

## 1 PUBLISHABLE SUMMARY

Wireless communications systems based on electromagnetic fields have been increasingly used over the past 30 years. Nowadays, the versatile use of new mobile phones, the development of home wireless LANs and the emergence of all-pervasive wireless communication systems are strengthening this tendency. This intensive use and the present trends have also created a public risk perception about possible health impact of EMF.

To protect the public from sanitary health impact induced by EMF, the International Commission on Non Ionising Radio Protection (ICNIRP) has established guidelines defining basic restrictions that limit the specific absorption rate (SAR), expressed in Watt/kilogram, and characterising the RF human absorption. ICNIRP defines also the reference levels that are limiting the incident field strength to the level inducing an exposure compliant with the basic restrictions. The European Council adopted in 1999 a recommendation (1999/519/CE based on ICNIRP guidelines) on the limitation of the exposure of the general public to electromagnetic field. Today in Europe, telecommunications have to comply with the RTTE directive that requires products to comply with the European Council recommendation. In spite of these existing protection limits, public concern still exists. In 2010, a survey performed by the European Commission through the Euro-barometer has shown that about 70% of the respondents believed that EMF can have maybe an impact on health.

To respond to this risk perception, some countries have tried to minimize the exposure, but most of the time these initiatives have been dedicated to base stations emission. Since the day-to-day exposure is a combination of uplinks and downlinks, to focus only on the downlink can unexpectedly lead to raise the uplinks emissions and therefore increase the exposure. Focus only on base stations can also lead to reject some innovations in network technologies and architecture even if they can reduce the global exposure. Unfortunately, most of the works dedicated to EMF exposure were dedicated to compliance tests using worst cases scenarios, considering separately the mobiles and base stations. A key challenge is to change the paradigm and create a new acceptable metric able to quantify the global exposure of a population exposed to the emission of a wireless network.

The strategic goal of LEXNET is to take into account the public concern and improve the acceptability of existing and future wireless systems through low exposure systems, reducing the human exposure without compromising the user's perceived quality. The project use a holistic approach targeting innovative low radiation exposure solutions at many levels, ranging from the radio devices and the radio link, to the network architecture, topologies, management and the provision of services. To assess the human exposure, metrics and tools are being defined and built. The project is composed of 17 network providers, manufacturers, research centres and universities from 9 European countries.



<http://www.lexnet-project.eu/>

The project is divided in 7 Work Packages (WP).

WP1 is dedicated to the project management.

WP2 is dealing with "Socio-economic analysis, EMF exposure metrics, and reduction

targets". The objective of this WP is to design a human exposure index combining exposure induced by access points or base stations and the exposure induced by the devices (mobile, laptop). Its objective is also to analyse people's exposure beliefs, risk perceptions and attitudes towards acceptance of exposures in order to take into account these aspects in the exposure index and in the planned communication efforts.

WP3 is working on "Efficient EMF Measurement and Assessment of the Exposure Index". Its objective is to design a dosimeter that provides 'in situ' and real time measurements of the EMF and to design an expert system that combines the distributed time-domain dosimeter and network measurements to calculate the exposure index.

WP4 is dealing with "Smart Low EMF Radio". Its objectives is to focus on Innovations for Radio techniques, at component, device level (HW), but also from a Radio Transmission System standpoint, that could optimise and minimize indices of Exposure.

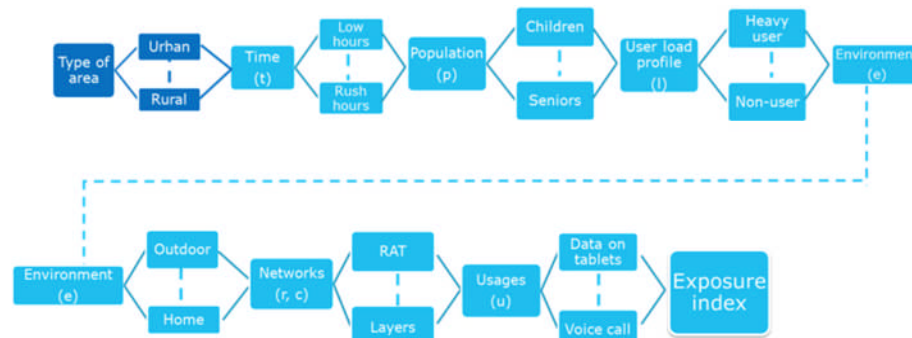
WP5 is working on "Smart Low EMF Architectures". The objectives of this work package is to design effective network topologies that will further reduce the ubiquitous and ever-increasing electromagnetic radiation to acceptable levels, while also maintaining low cost, efficient communication and required Quality of Service and Quality of Experience. The objective is also to produce analysis and solutions of the network management associated with such topologies as well as existing network topologies, which can be later output to networking demonstrators.

WP6 is dedicated to "Validation and assessment of the objectives". Its objectives are the validation of the low EMF radio and network solutions developed in the project by means of real-world prototypes, system level simulators and lab demonstrator. The objectives are also to deploy wideband EMF dosimeters over a Smart City scenario, which enable the creation of an exposure index map available to all involved stakeholders (citizens, authorities, network operators, etc.) within a field trial.

The last work package, WP7, is dedicated to "Standardisation and dissemination". It disseminates the work performed in LEXNET in the general public, the scientific community and in standardisation and regulatory bodies.

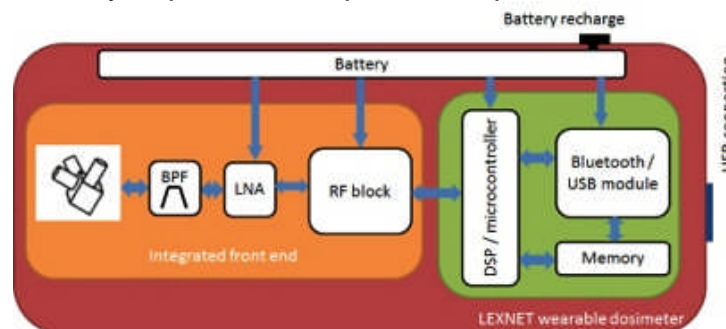
During the 1<sup>st</sup> year of LEXNET, large efforts have been dedicated to build the needed new metric and to analyse the public risk perception in order to propose an acceptable concept of exposure index. As a consequence, the WP2 has focused mainly on the population exposure index definition and on the evaluation of the risk's perception and exposure's perception. An online survey on exposure pattern of how they use various telecommunication devices, such as cell phones and tablets, in their everyday life has been elaborated and conducted in 7 countries. A consolidated analysis based on about 2400 respondents has been performed. The analysis of the results of this survey has highlighted that WLAN connection with laptop is the most common usage among respondents (most of them use the Internet on a daily basis). The results have confirmed that Base stations for mobile telephony are seen by respondents as the most intensive RF EMF exposure source. In summary, the risk perception is guided by subjective models, which underestimate the near field exposure and overestimate the far field exposure. Dealing with the definition of the new Exposure Index, as explained previously, the huge novelty consists in taking into account both uplink exposure induced by personal equipment (as mobile phone) and downlink exposure induced by far sources (as base station antennas) and to cover a population in a given area. The exposure index is aggregating various possible day-to-day configurations. Its definition and mathematical expression (in order to be used in optimisation process) has been discussed within the LEXNET consortium. The transfer functions that allow assessing the local and whole body exposure induced by emission of a mobile or base station in various configurations have

started to be calculated. The new concept of population exposure index has also been discussed with stakeholders. To do that, a specific workshop involving standardisation bodies, regulators, industry and NGO has been organised in September 2013. The discussions during the workshop showed that the LEXNET objectives are responding to question faced by participants.



*Tree of exposure covering all the configurations addressed by LEXNET*

During this first year, efforts have also been dedicated to measurement systems. WP3 partners have discussed and defined specific characteristics for the LEXNET wearable dosimeter. Two preliminary dosimeter architectures were finalized in February and after initial study and tests, they were merged in July in one architecture. This finalized architecture was an intermediate solution between a very low cost configuration and highly complex and power consuming one. Most of the components of the final dosimeter design have been tested and validated individually, and some initial tests have been done in cascade. Initial work has started on the measurement methodology, and the control strategy of the dosimeter. The finalized dosimeter consists in a three axial probe developed and tested to cover the whole of the frequency band 700 MHz to 6 GHz. After this probe, the signal is filtered, amplified, down converted and finally detected. The total size for this dosimeter will have the form factor of a smart phone device. A flat battery is chosen with sufficient durability to provide an operational period of 24 hours.

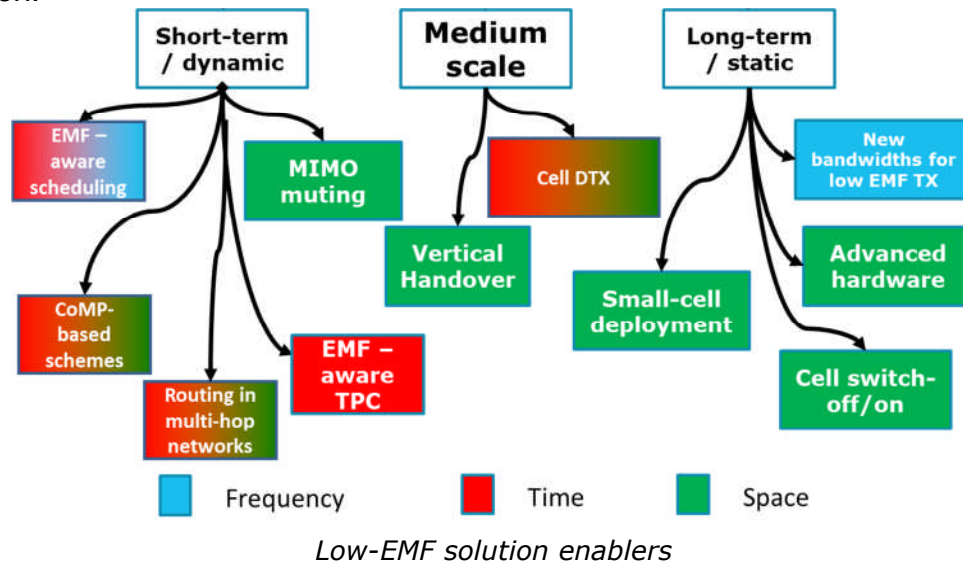


*Block diagram for the LEXNET dosimeter*

WP4 focuses on innovations for radio techniques that could optimise indices of Exposure, at component, device level (HW), but also from a Radio Transmission System standpoint. In order to reach the 50% reduction on the Exposure Index with LEXNET solutions, WP4 has organized its work in three steps: identify, develop and evaluate promising low exposure radio technologies. Studies are analysing DTX mechanisms both at the hardware component and system levels. One is dealing with power amplifier that enables fast deactivation and activation to implement cell DTX (TTI). The WP4 is also analysing transmission techniques and in particular relaying, multicarrier relaying, network

interference management and retransmission and control signal optimisations. The work package is also analysing the antenna design and antenna processing, such as beamforming, developed to radiate power only in the useful directions.

The WP5 plan for the first year of LEXNET was to provide a comprehensive overview of the EMF footprint of existing and emerging wireless networks, and of the impact of most common network management techniques on EMF, resulting in a clearly-defined way forward. One particular challenge was to differentiate between the better known “Green Wireless” concept (where the focus is reducing energy consumption) and the LEXNET approach which is focused on reducing combined UL and DL EMF exposure of a segment of the population.



The WP6 activities officially started 6 months after the beginning of the project. However some initial work started at the earliest stage of the project regarding the definition and deployment of a low-cost dosimeter in the smart city Santander platform. The technical specifications of the low-cost dosimeter have been defined taking into account the Santander environment. Some partners are working on the preparation of the validation platforms, in the perspective of the Exposure index implementation.

In order to analyse the impact of LEXNET on standardization and regulatory bodies, WP7 organised a workshop on September 18<sup>th</sup> 2013 in Berlin. The main purpose of this workshop was to ensure that the key outputs of the LEXNET project are responding to the objective and question of relevant standardization and regulatory bodies. Twenty people, representatives of national agencies, standardization bodies, network providers and manufacturers as well as NGOs gathered in Berlin to discuss the objectives of LEXNET and in particular the new metric proposed to assess the exposure of population generated by wireless telecommunications networks. The external participants supported the LEXNET objectives. During the meeting, the importance of standardization has also been discussed. A presentation of LEXNET was then planned in CENELEC TC106x in Dec. 2013 and in 3GPP in March 2014.

Among other dissemination activities, the LEXNET public website <http://www.lexnet-project.eu> was launched in February 2013. It provides information about LEXNET to different targets. Different scientific contributions were submitted or presented in symposium and conferences. A white paper was prepared and submitted to IEEE VT Magazine in September 2013. Contacts with projects in the EMF exposure area and related ones (e.g. FP7 METIS, MOBIKIDS, GERONIMO) have also been established.