



## MUSCLES

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### Partners:

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- BCE Broadcasting Center Europe, Luxembourg
- EURICO Ferreira, Portugal
- Instituto de Telecomunicações, Portugal
- Instituto Politecnico de Castelo Branco, Portugal
- Siklu Communication Ltd., Israel

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### Project Websites

[www.celticplus.eu/project-muscles](http://www.celticplus.eu/project-muscles)  
<http://muscles.av.it.pt/>

## Mobile Ubiquitous Small Cells for Low-cost Energy and Spectrum efficient cloud service delivery

The MUSCLES project is a collaborative multi-national project (including 3 different countries), which mainly targets the automation of network management, for the principal goal of reducing the CAPEX (Capital Expenditure) and OPEX (Operation Expenditure) of mobile network operators. MUSCLES has specifically targeted the design of autonomous network performance optimization, built based on self-organizing network (SON) concepts.

### Main focus

With the rapid penetration of wireless networking in every aspect of our life, the increase in the size of communicated data and the number of connected devices, together with the high mobility of those devices, and the densification of mobile networks, the management of current and future wireless networking is getting very complex, incurring high costs for mobile operators. Moreover, network planning is another dimension that presents a burden to mobile operators. MUSCLES has specifically targeted overcoming those issues by proposing autonomous network performance optimization, built on self-organizing network (SON) concepts. Additionally, MUSCLES targeted the automation of network planning, through the design of a cloud-based advanced network planning tool, combining optical fiber networking along with newly widely adopted, e.g. in 5G, mmWave (millimeter wave) communication technology.

The achieved results are foreseen to highly affect the performance of already deployed networks, through enabling networks to almost always operate at optimum point, increasing resource utilization; hence, reducing operators' CAPEX. On the other hand, the automated network design will reduce the cost and time required for network planning towards deployment, resulting in further savings in OPEX.

At least one photo or easily understandable drawing/ chart should be provided. A photo is generally preferred. Make sure that the rights for publication are available.

### Approach

MUSCLES has defined three main use-cases, which reflect the main innovations of the MUSCLES project:

**Self-organizing networks (SONs):** In current networks, the mobile network should detect traffic trends and alter its configuration in order to provide the best service possible taking advantage of the installed infrastructure. Currently, most of radio network management is done manually, which makes the process difficult, costly, and time consuming.

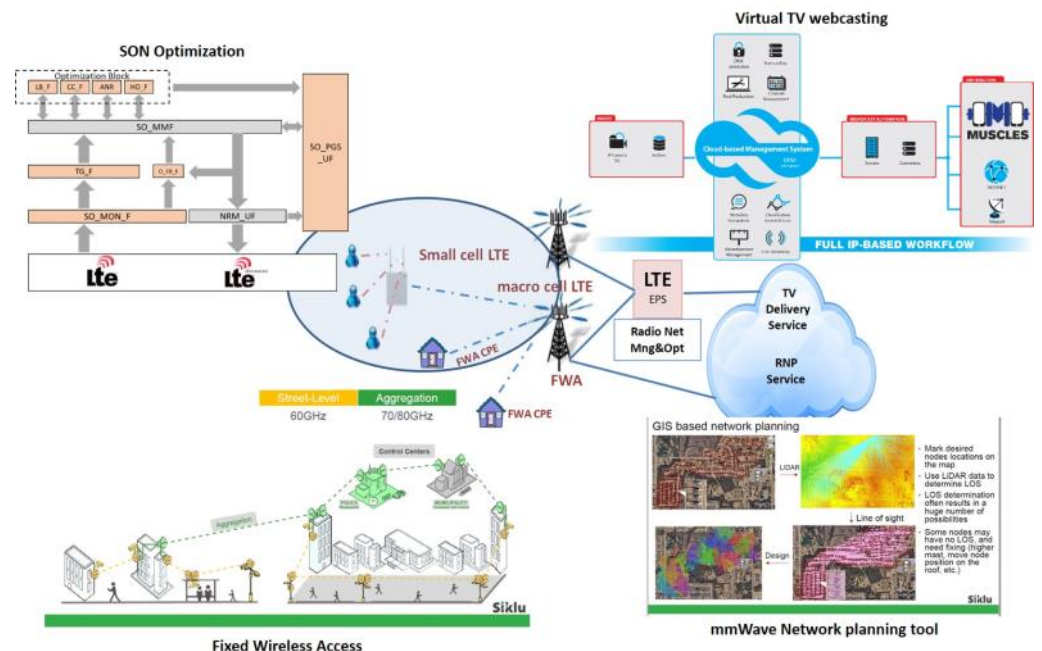
The MUSCLES SON solution analyses KPIs, detects trends, predicts future networking status, and autonomously changes network configuration to keep network performance as optimum as possible. Main blocks which have been considered are:

- Load Balancing;
- Handover Optimization;
- Automatic Neighbour Relation.

The project designed the above mentioned optimization algorithms, and integrated them into a full SON architecture as a proof of concept.

**Fixed Wireless Access (FWA):** In the current situation of scarce frequency resources, mobile networks operators and key players are looking for new innovative solutions. One of the main promising innovation of 5G is the use of new spectrum. MUSCLES elaborates on such solution through an envisioned wireless system with hybrid mesh architecture, which is mainly based on mmWave frequency. MUSCLES proposed point-to-multipoint mmWave technology, which is fast to deploy and provides capacities in the gigabit/second range, with low interference footprint. The hybrid fiber-wireless network thus enhances the utilization of existing fiber infrastructure and promotes its growth and extension.

**Neighbourhood TV:** An urban neighbourhood in X-City wants to operate its own low-cost channel for its district. The envisaged program contains mostly



UGC-videos created by the people, living in the area or any other type of free-to-air content. The TV management solution is following the current trend of cloud-based solutions. The system is designed to be able to operate on any operating system, for all types of devices. The Virtual TV solution delivers the feed in any existing adaptive streaming format through integrated encoding. A dynamic player is provided, which automatically identifies the OS of the viewer and adapts the streaming format to the device.

### Achieved results

The project final achievements can be listed as follows:

#### A Self-Organizing Network (SON) Optimization

MUSCLES designed a functional architecture, built on the definitions of 3GPP, for autonomous SON architecture for network management. The architecture includes multiple algorithms, namely Self-optimization Input Monitoring function; A SO handover optimization solution based on fuzzy logic; A SO load balancing algorithm based on fuzzy logic; Conflict manager block to determine which action to execute, if conflicting decisions are produced from different optimization blocks; Load balancing algorithm using on-demand small cells deployment; Optimization of allocation of small cells; and Optimization of automatic neighbour relation (ANR) algorithm.

#### A fully functional System Level Simulator (SLS)

The MUSCLES project has achieved its goal to design a functional system level simulator (SLS), ready for 5G, for future exploitation by the partners, towards the evaluation of new algorithms and design of 5G networking and beyond. This simulator will be a good asset to be offered to mobile operators, to test their new designs. MUSCLES has enhanced an existing SLS, built on MATLAB Vienna simulator, which was designed for 4G networks.

#### Fixed Wireless Access RANP as SaaS

MUSCLES has designed a cloud-based tool for network design. The software planning tool is an integrated solution for the challenge of planning and rolling out a mm-wave communication network. The

purpose of the tool is to integrate a high level of automation in the design process, in order to simplify the process, make it repeatable and more efficient in every step, from acquiring the equipment, installing it, defining it, and comparing its planned performance to its actual performance. The designed tool performs the following tasks:

- Calculation of propagation for all geographical locations, perceived as inputs;
- Filtering out connections that do not support establishment of a wireless link;
- An analysis of the RF signal quality and interferences, and selection of operating frequency channels to minimize interference;
- Automatic generation of the network schematics and configuration;
- Generation of an information layer that could be fed into the geographic database to show network design.

#### Virtual TV Webcasting, SaaS (Software as a Service)

This solution allows the broadcasting of individual video content and lets neighbours in a community view it with a web-enabled device.

It consists of two core products; VirtualTV and STREAMOVER. These products come together and allow to create and broadcast a fully managed TV channel. Both combined allow a rather simple approach as the MUSCLES Neighbourhood TV or for a fully operational TV - or WebTV channel at very low cost.

The complete technology is based on an IP-infrastructure and "hidden" in a cloud solution. The cloud solution is laid out as a SaaS.

#### MUSCLES quantitative results:

**MUSCLES has resulted in multiple achievements. To start, MUSCLES has produced 4 completed ready for market products:**

- Virtual TV: Virtual TV is a cloud-based solution. It is a professional platform to create and manage Web TV and/or IPTV channels.
- Streamover: STREAMOVER automates the seamless distribution of content to WebTV, IPTV and OTT on any platform

and device. It is an independent solution based on open source components, available as cloud service or on premise.

- mmWave network rollout designed tool (deployed)
- mmWave network management tool (currently in planning)

**Additionally, the output from MUSCLES included some contributions to standardizations efforts, in the shape of recommendations and presentations:**

- **European ECC SE19:** Siklu contributed to a paper titled "V-band 3D Ray-Tracing Interference and Network Analysis" and submitted on behalf of a large group of companies to the European ECC SE19 working group in order to promote regulations that will allow use of point-to-multipoint, outdoor, beam-steering antennas and systems in the 60GHz band.
- **ETSI ENI:** Altice Labs, as an active member, contributes the project's technical solutions at the relevant scientific conference, workshops and standardization entities.
- Peer-reviewed output: MUSCLES has produced 8 conference papers and 5 journal publications.

### Impact

MUSCLES main impact is the reduction in expenses of mobile operators, to enhance their offer and/or profitability in the era of mobile communications, in which CAPEX and OPEX are increasing fast, and income of mobile operators cannot keep up, to sustain the industry.

Mobile operators will be able to reduce their costs significantly in different directions:

- Using MUSCLES SON solution, mobile operators can reduce their OPEX, profiting from better resource utilization, resulting from SON optimization, which aims are almost always operating at optimum point of operation, which is continuously changing.
- Using the concept of self-organizing small cells should also help in avoiding extra expenses in CAPEX, required for the deployment of additional networking infrastructure, in addition to the high cost and long procedure of network planning.
- The automated cloud-based network planning tool will also help speed up the network planning procedure, in addition to reducing the cost, thus additionally contributing to reducing the overall costs of the network operator.

Additionally, one of the SON optimization objectives is the energy efficiency of the network. Through the use of on-demand small cells, and the use of user equipment as temporary small cells, the operator will be able to minimize the overall energy consumption of the network; hence, contributing two folds:

- Reducing overall energy consumption, contributing to the green communications concept, helping the environment in general;
- Minimizing the energy consumption of the network will also result in reducing the costs of operating the mobile network in general; therefore, also contributing towards the reduction of the OPEX of mobile operators.

MUSCLES is hence seen to contribute towards the overall savings in the expenses required in the deployment and the operation of mobile networks, in addition to decreasing the overall energy consumption of the network, contributing to the universal green goal.

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

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