

# **Versatile Sensor Node**

## **A Platform for the Sensor as a Service Concept**

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# Outline

- SensorLab
- Wireless Sensor Networks
- Versatile Sensor Node
- Vertical Integration
- Applications

# SensorLab



- Department of Communication Systems @ JSI  
Department of Knowledge Technologies @ JSI  
ISOTel d.o.o.
- Coordinated activities on the development of custom WSN solution started in May 2009
- Key words: Versatile Sensor Node, Vertical Integration, Sensor as a Service (IP connectivity, WEB access), Deliberate/Participatory Sensing, Semantics

# Wireless Sensor Networks

## General characteristics and requirements:

- **adaptable** (diverse application requirements)
- **periodical, external event triggered** and/or **on request** measurements
- **asymmetric & directional** information flow (centralized, distributed, hybrid data aggregation and network control)
- **energy efficient** (long lifetime, all layers)
- **scalable** (huge number of nodes)
- **robust** (long runtime)
- **secure** (data confidentiality)

# Current state in WSN

- **Research**
  - Well developed field with many degrees of freedom
  - Complex, large-scale, resource constrained systems
  - Focus is on intra network communications
- **Development**
  - Solutions are tailored to specific application requirements
  - Standard compliance (interoperability)
  - Focus is on communication between WSN and Internet, to facilitate IoT/WoT
- **Business**
  - Slowly taking off (evolving standards, endless proprietary solutions multi-vendor interoperability)
  - Interference and congestion in ISM bands
  - Huge savings are promised (e.g. smart grids)

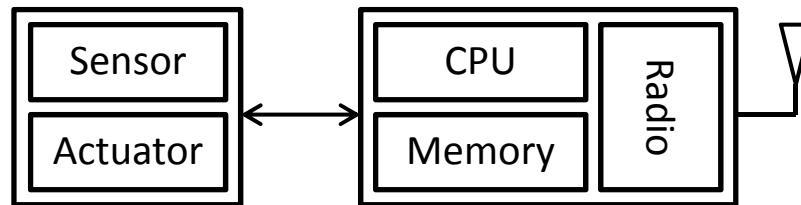
# WSN Technologies

- **Traditionally:** low complexity, low power, small size and weight, long life, autonomous, short range, low cost ...
- **Standardised**
  - IEEE 802.15.4 - Low Rate WPAN (PHY & MAC)
  - ZigBee, 6LoWPAN, WirelessHART, Dash7, Wavenis ...
  - IEEE 802.15.1 – Bluetooth (BT 3.0 Low Energy Mode)
  - IEEE 802.11x – Wi-Fi
  - Other dedicated communication technologies (Ethernet, GPRS, ...) in WSN concept – gateways
- **Proprietary**
  - Z-Wave, ANT, MiWi, SimpliciTI, DigiMesh ...

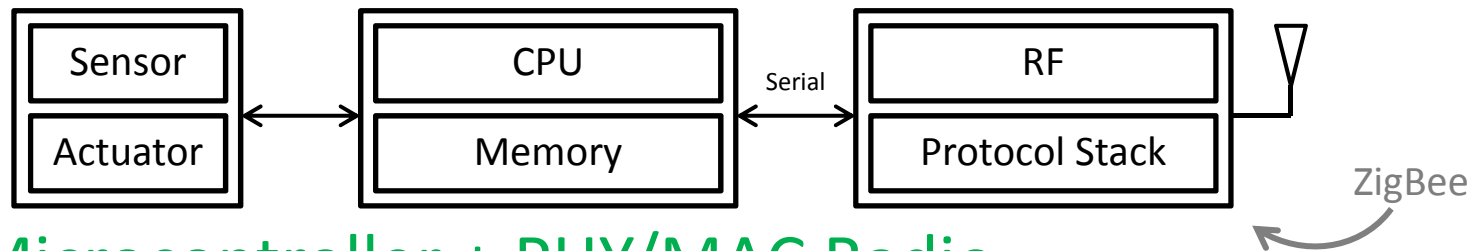
# WSN Implementation

- Node structure

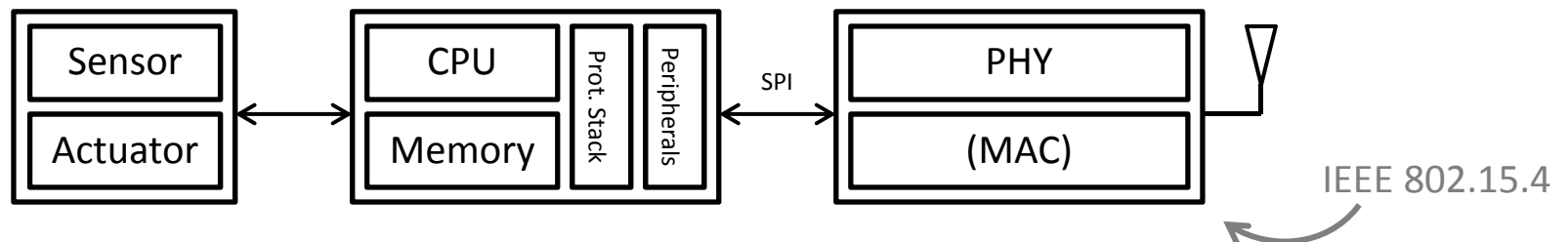
- System on Chip (SoC)



- CPU + OEM Radio



- Microcontroller + PHY/MAC Radio



# Versatile Sensor Node



## Processing platforms

- ST ARM Cortex-M3

## Comm. tech.

- ZigBee, 6LoWPAN, IEEE 802.15.4
- Bluetooth
- Wi-Fi
- GSM/GPRS
- Ethernet
- Sensor Network Protocol (SNP)
- Satellite

## Sensors

- Temperature
- Humidity
- Luminance
- Color
- Reflectance
- Pressure/Force
- Camera
- Optical Detector
- GPS
- Sound
- Accelerometer
- Gas (O<sub>2</sub>, CO<sub>2</sub>, CO)
- Hall effect

- Motion, presence, range (IR, ultrasonic)
- Capacitive/inductive touch
- Gyroscope
- Compass
- ...

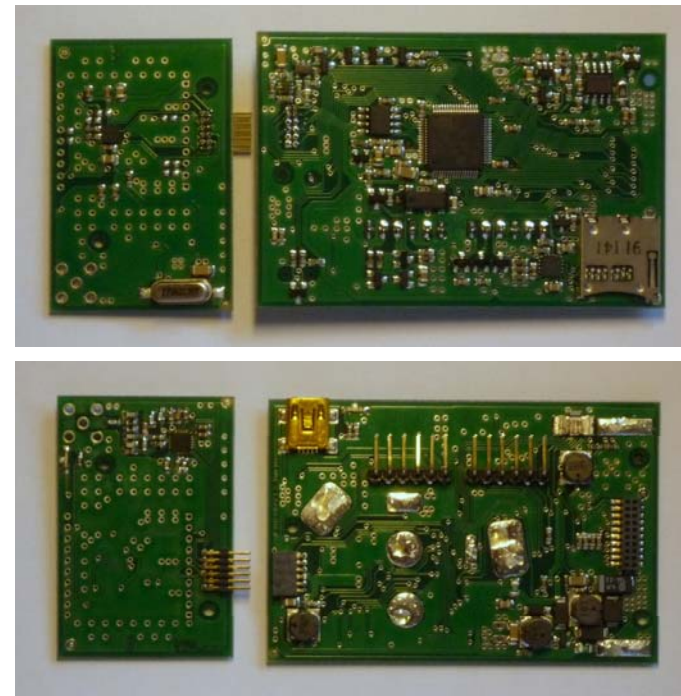
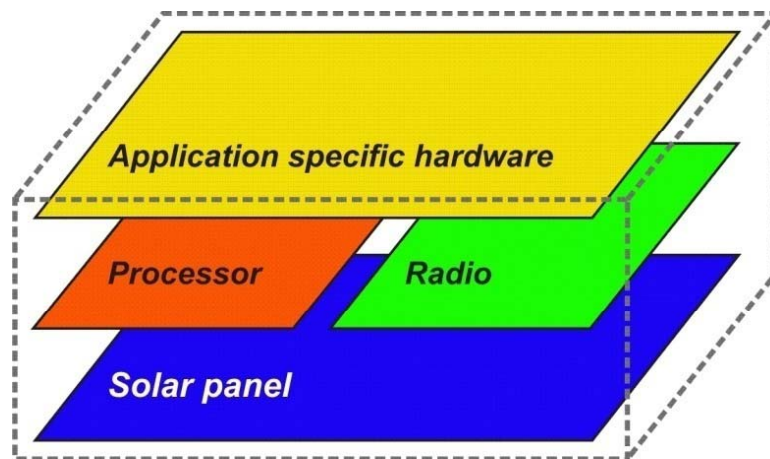
## Actuators

- Pulse Width Modulation (Light, Motor)
- Switch, Relay
- Servo
- Alarm



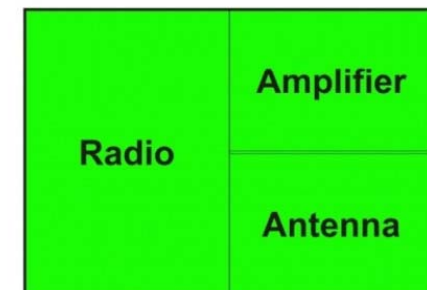
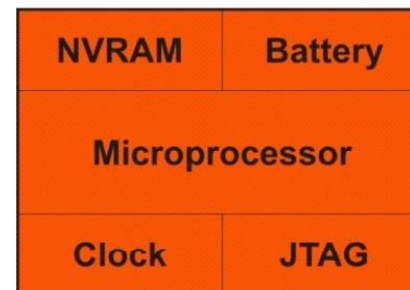
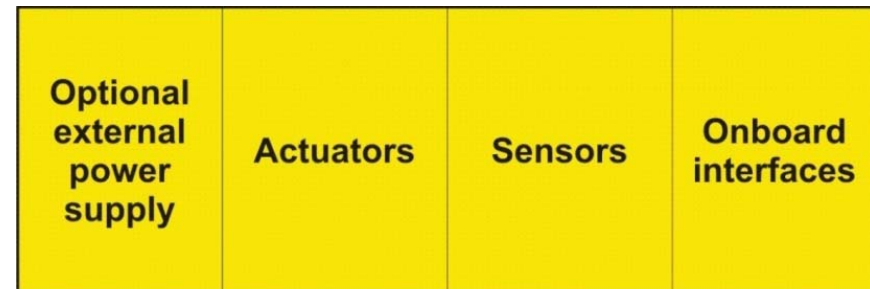
# Versatile Sensor Node

- Modular platform for WSN ( $VSN = VSC + VSR + VSA + VSP$ )
  - High processing power and low energy consumption
  - Sensor node & gateway (multi-tier / IP) capability
  - Battery, solar or external power supply
  - Re-configurable radio



# Versatile Sensor Node

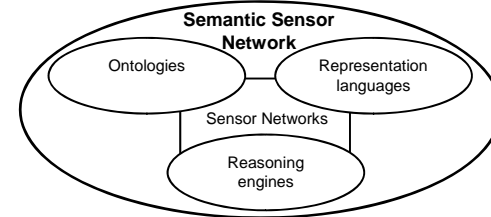
- **VSC**
  - Analog and digital sensor/actuator interfaces
  - Possibility to use operating system (real-time, event-driven)
  - Multiple expansion options
  - Open C/C++ code libraries
  - Onboard memory
- **VSR**
  - 300-900 MHz, 2.4 GHz radio interface (all ISM bands)
  - ZigBee, 6LoWPAN and other IEEE 802.15.4 based solutions
- **VSA**
  - Bluetooth, Wi-Fi, Ethernet, GSM/GPRS
  - Sensors/actuators
  - PoE



# Vertical Integration

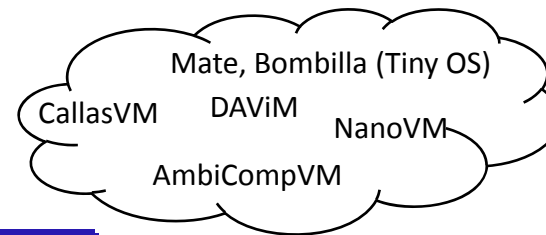
Semantics  
Applications

**Ontology:** CSIRO, Ontosensor, W3C SSN (concrete sensor description)  
**Representation language:** OWL, CycL (for ontologies), SensorML (for local sensor description)  
**Reasoning engine:** Cyc, LarKC (resource constraints!)



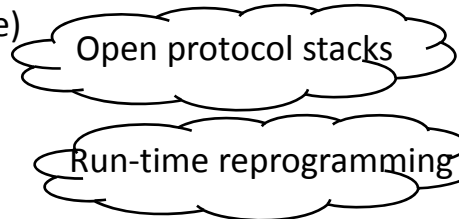
VM

**Darjeeling** on Contiki (and TinyOS)  
**Embedded web server** (Ethernet module)



OS

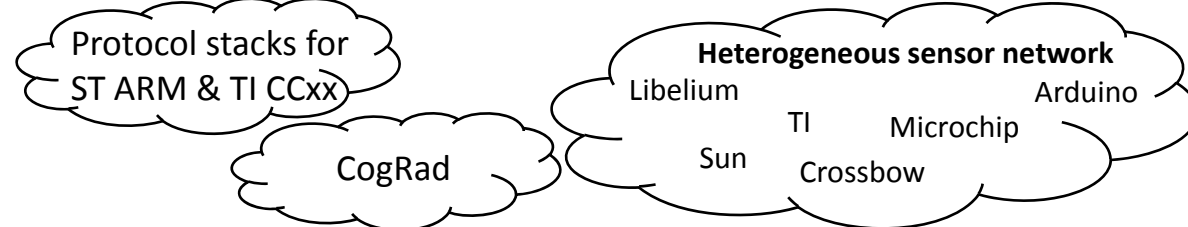
**Contiki** (event driven/real-time)  
**TinyOS** (event driven)  
**CooCox** (real-time)



**Squawk**

VSN

**VSC**  
**VSR**  
**VSA**  
**VSP**  
**Sensors**

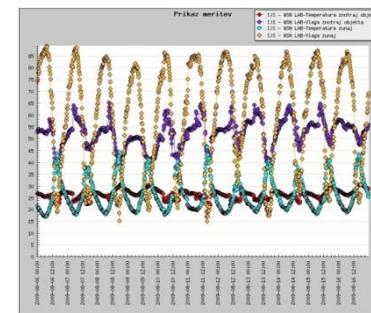


# VSN in multi-tier WSN

- Temperature and humidity monitoring for environmental applications
- ZigBee based local sensor networks
- GSM/GPRS interconnection with control center
- Joomla extension **WEB interface**
  - Customised data export (Chart, Table, GoogleMaps, XML, Database)
  - <http://diploma.idealna.si/> (U:gost, P:gost)

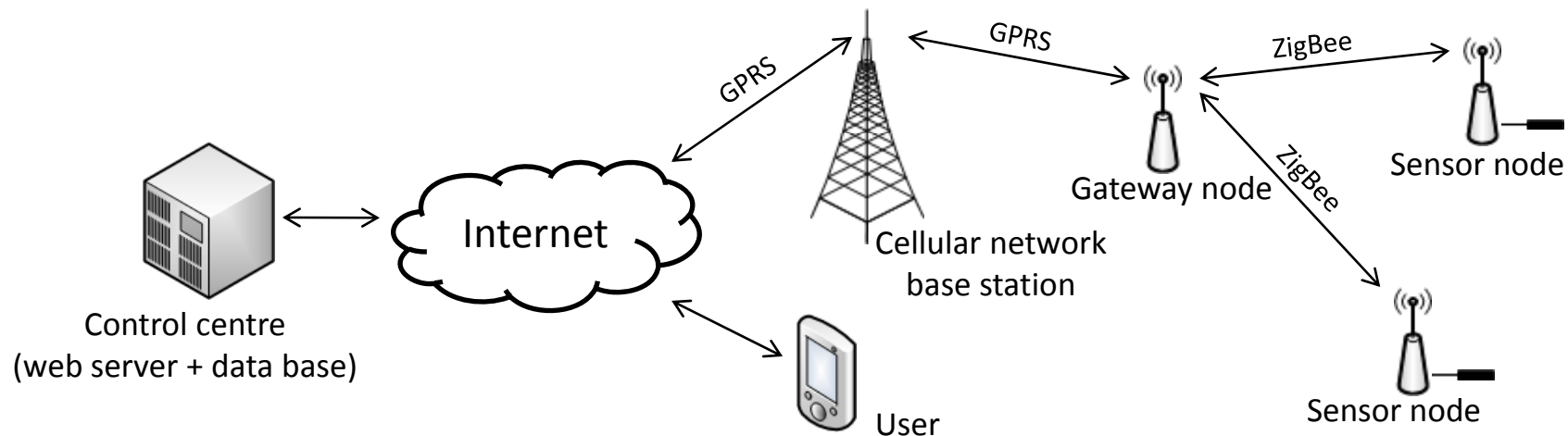
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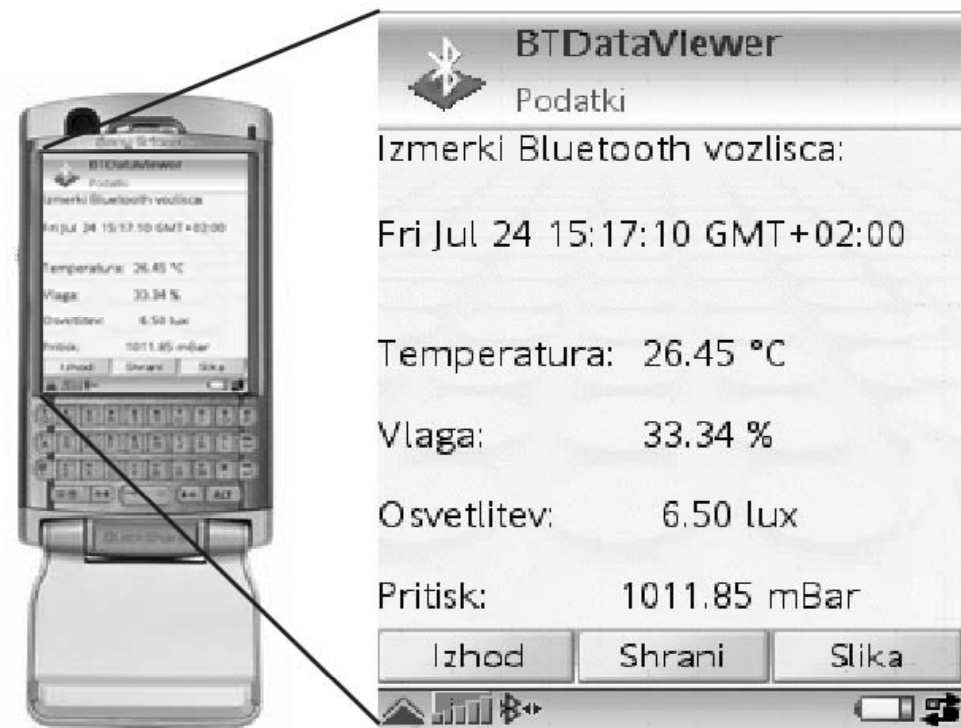
Izpis vsebine za IJS - WSN LAB

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2009-06-14 00:35:19	27.22	42.69	21.13	46.64
2009-06-14 00:50:27	27.16	42.58	20.90	47.64
2009-06-14 01:05:29	27.09	42.75	20.52	48.33
2009-06-14 01:20:36	27.02	42.94	20.28	49.71
2009-06-14 01:35:40	26.87	43.26	19.95	49.82
2009-06-14 01:50:44	26.90	43.26	19.70	51.40
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2009-06-14 02:20:51	26.72	43.21	19.22	53.30
2009-06-14 02:35:44	26.63	43.36	19.03	54.20
2009-06-14 02:50:59	26.51	43.28	18.84	55.12
2009-06-14 03:06:00	26.54	42.88	18.71	56.11
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2009-06-14 03:36:08	26.37	42.53	18.12	57.11
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2009-06-14 04:36:35	26.15	42.17	17.45	60.35
2009-06-14 04:51:41	26.00	42.32	17.14	60.97
2009-06-14 05:06:36	25.93	41.98	16.77	61.48
2009-06-14 05:21:39	25.83	41.40	16.57	61.91
2009-06-14 05:36:47	25.83	41.06	16.53	62.69



# Bluetooth equipped VSN

- Bluetooth link between sensor node and smart phone
- Video and voice capturing
- Temperature, humidity, pressure, light monitoring
- Java test application



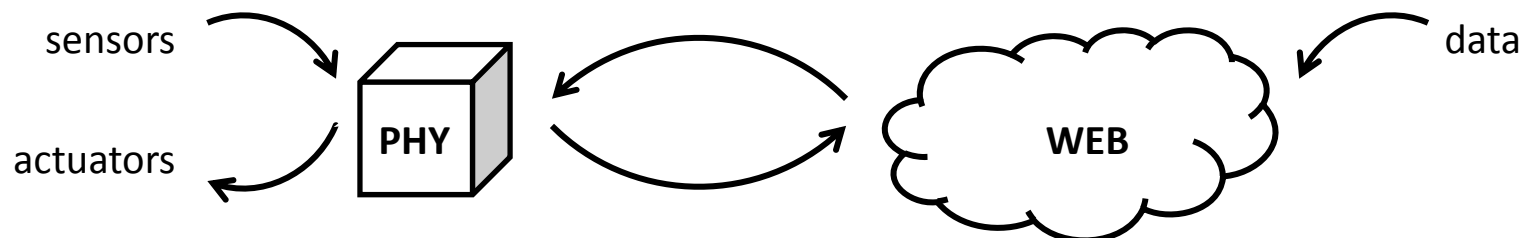
# VSN for IoT & WoT

**Internet of Things - IoT:** world-wide network of heterogeneous smart objects (sensors, actuators, RFID, MEMS ...) based on standard communication protocols

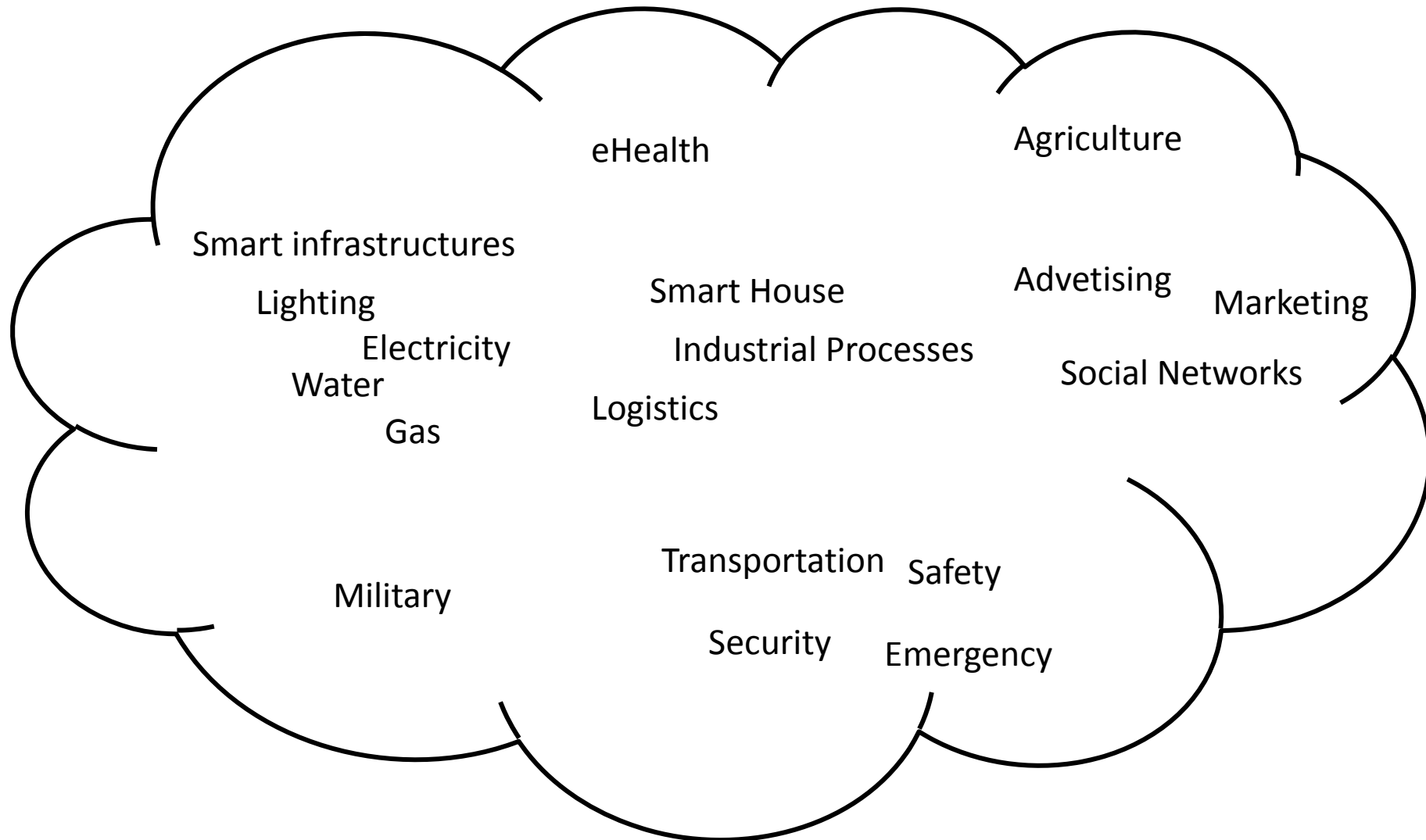
**Web of Things - WoT (also SensorWeb or The Physical Web):** integrating embedded devices to the Web using standards like HTML, XML, RSS ...

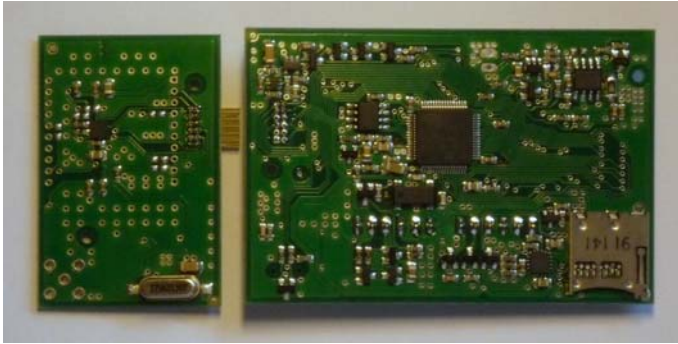
## Pachube

- Web service that enables storing, sharing & discovering of real-time sensor, energy and environment data from objects, devices & buildings around the world.
- Captures input data (from remote sensors) and serves output data (to remote actuators)
- <http://www.pachube.com/feeds/6894>



# VSN Application Areas





**Thank you and welcome at the exhibition desk!**

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# SensorLab – The Team

