Celtic-Plus
Smart Connected World

Project Achievements

Service-oriented optimization of Green mobile networks

SooGREEN

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Partners:

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ATAWEY SAS, France

Eurico Ferreira S.A., Portugal

Flexenclosure, Sweden

INESC TEC, Portugal

Institut Mines Télécom, France

LEMASSON, France

MIC Nordic AB, Sweden

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Project Website

www.celticplus.eu/project-soogreen

Mobile networks are witnessing an exponential growth of traffic volumes, associated with the emergence of new services. In particular, video services constitute a major part of the traffic and their share is expected to increase. At the same time, Internet of Things (IoT) related traffic will gain in importance with the explosion of the number of connected objects. This situation pushes towards an evolution of network architectures (e.g. LTE-A features on centralized/virtual RAN) and of content delivery solutions (e.g. in network caching).

Main focus

The SooGREEN project addressed the need of reducing the energy consumption of services in the context of traffic evolution, virtualization and new network architectures like 5G or Device2Device or Wi-Fi-6. The project also addressed new "green" levers, like how telecom networks can help smart grids or how networks could be smartly shared through marketplaces.

Approach

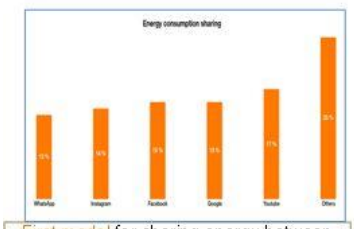
SooGREEN was built around the need of reducing the energy consumption of services, while keeping in mind the development of smart grids. This includes:

- Modelling the energy consumption of services in different mobile network architectures and taking into account the end-to-end path
- Definition of KPIs for energy efficiency of services and adequate measurement and reporting methods (for energy efficiency standard evolutions)
- A joint dynamic optimization of the mobile access network and the content delivery solutions
- Definition of service-specific offload solutions that reduce the energy consumption
- Proposal of solutions for enabling the bi-directional interaction of the mobile network and the smart grid by exploiting the flexibility of some services and the energy storage capabilities in the network.
- Development of dynamic energy-saving mechanisms for Wi-Fi networks, taking advantage of periods of low network usage, while maintaining standard performance.

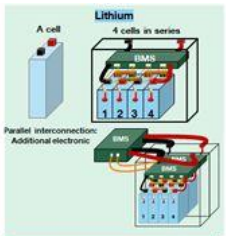
While focusing on services, SooGREEN watches the improvement of the technical environment in order to improve the overall energy efficiency including:

- An efficient passive cooling solution for central offices hosting centralized base stations
- The optimization of the energy storage in base station sites of mobile access network, by introducing an innovative Battery Management System (BMS) and a new concept of integrated fuel cell for energy off-grid.

SooGREEN is an industry-driven project where practical solutions and demonstrators were privileged, but also theoretical and simulation studies were conducted.



First model for sharing energy between services and per service energy efficiency

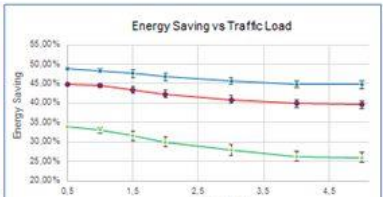


BMS lithium battery use

Passive cooling
Proof of concept

Symbol power saving and frequency switch off in Tele2 and proposed a new ETSI standard.

Energy monitoring solution tailored to cloud architectures



Definition and development of a dynamic energy saving system for Wi-Fi networks

Achieved results

Modelling and Measurement of services energy consumption in mobile networks:

- SooGREEN proposed a mathematical model for the sharing of the energy consumption of a given network or equipment between the delivered services
- The project proposed a classification of the base stations under real operational conditions based on their energy efficiencies and a new energy efficiency KPI of a service as an extension to ETSI KPIs and based on our mathematical modelling.

Energy-Oriented optimization of service delivery solutions in mobile networks:

- The project proposed solutions for an energy efficient access network. Including theoretical studies on the challenges posed by a state of the art on service delivery solutions in mobile networks and their energy efficiency issues. Covering the energy efficiency and measurements thereof in existing and future telecom networks, both indoor and outdoor, offloading by other systems, WiFi, broadcasting (DVB-T2) and among other cellular networks and also D2D.

Energy Efficient service delivery in Centralized and Virtual RAN:

- Theoretical results provide key insights on performance compromises (including energy) on architectural options for emerging telco clouds. A set of demonstrators have been realised, on all main WP4 topics:
  - passive cooling of telco/cloud cabinets,
  - cloud-native energy monitoring
  - hardware-accelerated CRAN
  - new high-performance coding for 5G front haul.

Interaction between service delivery in mobile networks and smart-grid:

- the project has identified the possible interactions between the Mobile Network Operator (MNO) and the energy provider and presented the business opportunities that the operator can seize in order to make profit
- The project provided studies for BMS for Lithium systems and Hydrogen storage possible use for back-up power. The Lithium BMS was delivered only in a reduced version, a study was provided with indications for future work on the Lithium BMS.
- SooGreen has defined limits for power and energy losses in a modern telecom power system for mobile towers.

Solutions Integration and Harmonization:

- The project developed a solution to reduce energy consumption in Wi-Fi networks, having set up a real test bed. Based on achieved results, it was confirmed that the implemented energy-saving algorithm has a very little impact on user experience, even in the presence of unexpected network traffic.
- The project implemented a Demo of the energy-aware CRAN, shown at different venues, showing energy monitoring fully integrated into a cloud-native approach/architecture. The monitoring can be activated through an intent-based interface and be deployed in real-time on any cloud infrastructure used by the service.

Several of the SooGREEN project partners (Orange, Tele2 and Nokia) supplied project results for further consideration in future standards, in particular, ETSI and ITU-T standards. SooGREEN experts worked towards presenting contributions to 3GPP on energy saving solutions in LTE-Advanced.

Prospects for the future

- The cloud-native energy monitoring is ready for industrial transfer and it is already planned to be tested on a real-life Orange-Nokia 5G Trial in Marseille, France. It is expected that the use of hardware-accelerators will appear in the close future in telecom clouds, including Nokia products. SooGREEN results will be instrumental in the decision-making phase as well as in defining optimal offloading strategies, also considering energy consumption minimization
- Polar-code FEC (Forward Error Correction,) is a valid front-haul option that must be further compared with traditional schemes. This solution requires further investigation.
- Potential benefits of the passive cooling solution have been clearly identified during SooGREEN project. However, the solution requires further investigation before industrial transfer.
- There is a power systems challenge (batteries, operational modes, interactions with smart-grid and passive cooling) which requires further investigation, like future work on the Lithium BMS.
- Due to the large implementation of Wi-Fi networks, the improvements in energy-saving mechanisms are quite important and will certainly continue.
- 5G networks dimensioning using energy efficiency as one as the main criteria, thanks to SooGREEN results.
- On the longer term, operators are willing to improve its networks energy efficiency by detecting networks defaults (base stations with low energy efficiency) and planning an action plan for their improvement.Further work will be needed to improve saving technologies even more. Artificial Intelligence could be an enabler for “greener” services for wireless networks and power systems. The next logical step in the SooGREEN project would be to include properties of specific services into the research.

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 join a Celtic-Plus project under certain conditions.

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