LEXNET WORKSHOP
Agenda

September 18th, 2013

Fraunhofer Spektrum, Spreepalais,
Anna-Louisa-Karsch□Str. 2
10178 Berlin
Germany

9:30 - 10 :00 Registration

10:00 - 10:20 Welcome and scope of the workshop

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10:10 Views from the European Commission

10:20 - 11:20 Lexnet rationale

10:20 Why to revisit the exposure paradigm?

10:40 How is the exposure perceived?

11:00 Open discussion

11:20 – 11:50 Coffee break

11:50 – 13:00 Session 2: Personal Human exposure vs Human Population exposure to EMF

11:50 Existing metrics and their limits in view of a population exposure assessment.

12:10 What should be index of a population exposure? How to compute the index?

12:30 Open discussion

13:00 – 14:00 Lunch

14:00 - 15:00 Session 3: Network optimization in view of reducing the exposure

14:00 How to use measurements and simulations to assess the index of exposure?

14:20 How to reduce the exposure with new technologies and new architectures?

14:40 Open discussion

15:00-16:30 Closing session

Chair :

15:00 Debate “What are the consequences of Lexnet for RF exposure protection and standardization?”

16:30 Closing

LEXNET rationale: why to revisit the exposure paradigm?

Joe Wiart and Emmanuelle Conil

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Wireless communications have known a tremendous rise over the past 30 years. The mobile-cellular penetration is worldwide huge exceeding 100% in developed countries. At the same time, a public concern has raised about possible adverse health effects, even if, to date, no sanitary health effects have been established. To respond to such public concern, the minimization of the electromagnetic fields (EMF) exposure has been investigating, but such action mainly focus on cellular networks base stations. Since the global exposure is induced by both up- and downlinks, these actions do not fully respond to the relevant questions, and they even can induce a rise of exposure.
If by now, the exposure induced by devices and the exposure induced by radio-access network antennas are totally separately managed, LEXNET project aims at filling this gap in the exposure assessment.

As pointed out in the survey conducted in the project LEXNET, the people have subjective models of EMF exposure, which underestimate the exposure induced by personal devices and overestimate the far-field exposure induced by base stations or access points.
Moreover, existing metrics as detailed in a later talk, have been established to check the compliance to existing limits and they consider the systems separately. Because of that they are not suitable to evaluate the real exposure of a population.

LEXNET rationale aims at revisiting the exposure paradigm by dealing with the exposure of a population induced by a telecommunication network as a whole. The new exposure metric will evaluate the end-to-end exposure by managing at the same time the exposure induced by personal devices (mobile phones, tablets…) and the exposure induced by the network antennas (access points or base stations).

This new index will contribute to a realistic representation of the population's exposure induced by telecommunication networks. By this way, a better understanding of exposure and risk will be fostered and the EMF exposure will take a full role in the networks' architectures.

Risk and exposure perception: The EMF case

Prof. Dr. Peter Michael Wiedemann, Karlsruhe Institute of Technology (KIT), ITAS, WF-EMF

The WF EMF of the Karlsruhe Institute of Technology (KIT) is a partner within the EU-project LEXNET and is participating in the working group WP2, which deals with socio-economic issues.

Together with its LEXNET partners, WF EMF has recently conducted a study on “Risk and Exposure Assessment” in 7 European countries with a sample size of 2392 participants. This online study investigates participants’ use of RF-EMF emitting devices, their intuitive exposure assessment, and their risk perception.

The results indicate that laptops with WLAN connection are the most commonly used device; they are even more often used than mobile phones. Participants assessed base stations as the strongest exposure source and most dangerous source of EMF. Overall, participants underestimated distance to exposure source as a key factor of exposure strength.

The results suggest that risk perceptions of the general public and their underlying EMF-related health concerns are determined by people´s subjective models of EMF exposure, which underestimate near-field exposure and overestimate far-field exposure. People are more concerned about base stations than about all other RF-EMF sources. This distortion may explain why devices such as laptops and cell phones are not a key factor in the public’s risk perception.

The study’s implications for risk communication include the need to emphasize that distance to an EMF exposure source is a critical parameter in risk assessment and also that near-field exposure is usually more important than far-field exposure.

KIT is currently in preparation for focus groups regarding the understandability and acceptance of an exposure index, which aims to collect optimal exposure data for the people in a specific area. Preliminary data and findings from a focus group pre-test will also be presented.

Existing metrics and their limits in view of a population exposure assessment

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1. Introduction

Different methods exist to assess the exposure depending on the aim of the exposure assessment. Compliance testing aims at worst-case exposure assessment, while epidemiological studies focus on daily-life exposure assessment. Standards have been developed to assess the contribution of wireless base stations (BS) to the worst-case exposure. Base stations (BS) are tested when put into service, which results in a lot of measurements in the vicinity of base station locations. On the other hand, personal wireless devices, used close to the body, are tested with respect to compliance with limits for local averaged SAR (Specific Absorption Rate). In neither case realistic exposure is assessed. Recently, new quantities are defined in scientific literature, such as dose and exposure ratios, to determine realistic exposure of people to RF EMF. The nature of electromagnetic fields (frequency, intensity, duration of exposure) offers a large variety of quantities which can be used as exposure metrics [1]. Moreover, a wide range of exposure conditions can exist: individual or multiple source exposure, near- or far-field exposure, short- or long-term exposure, …. So far, multiple methods to assess the exposure are present in the epidemiological literature.

2. Current exposure metrics and their limits

Current exposure metrics can be classified into four categories: (1) incident field metrics (such as electric field, magnetic field and power density), (2) exposure ratios (which are a measure for the proportion of the exposure of a single wireless communication technology into the total exposure), (3) absorption metrics (SAR), and (4) dose metrics (these metrics take the time into account by multiplying the absorption or incident field metric with time) [2]. These exposure metrics do not allow the network-centric management of the realistic exposure to radio-frequency electromagnetic fields as they mainly aim at compliance testing or personal exposure assessment (as of interest in epidemiological studies). So, they are not useful to optimize the wireless network for low exposure while maintaining the overall Quality of Service and Quality of Experience. Network-centric management of the exposure (objective of the LexNet project) requires assessing the exposure metric over an area within a certain time frame (e.g., one day) and determining the network parameters that influence that exposure. The exposure in an area varies during the day and depends on the environment (urban, suburban, rural, office, public areas, etc.), the activities of the population (work, commuting, travelling, etc), the user profiles within the population (professional, consumer), the usage profiles in the population (voice, data, video, …) and the network parameters and techniques of the deployed networks in the area. Moreover, to assess the realistic exposure due to downlink and due to uplink communication needs to be considered together.

4. References

1. Samaras T, et al., “Deliverable D38: Recommendations on exposure assessment for epidemiological studies”, *FP6 project EMF-NET*, 2008.
2. Vermeeren G, Thielens A, Aerts S, Oliviera C, Mackowiak M, Varsier N, Gati A, Hadjem A, Conil E, Pejanovic-Djurisic M, Veljovic Z, Neskovic A, Koprivica M, Joseph W, Correia L, Wiart J and Martens L. “D2.1 Current metrics for EMF exposure evaluation”. Deliverable 2.1 of the FP7-project *LexNet*, 2013.

What should be the index of a population exposure? How to compute the index?

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[1] Orange labs , Whist Lab Issy les Moulineaux France

1. Introduction

The question of RF-EMF exposure has so far been focused on the individual user, handling the exposure induced by personal devices and that of the network equipment separately. LEXNET will change this by putting the issue of the exposure not at the network level and by introducing exposure into network optimization.
We present here an important concept of LEXNET, that is the formulation of a new exposure metric, which we term the Exposure Index, that would be associated with a given wireless telecommunication network. This Exposure Index merges the exposure incurred by personal devices with that attributable to access points or base stations, thus becoming a new parameter to be reduced as part of network optimization. In this paper a simplified example of calculation of this exposure index is introduced.

2. The concept of index of exposure

The Exposure Index shall cover the day-to-day exposure of people in a given area incurred by entire wireless network from base stations to individual devices. The Exposure Index shall aggregate the downlink exposure induced by the base stations and access points, the uplink exposure induced by the devices in communication, the different usage patterns, the category of users (children or adults), the user posture and device position with respect to the body of user, the different environments such as indoor or outdoor, the different RATs and layers in the network, and the different periods of the day.

2.1 The tree of exposure

A set of technical data are going to be considered and aggregated in a Tree of Exposure (Figure 1). Each branch of the Tree is a possible scenario. Different exposure scenarios are considered and aggregated by putting weights on each configuration, thereby determining the Index.

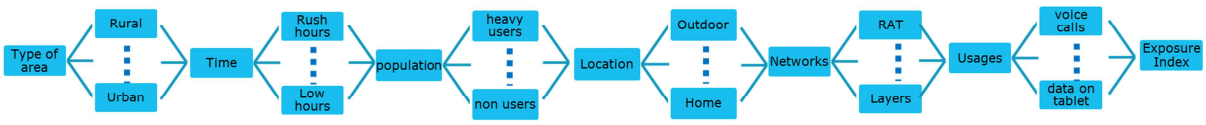

Figure 1 The tree of exposure

2.2 Exposure index equation

$$EI = \sum_i \sum_j \sum_k \sum_l \left(\sum_m \left(A_{i,j,k,l,m} \times TX \right) + B_{i,j,k,l} \times RX \right)$$

with the summation over

- *i* depicting the summation over different times of day
- *j* depicting the summation over all the population in the area
- *k* depicting the summation over all considered environments (indoor, outdoor..)
- *l* depicting the summation over all the RATs and layers in the area
- *m* depicting the summation over all the usages

3. Simplified realistic index computation example

We evaluated the exposure index in a real geographical area - 14th district of Paris (see Figure 2)

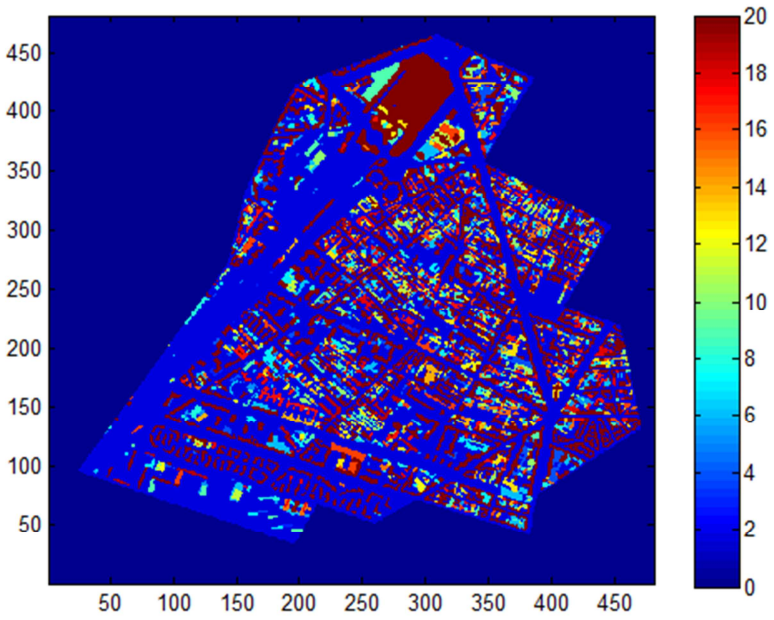

Figure 2. 14th district of Paris (color scale represents the different building heights)

How to use measurements and simulations to assess the index of exposure?

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1. Introduction

One of the main goals of the LEXNET project is to design techniques, algorithms and protocols to reduce the exposure of the users to electromagnetic fields without jeopardizing the perceived quality of experience. In order to assess their operation, various approaches will be fostered, although all of them require having means to appropriately estimate the index of exposure. Providing accurate values might become rather complex, if not impossible, to achieve. Therefore, LEXNET will explore different alternatives to bring index of exposure assessment techniques that might be easily integrated within the tools used by the various partners.

A first step is to respectively measure and simulate the index, considering both the uplink and downlink contributions, and defining the detailed methodologies to be used. While measurements might help to tune the values provided by the LEXNET simulation frameworks, the simulations can be merged with measurements to produce exposition maps or assess the index in live networks.

2. Measurement tools

Existing solutions for E-field measurements include normative E-field measurements (as described in [1] for instance), and dosimeter based measurements. The first solution lacks the ability to achieve a wide scale deployment, with mobility and a wearable topology. The existing dosimeter measurement tools present a portable, small size solution, but the issues relating to architecture flexibility, and impact of environment (on body configuration, posture, etc.) are not addressed.

LEXNET project will study all the issues stated above and propose two dosimeter solutions. The first one is a wearable dosimeter system, providing a small portable measurement tool, to carry out E-filed measurements at different places over a specific interval of time. It will therefore help calibrating the exposition maps. On the other hand, a low cost dosimeter, suitable for deployment over a large scale (e.g. a smart city scenario), will be as well implemented to carry out measurements at fixed points, and integrate the results with simulations, to generate exposition maps. This simplified dosimeter is in the prototyping phase and deployment is scheduled for mid-2014 in Santander smart city, Spain.

These two tools will be the backbone of a complete system which will minimize the exposition over a given area, by reducing the transmitting power from base-station antennas and mobile devices without jeopardizing the quality of experience perceived by the end-users.

3. Simulation tools

Two types of simulation tools will be used during the LEXNET project life-time. The first group encompasses detailed and accurate radio-planning tools, which will be extended so as to be able to reflect and characterize the index of exposure.

Since the aforementioned tools are not appropriate to deal with networking solutions, the use of alternative approaches will be also fostered within the LEXNET project. In this case, the challenge is to be able to reach a minimum level of accuracy in the modeling of the index of exposure (or, at least, some of its components), without adding too much overhead in terms of the simulation time, since it is quite likely that complex scenarios, comprising several technologies, user-profiles, etc. will be analyzed.

4. References

[1]. European Committee for Electro technical Standardization (CENELEC): “Basic standard for the in-situ measurement of electromagnetic field strength related to human exposure in the vicinity of base stations”, EN 50492:2008, Nov. 2008.

How to reduce the exposure with new technologies and new architectures?

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1. Introduction: Exposure Index revisited

In this talk we start off by looking at how the previously introduced Exposure Index (EI) impacts the network optimizations in practical terms. We highlight some particularities of adopting EMF as one of the network management Key Performance Indicators (KPIs) and examine how this differs from related research efforts such as Green Radio using a couple of illustrative examples. Typical trade-offs inherent to communications systems are revisited within the LEXNET EMF-aware framework.

2. Radio link components and EMF

The future networks envisaged by LEXNET will need to integrate flexible hardware at both the access nodes and user terminals, which enables limiting superfluous emissions (in space and in time) by adapting transmission parameters to the specific environment and network characteristics. This talk will highlight some of the promising hardware solutions, including:

- Small and directive antenna for low EI;
- Antenna on terminal for low EI;
- Enhancement of low noise amplifier sensitivity;
- Sleep/wake-up mechanisms for multi-RAT gateway.

3. Radio link protocols and EMF

As is already known there exist radio link protocols that (if properly configured) could lead to significant EMF exposure reduction, and LEXNET will work on furthering such solutions. The talk will describe the most promising research avenues in this arena, such as:

- Management and mitigation of interference using advanced beamforming techniques;
- Cell discontinuous transmission;
- Enhancing scheduling and transmit power control;
- EMF-aware radio protocol optimization.

4. Network management and EMF

Current network management techniques do not take into account EMF exposure, neither via EMF KPIs nor via EMF “alarms”. Nevertheless, various network management schemes use different EMF exposure “proxies”, which will be extended by LEXNET towards true EMF-aware techniques. LEXNET work in this area is streamlined via following activities:

- EMF / QoE trade-offs in cellular networks—a mix of theoretical analysis, simulations and possible testbed use to link QoE and EMF;
- Routing for multi-hop networks—efforts to try and distribute exposure amongst nodes / people in WiFi / WSNs / D2D networks;
- Network engineering services—designing a database for storing measurements, events, supporting multiple users;
- Novel network topologies—radio planning and EMF exposure maps, AP placement for low EMF exposure, cell co-ordination, and AP / network selection.