



OPERA-Net2

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www.celticplus.eu/project-opera-net2

Optimising Power Efficiency in Mobile Radio Networks 2

The OPERA-Net 2 project was set-up to reduce the overall environmental impact of mobile radio networks, in order to contribute to fulfil European and national environmental targets. The project addressed high data rate wireless networks.

Main focus

The main goals were to considerably improve the energy and material efficiency of mobile radio networks, which is essential for an environmentally friendly evolution of cellular systems. Taking advantage of the different skills of the project partnership, the following areas were 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 optimizing inputs from solar/wind and energy storage management.
- ◆ Introduction of a methodology for considering impacts in terms of energy and material efficiency of materials by means of life cycle assessment.
- ◆ Liaison with standardization bodies.

Approach

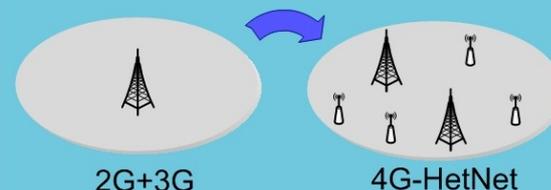
The project was divided into four technical work packages:

- ◆ The E2E work package focused on both investigating energy efficiency from the life cycle perspective and advanced cooling systems. Lower environmental impacts have been found out with less and lighter material on subsystem base station (RRH). Two energy efficient cooling techniques have been proposed based on liquid at cabinet level or based on passive cooling without electricity consumption.
- ◆ Hybrid energy sites using multiple power sources mainly focused on wind energy usage and management of multi-strings battery storage. The trial site in Orange Labs Lannion (France) highlights at least 10% gain in charging time due to the battery storage architecture adapted for high charging current.
- ◆ The work package dedicated to energy efficiency improvement of next generation radio access networks (RAN) considered distributed MIMO networks for single and multi-users configurations. Management principle recommendations have been set up for optimizing energy consumption of different network configurations, from pure macro net-

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Main challenge is to improve:

- 1) Energy and material efficiency
- 2) Usage of renewable energy for telecom networks to enable
 - a) increasing usage of faster and better mobile services
 - b) growing telecom usage in emerging markets
- 3) Energy efficiency metrics addressing total network impact



Work packages

End-to-end efficiency

Hybrid energy sites

Access networks optimisation

Architecture optimisation and hardware design

Standardisation

works, to extremely dense networks and through to heterogeneous networks.

- ◆ The architecture optimization and hardware design tasks focused on two main critical topics for the efficient operation of compact base stations for the next generation RANs. A first achievement consists in a linear transmitter able to deliver a very wide bandwidth operation, whilst operating at very high efficiency. This is completed with new optimized power supply system for compact and macro base stations.

Close cooperation between work packages was implemented in two dedicated approaches:

- ◆ benchmarking between Si and GaAs in terms of material efficiency
- ◆ hardware platform integration test bed exercising in real life the different outcomes from work packages, measuring and quantifying energy efficiency improvements at base station level.

Achieved results

One main achievement from Opera Net2 project was to deliver energy efficient optimized power amplifier transmitter hardware. It served as test bed for studies first done in different work packages as follows:

- Envelope tracking studies applied to 50V technology and optimized power supply unit respectively decrease power consump-

tion by 20% and 60% versus state of art.

- Smart frame filling and cell breathing techniques to enable more efficient data transmission and optimized resource usage

Final measurement campaign with this integrated test bed is currently ongoing.

Related to access network optimization, following example results



Outdoor view of the hybrid system installed in Orange Labs Lannion

were obtained:

- Proposal of a simple downlink power control improving energy efficiency of LTE Base Station.
- Smart Frame Filling algorithm to reduce active LTE Base Station energy consumption up to 30% .
- In material efficiency, selection of technical properties, manufacturing method, design (materials amount) and recycling are key areas requiring careful consideration. Practical outcome of materials efficiency study, which can potentially help designers in their materials related choices, was a

material comparison and selection approach, which combines technical requirements, environmental impact and cost.

- Advanced cooling study focused on development and performance optimization in laboratory scale and piloting in field. Completely liquid cooled radio base station site was built for proving the applicability – from reliability point of view – and energy consumption impact of techniques in telecoms. Key advantages of liquid cooling media are huge miniaturization (materials efficiency) and energy reuse potential. In addition, a passive cooling street cabinet prototype has been carried out showing high interest due to its energy free concept.

- For renewable energy use in macro radio access networks, a cost minimization algorithm combining energy allocation policy and switching-off mechanism was proposed. With this approach, up to 50% of electricity bill reduction can be achieved with 20% of energy from renewable energy sources.

- A field trial was performed in live network (Mobinil in Egypt) to assess energy saving brought by dedicated features: up to 30% of energy saving at BTS level during feature activation could be shown.

- Several standardization contributions were made within ETSI EE, ITU-T and 3GPP on energy efficiency and life cycle assessment of telecom systems. The project organized scientific workshops in IEEE PIMRC'13 and ICT26 conferences in London (2013) and Karlskrona (2014), respectively. The project contributed to 10 journal articles and about 35 conference papers.

See foreseen results in:

http://projects.celticplus.eu/operanet2/docs/OPERA_Net2_leaflet_hq.pdf

Impact

Environmentally sustainable solutions for mobile radio networks were achieved. Efficient use of materials was proposed for minimizing environmental impacts throughout the product life cycle. For the basestation equipment, new energy efficient power amplifier technologies and cooling systems were obtained. These together with the obtained power savings in radio access and network level software solutions will reduce OPEX of the operators and improve competitiveness of the European industry.

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 inter-governmental 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 organizations. Even companies outside the EUREKA countries may get some possibilities to join a Celtic-Plus project under certain conditions.

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