



Cooperative Radio Communications in Green & Smart Environments

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Chairman of COST IC1004

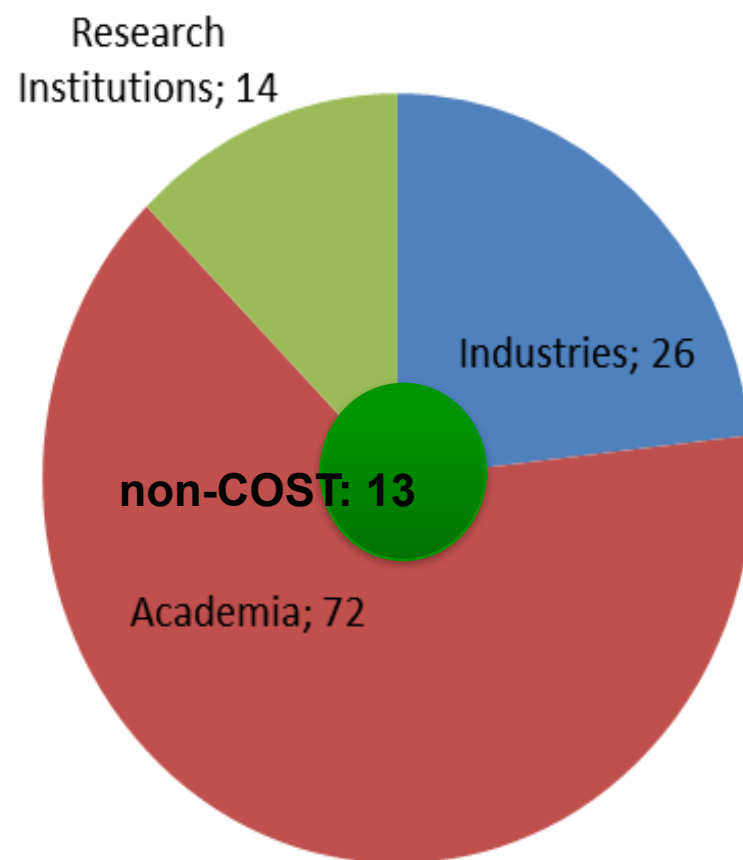
Vice-Director of iTEAM Research Institute

Outline

- What is COST IC1004 about
- Scientific Challenges and priorities

What is COST IC1004

IC1004 is a EU COST Action on Cooperative Radio Communications for Green and Smart Environments



460 registered participants from 37 Countries
Predecessors: COST 207, 231, 259, 273, 2100

Inclusive Scientific Forum becoming a stable Network of Knowledge

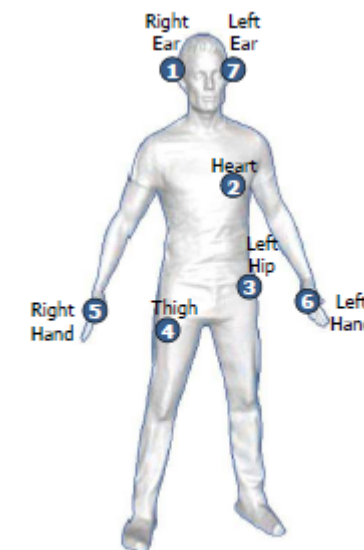
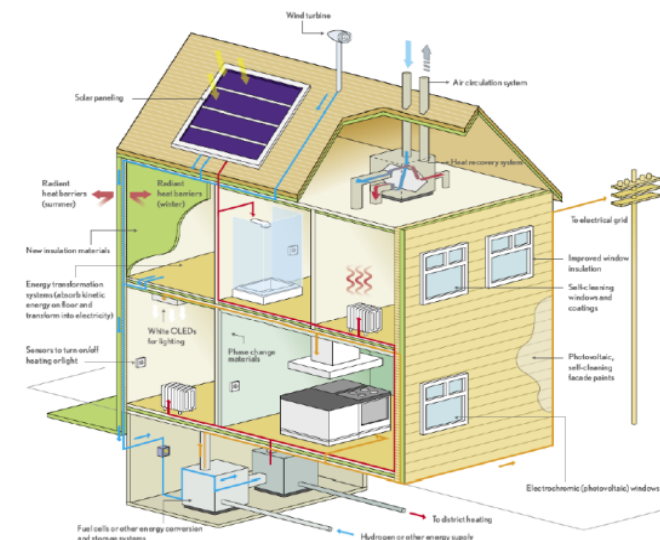
What is COST IC1004

COST IC1004 relays on two main concepts:

1. Scenarios for our research: “Green & Smart Environments”

Physical spaces populated by sensors, actuators, embedded systems, terminals, which cooperatively operate by exchanging information, and share resources, e.g. radio spectrum, energy.

- Human Bodies
 - Vehicles
 - Buildings
 - Urban Environments
- ☒ Smart Health
 - ☒ Smart Transport
 - ☒ Smart Energy
 - ☒ Smart Cities



What is COST IC1004

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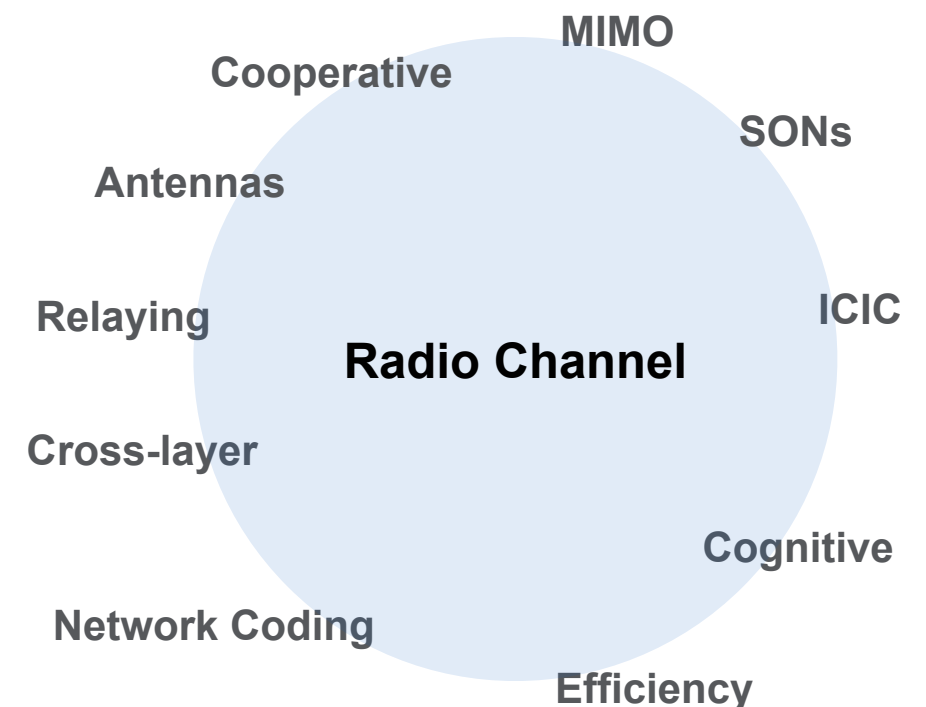
2. Technologies for the Radio Networks: “Cooperative Radio Communications”

*The main objective of the Action is to increase knowledge of **Cooperative Communications** applied to Green Smart Environments (GSEs), by exploring and developing new methods, models, techniques, strategies and tools.*

The Radio Channel is central to GSEs.

This Action is combining experience on

- Radio Channel Characterisation
- Transmission Techniques
- Radio Access Networks

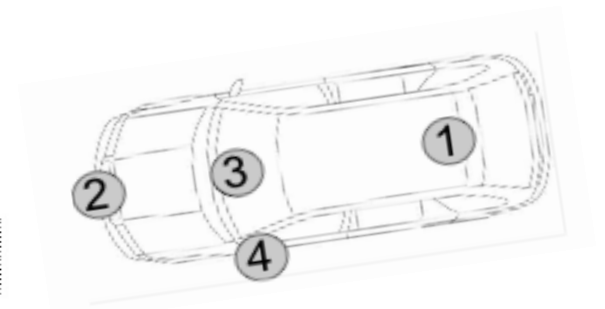
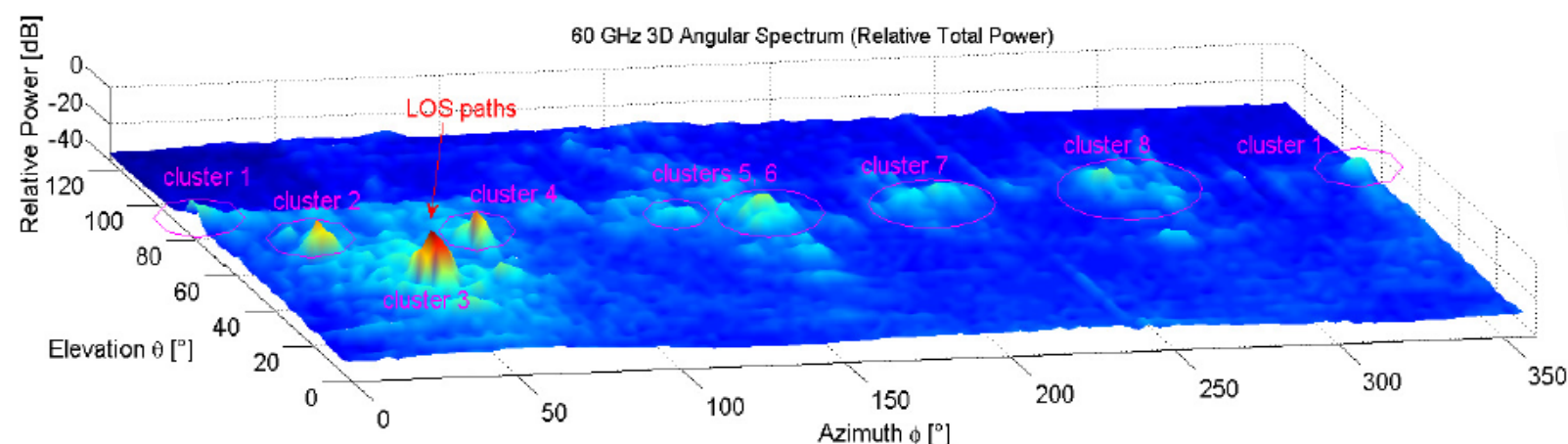
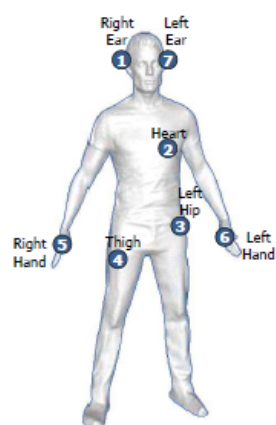
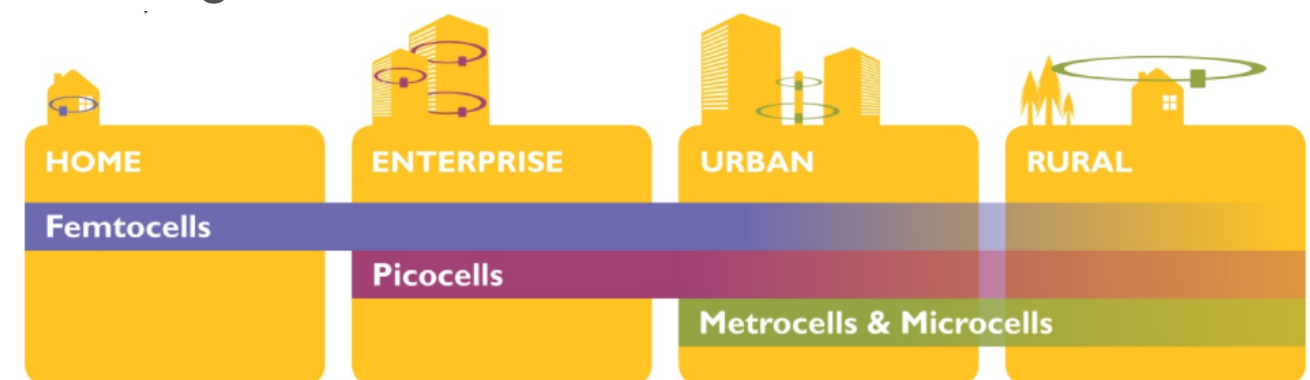


Scientific Challenges

New Radio Communications Networks Scenarios

COST IC1004 is exploring new areas of interest among the **Radio Communications** community, creating a **network of researchers** and institutions within IC1004, to perform joint scientific activities, which results are applied to:

- Cooperative Networks
- Wireless indoor localization
- High-throughput wireless systems for medical applications
- 60 GHz channel measurements and modelling
- Indoor femtocells in LTE networks
- Body area radio channel modelling
- Vehicular communications
- OTA testing

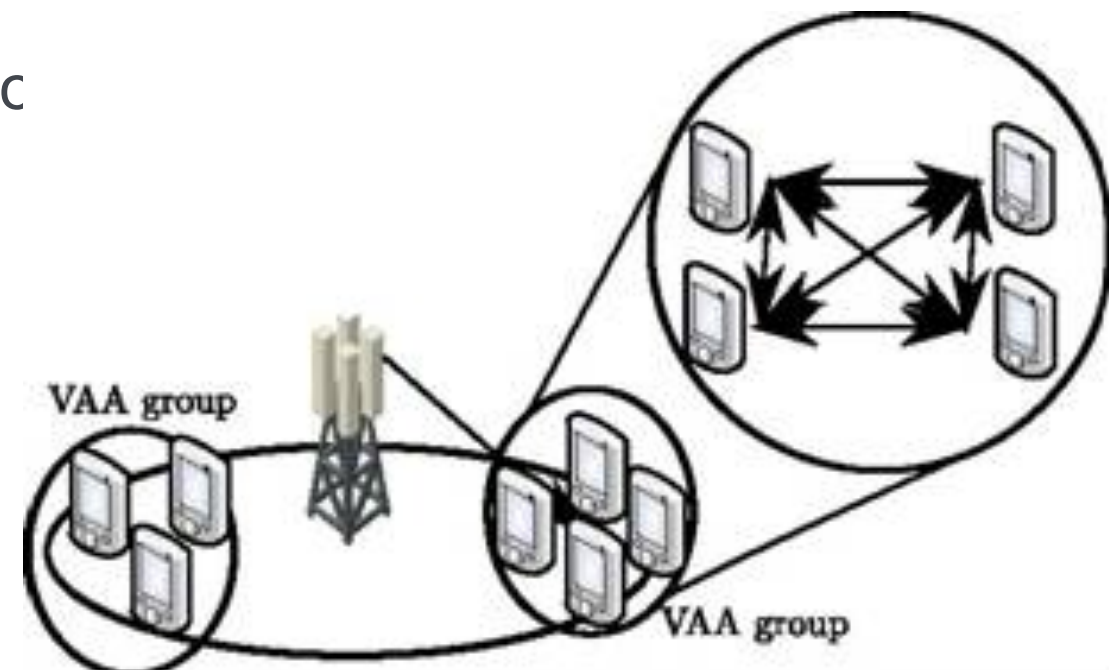
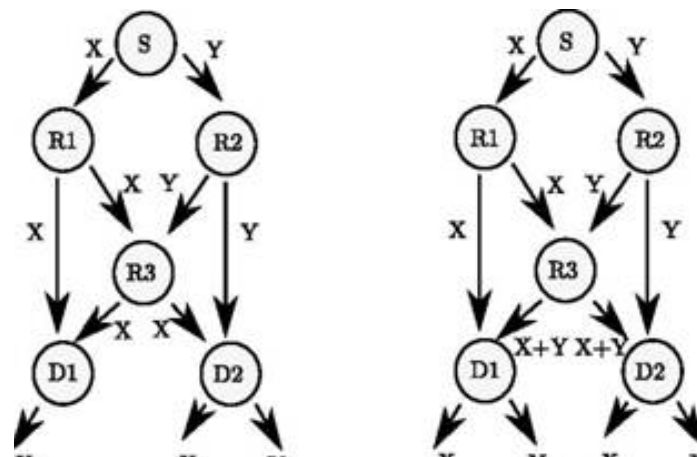


Scientific Challenges

Cooperative Networking

Based on extending coverage/service from the existing infrastructure:

- Relaying (fixed ...also mobile)
- Multiuser, virtual MIMO, ...
- Network Coding (PHY Layer Network Cc)
- Inter-cell cooperation (ICIC, ...)

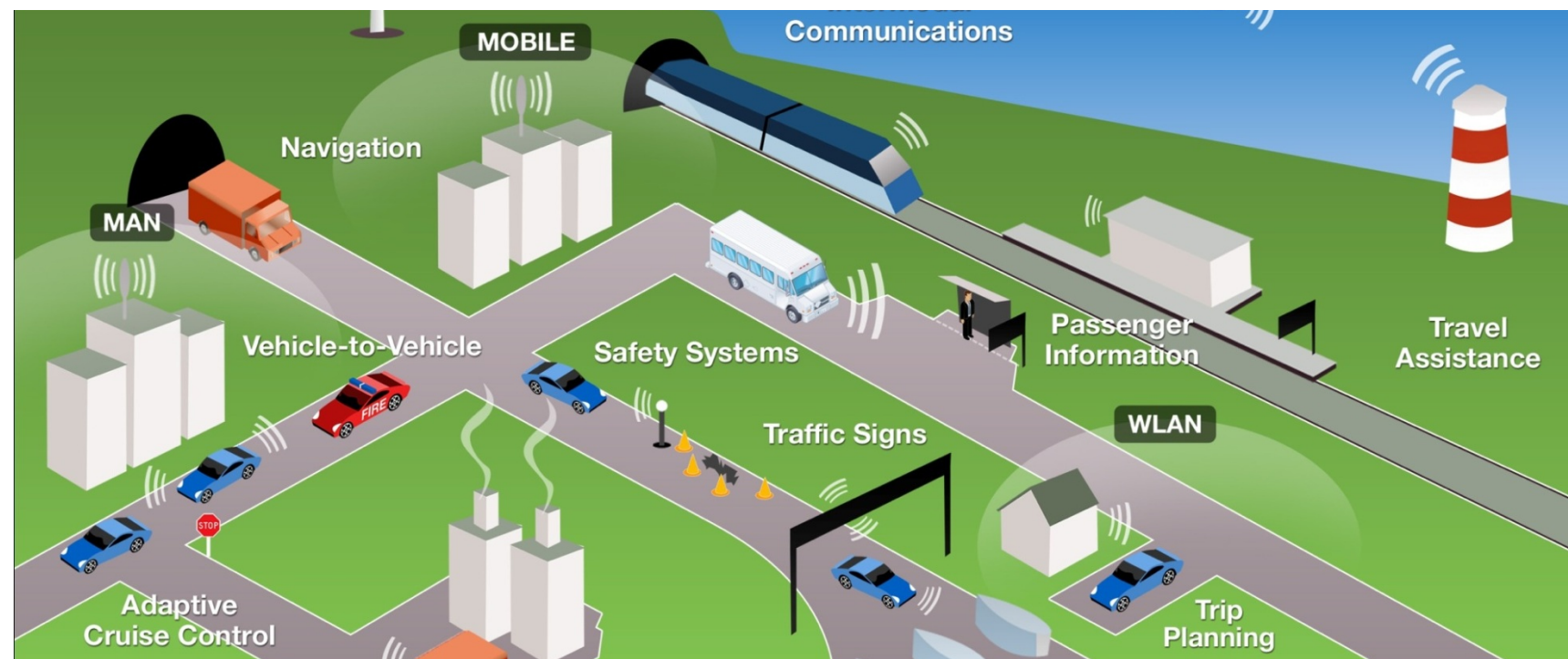


- The aggregation of cooperating terminals or cooperating cells creates “Cooperative RAN Areas”, beyond the concept of “Cell”, saving energy (at the BSs) and infrastructure costs.

Scientific Challenges

Vehicular Communications

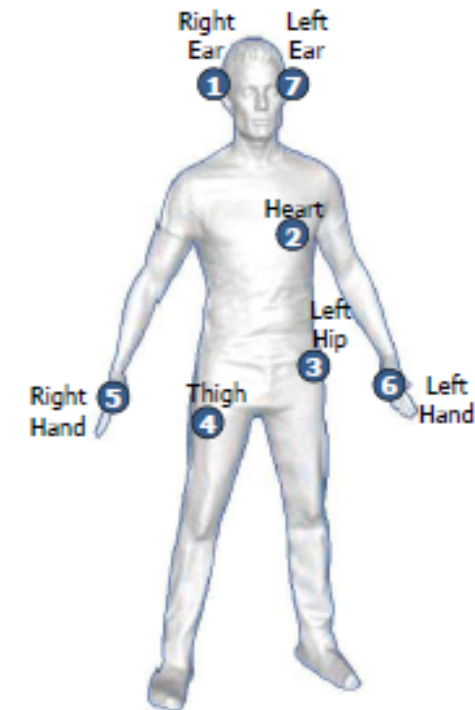
- The Vehicular Communications WG of IC1004 works on modeling, characterization, and estimation of the vehicle-to-vehicle and vehicle-to-road side radio channels at several frequencies, mainly at the 6 GHz band, allocated for **traffic safety applications**.
- Interest in evolving the current ITS standards and testing vehicular communications protocols in real scenarios, as well as defining the elements of an **integrated "ecosystem" for vehicular communications**



Scientific Challenges

Body Area Networks (BAN)

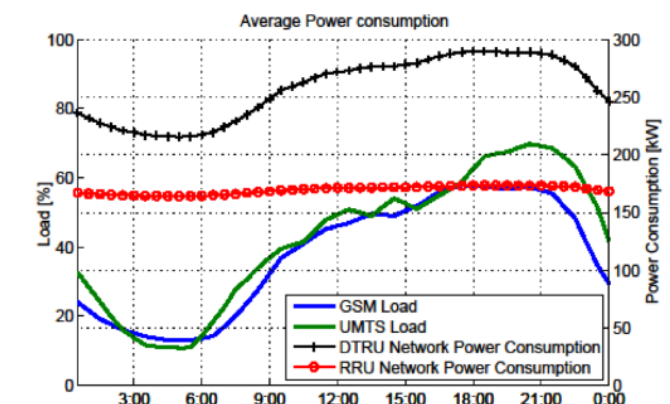
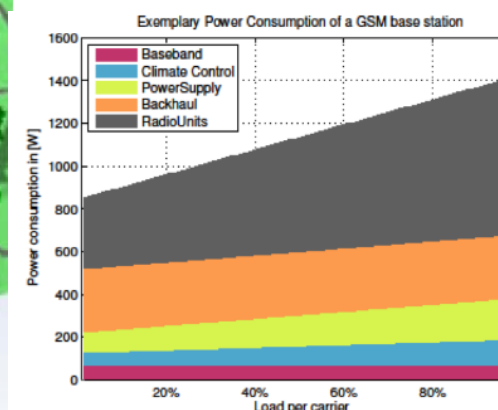
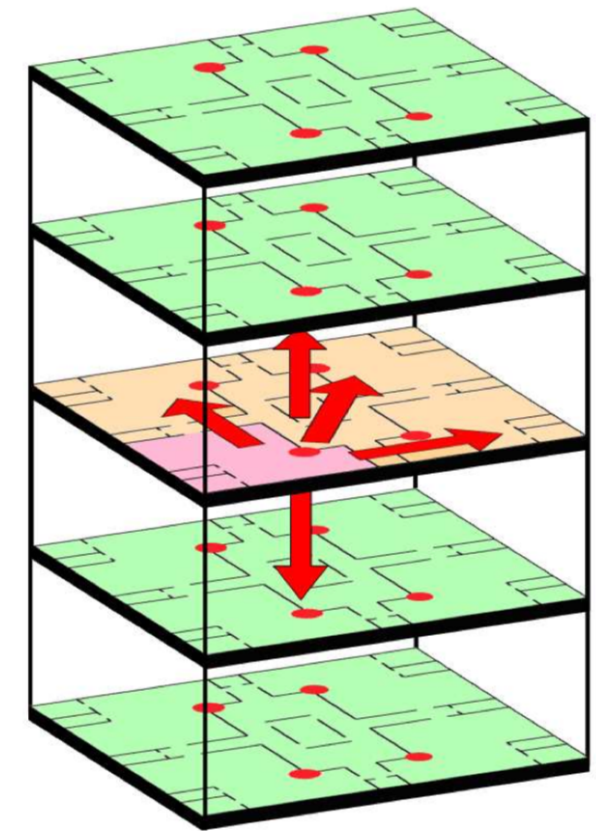
- COST IC1004 Working Group on BAN has developed radio channel models for Body Area Communications, as well as protocols for the optimum **networking of body area sensors**. Measurements in hospitals, experiments in anechoic chambers and office environments have validated the theoretical proposals.
- Strong interest in continuing the investigations in several bands, **60GHz** mainly, but also UWB, ISM and MICS.
- Interest in healthcare moving sensors and its **opportunistic networking in emergency** situations applications.
- Interest in **implementation** aspects, energy efficiency, high dense networking and reliability of BANs



Further Scientific Challenges

Radio Access Networks in Urban Environments

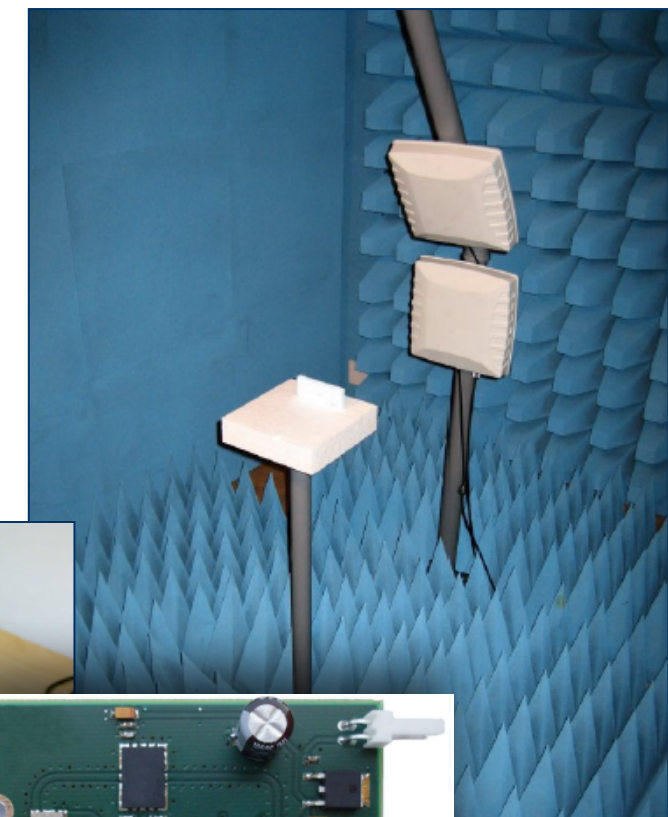
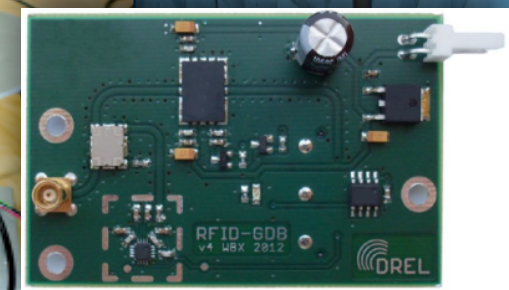
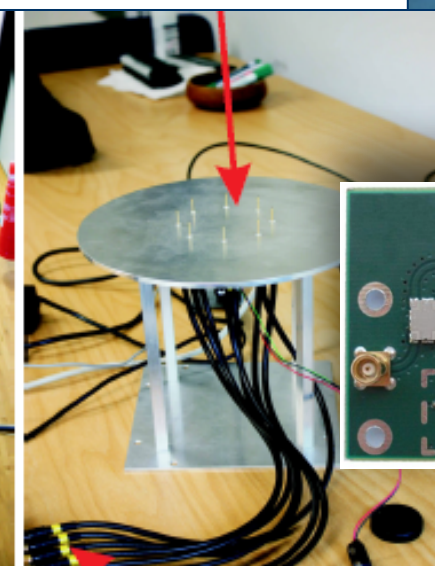
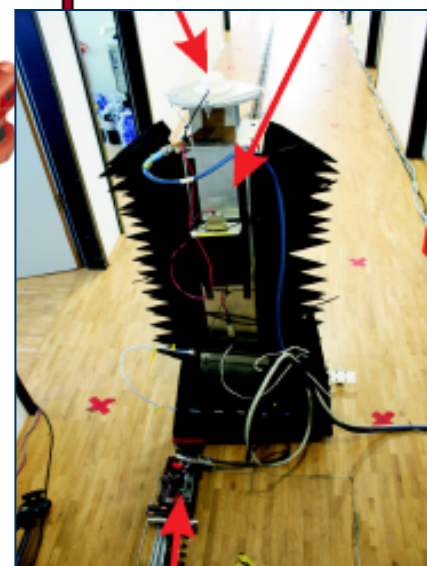
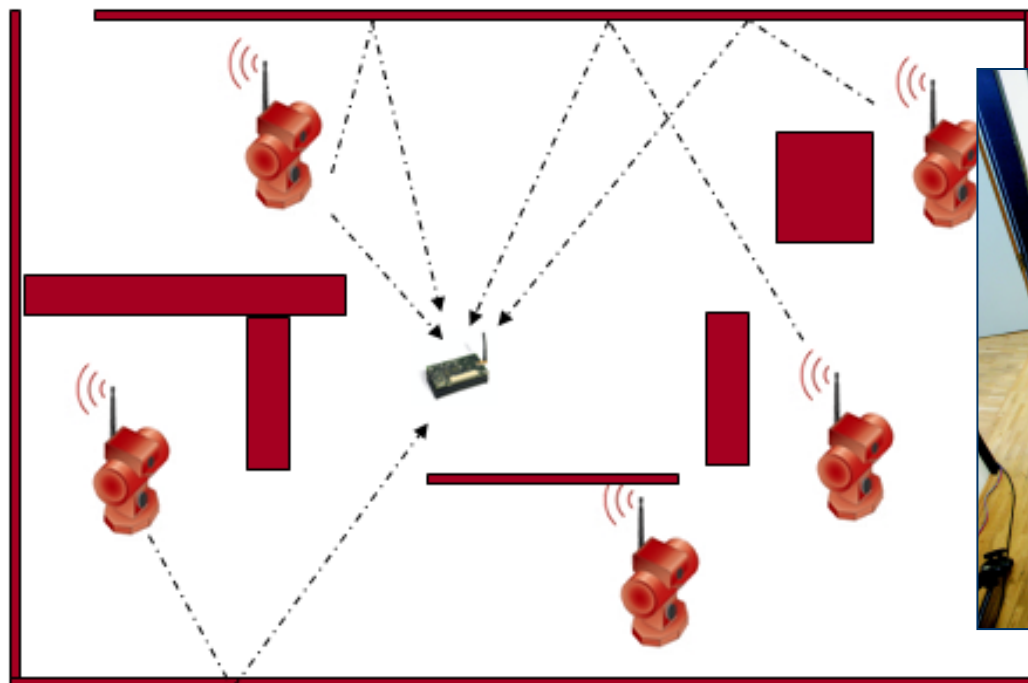
- Urban Environment Reference Simulation Scenarios
- Energy efficiency and performance enhancements
- Heterogeneous networks (Multi-Layer and Multi-RAT)
- MIMO modelling in system-level simulations
- Comparison of Ray-Tracing Tools
- Harmonization of system-level simulators
- Indoor-to-Outdoor-to-Indoor Propagation models



Scientific Challenges

Indoor Environments

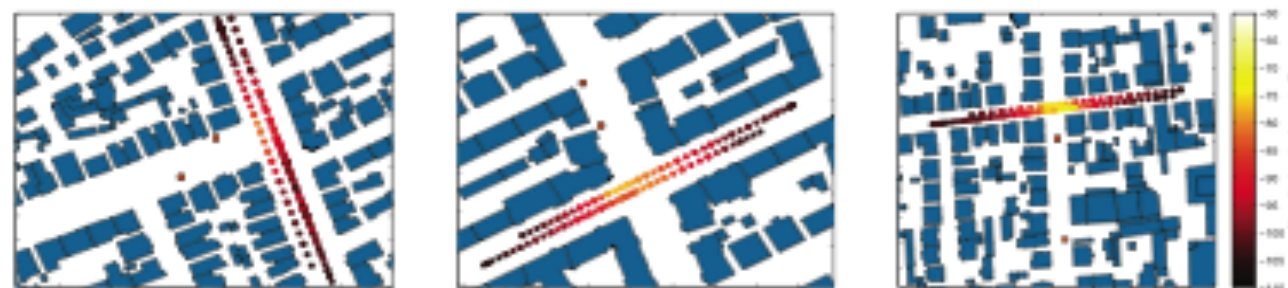
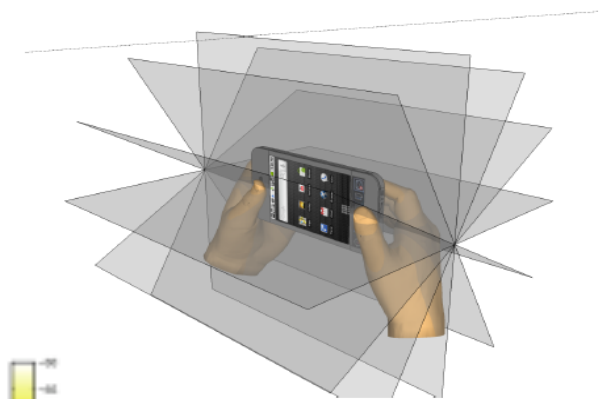
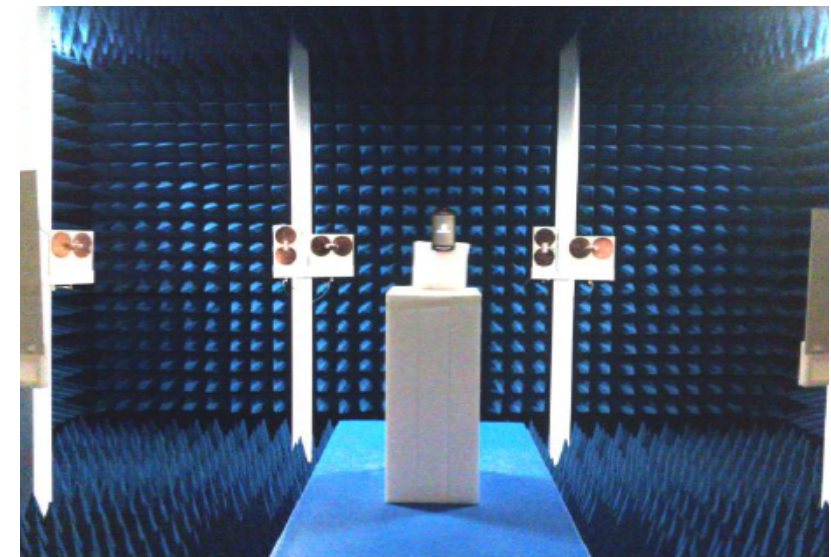
- Indoor radio channel modeling
- Ultra WideBand systems
- passive localization measurements and methodology.
NLoS identification and mitigation techniques
- RFID systems: tests with SDR, MHz band
- Testing and measurements at 868MHz, 5.2 GHz, 11GHz, 60 GHz for localization and medical environments



Scientific Challenges

MIMO-OTA testing and Standardisation

- Participation of many COST IC1004 experts in the official LTE Round Robin for ETSI 3GPP RAN4, on the several proposed OTA technologies.
- A liaison with the North-American CTIA MOSG (MIMO OTA Sub Group) established, meaning bilateral information exchange. Simulation activities to support the choice of MIMO OTA technology by 3GPP and CTIA at the end of this year has started in IC1004.
- The knowledge produced as the result of the Vehicular Communications WG work is expected to impact ETSI ITS standardization work on intelligent transport systems, and hence will impact the safety, comfort, and environmental impact of the road transport system in the future



Further Scientific Challenges

Smart Environments and “iObjects”

Smart Environments (SEs) are those spaces populated by hundreds of sensors and actuators, some communication node(s) and eventually some mobile terminals.

- Some new aspects are appearing in the SEs which open challenges for joint research:
 1. The role of the Mobile terminals as **radio access enablers** to other wireless devices (Mobile Relaying, Opportunistic Networking, Cooperative Connectivity, ...)
 2. The possibility that object has an electronic identity, either by active (wireless) or passive (RFID/NFC,...) systems, can be complemented with the **networking from mobile terminals** to create new types of services and applications
 3. The extension of moving objects tagging to wireless **positioning** applications

Further Scientific Challenges

Radio Access Networks beyond the Cellular Architecture

- New scenarios and wireless data sources, M2M, V2x, ...
- New terminals concepts and interfaces, *pocket computers*
- No single *killer app*, but millions of APPs available
- Clouds of personal information, *stormy-raining of data*
- New user terminal behaviour, very high signalling load

is the cellular deployment DOWNSCALING from MACRO to FEMTOCELLS the only way?

... how EFFECTIVE is this approach? (Energy, Spectrum, CAPEX, OPEX, ...)

Isn't CLOUD RAN concept more efficient at least for high-dense traffic (urban/metropolitan) areas?

Will LTE-B, -C, the way towards 2020 communications?... 5G?

What is COST IC1004

Further Scientific Challenges and priorities:

- Networks beyond the Cellular concept
- Energy Efficient Cooperative Networking
- Wireless Communications for Traffic Safety and Efficiency
- Efficiency and Security at the Wireless Terminal side
- Testing adaptive, distributed, cognitive mobile systems
- ...

Read our Action NEWSLETTER
www.ic1004.org/newsletter

And the:
[*COST IC1004 Position Paper to Horizon2020*](#)





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www.ic1004.org

