



**Cognitive radio and Cooperative strategies for  
POWER saving in multi-standard wireless devices**

**Olivier Perrin, Cassidian**  
**PSC Europe Forum Conference**  
**Helsinki, Finland**

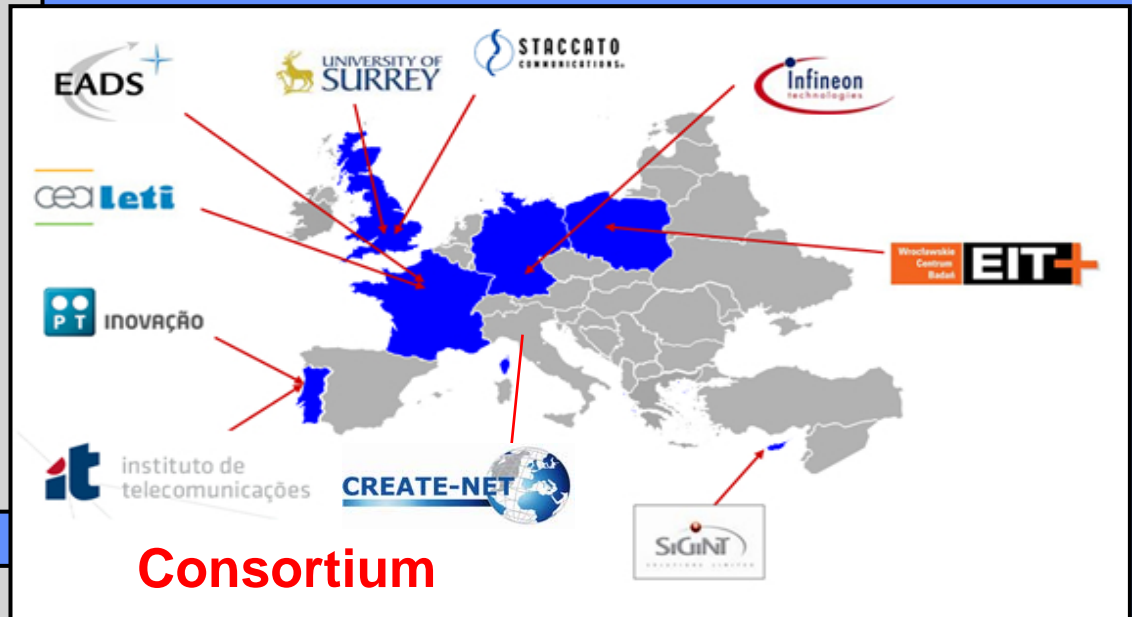
<http://www.ict-c2power.eu>



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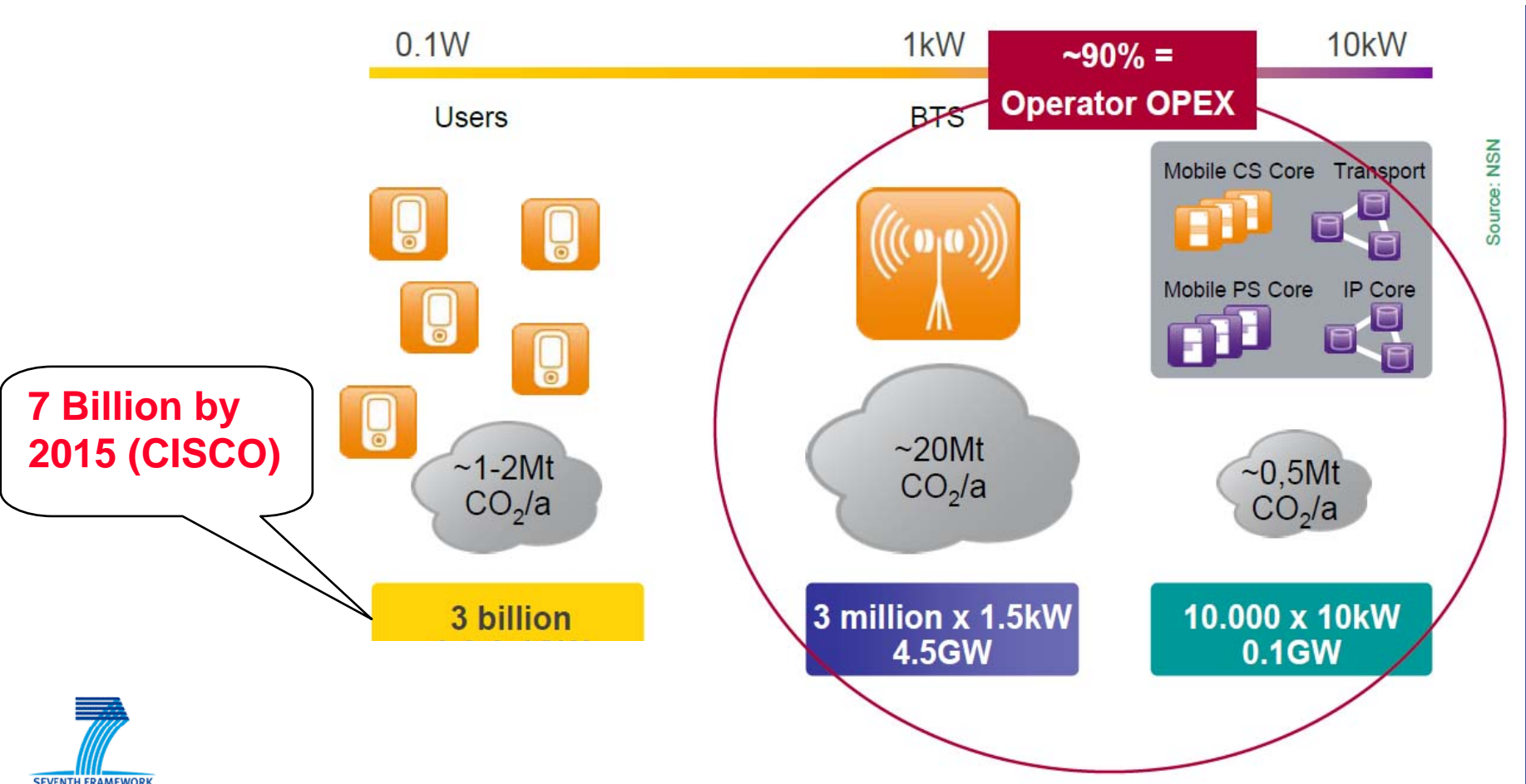
**Duration:** Jan. 2010-Dec. 2012  
**Funding scheme:** STREP  
**Total Cost:** €5,14m  
**EC Contribution:** €3,45m  
**Contract Number:** INFISO-ICT-248577

So far, mobile networks standards and design rules have ignored EE

- Cellular networks have been optimized in terms of spectral efficiency, **Max** capacity, not really in terms of Energy Efficiency!
- Efficiency metrics
  - Spectral efficiency b/s/Hz
  - Energy efficiency J/b
- With mobile networks becoming ever so power hungry, there is a need for huge efficiency improvement !
  - Opex increase
  - Battery lifetime

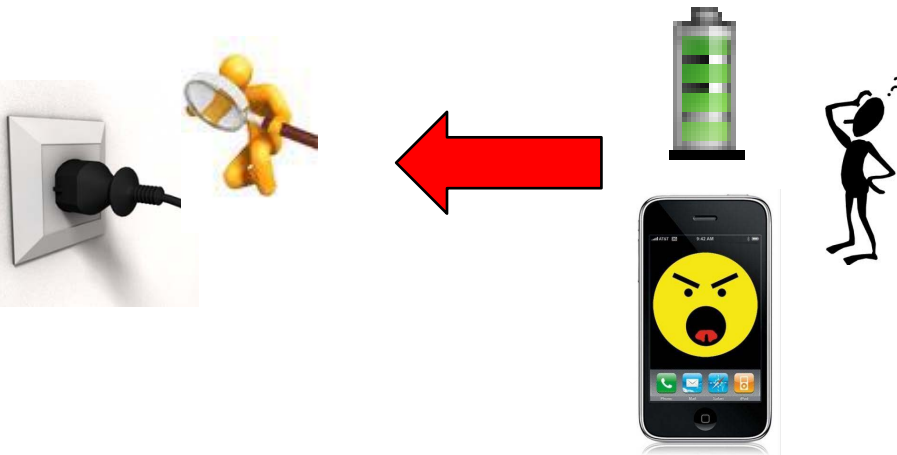
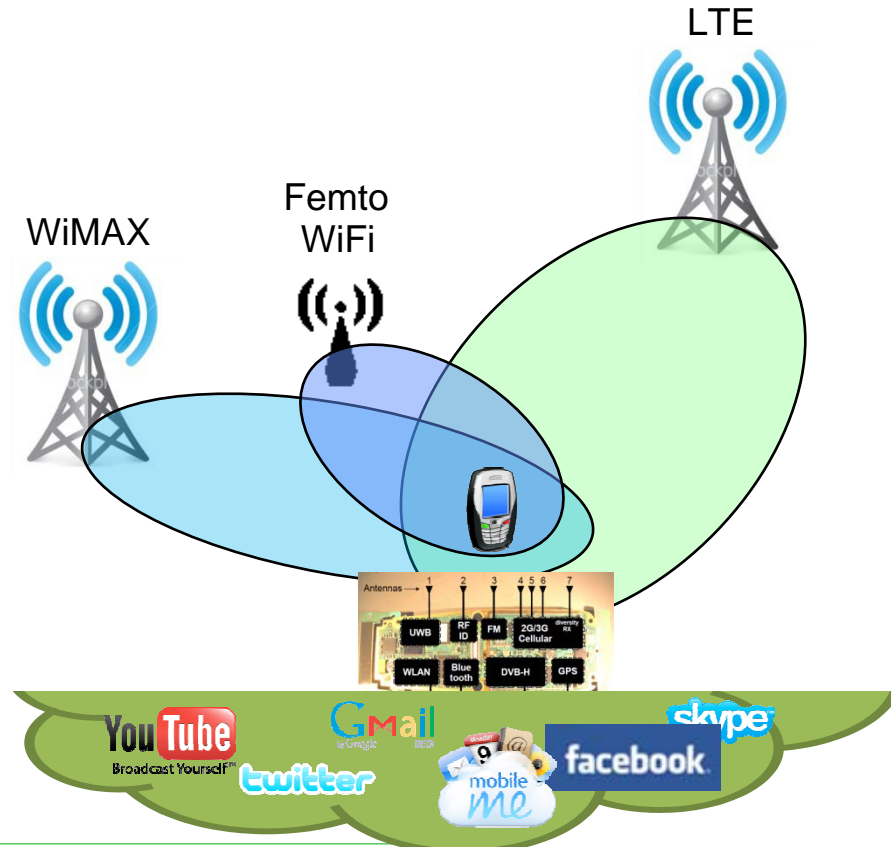


- Research projects are discussing energy efficiency on the network side or terminal side



There is a continuously growing gap between the energy requirements of emerging radio systems and what can be achieved by:

- Battery technology evolution
- Scaling and circuit design progress
- System level architecture progress
- Thermal and cooling techniques



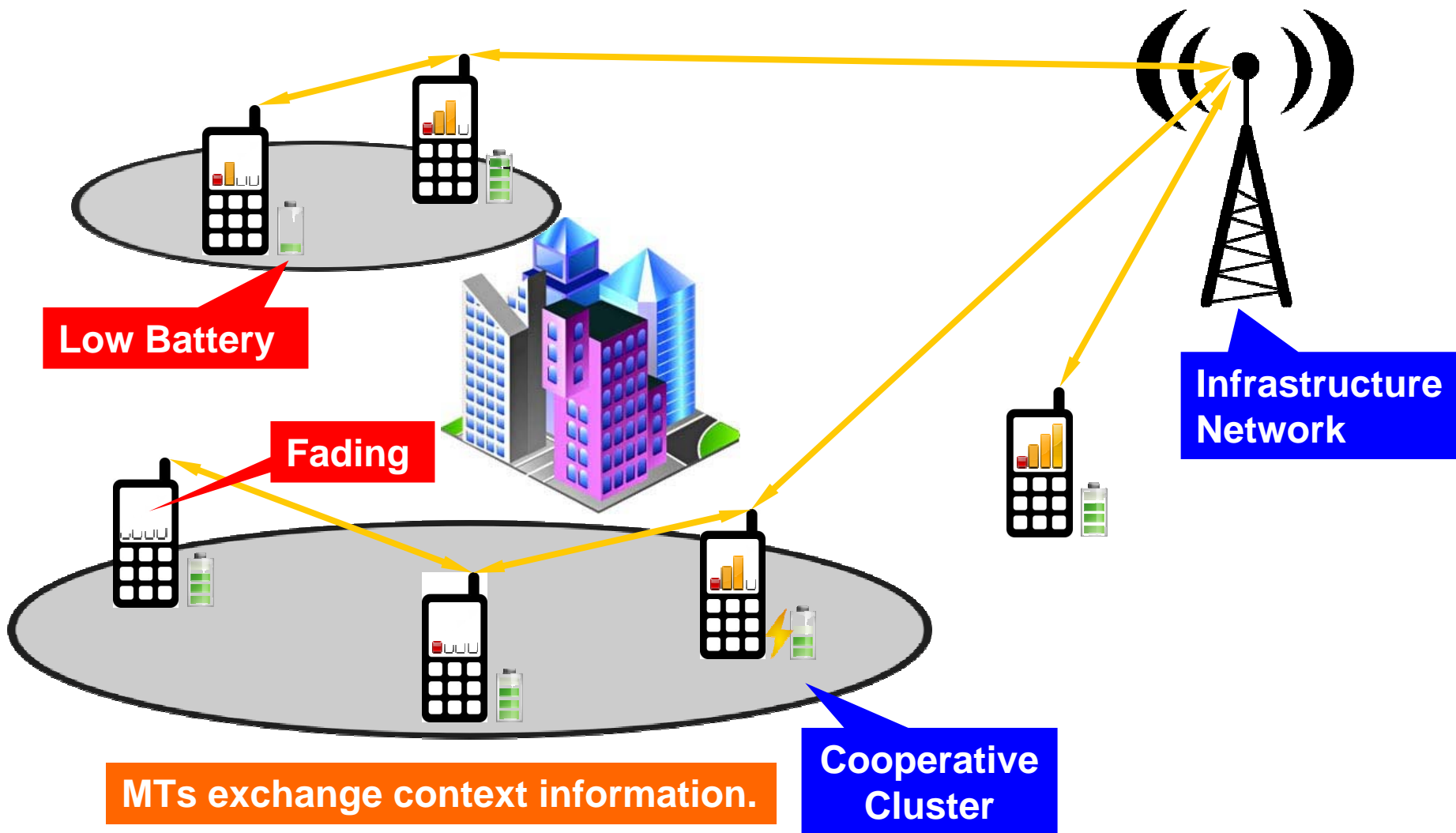
- **Short range cooperation among mobile terminals**
- **Cognitive Vertical Handovers between RATs**
- **Context Awareness**
- **Energy-efficient Reconfigurable Radio transceivers**
- **Business models**

## Technical

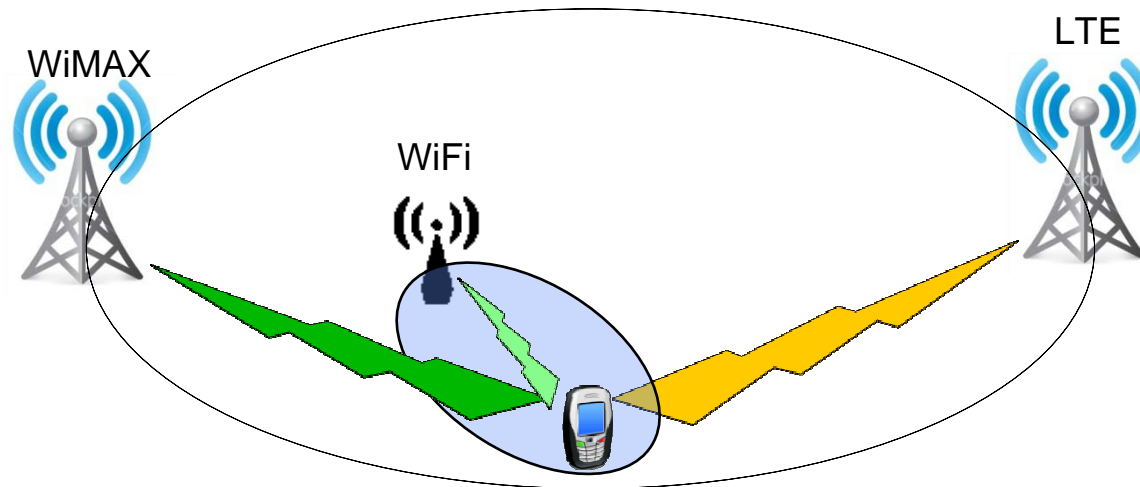
- ❑ Investigate how context information can be used by cooperative strategies to achieve power efficiency at the wireless interface of mobile devices.
- ❑ Investigate and demonstrate the potential of cooperative techniques based on advanced short range communications for the goal of power/battery lifetime saving of mobile wireless devices.
- ❑ Investigate and demonstrate minimum energy consumption handover procedures and policies between heterogeneous technologies and associated tradeoffs in realistic scenarios.
- ❑ Investigate, design and demonstrate energy efficient reconfigurable multi-standard transceivers able to switch from one standard to another according to a power saving strategy.

## Business

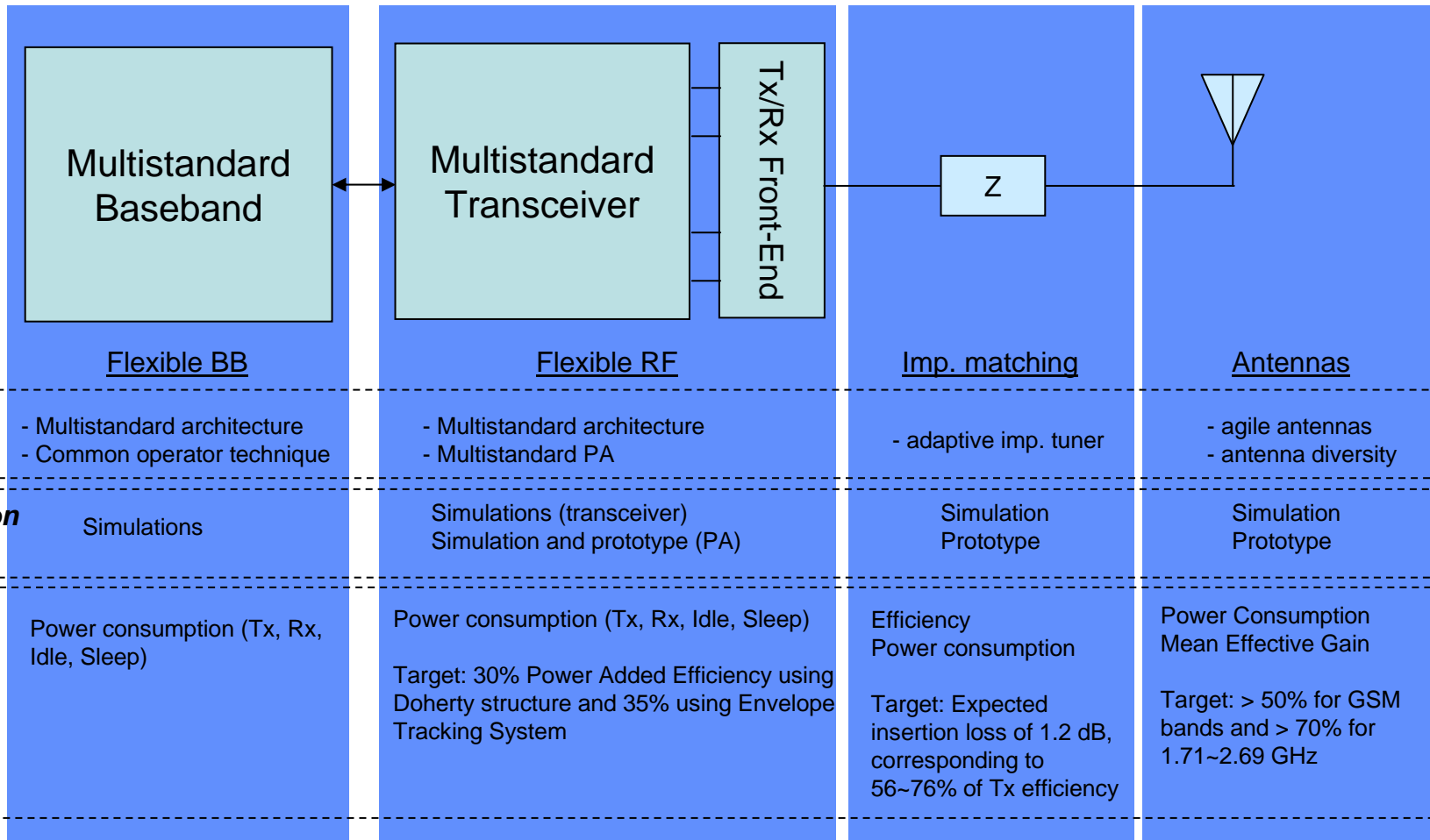
- ❑ Investigate methods and incentives to encourage cooperation and develop attractive business models for the network/service provider (Stimulate and motivate cooperative networking among users and between heterogeneous networks , e.g. financial incentives / bio-inspired reputation mechanisms).

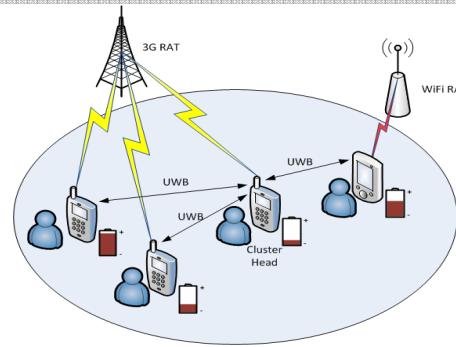
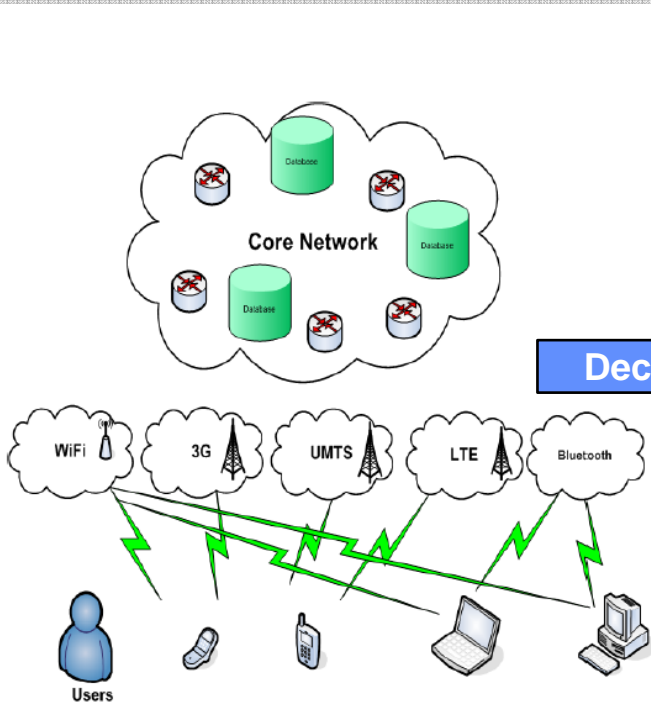




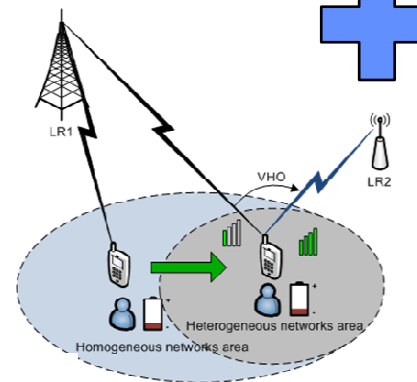


**Choose the most energy efficient available RAT  
(Goal: 20% Gain)**

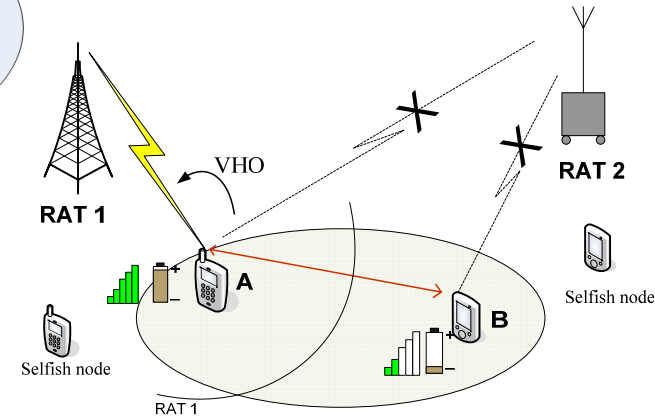




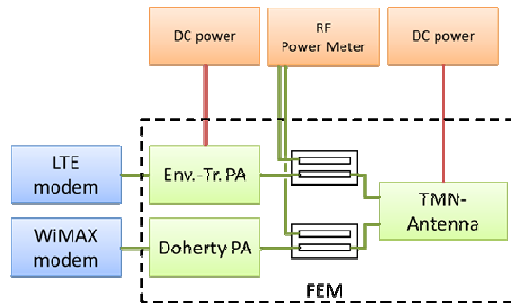
## SR Cooperation



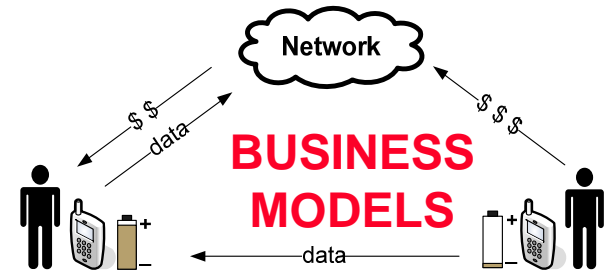
## EE Cognitive VHO



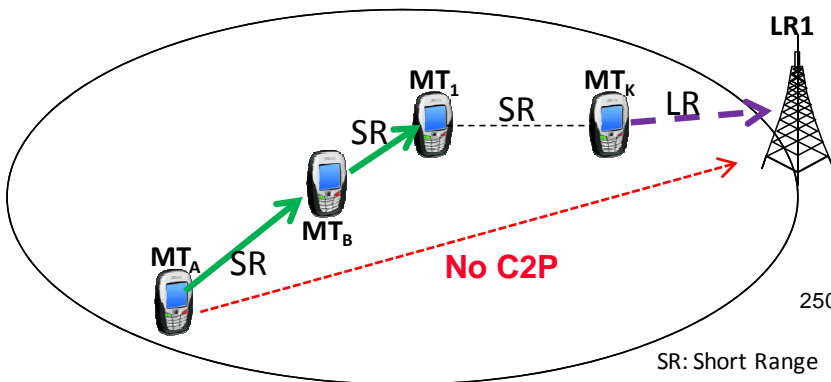
Cooperative cluster between nodes connected to different RATs



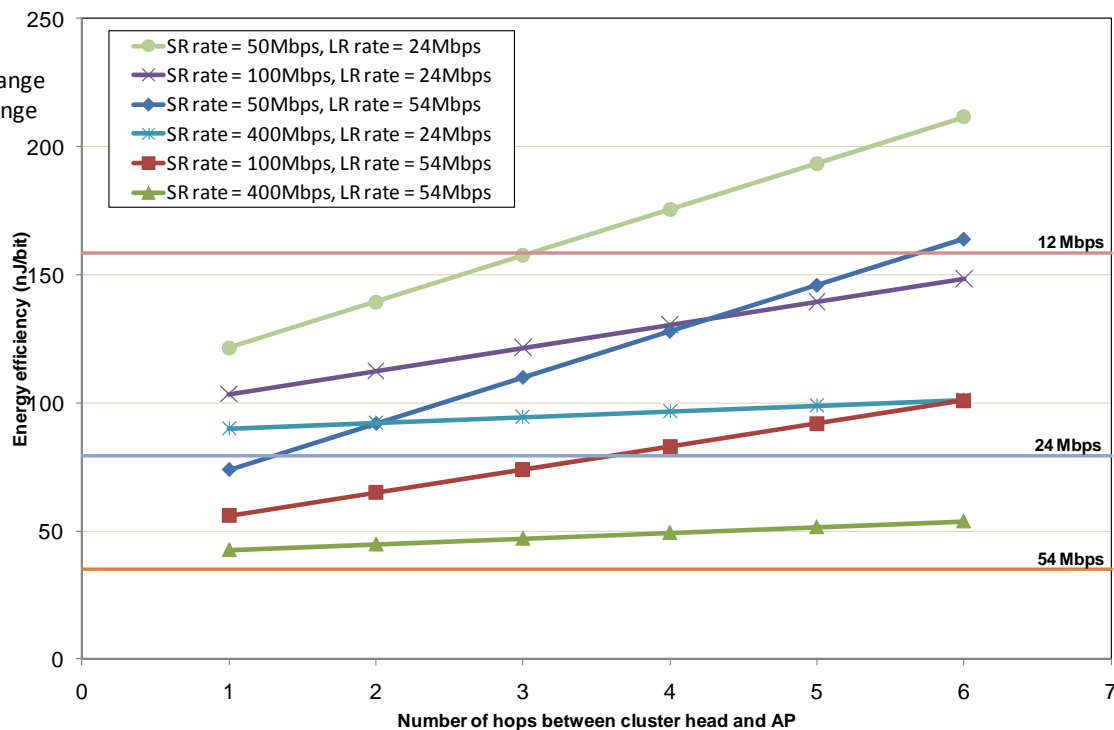
## EE Reconfigurable Transceivers

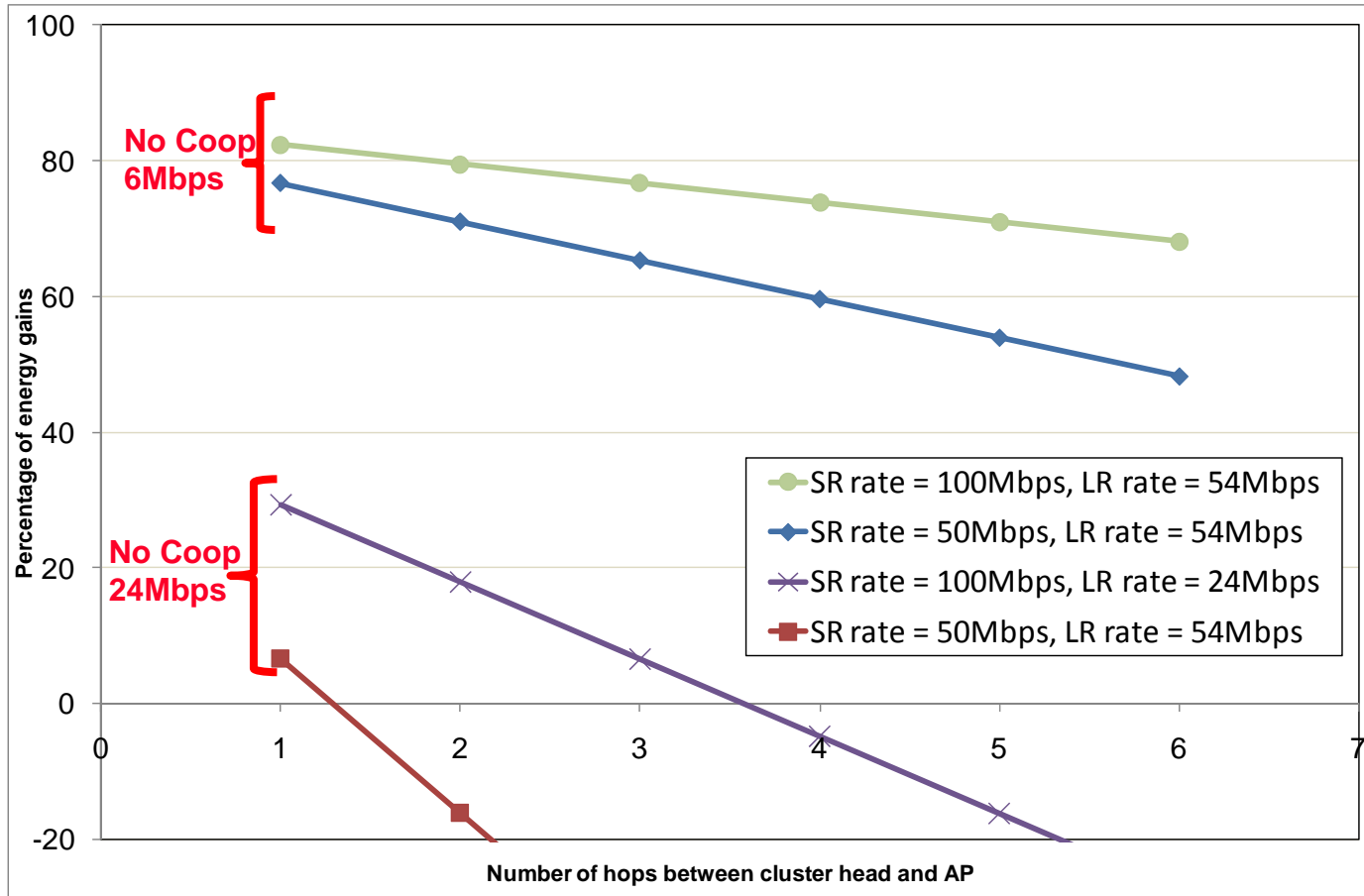


# C2POWER Gain: Short Range Cooperation



## WiMedia - WiFi

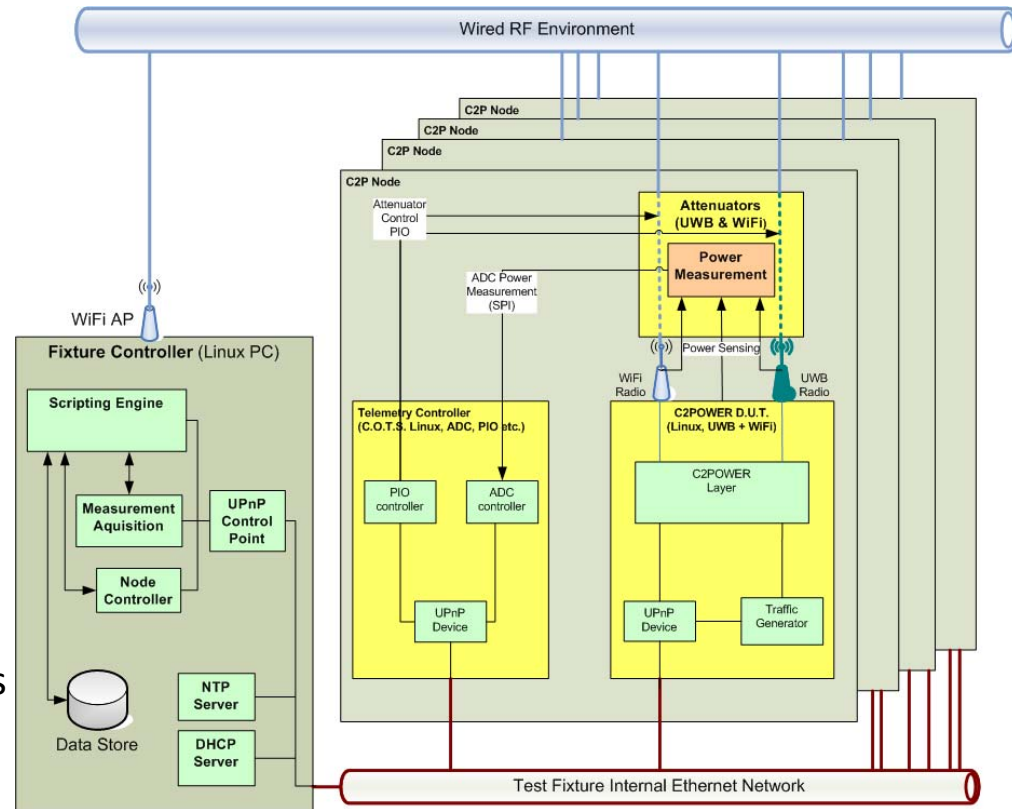


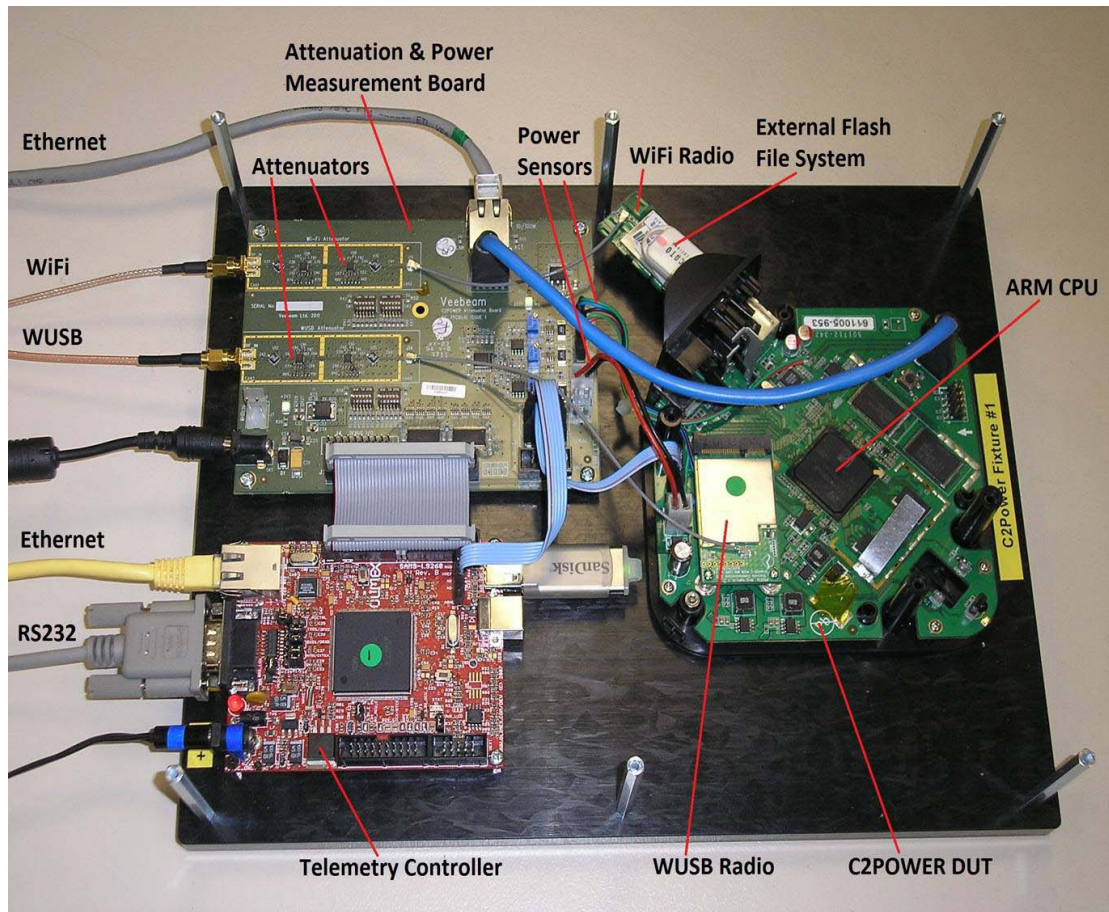


## WiMedia - WiFi

- **Short range cooperation testbed**
  - **WiMedia nodes with enabled WiFi interface**
- **Vertical Handover Mobility platform**
  - **WiMAX and WiFi**
  - **Femto cell**
- **RF prototypes**
  - **Energy efficient power amplifier**
  - **Low power consumption antennas**
- **Installing manufactured antennas on WiMedia Nodes**

- Nodes
  - DUT (Device Under Test)
    - Wi-Fi & UWB radios
  - Telemetry controller
  - Power measurement electronics & RF attenuators (UWB & Wi-Fi)
- Wired RF Environment
  - Shared by Wi-Fi and UWB
  - Reproducibility and stability
- Test Fixture Controller
  - Controls nodes & gathers measurements via independent telemetry network
  - Automated scripting capability
    - RF attenuation (controls the effective inter-node ranges)
    - Power measurement
    - Traffic control
  - Wi-Fi access point

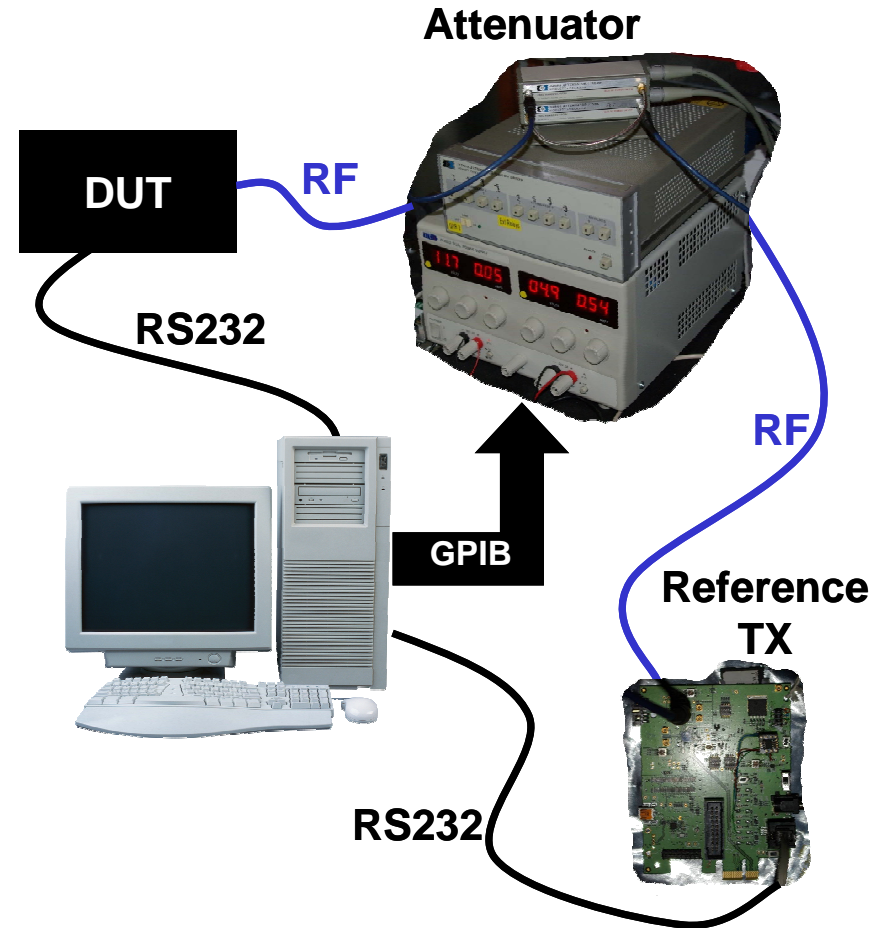






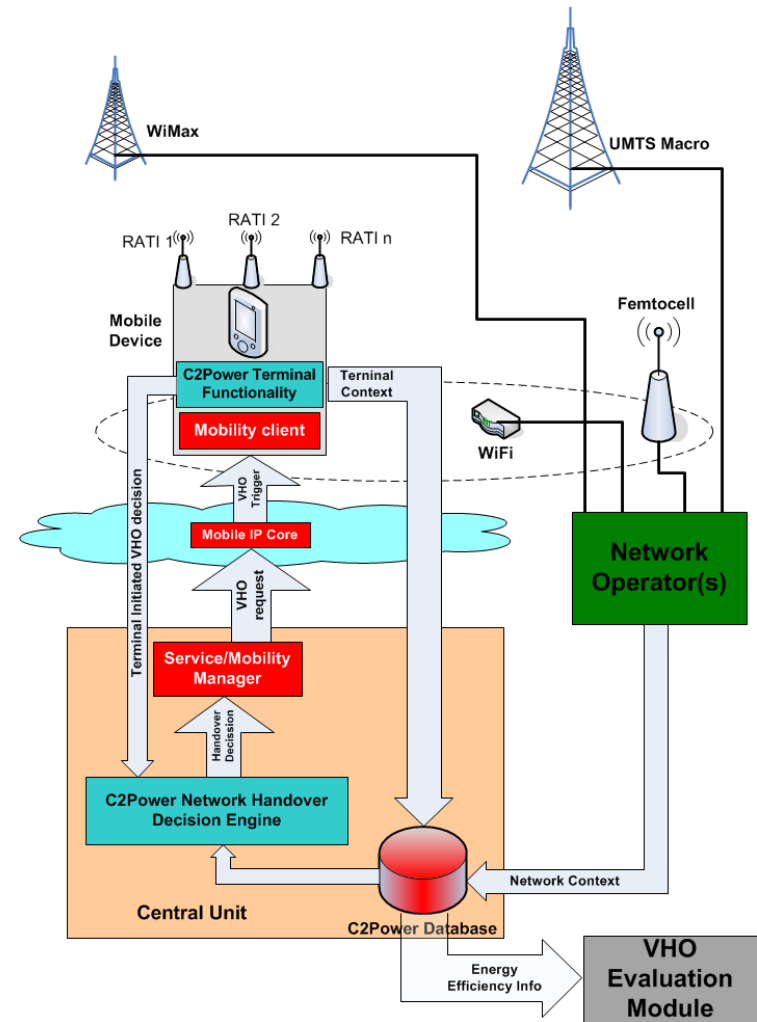
## Receiver Performance Tester

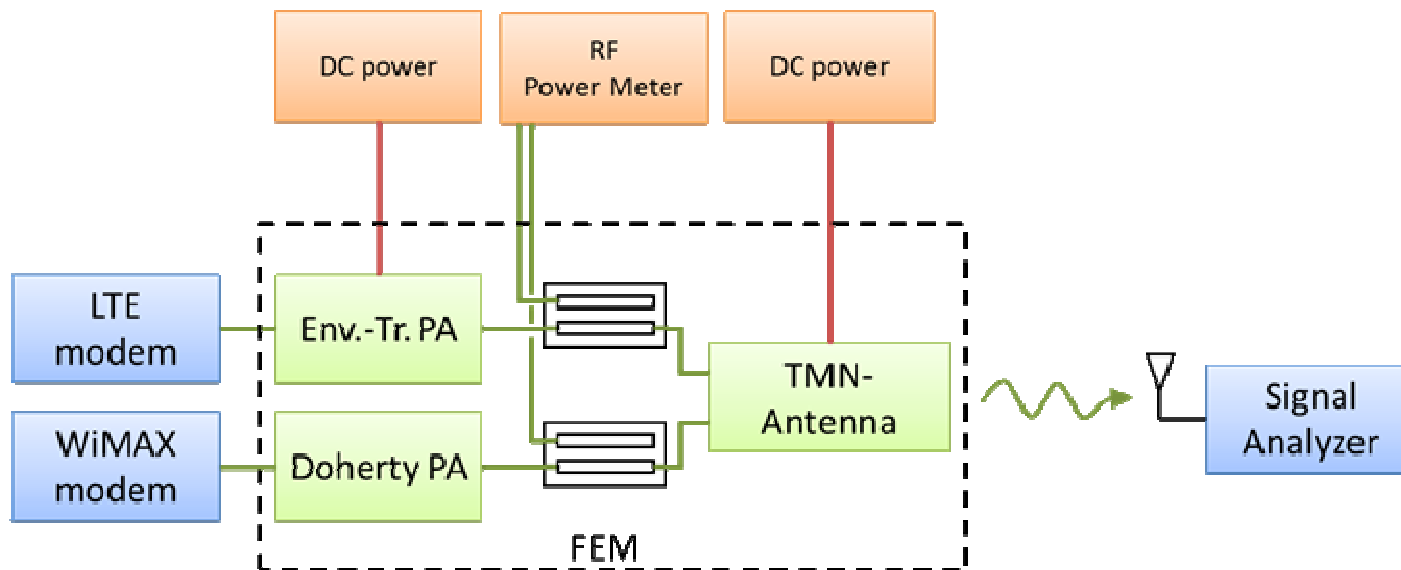
- Reference transmitter
- GPIB-controlled attenuator
- Receiving DUT.
- Automated with Python scripts
  - Attenuator
  - Rx sensitivity, PER
  - Channels and data rate selection
- Various UWB devices are tested
  - Products under development
  - Application development kits.



## 4 main parts

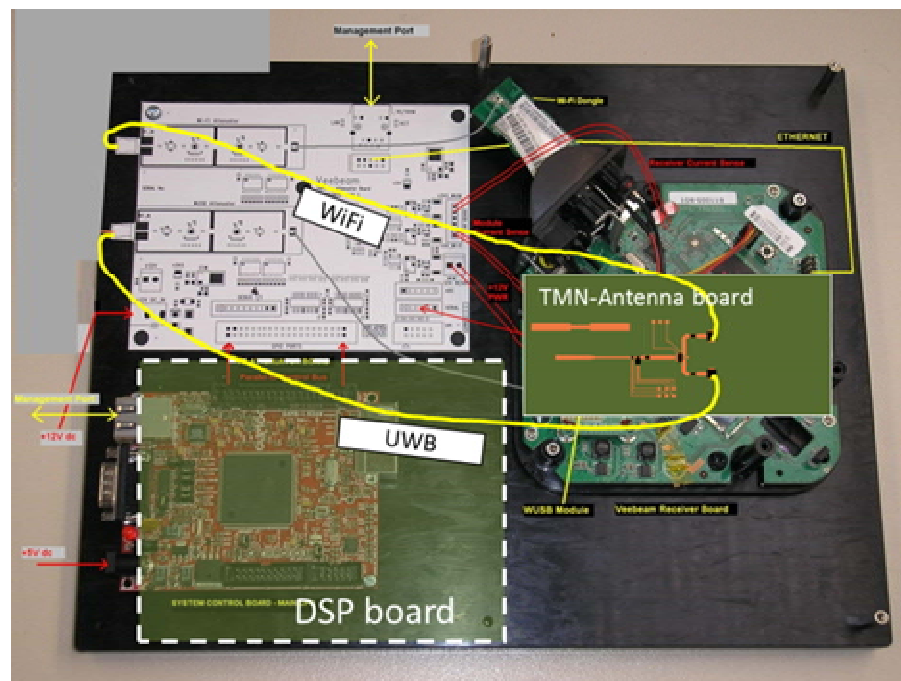
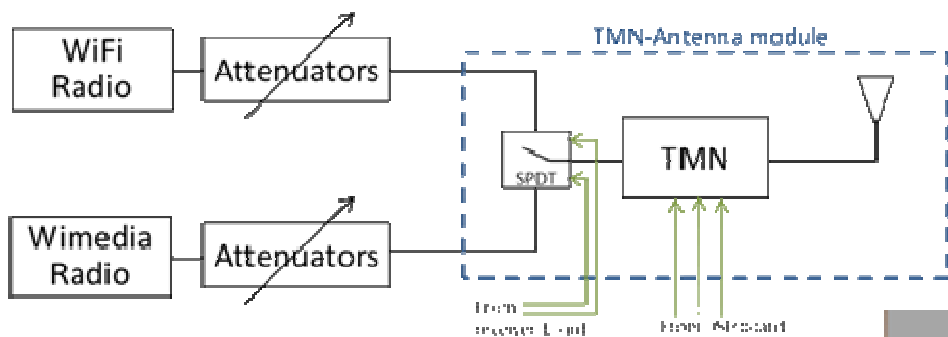
- The Central Unit: includes the Mobile IP core, and the mobility manager
  - Based on Mobile IPv4
- The Terminal Unit: includes the mobile IP client and the Terminal Context aware module
- A database: houses all the context needed by VHO decision making
- A VHO Evaluation module for evaluating the energy efficient VHO algorithms.





**Showcase of the FEM with the Envelope-Tracking (ET) PA, the Doherty PA and the TMN-Antenna modules**

# C2POWER wireless node cooperation testbed



- **3<sup>rd</sup> C2POWER Workshop**
  - **CAMAD 2012**
  - **17-19<sup>th</sup> September 2012**
  - **<http://camad2012.av.it.pt/>**
  - **Barcelona, Spain**
  - **Demo Session**

# Thank You

