Applications of Wireless Sensor Networks (WSN) in Healthcare

Peter Planinšič,

University of Maribor

Faculty of Electrical Engineering and Computer Science

peter.planinsic@uni-mb.si

UNIVERSITY OF MARIBOR   FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
Smetanova ul. 17
SI-2000 Maribor
SLOVENIA
Telephone: +386 2 220 70 00
Telefax: +386 2 220 7272
Internet: http://www.feri.uni-mb.si/
email: feri@uni-mb.si

Institute of Automation
(Laboratory for signal processing, systems and control)

Institute of Electronics and Telecomunications

Institute of Power Engineering

Institute of Robotics

Institute of Computer Science

Institute of Informatics

Institute of Mathematics and Physics

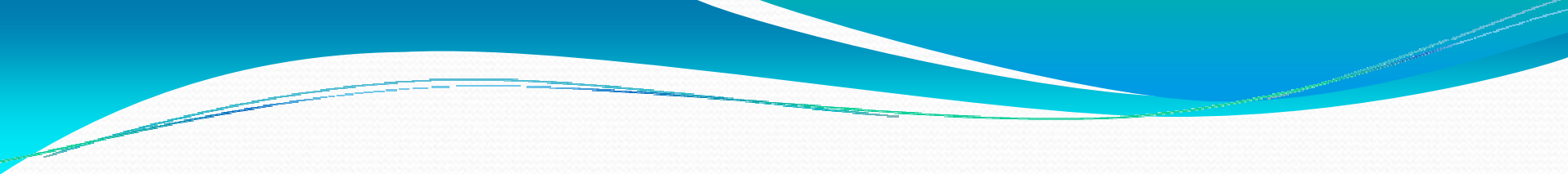Institute of Media Communications

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INTRODUCTION

- **Advances** in wireless communications and electronics and MEMS lead to development of WSN of **low cost**, **low power** and **multifunctional sensors**

- This sensors, referred also as sensor nodes or **WSN-nodes or motes** are small and able to sense physiological data, process this data and communicate with each other or with base station.

- **Basic futures** of WSN that make them different from other wireless ad hoc and mesh networks :
  - self organizing capabilities
  - short range broadcast applications
  - multihop routing
  - dense deployment
  - corporative effort
  - changing of topology
  - limitation in energy, memory and computing capabilities.

- WSN can monitor **different physical values**:
  - temperature
  - humidity
  - light
  - pressure
  - noise
  - soil composition,
  - object motion (detection, and tracking)
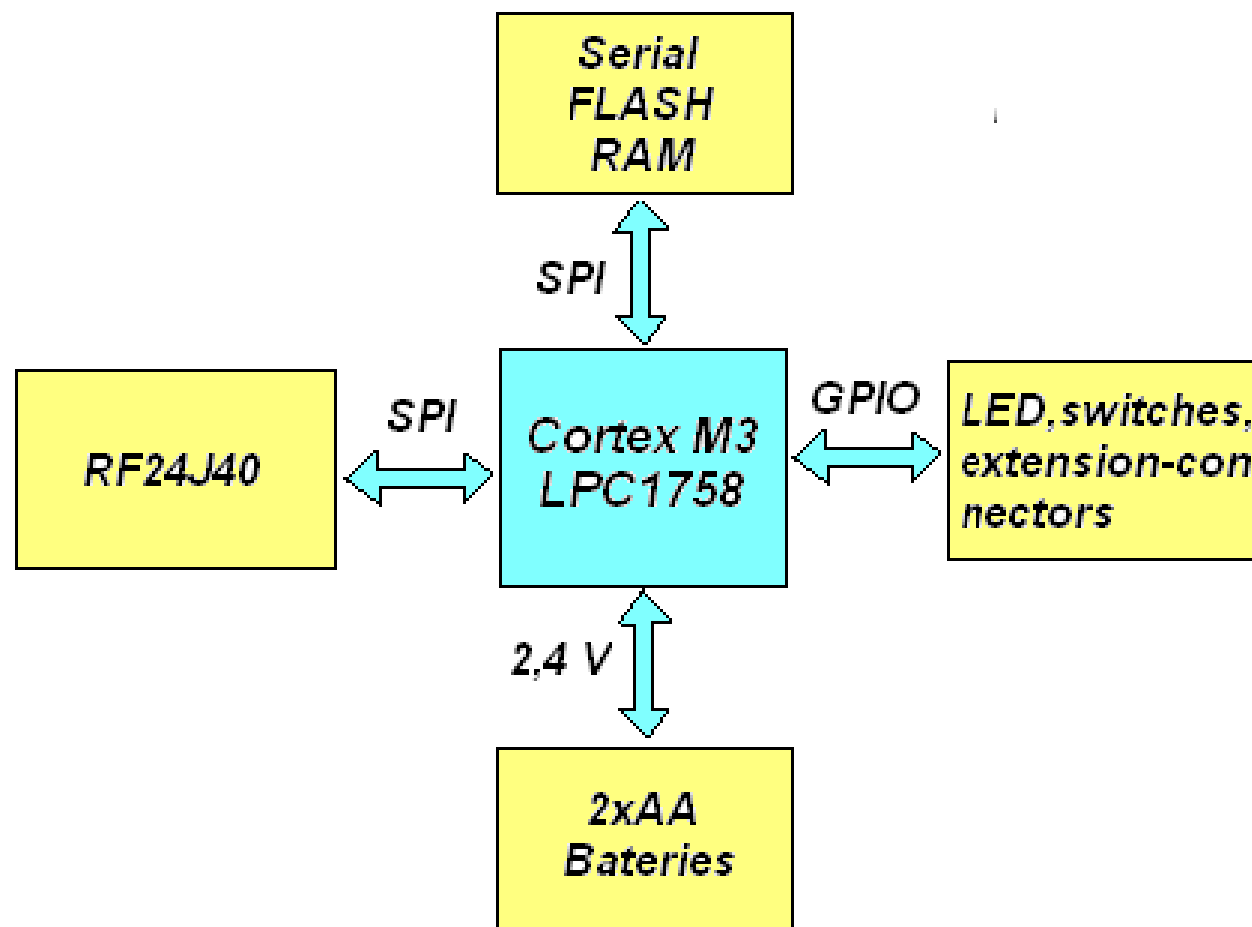 - objects weight, size, etc

- Therefore WSN can be used in many **applications**:
  - military applications,
  - environment monitoring,
  - disaster prevention, home intelligence,
  - Surveillance
  - *medical care (healthcare)*
  - and many others

Applications of WSN and healthcare :

- remote virus monitoring
- patient tracking and monitoring
- people with acute respiratory syndrome (SARS)
- WSN-sensors attached to medical devices to measure their heart rates, body temperature
- blood pressure, pulse etc.
- continually analyze the blood stream
- an automatic alert is generated
- medical statistics
- glucose monitoring (diabetes)

WSN USING MODULE SPaRCMosquito v.2

- It consists of three components: hardware, software and simulation software.
- Hardvare: **SPaRCMosquito v.2 Module**
  - **Base module**
  - **Extended module** (with **Daugther module**)

Bloch Scheme of SPaRCMosquito v.2 Base Module

Peter Planinšič   IBM Academic Days   Brasov 2012

- **Radio chip MRF24J40:**
  - support communication standard IEEE 802.15.4 (Zigbee).
  - It supported free RF-band 2.4 MHz
 - uses compact printed circuit antenna ("microstrip" antenna).

SPaRCMosquito v.2 BaseModule

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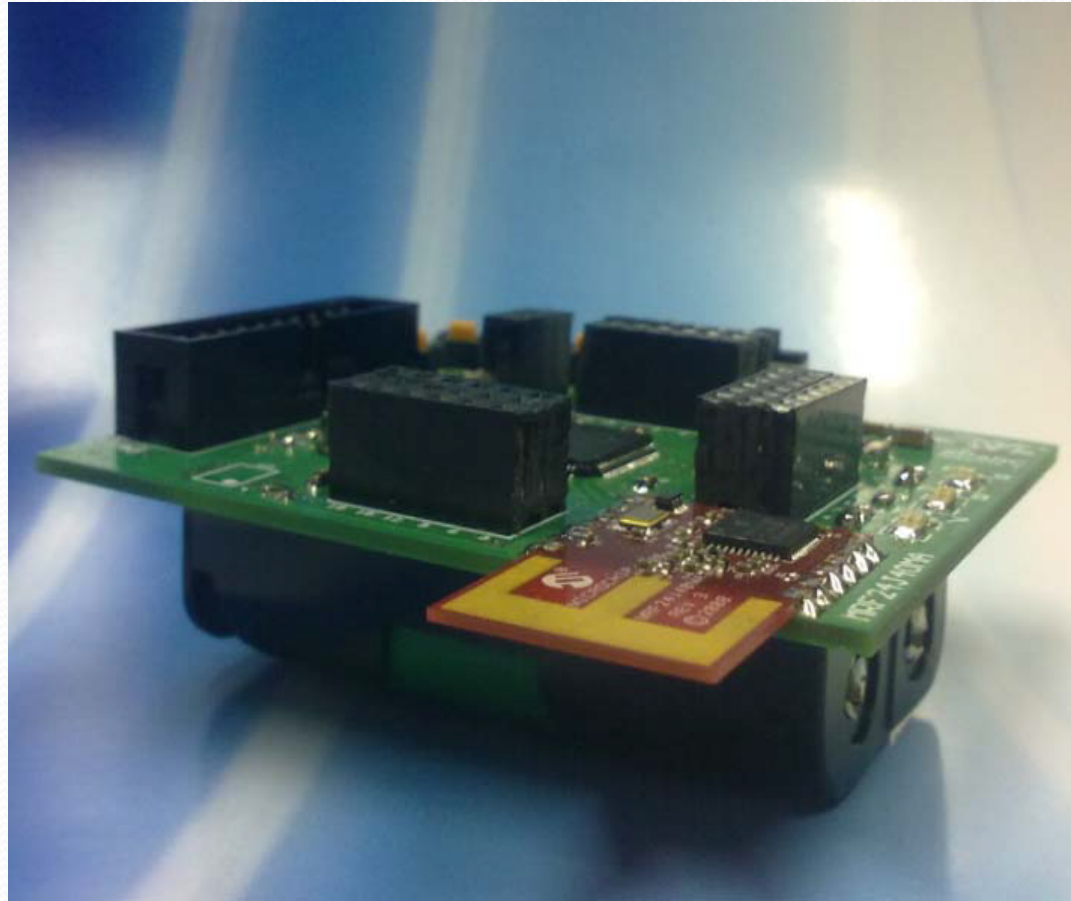
- **Extended (Daughter) module:**
  - consists of several *communication interfaces*
  - different kinds of communication *protocols* (TCP/IP, CAN, and USB (over VCP)
  - The Cortex M3 processor is power enough for emulating *web server*; therefore the module can be connected over IP-network, if it has *free IP-address*.
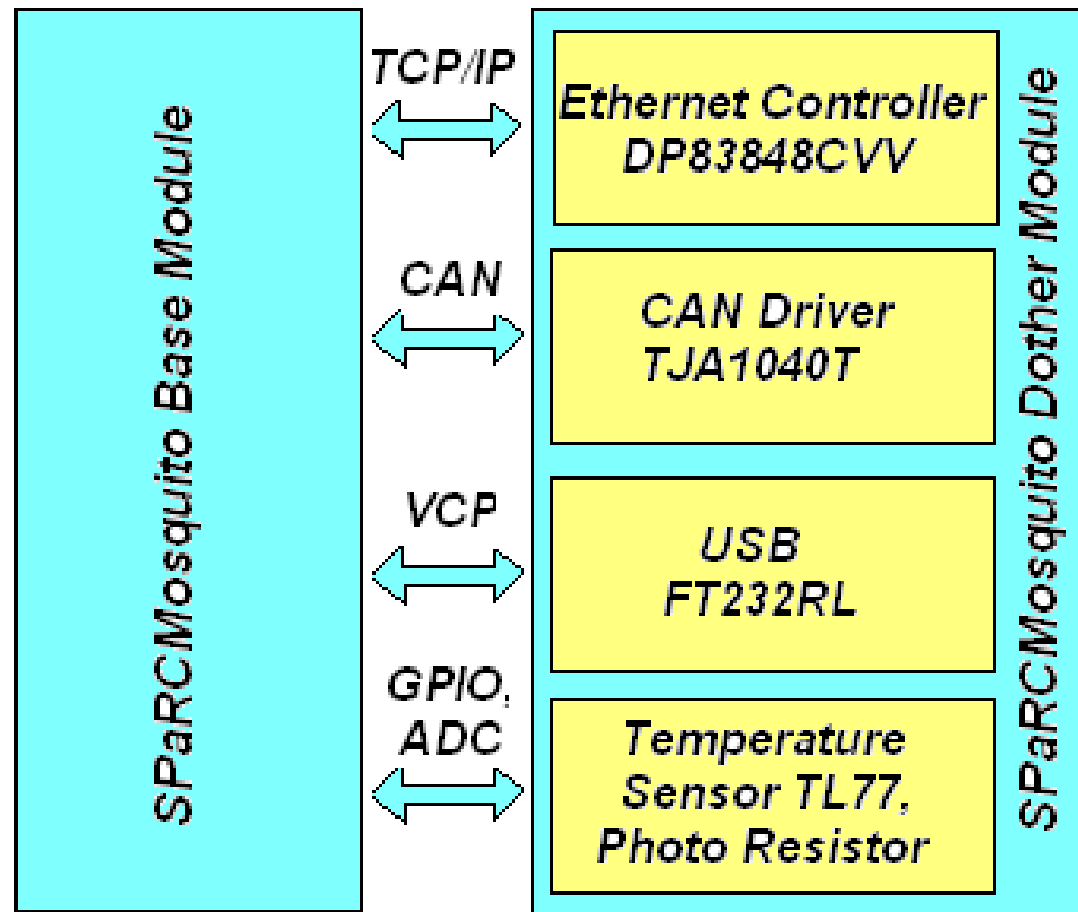
**Block Scheme of SPaRCMosquito v.2 Extended (Daughter) Module**
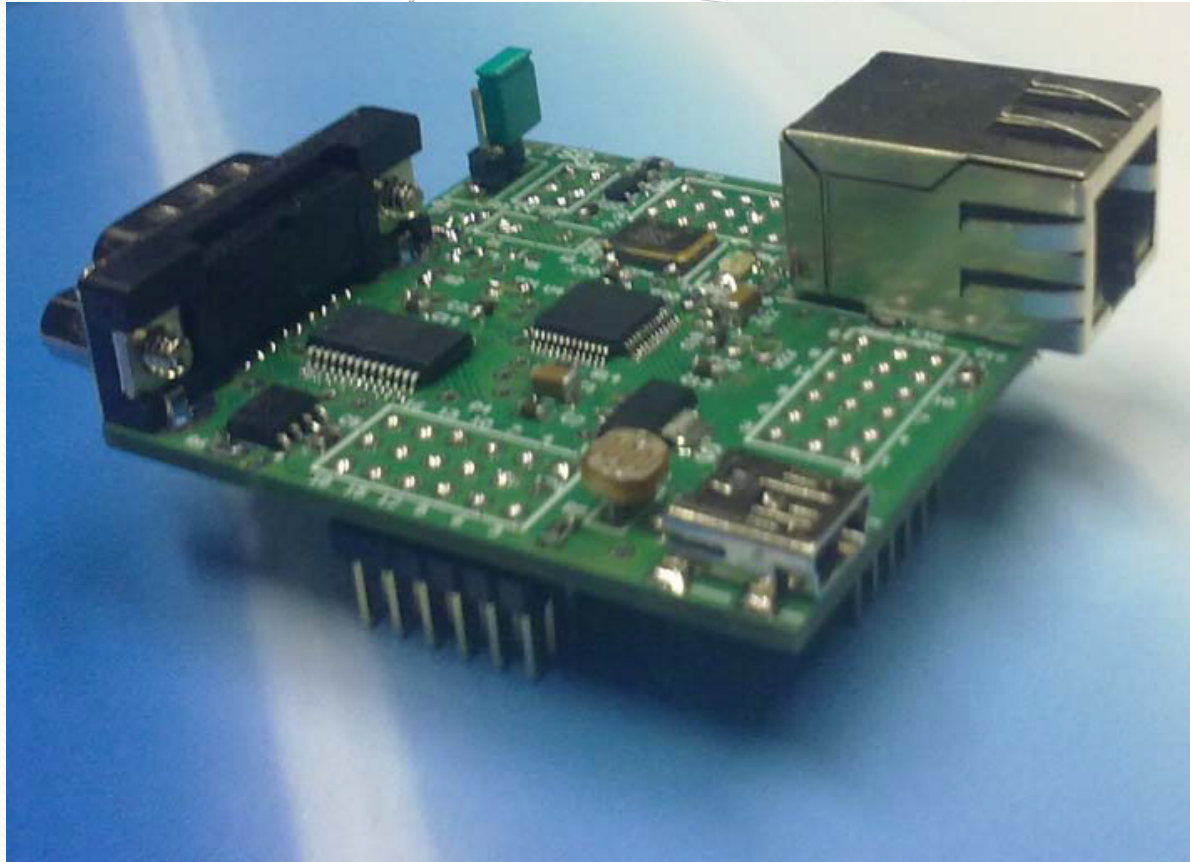
SPaRCMosquito v.2 Daughter Module

RESEARCH AND APPLICATION

- Some of our applications :
  - *The temperature distance measurement*
  - *Distance measurements and localization*
  - *Compression of ECG signals*

The temperature distance measurement:

- The applications can be *modified* for the monitoring the temperature or other *clinical parameters* (blood pressure, pulse etc) of patients in healthcare applications.

- suitable arranged extended modules

- communicate over WSN with base or central station.

- The digital temperature sensor TL77 is used

- Zegbee – protocol or ''MiWi'' of company Microchip can be used or simple own

- used WSN-base station cans servers as web server (monitoring over IP, Ethernet-connector)
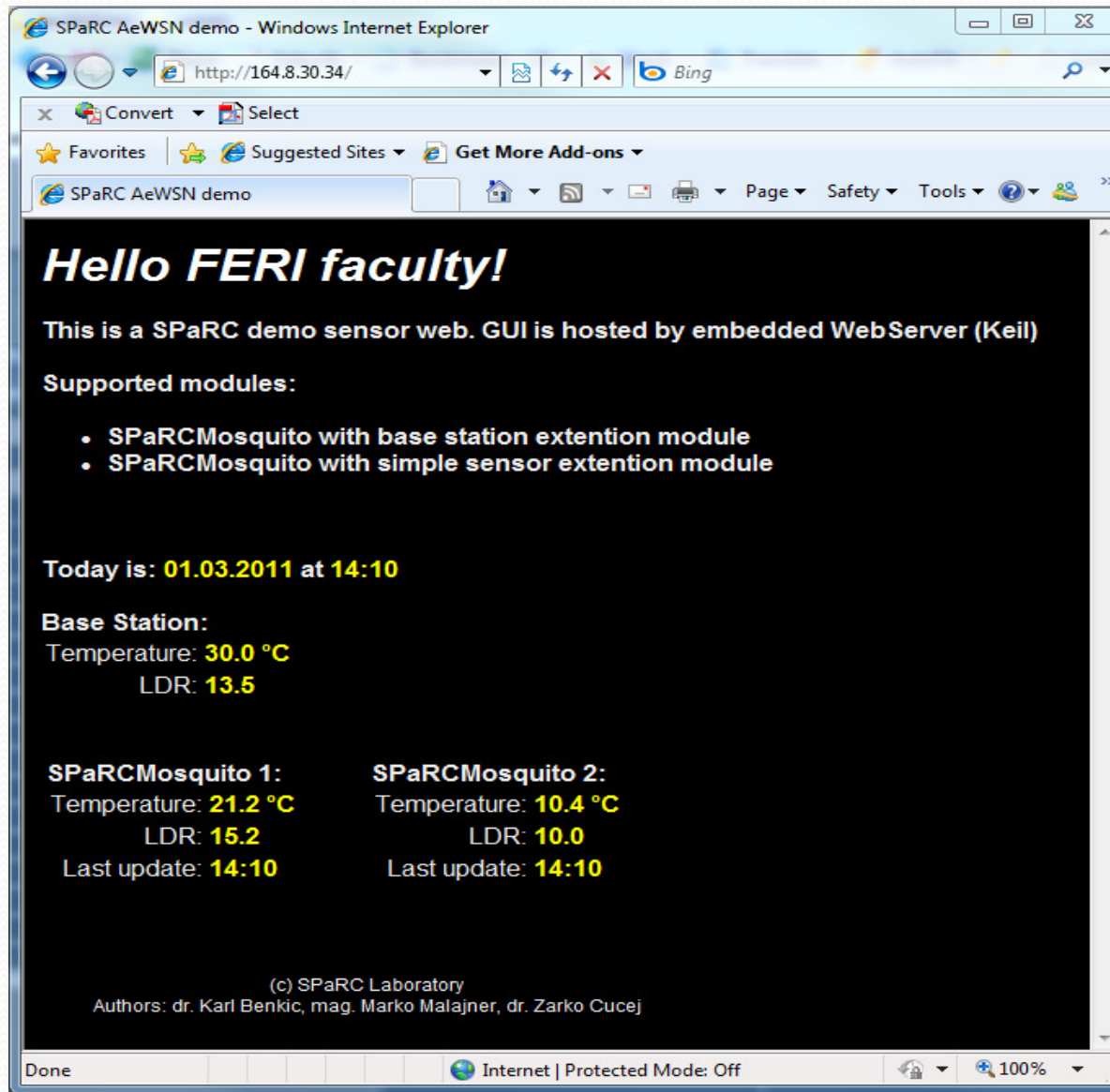
The web page running on Cortex M3

- **Distance measurements and localization:**
  - this field is still the object of intensive research
  - can be directly *applied for patient's localization and monitoring* in healthcare applications.
  - this field is still the object of *intensive research*
  - MRF24J40 using standard IEEE802.15.4 enable measurement of <u>received RF signal power</u>, the so called *Received Signal Strength Indicator* (RSSI) and *Link Quality Indicator* (LQI).
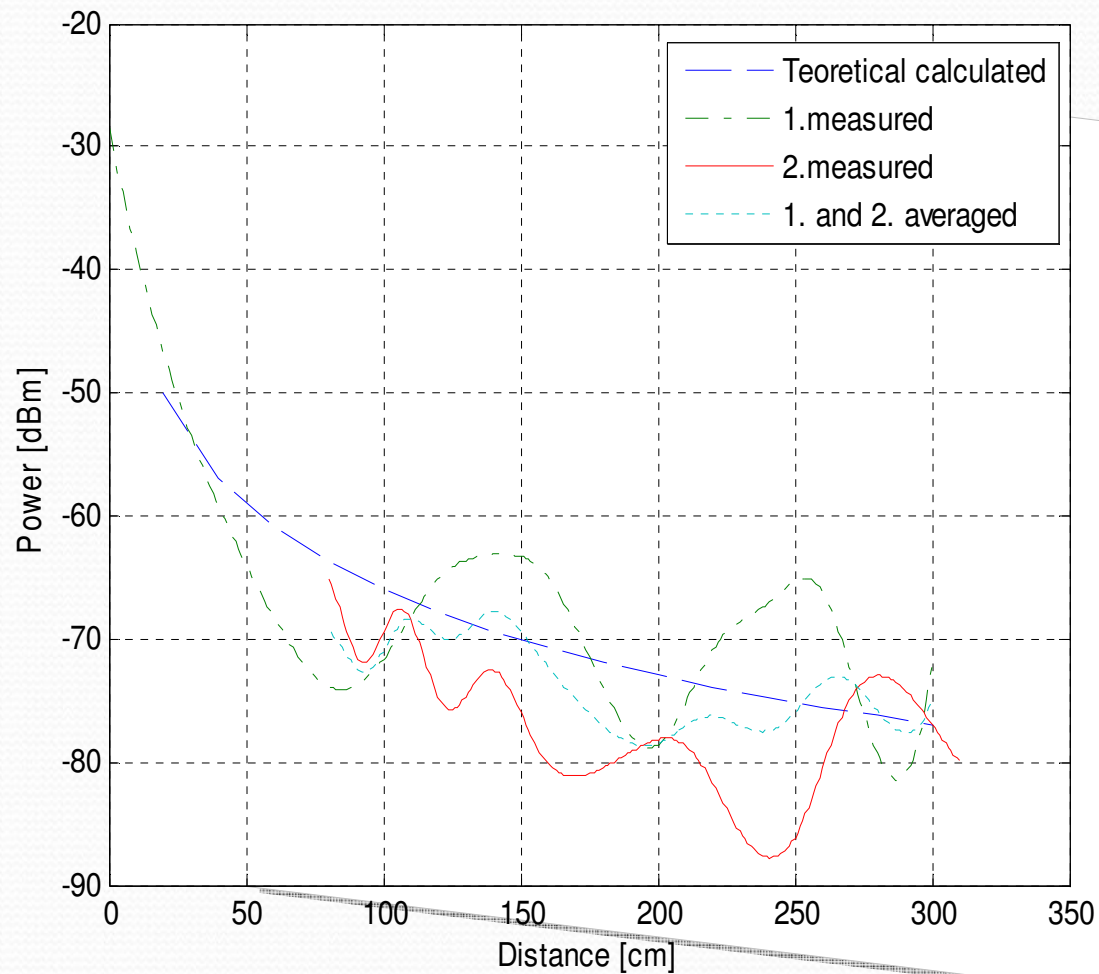
- **Free space propagation model :**

$$P_R = P_T \frac{G_R \cdot G_T \cdot \lambda^2}{(4\pi) \cdot d^n}$$
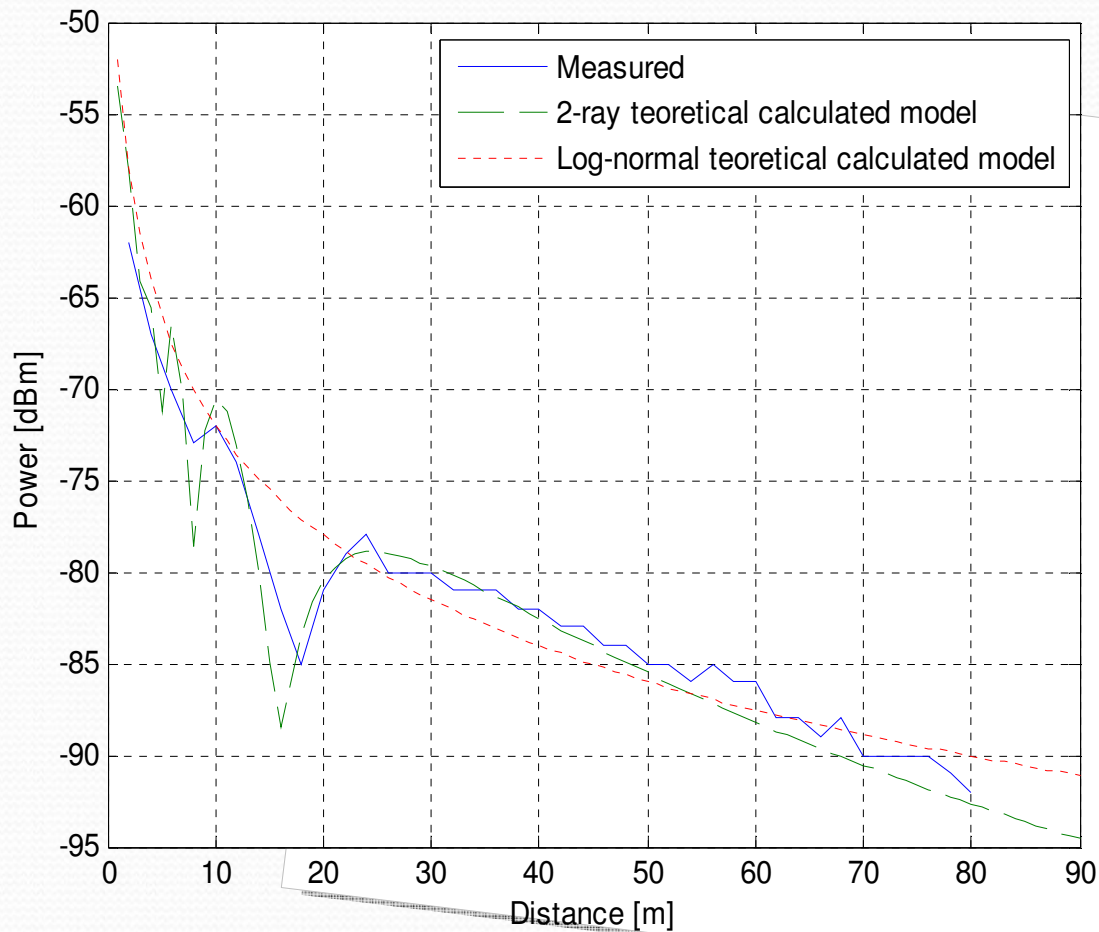
- **Log normal model :**

$$\overline{P_0}(d) = P_0 - 10 \cdot n \cdot \log(d / d_0)$$

- **2-ray or ground reflection model**
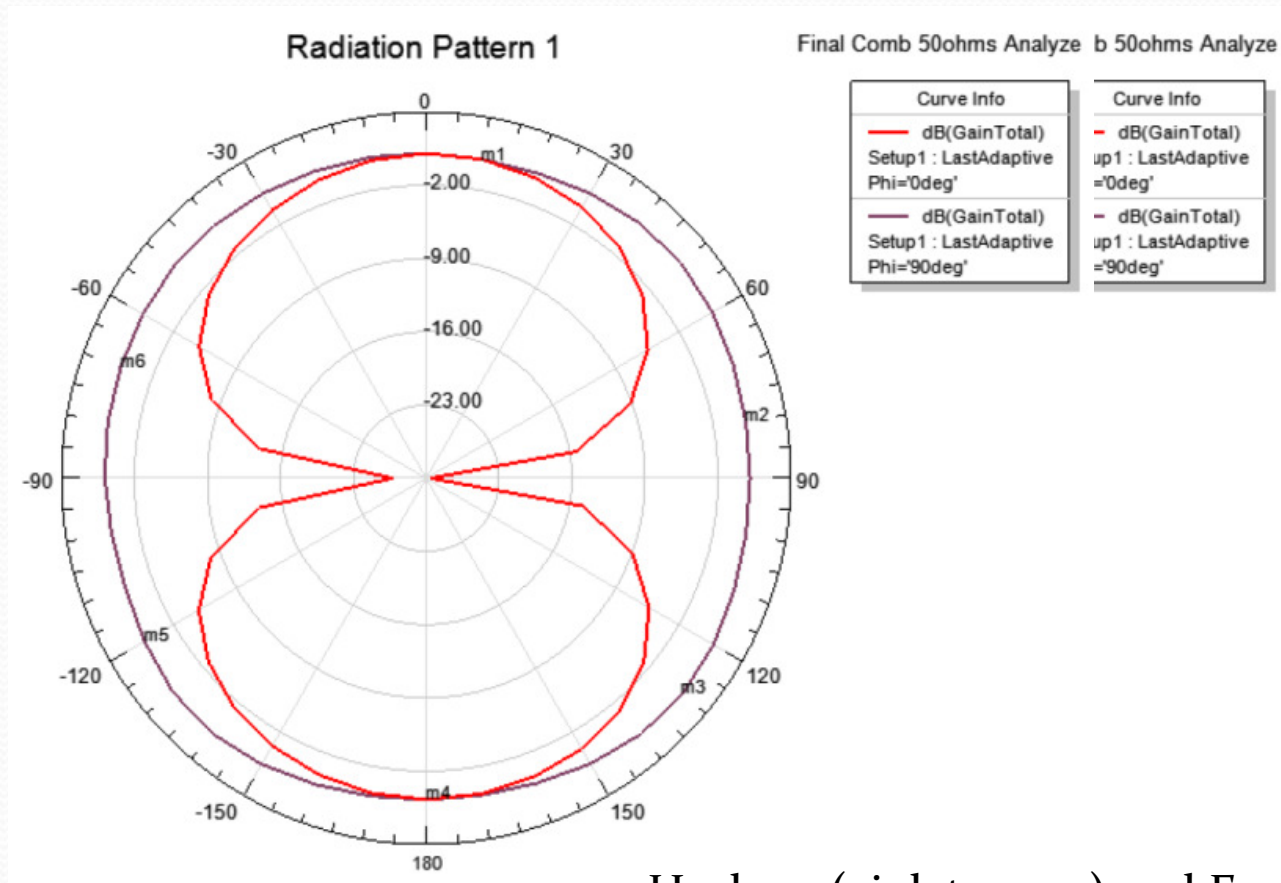- **More sophisticated models (Bayes, particle filters)**
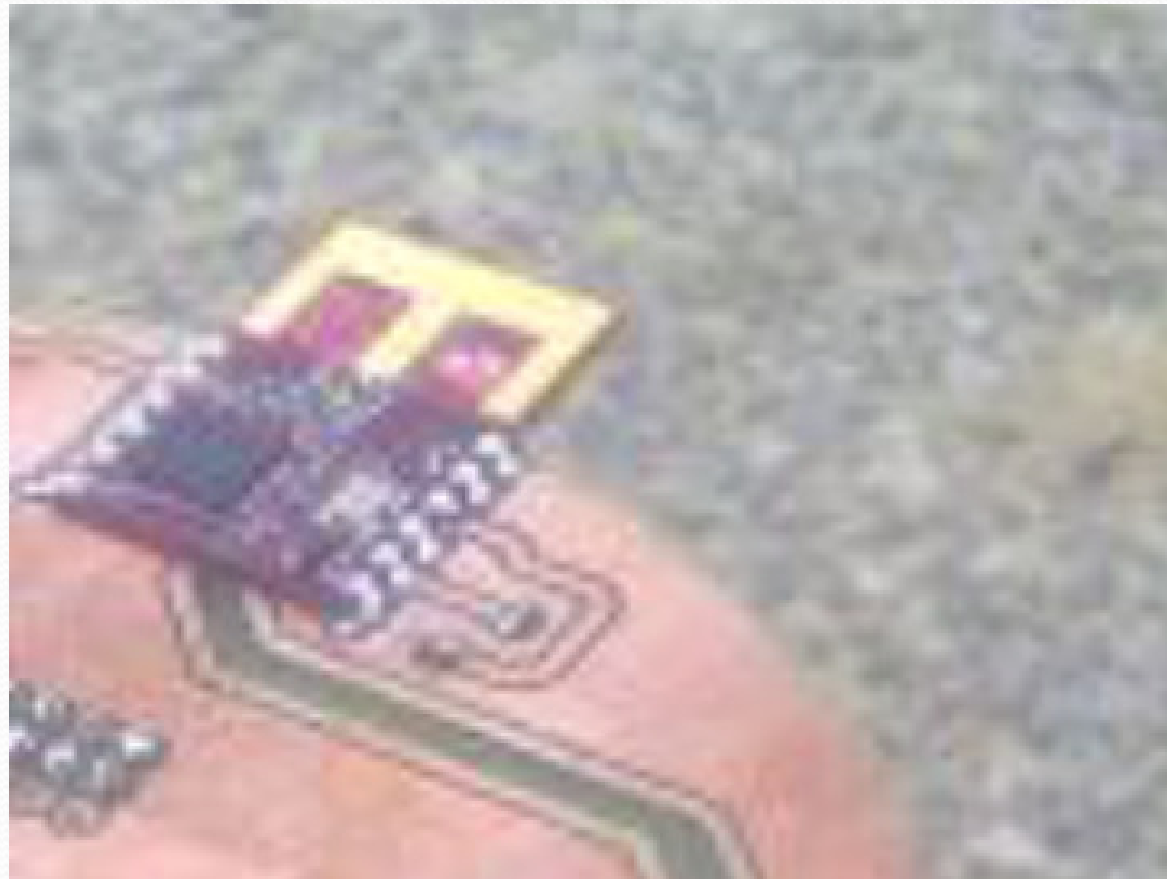
Inside measurements

Outside measurements

Angle of arrival (AoA) measurements with rotatable omnidirectional microstrip antenas
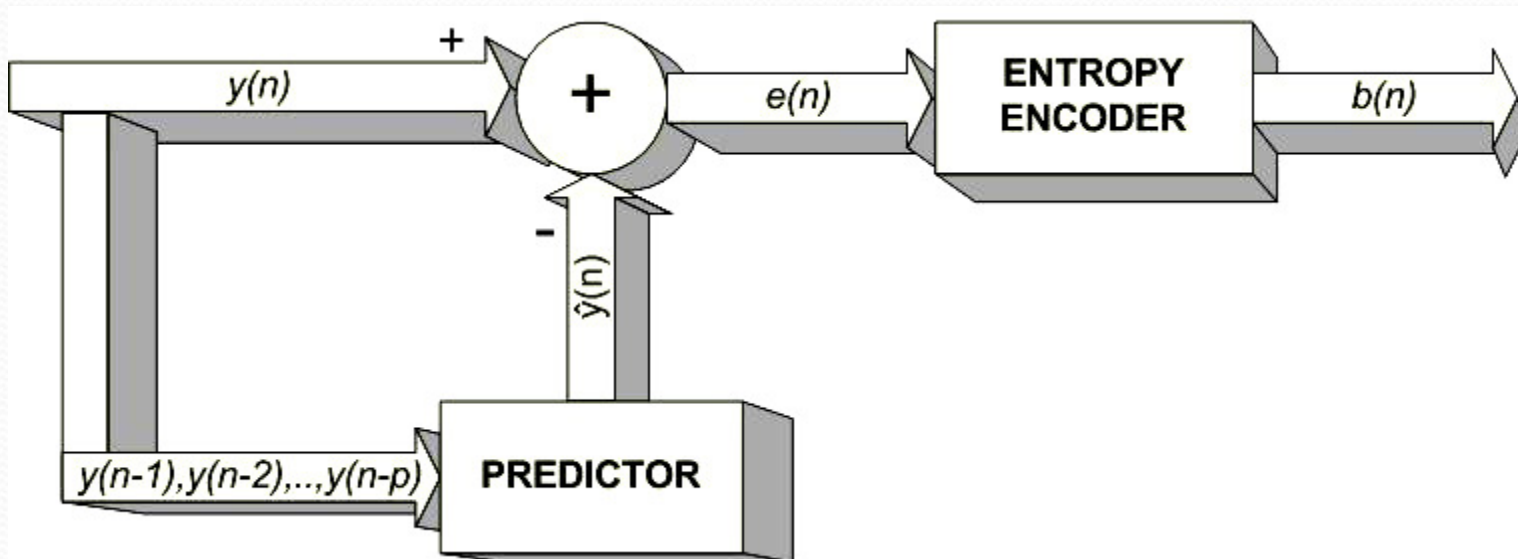
- Accepted paper for IEEE Sensor Journal

H-plane (violet curve) and E-plane (red curve)
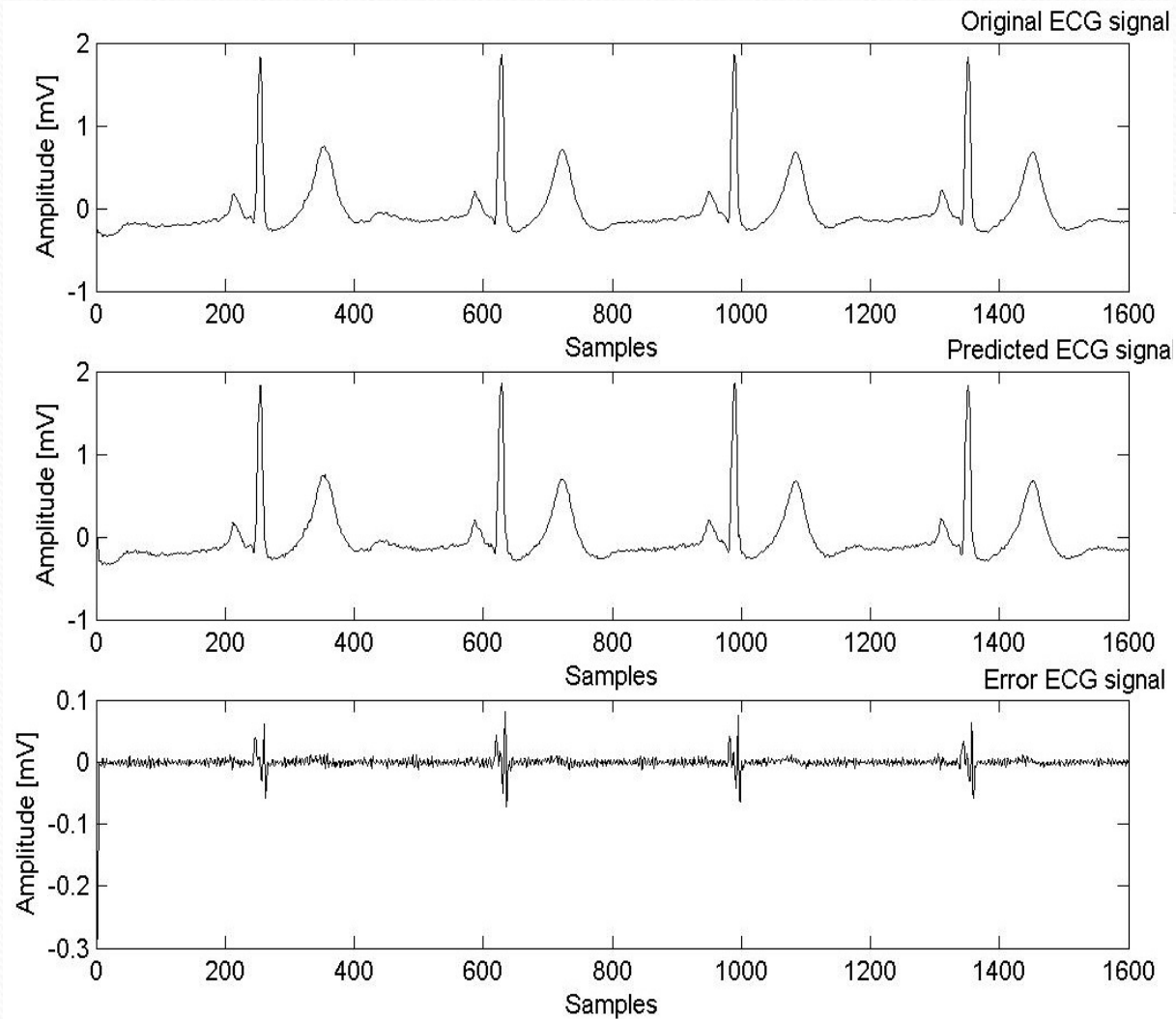
The AoA measuring device

Compression of ECG signals

- Autoregressive (AR) predictive coding
- bit-rate reduction and energy saving

Compression side scheme

ECG-signals : original, predicted, error signal

IBM AND WSN

- **http://domino.research.ibm.com/comm/research.nsf/pages/r.communications.innovation2.html**:
  - Zurich **Sensor Networks & Edge Server Software projects**
  - **A reference testbed** as a demo platform for client engagements. Uses the ***Service Management Framework*** (SMF), IBM's implementation of the Open Services Gateway Initiative (OSGi) specification, (remotely start, stop and manage message filtering applications and software packages -running on the ***gateway*** without interrupting the operation of the device).

- **IBM WebSphere Micro Environment running a J9 Java virtual machine** (the *gateway* for WSN, using telemetry transport protocol (MQtt))
- The **IEEE 802.15.4 / Zigbee standard** is one of the most *promising candidates* for designing WSN

- **http://www.zurich.ibm.com/moterunner/:**
  - **Mote Runner**, *IBM's infrastructure platform* for wireless sensor networks (WSN):
    - is based on a virtual machine tailored from scratch for resource-constraint hardware environments.

CONCLUSION

- Advances in research and development in wireless sensor networks enable many useful healthcare applications

- The possibilities of WSN are ubiquitous

- However, many formidable challenges must be solved before some exciting applications may become reality