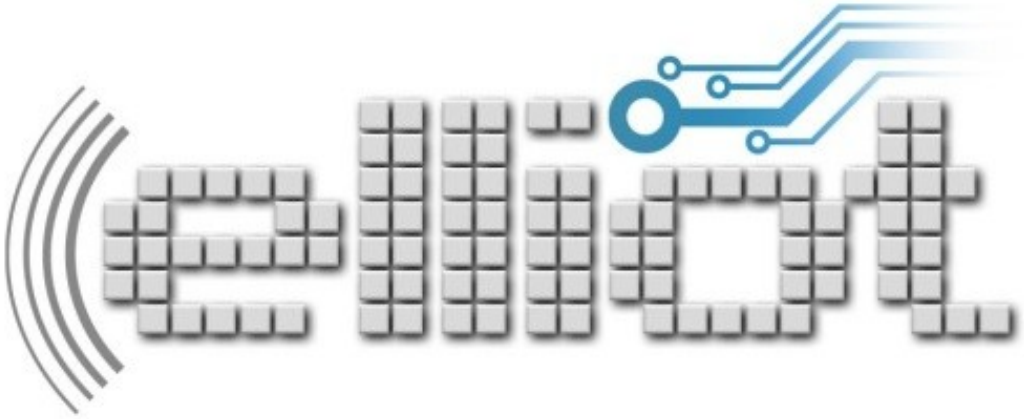
Experiential Living Lab for the Internet Of Things



Smart Office

IoT-based Energy Efficient Office - presentation of pilot application

InterSoft, a.s., Košice, Slovakia
www.intersoft.sk

intersoft

Energy Efficient Office use case

- **Energy Efficient pilot application of ELLIOT:**
  - Managing energy for buildings and offices
  - the application is developed and maintained by InterSoft, a.s., Slovakia

- **Goal:** to enhance the ELLIOT platform by integrating Semantic AmI with the Internet of Things, People and Services applications in the Energy Efficient Office use case (so-called *Smart Office*)

- **Focus:**
  - experiment the ELLIOT outcomes and the new semantically enhanced AmI technology in the Energy test case in Slovakia
  - demonstrate the platform capabilities towards a positive impact on environment (energy consumption, CO2 footprint)

- **Technology:**
  - AmI-IoT: based on LinkSmart middleware, http://sourceforge.net/projects/linksmart/, using outcomes of the FP7 project ebbits, http://www.ebbits-project.eu.
  - Semantics: device ontology, fusion of generated events, business rules
  - Devices: energy consumption, environment conditions, and occupancy sensors - Plugwise, Arduino, …

The Smart Office concept

From “Smart Houses” to “Smart Offices”

- **Smart House:**
  - a house that has advanced automatic systems for lighting, heating, air-conditioning, window and door operations, security etc.
  - lot of solutions, both commercial and research
- **Smart Office:**
  - to employ the paradigm of the smart house in a business environment,
  - inclusion of / integration with business processes,
  - optimization of existing processes in an organization (or office),
  - ability to implement new and more efficient business processes,
  - expected benefits on the user level regarding to more organized and coordinated social interactions.
- **Challenges:**
  - correspondence of AmI-IoT with business processes,
  - acceptance and support from the side of employees (and management),
  - possible solution: AmI-enhanced services and processes should follow the recommendations of IT Infrastructure Library (http://www.itil-officialsite.com) and the related standard ISO/IEC 20000:1-5.

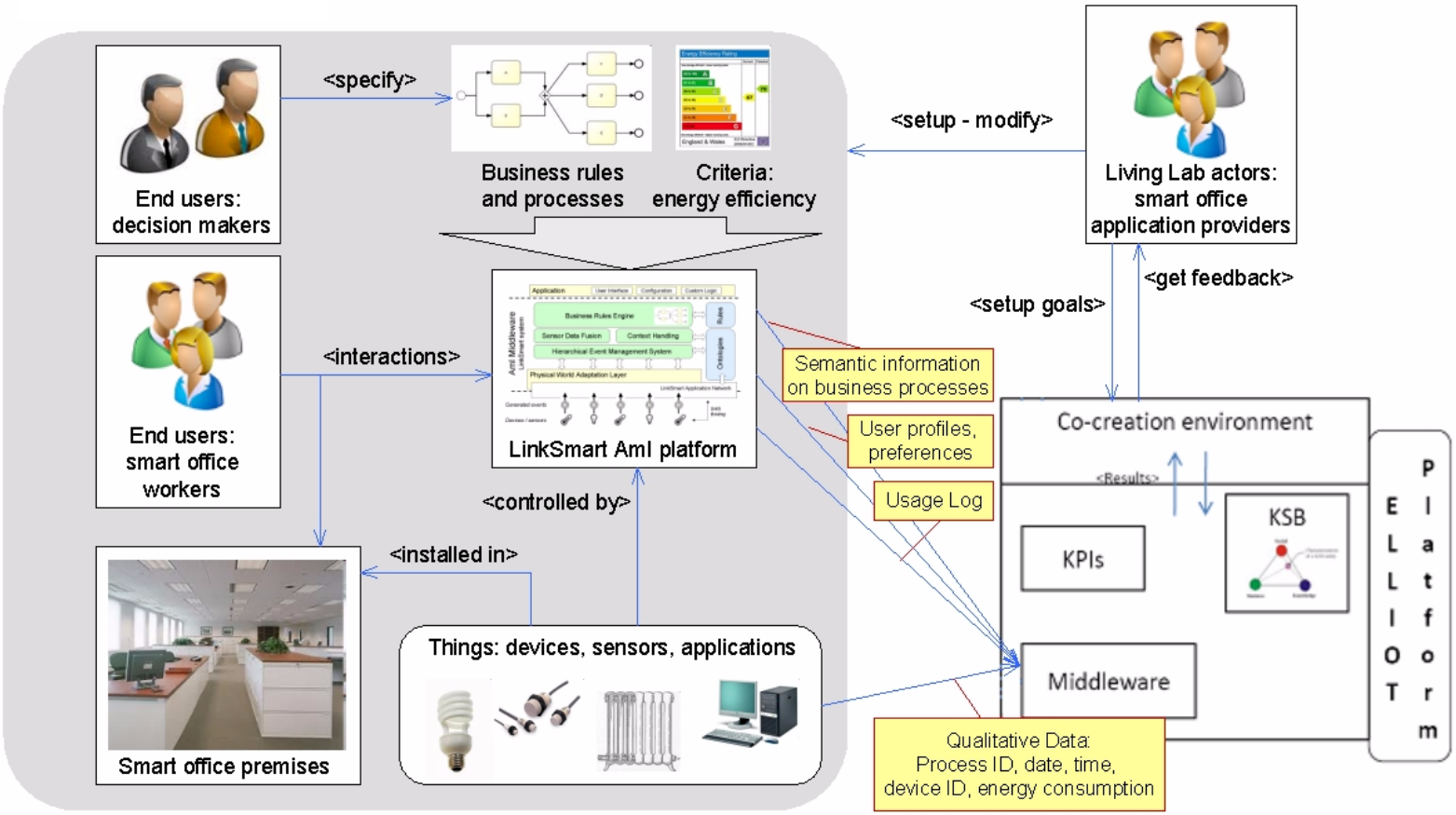
Application partner: RWE IT

- **RWE IT Slovakia,**
  http://www.rweit-slovakia.com
  - belongs to RWE group, leading energy (gas, electricity) distributor in Eastern Slovakia
  - daughter company of RWE IT GmbH, IT services provider for RWE

- **Smart Office pilot** is implemented in the premises of RWE IT:
  - office type: open space room
  - 8 employees in the office (administration department)
  - central heating, air conditioning individually controlled within the office
  - equipment: computers, monitors, phones, 2 x printers, 1 x scanner / copier

Living Lab for the Smart Office

- **General Goal:** a systematic user co-creation approach integrating research and innovation processes towards the energy efficiency in business environment, using AmI-IoT technologies.



Living Lab scenarios

Scenario #1: *Exploration of a suitable occupancy sensing device*

- Includes three different types of occupancy sensors identified by IoT experts;
- Goal: To find the most suitable toolkit for occupancy sensing;
- Focus: To find a balance between (1) comfortable environment, (2) amount of saved energy / CO2 emissions, and (3) privacy loss.

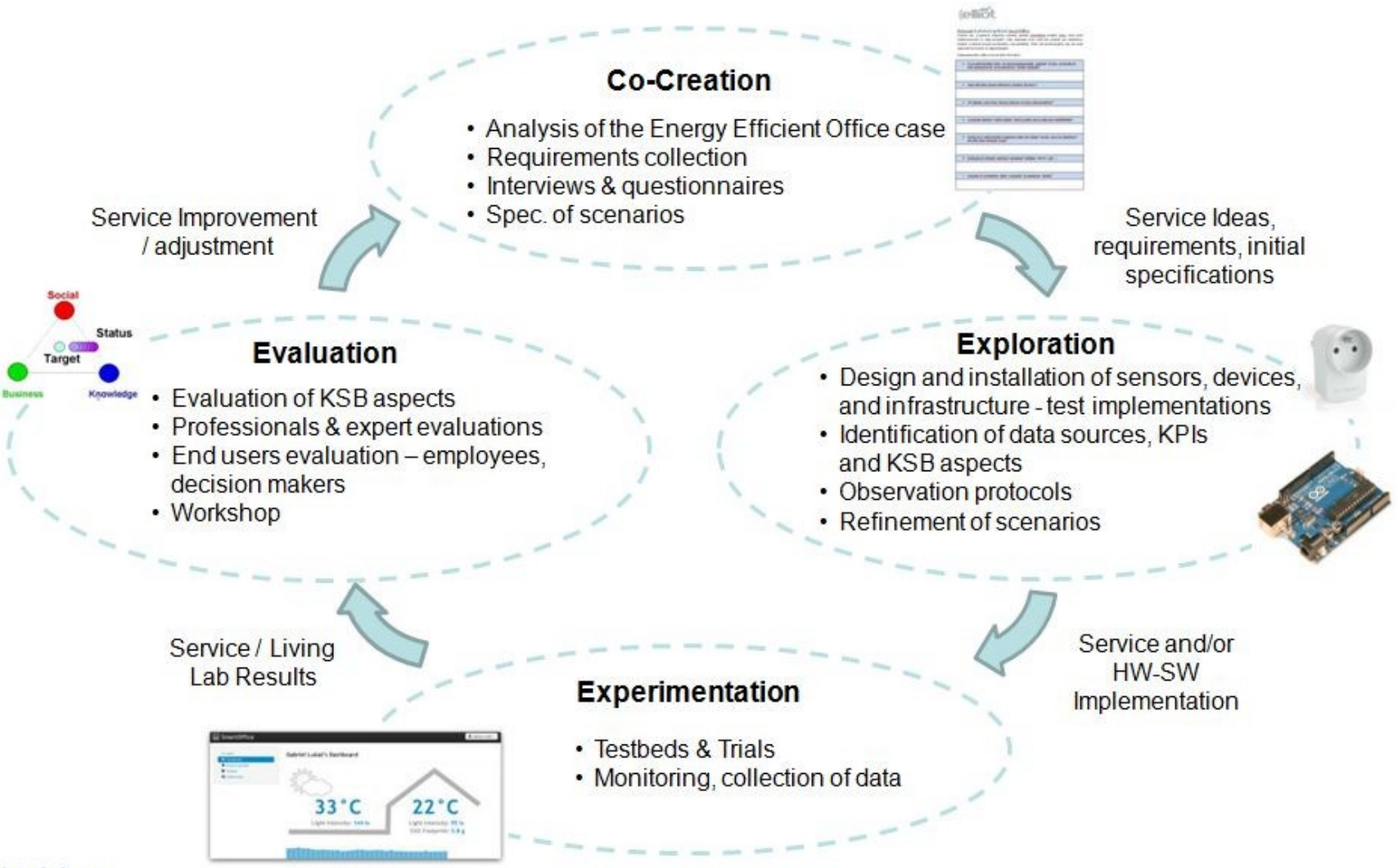
Scenario #2: *Process-based adaptation of the working environment*

- Settings of working environment based on process model templates - predefined working hours, planning of absences, business trips, etc.;
- Goal: To provide an adaptable process model of the working environment, which functionally complements the Smart Office IoT application;
- Focus: Experiment with adaptations of the working environment according to process model templates and user's preferences;

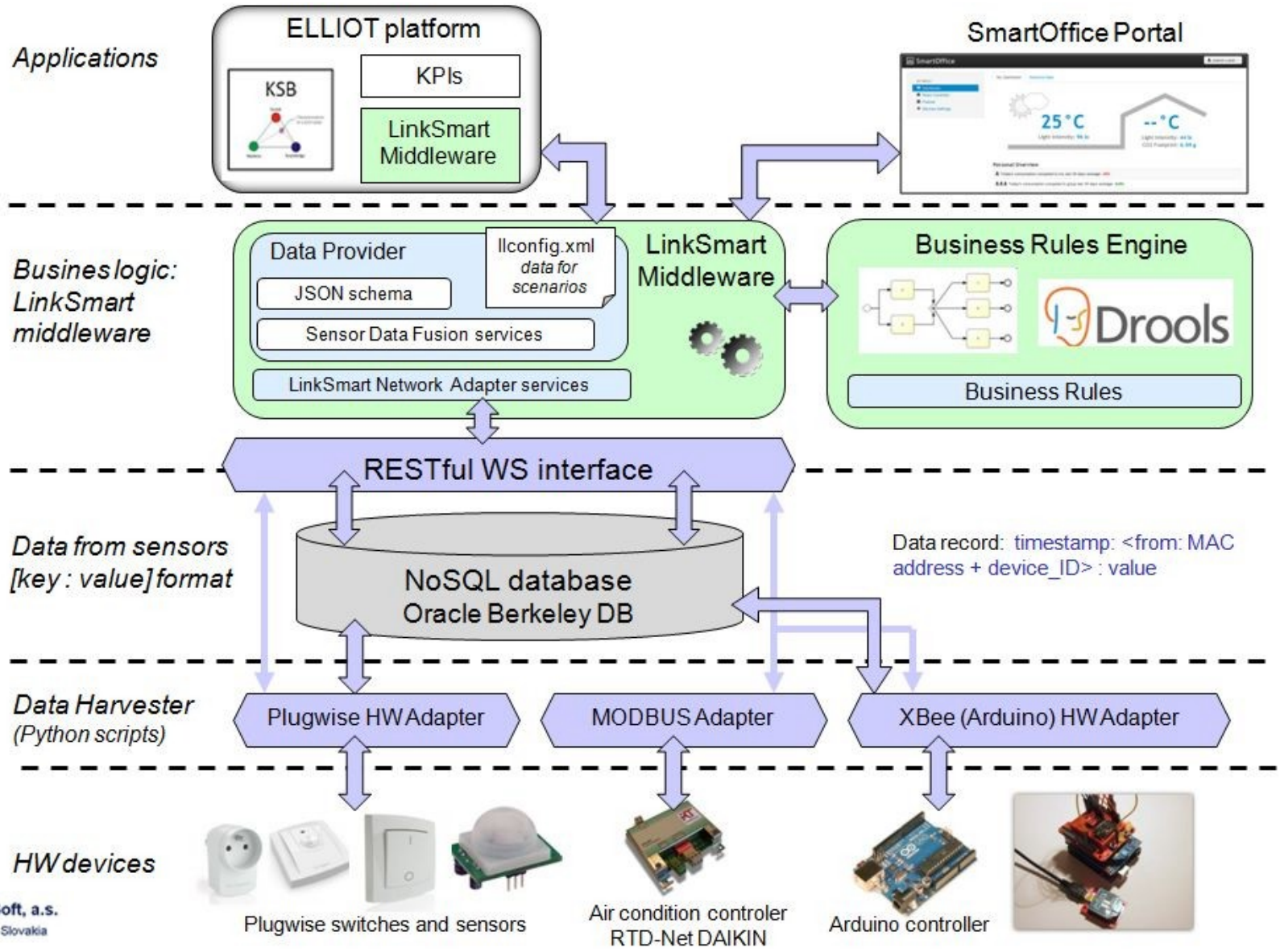
Scenario #3: *Competition on energy savings*

- A visualization showing actual/historical energy consumption and CO2 footprint data;
- Goal: To enable users to play a “game” that helps and encourages energy savings;
- Focus: To increase energy savings; to provide overviews and reports on energy savings for managers, decision makers.

Living Lab phases



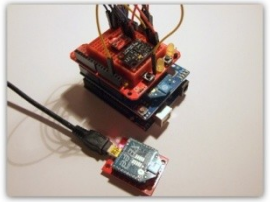
Architecture



Sensors and devices

- Electricity consumption measurement and control: Plugwise Home Automation solution. Communication: ZigBee network

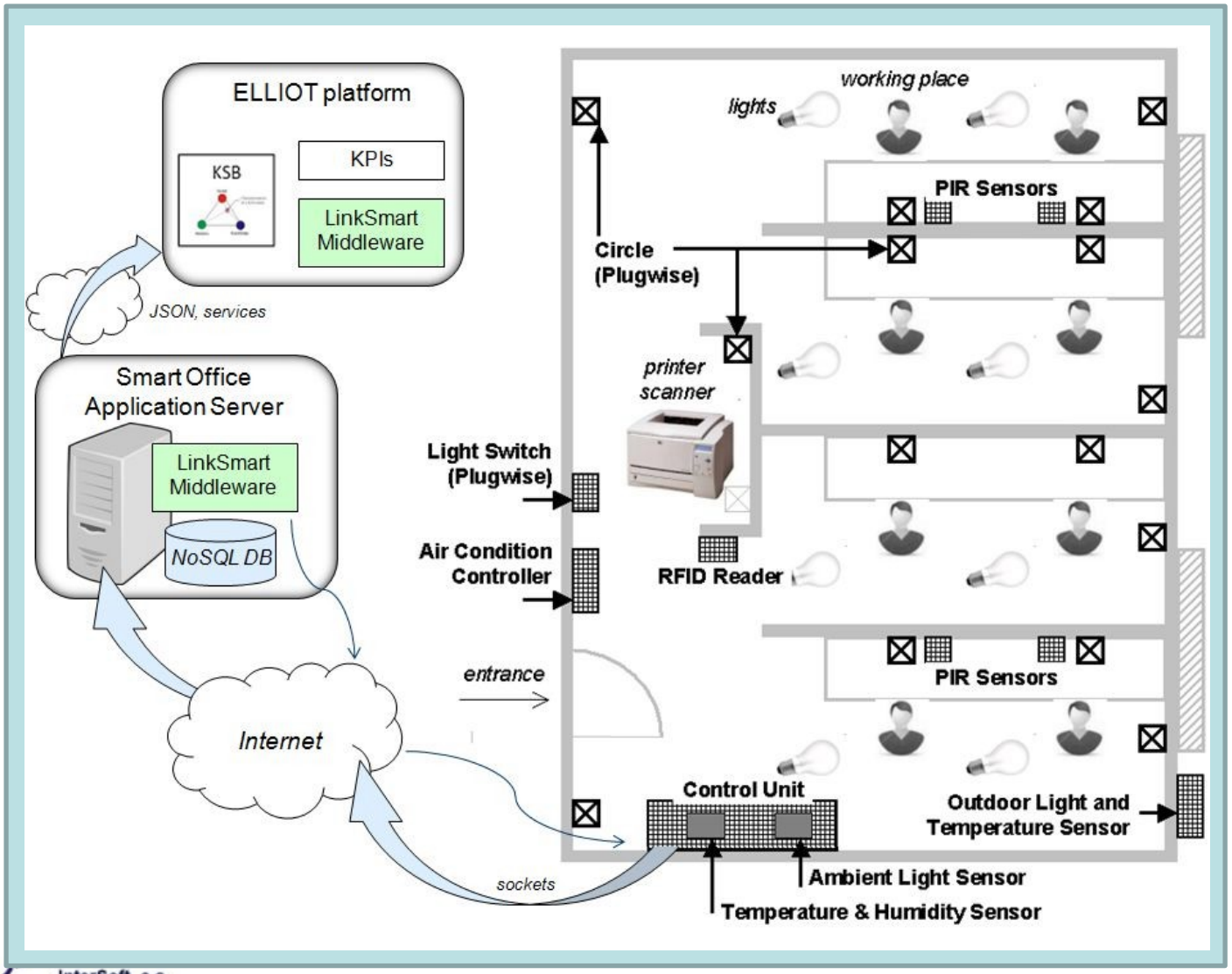
- Indoor/Outdoor ambient light and temperature sensors: based on the BH1750FVI chip (light intensity), TMP102 of Texas Instruments (temperature). Controller: Arduino Uno Rev3. Communication: XBee Z2 module.

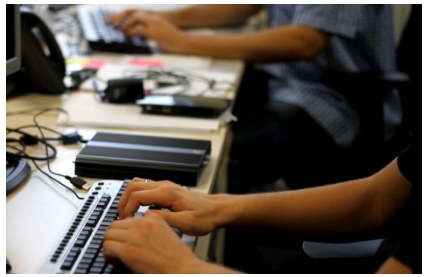


- Occupancy sensors: RFID cards / PIR - passive infrared motion sensors / virtual sensor: analysis of actual power consumption on the working place

- Air conditioning control: RTD-Net DAIKIN bus/hardware controller, MODBUS communication protocol.

Distribution of sensors

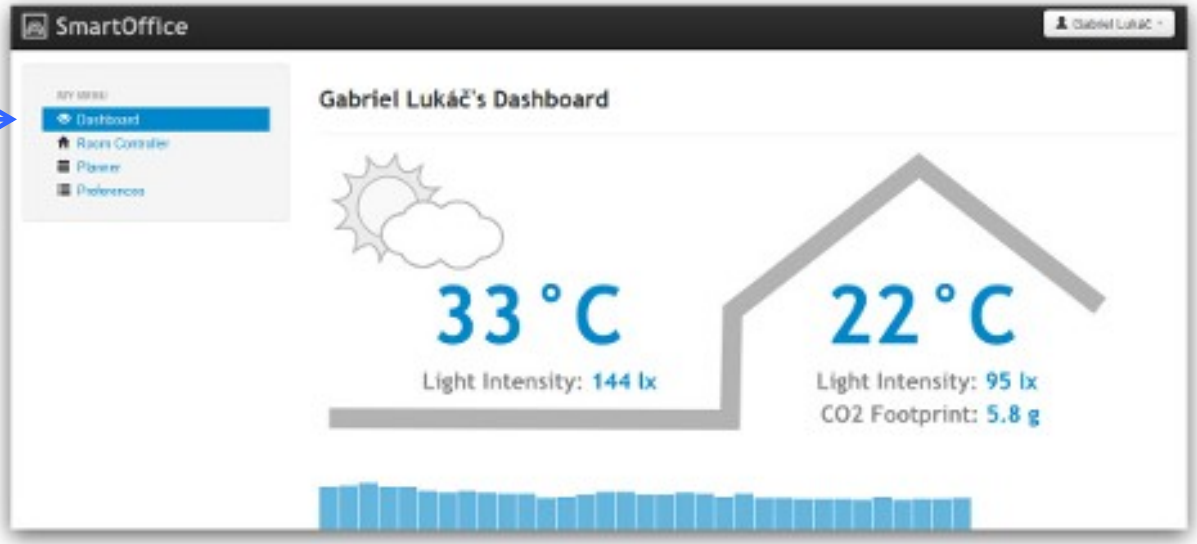




User interface

SmartOffice Portal - the main user interaction tool

Room controller
Planner
Preferences



Dashboard - energy consumption and environmental conditions for a logged user

- history of energy consumption
- tips / recommendations on energy savings

Room controller - manual correction of automated settings

Planner - planning of a presence / working schedule

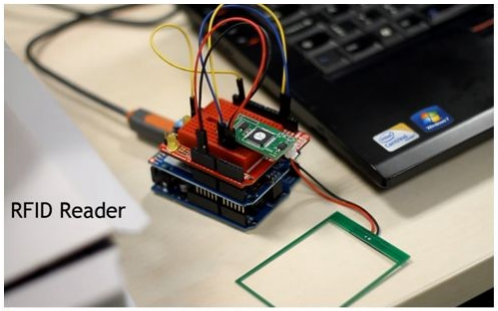
Preferences - user profile, personal preferences on light / temperature settings

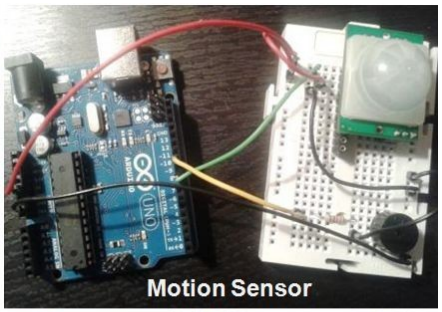
Collecting the data (1)

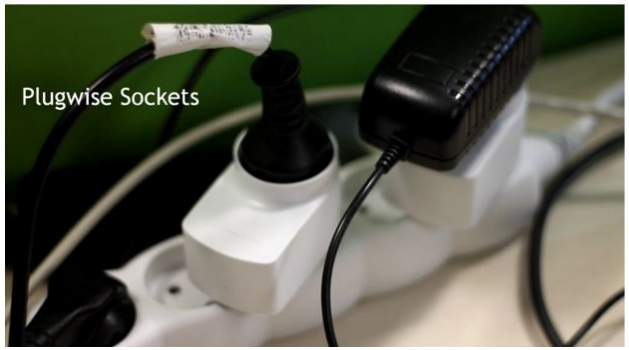
- **Means of collecting the data:**
  - direct measuring – outdoor / indoor temperature, power consumed on a single plug, light intensity on a single place, etc.
    - a value fetched in a single shot from a sensor, e.g. Immediate power consumption in watts, temperature value in °C, etc.
  - simple calculation – i.e., CO2 footprint (CO2 emission factor for electricity = 0.527 kg / kWh, http://www.carbonindependent.org) , light intensity in whole room, etc.
    - single value, calculated by a simple algebraic statement from one or several directly measured values
    - data series of two dimensions (e.g. indoor temperature for given time period)
  - data merging – i.e., occupancy sensing (calculated by merging Power consumption data analysis, PIR motion sensors, and RFID cards), average energy consumption of a working team for a given time period, etc.
    - multi-dimensional data structures, calculated by algebraic statement s and rules

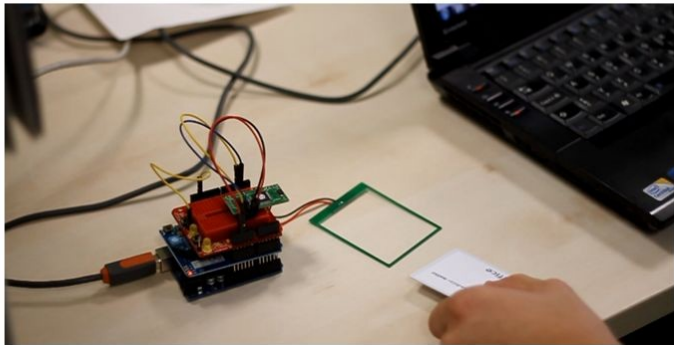
Collecting the data (2)

- **Data sources:**
  - sensors: power consumption on plugs, outdoor / indoor temperature, light intensity, power / light switches, PIR motion sensors
  - devices: RFID cards for occupancy sensing, air conditioning control unit, LinkSmart middleware system (provides system logs)
  - user interface: web based Smart Office portal (user interactions, user profiles & preferences, system logs)









Data logs from sensors

- **Power consumption:**
  - 8 devices measuring immediate power consumption on power sockets (at every workplace)
  - 2 more power consumption sensors on light
- **Log example:**

  power usage: 46.00W on 000D6F000072AF09 at 11-07-12 11:17:17
  power usage: 42.00W on 000D6F0000D33655 at 11-07-12 11:17:17
  power usage: 3.00W on 000D6F000076937D at 11-07-12 11:17:17
  power usage: 36.00W on 000D6F00007690CB at 11-07-12 11:17:17

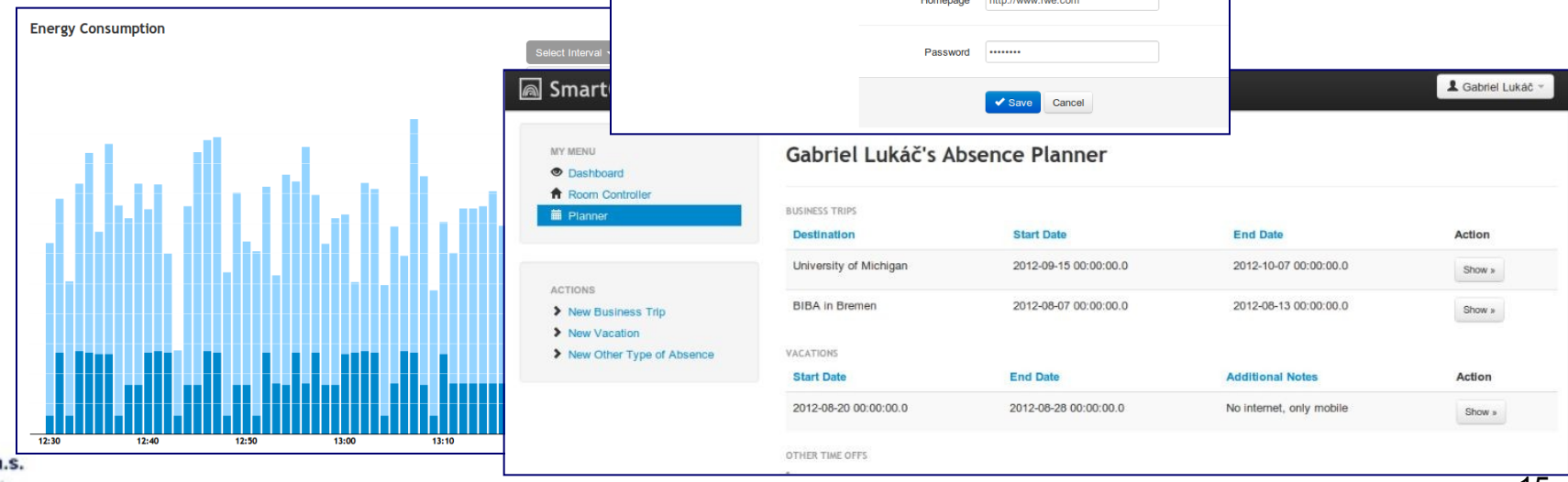
  Log format: [Immediate power consumption in watts] [ID: MAC address of sensor] [timestamp]

- **Other measured data:**
  - Temperature (outdoor / indoor), Light
  - Occupancy sensing (*data available via REST-ful web service on demand*):
    - Power consumption data analysis
    - Occupancy sensing - PIR motion sensor
    - Occupancy sensing - RFID card

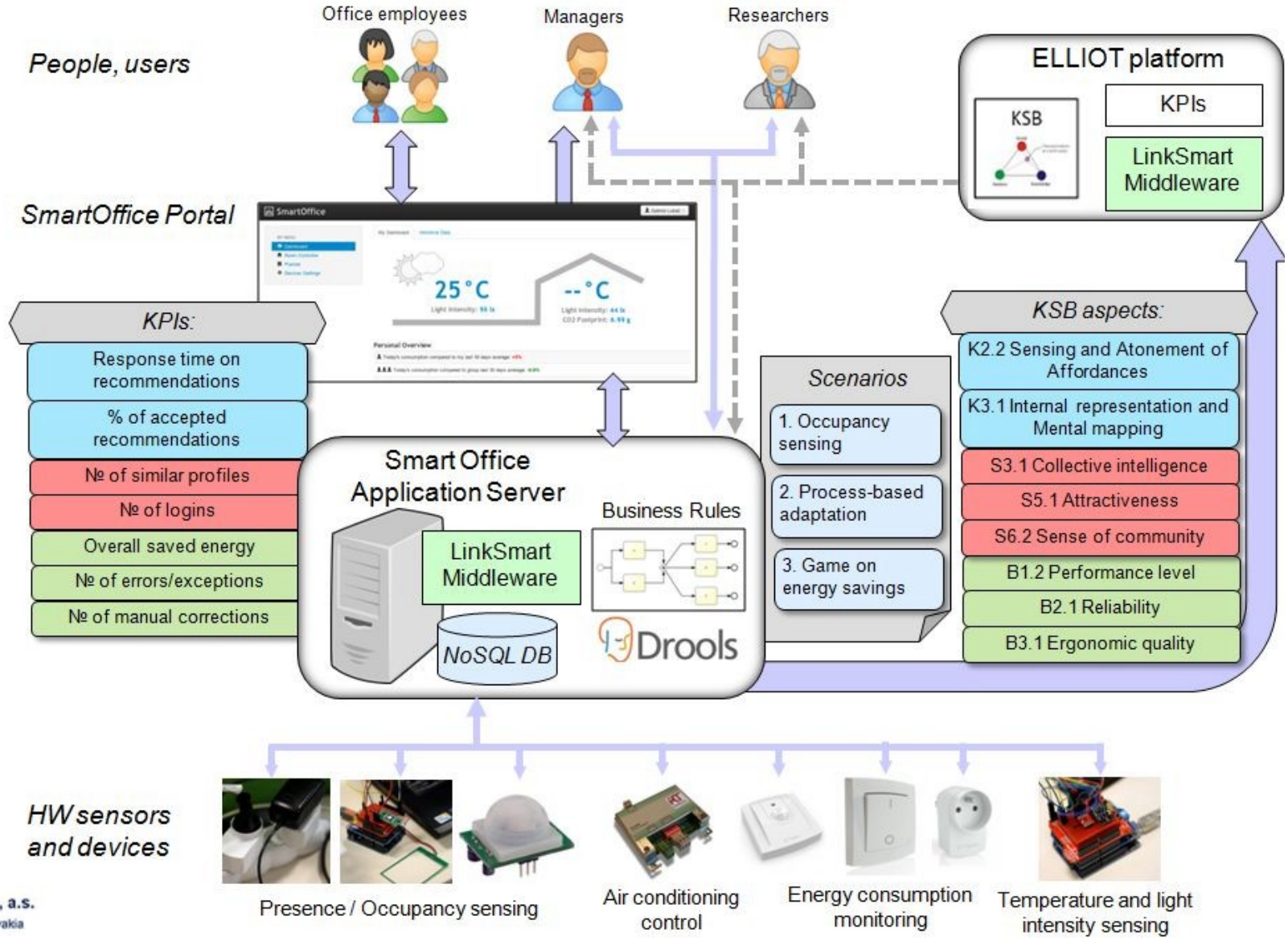
Data collection and evaluation

KPIs:

- % of similar profiles / preferences
- 5 accepted recommendations on energy saving actions
- overall amount of saved energy for a given period
- No. of manual corrections of settings of the working environment (I.e. light intensity, air conditioning, temperature)
- …



KPI - KSB evaluation



Thank you!

More information:

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- www.elliot-project.eu
- http://www.linkedin.com/groups?gid=4541423
- http://www.linkedin.com/groups?gid=4012324

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