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User Created Machine-readable Policies for Energy Efficiency in Smart Homes

SESAME – Project overview



- **SESAME** stands for **Semantic SmArt Metering: Enablers for Energy Efficiency**

- not a kind of a seed or a plant
- not an RDF repository
- not „Sesame Street“ show

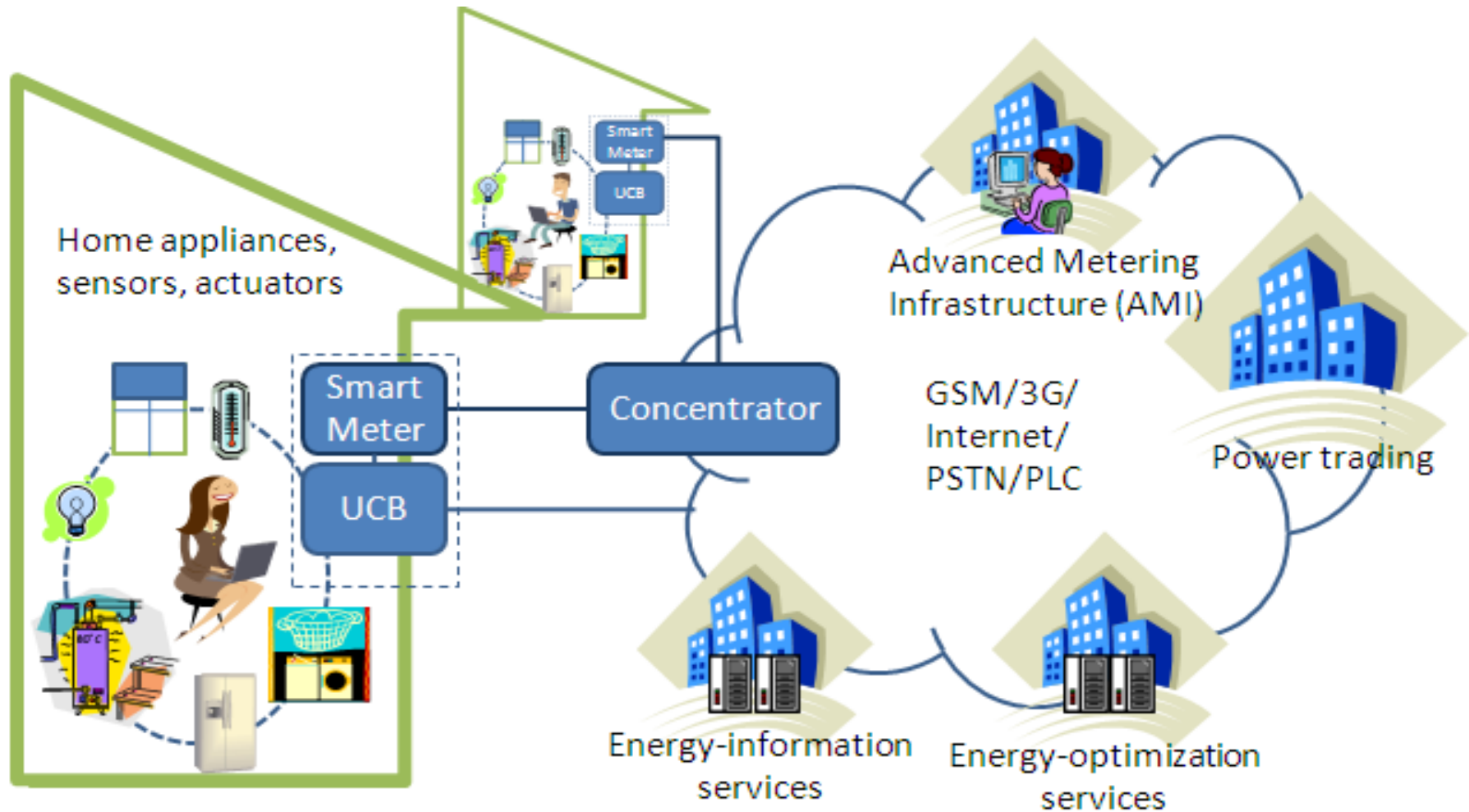


- **Project goal:** *to facilitate home owners and building managers in saving energy within their environments and in optimizing their energy costs, while actively controlling and maintaining their preferred quality of living.*
- **Funding line:** FFG COIN; **Total budget:** ca. 810K Euro
- **Project duration:** September 2009 – November 2010
- **Web:** <http://sesame.ftw.at>

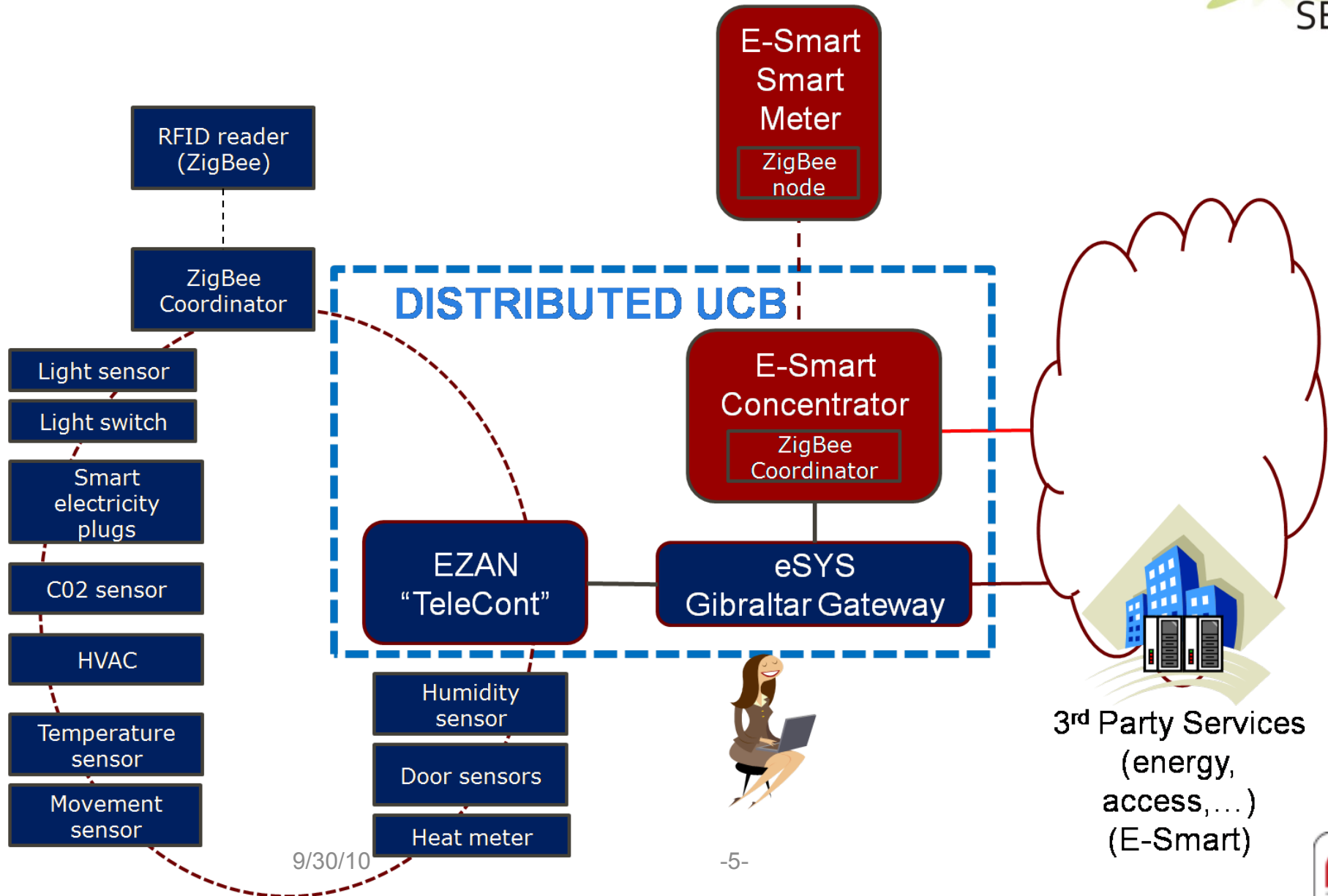
SESAME – Project goals

- Balancing requirements of energy **end-users** and **providers** (producers, suppliers)
- **End-users** are supported by:
 - **Data acquisition** in the home and integration of provider-managed metering data
 - **Semantic reasoning** based on sensor data
 - **Control** of home utilities based on semantic rules
- **Providers** are supported by:
 - **Aggregated data of energy usage** from smart homes for better usage predictions
 - Some level of **control over energy usage** in homes to smoothen peak usage

System overview

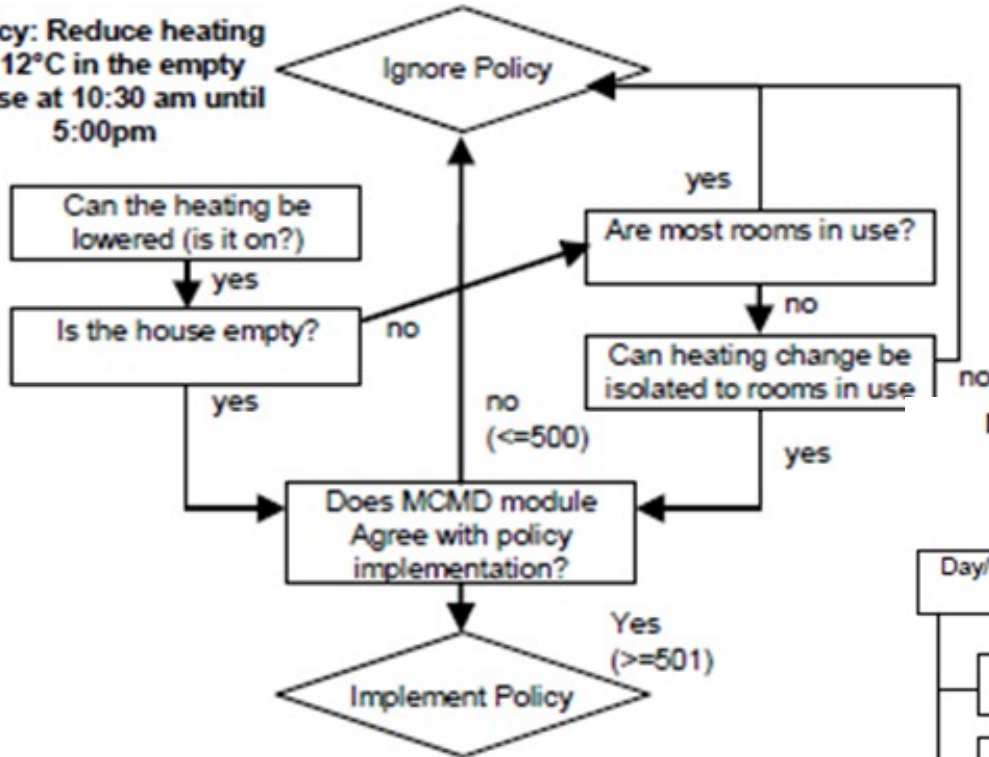


Technical components

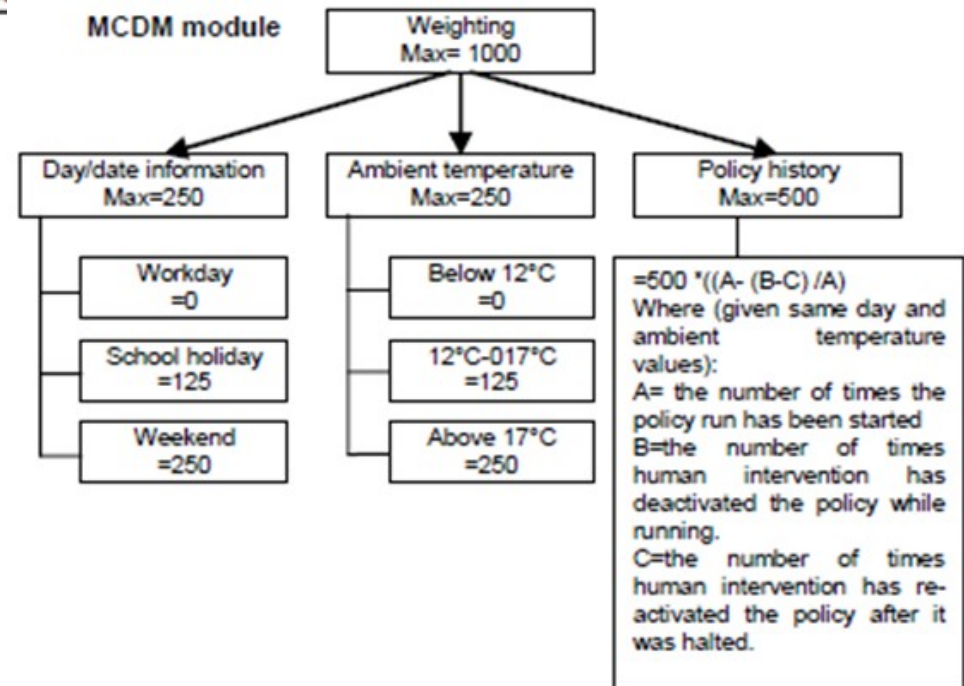


Multi-Criteria Decision Making in SESAME

Policy: Reduce heating to 12°C in the empty house at 10:30 am until 5:00pm



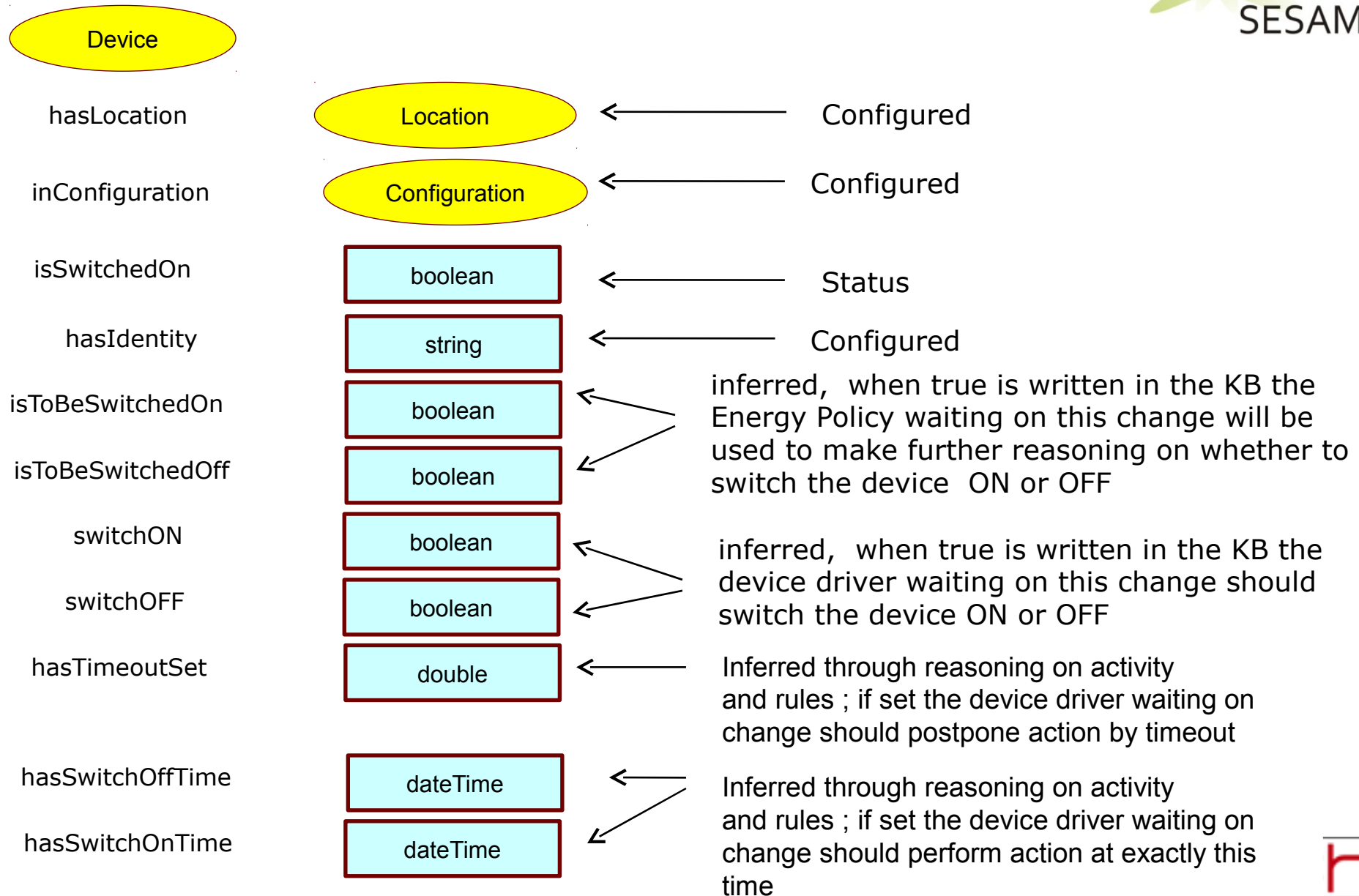
MCDM module



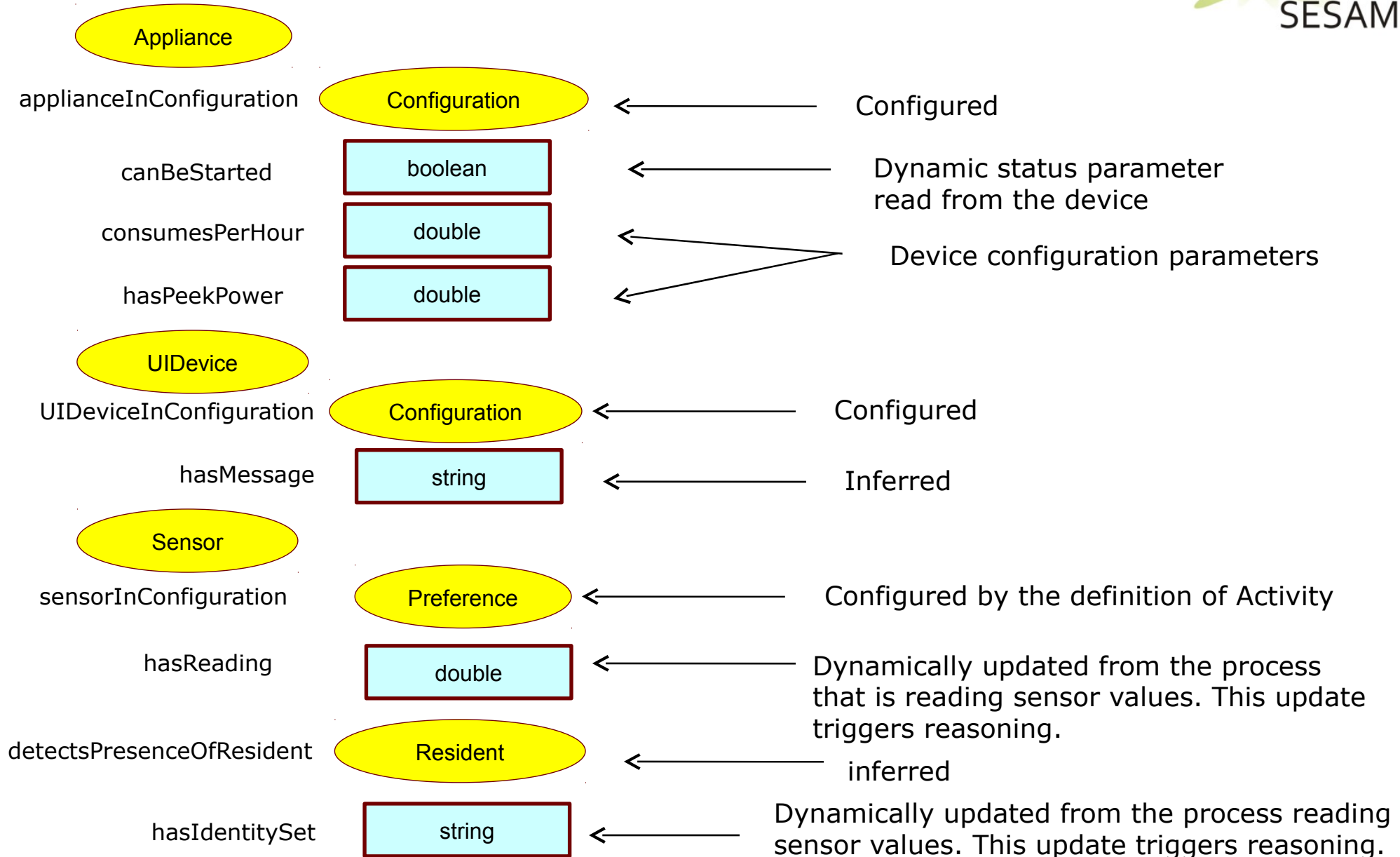
System rules vs. User rules

- **System rules** pre-configured or set up during installation of the home network, typically by experts or power users, e.g.:
 - Tariff dependent
 - Device dependent (permanent vs. standby/ad-hoc)
 - Environmental thresholds (e.g. based on temperature)
- **User rules** reflect personal preferences and may be determined by questionnaires/wizards, e.g.:
 - Usual behaviour/routines
 - Desired environment
 - Pricing/tariff preferences

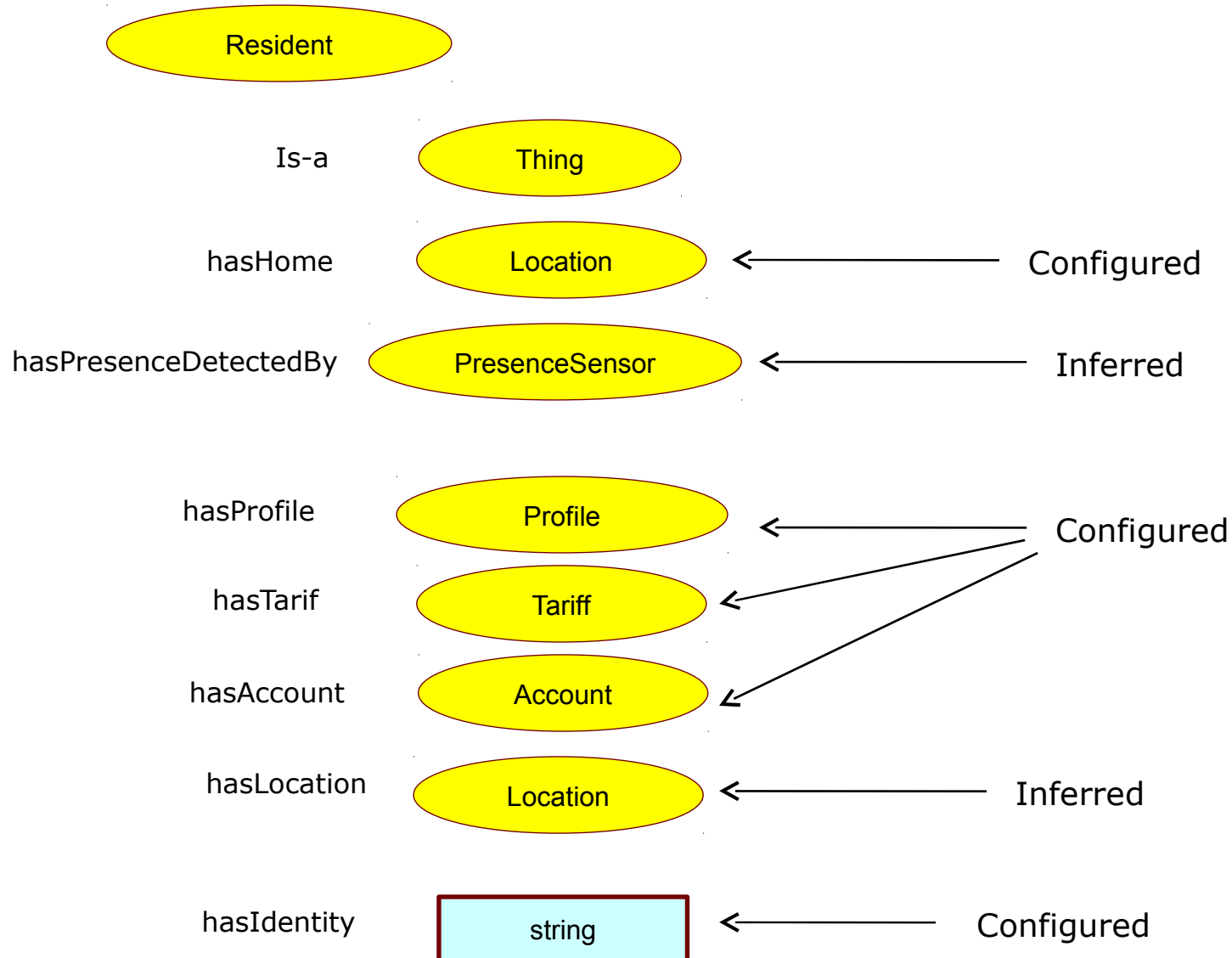
Device model



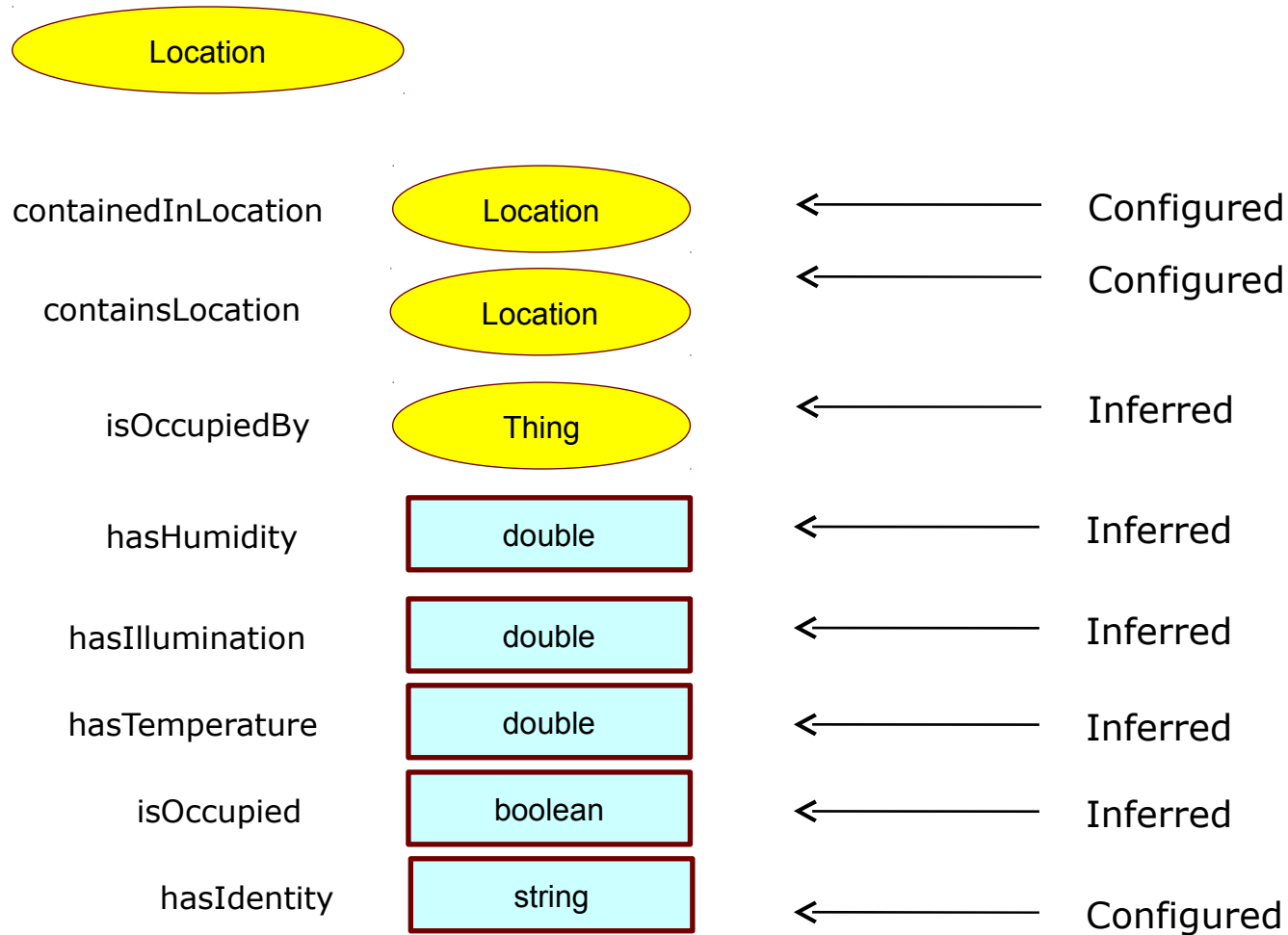
Device subclasses



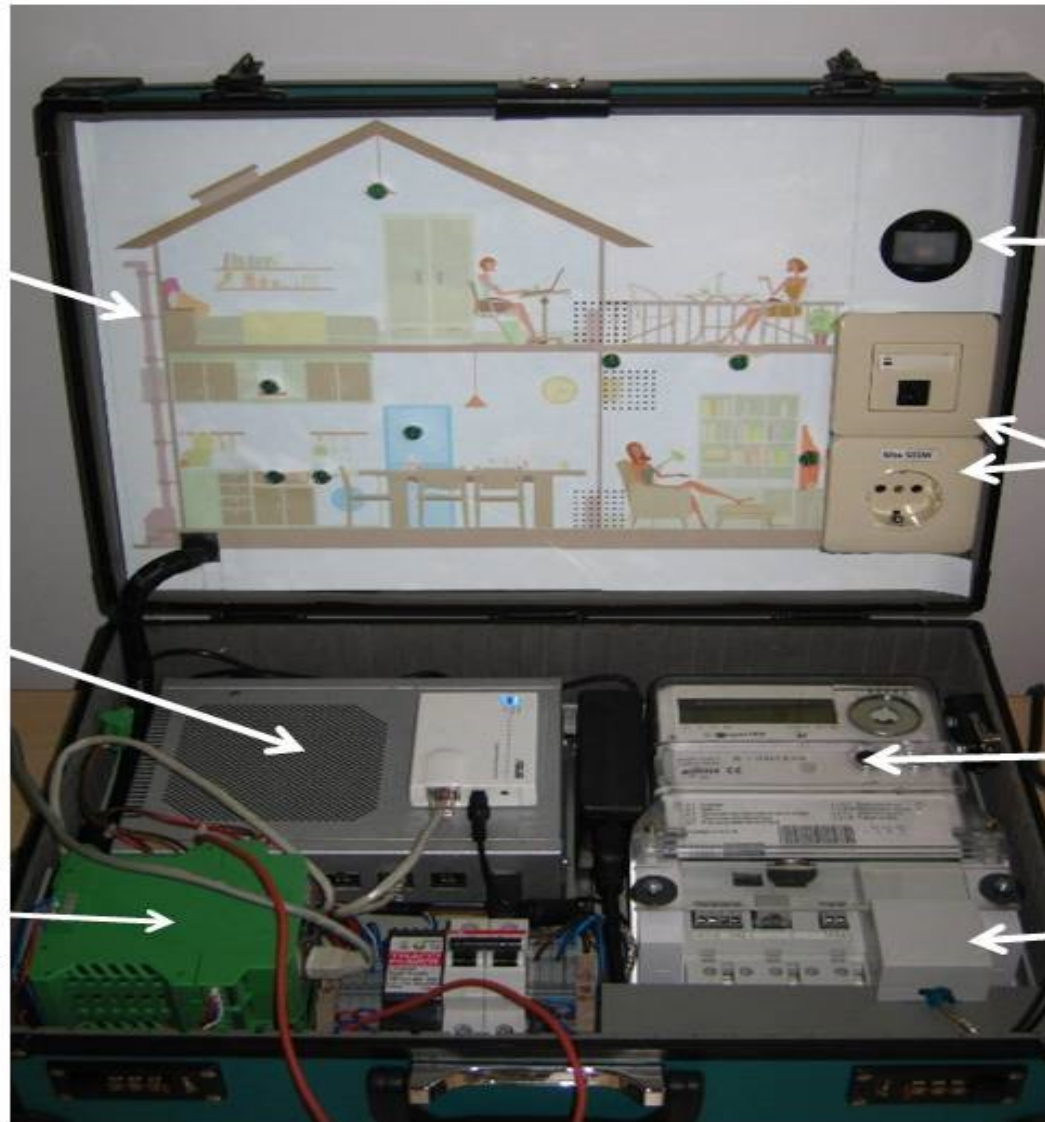
Resident



Location



SESAME demonstrator



Household Simulation Map:
This map simulates default appliances in a household

Gibraltar Gateway & Concentrator:
Contains firewall, storage, ontology repository and rules engine

Universal Control Box:
Handles all data input

Light Sensor:
Measures the brightness in the room

Smart Plugs:
Handles external devices and sensors

Conventional Smart Meter:
Provides base functionality for metering

3G Modem

SESAME demonstrator



User interface: Kitchen



The screenshot shows the HAN Monitor application window. The main display area is titled "Kitchen" and "Kitchen Sensors". It features a list of sensor readings overlaid on a background image of a kitchen. A vertical toolbar on the left contains icons for various functions, including "AVG". At the bottom, there are four room selection buttons: Bathroom, Bedroom, Kitchen (highlighted with an orange border), and Livingroom.

Sensor	Value
Temperature	18 °C
Humidity	23.3 %
Pressure	998 mBar
Light	420 Lux
CO ₂	230 ppm
Acceleration	0 m/s ²
Air flow	0.2 m/s
Noise	30 dBm

User interface: Bathroom



HAN Monitor

Bathroom

Inst. Consumption

533 W

Inst. Consumption

Bathroom

Bedroom

Kitchen

Livingroom

User interface: Bathroom



HAN Monitor

Bathroom

Device Name	Consumpti	Energy	State
Heater Plug	200.00	4.49	ON
Laundry Plug	333.00	7.44	ON

- Acceleration: 0 m/s²
- Air flow: 0.2 m/s
- CO₂: 224 ppm
- Humidity: 32 %
- Light: 620 Lux
- Noise: 13 dBm
- Pressure: 993 mBar
- Temperature: 21 °C

Consumption: 533 W Total Consumption: 1233 W
Energy: 11.93 kW Total Energy: 24.3 kW

Bathroom Bedroom Kitchen Livingroom

Questionnaire experiment and results

- **Non-representative** sample (2 male, 2 female, single households) used to determine personal routines and devices/appliances in use
- Combination of pre-configured system rules and user rules based on questionnaire answers
- **Simulation of power consumption** promises reduction of up to 22% in electricity usage

Insights concerning big picture

- **Balancing supplier and consumer needs is hard**
 - International energy trading market is complex
 - Therefore, cost and energy consumption often do not correlate
 - Hard to find incentives for end-users
- Smart metering is technically solved, but subject to **policy decisions**
 - Legal regulations (who owns the equipment, who owns the data)
 - Privacy concerns
 - Mass rollout is expensive (so far, only pilot projects)

Insights concerning autonomous system

- Many data sources freely available
 - International energy pricing with future estimates
 - Weather forecast, major events, etc.
- **Integration is key**
 - SESAME approaches this with semantic reasoning
 - But: modelling the world is hard (we know that from context awareness...)
 - Getting suppliers and device manufacturers to agree on an ontology is even harder
- **Always respect the user** → any local decisions must override rules

Thank you for your attention!