Experiences on the Development and Pilot Testing of Autonomous Wireless Sensor Networks

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Outline

- History and introduction to WSNs
- TUTWSN technology
- TUTWSN pilots
- Conclusions

Wireless Sensor Networks

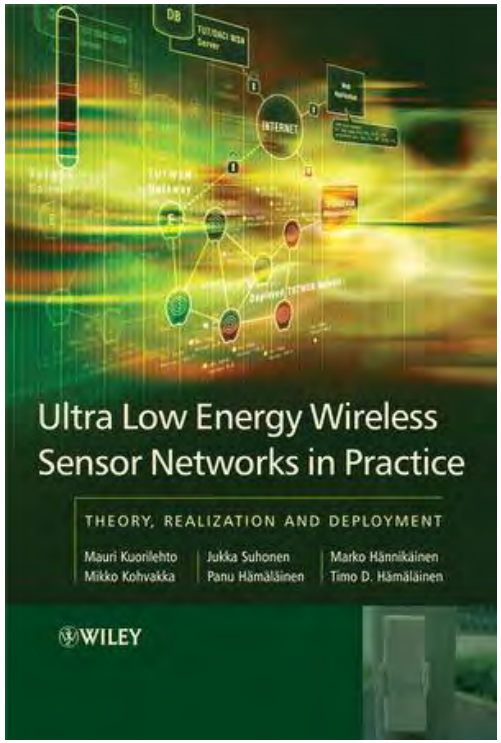
- WSN consists of a large number of nodes that organise autonomously
- WSN nodes are resource constrained (limited computing, communication, and energy)
- WSN targets at low price, small size, robustness, maintenance freedom and fast installation
- WSN applications are versatile, they
  - Measure environment
  - Control other systems
  - Identify, locate persons and assets
  - Transfer, save, and refine information

Main WSN standards

WSN research at TUT

WSN Research on Low-Energy WSNs in Practice

1. WSN theory and technology
2. Design tools and infrastructure integration
3. Applications and services
   - Pilots is real environments and application cases
   - Feasibility on business models



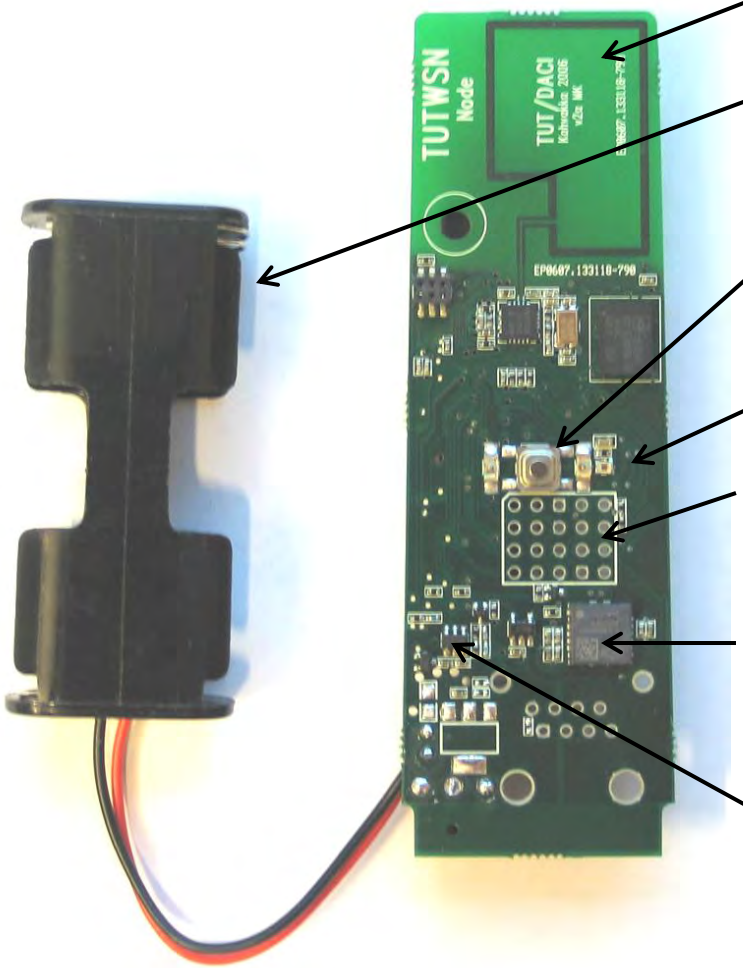
Technology base 1999-2005

First pilots started 2006

Pilots with companies 2009-

2002 2003 2004 2005 2006 2007 2008 2009 2010

TUTWSN (2.4 GHz), wireless sensor/router node



Loop antenna

Battery holder

Pushbutton
2xLed

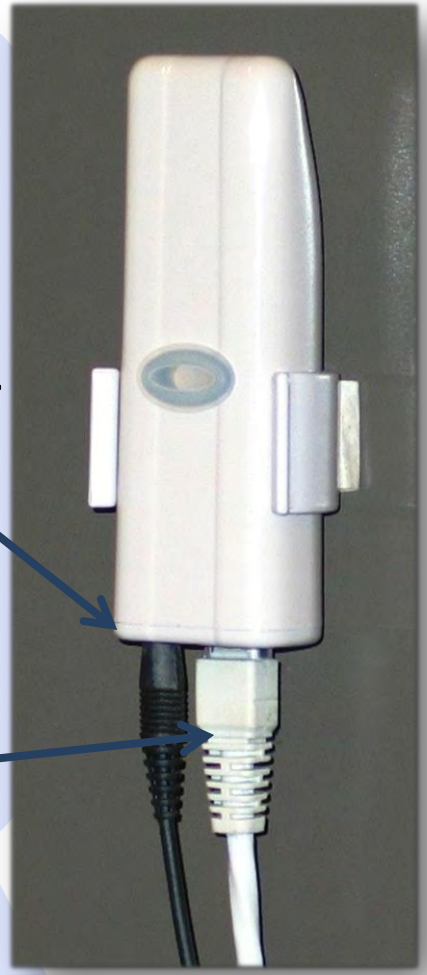
Lux sensor

Extension area for
add-on sensors

3D vibration sensor
(shock detection)

On-board temp
sensor

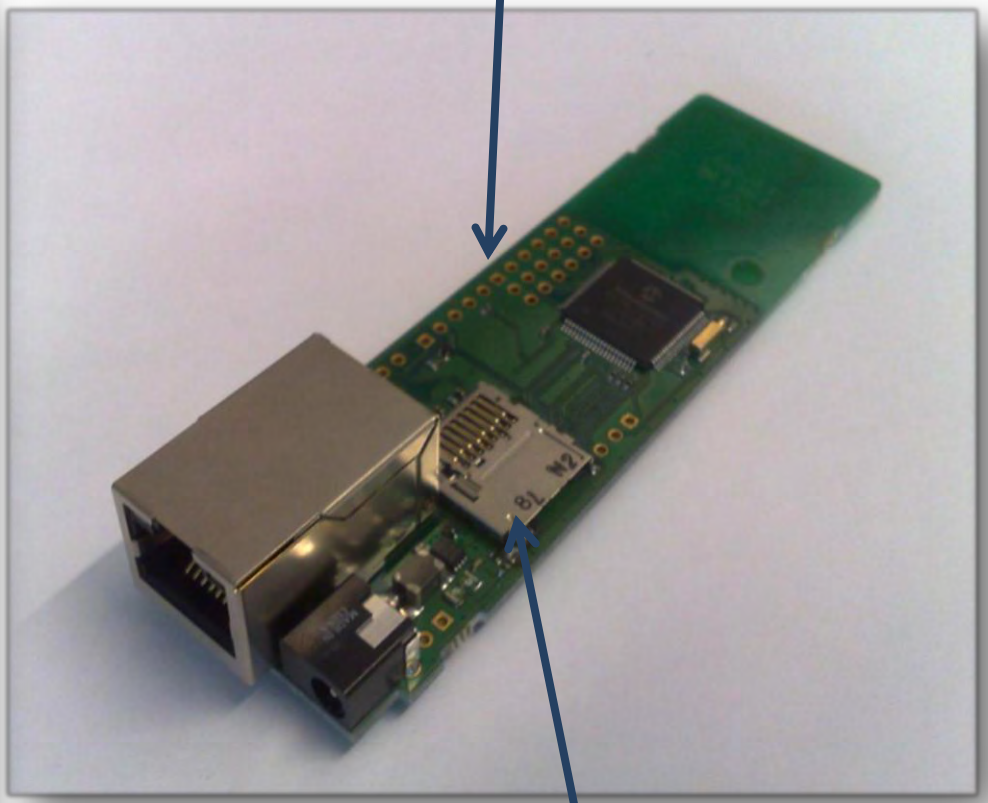
Gateway node (2.4 GHz)



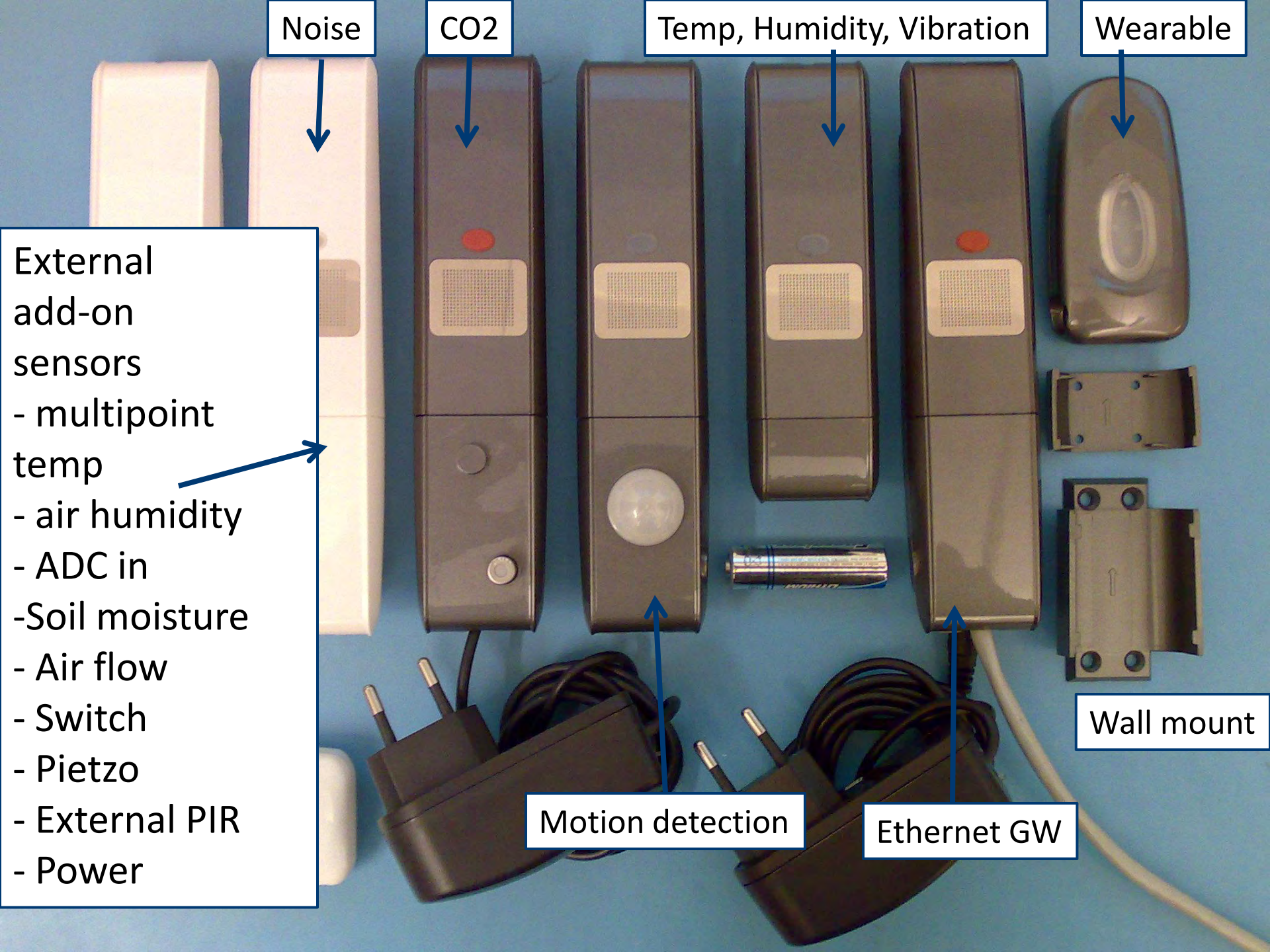
DC power

Ethernet

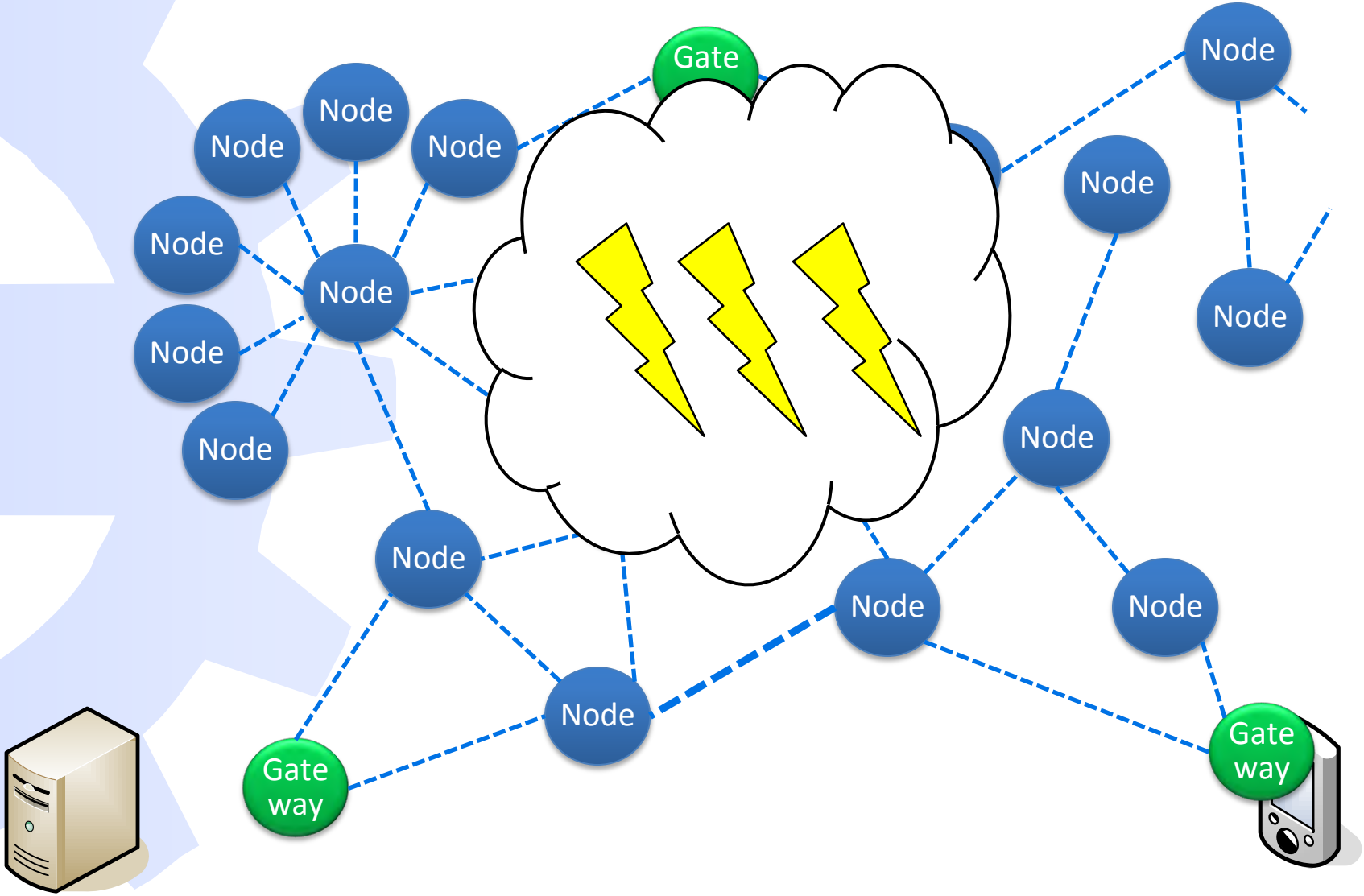
Auxliary sensors



Memory card (microSD)

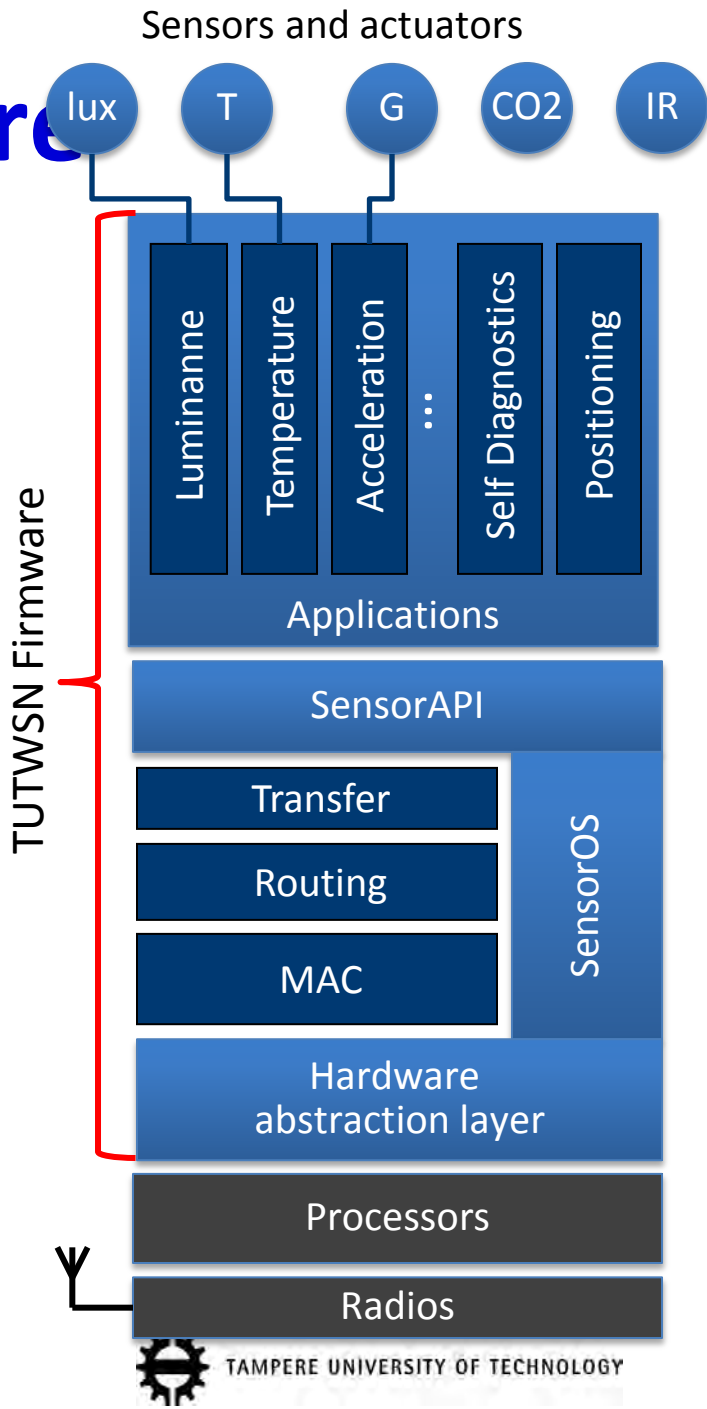

Noise
CO2
Temp, Humidity, Vibration
Wearable
External add-on sensors
- multipoint temp
- air humidity
- ADC in
-Soil moisture
- Air flow
- Switch
- Pietzo
- External PIR
- Power
Wall mount
Motion detection
Ethernet GW

TUTWSN networking



TUTWSN node software

- Node is an embedded system running protocols and several applications
- Interfaces for RS232, I/O, Ethernet (TCP/IP), sensors
- Energy optimised MAC layer and cost-based multi-hop routing
- Firmware can be updated on-the-field
- Performance is trade-off (cross layer design)



Pilots examples

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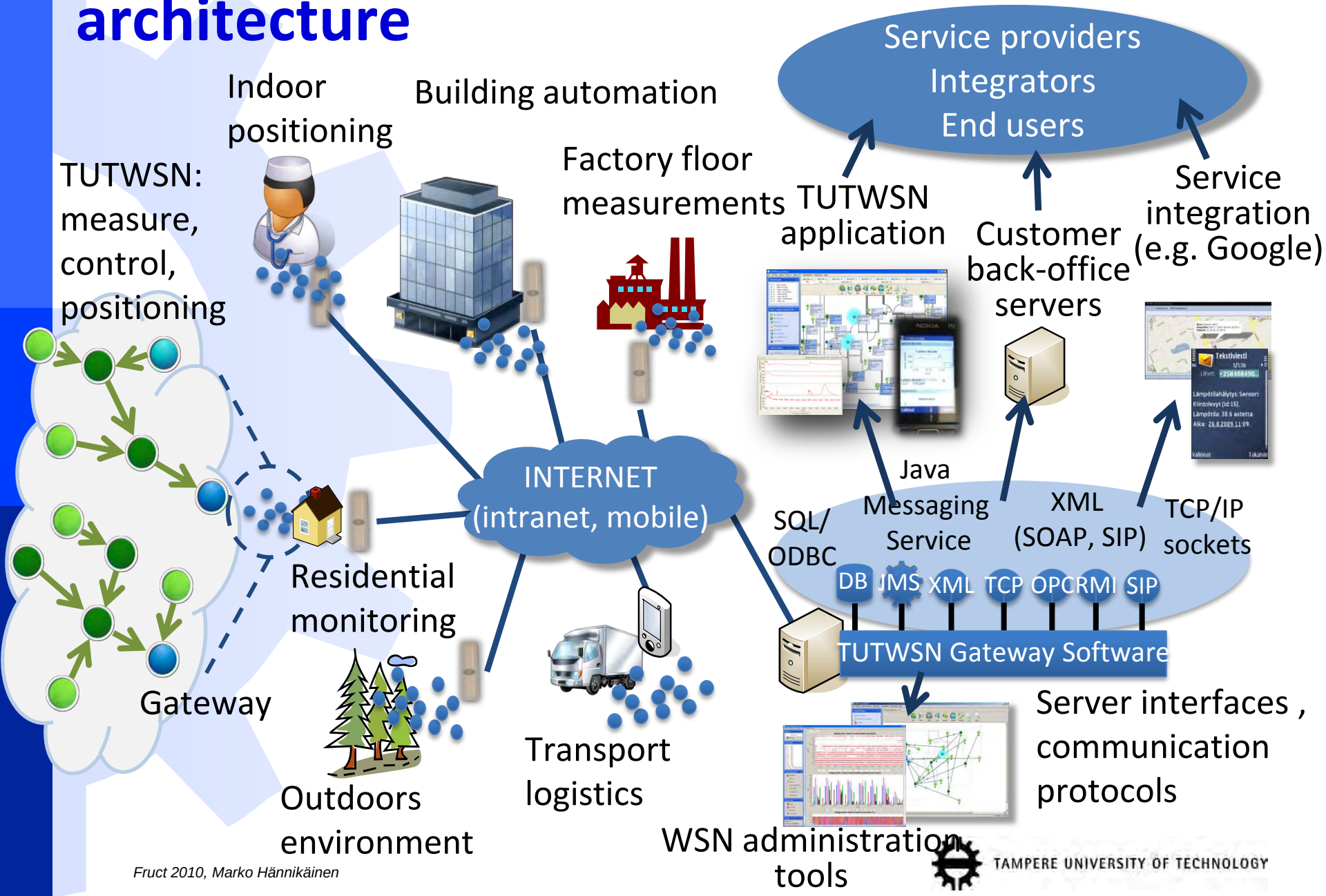
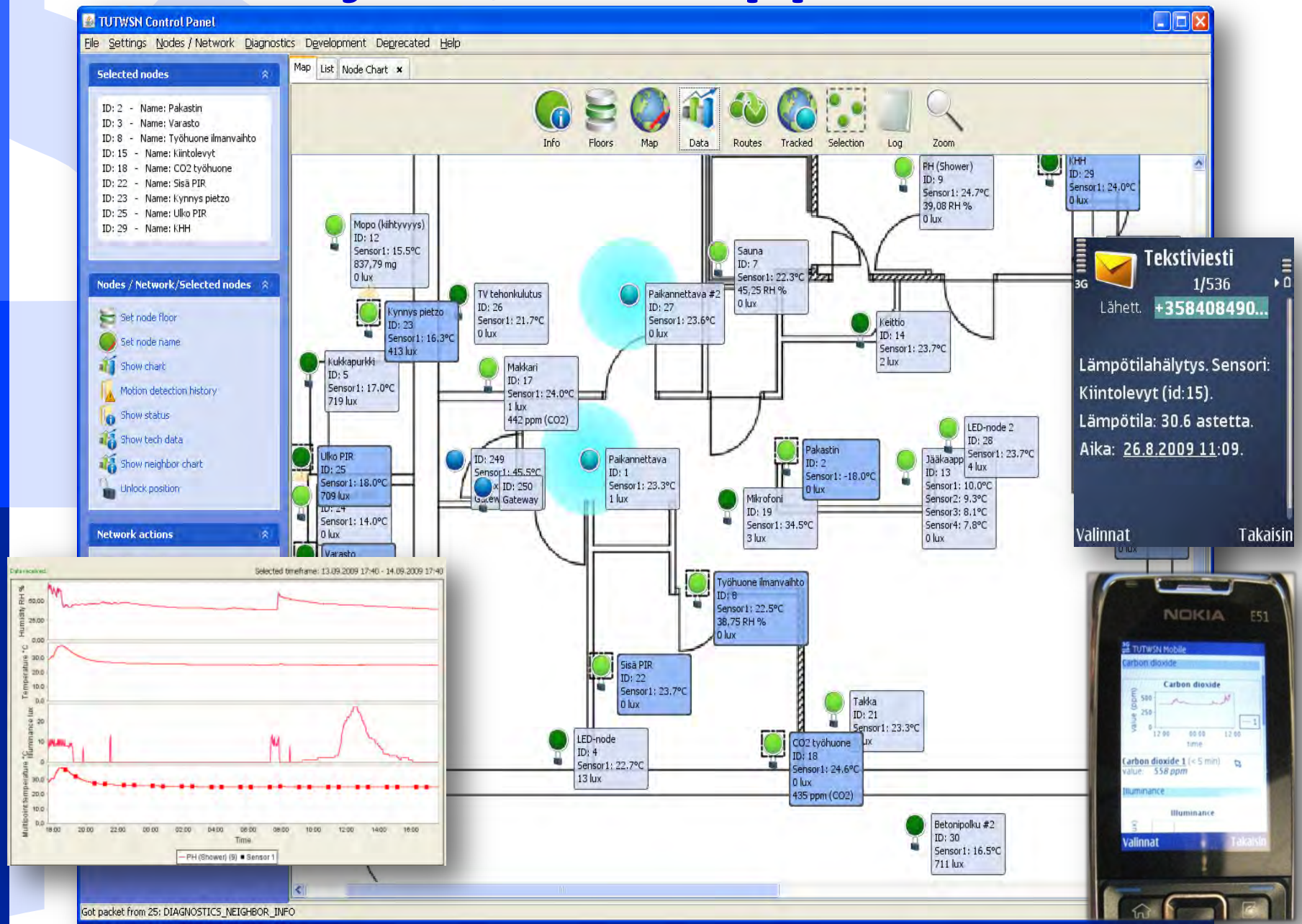
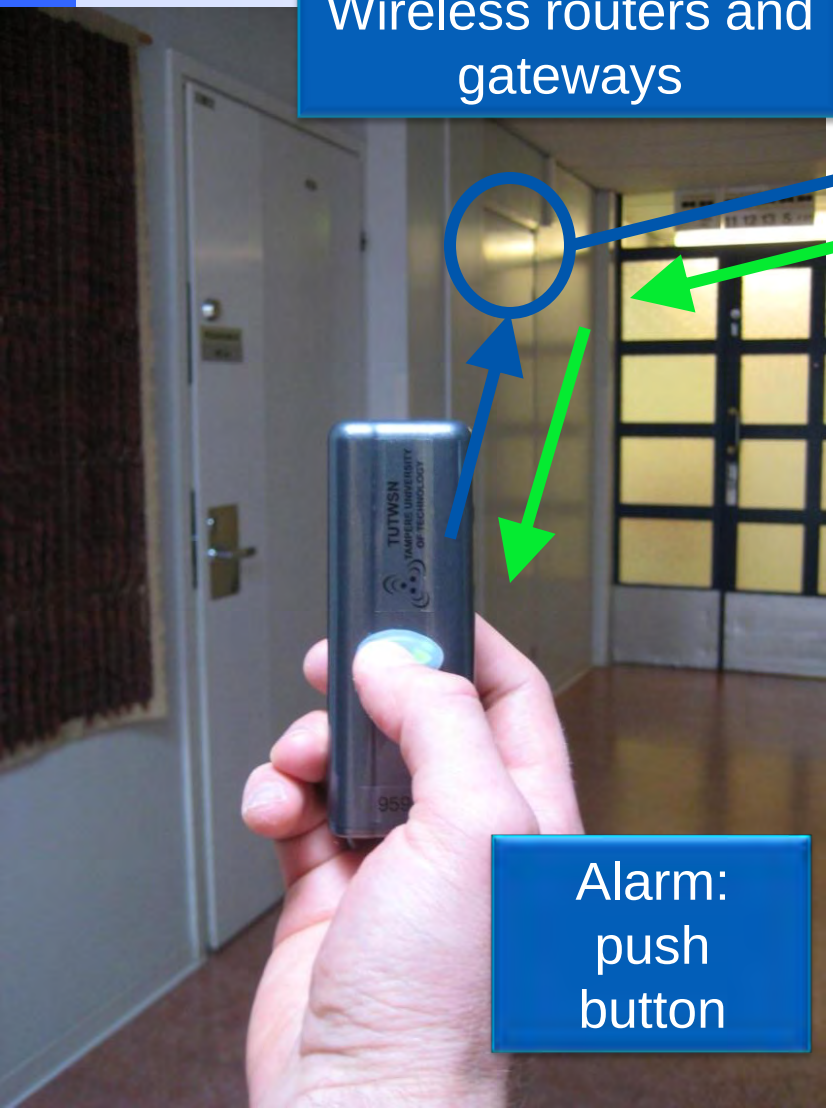
End-to-end service architecture



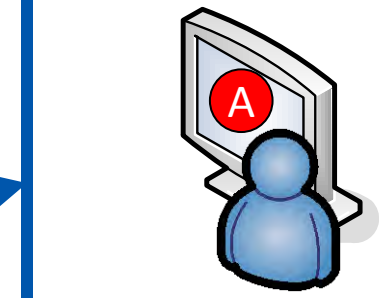
Online java, web applications



Personnel locationing and alarm button at hospital



Wireless routers and gateways



Monitoring room

Colleague acknowledges alarm

Alarm: push button

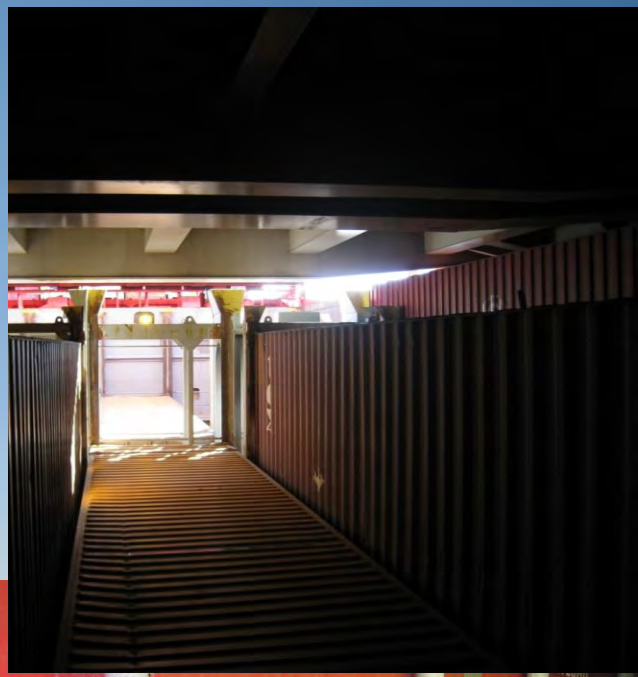
Sewer line monitoring, a Solvay Chemicals, Voikkaa

- Water level alarms on 5km sewer line
- 23 nodes, 2 Gateways
- 433MHz technology

Horse monitoring application

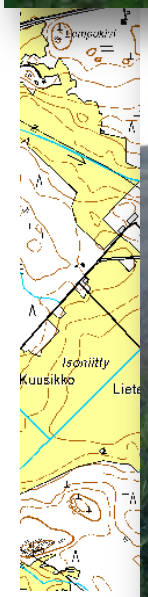
Photos Henri Välimäki

Container monitoring, on a container ship below deck



Outdoors pilot

- 6 km2
- Mainly fields, gardens, lakes, forests, hills
- Up to 70 sensors scattered
- Temperatures, light, moisture

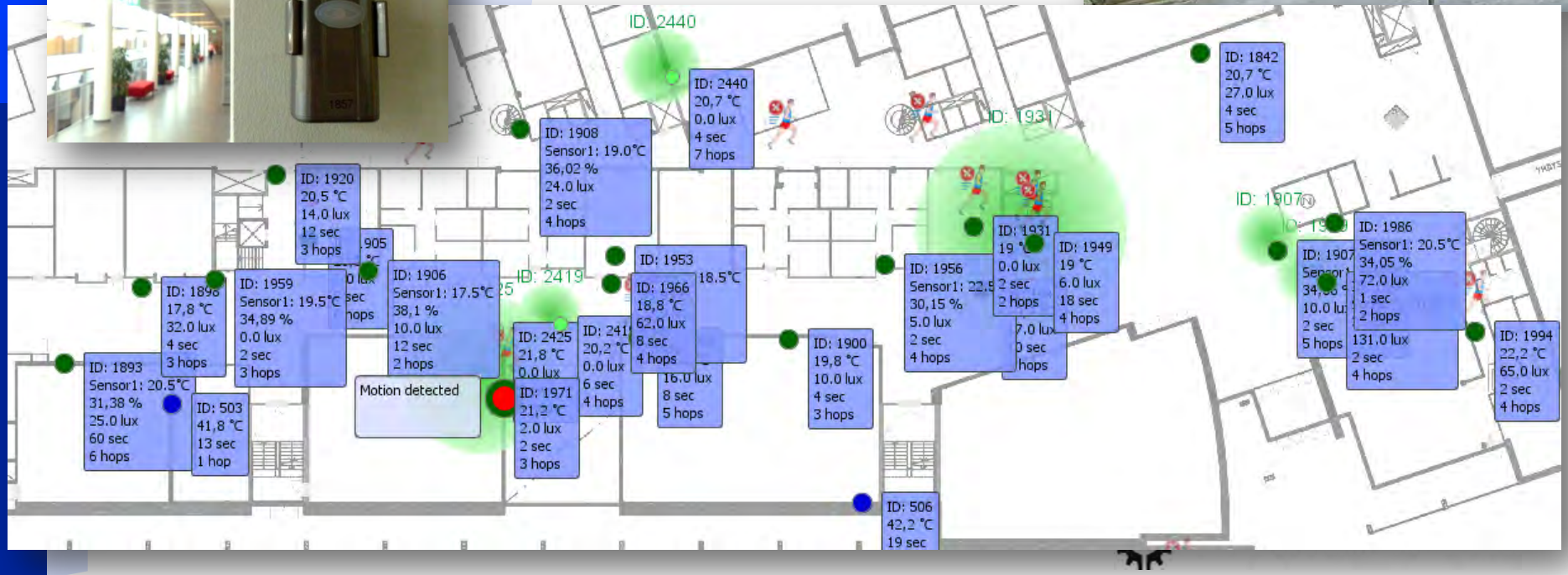


Greenhouse monitoring

- For adjusting greenhouse climate based on WSN measurements

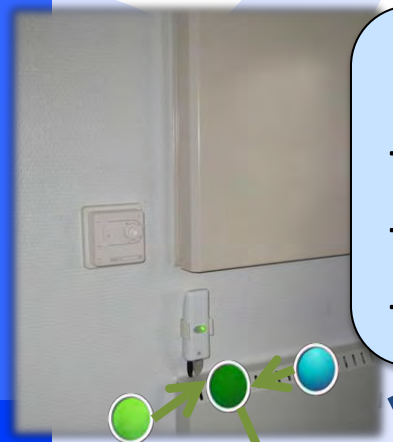
TUTWSN in TUT's campus (about 300 nodes)

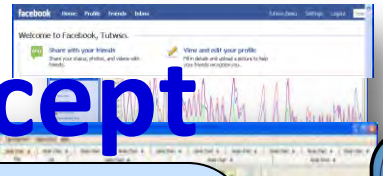
- Building automation and maintenance services
- Students design new applications

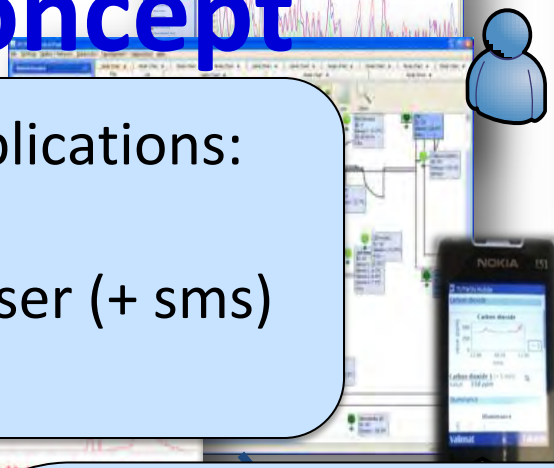


wsn@home concept

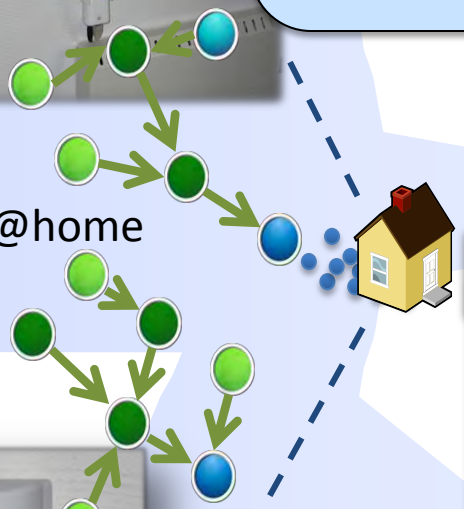
Resident's applications:
- web/java
- mobile browser (+ sms)
- Facebook







wsn@home



wsn@home online services
- Everything ok at home?
- Anyone home right now?
-Someone at the door?
- Freezer is going to break down?
- Is my motorcycle still parked at front?
- Too much CO2 at bedroom?
- TV is on for nothing?
- Garden is too dry?
- Air is too humid?
- Everything ok at the neighbors'?

Conclusions

Conclusions on TUTWSN Pilots and R&D requirements

- Piece-wise solutions, lack of common interfaces and tools -> Cross-layer design
- Lack of killer application & strong belief in killer application -> Niche markets the first to start
- Lack of de-facto standard & strong belief in near future de-facto standard -> WSNs implemented with standard components
- Nice ideas -> New services and business models