Celtic-Plus
Smart Connected World

Project Information

OPERA-Net 2

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Cardiff University, UK

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www.celticplus.eu/project-opera-net2

Optimising Power Efficiency in Mobile Radio Networks 2

The OPERA-Net 2 project aims to reduce the overall environmental impact of mobile radio networks, extending the previous OPERA-Net results. The project addresses both 3G and 4G wireless networks, identifying and developing improvements especially for energy and material efficiency in the radio base transceiver station (BTS).

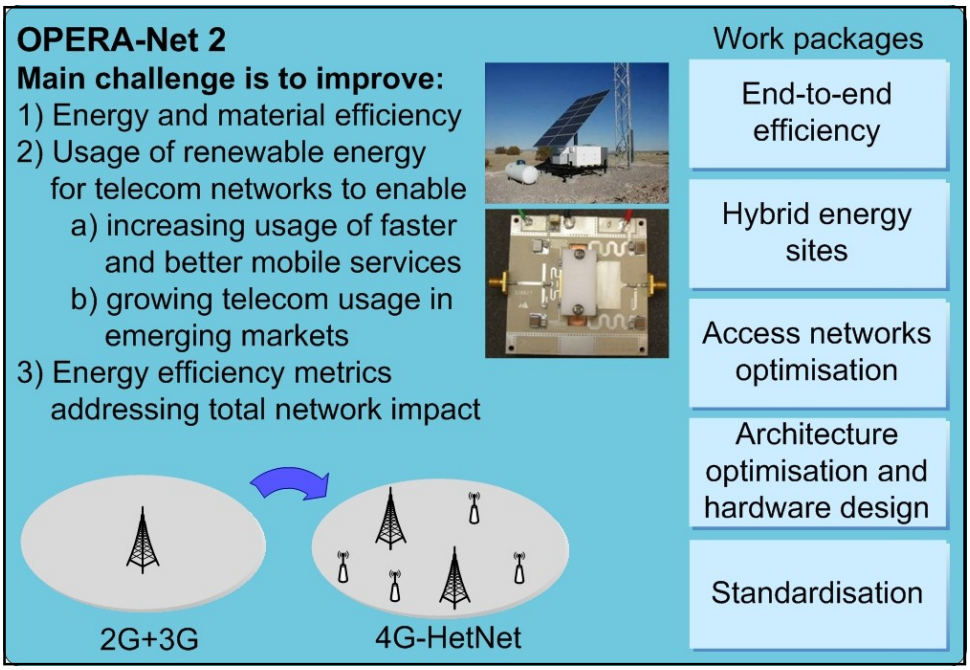
Main focus

The main goal of the work is to improve considerably the power and material efficiency of mobile radio networks, which is essential for an environmentally friendly evolution of cellular systems. The following focus areas have been identified to achieve this goal:

- Radical reduction in power consumption of the radio base station by proposing optimized network access techniques and new hardware.
- Concept and design of low power cooling systems.
- Development of a hybrid power system and its management, optimizing inputs from solar, wind and fuel cell energy generation.
- Introduction of a methodology for considering impact, in terms of energy and efficiency of materials by means of life cycle assessment.
- Liaison with standardization bodies.

Approach

The project is divided into four technical work packages that all involve practical demonstrations, contributions to standardization bodies and scientific publications. These work packages are end-to-end efficiency (E2E), hybrid energy sites, access networks optimization, and architecture optimization and hardware design. The E2E work package delivers guidelines and requirements for all other work packages. Close co-operation between work packages is key as these topics have many interdependencies, and this may enable joint architecture optimization.



The E2E work package focuses on investigating energy efficiency from the life cycle perspective. The aim is to improve evaluation methodologies for life cycle analysis and the impact of material efficiency on products and networks. The ultimate goal is to identify the most appropriate ways by which to include life cycle and material efficiency aspects into practical requirements, with a specific focal point being the demonstration of advanced cooling solutions and the evaluation of their impact on lifecycle and materials efficiency.

The work package considering hybrid energy sites analyses future energy usage and power sources. Modelling and optimisation of energy supply will take into account for example investment and operational costs, energy storage and management in case of emergency. Smart energy usage solutions for grid connected and stand-alone base stations (BTS) are also considered. A proof of concept with an optimised power system for remote area operation will be developed.

Work on access networks addresses energy efficiency improvement of next generation radio access networks (RAN). The work package will consider link level energy efficiency of distributed MIMO networks for single and multi-users configurations, taking into account power amplifier efficiencies and energy-aware scheduling strategies in these environments. The next step will then be to recommend management principles for optimising energy consumption of different network configurations, from pure macro networks, to extremely dense networks and through to heterogeneous networks. Finally, trials are planned with existing networks as well as 4G networks to evaluate reduction in energy consumption when dedicated features such as *sleep mode* are enabled.

The architecture optimization and hardware design work package focuses on two main topics critical for the efficient operation of compact base stations for the next generation RANs. The first goal is to develop a linear transmitter that is capable of delivering very wide bandwidth operation, whilst operating at very high efficiency. To achieve this goal, several power amplifier technologies and architectures will be investigated, and their suitability to linearization by digital pre-distortion investigated. Another main goal is to design optimised power supply system architectures for compact base stations. The solution needs to have high energy efficiency and power density, as well as the ability to support transmitter efficiency improvement e.g. with adjustable supply voltage levels.

Main results

The project is expected to deliver following main results:

Designs, energy efficient solutions and hardware prototypes for

- Linear transmitters and power system for distributed/compact base stations
- Stand-alone, hybrid energy supplied sites
- Advanced cooling technologies at component, rack, cabinet and site levels
- Energy-aware scheduling algorithms for joint energy consumption and interference optimization

Three separate trials to evaluate energy efficiency improvements for

- Radio resource management in a live 3G cellular network
- Radio resource management in the 4G ImaginLab platform
- Hybrid power systems

Standardization of or high quality scientific publications on

- Key performance indicators for 4G equipment energy efficiency
- Material efficiency and life cycle assessment
- Network-level power saving protocols
- Energy efficiency measurements methods

Impacts

The anticipated impacts are:

1) Significant, improvements in overall energy efficiency and a decrease in the environmental burden, in compliance with objectives of the international community, industry, operators and consumers.

2) Improvements in energy efficient products and systems in the area of wireless communications in Europe and worldwide.

3) Decrease of both capital and operational expenditures for hybrid power systems. This enables the roll-out of mobile networks in emerging countries and a contribution to economic and social growth.

4) Introduction of advanced 'green' solutions into the standardization of wireless networks, and an increase in worldwide scientific knowledge on energy efficient communications.

About Celtic-Plus

Celtic-Plus is an industry-driven European research initiative to define, perform and finance through public and private funding common research projects in the area of telecommunications, new media, future Internet, and applications & services focusing on a new „Smart Connected World" paradigm. Celtic-Plus is a EUREKA ICT cluster and belongs to the intergovernmental EUREKA network. Celtic-Plus is open to any type of company covering the Celtic-Plus research areas, large industry as well as small companies or universities and research organisations. Even companies outside the EUREKA countries may get some possibilities to joine a Celtic-Plus project under certain conditions.

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