Exploiting the Semantic Technology for Developing Smart Space Application
Outline

Semantic Smart Spaces Overview
- Smart Environment
- Smart Environment Requirements
- Smart Environment Challenges
- Smart Environment Key Concept
- Semantic Web
- Semantic Smart Environment

Energy Aware Smart Building Scenario
- Overview
- Objectives
- System Actors
- Usage Scenarios
- Devices
- Technologies
- Hardware / Software Architecture
- Events and Data Flow
- Test Environment
SEMANTIC SMART SPACES
OVERVIEW
A smart environment is a *context aware* environment that is able to *interact* with its inhabitants through *autonomous devices* embedded all around this physical world.
Smart Environment Requirements (1/2)

Context Awareness

Who I am?

Where I am?

Who I am with?

What I am doing?

How do I feel?

What do I like?
Smart Environment Requirements (2/2)

Interoperability
Evolvalbility

Network

Industry

Sightseeing

Traffic

Navigation

Agriculture

Health care

Home Automation

Store info.
Smart Environment Challenges

- Multi-vendor devices
- Lack of a shared data storage
- Lack of common information exchange methods and standards
If information about the surrounding environment is machine understandable, then the variety of applications that can benefit is tremendous.

Here Comes the Role of Semantic Web
Semantic Web

- Extension of the current web
- Web of data
What Semantic Web is all About? (1/2)

MAKE THE WEB

WORLD WIDE DATABASE

Build the Internet of things
What Semantic Web is all About? (2/2)

- **MACHINE UNDERSTANDABLE**

- **WORLD WIDE DATABASE**

  - And so the web becomes

  - **SPARQL**

- **QUERY LANGUAGE**

  - Using

  - **FEDERATED DATA SETS**

  - So that we can find information in

- **RESOURCE DESCRIPTION FRAMEWORK**

  - Using

  - **RDF**

  - To link data

  - **LINKED DATA**
Semantic Smart Environment

- A smart environment that uses semantic web technologies for data representation
ENERGY AWARE SMART BUILDING SCENARIO
Overview

**WP2 Technology Road Mapping**
TRM Course, Market Analysis Seminar, Input Gathering, Consolidation, and Final Presentation

**WP3 Training Development**
Develop training tracks; SOA, Semantic Web, MDD, Ubiquitous Computing

**WP4 Joint Experiments**
Joint experiments with TECNALIA, VTT and UNIBO

**WP5 Staff Exchange**
3 months collaboration missions with TECNALIA

**WP6 Dissemination and Exploitation**
Training rounds
Exploitation cluster projects
Participants

Software Engineering Competence Center

University of Bologna - Italy

ANSR Lab Cairo University

TECNALIA - Spain
Objectives

- Low Cost Devices and Sensors
- Extendible and Configurable System
- Varity of End User Apps (Mobile – Web)
- Power Harvesting Policies
Key Features

- User Identification and profiling
- Detect user presence, localize user, and apply preferences
- Apply energy saving policies
- Device self identification
- Remote monitoring and control
- Fault detection and notification
System Actors

- **Home User**
  - Register user preferences
  - Remote monitoring and control via web interface
  - Receive fault notification and alarms via mobile

- **Maintenance Company**
  - Register profile via web interface
  - Contact info
  - Rates and working hours
  - Devices to fix

- **Admin**
  - Configure smart home
  - Create smart home ID
  - Plugs devices to enter the smart space
Usage Scenarios (1/4)

1. **Smartification**

   - Send Identification Packets
   - Smart Space
   - Admin Configure and Localize Devices

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Usage Scenarios (2/4)

User and Company Registration

Send Data

Smart Space
Usage Scenarios (3/4)

3 Actuation

- Detect user Presence
- Localize User
- Apply user preferences
- Apply Energy Saving Policy in case of no presence
Usage Scenarios (4/4)

4 Monitoring, Control, Fault Detection

Send Periodic Data

Smart Space
Devices
Technologies (1/4)

- JN5148-EK010 ZigBee PRO Evaluation Kit
  - Jennic JN5148 wireless microcontroller
  - 1 Controller board with LCD
  - 4 Sensor boards
  - Temperature, humidity, and light on board sensors
Technologies (2/4)

- Knowledge processor (KP):
  - Interacts in R/W mode with the information world
  - Adapts the legacy technology to the software architecture to share all relevant information
  - Multiplatform: libraries (KPI) and tools for the most common languages and platforms augment developers productivity

- Semantic Information Brokers
  - Information as a semantic graph made of RDF triples
  - Notification mechanism to promptly react to context changes
  - (insert/add/remove/query/etc.)
SOA and Open Source Mule ESB

- Service-oriented architecture (SOA) is a set of principles and methodologies for designing and developing software in the form of interoperable services
- An Enterprise Service Bus (ESB) is a set of rules and principles for integrating numerous applications together over a bus-like infrastructure
Android Application using GCM

- Google cloud messaging service that provides some APIs to communicate with the GCM server in both communication directions, sending and receiving
System Layers

Applications (Web, Mobile)

ESB

Consumer/Aggregator KP (Actuation/web service adapter)

SSAP over TCP/IP

SIB

Ontology

Device Family 1 KP
KPI
Data acquisition

Device Family N KP
KPI
Data acquisition

Producer / Aggregator KP’s

Semantic Middleware

Applications

Service Layer

Sensors
Data and Events Flow - Smartification

Ontology

- PhysicalThing
- Preference
- Room
- EA_SmartHome
- Device
  - Fault
  - CommandInterface
  - DeviceType
  - Alarm
  - SensorData
  - CapabilityType

SIB

Inserts data to SIB

Adapter KP

Send identification packets to coordinator
Data and Events Flow - Actuation

**Brain KP**
Consumes data from SIB and insert commands based on user presence or identification

**Send user ID**

**Send commands to devices**

**Actuate devices**

**Driver KP**

**SIB**

**Data and Events Flow - Actuation**

**User Identification**

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Data and Events Flow – Monitoring

**Brain KP**
Consumes data from SIB and insert commands based on user presence or identification.

**Service Adaptation Layer**
Consumes data to display on web application and add new home, user, company, or command.

**SIB**

**Adapter/Driver KPs**
Send periodic data packets to coordinator.

**Coordinator**

**ZigBee**

**ZigBee**

**DIO**

**Light**
Data and Events Flow – Fault Detection

Fault Dispatcher KP
Consumes data from SIB and send faults and alarms to mobile device via Google cloud messaging

Fault Detector KP
Consumes data from SIB and insert faults if any is detected

Service Adaptation Layer
Consumes data to display on web application and add new home, user, company, or command

Adapter/Driver KPs
Send periodic data packets to coordinator

SIB
Consumes data from SIB and send faults and alarms to mobile device via Google cloud messaging

Faults and alarms are sent to the mobile device via Google cloud messaging.
Test Environment
Test Environment – Rooms
Test Environment – Nodes (1/3)

Multimedia node

RFID module

Light node
Test Environment – Nodes (2/3)

Environmental node

Refrigerator and AC nodes
Test Environment – Nodes (3/3)

Coordinator node
Web Application (1/5)

- ECWebSec is the website for:
  - Admin: to add new smart homes
  - User: to monitor and control smart home remotely
  - Maintenance company: to register info and contact data
User can configure preferences

- [ ] User can configure preferences

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<th>Device Name</th>
<th>Mac Address</th>
<th>Capabilities</th>
<th>Current Value</th>
<th>New Value</th>
<th>Default</th>
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<td>0015Bd0000143e5b</td>
<td>AC_FanStatus</td>
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<td></td>
<td>AC_GridStatus</td>
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<td>AC_GridOn</td>
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<td>PlayMusic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Web Application (3/5)

- User can monitor and control appliances from the website
User can browse list of available companies that can fix a certain fault

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Website</th>
<th>Phone</th>
<th>Email Address</th>
<th>Working Hours</th>
<th>Rate ( $ Per Hour )</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI</td>
<td>ciwebsite.com</td>
<td>02 33556818</td>
<td><a href="mailto:c1@ciwebsite.com">c1@ciwebsite.com</a></td>
<td>9AM - 5PM</td>
<td>25</td>
</tr>
<tr>
<td>CI</td>
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</tr>
</tbody>
</table>
- Maintenance company can register to fix certain faults

![Web Application Form]

**Log in Information**
- Company Name
- Password
- Confirm Password

**Contact Information**
- Website
- Email
- Phone Number

**Fault Types**
- Can Fix Faults:
  - Air Condition
  - Refrigerator
  - Multimedia Player
  - Light

**Working Information**
- Working Hours
- Rate ($ Per Hour)
Thank You

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