
**PHealth International Workshop 2009
24th to 26th June 2009, Oslo, Norway**

**In vivo ULTRAsonic Transponder System
for Biomedical Applications**

ULTRAsponder

FP7 Collaborative Project, STREP

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ULTRAsponder consortium

- **Sectorial composition**

- Universities: 3
- R&D Centres: 2
- SMEs: 3
- Industries: 1

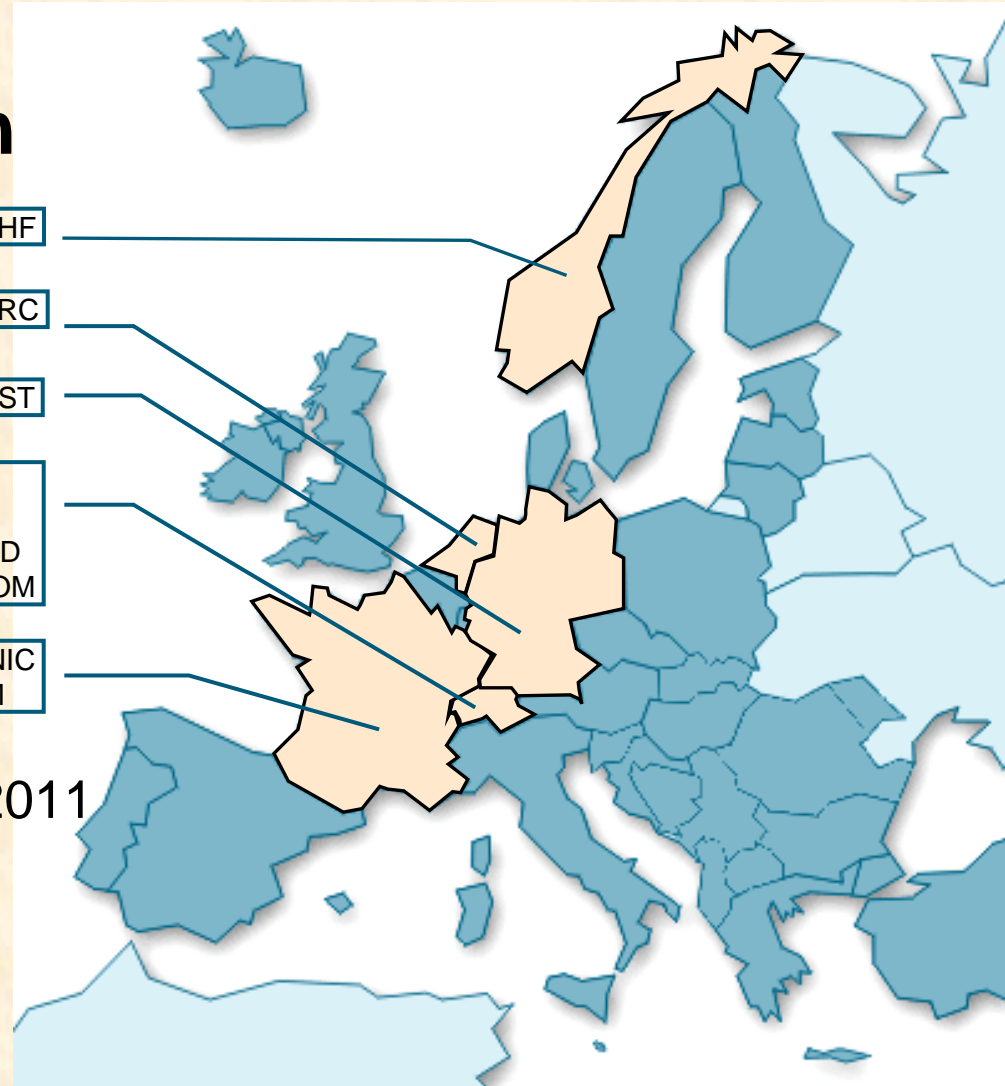
RHF

MDT-BRC

IMST

EPFL
CSEM
HEIG-VD
SCIPROM

IMASONIC
INSERM



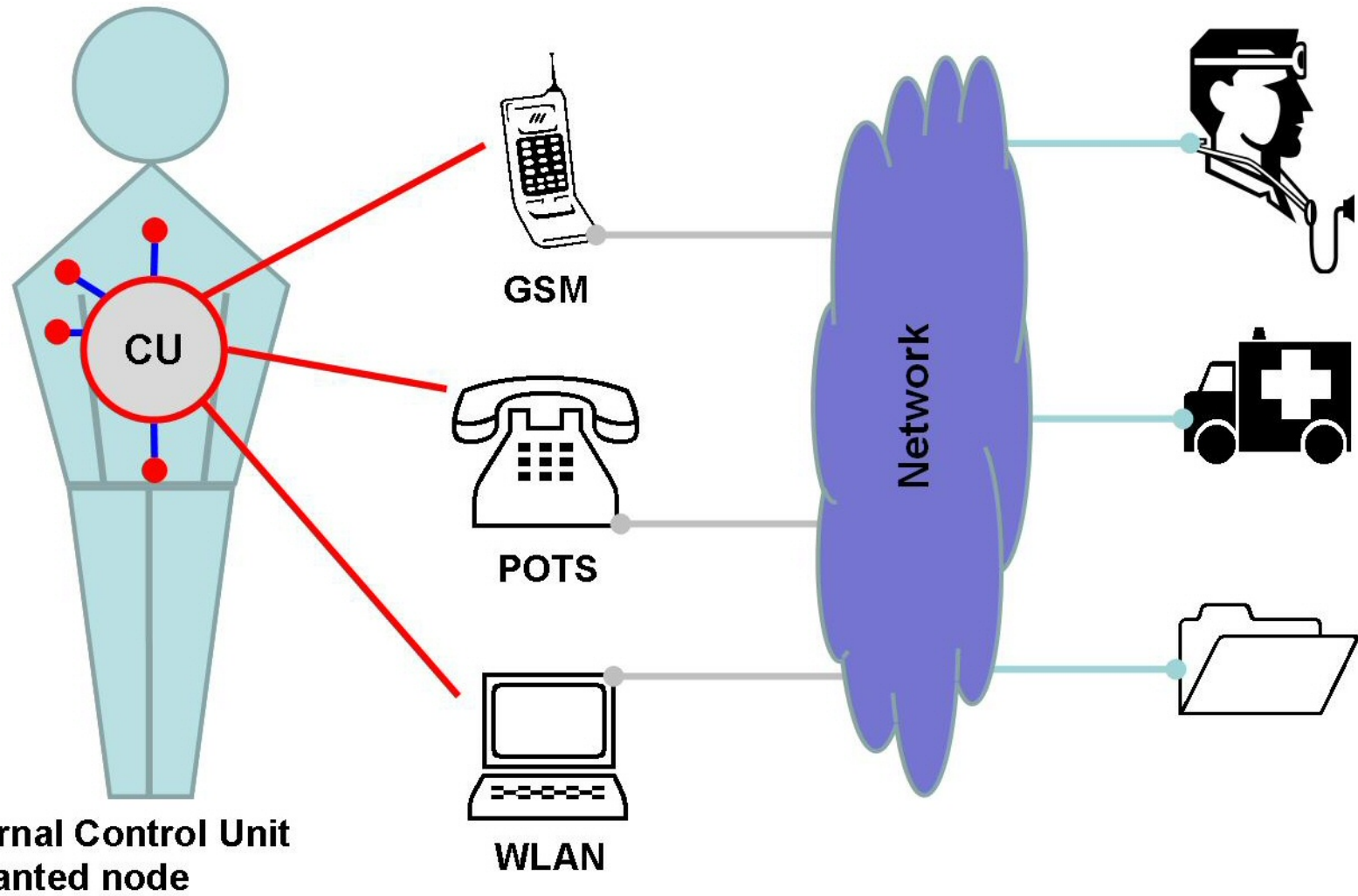
Duration: 1 Sept. 2008 to 31 Aug. 2011

Coordinator: EPFL

Total Budget: 4'326 kEuros

EC Contribution: 3'150 kEuros

Implantable biosensing transponder network



Motivation

- **Design issues for deeply implanted devices**
 - miniaturization, power consumption and body's dielectric nature
- **Electromagnetic compatibility**
 - it is becoming more and more difficult to ensure a radio communication characterized by a high immunity to external radiators
- New roads need to be opened to overcome these limitations and to ensure the development of **deeply implanted medical devices**
- ULTRASponder aims at developing exclusive technologies based on **ultrasonic telemetry techniques**

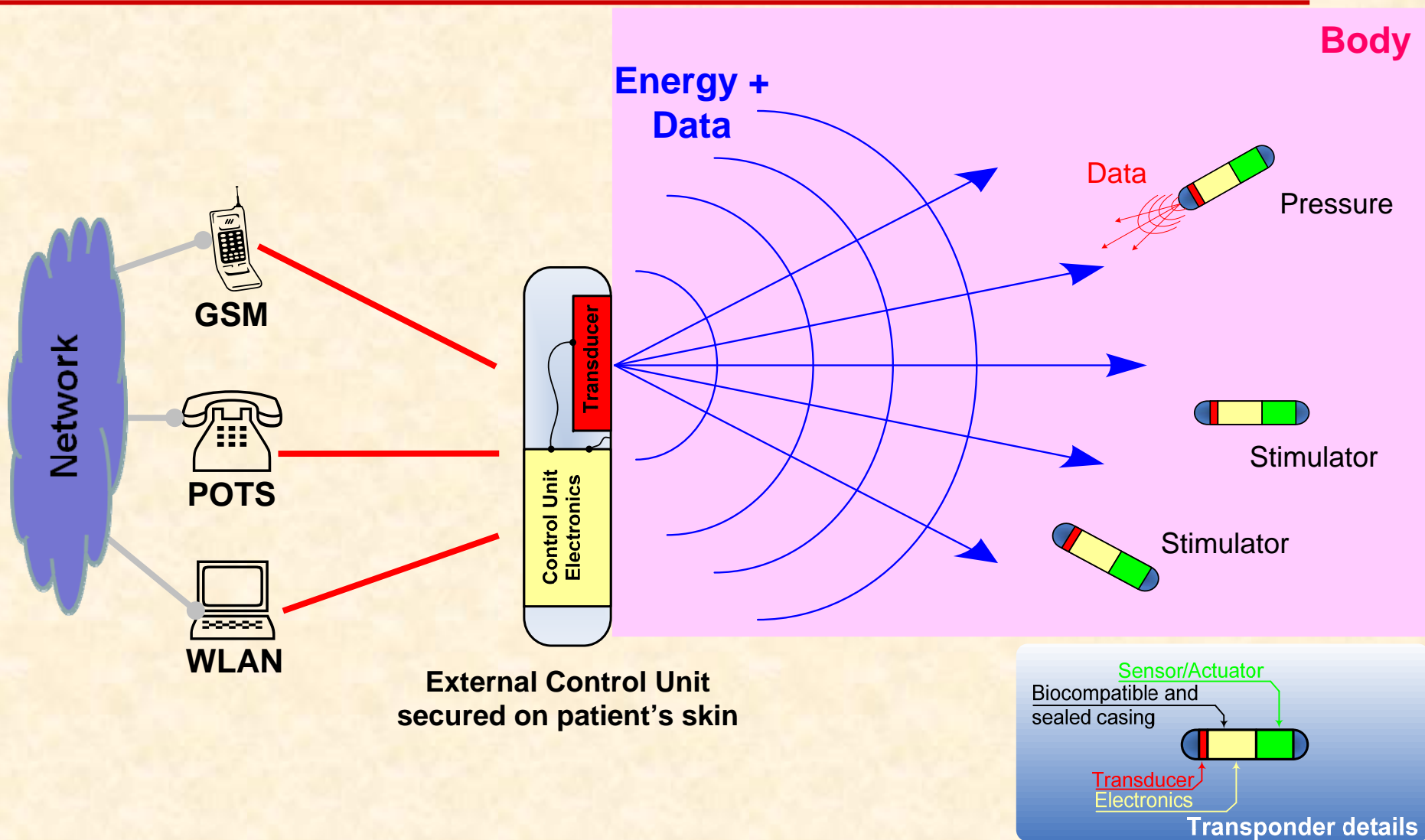
Technology challenges

- **To prove the concept by developing a new technology** for a network of ultra-low power transponders deeply implanted inside the body for long term periods
- To develop innovative **wireless data and energy transmission** techniques for **ultra low power sensor/actuator nodes**
- To propose key innovative features
 - **Remote powering** through acoustic wave
 - Half-duplex acoustic **wireless data transmission**
 - **Local signal processing**
- **To assess the overall system in a real environment** for a particular application aimed at measuring physiological parameters.

Competencies of the consortium

- Specifications of medical applications devoted to deeply implanted sensors
- Ultrasound propagation
- Acoustic transducers
- Wireless communication
- Remote powering
- Low power A/D Converters
- Low power integrated circuits
- Ultra low power signal processing
- System integration and packaging
- Clinical trials
- Project management

Communication between the CTRL unit and the body



Technology challenges

- **Half-duplex wireless communication**
 - The implants can be placed anywhere deep inside the body, without connecting leads or wires.
- **Remote powering**
 - The implant is energized and activated on-demand via the external CTRL unit worn on the patient's skin.
 - An energy storage device is recharged through acoustic wave sent from the CTRL unit.
- **Small size**
 - to enable its implantation at locations deep inside the body.
- **Safe and recognized technology**
 - Healthcare professionals have been using acoustic communications for decades (ultrasonography).

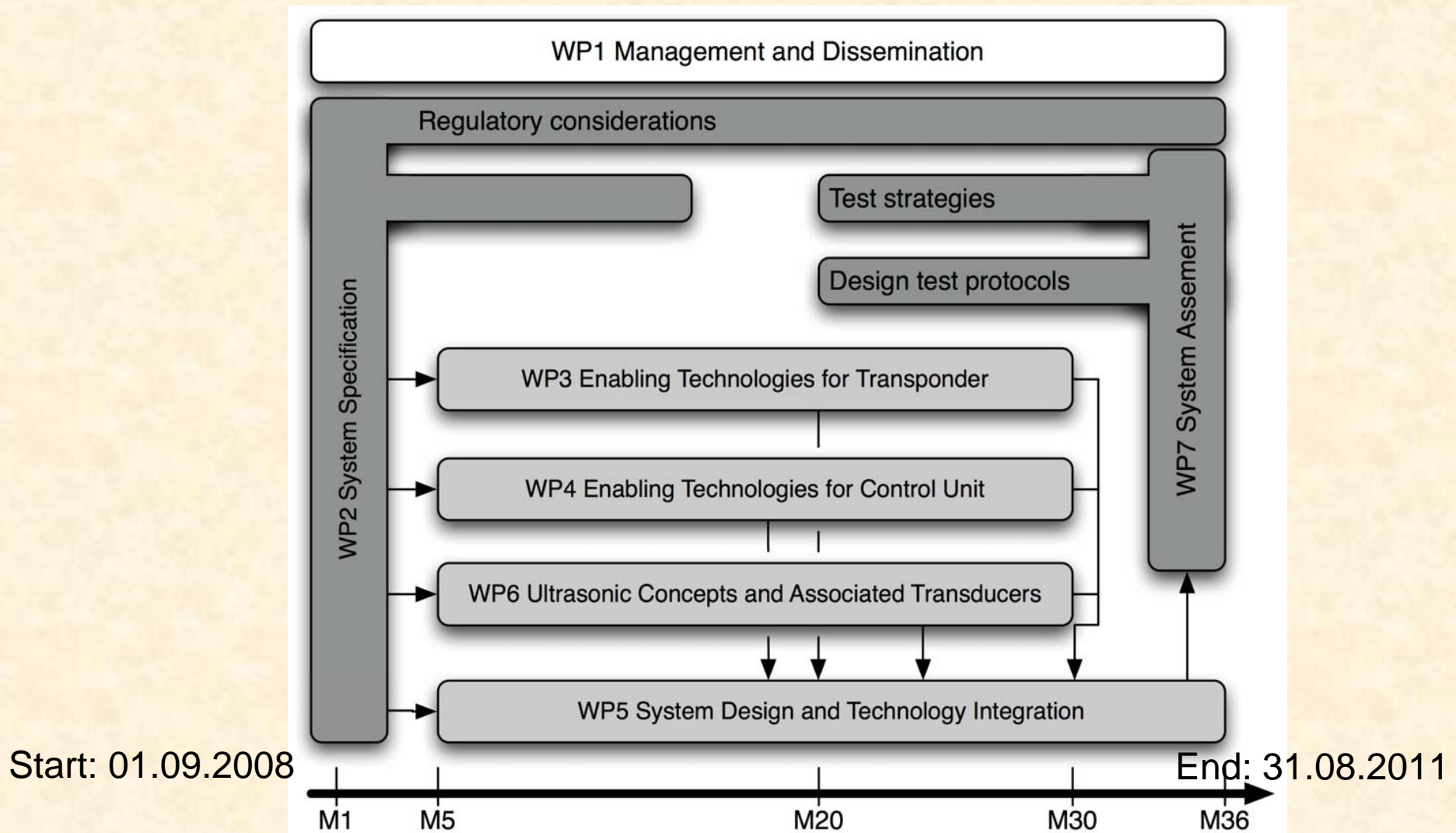
Implanted Sensor

- The energy storage device is recharged via the acoustic transducer configured for converting acoustic signals into electrical energy.
- This electrical energy powers the electronics which control the sensor.
- Data processing is performed locally by an ultra low power DSP, namely the icyflex.
- Half duplex communication is performed between the implanted sensor and the external CTRL unit.
- Important data is permanently stored in a non-volatile Ferroelectric Random Access Memory (FRAM).

External Control Unit

- It is worn externally and fixed to the patient's skin ensuring energy and data transmission to the implanted sensor network.
- It is light and compact.
- It is applied with silicon gel, hydrogel or other acoustically conductive materials to provide substantial continuity and minimize excessive acoustic impedance mismatch or other losses.
- It ensures the gateway function to cellular, POTS or IP based networks.

Workplan



Summary on the Technology

- **Simulation**
 - develop model to represent tissues exposed to ultrasound
- **Half-duplex** wireless communication through acoustic wave
- Design, manufacturing and test of **electro-acoustic transducers**
- **Remote powering** through acoustic wave
- **Signal processing capabilities**
 - ultra low power digital signal processing and energy management
- Small footprint, **high flexibility**, modular and generic

Impact for the Patients, the medical Doctors and the medical Industries

- **ULTRAsponder provides an innovative medical survey conception**
 - Patients' vital parameters are sensed and pre-processed in the deeply implanted transponders allowing for continuous monitoring.
 - The external control unit periodically communicates and energizes the sensors via ultrasound waves and relay significant data to the appropriate centers.
- **Impact for the patients and the medical doctors**
 - More reliable and comprehensive monitoring of chronicle dysfunction brings present therapy to a new and more personalized level.
 - Patients feel more comfortable and receive a more precise diagnosis and hence higher quality treatments.
- **Impact for medical industry**
 - Small biocompatible implantable devices will be massively produced and commercialized.

Contact for ULTRAsponder

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