Low EMF Exposure Future Networks

LEXNET
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D7.3 - Standardisation Action Plan

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Abstract	This deliverable describes the standardisation action plan to incorporate LEXNET concepts and technologies in standardisation bodies. An overview is provided with potential LEXNET techniques suitable for integration in standards. This deliverable also describes the procedures to bring LEXNET outcomes to standardisation and identified partners within the project consortium that has links to a standardisation body.		
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LIST OF ABBREVIATIONS

3GPP	3rd Generation Partnership Project
ANDSF	Access network discovery and selection function
AP	Access Point
ARIB	Association of Radio Industries and Businesses (Japan)
ATIS	Alliance for Telecommunications Industry Solutions (USA)
BTTF	Task Force of the Technical Board
CCSA	China Communications Standards Association
CENELEC	European Committee for Electrotechnical Standardisation
EDGE	Enhanced Data Rates for GSM Evolution
EFTA	European Free Trade Association
EI	Exposure Index
EMF	Electromagnetic Field
EPS	Evolved Packet System
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile Communications
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	IP Multimedia Subsystem
IoT	Internet of Things
IP	Internet Protocol
IPR	Intellectual Property Rights
ISG	Industry Specification Group
LEXNET	Low EMF Exposure Future Networks
LTE	Long Term Evolution
M2M	Machine to Machine
NC	National Committee
NWI	New Work Item
RAN	Radio Access Network
RAT	Radio Access Technologies
RF	Radio-frequency
RFSP	RAT/Frequency Selection Priority
R&TTE	Radio and Telecommunications Terminal Equipment
SC	Subcommittee
SDO	Standard Development Organisations
SON	Self-Organising Network
TB	Technical Board
TC	Technical Committee
TG	Task Group
TR	Technical Report
TSG	Technical Specification Groups
TTA	Telecommunications Technology Association (Korea)
TTC	Telecommunication Technology Committee (Japan)
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
WFA	Wi-Fi Alliance
WG	Working Group
WLAN	Wireless Local Area Networks

Executive Summary

One of the aims of the LEXNET project is socialising the Exposure Index among different stakeholders (general public, regulatory bodies, standardisation bodies, industry and technical stakeholders, local and national governing bodies), how it is assessed, and how future low-EMF networks are designed and deployed in order to minimise the Exposure Index.

This deliverable D7.3 – Standardisation Action Plan lists the LEXNET methods suitable for standardisation and describes the steps to incorporate LEXNET technologies and methods in standards. The Standardisation Action Plan consists of the following steps:

1. Identify LEXNET technologies which can be incorporated in standards;
2. Identify the standardisation body (and work groups) for each of the selected LEXNET technologies, and identify the existing link(s) between LEXNET partners and standardisation bodies;
3. Identify the standard-specific procedures to bring a LEXNET method to a particular standard.

This deliverable provides an overview of potential LEXNET techniques suitable for integration in standards. LEXNET technologies are mainly aimed at the standardisation bodies CENELEC, IEC, ITU, 3GPP, ETSI, Wi-Fi Alliance and IEEE 802.11 and cover the definition of a new exposure metric – taking into account both up- and downlink exposure –, and methods to assess and optimise the exposure index in radio access networks. This deliverable also describes the procedures to bring LEXNET outcomes to the identified standardisation bodies. The industrial partners in the LEXNET consortium, i.e., FLE, Sagemcom, and Orange are the identified partners with links to the aimed standardisation bodies.

1 INTRODUCTION

Within the LEXNET project, a global wireless exposure metric is defined in order to evaluate the averaged exposure of a population in a given area induced by a given network including base stations, access points of the network but also the personal devices of the population.

One of the aims of the LEXNET project is at making known to different categories of people (general public, regulatory bodies, normalisation bodies, industries and technical stakeholders, politicians, cities and administrations) the notion of exposure metrics, the criticality of the Exposure Index (EI) for future low-EMF network design and deployment, the way the Exposure Index is assessed and how to minimise it in practical deployments.

Bringing LEXNET methods into standards require different consecutive steps to take, i.e., a Standardisation Action Plan:

1. Identify LEXNET technologies which can be incorporated in standards;
2. Identify the standardisation body (and work groups) for each of the selected LEXNET technologies, and identify the link(s) between LEXNET partners and standardisation bodies;
3. Identify the standard-specific procedures to bring a LEXNET method to a particular standard.

Each of the steps in the Standardisation Action Plan is discussed in a separate section of the deliverable.

Aimed standardisation bodies are: European Committee for Electrotechnical Standardisation (CENELEC), International Electrotechnical Commission (IEC), the 3rd Generation Partnership Project (3GPP), the European Telecommunications Standards Institute (ETSI) and the International Telecommunication Union (ITU).

Deliverable 7.3 consists of five sections. Section 2 identifies the LEXNET technologies suitable for standardisation. Section 3 lists the standardisation bodies aimed at for the LEXNET techniques, and provides an overview of the partners within the LEXNET consortium with links to the targeted standardisation bodies. In Section 4 the standard-specific procedures and schedule is discussed to bring the concepts and methods developed within LEXNET (listed in Section 3) to the standards. Section 5 finalises the deliverable with the conclusions.

2 LEXNET TECHNOLOGIES FOR STANDARDISATION

2.1 New exposure paradigm: the Exposure Index (EI)

To date, standardisation efforts concerning the radio-frequency (RF) exposure have mainly concerned the compliance with existing limits and the methodologies to measure and calculate the human exposure to EMF [1]. Efforts are ongoing to harmonise from one hand the standards established by the technical committee TC106 of the IEC [2] and from the other hand the basic and products standards established by the technical committee TC106x of the CENELEC [3].

The LEXNET project aims at reducing the combined downlink (DL) and uplink (UL) exposure of the population in an area to EMF induced by wireless networks. DL exposure is induced by base station antennas or wireless access points whereas UL exposure is generated by mobile wireless devices. The principle of evaluating the exposure for a whole population induced by both devices and network could be proposed in the standardisation bodies CENELEC and IEC.

2.2 Assessment of Exposure Index

Exposure data can be obtained by measurements and simulations. The equipment and methodologies for measuring DL exposure are discussed in D2.1 [1]. Measurement data can also be obtained from drive tests and smartphone apps which record transmitted and received power at the mobile device. In addition, simulations can be used to predict exposure.

In practice the EI will be assessed by combining this heterogeneous set of exposure data (coming from measurements and simulations). This, of course, requires a methodology on how to best combine or deal with these heterogeneous exposure data. The methodologies to measure and calculate the EI could also be introduced in the CENELEC standard.

When combining exposure data from different measurements or simulations, it is also important to determine the combined uncertainty of the EI induced by the different tools. The procedure for assessing this combined uncertainty could also be included in the CENELEC standard.

2.3 Smart low EMF radios

Radio link protocols, if properly configured, could lead to significant EMF exposure reduction, and LEXNET has worked on furthering such solutions. More specifically, radio resource allocation techniques (with particular focus on power control and user scheduling) can have a significant impact on user EMF exposure. Techniques such as:

- Inferring device location with respect to the user;
- Estimating past exposure history;
- Accommodating delay-tolerant services when EMF exposure of the user is lower;
- Making use of the fact that exposure is network- and device-specific as well as traffic- load dependent;
- Reducing control signalling overhead to limit superfluous emissions;

- Appropriate selection of scheduling algorithms.

Each of these techniques has aspects that may impact standardisation. Typically techniques that focus on the radio interface will also impact products such as future base stations and mobile devices. The concept of exposure as a metric for designing future radio technologies still has to gain traction within the product focused standardisation groups such as IEEE and 3GPP. However, in some cases performance indicators such as improved spectrum efficiency, reduction in transmit power and energy saving can serve as proxies for the exposure index.

Product impacting technologies such as those studied in WP4 requires a strong justification to be accepted in the standards. Consequently standardisation contributions will necessitate a strong justification in the standards committees typically requiring validation results such as those being generated in the latter stages of the LEXNET project.

2.4 Low EMF architectures

In wireless systems, network topology and the specific access technology, have a significant impact on EMF exposure. Additionally, exposure from different devices including cellular and Wireless Local Area Networks (WLANs) is heavily dependent on the proximity of the transmitting device to the user.

The networking trend is towards smaller base stations located nearer to the users (due to rising traffic demand). This reduces UL power but moves APs closer to the user and increases inter-cell/cross-tier interference.

Internet of Things (IoT) / Machine to Machine (M2M) paradigm promises billions of small wireless-enabled devices located near the public and in some cases attached to the body [4,5]. There is a risk that the public perception concerns on the EMF impact may increase and the need to future-proof wireless networks against public concerns while reducing any potential (objective) increase in EMF levels.

To address these trends WP5 looks at a variety of commonly used and emerging radio access technologies (RATs), the ways in which they are managed, and how their deployment and management impact the EMF levels.

A number of studies in WP5 consider the impact of network topologies on the overall Exposure Index. In this respect they focus more on the planning and deployment phases of a networks lifecycle. From this perspective such techniques will impact future network planning tools and methodologies rather than standardisation per se.

Other studies in WP5 focus on network management techniques that enable reduction in the overall Exposure Index. Generally such management techniques are algorithmic based and as such aren't an issue for standardisation. However, in the case where such algorithms are built on new network measurements and new events or require additional control points in the network standardisation will be essential to enable future EI aware networks.

Key technologies currently under consideration which are expected to require standardisation in future EI aware networks include:

- Low-EMF communications using IP Multimedia Subsystem (IMS);
- EMF-aware optimisation of Wi-Fi settings;
- Algorithms for data offload;

- Changes in cellular architecture and signalling, including access network discovery and selection function (ANDSF) and self-organising networks (SON)
  - the triggers which set in motion EMF-reducing cellular network strategies;
  - said network strategies and how they can be implemented using existing and emerging network management systems.

3 IDENTIFICATION OF STANDARDISATION BODIES PER LEXNET TECHNOLOGY

3.1 Identified technologies for standardisation

Table 1 provides an overview of the developed LEXNET technologies and links these technologies to a suitable standardisation body. The LEXNET project identified the following standardisation bodies: CENELEC, IEC, 3GPP, ETSI and ITU as potential targets.

The project is taking a pragmatic approach to potential standardisation and has focused on bodies in which the project members have direct experience with existing routes to exploit the developed technologies. Some of the technologies under study may have future impacts on other standardisation bodies such as IEEE for some of the Wi-Fi techniques. Any potential inputs to such standards bodies will be left to the individual partners to pursue after the current LEXNET initiative.

Table 1: Identified LEXNET methods for standardisation and corresponding candidate standardisation bodies

LEXNET technology	Standardisation Body	Target Standards
Exposure of a population induced by both devices and network transmitters	CENELEC, IEC, ITU	TC106x
Methodology to combine heterogeneous exposure data	CENELEC, IEC, ITU	TC106x
Uncertainty of EI	CENELEC	TC106x
Radio resource allocation techniques	3GPP	RAN WG1 Radio Layer 1 (LTE, UMTS) RAN WG2 Radio Layer 2 (LTE, UMTS) - RRM
Low-EMF communications using IMS	3GPP	SA WG2 System Architecture (UMTS, LTE) SA WG5 Network Management (UMTS, LTE)
EMF-aware optimisation of Wi-Fi settings	Wi-Fi Alliance, IEEE 802.11	802.11ax
Measurements and network control points to enable algorithms for data offload	3GPP	SA WG2 System Architecture (UMTS, LTE) RAN WG3 RAN Architecture
Changes in cellular architecture and signalling	3GPP	SA WG2 System Architecture (UMTS, LTE)

From a technology perspective LEXNET is considering a number of technologies covering the radio interface, network architectures and network management for the reduction of EMF in radio communications systems as well as specific implementation technologies. For studies related to cellular systems such as GSM, UMTS and LTE, the target if such techniques are to be adopted by the industry is 3GPP. The future target for LEXNET developed technologies within 3GPP are:

- Technologies addressing Radio Layer 1 – RAN WG1;
- Technologies addressing Radio Layer 2 – RAN WG2;
- Technologies impacted Network Management – SA WG5;
- Technologies impacting Network Architectures – SA WG2 (Core Network), RAN WG3 (Radio Access Network).

The Wi-Fi technology is essentially built around IEEE 802.11. Since this standard does not define any inter-operability testing, a global non-profit association was formed back in 1999 to develop such procedures and promote the “Wi-Fi” brand. Today, only the “Wi-Fi certified” products ensure that interoperability with a wide range of vendor products has been performed. Despite not being a standardisation organisation but an industry group, the Wi-Fi Alliance regularly issues certification programs and testing plans which are followed by the main Wi-Fi manufacturers. Therefore, the Wi-Fi Alliance should also be considered by any LEXNET innovation related to the Wi-Fi technology in the future in addition to IEEE 802.11.

3.2 LEXNET links to standardisation bodies

The link between the LEXNET consortium and the standardisation bodies is provided by the companies involved in the LEXNET project: Orange, FLE, and Sagemcom. Table 2 list the link between the project partner and the standardisation body.

Table 2: Link between LEXNET project partners and standardisation bodies

Standardisation body	LEXNET partner
CENELEC	Orange
IEC	Orange
ITU	Orange
3GPP – RAN WG1, WG2,WG3s (FLE), RAN Plenary	Orange, FLE
ETSI – SmartM2M, ISG Open Radio Equipment Interface, ISG Network Function Virtualisation, ISG Mobile Edge Computing, General assembly	FLE
Wi-Fi Alliance, IEEE 802.11	Sagemcom

The exposure definition and methodology are linked to the human exposure. EU has given to CENELEC the mandate to standardise the standard dedicated to RTTE directive. Because of that the standardisation of EI and method to assess the EI is more adequate to be discussed in CENELEC. So this is why LEXNET has been presented in the TC106x.

Technological methods and architecture to achieve low exposure is more linked to ETSI, 3GPP, Wi-Fi Alliance and IEEE 802.11.

As vendor of a wide range of “Wi-Fi Certified” technologies, SAGEMCOM is naturally a member of the Wi-Fi Alliance. This status allows to participate to any “task group” active within the alliance dedicated to the development of new or the update of existing certification programs. Since SAGEMCOM is acting more as an integrator of the Wi-Fi technology than a driver, it follows the active task group as reader only, but not currently participating to any of them (i.e., using voting rights).

4 STANDARD-SPECIFIC PROCEDURES AND SCHEDULE

4.1 Standardisation action in CENELEC

4.1.1 CENELEC focus, organisation and procedure

Within the CENELEC TC106x, there is a working group (WG1) dedicated to mobile and base station exposure assessment. This WG has the mandate to draft basic and product standards linked to the R&TTE directive in the RF domain. For instance the WG1 has produced the basic and product standards EN50360 and EN50361 linked to the "put on the market" of the mobile phone used close to the head, it has produced the basic and product standards EN50383 and EN50384 dedicated to "put on the market" of base stations. Dealing with the "put into service", the WG1 has also output the basic and product standards EN50400 and EN4001. The WG has also the mandate to develop methods to assess the human exposure not necessary dedicated to the R&TTE directive. For instance the WG has produced the standard EN50492 dedicated to the "in situ" human exposure assessment. This standard responded to the need of a well define method that can be used in all the European states to assess the exposure. The national authorities (as in France by the French National Agency managing the frequencies and the exposure www.anfr.fr) can use the method develop in the standard to assess the RF human exposure in their countries.

The WG is in charge to draft a document but the final decision of the acceptation of the standard depends on the National Committees (NCs). The documents drafted by the WG are sent to the NCs for enquiries. The NCs can ask questions and propose amendments. After this the WG has to review the comments and proposal and respond to all the questions and amendments. Based on this work a new improved document is produced and proposed again to the NCs that can ask questions, propose modifications, accept or reject the proposal. Since NCs inquiries request 6 months, the go and return process can request one or two years.

The final decision requests a double acceptation. On the one hand, the proposal must be accepted by a majority of the NC, on the other hand the proposal must have the majority of the weighting vote (in CENELEC each country has a weight that depend on the size of the population). The double condition is requested for a CENELEC endorsement.

Since the experts working in the WG are mandated by the NCs, the WG does not decide alone the work items under investigation. The National committees must endorse any work items performed in the CENELEC. So a NWI must be proposed by a NC or by the TC and requests a minimum number of countries accepting this new item.

When the technical material that can be requested for a standard is not enough mature for a basic standard but requests nevertheless to be disseminated and discussed within the NCs and disseminated. The works items proposal can be a Technical Report (TR). A TR is an informative document made available by CENELEC in at least one of the official languages, established and approved by a technical body by simple majority vote of CENELEC national members. It gives information on the technical content of standardisation work. Technical Reports may be established in cases when it is considered urgent or advisable to provide information to the CENELEC national members, the European Commission, the

European Free Trade Association (EFTA) Secretariat or other governmental agencies or outside bodies, on the basis of collected data of a different kind from that which is normally published as an EN. The decision to develop a TR can be taken by the Technical Board (TB), by a CENELEC Technical Committee (TC), a Technical Subcommittee (SC) or by a BTTF.

4.1.2 Schedule

During the TC 106X 29th meeting of CENELEC TC 106x, 4th December 2013 in Brussels, it has been decided to send to the National Committees (NCs) a New Work Item (NWI) for a Technical Report (TR) on the assessment of the population exposure (decision TC106x D29/09: “TC 106x agreed to send to the NCs a NWI for a TR in WG1 on the proposal to develop a methodology on day to day assessment of exposure to the population”).

In the LEXNET case, a new work item has been adopted by CENELEC in 2014. The NWI will draft a Technical Report. The proposed TR will be proposed to develop a methodology on the assessment of a day-to-day exposure of population that is exposed to the infrastructures and terminals emissions of a wireless network. The TR should specify the concept of the EI, explain how assess by simulation or measurement, the EI will, develop comprehensive methods and flowcharts and specify the basic requirements of the simulation tools and measurement equipment. The documents and report of LEXNET are circulated within the CENELEC TC106x/WG1 to initiate the discussion and drafting of the TR.

4.2 Standardisation action in IEC

4.2.1 IEC focus and organisation

International Electrotechnical Commission promotes international cooperation on electrotechnical standardization and related matters, such as the assessment of conformity to standards, in the fields of electricity, electronics and related technologies relationship with other standards bodies – CENELEC, IEEE…

Objectives for IEC standards include contributing to the improvement of human health and safety, meeting the requirements of the global market efficiently and increasing the efficiency of industrial processes. Many Technical Committees are set up to deal with a wide range of issues.

TC 106 scope relates to human exposure to RF fields. The standards IEC 62209 and IEC 62232 are respectively related to the mobile phone compliance tests and the determination of RF field strength and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure.

4.2.2 Schedule

During the meeting of IEC 62232 June 2014 the LEXNET project was presented as well as the new work of CENELEC on the assessment of the population exposure. During the IEC meeting June 2015, a new LEXNET presentation was given on the use of the Exposure Index to assess the population exposure.

4.3 Standardisation action in ITU

4.3.1 ITU focus and organisation

ITU is the United Nations specialized agency for Information and Communication Technologies (ICTs). ITU develop the technical standards that ensure networks and technologies to seamlessly interconnect. ITU also allocates global radio spectrum and satellite orbits. ITU T Standardization work is carried out by the 20 technical Study Groups (SGs) in which representatives of the ITU-T membership develop Recommendations (standards) for the various fields of international telecommunications.

The Study Group 5 (aka SG5) is responsible for studies on methodologies for evaluating ICT effects on climate change and publishing guidelines for using ICTs in an eco-friendly way. Under its environmental mandate SG5 is also responsible for studying design methodologies to reduce ICTs and e-waste's adverse environmental effects.

In addition to its climate-focused activities, the ITU-T Recommendations, Handbooks and other publications produced by SG5 have in its main objectives to avoid health risks from electromagnetic fields (EMFs) produced by telecommunication devices and installations. In line with this objective, the SG5 developed to assess EMF levels and to verify compliance with the World Health Organization (WHO) recommended human-exposure guidelines set out by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the IEEE International Committee Electromagnetic Safety (ICES).

4.3.2 Schedule

ITU has been identified as a key organisation to promote the LEXNET concepts and achievements linked to the new metric dedicated to the population exposure.

Taking advantage of the new work carried out in CENELEC, a contribution on the Exposure Index to assess the population exposure will be delivered in ITU-T SG5 meeting in October 2015. The EI concept and results have been presented during the ITU SG5 meeting, the discussion shows a great interest for the lexnet output. A new contribution will be drafted and send to ITU in 2016 to start a New Item Proposal dedicated as in CENELEC to the EI standardisation and assessment.

4.4 3GPP

3GPP provides the basis for standardisation of EI aware technologies for LTE, UMTS and GSM. The LEXNET technical studies in this area have mainly focused on LTE.

4.4.1 3GPP focus and organisation

The 3GPP focus is on the cellular telecommunications network technologies, including radio access, the core transport network, and service capabilities covering the complete system specifications for wireless cellular networks including GSM, UMTS and LTE (4G). The current focus on LTE Advanced is due for completion at the end of 2015. Currently Low EMF networks are not considered as part of that Release (Release 13). The first opportunity to introduce low EMF concepts into 3GPP will be the next release in which the activities will move towards the next generation wireless access becoming known as 5G. These activities also provide

conduits for non-radio access to the core network, and for interworking with Wi-Fi networks. Introducing EI aware networking concepts into 3GPP will be greatly facilitated by standardisation of the Exposure index in bodies such as CENELEC and the ITU.

3GPP is organised into four technical specification groups (TSGs) covering:

- Radio Access Technology;
- Service & System Aspects;
- Core Network and Terminals;
- GSM EDGE Access Networks.

Each of the TSGs is segmented into a number of WGs who have the responsibility to develop standards for a specific interface including the creation and maintaining the specifications that define the protocols over that specific interface.

In general 3GPP specifications follow the traditional 3 stages approach for standards development namely requirements (stage 1), architecture (stage 2) and protocols (stage 3). In order for 3GPP to adopt an holistic view of EMF aware networking, the concept will need to be socialised at all levels within the 3GPP organisation. However, some EMF aware technologies, when validated may be justified by more traditional KPIs serving as EMF proxies.

4.4.2 3GPP specifications impacted by LEXNET technologies

From the LEXNET perspective, the 3GPP specifications that will potentially be impacted by each of the cellular focused activities in WP4 and WP5 need to be identified. Below is a list of relevant 3GPP working groups and specifications that are potentially targets for LEXNET developed EMF aware technologies in the future. LEXNET WP4 focuses on radio link protocols. From a 3GPP perspective, techniques for cellular solutions will need to target the RAN working groups in 3GPP e.g.

- “Reduced Reference Symbol Usage for EMF Reduction” has potential impact to the 3GPP specification TS 36.211 Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation.

LEXNET WP5 focuses on networks and network management. In this respect the specific low-EMF technologies developed for cellular technologies will be most relevant to the higher layer services and network activities in 3GPP:

Many of the (cellular) technologies LEXNET WP5 is developing would most likely fall within the 3GPP SA2 remit. Here is a list of standards and corresponding technologies WP5 is looking into:

- *3GPP TS 23.401*: This is the Stage 2 service description for the Evolved Packet System (EPS). Aspects where WP5 work may have an impact include Inter-RAT handover, the UE-specific “RAT/Frequency Selection Priority” (RFSP Index), mobility, and so on;
- *3GPP TS 23.261*: This document specifies the Stage 2 system description for IP flow mobility between 3GPP and a WLAN. The solutions therein allow the operator to indicate how the IP flows are routed through the available access systems and to selectively offload some traffic, and EMF could be brought into this, meaning we may need to standardise new network commands;

- *3GPP TS 23.402*: This is the Stage 2 service description for providing IP connectivity using non-3GPP accesses to the EPS. The criteria specified therein pertaining to the selection of a WLAN could be modified to e.g. include awareness of EMF exposure. Additionally, the UE behaviour Based on the ANDSF information could be modified.

4.4.3 Procedures in 3GPP

In order for LEXNET members to contribute towards 3GPP standardisation, the overall process within 3GPP needs to be understood. Contributions that impact the 3GPP specifications are only possible for companies affiliated to one of the associated SDOs.

3GPP standardisation procedures are based on releases, each incorporating a specific well defined set of features driven by market requirements. The specifications covered by each release are maintained and supported as a separate set of standards. This ensures that deployed implementations for a particular release are fully supported throughout the lifetime of the system.

The activities that are undertaken within each working group for a specific release are determined by a work programme that consists of a set of features. These features are outlines in a set of work items each with its own defined set of outputs and timelines as described in the associated work item description.

A work item is proposed to a working group, supported by at least four member companies and approved at the technical specification group level. In addition study items may similarly be proposed. However, these do not normally result in changes to the 3GPP standard specification but rather focus of the overall impact of a new feature on 3GPP activities and may include recommendations to establish a subsequent work item. EI aware networking could become a future work or study item in 3GPP with sufficient backing from the industry members.

Contributions to any of the 3GPP working groups would normally target one of the work items that form the overall work programme.

4.4.4 Schedule

3GPP is currently working on Release 13 with a target date of December 2015. For this release, the list of requirements and features are agreed and the industry effort is on the finalisation of the stage 3 specifications. In this respect, there is limited opportunity for LEXNET to impact the 3GPP specifications for this Release.

The Release 14 schedule is still to be finalised but Release 14 is unlikely to be completed before mid-2017 and could be the target for any appropriate LEXNET technologies.

At this stage initial socialisation of the low EMF technology was considered with 3GPP within the framework of the TSG discussions on Release 13 – especially the SA and RAN meetings. However, in discussions with standardisation experts, it was felt premature without a concrete action plan for 3GPP.

LEXNET low-EMF technologies were developed throughout 2014 and validated during 2015. These covered a range of technical areas from the radio interface (WP4) through to the network management and services (WP5).

At this stage, no work item exists that focuses on EMF aware networking. The target for such a work item would be 2016 in order to meet 3GPP's release 14 schedule. 3GPP member companies would then be in a position to propose relevant contributions against an agreed work item.

4.5 ETSI

4.5.1 ETSI focus and organisation

ETSI produces global standards for a wide range of Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies. ETSI has around 30 different standardisation groups each operating within the ETSI operating procedures but developing specification autonomously. The ETSI General Assembly provides the overall coordination, policy setting and decision making.

4.5.2 ETSI specifications impacted by LEXNET technologies

Within the ETSI framework there isn't a specific group focused on the definition of or investigation into exposure metrics. There is a group responsible for Electromagnetic Compatibility of Equipment and Radio Spectrum matters within the European Domain. However, whilst there may be interest in the LEXNET project from members it doesn't appear that their specifications would be impacted by LEXNET technologies directly.

4.5.3 Procedures in ETSI

Operating under similar procedures adopted by 3GPP, much of this work is carried out in committees and standardisation groups composed of technical experts from the Institute's member companies and organisations.

One mechanism that exists within the ETSI remit is that of an Industry Specification Groups which exist alongside the current Technical Organisation supplementing the existing standards development process. An Industry Specification Group, supported by Working Groups where appropriate, is an activity organised around a set of ETSI work items addressing a specific technology area. An Industry Specification Group (ISG) may establish its own procedures for the creation and approval of Group Specifications, within the broad framework of the ETSI Directives.

The Industry Specification Groups may usefully help to speed up the standardisation process (fast approval, instant operational pack and fast set-up) and has advantages such as:

- Forming industry interest groups outside the constraints of a single research project such as LEXNET;
- Increased visibility for a specific technology and wider engagement across industry members;
- Providing a focus group beyond the timescales of an individual research project.

One potential exploitation for Low EMF networking is through an ISG within the ETSI framework. However, industry momentum will be necessary to enable the establishment of an ISG. Again this can be facilitated through the standardisation of the Exposure Index in CENELEC or ITU.

4.5.4 Schedule

Within ETSI each standardisation groups operates under its own schedule. Part of the process in setting up an Industry Steering Group would be to define its own schedule.

4.6 Wi-Fi Alliance

4.6.1 Wi-Fi Alliance focus and organisation

The Wi-Fi Alliance (WFA) [6] focus is on the wireless local area network (WLAN) using IEEE 802.11-based technologies [7]. Though certification programs and test plans, this global non-profit industry association produces interoperability testing, industry-standard security mechanisms and integration of the most recent ready-to-the market features developed within IEEE 802.11. WFA owns the "Wi-Fi" trademark. Products going through one (or several) certification program(s) from the WFA can display the "Wi-Fi Certified" logo on them, ensuring that intensive interoperability testing has been successfully passed.

As an industry forum, the rules to be member of the Wi-Fi Alliance are quite simple. According to [8] (verbatim), the "*applicant must:*

- *Publicly display a legitimate business interest in the IEEE 802.11 standard for wireless LANs;*
- *Publicly support the IEEE 802.11 standard wireless LANs by shipping products or enabling technology or deploying for public access products employing the IEEE 802.11 standard for wireless LANs, or by issuing press releases in support of the IEEE 802.11 HR standard for wireless LANs;*
- *Pay the annual dues associated with your membership type. The initial annual dues are payable upon membership acceptance".*

Three levels of membership are available in the WFA:

- *Regular Membership*: Regular members can contribute to the development of the certification programs (including voting rights) and certify their products;
- *Affiliate Membership*: Affiliates of Regular and Sponsor members can certify products under their own company name, use the Wi-Fi Alliance certification marks, and have a non-voting participation in organisational activities at no additional cost (a controlled or controlling regular member is still needed);
- *Adopter Membership*: Membership for company willing to take advantage of the insight, networking and marketing opportunities available to Wi-Fi Alliance members, but which don't have a need to certify Wi-Fi products.

The main benefits of being a member of the WFA are described in [9].

4.6.2 Wi-Fi Alliance certifications impacted by LEXNET technologies

The current certification programs available are given in [10]. They cover the following categories:

- *Connectivity* (e.g., Wi-Fi CERTIFIED n, Wi-Fi Direct® …);
- *Security* (e.g., WPA2, Protected Management Frames …);

- *Access* (e.g., Passpoint™ , Wi-Fi Protected Setup™ …);
- *Application* (e.g., Miracast® …);
- *Optimisation* (e.g., WMM®, WMM-Power Save …);
- *Joint Programs* (only CWG-RF so far, for Wi-Fi and cellular convergence).

LEXNET may have an impact on new programs or update of programs dedicated to the “optimisation" category. While in the past, certification programs in development (new ones or update of existing ones) were only available to the WFA members, the WFA alliance decided in the middle of the year 2015 to make public its areas of research.

In the current work area section of the WFA [11], the early development section presents the current program being developped. Of particular interest for LEXNET, we can find:

- *Multiband Operation* program, which tries to adress a better usage of the frequency bands available.

4.6.3 Procedure in Wi-Fi Alliance

The Board of the WFA can decide to create or terminate a task group (TG) either on its own initiative or in response to a request by one or more WFA members. The TG should be actively supported by a critical mass of members ensuring sufficient discussions and contributions and of course supports the goals of the WFA, which include seamless connectivity.

Usually, each certification program comes with a Marketing Requirement Document (MRD) which describes the main uses cases addressed by the certification, the shortcoming of the existing solutions and the reasons why a new certification should be issued. Marketing TG is formed to issue such document, trying also to identify the relation with the existing certification programs. Once the MRD is adopted, a Technical TG may also be formed to derive the test plans and interoperability procedures. There are also Regulatory TGs which deal with regulatory issue or spectrum management (harmonisation) for instance.

Only regular member of the WFA can have a voting right in a TG. This voting right is kept mainly, based on the regularity of attendance at TG meetings.

4.6.4 Schedule

Currently, the WFA has several TGs ongoing, which exact details are only accessible to the WFA members. The current (core) programs are regularly updated, while the new ones usually follow the amendments from the IEEE 802.11 standard.

To promote LEXNET innovation within WFA, it is essential to have regular members, attending on a frequent basis the TG meeting. The creation of a specific TG would require the constitution of enough members to be validated by the WFA board.

A first step will be to be able to form such group of regular members and either propose a new TG or identify an existing one (e.g. Multiband Operation) and request to be part of it.

Due to the nature of the WFA (both industrial oriented and heavily focused on wireless), it is also more than likely than any techniques derived from LEXNET but

presented through a power saving or an interference reduction prism would have a better chance to be considered instead of mentioning exposure as the objective.

4.1 IEEE 802.11

4.1.1 IEEE 802.11 focus and organisation

IEEE 802.11 [7] is a Working Group (WG) responsible for generating WLAN (typical range up to 100m) standards, targeting the MAC and PHY layers only. Except for two amendments, IEEE 802.11 generally targets unlicensed band and its technologies are widely present in broadband network access, public venue access, sensor networks, meh networks, automotive to name a few.

The work in IEEE 802.11 is divided into various activities:

- *Task Groups* – one per approved standard or amendment to be developed;
- *Study groups* – the precursor to a task group that determines initial requirements and seeks approval;
- Various *standing committees*' responsible for ongoing work, such a publicity and regulatory.

4.1.2 IEEE 802.11 specifications impacted by LEXNET technologies

The current status of IEEE 802.11 standards is given in Figure 1. The IEEE.802.11 working group is actually in charge of a single standard (IEEE Std 802.11), which is maintained since 1999. So far only four revisions of this standard have been published, while the fifth one is expected to land in 2016. One revision and maintenance version usually integrates the past published amendments in a single document. An amendment, pushed by a task group, focuses on a PHY and/or MAC feature. For instance 802.11n amendment provided "higher throughput", 802.11s introduces the mesh capability …

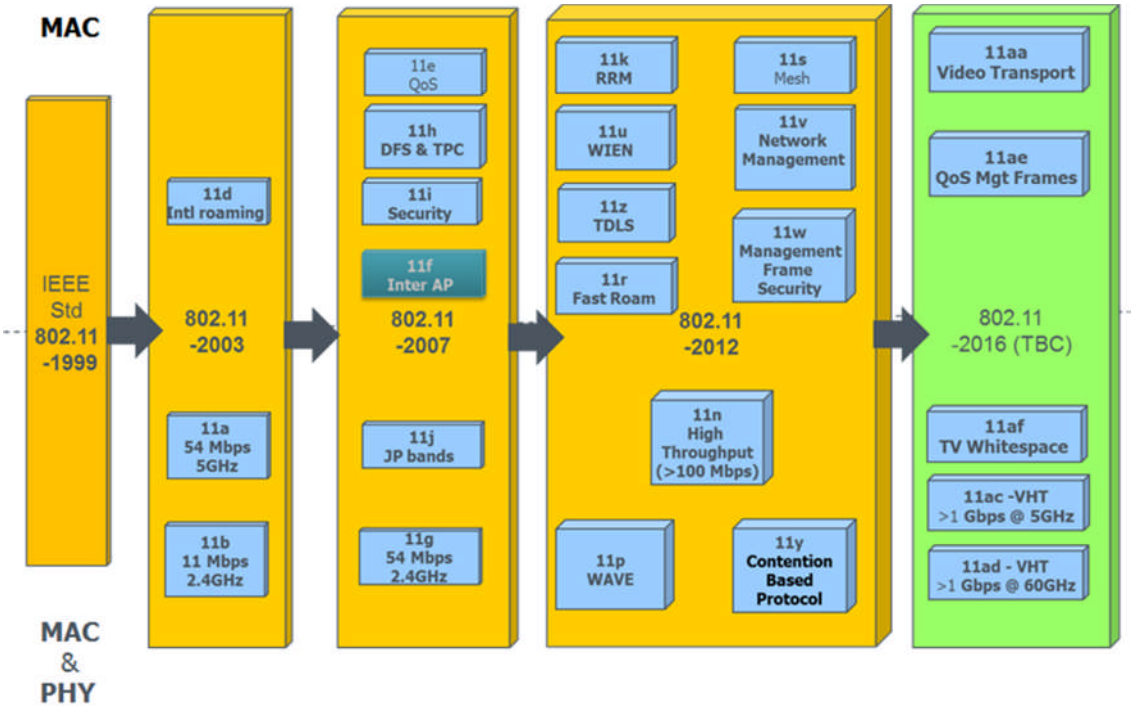

Figure 1: IEEE 802.11 status [12]

From a LEXNET perspective, ongoing amendments (i.e. not yet published) should be the primary target for dissemination. The status of ongoing work within IEEE 802.11 as of March 2015[1] and the work flow associated are given in Figure 2. As a summary, ideas are discussed and presented in the WNG WG and if they fall within the 802.11 scope with sufficient support they can be investigated in study group and drafted in task group for publication.

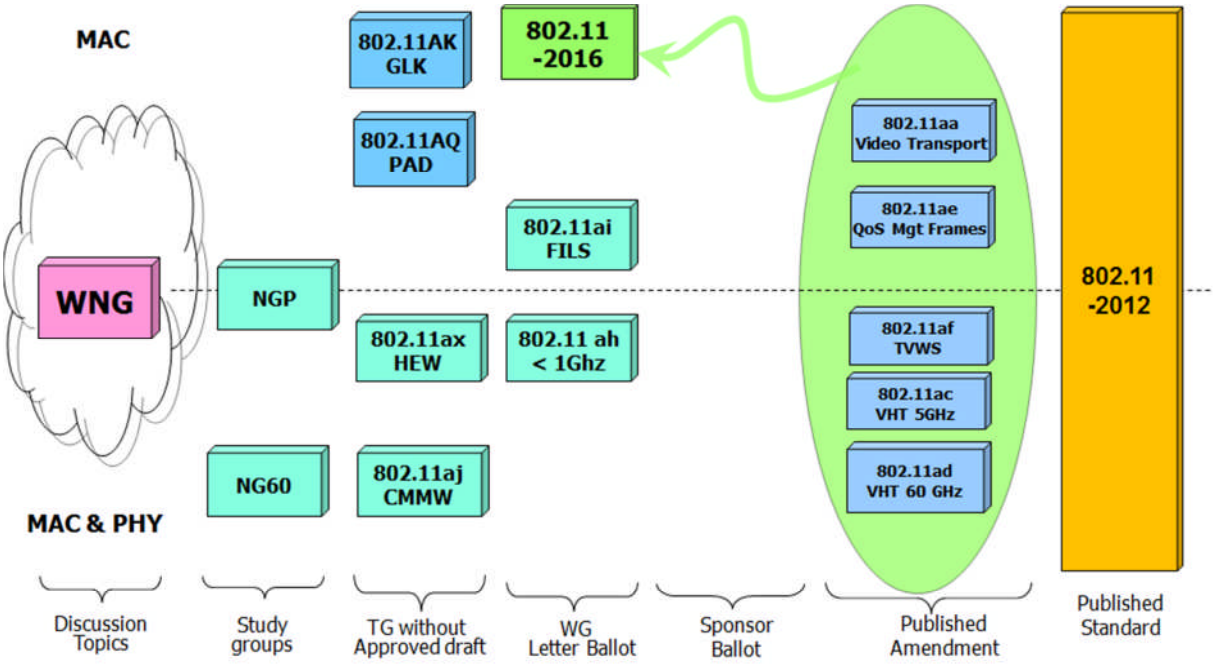

Figure 2: IEEE 802.11 ongoing work [12]

Among the work actually in progress within IEEE 802.11, the recently started Task Group (TG) on High Efficiency Wireless LAN (802.11ax HEW) may be of interest. This group was started in May 2014 with a special focus on WLAN indoor and outdoor operation in the 2.4 GHz and the 5 GHz frequency bands in dense deployment scenarios.

This amendment is allowed to modify both the IEEE 802.11 PHY and MAC in order to enable at least one mode of operation capable of:

- supporting at least four times improvement in the average throughput per station (vs 802.11n/ac);
- maintaining or improving the power efficiency per station;
- coexisting and being backward compatible with legacy IEEE 802.11 devices operating in the same band.

The dense deployment of stations generates an increase of interference and transmission repetitions leading to an EMF exposure increase with actual IEEE technologies. Improving the transmission for a given traffic in such crowded environment, thus reducing the transmission time and exposure seems to be within

[1] July 2015 status is that NG60 study group (60GHz improvement) has been moved to TGay task group

LEXNET scope. By following this TG and understanding the internal procedure within IEEE, we may better identify if LEXNET-related contributions are possible.

4.1.3 Procedures in IEEE 802.11

IEEE-SA produces individual and corporate standards, the difference being the voting rights being either at individual or corporate level. The classical procedure to give birth to an IEEE standard or amendment is depicted in Figure 3.

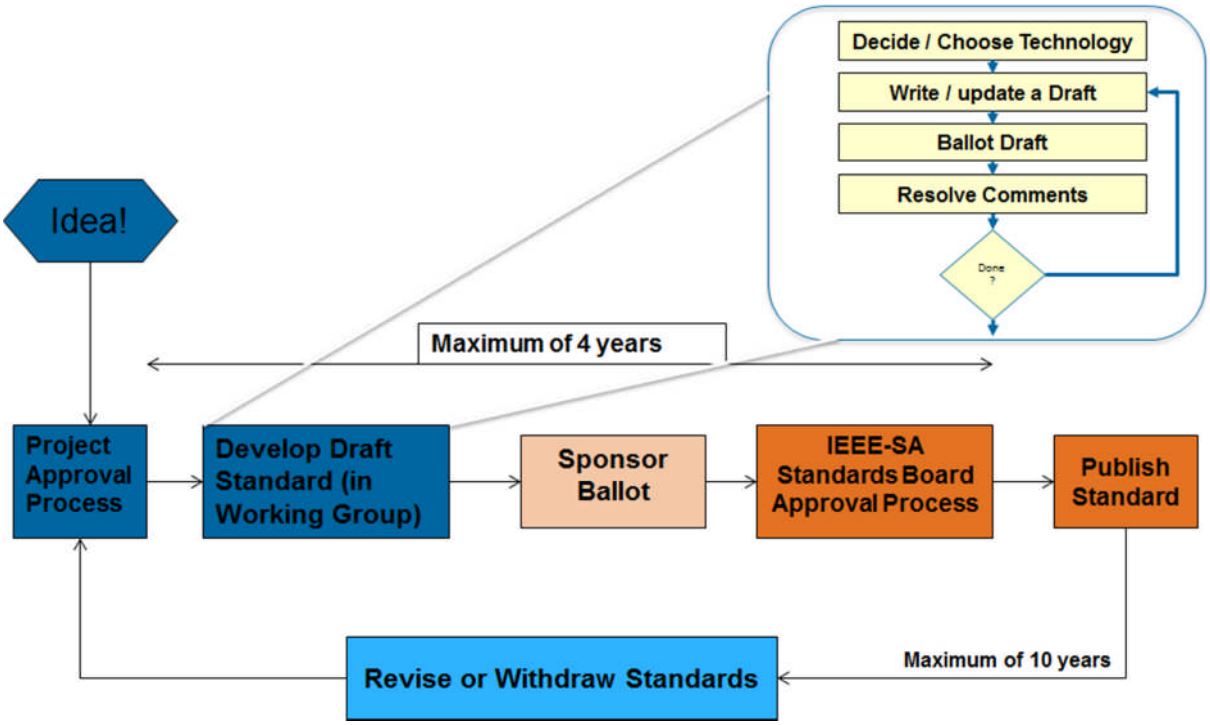

Figure 3: IEEE Standards development: Process flow [12]

A project may be started by any individual or company. Each project must be supported by a technical group in the IEEE, referred to as a “Sponsor” (IEEE 802). Projects are approved through document called Project Authorization Request (PAR), which summarizes details of the project.

A standard is written by one working group (IEEE 802.11), which consist of developers interested in creating the standard. The working group chooses way to create the first draft document which is later refined in working group through multiple iterations and review.

Consensus is determined through a ballot, where interested persons or organizations are invited to participate. Ballot group receives document, reviews it, and votes/comments on it. Ultimate approval of standard is granted by IEEE-SA Standards Board.

It is important to note that for amendment like 802.11ax, voting rights are per individual and not companies, which makes a difference compared to 3GPP or WFA. The voting right is acquired only during the plenary meetings (three per year) and after attending at least two meetings of four consecutive meetings (plenary and interim). This right is kept as long as attendance and response to mandatory ballot is regularly done.

4.1.4 Schedule

During the May 2014 kick-off meeting, preliminary milestones of 802.11ax have been defined with a timeframe similar to the 802.11ac one and shown in Figure 4, with expecting first commercial products by 2016-2017.

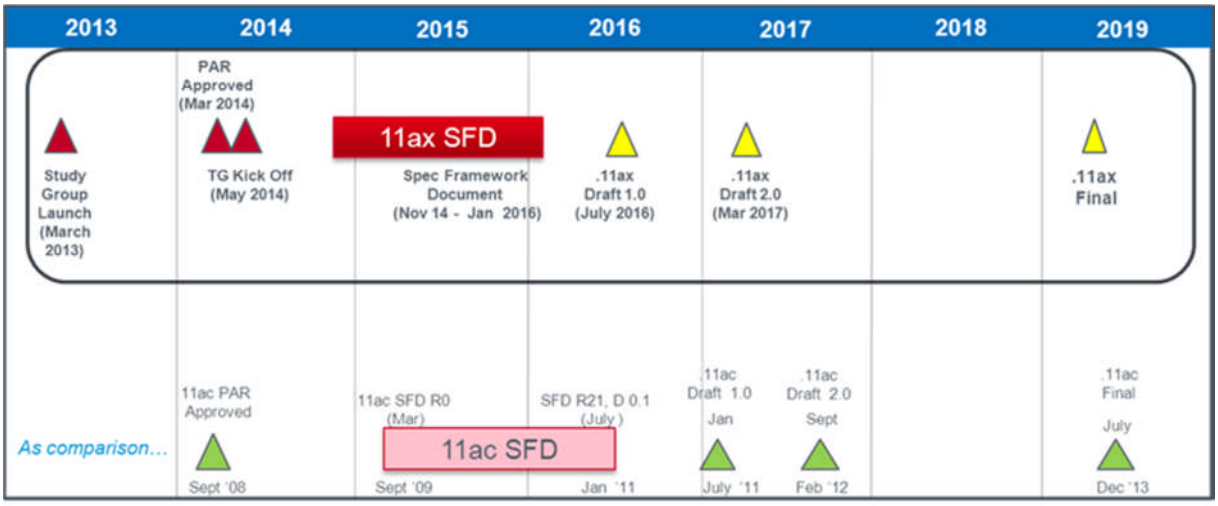

Figure 4: IEEE 802.11ax (tentative) timeline

Currently, IEEE 802.11 TGax is drafting a Specification Framework Document (SFD) which will describe the main features of this new amendment with a completion expected by the end of 2015. We are actively following this TG in order to identify opportunities for LEXNET-based contributions related to be submitted in the WLAN domain.

5 CONCLUSIONS

This deliverable summarises the standardisation activities during the LEXNET project and considers the way forward to introduce EMF aware networking concepts and technologies into the standardisation bodies. The initial LEXNET action plan consisted of three steps: 1) identification of potential LEXNET techniques suitable for standardisation, 2) identification of standardisation bodies (and work groups) for each of the selected LEXNET technologies as well as the link(s) between LEXNET partners and standardisation bodies, and 3) standard-specific procedures required in order to bring a LEXNET method to a particular standard.

The LEXNET technologies are within the remit of following standardisation bodies: CENELEC, IEC, ITU, 3GPP, ETSI, Wi-Fi Alliance and IEEE 802.11. They can be split in two sets.

The first set deals with the definition of a new exposure metric – taking into account both UL and DL exposure –, and methods to assess and optimise the exposure index in radio access networks. During the execution of the project, it became evident that the concept of EMF aware networking could be pushed in standardisation bodies like CENELEC, IEC and ITU. These standardisation bodies were targeted during the project.

The second set of technologies deals with the smart low EMF radios and low EMF architectures which have the potential to impact future products. On these technologies, a different strategy was required. Within the scope of LEXNET, a number of point technologies have been developed. In some cases, when validated, some of these technologies may be taken to standardisation by the individual companies based on alternative performance indicators that are well recognised in the standardisation groups e.g. energy saving, enhanced spectral efficiency.

However, in order to adopt a more holistic view of energy aware networking, other strategies will be necessary in the future such as establishing work items in standards bodies or an Industry Steering Group within ETSI. The top down approach in LEXNET of targeting CENELEC and ITU on a new exposure metric will greatly facilitate such strategies.

The LEXNET standardisation plan is summarised in Figure 5.

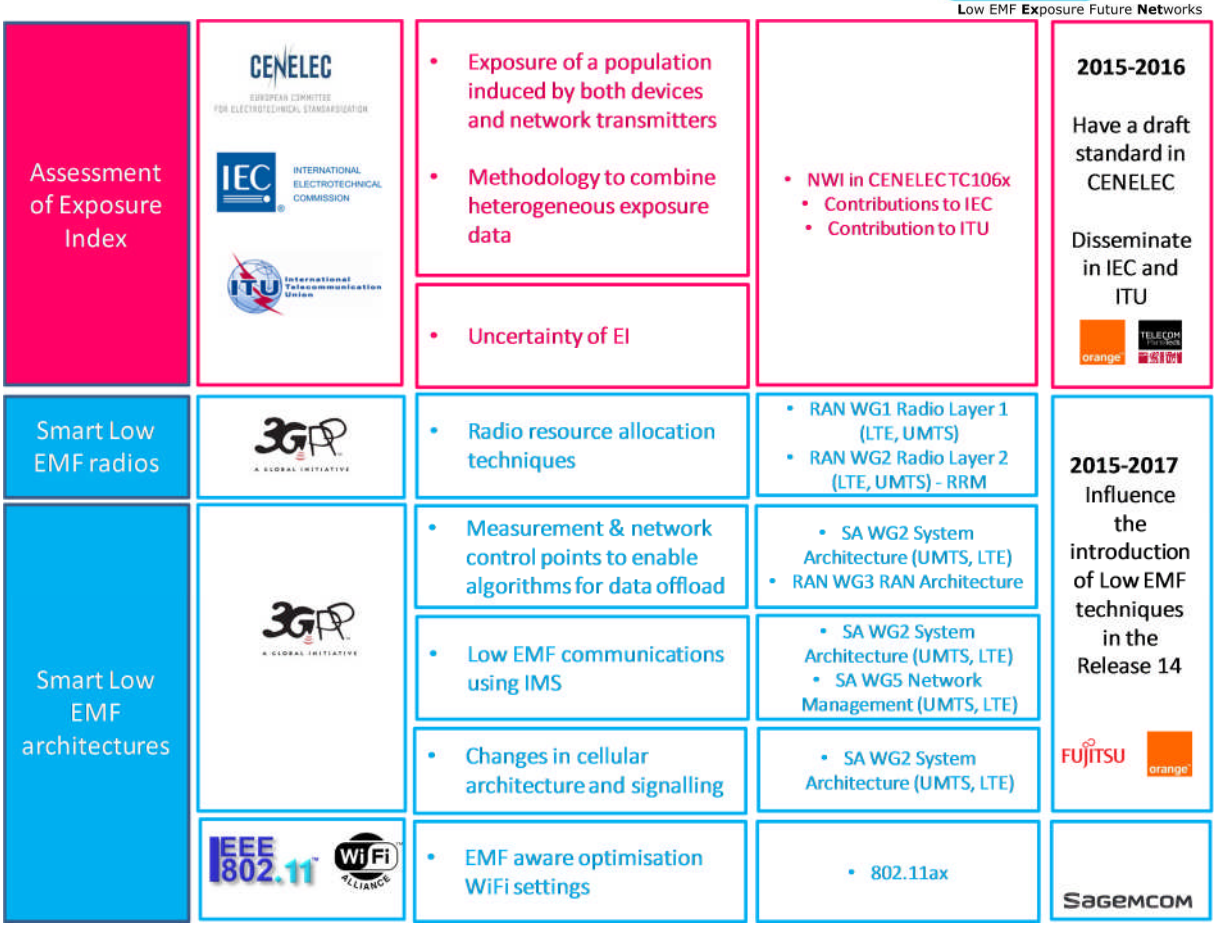

Figure 5: LEXNET standardisation plan

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APPENDIX 1: INTERNAL REVIEW (VERSION 2)

	Reviewer 1: Milos Tesanovic			Reviewer 2: Filipe Cardoso		
	Answer	**Comments**	**Type***	**Answer**	**Comments**	**Type***
1. Is the deliverable in accordance with						
(i) the Description of Work?	☒ Yes ☐ No		☐ M ☐ m ☐ a	☒ Yes ☐ No		☐ M ☐ m ☐ a
(ii) the international State of the Art?	☒ Yes ☐ No		☐ M ☐ m ☐ a	☒Yes ☐ No		☐ M ☐ m ☐ a
2. Is the quality of the deliverable in a status						
(i) that allows to send it to EC?	☒ Yes ☐ No	But it is hoped that minor issues identified will be resolved beforehand.	☐ M ☐ m ☐ a	☒ Yes ☐ No		☐ M ☐ m ☐ a
(ii) that needs improvement of the writing by the editor of the deliverable?	☒ Yes ☐ No	Please see my detailed comments above.	☐ M ☒ m ☐ a	☒ Yes ☐ No	Typos, comments about the choice of the relevant standardisation groups (IEEE, ITU, FCC?) and about the actions to be launched in the project.	☐ M ☒ m ☐ a
(iii) that needs further work by the partners responsible for the deliverable?	☐ Yes ☒ No		☐ M ☐ m ☐ a	☐ Yes ☒ No		☐ M ☐ m ☐ a

* Type of comments: M = Major comment; m = minor comment; a = advice