Come controllare gli elettrodomestici "Smart" (e perché) con la soluzione aperta JEMMA

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Today’s outline

1. Introduction to Energy@home
2. What: The JEMMA Framework
   – Architecture & main components
   – Key Technologies
3. How: Hands-on Demo
   – How to make a configurable Arduino-based wifi switch to control your appliance
   – How to interact with JEMMA API using Python, Javascript, …
4. Why: 5 different ideas developed from projects adopting JEMMA
Energy@home Association

Non-profit Association
Networking & pre-competitive tool

Scope: smart home & demand side management, not limited to the Italian market

Goal: create a market for new Value Added Services based upon device-to-device communication and demand side management

Approach:
International Standards, trials, regulations, scope synergies

www.energy-home.it
Energy@home vision: Smart Home Eco-system

Eco-system:
– Adds new value into the overall system
– Provides a homogenous user experience
– Exploit scope synergies
– Bases for a unifying service provisioning architecture

A cross-services partnership-oriented horizontal solution versus vertical independent silos solutions
For more insight on the Energy@home vision come to:

Area Talk at 14:30

«Smart Home ed efficienza energetica: Energy@Home a Casa Jasmina»

Fabio Belifemine (Energy@home Director)
JEMMA: the Energy@home CEMS

- **JEMMA**: Java Energy ManageMent Application is the CEMS reference implementation delivered by Energy@home
- It can be used to **rapidly prototype** and **deploy** smart energy applications at home
- First Released (v0.0.1) in October 2013
- Based on an a CEMS solution developed and validated in the Energy@home trials
- Initial code contribution by Telecom Italia
- Current version: v0.9.2
- Hosted on GitHub

http://jemma.energy-home.org
JEMMA: License

• Most of JEMMA has been released under the LGPL (Lesser General Public License v3)

• LGPLv3 is a permissive “copyleft” license:
  – it allows bundling and re-distributing the software for any purpose including commercial, also integrating 3rd party components released under other licenses

• It is thus allowed:
  – To freely share JEMMA and its source code
  – To extend and integrate JEMMA with other (free and non-free) products or services
**DAL - Device Abstraction Layer**

- **Device Abstraction Layer** is a draft OSGi standard (**RFC 196**) expected for release within 2015.
- It provides **unified, self-descriptive API** to access devices.
- It supports the inter-connection of **heterogeneous** protocol connectors.
- It exposes devices functionalities in granular fashion e.g. in terms of **Functions**, each exposing a set of **Properties** and **Operations**.
- Reference implementations already available or under development for other Smart Home Standards beyond ZigBee:
  - e.g. enOcean, z-Wave, KNX, etc.

DAL Philosophy

OSGi Context

Washing Machine

Property

OnOff

Operation

Reverse

Function

Property

Function

OperateNon

Function

Property

Property

Function

Function

OnOff

Metering

SmartPlug

(Examples in red)

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In JEMMA, the DAL is the recommended interface to interact with devices for both *Control operations* and *eventing*.

**Accessible through**

**REST APIs**
- Get devices, devices functionalities and invoke them (e.g. switch on a lamp)

**WebSocket APIs**
- Obtain events from devices (e.g. power consumption changed)
Jemma stack

3rd parties apps

LAN/Internet

DAL web APIs (HTTP REST and WebSocket)

JEMMA DAL adapter

OSGi DAL Device service

OSGi DAL Function service

JEMMA Home Automation platform
(JavaGAL, ZigBee network manage, Home Automation Core)

http://www.energy-home.it
Rapid development 3rd parties javascript apps

1 - Download test environment: https://goo.gl/TJFggY

2 - Exec start.bat (Windows) or start.sh (Linux)

3 - Open your web Browser: http://localhost:8080/virtualhome/index.html
   (HINT: right click -> view source)
GET /devices/

$.getJSON('http://localhost:8080/api/devices',
  function(data){
    //process data.result
  });

{  "code": 200,  
  "result":
    [  
      {  
        "dal.device.status": 2,  
        "dal.device.UID": "ZigBee:12345",  
        "dal.device.name": «Door Lock",  
        "dal.device.driver": "ZigBee",  
      }, ....  
    ]
}
GET devices/${device_uid}/functions

$.getJSON('http://localhost:8080/api/devices/ZigBee:12345/functions',
    function(data){
        //process data.result
    }
);
POST /functions/${function_uid}

$.ajax({
    type: 'POST',
    data: JSON.stringify({operation:"getStatus"}),
    success: function(data) {
        //process data
    }
});

{}
    "code":200,
    "result":
        {
            status: "OPEN",
            timestamp: 1433410604989
        }
}
WebSocket events

```javascript
websocket = new WebSocket("ws://localhost:8080/ws");
websocket.send({'dal.function.UID":"ZigBee:12345:DoorLock","dal.function.property.name":"*"});
websocket.onmessage = function(evt) {
    //parse evt
}
```

```json
{
    "topic": "org.osgi/service/dal/FunctionEvent/PROPERTY_CHANGED",
    "properties": {
        "dal.function.UID": "ZigBee:ah.app.12345:DoorLock",
        "dal.function.property.name": "status",
        "dal.function.property.value": {
            "status": "CLOSED",
            "timestamp": 1433413157458
        }
    }
}
```
**Verified Devices / Smart Appliances**

- JEMMA can interact with any device which can be registered through the DAL Specifications
- It is compatible with all ZigBee HA 1.2 devices and a few WiFi native devices
- It has currently been verified with a large number of different **devices** and **appliances** e.g.:
  - environmental sensors, smart plugs, switches, shutter controls, door locks, webcams, ovens, washing machines, fridges, etc.
  - Full list available on the [JEMMA Website](http://www.energy-home.it)
- The **hands-on session** will now show how devices can be accessed from any REST-capable application or device using JEMMA
Hands-on Session Setup

- ATmega32u4
- Atheros AR9331
- WiFi

Bridge Lib

JEMMA DAL Python Client

A (very!) simple HW Button

JEMMA HAG

Any Device...

Button Example

http://www.energy-home.it
Yun Hardware Sketch

Yun Software Sketch

• A combination of:
  – http://www.arduino.cc/en/Tutorial/Button and

• Check out the commented example on GitHub
The JEMMA Python Bindings

- Simple Python bindings to interact with the JEMMA DAL API via REST are available on GitHub.
  - ismb/py-jemma-dal-rest-client
- A simple wrapper script is available to use bindings from any Linux-like shell. Supported operations:
  - DAL Device discovery
  - DAL Functions discovery
  - Access to DAL property get/set and DAL operations

- Examples (from the README):
  - ./py-jemma-dal-rest-client.py -a 192.168.10.103 -c listd
  - ./py-jemma-dal-rest-client.py -a 192.168.10.103 -c listf -d "ZigBee:EletricHeater:ah.app.3521399293210526015-8"
  - ./py-jemma-dal-rest-client.py -a 192.168.10.103 -c operate -d "ZigBee:EletricHeater:ah.app.3521399293210526015-8" -f "OnOff" -o "reverse"
To call the JEMMA DAL from Yun

The Yun AR9331 already comes with Python 2.7 pre-installed. You just need to

• Copy `ismb/py-jemma-dal-rest-client` (e.g. via SFTP) to Yun
• Test it from console (e.g. from SSH)
• Hook the right shell command in the `p.runShellCommand(…)` clause in the Arduino Sketch.
• … cross fingers!
And now .... the «why»!

- The following slides show some **explanatory use cases** from projects/initiatives adopting JEMMA or some of its components.
- The list is not exhaustive – but it is just meant to provide some ideas about current and future potentials of the JEMMA approach.

http://www.energy-home.it
Some Energy@home use cases *

- A number of use cases specified by Energy@home are implemented in the default JEMMA distribution
  - Visualization of Energy/Power information from meter and appliances
  - Visualization of costs (cumulative cost, before cycle starts, etc. …)
  - Visualization of historic consumption
  - Energy production forecast
  - Overload warning & management
  - Scheduling devices based on production/cost forecast

* Full «Energy@home Use Case» document freely available at http://www.energy-home.it
Case 1: The GreenCom project

- EU-project with 7 partners – expected to be completed in 2016
- Piloted in the island of Fur in the municipality of Skive, in the area served by GreenCom Partner EnergiMidt
- **21 Real Households** instrumented with GreenCom solutions featuring a combination of home automation systems, PV installations, Heat Pumps, Energy Storage
- Pilot Co-funded by EC (providing ICT components) and Danish National programmes (co-funding appliances) – but with a significant financial investment by prosumers

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Case 1: GreenCom - Devices

- **Air to water Heat Pumps**
  - Source: Nibe (VVM310)

- **Sub-meters, Smart Plugs**
  - Source: Develco, ABB

- **PV installations**: various sizes
  - Source: Fronius

- **Storage**: 5 kW hybrid Inverter with 4,5 kWh battery.

- **Indoor and outdoor Temperature, Humidity, Occupancy Sensors**

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Case 1: GreenCom - sharing flexibility with the (micro) grid

- Each of the 21 Houses is provided with the OSGi-based GreenCom Gateway, feeding data into a dedicated cloud-based MicroGrid Manager.

Users have signed a contract which secures cheaper heating cost in exchange for their flexibility.

- Depending on contractual agreements, data and control capabilities are shared among stakeholders i.e., Prosumer, DSO, Aggregator, Service Provider which access to different “views” on the GreenCom systems.

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Case 2: The SORRISO Living Lab

- SORRISO is a regional-funded project («Internet of Data» call) to be completed in 2015
- Expected outcomes:
  - Integration with the «Smart Data Platform» realized by CSI for the Piedmont region
  - Full Integration of an existing «made in Piedmont» home storage solution developed by a local company
  - Validation in 2 residential and 2 public buildings
    - Istituto Vallauri (Fossano)
    - Istituto Comprensivo Bruino
  - Engagement of professors and students (training activities, etc.)

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Case 3: MAS2TERING

- EU project with 9 partners
- Multi-agent systems attached to Jemma gateways
- Jemma is being extended to provide support of Mains Meters from UK, Belgium and France
- Multi-agent systems exploited to take right decision in each point of the grid, taking into account a range of different conditions, constraints and end-user preferences
Case 3: MAS2TERING - Use Cases

UC1: Secure and effective connection of commercial home energy boxes with public DSO smart meter and consumption profile optimization - exploit the in-home monitoring and control systems on Telecom’s infrastructure deployable for the HAN management

UC2: District energy management - how the multi-agent technology can be effectively applied to a decentralized energy management system at a district scale for local dispatching

UC3: Enhancing grid reliability, performance and resilience - demonstrate that local or district-level energy management, combined with effective grid monitoring and enhanced DSO / ESCO connections, can significantly improve the flexibility and global balancing of the grid

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Case 4: APIO, easy and open Platform for “Internet of Things”
Case 5: co-existence with other frameworks

*Note: this is just an example – but several integration activities are being performed around the world using JEMMA with other open source projects such as OpenHAB/Eclipse, DOG, OpenADR, LinkSmart, VIRTUS, etc.

Icon Credits:
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http://www.energy-home.it
Case 5: interaction through augmented reality
Case 5: Voice control
Thanks for your attention!

• To know more:
  – Stay in touch with latest news from Energy@home on http://www.energy-home.it
  – check tutorials on http://jemma.energy-home.org
  – contact us on the JEMMA Mailing list
    • (see website, «contacts» section)

• Information about projects available at:
  – http://www.greencom-project.eu/
  – http://www.progetto-sorriso.it/
  – http://www.mas2tering.eu/
  – http://jol.telecomitalia.com/jolscube/
  – http://www.apio.cc/