Instrumenting the buildings for improved energy efficiency - a holistic and durable approach

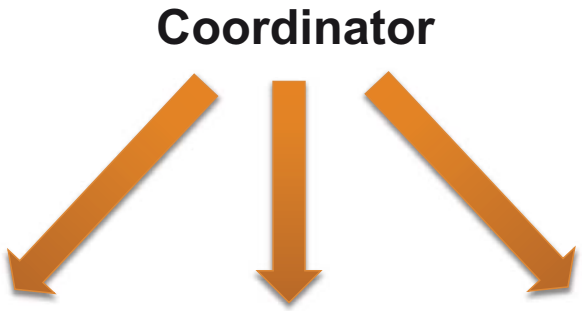
Alexander Pelov
Nicolas Montavont
Cendrine Le Locat

Second Meeting of the Monitoring and Control Cluster on Smart Buildings/Smart Spaces
Lisbon, 11 November

Introduction of Télécom Bretagne

- **It is a university**
  - Specialized in telecommunications
- **Two campuses**
  - Brest (main campus)
  - Rennes
- **Human resources**
  - ~ 1200 students
  - ~ 300 staff (1/2 faculty)

Sustainable Development @ Campus Organization



Logistics
> Reducing our footprint

Research
> ICT and Energy Efficiency

Education
> Citizenship

Plan

- **Sustainable Development @ Campus**
  - 2006-2009
    - Commitments
    - Actions
    - Results
  - Current and future initiatives
- **BiPs**

Sustainable Development @ Campus Challenges

- **Wide cultural mixture**
  - 50% of the students are from abroad
  - Students coming from over 50 countries
    - Divergent ways of life, priorities and attitude towards resource conservation
- **Campus split in two distant cities (~250 km)**
- **Budget limitations**
- **Significant increase**
  - Students
  - Staff (faculty and non-faculty)
  - Research and teaching activities and related trips

Sustainable Development @ Campus Actions (2006-2009)

- **100% of wastes were sorted and recycled**
  - Example: electronic waste, toxic waste, making compost from organic waste, etc.
- **The village greens were improved**
- **10% of the buildings in the bigger campus were renovated**
- **Water efficiency**
  - Water cranes were changed with smaller ones
  - Rain water collection
  - Replaced inefficient air conditioners
- **Paper waste reduction**
- **Trip optimization**
- **Introduced the subject in research and education**

Sustainable Development @ Campus Results (2006-2009)

- **Education**
  - Several courses related to resource conservation, energy efficiency, environmental ethics, etc. introduced at all levels
  - Research and development projects
- **Research**
  - Group consisting of researchers from all departments
  - New recruitment focused on energy efficiency
  - Multiple research projects (e.g. optical fiber LAN, energy-efficient radio transmissions, etc.)

Sustainable Development @ Campus Results (2006-2009)

- **Energy consumption: -1.8%**
  - Electricity + gas
- **Water consumption: -42%**
  - Total savings of ~126k€
- **Paper usage: -18%**
  - Total savings of ~15k€
- **However**
  - The number of missions increased by 4,5%
    - The related carbon footprint increased by 28%
    - Related to the significantly increased number of faculty and staff – currently looking into the details
  - Some of the ideas did not gain popularity or were not implemented due to budgetary limitations or lack of support
    - Car pooling
    - Automatic PC shutdown

Sustainable Development @ Campus
Current and future initiatives

- **Involve the students more actively**
  - "Idea box"
  - Organized competition among the dorm buildings
  - Posters and information in the center of the university's main building
  - Student club related to sustainable development
- **Lesson learned**
  - Communicate
  - Motivate your peers
  - Educate students and supporting staff
  - Most importantly - get the decision makers to take specific commitments
- **We have a new dean who actually wants to join the research group for sustainable development**
  - We are on a fast track – if you have any ideas or proposals please do share!

Plan

- **Sustainable Development @ Campus**
- **BiPs**
  - Holistic and durable approach to smart buildings
  - Project BiPs
    - Improving ICT efficiency
    - Societal effects

Smart buildings

- **Construct energy efficient, "smart" buildings**
  - From passive objects to active, smart "things"
  - Container for the in-building life
  - Element of the local infrastructure grid
- **Instrumenting the buildings**
  - Energy conservation
  - Healthcare applications, etc.
- **However**
  - Take into account the social impact
    - Holistic approach
  - Buildings typically outlast computer technologies
    - Durable technologies

BiPs (Bringing IPv6 to the Sensor)

- **Develop sensor network infrastructure for monitoring and control**
- **Main axes**
  - ICT-centered research and impact
  - Societal impact
  - ICT for improved building efficiency
    - Define rule-based system built upon the previous two axes
      - Following NATO's CCC (Command and Control Centre)
      - Use user activity and building energy consumption models
    - Employ actuators to apply the rules
- **Submitted to ICT6 call of FP7**
  - Lack of industrial partners
    - ➢ Resubmission to ICT7

ICT-centered research and impact

- **Sensor network**
  - Autonomous systems
  - Self-healing, -configuring, etc.
- **Design new sensors**
  - Last longer
    - Use ambient energy
    - Energy-efficient
    - Use/develop battery-less sensors
- **IPv6-based networking**
  - IP is an evolutionary kernel for the Internet [Dovrolis2008]
    - Avoid reinventing the wheel (every 5-10 years)
  - Over technologies such as IEEE 802.15.4, WiFi
  - Bi-directional communication between the Internet and the sensors
  - Energy-efficient routing, service discovery, etc.

ICT-centered research and impact

- **Building SN may become critical infrastructure**
  - E.g. energy outages may occur if a city relies heavily on privately-owned sensors for energy management and a virus brings all sensors down simultaneously
- **Interference management**
  - Having a heart-attack go undetected because the neighbor is making a pizza in his micro oven
- **Security**
  - Limit the sensor information to authorized services only
  - Sensor localization
  - Handle misbehaving sensors
  - Mechanisms of guaranteeing data privacy and anonymity
  - Automatic discovery of attacks
  - Adaptive security enforcement

Societal impact

- **Privacy concerns**
  - Determine the conditions to use the system without being invasive in the private life
- **Increased energy efficiency by itself is not enough**
  - Rebound effect
  - Technology appropriation
    - Intuitive interfaces
    - Counter-example: the EPA recently suspended the Energy Star certification program for all programmable thermostats, effective December 31, 2009 [Epa2009]
- **Legal framework**
  - Data belong to the user ?
  - Counter-example: It is possible to profile the behavior of the inhabitants of an apartment by only looking at the electrical consumption @ 1 Hz

Conclusion

- **Campus > Sustainable campus > Smart campus**
  - Opened to proposals
- **BiPs**
  - Societal effects
  - Energy efficient IPv6-based technologies
  - All critics and proposals are welcome

Thank you for your attention!

Alexander Pelov
alexander.pelov@telecom-bretagne.eu

Nicolas Montavont
nicolas@montavont.net

Cendrine Le Locat
cendrine.lelocat@telecom-bretagne.eu

References

- **[Dovrolis2008]**
  - Constantine Dovrolis. 2008. What would Darwin think about clean-slate architectures?. SIGCOMM Comput. Commun. Rev. 38, 1 (January 2008)
- **[Epa2009]**
  - EnergyStar. Programmable Thermostats Suspension Memo. http: //www.energystar.gov/ia/partners/ prod_development/ revisions/downloads/ thermostats/Spec_Suspension_Memo_ May2009.pdf.