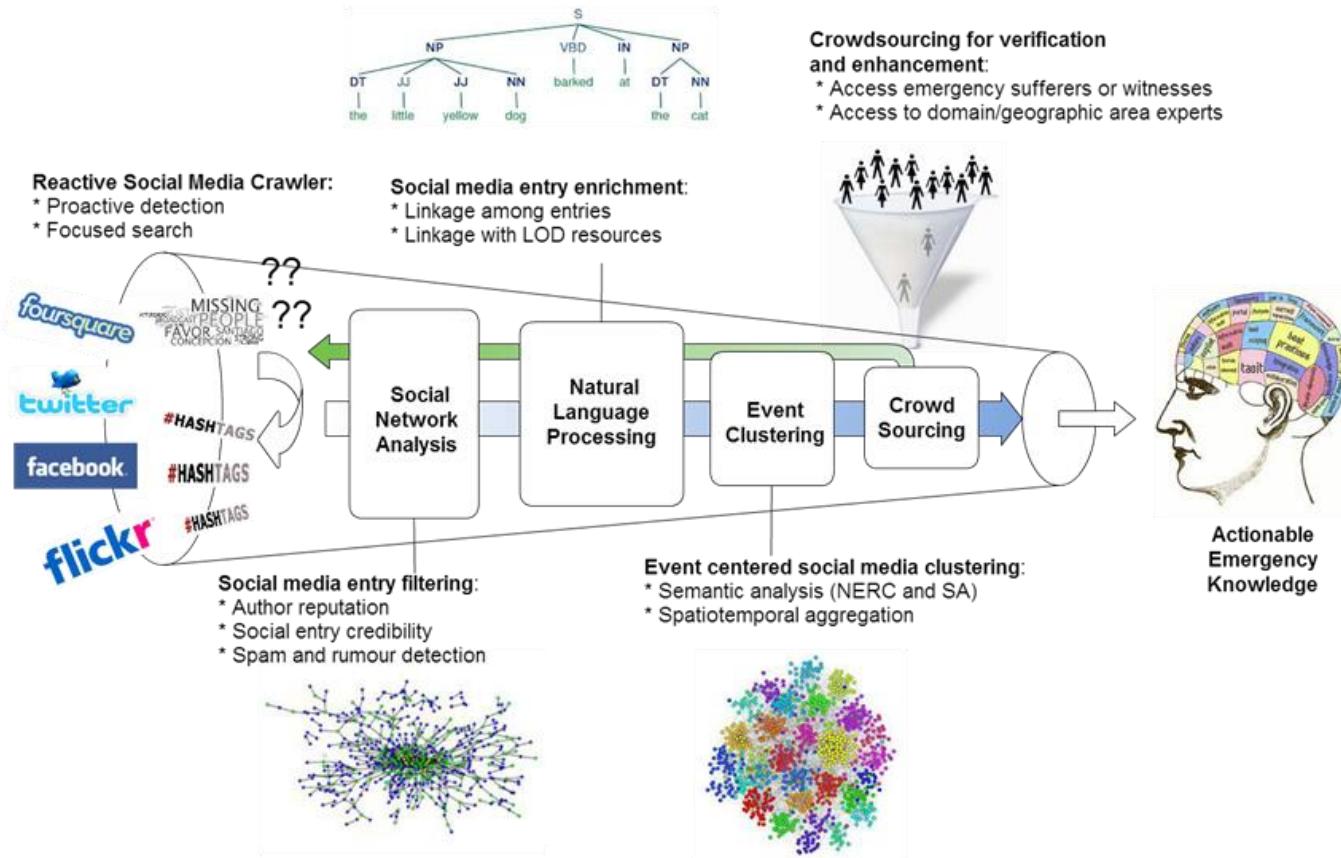
Federating Labs for Remote Experimentation using the Web



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

<https://github.com/weblabdeusto/weblabdeusto/>

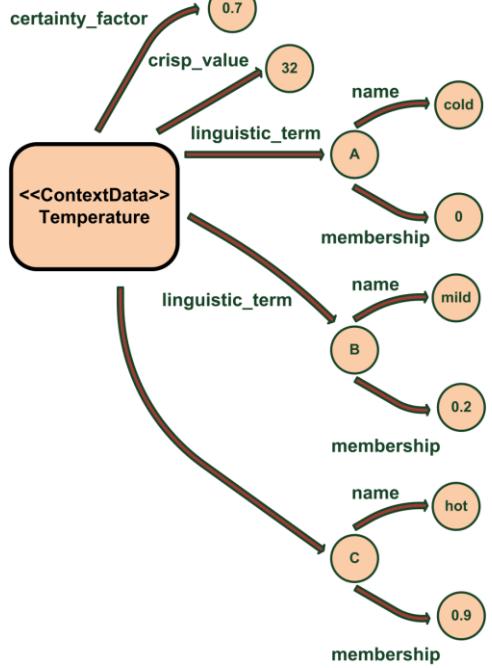
SABESS: Social Data Mining for Emergency Detection



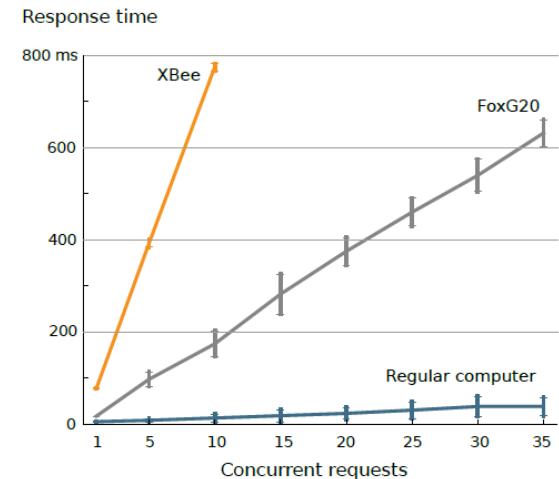
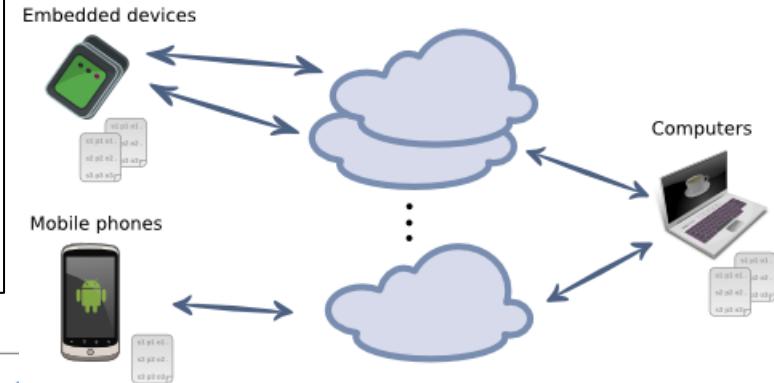
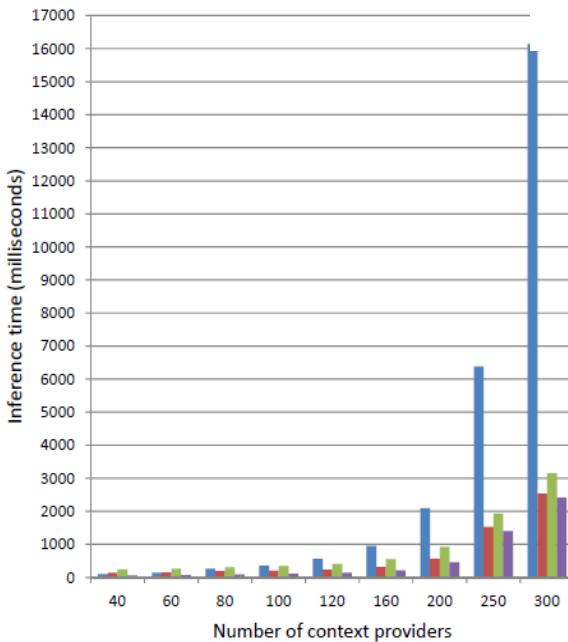
PhDs defended in the group

1. "CONCERT: A new framework for contextual computing in tourism to support human mobility", by **Carlos Lamsfus**, supervised by Diego López-de-Ipiña y Aurkene 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. Aurkene 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

Latest PhD results: Ambiguity supporting ontology + Reasoning engine + Coorsdination and interoperability middleware



RULE CF 1
LaboratoryA hasGlobalTemperature
temperatureX
temperatureX HOT
->
airConditioningX type AirConditioning
airConditioningX location LaboratoryA
airConditioningX temperature 22



Some Selected Publications

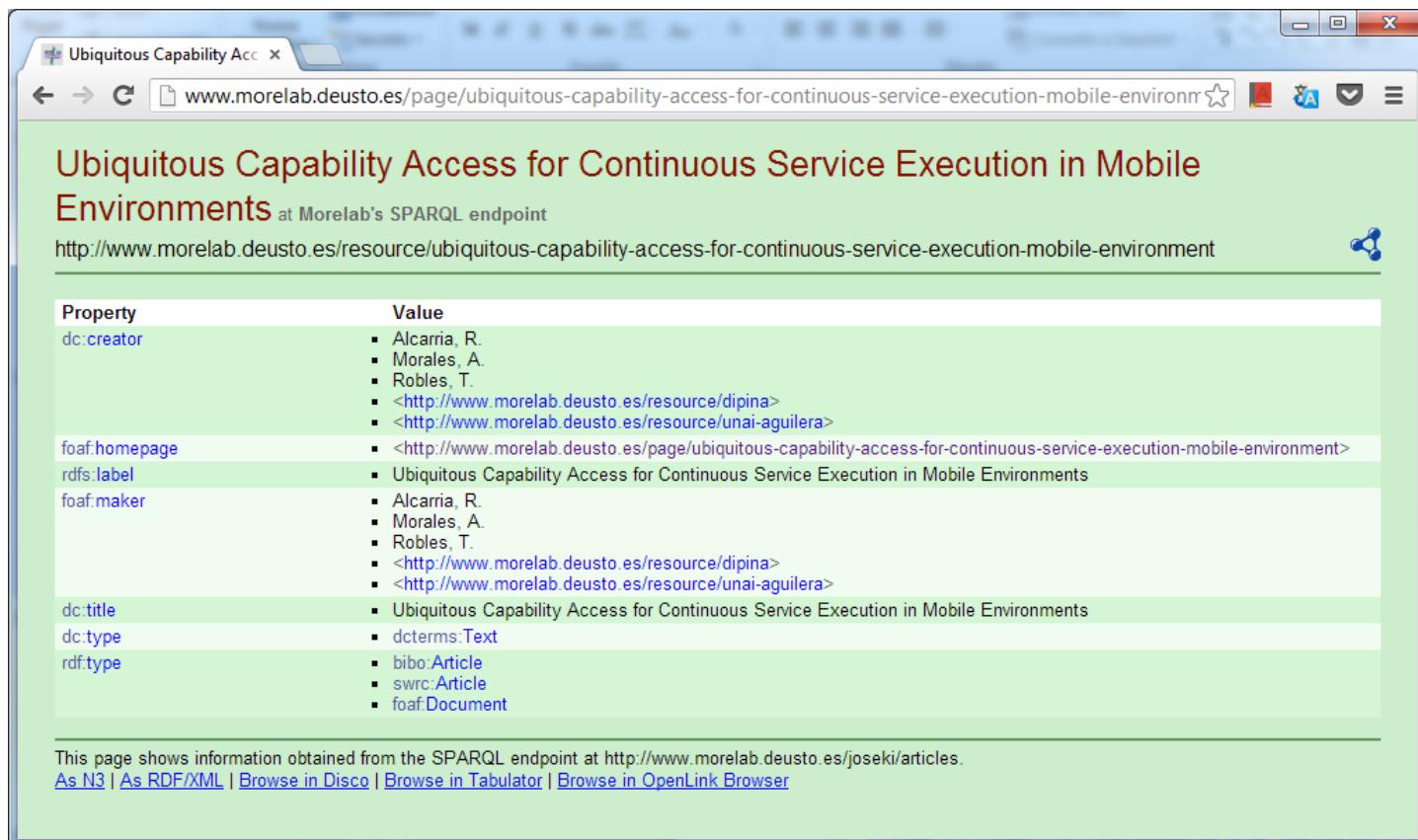
1. *Towards federated interoperable bridges for sharing educational remote laboratories.* Pablo Orduña, Philip H Bailey, Kimberly DeLong, Diego López-de-Ipiña, Javier Garcia-Zubia. Computers in Human Behavior (Journal), <http://dx.doi.org/10.1016/j.chb.2013.04.029>, ISSN 0747-5632, JCR Impact Factor (2011): 2.293, Q1(PSYCHOLOGY, MULTIDISCIPLINARY), ranked 22/125, PERGAMON-ELSEVIER SCIENCE LTD, March 2013.
2. *Software Engineering Aspects of Ubiquitous Computing and Ambient Intelligence.* Diego López-de-Ipiña, Sergio F. Ochoa and José Bravo. Science of Computer Programming, <http://dx.doi.org/10.1016/j.scico.2013.03.001>, ISSN 0167-6423, JCR Impact Factor (2011): 0.622, Q3(COMPUTER SCIENCE, SOFTWARE ENGINEERINGATION), ranked 70/104, ELSEVIER SCIENCE BV, March 2013.
3. *RFID breadcrumbs for enhanced care data management and dissemination.* José Bravo, Diego López-de-Ipiña and Ramón Hervás. Personal and Ubiquitous Computing, JCR Impact Factor (2011): 0.938, Q2(COMPUTER SCIENCE, INFORMATION SYSTEMS), ranked 66/133. <http://dx.doi.org/10.1007/s00779-012-0557-7>. May 2012.
4. *Assessing Ambiguity of Context Data in Intelligent Environments: Towards a More Reliable Context Managing System,* Aitor Almeida and Diego López-de-Ipiña, Sensors (Journal). Volume 12, Issue 4, pp 4934-4951. MDPI. JCR Impact Factor (2011): 1.739, Q1(INSTRUMENTS&INSTRUMENTATION), ranked 14/58. <http://dx.doi.org/10.3390/s120404934>. April 2012
5. *Imhotep: an approach to user and device conscious mobile applications,* Aitor Almeida, Pablo Orduña, Eduardo Castillejo, Diego Lopez-de-Ipiña, Marcos Sacristán, Personal and Ubiquitous Computing (Journal). Springer. Vol. 15, no.4. pp.419-429. JCR Impact Factor (2011): 0.938, Q2(COMPUTER SCIENCE, INFORMATION SYSTEMS), ranked 66/133. ISSN: 1617-4909. <http://dx.doi.org/10.1007/s00779-010-0359-8>. January 2011

Some Selected Publications

6. *Enabling Flexible and Continuous Capability Invocation in Mobile Prosumer Environments*. Ramon Alcarria, Tomás Robles, Augusto Morales, Diego López-de-Ipiña and Unai Aguilera. Sensors (Journal). MDPI. Vol. 12, no. 7, pp. 8930-8954, <http://dx.doi.org/10.3390/s120505273>, ISSN 1424-8220, JCR Impact Factor (2011): 1.739, Q1(INSTRUMENTS&INSTRUMENTATION), ranked 14/58, Basel, Switzerland, June 2012.
 7. *Addressing Software Impact in the Design of Remote Laboratories*, Javier Garcia-Zubia, Pablo Orduña, Diego Lopez-de-Ipiña and Gustavo R. Alves, IEEE Transactions on Industrial Electronics, <http://dx.doi.org/10.1109/TIE.2009.2026368>, ISSN 0278-0046, vol. 56, no. 12, pp. 4757-4767, December 2009: JCR Impact Factor (2009): 4.678, Q1(AUTOMATION & CONTROL SYSTEMS), ranked 1/59
 8. *mRDP: An HTTP-based lightweight semantic discovery protocol*, Vazquez J.I. and López de Ipiña D. Computer Networks: The International Journal of Computer and Telecommunications Networking, Elsevier North-Holland Publisher, Inc., <http://dx.doi.org/10.1016/j.comnet.2007.06.017>, ISSN:1389-1286 vol. 51 , no. 16, pp. 4529-4542, November 2007: JCR Impact Factor (2007): 0.829, Q2 (TELECOMMUNICATIONS), ranked 25/66
 9. *EMI2lets: a Reflective Framework for Enabling Aml*, López de Ipiña D., Vázquez J.I., García D., Fernández J., García I., Sainz D. and Almeida A., Journal of Universal Computer Science (J.UCS), vol. 12, no. 3, pp. 297-314, March 2006, <http://dx.doi.org/10.3217/jucs-012-03-0297>, ISSN: 0948-695x : JCR Impact Factor (2006): 0.338, Q4(COMPUTER SCIENCE, SOFTWARE ENGINEERING), ranked 72/82
 10. *Collaboration of Sensors and Actuators through Triple Spaces*. Aitor Gómez-Goiri, Pablo Orduña, David Ausín, Mikel Emaldi and Diego López-de-Ipiña.. In IEEE Sensors 2011, pages 651-654. Limerick, Ireland, October 2011. ISBN: 978-1-4244-9290-9.
- For more details look at:
 - <http://paginaspersonales.deusto.es/dipina/publications.html>
 - <http://www.morelab.deusto.es/index.php/publications-1879995610>

Some Selected Publications

- For more details look at:
 - <http://paginaspersonales.deusto.es/dipina/publications.html>
 - <http://www.morelab.deusto.es/index.php/publications-1879995610>



The screenshot shows a web browser window titled "Ubiquitous Capability Acc" displaying a SPARQL endpoint result. The URL in the address bar is <http://www.morelab.deusto.es/page/ubiquitous-capability-access-for-continuous-service-execution-mobile-environment>. The page content is as follows:

Ubiquitous Capability Access for Continuous Service Execution in Mobile Environments at Morelab's SPARQL endpoint
<http://www.morelab.deusto.es/resource/ubiquitous-capability-access-for-continuous-service-execution-mobile-environment>

Property	Value
dc:creator	<ul style="list-style-type: none"> ▪ Alcarria, R. ▪ Morales, A. ▪ Robles, T. ▪ <http://www.morelab.deusto.es/resource/dipina> ▪ <http://www.morelab.deusto.es/resource/unai-aguilera>
foaf:homepage	<ul style="list-style-type: none"> ▪ <http://www.morelab.deusto.es/page/ubiquitous-capability-access-for-continuous-service-execution-mobile-environment>
rdfs:label	<ul style="list-style-type: none"> ▪ Ubiquitous Capability Access for Continuous Service Execution in Mobile Environments
foaf:maker	<ul style="list-style-type: none"> ▪ Alcarria, R. ▪ Morales, A. ▪ Robles, T. ▪ <http://www.morelab.deusto.es/resource/dipina> ▪ <http://www.morelab.deusto.es/resource/unai-aguilera>
dc:title	<ul style="list-style-type: none"> ▪ Ubiquitous Capability Access for Continuous Service Execution in Mobile Environments
dc:type	<ul style="list-style-type: none"> ▪ dcterms:Text
rdf:type	<ul style="list-style-type: none"> ▪ bibo:Article ▪ swrc:Article ▪ foaf:Document

This page shows information obtained from the SPARQL endpoint at <http://www.morelab.deusto.es/joseki/articles>.
[As N3](#) | [As RDF/XML](#) | [Browse in Disco](#) | [Browse in Tabulator](#) | [Browse in OpenLink Browser](#)

Other achievements

- 1 spin-off came up from the research group, <http://www.symplio.com/>
- Open source contributions:
 - Imhotep framework (Apache license):
<http://www.morelab.deusto.es/imhotep/>
 - WebLabDeusto – <https://www.weblab.deusto.es/web/>
 - Otsopack – <http://code.google.com/p/otsopack/>
 - Zxing – databar – <http://code.google.com/p/zxing/>
- Open dataset released in CKAN about MORElab's people, projects and publications:
 - <http://ckan.linkeddata.es/dataset/morelab>
 - Our datasets are scheduled to appear in next <http://lod-cloud.net/>
- MORElab researcher Pablo Orduña was nominated MIT's TR35 SPAIN in 2012

Activities Organized @ **MORElab**

- Open Hack Day 2013:
 - http://dev.morelab.deusto.es/hackathon/index.php/P%C3%A1gina_principal#Resultados
- Random Hacks for Kindness @Bilbao
 - <http://www.morelab.deusto.es/index.php/news-287822021/past-news/405-random-hacks-for-kindness-bilbao>
- AppCircus in Bilbao
 - <http://appcircus.com/event/appcircus-en-bilbao>
- Apps4BetterWorld
 - <http://www.morelab.deusto.es/concurso/index.html>

Goal in this placement

- Think on the topic: "**Linked Open Data as the fuel for Smarter Cities**, where **SmartCities = citizen-focused apps + council linked data + IoT + data prosumed** by users and the sensors of their mobile devices"
- Giving place to collaborations in:
 - New project proposals
 - New publications
- Just have time to think, read, study ... ☺

I have a dream ... the user-empowered inclusive City

The end



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