

# C2POWER

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



Dr. Jonathan Rodriguez  
Instituto de Telecomunicações/4TELL



# C2POWER At a Glance



**Project Coordinator**  
**Jonathan Rodriguez**

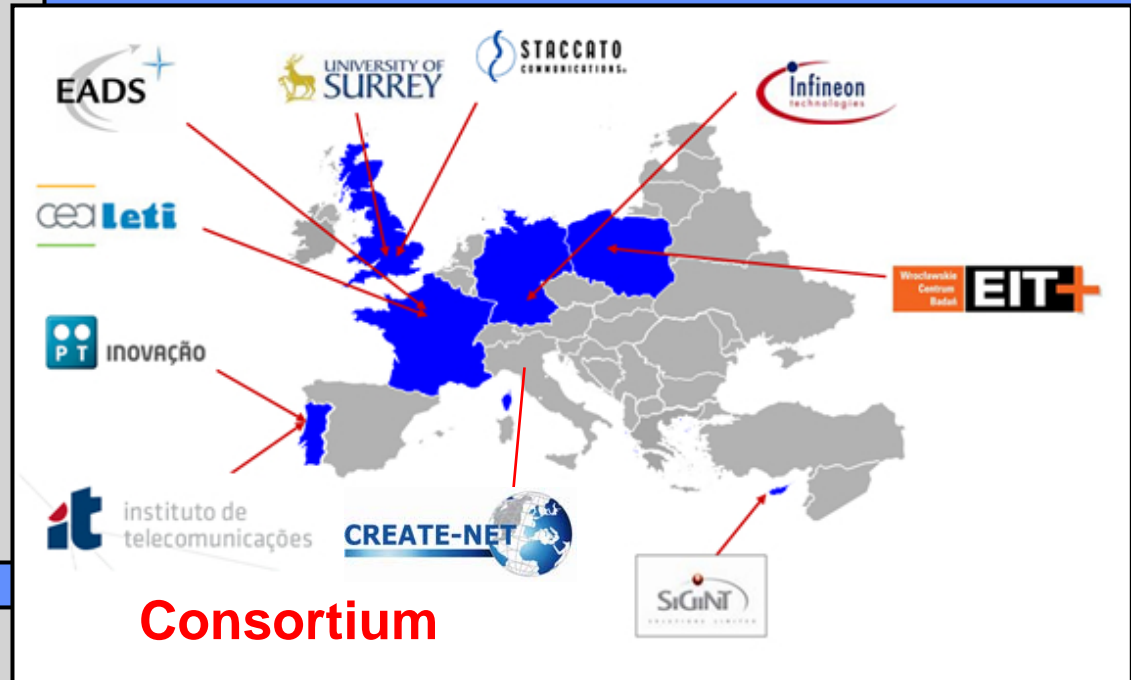
Instituto de Telecomunicações

Tel: +351 234 377900

Fax: +351 234 377901

Email: [jonathan@av.it.pt](mailto:jonathan@av.it.pt)

Project website: [www.ict-c2power.eu](http://www.ict-c2power.eu)



**Duration:** Jan. 2010-Dec. 2012

**Funding scheme:** STREP

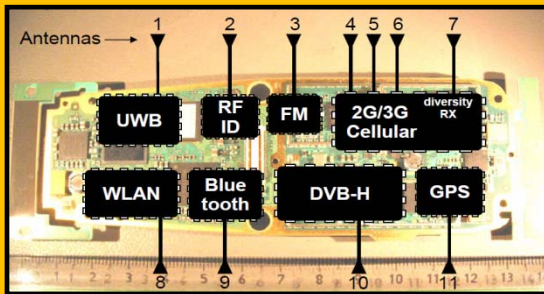
**Total Cost:** €5,14m

**EC Contribution:** €3,45m

**Contract Number:** INFISO-ICT-248577

# C2POWER Motivation

- ❑ **4G higher data rates and multi-mode functionality:** As energy per bit decreases, in order to operate with acceptable signal-to-noise ratios, the transmitted power needs to be increased.



- ❑ **4G extra functionalities** like advanced imaging features, camera, high-definition display, GPS, ... are power demanding.
- ❑ 4G ability to provide users with a continuous connection, or as it is typically referred to “**always being connected**”. From the battery standpoint, this can also be interpreted as “**always being drained**”.
- ❑ High power dissipation in terminals means that the temperature of the small handheld devices would rise to unpleasant values for the user, and make **active cooling** necessary
- ❑ **Battery capacity** has only increased by 80% within the last ten years, while the processor performance follows Moore’s law..

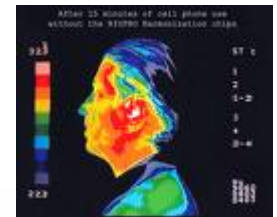
- ➡ ❑ **4G users will be left searching for power outlets rather than network access**



- ➡ ❑ **4G devices will get hot !!!**

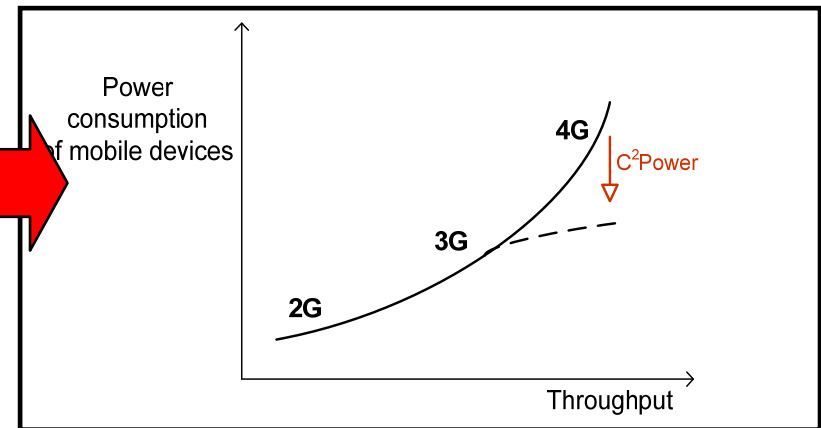
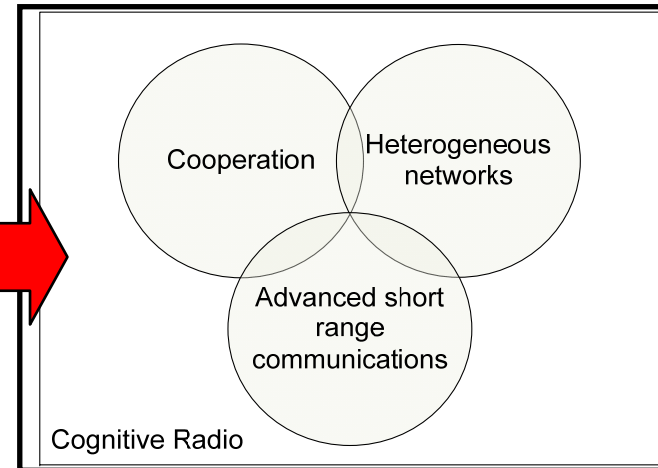


- ➡ ❑ **Increased human exposure to radiation**



# C2POWER Objectives I

- ❑ **C2POWER** main objective is to research, develop and demonstrate energy saving technologies for wireless mobile devices, exploiting the combination of **cognitive radio** and **cooperative strategies** while still enabling the required performance in terms of data rate and QoS to support active applications.
- ❑ **C2POWER** focus on the power that is consumed in the wireless transmission and reception process, i.e, the wireless subsystem of the **mobile devices** without considering any power issues at the other mobile phones functionalities (display, memory, camera,..)



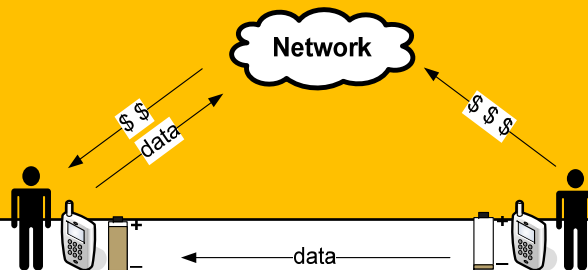
# C2 POWER Objectives II

## 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

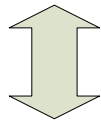
- ❑ Investigate methods and incentives to encourage cooperation and develop attractive business models for the network/service provider (Stimulate and motivate cooperative networking among users and between heterogeneous networks , e.g. financial incentives / bio-inspired reputation mechanisms).



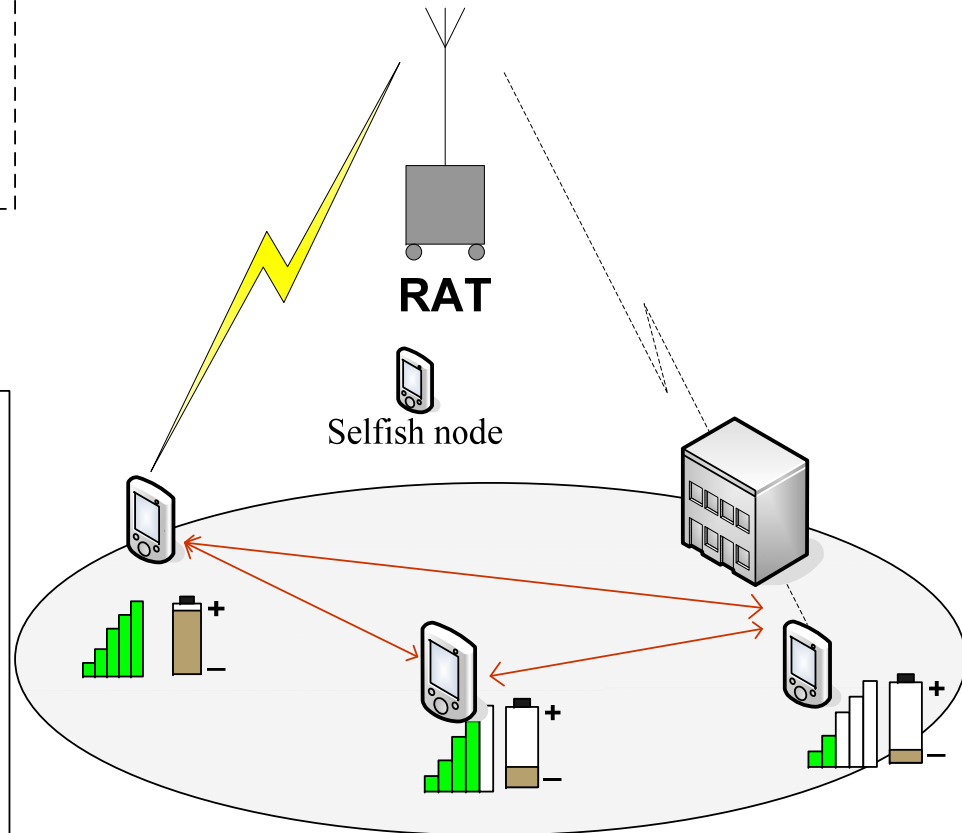
# C2Power Concept

## Short range Cooperation for homogeneous RATs

**Centralized RAT**  
UMTS, WiFi, WiMax, DVB



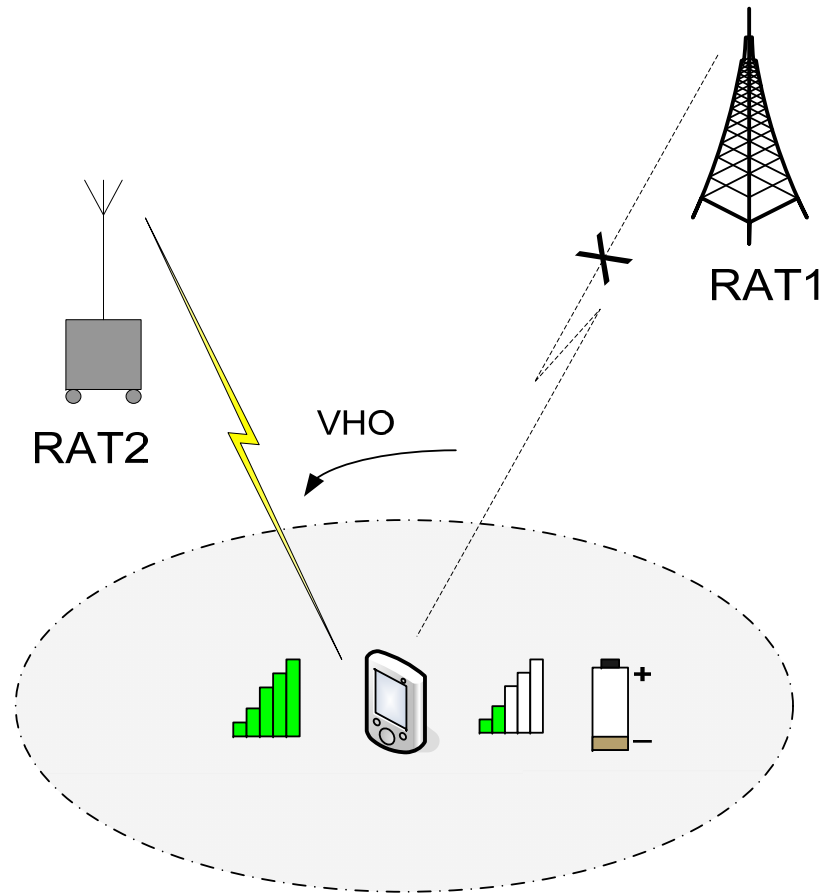
**Advanced Short-range**  
Enhanced Short Range  
(cognitive UWB, ...)  
Cooperative cluster  
Distributed, reconfigurable  
Low power / High data rate



**Cooperative cluster between nodes  
connected to the same RAT**

# C2POWER Concept

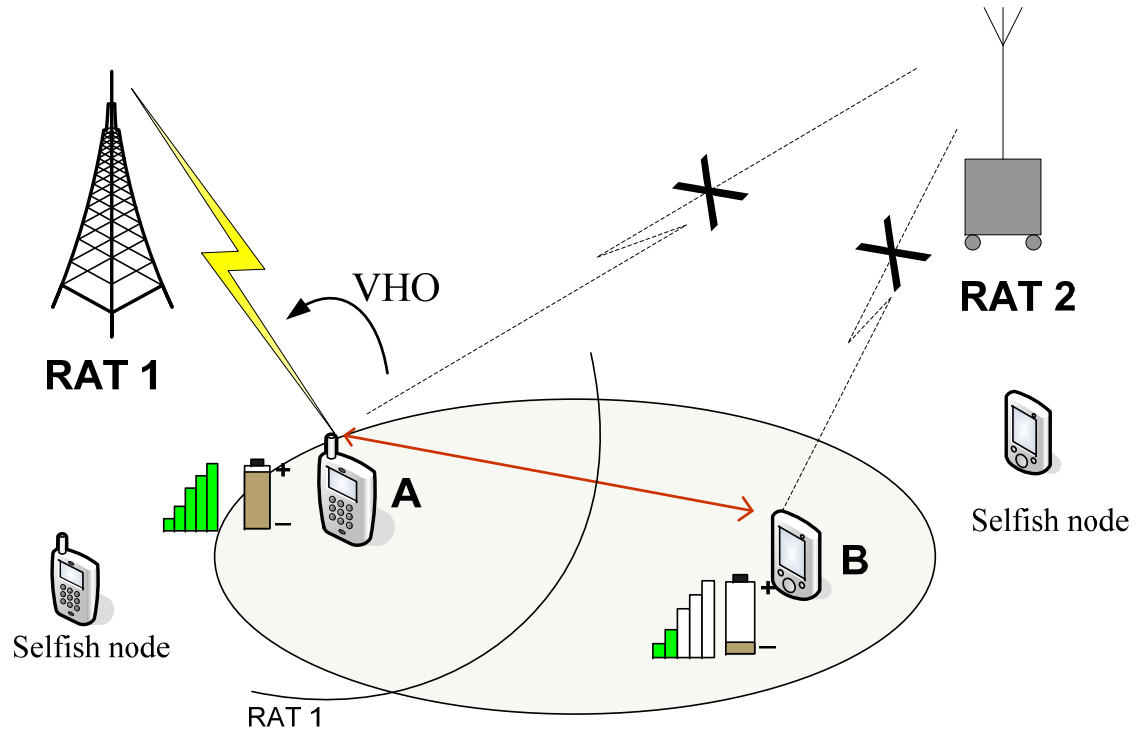
## Energy-Efficient Vertical Handovers



**Energy efficient vertical handover**

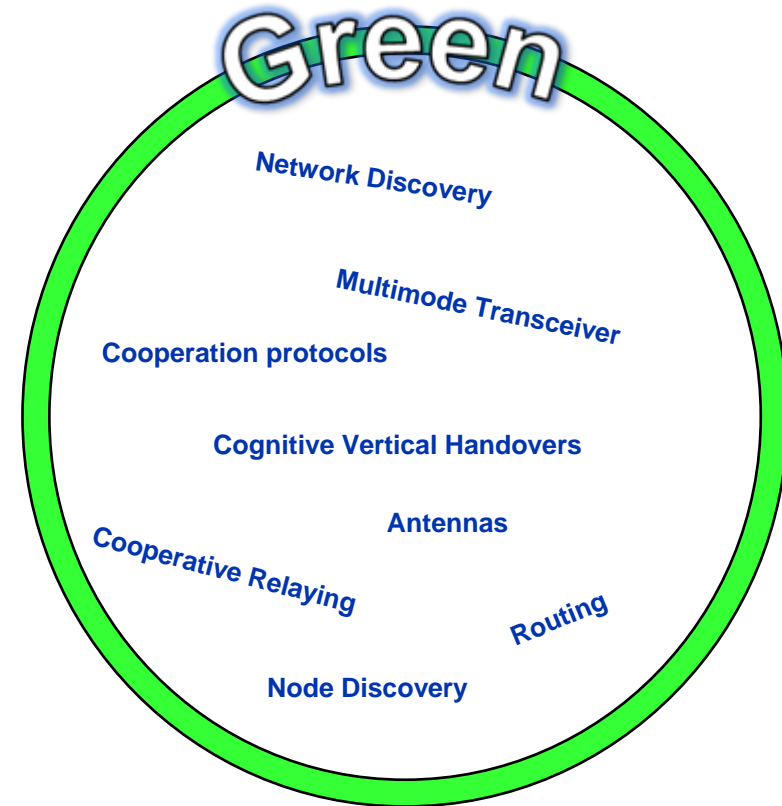
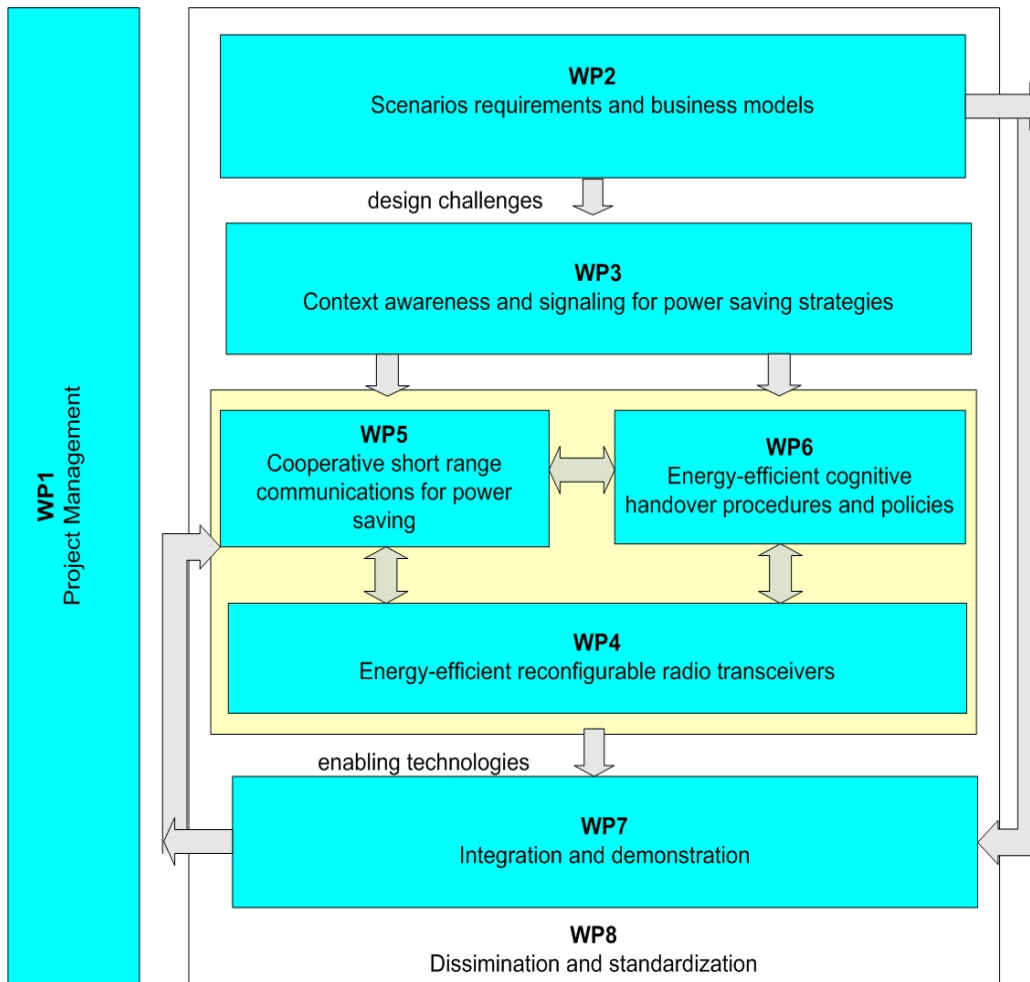


# C2POWER Concept



Cooperative cluster between nodes  
connected to different RATs

# Technical Approach and Key Issues





## C2POWER Impact



- ❑ **Cognitive radio and cooperative networks is still in its infancy** and Europe can be considered to be currently level with its major competitors in the USA and Far East. However, this situation is only short-term unless European industry undertakes a concerted research effort on these new disruptive technology paradigms
- ❑ Partners involved are active members of various standardisation organisations (that include **IEEE 1900.6**, **Bluetooth Special Interest Group (SIG)**, **Femto forum**, and the **ETSI EMTel Working group**) and are capable and committed to place the key project outcomes in these relevant standards
- ❑ C2POWER tangible outputs includes demonstrators for energy efficient short-range cooperation, and vertical handovers; where the aim is to **reduce the power consumption at the mobile device by up to 50%**
- ❑ Reduction in energy consumption together with the lowering of the “radio pollution” through **energy-aware and more effective radio resource usage** will help facilitate more sustainable ICTs in Europe, aligned with the vision set forth by the Lisbon agenda

