www.radio6ense.com

((■))RADIO6ENSE
The last meter of Internet of Things

A Spin-of of the University of Roma Tor Vergata

Prof. **Gaetano Marrocco,** President

Pervasive Technologies for
Human, Environmental and Structural Monitoring

Our first three months !

RADIO6ENSE

RADIO6ENSE originated in **Feb. 2013** as industrial hand of the

Pervasive Electromagnetics Lab
Università di Roma Tor Vergata

- Positive interaction of the classic **Electromagnetics** with the Materials Science, Computer Science, Sensors, Medicine, Mechanics and Electronics

- Cross-discipline with the potentiality to **provide the very physical layer of the emerging Internet of Things** that enables the Internet to get into the Real World of physical objects.

- **Core research**: Radio frequency Identification (RFID) devices and algorithms for **short-range sensing**, ready to be seamlessly embedded into objects, plants, buildings as well as over and even inside the human body with application to **Smart City**, **Environment**, and **e-Health**.

RADIO6ENSE

Ten years of research on Radio Frequency Identification (RFID) sensors

Many published **papers**, and some **patents**

**Emerging market** on low-cost passive and pervasive sensing

"*Hungry and Foolish*" bright post-graduated **students**

Program FIXO (Regione Lazio & Parco Scientifico di Ateneo) for technology transfer (open to PhD Students)

Grants from Regione Lazio for innovative Start-Up

Interest in **boosting social applications of our theoretical and experimental research**

Hunger to make research's results profitable in this time of crisis
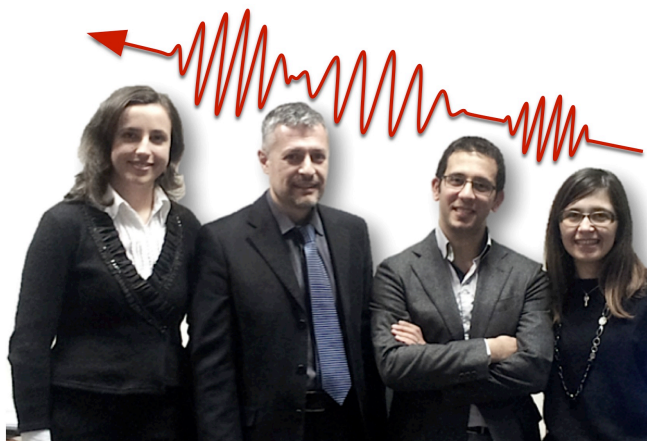
President: Gaetano **Marrocco**   (Faculty professor of Electromagnetics)

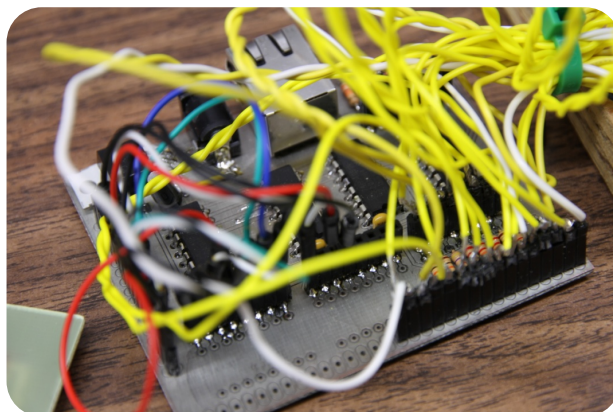CEO: Cecilia **Occhiuzzi**   (Medical engineer, PhD)

            Sabina **Manzari**   (Medical engineer, PhD student),
            Stefano **Caizzone**   (TLC engineer, PhD student)

Università degli Studi di Roma Tor Vergata

RATIONALE

The Cloud

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Collecting real-life data in a pervasive manner is the first step to better understand complex phenomena and provide support to high-level decisions.

RADIO6ENSE

Mobile Access
(10-1000m)

The Cloud

The Real World

SENSORS

Internet of Things
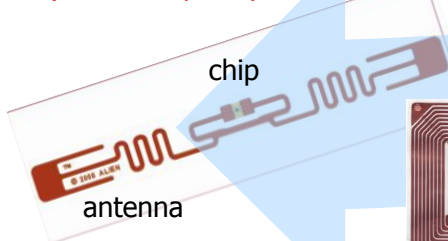

RADIO6ENSE

Printed Label

Barcode

42000 06200

Objects, goods, people and devices are currently identified by visual and electronic labels..

Electromagnetic tag
(Radio Frequency Identification RFID)

chip

antenna

Electromagentic access to data

Electronic tag (Magnetic & Smart Cards)

Smart Card Supply

PVC Cards
Gift Cards
Smart Cards
SC Accessories
ID Systems
http://www.smartcardsupply.com

RADIO6ENSE

The Thing

The Cloud
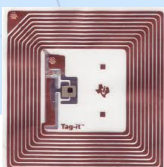
Sensor-labels
- Can go on almost everything
- Brings valuable information
- A few euro or less
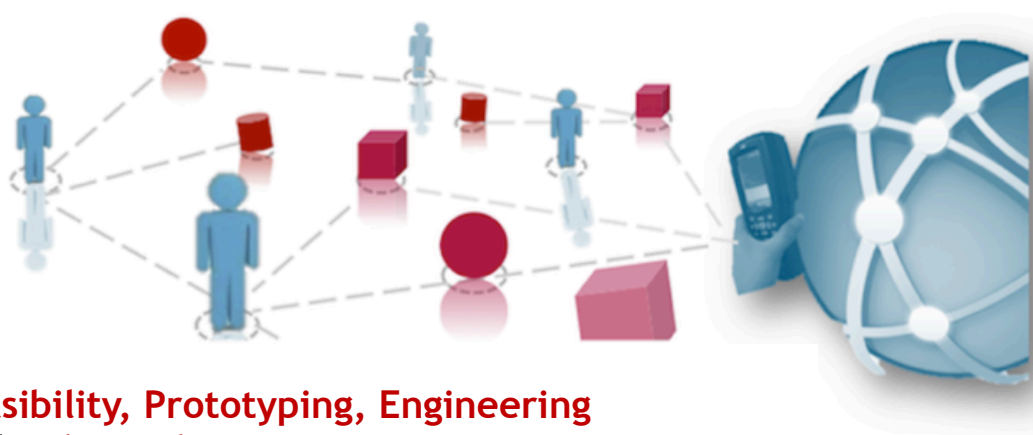- **No battery nor recharge.**
- **Pervasive Distribution**

RFID tag

- **ID**
- **Physical Status**

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RADIO6ENSE

The SHORT RANGE of the Internet of Things

The Short Range
(the last 10m)

Mobile Access
(10-1000m)

The Cloud

Sensing Labels
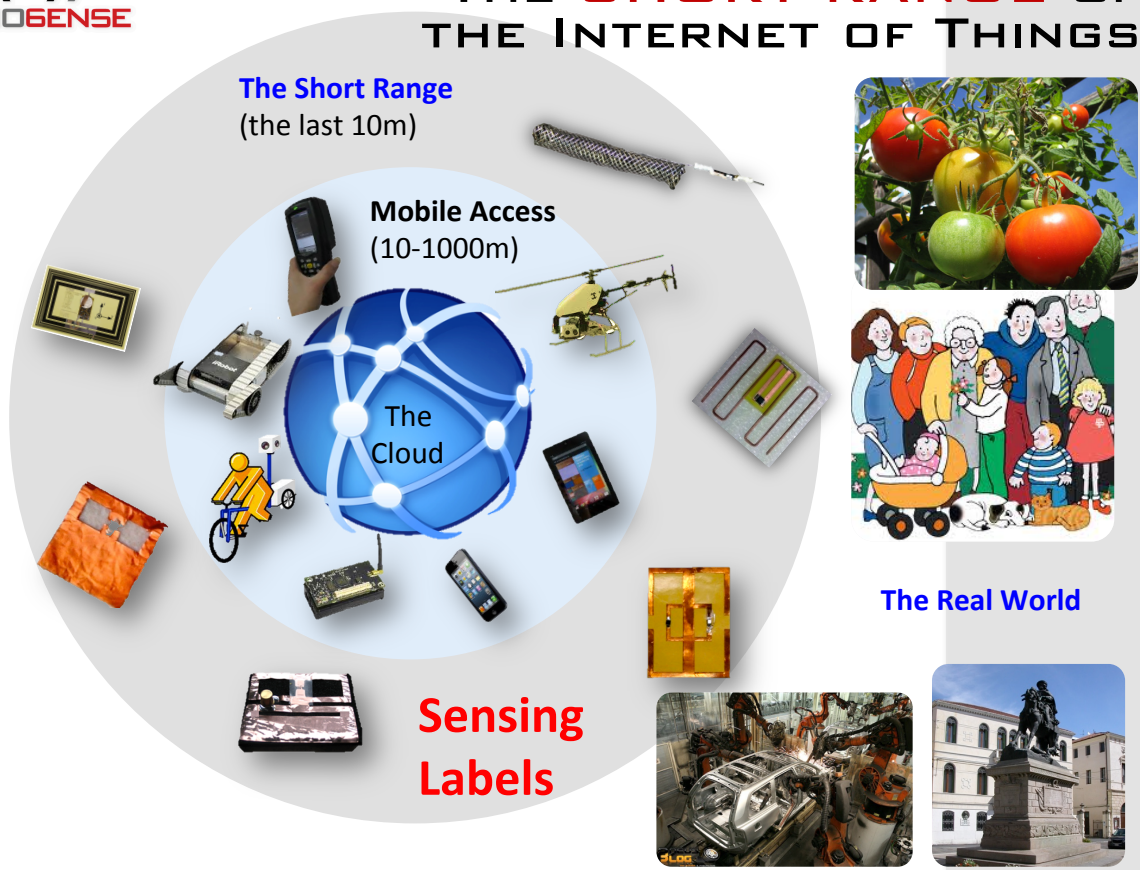
The Real World

MISSION

OUR MISSION

Feasibility, Prototyping, Engineering and Industrialization

of Low-cost Sensing technology (devices and systems) for the Short Range enabling Cloud Services to interact with the Real World

...wireless sensing for the last meter of Internet of Things
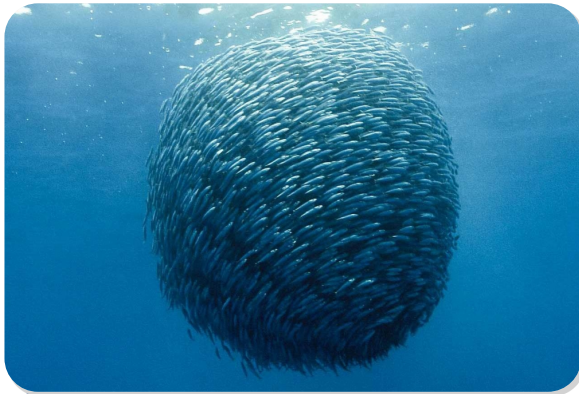
Higher spatial resolution thanks to low-cost and passive sensors to be spread over the entire application field

Rougher info from single sensor, but much more **aggregated** info from the **multitude**

Lightweight processing in the nodes

Powerful processing in the cloud,

SCOPE

((■)) E-Health
Sensing health and behavior of Persons and perishable goods

((■)) E-Environment sensing buildings and infrastructure, soil, crop and Smart Spaces

1. Pervasive healthcare

Body sensors
- motion
- ECG
- Evolution of pathologies

Ambient Intelligence systems
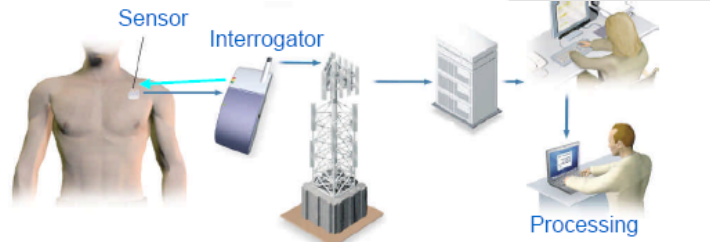
Smart Objects
- Localization
- Quality (food, drugs)
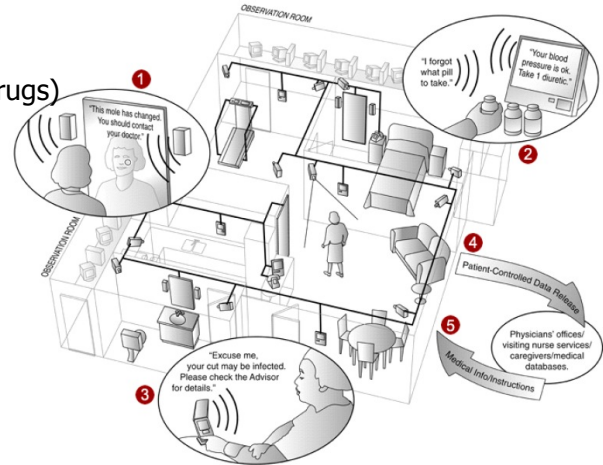
Smart House
- temperature
- Gas
- Structural safety
- localization systems

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2. Structural Health Monitoring
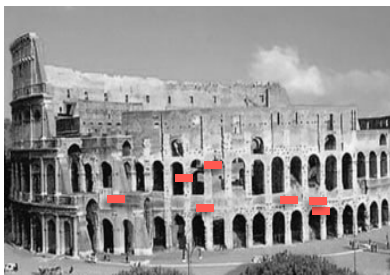
Passive systems to monitor crack, humidity and temperature in concrete walls, pillars and any other structure that need a continuous, distributed and low-cost monitoring of its "health".

- **Historical Buildings**
- **Civil Houses**
- **Post Disaster Assessment**
- **Geologic Instability**
- **Construction Monitoring**
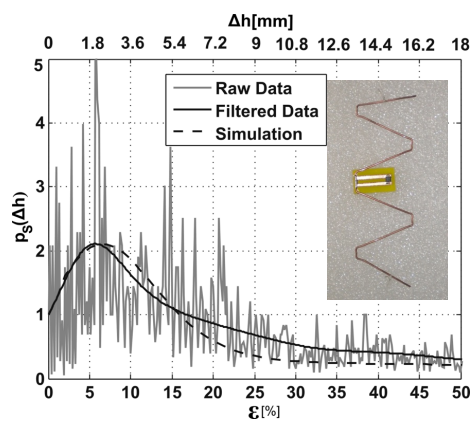
OUR TECHNOLOGY CAPITAL

- PASSIVE SENSING TAGS
- SENSING ALGORITHMS
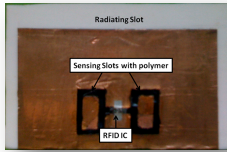

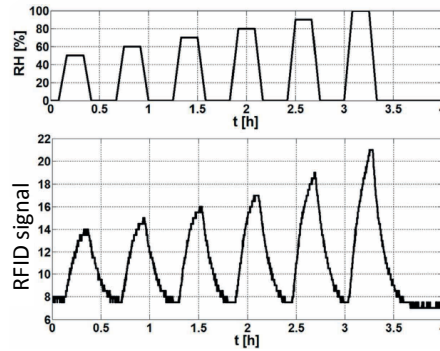# RFID-SENSORS FOR (SUB-MILLIMETER) DEFORMATION
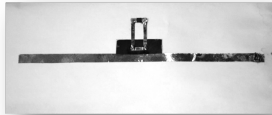
1. Strain Gauge tag

2. Crack-meter tag

RFID-SENSORS FOR GASES
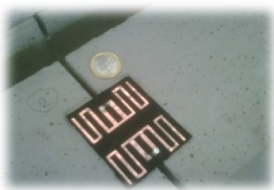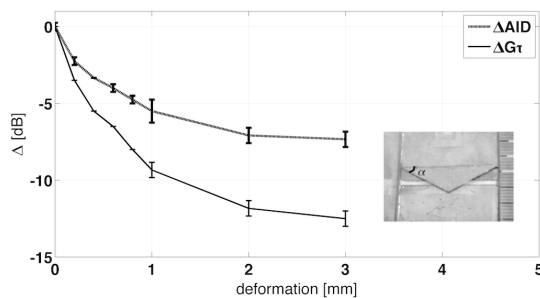
1. Humidity

Conducting polymer Tag

NANO-MATERIALS

Carbon Nanotube Tag

2. Ammonia
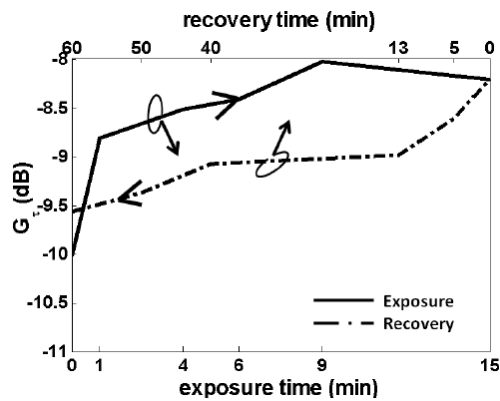
RFID-SENSORS FOR GASES
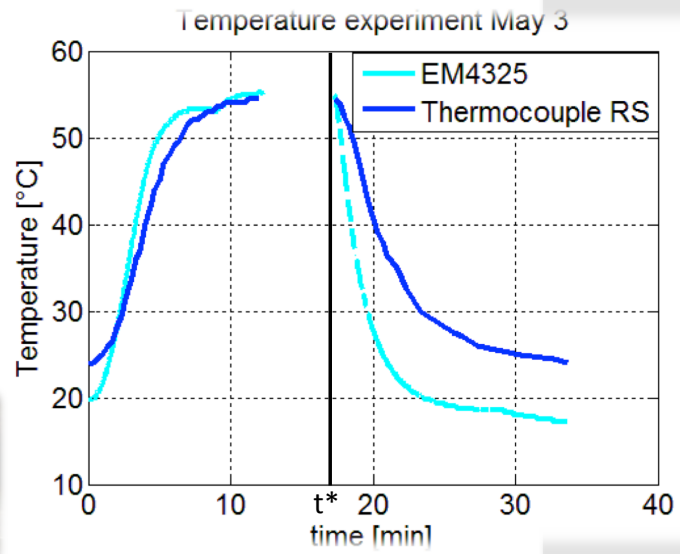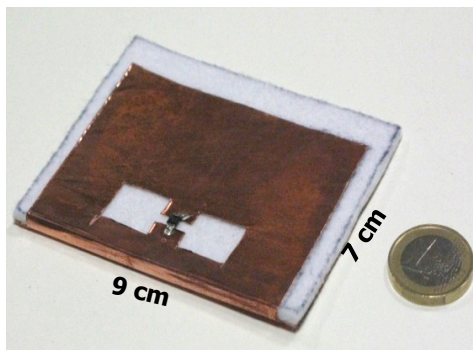## Chemical Lab-on-TAG

3. Moistures
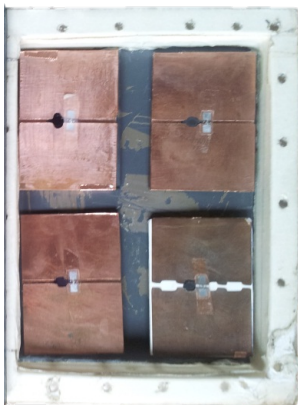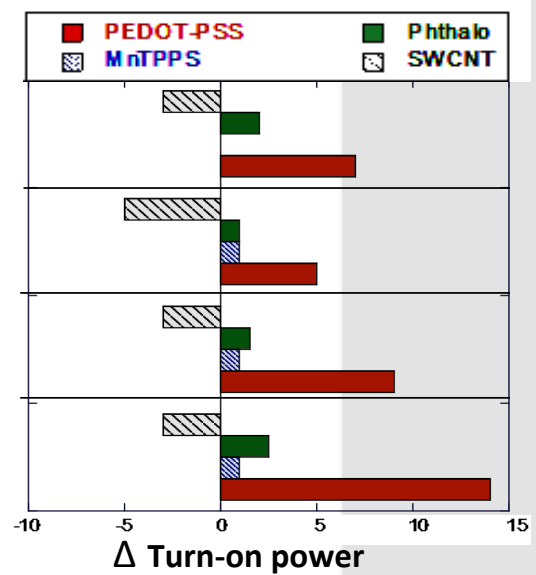
- Pedot:pss
- Single Wall Carbon Nanotubes
- Manganese-Tetraphenylporphyrin
- Phtalocyanine

Δ Turn-on power

RFID-SENSORS FOR TEMPERATURE

**Implantable
Passive thermal RFID sensor**

concrete

Temperature experiment May 3
- EM4325
- Thermocouple RS

RFID-SENSORS FOR BODY MOTION

7 cm
9 cm
FELT substrate

5 cm
5 cm
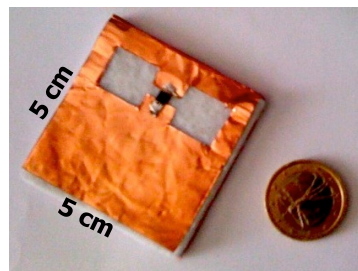
EPDM substrate

Wearable RFID tags

Tag
Smart Plaster
4,5 cm

A B C D E
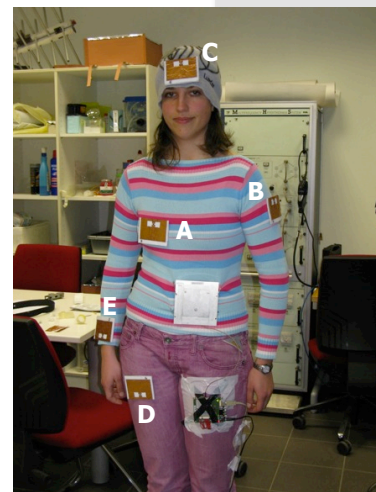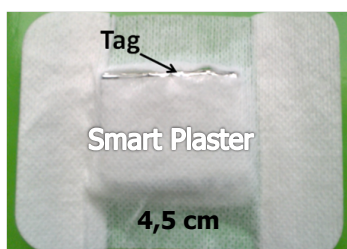
REAL-TIME DETECTION
OF BODY MOTION
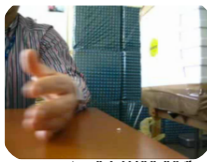
1. Hand-Tremors

2. Deep Breath

3. Walking

Application of
Brain Computer Interface
algorithms
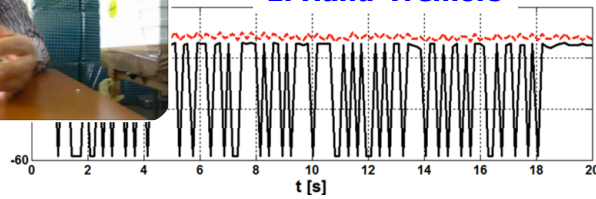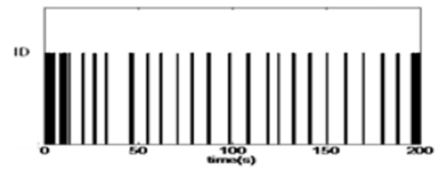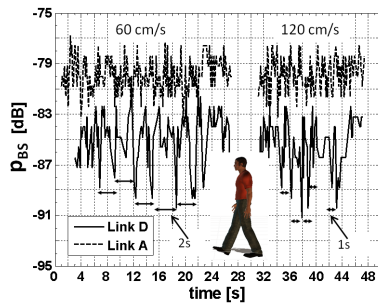
Automatic classification of motor sequences

PRODUCTS AND SERVICES

BUSINESS MODEL

Products (under development)

1. **Multi-sensors RFID tag** for Structural Health Monitoring
2. **Wearable Tags**

3. **NIGHTCARE**: Discrete Sleep monitoring system

Services

- Technology Process consultancy
- Electromagnetic planning of the sensor networks
- **Electromagnetic** compliance
- **Privacy** Compliance
- Training

Products are developed in close interaction with final possible users

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((■)) RADIOSENSE # 1. STRAIN-TEMPERATURE-HUMIDITY
STH-TAG

Multi-sensor TAG
for application over concrete
- Strain
- Temperature
- Humidity

Humidity	Strain	Temperature
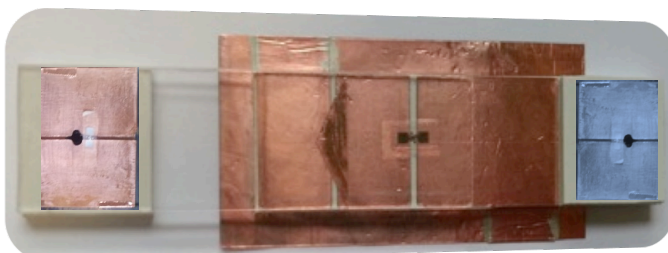
Integration of specialized
Sensing tags into a single
wireless, passive, low-cost
device

Status:
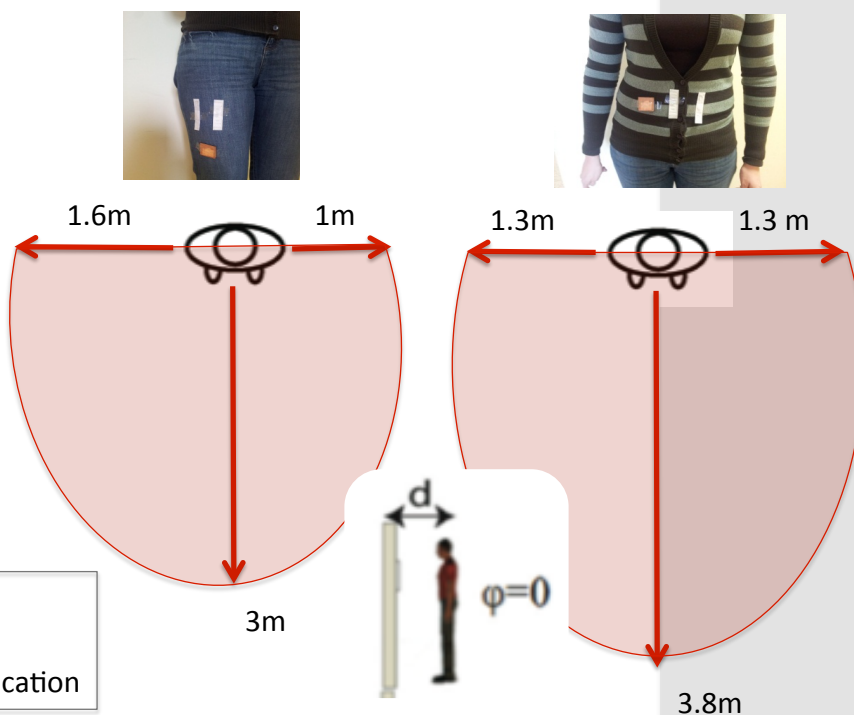Under development

READ REGION (@ EIRP=3.2W, LP, inside room)

RADIO6ENSE Tag (4.5x3.5cm)
- Felt
- Polyethylene
- Forex
- EPDM

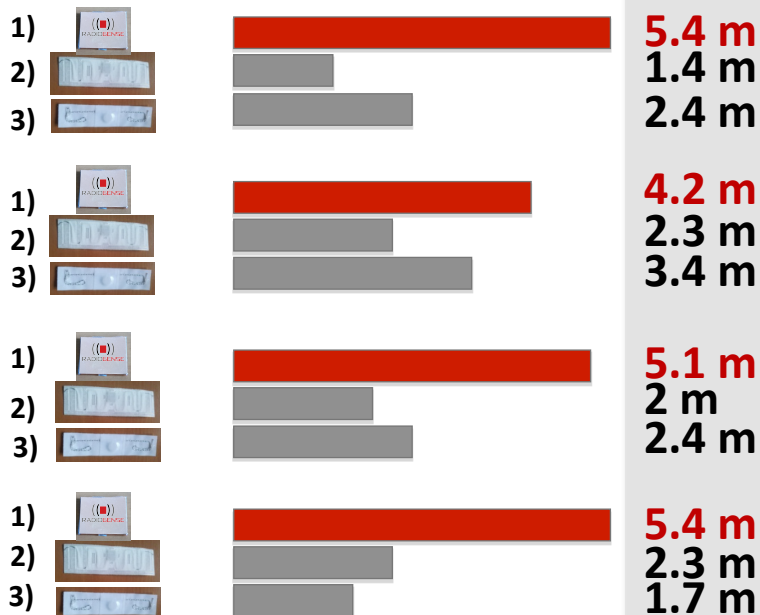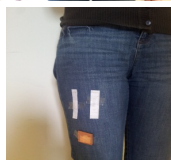1.6m 1m

1.3m 1.3 m

3m

$\varphi=0$

3.8m

Status:
Pre-Industrial phase
Production chain identification

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2. WEARABLE TAGS
COMPARISON WITH COMMERCIAL DEVICES

Max read Ranges (@ EIRP=3.2W, LP)

1) **5.4 m**
2) 1.4 m
3) 2.4 m

1) **4.2 m**
2) 2.3 m
3) 3.4 m

1) **5.1 m**
2) 2 m
3) 2.4 m

1) **5.4 m**
2) 2.3 m
3) 1.7 m

Ambient Intelligence system able to monitor the parameters of sleep quality and to identify anomalous events and **prompt for remote or local assistance**

The system analyzes the interactions of the person with the surrounding environment (bed, carpets, ..) by using our wearable Tags
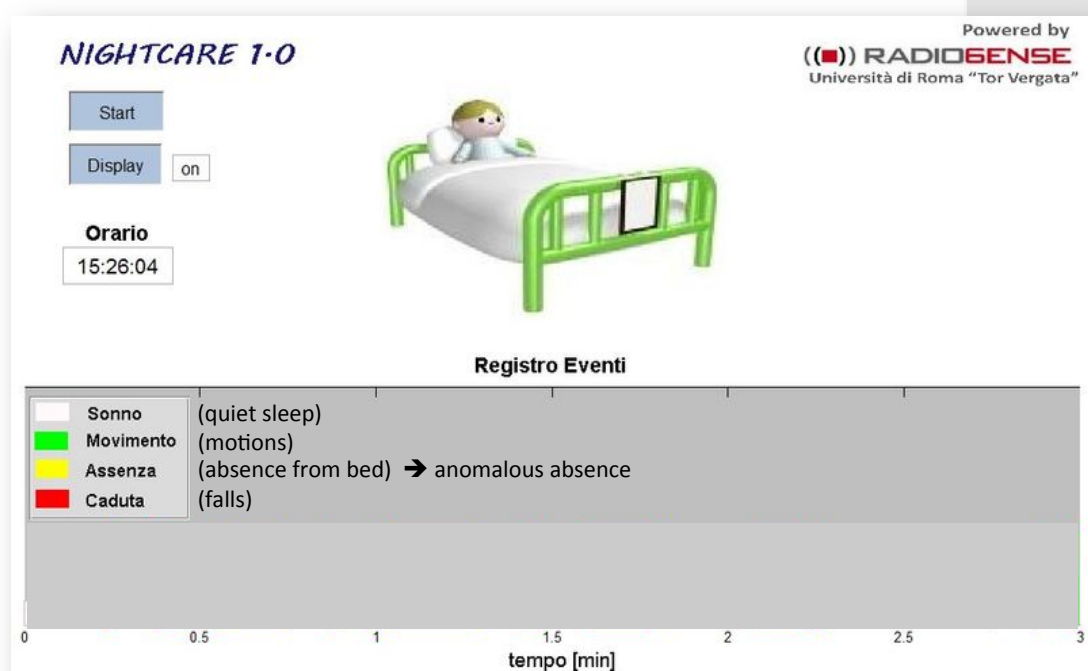
Status:
- Demonstrator
- Currently shown in an exhibition (Bologna)

pteexpo
10ª FIERA E CONGRESSO
Tecnologie, Prodotti e Servizi per la TERZA ETÀ

NIGHTCARE 1·0

Powered by
((■)) RADIO6ENSE
Università di Roma "Tor Vergata"

Start

Display   on

Orario
15:26:04

Registro Eventi

Sonno	Movimento	(quiet sleep)

Sonno (quiet sleep)
Movimento (motions)
Assenza (absence from bed) ➔ anomalous absence
Caduta (falls)

0   0.5   1   1.5   2   2.5   3
tempo [min]

(quiet sleep)
(motions)
(absence from bed)
(fall)
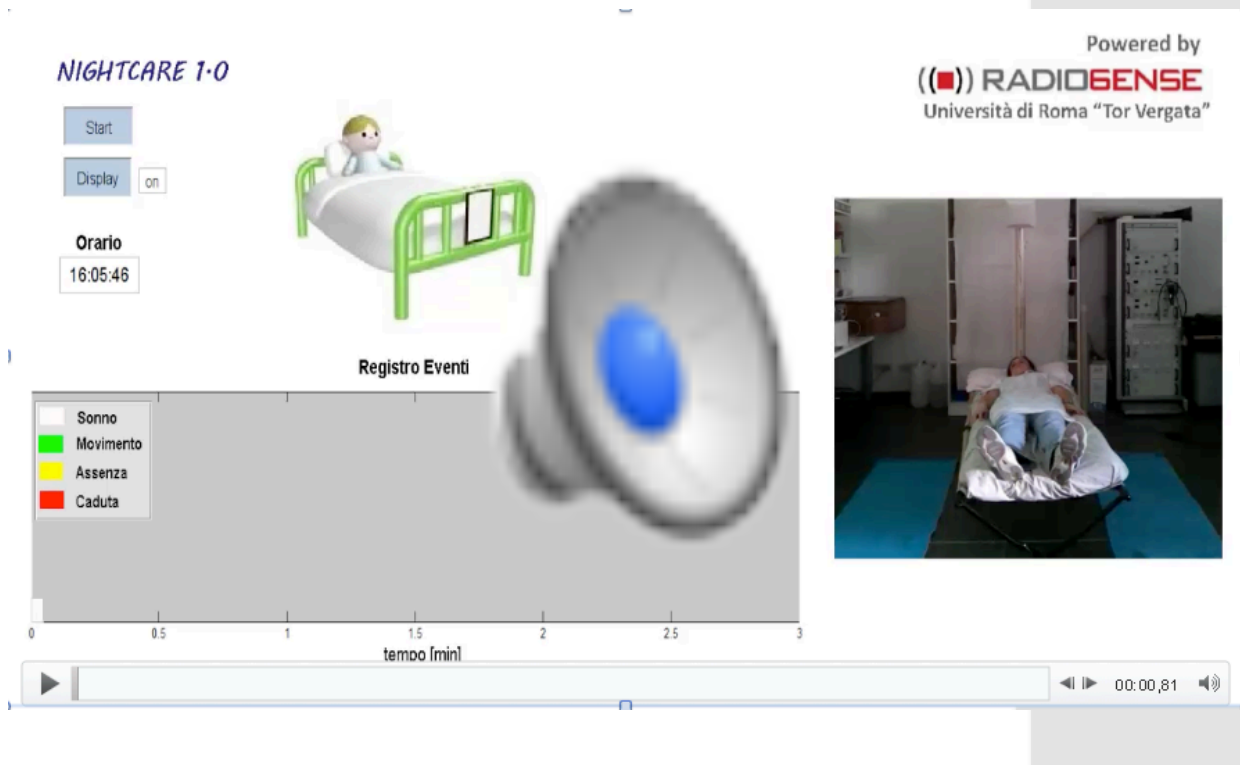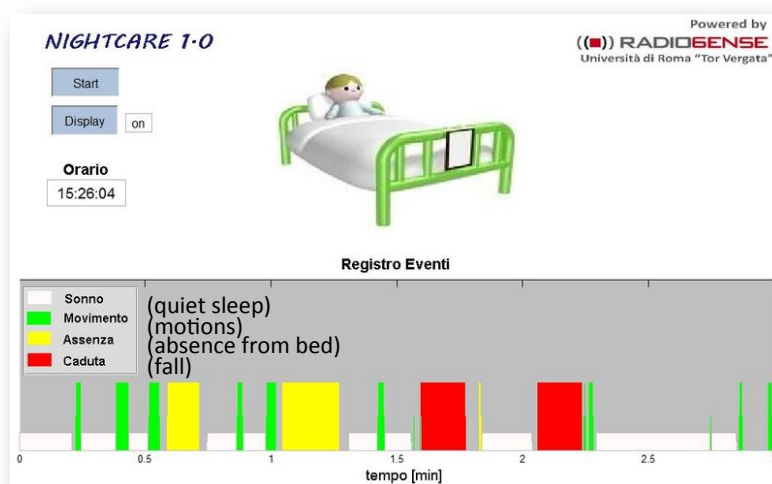
← Trace of the night-sleep

Applications
- Remote care of elders in rest house
- Remote care of children
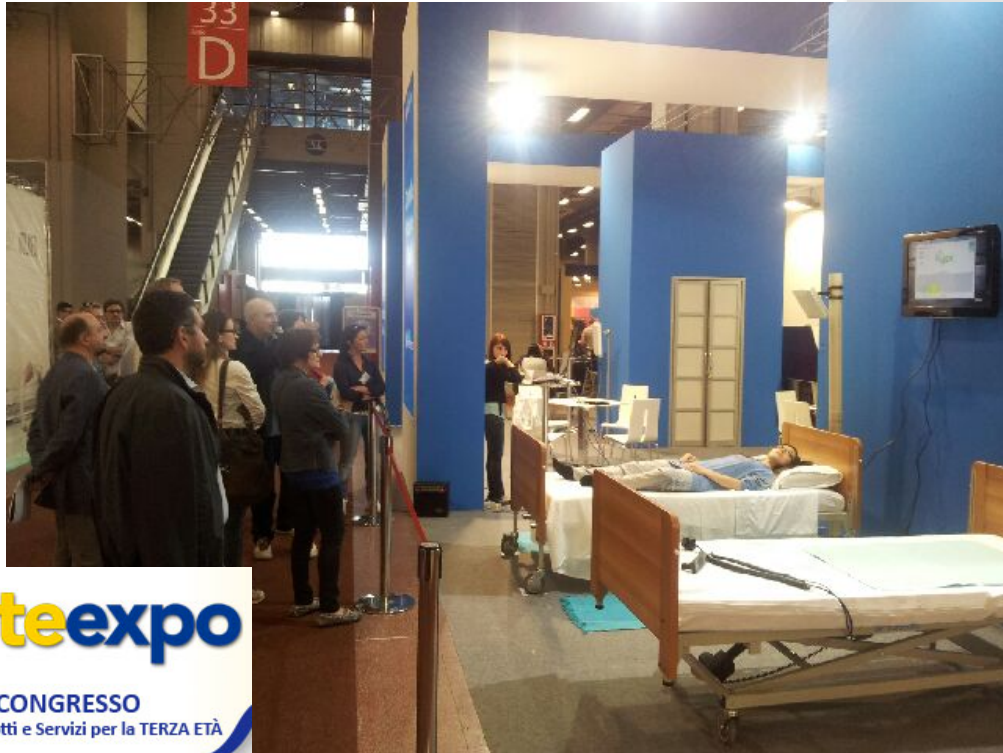- Diagnosis of sleep diseases
- Statistics

LESSONS LEARNT

1. It was not difficult to gain public funding, but **it is not easy to have advance payments**

2. **Bank credit** is unavoidable (not easy to get in these times !!)

3. Finalization of scientific prototypes to commercial products requires a close synergy with a potential customers.

4. Customers (especially SME) are **hardly available to pay for proof of concepts** or feasibility study. But **they can partly pay for demonstrators**

6. Proper kinds of agreements are required to **share the cost of feasibility and demonstrators with possible customers**

7. Search **for Partnership with complementary players** already placed in the specific market

8. The market is just **weakly aware about the full potentialities** of pervasive low-cost sensing

9. **Sensing "evangelization"** is required

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Human, Environmental and Structural Monitoring

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