TOWARDS *e*ENVIRONMENT
March 25-27, 2009 - Prague

A New Architecture for Reduction of Energy Consumption of Home Appliances

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speaker

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AIM Project

- AIM is a STREP project of the 7th Framework Programme, **“ICT for Environmental Management and Energy Efficiency”**
- A novel architecture for modelling, virtualising and managing the energy consumption of household appliances

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Context

- The AIM project is developing a new information and communication technology architecture for modelling, virtualising, and managing the energy consumption of home appliances.

- By using ICT to achieve technology-driven energy efficiency gains, AIM is supporting the European Union's Action Plan for Energy Efficiency.

Objectives

To define a generic technology for managing the energy consumption of home appliances

- Management of the energy consumption of home appliances beyond the simple ON/OFF model.
- Design of a generic method for measuring energy consumption of appliances at home.
- Design of an energy resources virtualization environment for building energy management services.
- Application of energy saving strategies on active as well as stand-by devices.
- Evaluation of the AIM technology in two phases with the involvement of real users.

Approach

- Generalized method for household appliance management
- accurate modeling of operational modes of appliances
- ability of the home network to switch on or off even some of their internal functions (not just to the active or stand-by states)
- AIM is focusing on:
  - **White goods**
  - **A/V equipment**
  - **Communication Equipment**

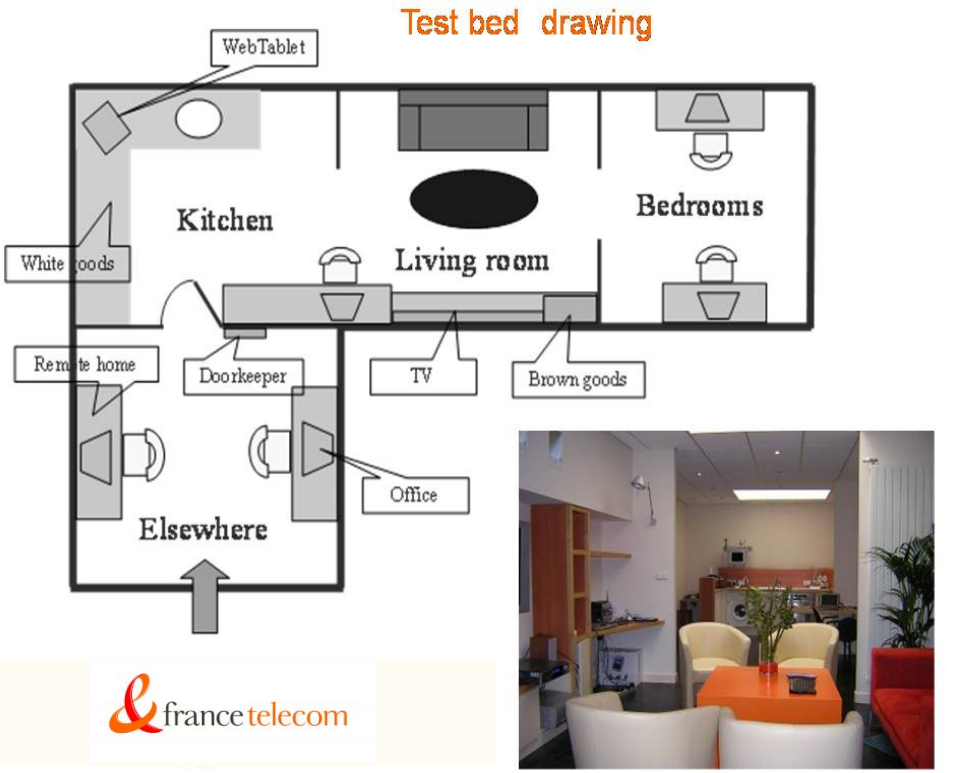
User groups

- AIM builds applications for 3 user groups:
  - Residential users
  - Subscribers of communication networks

Home users control their environment through the service interface of a home gateway that is able to get connected with any type of home terminal, like e.g. wireless PDA, embedded devices, etc.

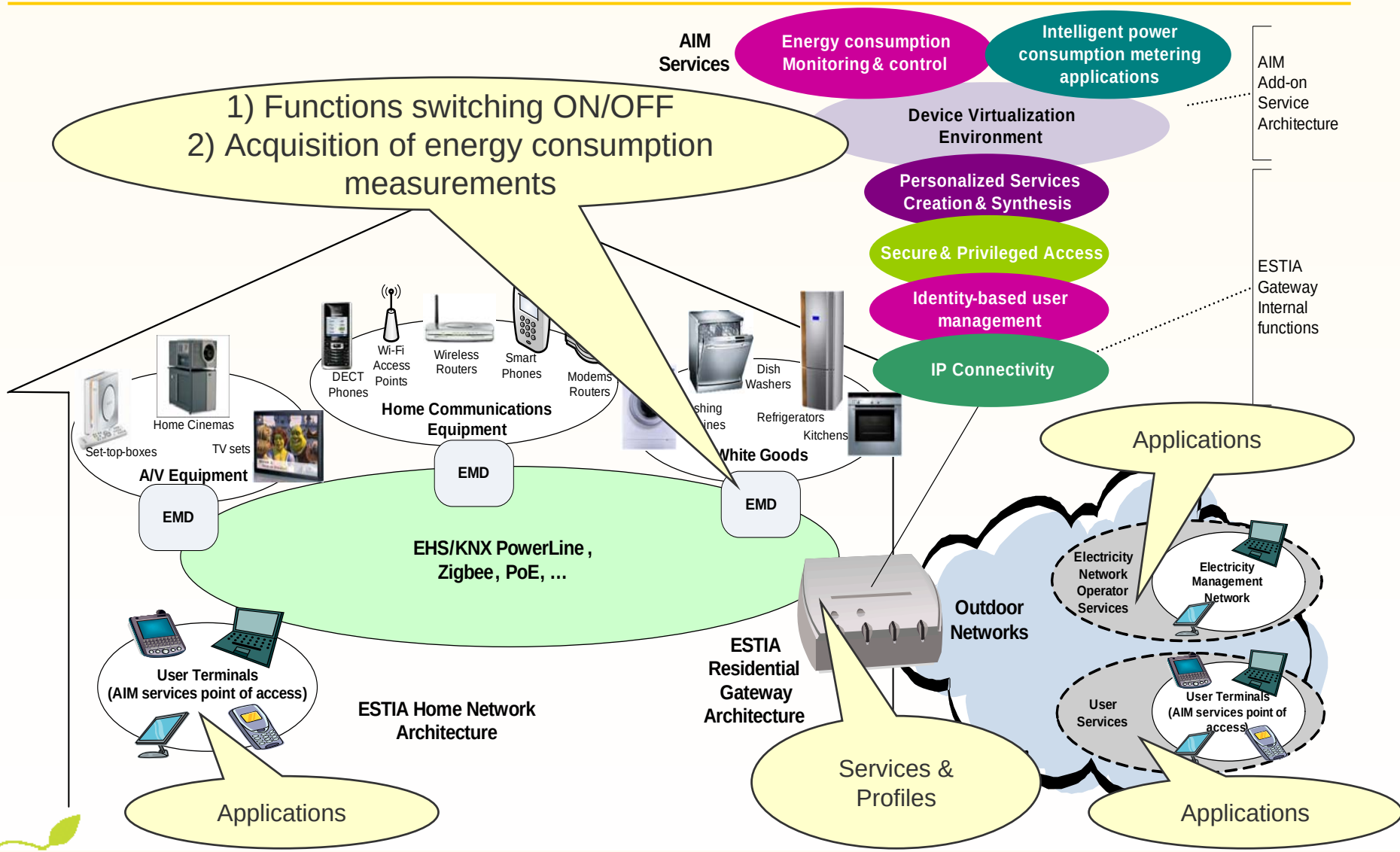
blocks of users on macroscopic level. Accessing households through such a system is an efficient and cost effective way of accomplishing such task.

Evaluation trials



- Step1: Present the AIM technology to real users and collect their feedback concerning usability aspects
- Step 2: Integration in two real households with the objective to:
- Measure capacity of the platform to minimize overall energy consumption by 20% for active and stand-by devices

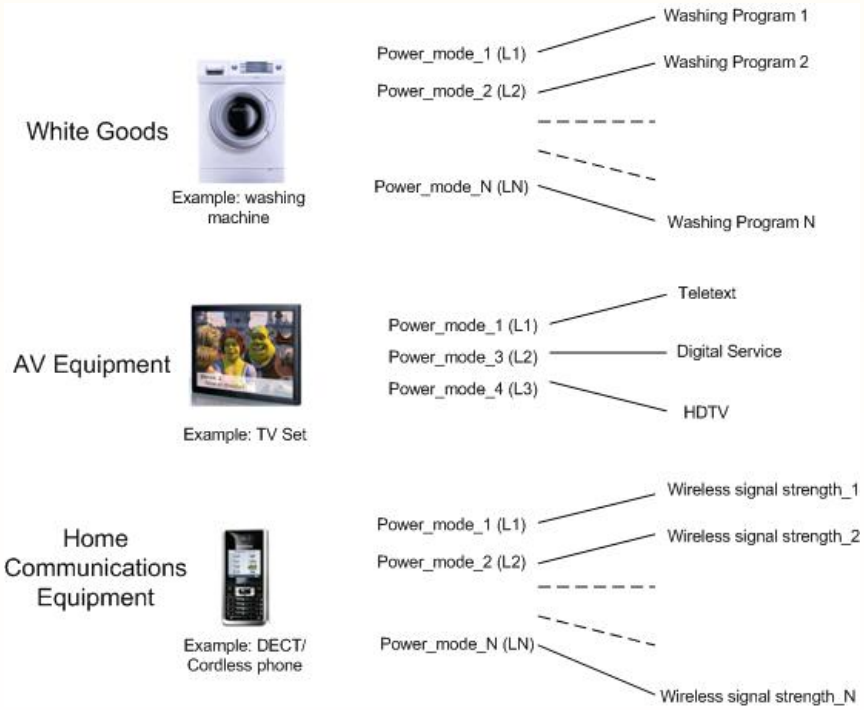
Architecture

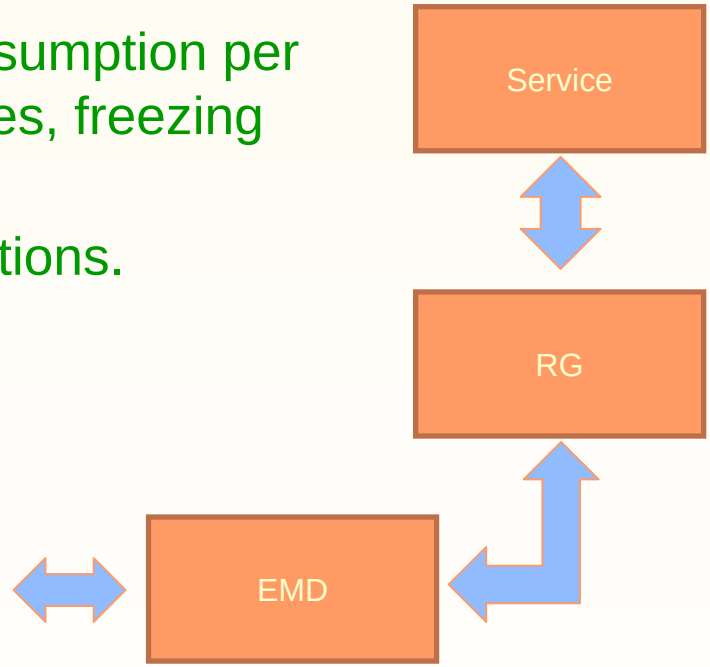


Profiling of appliances

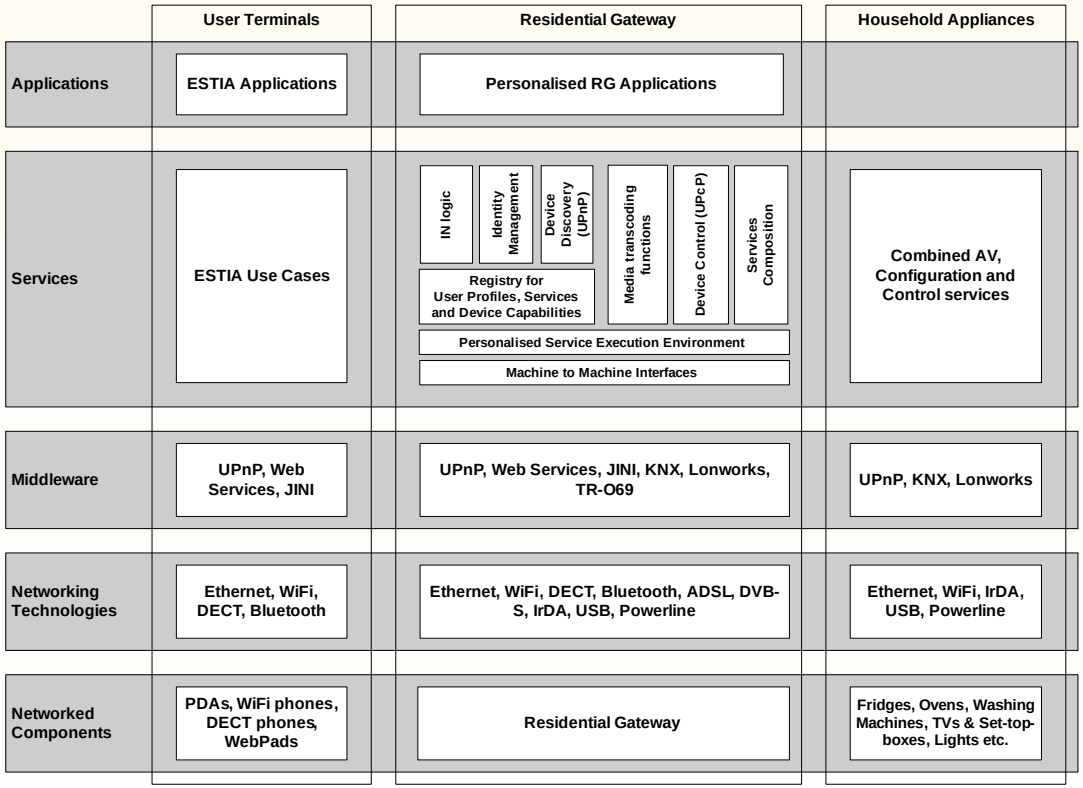
Profiling of appliances, allows:

- Characterization of appliance energy consumption per internal function (e.g. washing programmes, freezing programmes, etc).
- Granular implementation of ON/OFF functions.





The Home Gateway



- Offers:

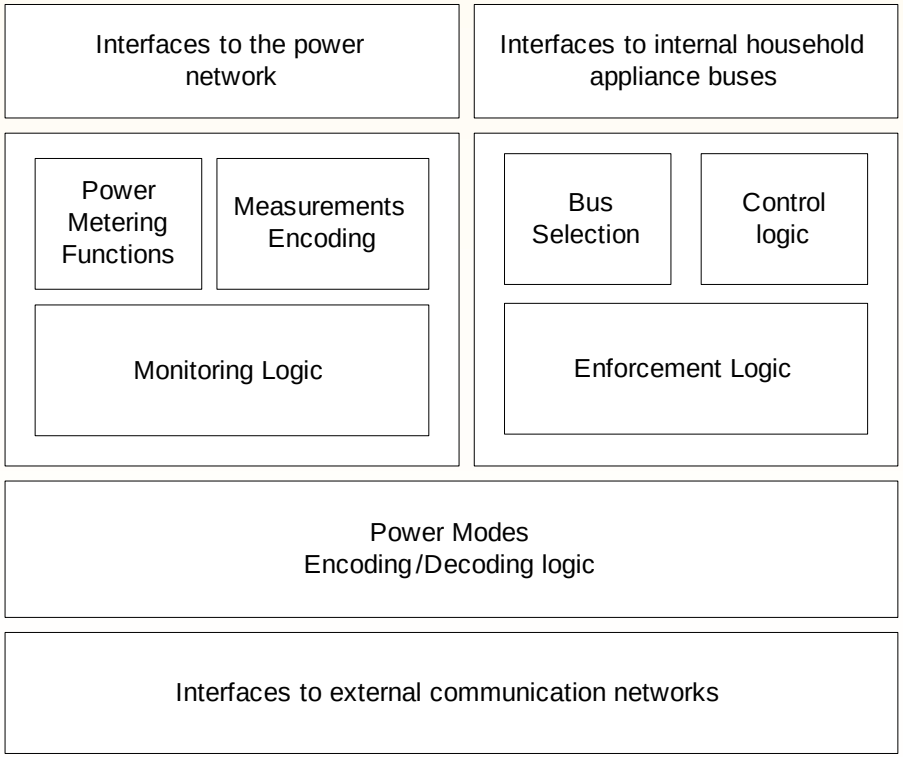
a) a solution for managing the resources of the home environment homogeneously

b) Service execution environment

c) Personalized services creation and activation

- Open Implementation using the Linux-based OSCAR platform
- Flexible physical implementation on PCs/gateways, etc.

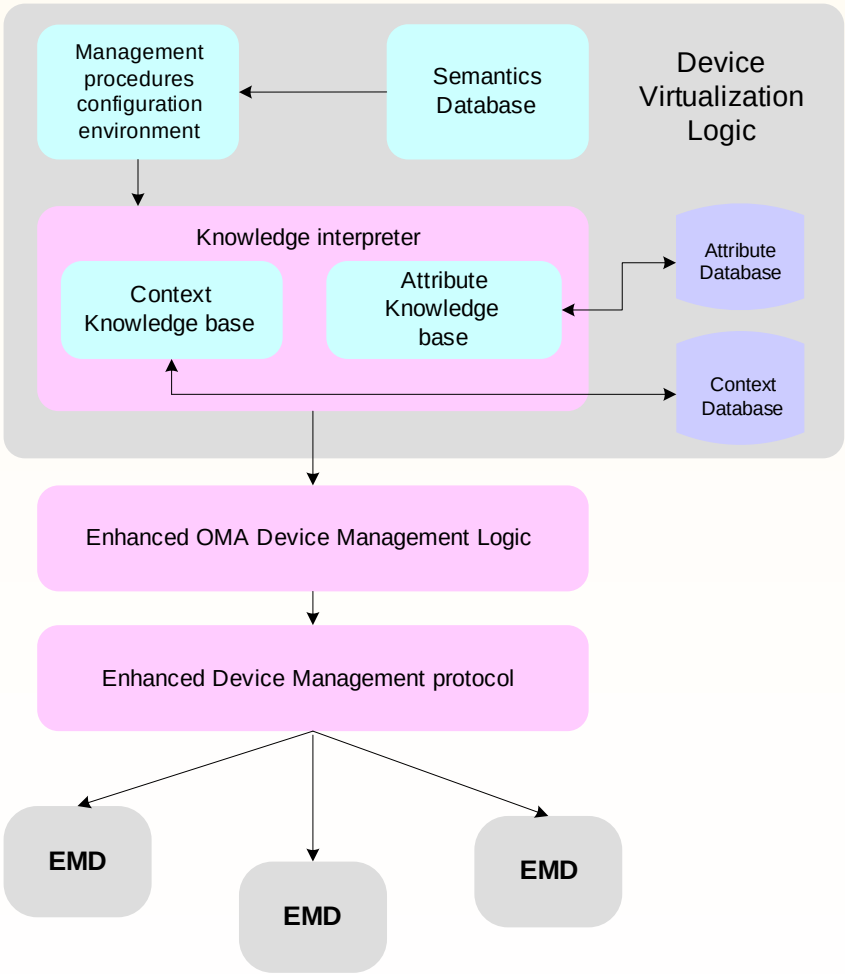
The EMD



Provides:

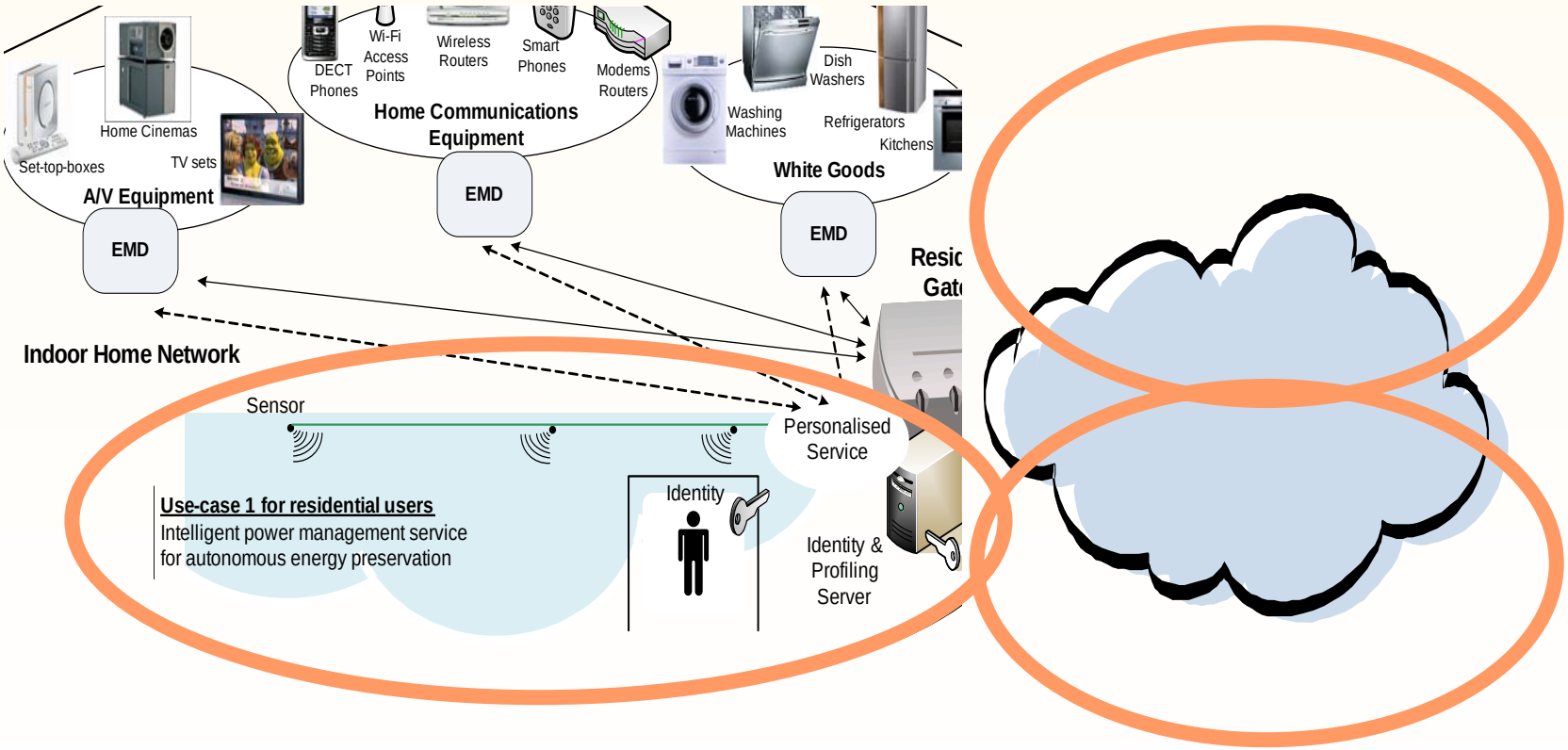
- Acquisition of energy consumption measurements per appliance type and function.
- Switching of appliance internal functions
- Switching ON/OFF of stand-by devices

Virtualization Environment



- Offers:
  - An environment for creating and instantiating energy management services
  - A semantics data with DM representing information of:
    - Appliance types
    - Supported functions
    - Energy Saving actions.
  - An interpreter that translates user configuration into service

Use-Cases


Home Cinemas
Set-top-boxes
TV sets
A/V Equipment
EMD
DECT Phones
Wi-Fi Access Points
Wireless Routers
Smart Phones
Modems Routers
Home Communications Equipment
EMD
Washing Machines
Dish Washers
Refrigerators
Kitchens
White Goods
EMD
Indoor Home Network
Sensor
Personalised Service
Identity
Identity & Profiling Server
Use-case 1 for residential users
Intelligent power management service
for autonomous energy preservation

User Interaction with the System

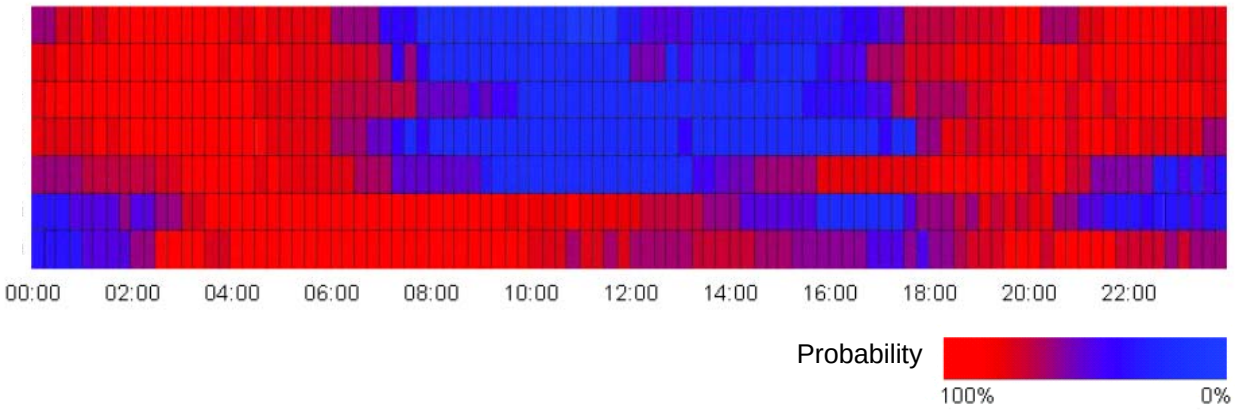
- Define a natural way of interacting with the AIM system through a **sensor network**
- Reduce configuration and management complexity by means of:
  - Real-time monitoring of users activities in the home (identification, presence, use of appliancies, etc.) and of physical parameters (light, temperature, etc.)
  - Profiling of users habits and preferences based on the way they interact with the system

Sensor network: Possible benefits

- Mainly:
  - Definition of per user energy management strategies
  - Definition of smart methods for automatic switching among different power mode levels of home appliances based on monitoring of user presence and activities at home
- But also:
  - Evaluation of user satisfaction levels for energy management strategies with different degrees of energy consumption
  - Point out to the users which are home processes that consume most energy and suggest possible modifications of home management strategy and user habits

User profiling

- The event recording system allows storing the presence of users at home and in specific rooms and the period of times in which it used specific devices
- From these data the learning system can extract some characteristics of the user habits in the form of probability distributions.



Examples (1)

Presence+historical data

The system regulate temperature at 21 C° in the kitchen and bathroom between 6:30AM and 8:00AM.

The system switch off devices will not be probably used in the other rooms

The system regulate temperature in all rooms at 21 C° before user comes back home after work.

The system set in stand-by A/V devices that are usually used after diner.

Real-time presence

The system activates the screen of the appliances in the kitchen when the user enters in the room

When the user enters in the living room after diner, the system activates the audio device with a preset playing list.

When the user sits on the sofa, the system activates the TV set with the menu of the preferred TV channels and evening shows

Examples (2)

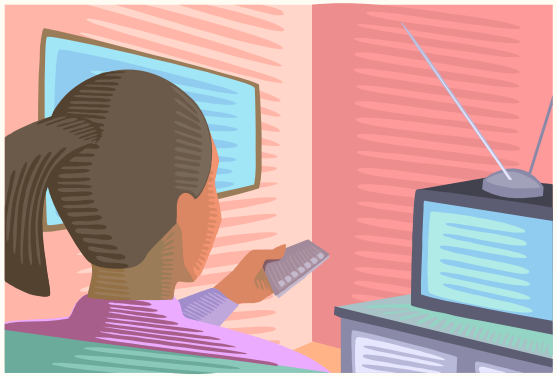
Presence historical data + task schedule

The user put the meal in the oven in the morning before leaving for work. The system dynamically selects the best time to cook the meal based on energy price and availability and warms the meal just before the user comes back home.

The user puts dirty clothes in the washing machine. The system selects the best washing program and time for executing it based on the information from the utility and the usual user schedule

The vacuuming robot needs two hours to clean the apartment. The system operates the robot when the user will probably nt be at home for at least two hours

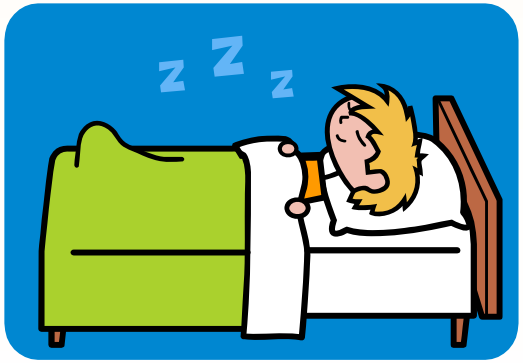
Examples (3)



Sensing + manual settings

The user increases the TV brightness with the remote. The system automatically reduces ambient light to improve relative brightness.

The system automatically regulate lighting based on external light.



Global settings

The system automatically regulate the temperature on night settings when all users are at bed. The system puts all non necessary appliances into low power mode. The system starts night processes (e.g. washing cycle of washing machine)

Conclusion

- AIM project is currently defining a home energy management system
- The final energy management system will provide enhanced services for home appliances energy consumption monitoring and management
- The system will be based on high technology product to be massively adopted by residential users for making optimal use of energy at home
- The system platform will open and easily extensible to any kind of appliances