E3NETWORK

Energy Efficient E-band transceiver for backhaul of the future networks

DELIVERABLE **D.6.4.3**

Recommendation for standardization in E-Band

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VERSION CONTROL

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	28-10-2013	ALU;OTE;CEIT	All
	30-10-2013	ALU;OTE;CEIT	All –final version
2	01-10-2014	ALU	Start revision 2
	30-10-2014	ALU	Mainly chapter 3 and 4 -Final draft Version
	31-10-2014	ALU;OTE;CEIT	All –final version
3	10-01-2016	ALU	ALL
	05-02-2016	ALU	Chapter 3 – listed the main contribution to Standardization bodies provided by E3NETWORK
	23-05-2016	ALU;OTE;SIVERSIMA	Final Revision

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EXECUTIVE SUMMARY

This document contains information on the relevant standardization bodies from the E3NETWORK project point of view. The ongoing standardization activities, strictly related to the project, carried out by these standardization bodies are also described.

It may be worth noting the high visibility of the E3NETWORK project that can be achieved through standardization initiatives. In fact, it is important that the results of the project are made known in order to have an impact on the wider research and industrial communities.

The E3NETWORK consortium will be active in the different standardization activities in order to achieve this goal. These standardization bodies are:

- ETSI
- CEPT ECC
- ITU
- National Administrations

A new group has also been identified, established in ETSI, the “millimetre Wave Transmission” (mWT) Industry Specification Group (ISG). Main scope of this group is to provide a platform and opportunity for companies and organizations involved in the microwave and millimetre-wave industry chain to address the challenges involved in using this spectrum.

The standardization bodies related to the Frequency Spectrum Management (CEPT ECC, ITU-R and national regulatory bodies responsible of spectrum management) have been monitored to ensure that an adequate frequency arrangement for E3NETWORK is maintained.

Throughout our activities, E3NETWORK has influenced and contributed to a plenty of working documents and decisions taken in ETSI ATTM TM4, ETSI mWT ISG and ECC SE19.

This deliverable is organised as follows, in chapter 1, an introduction to the scope of the standardization bodies is presented. Then, in chapter 2, an introduction of the European regulatory environment for radio equipment and spectrum and a description of the main players involved are provided.

In chapter 3, a deep description of the places, inside the standardization bodies, in which E3NETWORK contributed and the most relevant points touched are discussed.

In chapters 4 and 5, the E3NETWORK work and results to support ETSI ATTM TM4 are shown.

At the end, the relevant conclusions are summarized..

The requirements identified at the beginning of the project are in line with the last contribution submitted to the ETSI ATTM TM4 standard. Decision from TM4 is expected by the end of 2016, but there seems to be no reason for receiving a no go. Considerations on possible link planning issues have been highlighted during the last meeting and will be further discussed later on. Unfortunately, E3NETWORK does not have any specific results, coming from measurements, that could be shared for supporting and validating the assumption taken about introducing new capacity profiles in E-Band.

1. INTRODUCTION

The E3NETWORK project aims to not only validate actual wireless state-of-the-art technology, but also to upgrade and integrate it in order to prepare for the deployment of next generation Information and Communications networks across Europe. Basically, the E3NETWORK project proposes a solution for 10Gbps connectivity based on a wireless technology in E-Band, providing a flexible, cost-effective, energy-efficient system.

The results of E3NETWORK are expected to have an important role in the ongoing standardization processes carried out by the different standardization bodies. In this chapter, a brief summary of the potential contributions of E3NETWORK to the relevant standardization committees is presented.

1.1 E3NETWORK potential contributions to standardization activities

E3NETWORK is a new approach that allows a 10Gbps wireless interconnection useful for the next generation networks. One of the main objectives of the E3NETWORK project is to assess the feasibility of a high modulation scheme radio, 64QAM, operating in the highest frequency band today available, the E-Band, and with widest channel, never used so far, 2000MHz, to make it possible to transport with a single radio link, up to 10Gbps and up to 1Km with huge link availability, 99.995% of the time.

The contributions that E3NETWORK can provide to standardization bodies are related to the points listed below:

- **Frequency Arrangement of E-Band**. The consortium should recommend that 2000MHz channel will be available in the future.

  The CEPT/ECC is the European institute in charge of the Frequency arrangement Definition. An important role, in this context, is also played by the National Administrations that are in charge of the management of radio spectrum. In the next chapter, the relation between National Administration and CEPT/ECC will be explained, focusing on those related to E3NETWORK. The relationship between ITU and CEPT/ECC is also described in the following chapter.

- **Characteristics and requirements for point-to-point Fixed Radio Systems operating in E-Band in 2000MHz channel spacing carrying 10Gbps**

  This point is related to the requirements a radio link must fulfil to operate in compliance with the current EU mandatory rules; in particular, “the regulatory framework for placing radio systems on the market, established by the R&TTE Directive” is relevant for this project. The R&TTE Directive requires the availability of a Harmonized document, called ENs covering the essential requirements under article 3.2 of the R&TTE Directive.

  The ETSI ATTM TM4 is in charge of the EN 302 217 series that meet this demand by providing a rational subdivision of requirements into general, system dependent "not essential" and "essential" requirements from the perspective of the R&TTE Directive.

  Since, E3NETWORK aims to introduce a new radio equipment, the consortium will help ETSI to define or complement the essential and not essential requirements requested by the R&TTE Directive that fit with the E3NETWORK solution.

- **Energy efficiency metrics**

  It will be very interesting for the ETSI TM4 to know where E3NETWORK solution will be positioned according to the Equipment Energy Efficiency Ratio (EEER) metrics defined into ETSI TR 103 820 – Energy efficiency metrics and test procedure for Point-to-point fixed radio systems [22].

  Details will be reported in D6.5.3.

2. E3NETWORK TARGET STANDARDIZATION BODIES

2.1 European regulatory environment for radio equipment and spectrum

This section provides a short introduction to the regulatory environment in Europe for radio equipment and spectrum as described in [14].

2.1.1. Radio Regulatory Environment

At national level, radio spectrum is managed by National Administrations, which adopt a national table of radio spectrum allocations, define a framework for use of the radio spectrum and assign radio spectrum to the different users via licences or via licence-free arrangements.

At European level, the European Commission (EC), the European Telecommunications Standards Institute (ETSI) and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) cooperate on aspects related to the regulatory environment for radio equipment and spectrum both at the EU level and at the wider intergovernmental level across Europe.

Figure 1. Radio Regulatory environment

2.1.2. European Union Radio Spectrum Regulatory Framework

The European Commission embodies and upholds the general interest of the 27 countries of the European Union. Its four main roles are: to propose legislation to Parliament and Council; to administer and implement Community policies; to enforce Community law; and, to negotiate international agreements, mainly those relating to trade and cooperation.

EU radio spectrum policy aims to coordinate spectrum management approaches across the Union. The overarching objective is to support the internal market for wireless services and to foster innovation in electronic communications and other sectors. It includes a regulatory framework to harmonize access conditions at EU level to ensure efficient use of radio spectrum and to enable interoperability of radio equipment.

The Commission may also, under the EC Radio Spectrum Decision, harmonize the technical conditions for the use of spectrum with the technical assistance of CEPT, on the basis of specific mandates. EU Decisions and regulations take precedence in the EU over ECC

decisions, which are non-binding, in cases where both measures exist in relation to the same issue.

The electronic communications regulatory framework was also modified to introduce more flexibility through the principles of technology and service neutrality. The EC harmonizes the essential requirements for radio equipments, which include constructing radio equipment so as to avoid harmful interference, via the New Approach R&TTE Directive. The New Approach R&TTE Directive regulates the requirements that products must meet in order to be placed on the market and put into service. The Directive is implemented at national level by Member States.

The usual way for manufacturers to comply with these requirements is to apply Harmonized Standards developed by ETSI and by CENELEC.

2.1.3. ECC of CEPT

The CEPT is a cooperative body in Europe of 48 national regulatory administrations in the field of posts and telecommunications. It is a recognized regional organization acting in accordance with pan-European goals set up by CEPT.

The Electronic Communications Committee (ECC) brings together 48 countries to develop common policies and non-binding regulations in electronic communications and related applications for Europe, and to provide the focal point for information on spectrum use. Its primary objective is to harmonize the efficient use of the radio spectrum, satellite orbits and numbering resources across Europe. It takes an active role at the international level, preparing common European proposals to represent European interests in the ITU and other international organizations.

The ECC's approach is strategic, open and forward-looking, and based on consensus between the member countries. It applies its expertise in partnership with all stakeholders, the European Commission and ETSI to facilitate the delivery of technologies and services for the benefit of society.

The ECC, in particular on request of its members, among others, undertakes compatibility studies and establishes conditions and parameters under which the sharing between the different users of the spectrum may take place. This may result in the development of an ECC Decision. Other ECC deliverables are ECC Recommendations, CEPT Reports (responses to mandates from the EC) and ECC Reports. ECC documents can be found at [12].

Attendance at ECC meetings includes representatives of the EC and of the European Free Trade Association (EFTA) Secretariat, representatives of ETSI, possibly representatives of relevant inter-governmental organizations as well as other organizations or non-CEPT Administrations concerned with electronic communications. In addition, industry representatives may also be invited as Observers by the Chairman.

In 1988, ETSI, the European Telecommunications Standards Institute, was created under the auspices of CEPT, which transferred all of its telecommunication standardization activities to ETSI. The ECC has a strong cooperation with ETSI in order to ensure coherence between ECC Decisions and ETSI Harmonized Standards.

2.1.4. ETSI

ETSI produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies.

ETSI is officially recognized by the European Union as a European Standards Organization under the 98/34/EC Directive. ETSI is an independent, non-profit association with more than

700 members (including national administrations, companies and international organizations), drawn from 62 countries across 5 continents worldwide, participating directly in its work.

ETSI currently has more than 70 collaboration agreements with other organizations throughout the world. ETSI's purpose is to produce and maintain the technical standards and other deliverables which are required by its members. Much of the work is carried out in committees and working groups composed of technical experts from ETSI's member companies and organizations. ETSI, together with CENELEC, is responsible for the development of Harmonized Standards under the R&TTE Directive (1999/5/EC) in response to the EC mandates.

Applying Harmonized Standards referenced in the Official Journal of the European Union (OJEU) enable manufacturers and service providers to benefit from a presumption of conformity with the requirements of the Directive, and thus be able to sell, deploy and put into service (without prejudice to conditions attached to spectrum usage rights) the radio and telecommunications terminal equipment within the European Union.

ETSI also develops Technical Reports, named System Reference Documents (SRDoc), providing technical, legal and economic background on new radio systems under standardization and informs the ECC accordingly.

2.1.5. Cooperation between CEPT/ECC and ETSI

The ECC develops regulations for the effective use and Europe-wide harmonization of the radio frequency spectrum, and the efficient use of satellite orbits. Therefore, the ECC provides decisions regarding the allocation/designation of frequencies for radio communications services and applications within the CEPT countries. It also provides requirements for the use of spectrum by radio equipment.

ETSI develops standards for radiocommunication systems and equipment. These radio standards, and in particular those under article 3.2 of the R&TTE Directive, contain various requirements about the efficient use of the spectrum, including compatibility between different radio services.

A Memorandum of Understanding (MoU) has been agreed between ETSI and the CEPT Electronic Communications Committee (ECC), for co-operation. In the development of Harmonized Standards for radio equipment as well as in relevant ECC deliverables, the provisions of the ETSI-CEPT MoU are applied, as depicted in Figure 2.

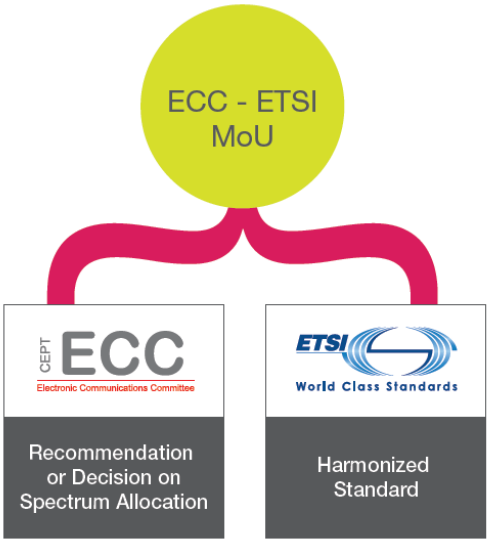


Figure 2. Relationship between ETSI and ECC

2.1.6. Cooperation between the EC and CEPT/ECC

ECC/CEPT develops CEPT Reports in response to mandates issued by the EC, as shown in Figure 3. Those CEPT Reports provide input for the development of Commission Decisions which may also reflect the technical parameters and sharing conditions identified by ECC/CEPT.

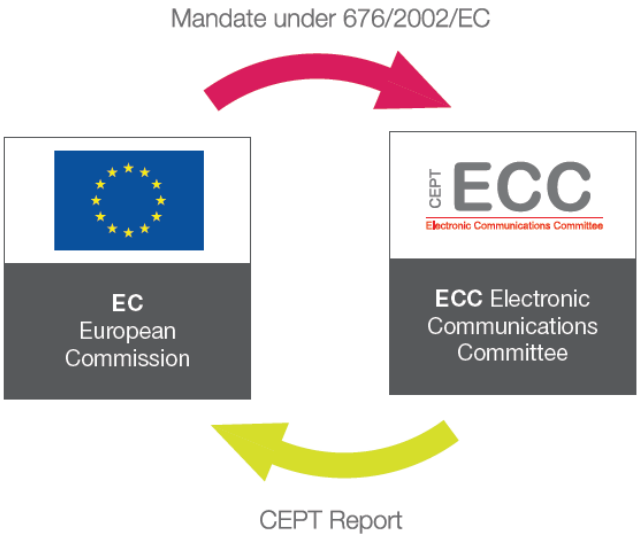


Figure 3. Relationship between ETSI and ECC

Commission Decisions are mandatory harmonization measures within the EU. Thus, the implementation of EC Decisions is mandatory for EU Member States, EEA countries, bilaterally "associated" countries as well as any accession country before it can join the EU.

Finally, the ECC also assists the Commission in the publication of sub classes for equipment in accordance to the R&TTE Directive by contributing to Telecommunications Conformity Assessment and Market Surveillance (TCAM).

2.1.7. Cooperation between the EC and ETSI

The Telecommunications Conformity Assessment and Market Surveillance (TCAM) Committee assists the Commission in the management of R&TTE Directive (1999/5/EC).

The R&TTE Directive (1999/5/EC) regulates the requirements that radio and telecommunication terminal equipment must meet in order to be placed on the market and to be put into service (without prejudice to conditions attached to spectrum usage rights, as described in Articles 6.1, 7.1 and 7.2). It harmonizes the requirements for radio equipment to use the radio spectrum effectively so as to avoid interference with the objective of ensuring the good functioning of the internal market of the European Union.

Stating from June 2016, a new EU Directive, the Radio Equipment Directive (RED) (2014/53/EU) supersedes the current R&TTE Directive (1999/5/EC).

The EC, after consultation with TCAM prepares mandates for development of Harmonized Standards. Under these mandates ETSI produce the Harmonized Standards (see figure 4). These mandates are subject to approval of the 98/34 Committee under the Directive on the procedure for the provision of information in the field of technical standards and regulations and of rules on Information Society services (98/34/EC).

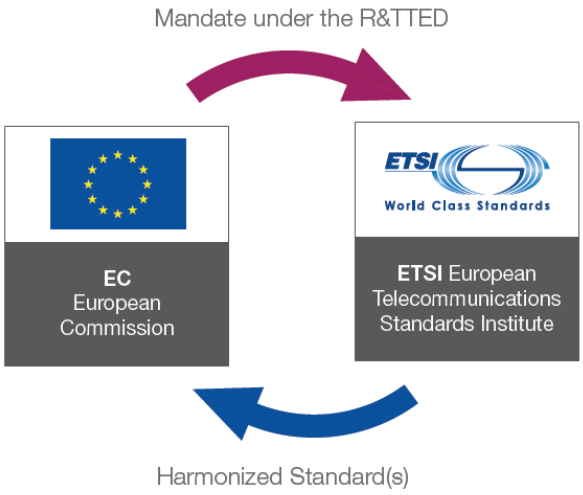


Figure 4. Relationship between EC and ETSI

2.1.8. Obligation of manufacturers

The picture below shows the responsibilities of manufacturers under the R&TTE Directive [6].

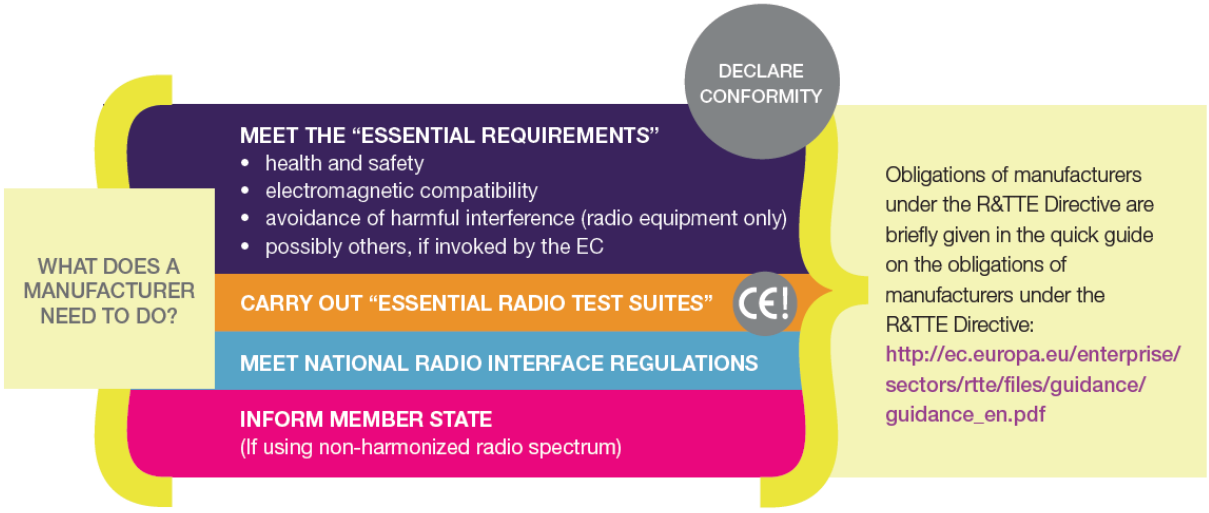


Figure 5. Responsibilities of the manufactures under R&TTE Directive

Basically, the scenario will remain practically unchanged when the new EU Directive "Radio Equipment Directive" (RED) will supersede the R&TTE. Main difference introduced is the essential requirement based on the concept of "efficient use of the spectrum", already taken into account in ETSI standard for wireless Fixed service.

2.1.9. ITU

ITU is the United Nations specialized agency for information and communication technologies (ICT). ITU allocates global radio spectrum and satellite orbits, develops the technical standards that ensure networks and technologies seamless interconnection, and strives to improve access to ICTs to underserved communities worldwide.

The ITU Radiocommunication sector (ITU-R) is the part of ITU relevant in the E3NETWORK context. The ITU-R plays a vital role in the global management of the radio-frequency spectrum and satellite orbits - limited natural resources which are increasingly in demand from a large and growing number of services such as fixed, mobile, broadcasting, amateur, space research, emergency telecommunications, meteorology, global positioning systems, environmental monitoring and communication services - that ensure safety of life on land, at sea and in the skies.

The mission of ITU-R is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including those using satellite orbits, and to carry out studies and approve Recommendations on radiocommunication matters. In implementing this mission, ITU-R aims at creating the conditions for harmonized development and efficient operation of existing and new radiocommunication systems, taking due account of all parties concerned.

The primary objective of ITU-R is to ensure interference free operations of radiocommunication systems. This is ensured through implementation of the Radio Regulations and Regional Agreements, and the efficient and timely update of these instruments through the processes of the World and Regional Radiocommunication Conferences.

Furthermore, ITU-R establishes ´Recommendations´ intended to assure the necessary performance and quality in operating radiocommunication systems. It also seeks ways and means to conserve spectrum and ensure flexibility for future expansion and new technological developments.

2.1.10. Cooperation between the CEPT and ITU

Com-ITU (Working Group ITU) is responsible for organising the co-ordination of CEPT actions. They also organize meetings for the Council, Plenipotentiary Conferences, World Telecommunication Development Conferences, World Telecommunication Standardisation Assemblies for and during the course of the ITU activities and other meetings as appropriate.

2.1.11. National Regulatory bodies

National regulatory bodies are responsible for the regulation and control of the communications sector in each country. It is their responsibility to define and propose strategies to develop the communication sector.

Moreover, they should also supervise the telecommunications market, in order to ensure the application of the defined laws, regulations and technical requirements, as well as guarantee that the communications operators are respecting the granted licences. Sometimes, the National Regulatory bodies ask for opinion about the possible review of the Spectrum Management Approach trough public consultation.

3. STANDARDIZATION PLAN

This chapter presents the standardization activities that have been planned within E3Network. The relevant working groups and tasks in each standardization committee are identified. Moreover, the activities performed in each relevant working group within the first period of the project are described in this chapter.

3.1 CEPT ECC

The following figure shows the structure of ECC.

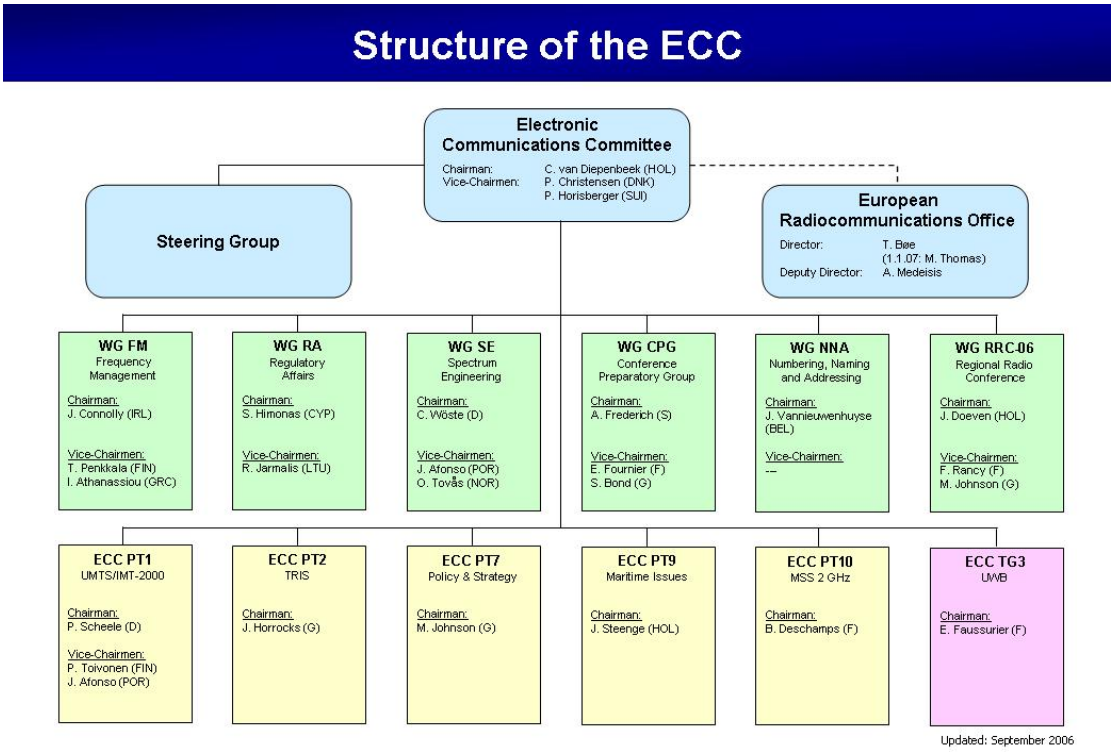


Figure 6. Structure of the ECC

The most relevant group of interest of E3NETWORK for contribution within ECC is the Working Group 'Spectrum Engineering' (WG SE). This working group (WG SE) shall:

- Develop technical guidelines for the use of the frequency spectrum by various radiocommunication services;
- Develop sharing criteria between radiocommunication services, systems or applications using the same frequency bands;
- Develop compatibility criteria between radiocommunication services using different frequency bands;
- Co-ordinate CEPT activities and contributions for the related work in ITU-R;
- Co-operate with relevant technical bodies in ETSI in accordance with the procedures given in the Memorandum of Understanding between ECC and ETSI;

- Study technical impacts of ISM and other non-radio equipment on radio services taking into account related activities in the relevant International and European Organisations;
- On request from the CPG (Conference Preparatory Group) contribute to the preparation of CEPT positions for WRCs (World Radiocommunication Conferences) and other relevant fora;
- Seek, where relevant, contributions and assistance from the Office and the relevant ECC subordinate bodies;
- Consult with various bodies and organisations within CEPT countries or Administrations outside the CEPT, with the principal aim to collect information and to broaden the support for the deliverables of the working group;
- Prepare draft Decisions as directed by the Plenary and prepare and approve Recommendations and Reports as necessary;
- Develop and maintain its work programme, approve the work programme of its subordinate bodies, and guide and co-ordinate the work of these bodies;
- Report to the Plenary.

Inside the WG PTSE, the most relevant group for E3NETWORK is “PTSE19 Fixed Service”.

3.1.1. CEPT ECC PT SE19 – Activities and contributions-

The SE19 takes care of:

- Preparing harmonised frequency plans and guidelines for introducing novel broadband applications in the FS;
- Studying developments in new FS technology;
- Studying compatibility/sharing issues involving traditional FS (such as radio relay links) as well as broadband FS applications;
- Co-ordinating the relevant activities in ITU-R;
- Liaising/contributing to ETSI ATTM/TM4 in accordance with the CEPT/ETSI MoU.

Some of the works currently under SE19 responsibility, and interesting for the E3NETWORK project, are listed below. In the following, the E3NETWORK contribution to the discussion is summarized:

- SE19_20: Technical conditions for FS deployment inside 71-76/81-86 GHz

  Scope: Revision of ECC REC(05)07 (E-Band frequency arrangement)

  - E3Network presented the Fronthaul application that achieves 10Gbps by means of larger channel spacing, in particular at least 2GHz channel as in our project. Outcome obtained is the current possibility, foreseen in annex 3, to have a FDD system in nx250MHz channel.

- SE19_19: Add in the ECC/REC(05)07 [14] the option of subdividing a number of contiguous 250 MHz channels into 50 MHz or/and 62.5 MHz slots in order to provide smaller

  It is a revision of the ECC/REC(05)07 (Radio frequency channel arrangements for Fixed Service Systems operating in the bands 71-76 GHz and 81-86 GHz).

- E3Network raised the point that E-Band should be dedicated to very high capacity system carrying on at least 1Gbps and more and this proposal approach will jeopardise the deployment of such a high speed application. Outcome obtained: ECC Recommendation (the ECC/REC(05)07 only but not the ITU-R F2006) foresees today this option. Nevertheless it has been observed, see [17], that very few administrations have currently adopted this option, recognising the fact of the concerns we raised.

- SE19_24: Coordinated inputs to ITU-R: WP5C

  This is the way used for coordination of contributions related to FS channel arrangements to ITU-R F series recommendations. In particular, the new version of ECC/REC(05)07 will be enclosed in the ITU-R F2006 "Radio-frequency channel and block arrangements for fixed wireless systems operating in the 71-76 and 81-86 GHz bands".

  - E3NETWORK supported this coordinated activity. Outcome obtained: A recognised Worldwide Recommendation for E-Band, adherent to E3NETWORK needs is today available

- SE19_35: Subject: To study and gather up-to-date information related to developments in the FS, including the millimetre wave bands (frequency bands higher than 50 GHz) in CEPT

  Scope: Revision of ECC Report 173 - Fixed Service in Europe Current use and future trends post 2011

  Revision of ECC Report 173 has started. First Questionnaire to gather information in the frequency bands above 50 GHz has been distributed and responses were examined.

  - E3NETWORK supported this activity. Outcome: A better understanding of mmWave ecosystem is captured and spread around E3NETWORK stockholders.

- SE19_37: ECC Subject: To facilitate the deployment of fixed service links in the frequency blocks already allocated to fixed service – W band-

  Scope: Recommendation(s) and/or ECC Report containing guidelines on deployment of fixed services operating in the allocated bands 92 – 94 GHz, 94.1–95GHz, 95–100GHz, 102 – 109.5 GHz and 111.8 – 114.25 GHz.

  The band 92 – 95 GHz alone did not attract interest from the industry due to its limited channel bandwidth and the narrow duplexing spacing. The study is expected to include future requirements in the fixed services (e.g. deployment scenarios, propagation models, radio channel arrangements, etc.). Sharing and compatibility will also be considered as required. Doc.SE19(15)29 for background.

  - E3NETWORK supported this activity because these new bands can be a place where some results from E3NETWORK can find place for future exploitation. Welcome and supported the approach of having a frequency raster based on 250MHz with a possibility of aggregating a free number of channels. Outcome: Currently very similar channel arrangement to E-Band, enabling a possible exploitation of some E3NETWORK approaches and results.

- SE19_38: Subject: To facilitate the deployment of fixed service links in the frequency blocks already allocated to fixed service – D Band

Scope: ECC Recommendation(s) and/or ECC Report containing guidelines on deployment of fixed services operating in the allocated bands 130 – 134 GHz, 141 – 148.5 GHz, 151.5 – 164 GHz and 167 – 174.7 GHz.

The study is expected to examine future requirements in the fixed services (e.g. deployment scenarios, propagation models, radio channel arrangements, etc.). Sharing and compatibility will also be considered as required.

- E3NETWORK supported this activity because these new bands can be a place where some results from E3NETWORK can find place for future exploitation. Welcome and supported the approach of having a frequency raster based on 250MHz with a possibility of aggregating a free number of channels. Outcome: Currently very similar channel arrangement to E-Band, enabling a possible exploitation of some E3NETWORK approaches and results.

3.1.2. CEPT ECC PT SE19 methodology for Contribution

The CEPT ECC SE 19 FIXED SERVICE organizes regular meetings, where it is possible to participate and provide feedback. The contribution to SE 19 may consist of preparation for supporting document to specific topics, or can be done orally during the face-to-face meetings. Sometimes a web-meeting is arranged for particular topics.

Table 1 reports the ECC SE 19 FIXED SERVICE meetings since October 2014 and the E3NETWORK attendees. During the first period of the E3NETWORK project, a full monitoring of the ECC WG group and ECC SE group, with particular focus on ECC SE19, has been performed both by meeting attendance and by reading the meeting documents off-line. The information relevant for the project has been reported to the E3NETWORK partners.

Table 1. SE19 meetings since October 2014

MEETING NUMBER	DATE	PLACE	Office	E3NETWORK ATTENDEES
61	JANUARY 2013	Copenhagen	ERO	MARIO FRECASSETTI
62	FEBRUARY 2013	Copenhagen	ERO	MARIO FRECASSETTI
63	APRIL 2013	Copenhagen	ERO	-
64	JUNE 2013	Copenhagen	ERO	-
65	OCTOBER 2013	Copenhagen	ERO	-
66	JANUARY 2014	Copenhagen	ERO	-
67	*APRIL2014*	*MAISON ALFORT - FRANCE*	*ANFR*	MARIO FRECASSETTI
68	*AUGUST2014*	*BUCHAREST*	*ANCOM*	MARIO FRECASSETTI
69	*NOVEMBER2014*	*BIENN/BIEL*	*OFCOM*	
70	*APRIL 2015*	*SOPHIA ANTIPOLIS*	*ETSI*	MARIO FRECASSETTI
71	*SEPTEMBER 2015*	*HELSINKI*	*FICORA*	MARIO FRECASSETTI
72	*DECEMBER 2015*	*MAISON ALFORT - FRANCE*	*ANFR*	-
73	*APRIL 2015*	Copenhagen	ERO	-

4. ETSI – ATTM

Figure 7 shows the structure of ETSI. Within ETSI, the most relevant group of interest of E3NETWORK for contribution is inside the Technical Committee (TC) ATTM "Access Terminals Transmission and Multiplexing" Technical Body.

The TC ATTM addresses Access, Terminals, Transmission and Multiplexing including all aspects within the ETSI scope - cabling, installations, signal transmission, multiplexing and other forms of signal processing up to digitalization in private and public domain; excluding those aspects that relate to Hybrid Fibre-Coaxial cable networks which are covered by TC Cable. TC ATTM closely collaborates with the Technical Bodies responsible for communications, networking and services and the exact boundary between the activities is adapted to the members' needs.

ATTM is organized around a set of ETSI work items addressing specific technologies, equipment, installations and regulatory aspects of the physical layer e.g.:

- Transmission issues of interfaces.
- Frequency management on the non-radio communication infrastructures.
- Analogue and digital presented communication interfaces of balanced wired (twisted pair), coaxial cable and optical fibre infrastructures.
- Interfaces based on new technologies, as far as they are relevant for communication infrastructures. These interfaces could be public or private, switched or non-switched, seen from either the network or the terminal side.
- Point-to-point and point-to-multipoint radio systems and infrastructures used for the fixed service (core and access networks), covering all equipment aspects including antenna parameters.
- Transmission related aspects of network architectures (including protection issues)-
- Specification of the transmission functions and performance of the network elements such as transmission paths, path elements, sections, systems, functional entities, antenna, cable and optical fibre.

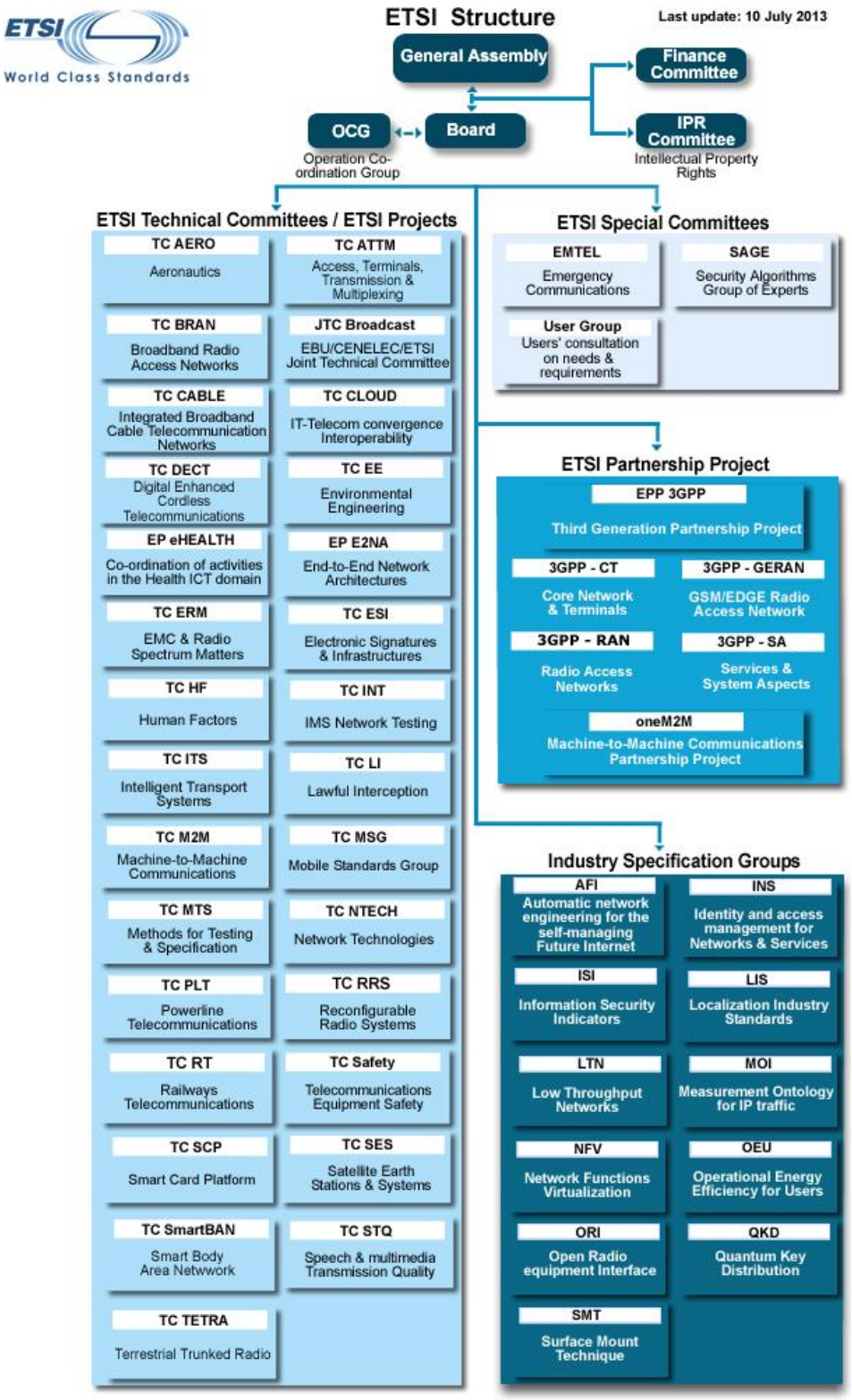


Figure 7. The structure of ETSI

TC ATTM consists of three Working Groups:

- WG AT2: Infrastructure, Physical Networks & Communication Systems
- WG TM4: Fixed Radio Systems

- WG TM6: Wireline Access Network Systems

Within TC ATTM of ETSI, the relevant group for E3NETWORK is WG TM4: Fixed Radio Systems.

4.1.1. ATTM TM4 – Activities and contributions-

WG TM4 has the following responsibilities:

- Specifications for point-to-point and multipoint radio systems, in the fixed service used in core and access networks, covering all equipment aspects including antenna parameters. Radio-frequency matters that may affect CEPT/ECC radio-frequency allocation and policy are excluded;
- Functional requirements for radio-frequency equipment interface, including allocation of overhead;
- Co-operation and technical support towards ECC/PT SE19 for channel arrangements and improved spectrum usage in the frequency bands allocated to fixed service (in co-ordination with ETSI WG ERM/RM).

In the following, we identify the works currently under WG TM4 responsibility that may have an impact in the context of E3NETWORK:

- TR 103 820, Energy efficiency metrics and test procedures for Point-to-point fixed radio systems [22]
- REN/ATTM-04025: Proposed revision of EN 302 217-2-2 (smaller CS in the E-band)
- REN/ATTM-04026: Proposed revision of EN 302 217-3 (smaller CS in the E-band)
- ATTM TM4(13)000028: From ITU-R WP5A on “Multiple Gigabit Wireless Systems in frequencies around 60 GHz”.
- DTR/ATTM-04015: New TR 103 053 for the study factors affecting Receiver Signal Level (RSL) thresholds and to define their practical values in view of possible standardization.
- Updating revision of TR 102 311, Technical Report on MIMO
- Revision of EN 302 217-1
- Revision of HS EN 302 217-2 [24] (merging of previous part 2-2 and part 3; channels aggregation + RED)
- EN 302 217-4 (PtP antenna under RE-D) DTR/ATTM-04027: New TR 103 230 on Small Cells Backhauling

It is worth noting that the EN 302 217-2 is the new Harmonized Standards relevant for the forthcoming RE-D directive that will soon supersede the R&TTE Directive.

4.1.1.1. ATTM TM4 Methodology for contribution

The ATTM TM4 organizes regular meetings, usually two per year, where it is possible to participate and provide contribution and feedback. The contribution to ATTM TM4 may consist of preparation for supporting document to specific topics, or can be done orally during the meeting.

Table 2 reports the ATTM TM4 "Fixed Radio Services" meetings since May 2011 and the E3NETWORK attendees. We can observe that E3NETWORK has been represented in these meetings since the beginning of the project (December 2012).

Table 2: ETSI ATTM TM4 meetings

MEETING NUMBER	DATE	PLACE	OFFICE	E3NETWORK ATTENDEES
45	MAY 2011	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
46	OCTOBER 2011	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
47	APRIL 2012	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI -
48	OCTOBER 2012	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI -
49	APRIL 2013	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI -
50	OCTOBER 2013	LONDON	UK	MARIO FRECASSETTI -
51	APRIL 2014	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
52	OCTOBER 2014	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
53	APRIL 2015	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
54	NOVEMBER 2015	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
55	APRIL 2015	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
56				

4.1.2. ETSI millimetre Wave Transmission (mWT) Industry Specification Group (ISG) [18]

ETSI has established a millimetre Wave Transmission (mWT) Industry Specification Group (ISG) to provide a platform and opportunity for companies and organizations involved in the microwave and millimetre-wave industry chain to address the challenges involved in using this spectrum.

Millimetre Wave Transmission concerns the use of millimetre wave spectrum for radio transmission. Millimetre wave spectrum lies in the 30GHz to 300GHz range (with wavelengths from 10mm to 1mm).

This spectrum is of interest for a number of reasons:

- Lots of spectrum available: There is one order of magnitude of more spectrum available in this band than in lower bands
- Larger bandwidth channels are possible, of 2GHz, 4GHz, 10GHz or even 100GHz. This allows for fibre-like capacity
- The spectrum can be made available quickly, and can be reused easily with the limited propagation range in this band
- Lower spectrum license costs lead to a lower total cost of ownership and lower cost per bit of radio systems using this spectrum

However, there are barriers to using this spectrum. Regulations for millimetre wave radio differ greatly from country to country, ranging from no regulation to full regulation. There is a lack of key components leading to high equipment costs, a huge variety in the types of equipment and applications using this spectrum and still a lack of confidence in the technology.

ETSI's mWT Industry Specification Group aims to be a worldwide initiative with global reach and will address the whole industry: national regulators, standards organizations, telecom operators, product vendors and key component vendors.

The mWT ISG aims to facilitate the use of:

- Traditional microwave frequency bands up to 60 GHz
- V-band (57 to 66 GHz)
- E-band (71 to 76 & 81 to 86 GHz) and
- in the future higher frequency bands (up to 300 GHz)

for large volume applications in back-hauling and front-hauling to support mobile network implementation, wireless local loop and any other service benefitting from high speed wireless transmission.

In the following, we identify the work currently under mWT ISG responsibility that may have an impact in the context of E3NETWORK and relevant contribution provided.

- MWT 001: Maturity and field proven experience of millimetre wave transmission [19]

  Scope of this document:

  - Enhance operator and regulator confidence in millimetre wave transmission
  - Provide an overview of traditional propagation and availability models for mWT and their status.
  - Share measurement results and experience from trials, deployments and propagation/availability test ranges of mWT.
  - Address additional experience in new dense urban street level environment (macro to small cell, as well as small cell to small cell) for example regarding near-LOS, non-LOS and mast sway for mWT.

- MWT 002: Applications and use cases of millimetre wave transmission [20]

  Scope of the work:

  - Millimetre wave spectrum technology overview
  - Millimetre wave spectrum technology key performance benefits
  - Potential transmission applications and use cases for millimetre wave spectrum technology
  - Key requirements per transmission application / use case of millimetre wave spectrum technology
  - Enablers of millimeter wave spectrum technology per transmission application / use case
    - E3NETWORK contributed to this document and in particular the parts related to application and uses cases.

- MWT 003: Overview on V-band and E-band worldwide regulations [17]

Scope of the work:

  - Provide an updated overview on the regulation and spectrum allocation of both V-Band and E-Band
  - Give updates on the international regulations from standardization bodies, such as ITU or ETSI and from Regional Organizations, such as ECC/ FCC
  - Provide the rules at national level which, for the scope of the analysis, can be considered as the key source of information, as they reflect the national status in several countries both in the European Union and outside.
    - E3NETWORK representative acted as rapporteur of this document. Our project has been quoted several times in the document.

- MWT 004: V-band street level interference analysis

Related to V Band. Not yet completed.

- MWT 005: millimetre wave semiconductor Industry technology status and evolution [to be released]

Scope of the work:

  - Provide an overview on technology/foundry processes current available and planned in future
  - Provide an overview on packaging processes current available and planned in future
  - Provide an overview on possible chip integration evolution on the technologies
  - Semiconductor: considerations to use frequency band from 90 GHz and above
    - E3NETWORK contributed to this document. The E3NETWORK technology and preliminary results have been reported.

- MWT 006: Analysis of the antenna use cases for Point-to-Point and Point-to-MultiPoint millimetre wave links [21]

Scope of work:

  - Provide an overview on Key Operator expectations: Functionalities; RF and environmental features; Interference limitations; Others
  - Provide an overview on use cases and related antenna requirements.
  - Review of the current technologies and regulatory status
  - Provide a white paper on antenna applications and related technology status

List of meetings and E3network attendees.

Table 3: ETSI ISG mWT meetings

MEETING NUMBER	DATE	PLACE	OFFICE	E3NETWORK ATTENDEES
1	JANUARY 2015	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
2	MAY 2015	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI
3	SEPTEMBER 2015	LONDON	LAYER123	MARIO FRECASSETTI – ANDREA PALLOTTA
4	JANNUARY 2016	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI -
5	APRIL 2016	SOPHIA ANTIPOLIS	ETSI	MARIO FRECASSETTI – ANDREA PALLOTTA

4.2 ITU

As there is a close relationship between ECC and ITU, the activities that will be performed within ECC should be considered enough to spread inside ITU-R the benefits of E3NETWORK results. Thus, in the context of E3NETWORK, it is not foreseen to provide a direct contribution to ITU, and in particular to ITU-R.

A workshop specifically addressed to millimetre waves, supported by the ETSI mWT ISG, was held in connection with the plenary meeting of ITU-R WP5C in Bucharest, 6-15 July 2015. During this workshop an E3NETWORK delegate, presented E3NETWORK project.

4.3 National Regulatory bodies

As mentioned above, sometimes the National Regulatory bodies are asking for the public opinion through a public consultation. It is important, in the context of E3NETWORK to monitor and eventually reach to this kind of consultations.

4.3.1. OFCOM –UK

The most relevant consultation, currently ongoing is issued by OFCOM –UK. OFCOM is the communications regulator of UK. OFCOM regulates the TV and radio sectors, fixed line telecoms, mobiles, postal services, plus the airwaves over which wireless devices operate. The consultation: “Review of the Spectrum Management Approach in the 71-76 GHz and 81-86 GHz bands. Consultation on the future management approach for the 70 / 80 GHz bands” was published in August 2013 and proposes changes to the management and authorization approach within the 71-76 GHz and 81-86GHz Band (E-Band). The consultation can be found in http://stakeholders.ofcom.org.uk/consultations/70-80ghz-review/

In the following picture, the frequency plan proposed in this consultation is shown.

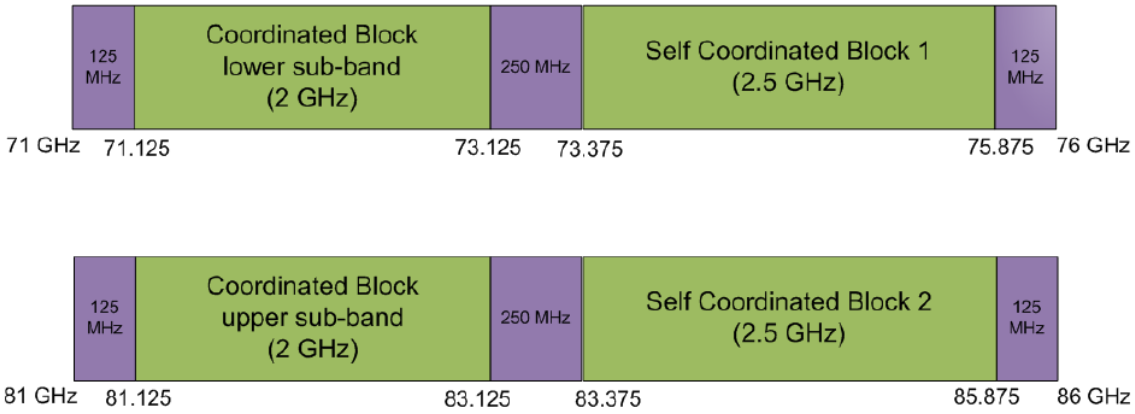


Figure 8. Frequency plan proposed in the consultation of OFCOM-UK.

Currents limits, in terms of Maximum channel bandwidth are reported in the following table.

Segment	Block Size	Frequency range	Maximum channel bandwidth	Band Plan
Self coordinated block (currently available)	2.5 GHz	73.375–75.875 GHz and 83.375-85.875 GHz	2.5 GHz	no channel plan
Ofcom coordinated Block (available from 17 December 2013)	2 GHz (limited to 1 GHz in the first instance)	71.125-73.125 GHz and 81.125-83.125 GHz	1000 MHz	CEPT band plan (ECC REC (05)07)
Spectrum separating the Self coordinated and Ofcom coordinated blocks	250 MHz	73.125-73.375 GHz and 83.125-83.375 GHz	-	-

Figure 9. Maximum channel bandwidth in UK.

4.3.1. National Telecommunications and Post Commission (EETT) - Greece

According to last decision of EETT [16] current situation is depicted into the following table.

Table 3: E-band frequency planning in Greece

Frequency Band (MHz)	Network Topology	Usage	Channel spacing (MHz)	Frequency Plan	Authorization regime	Interfaces	Equipment standards (ETSI)	Additional requirements
710000-760000 paired with 810000-860000	Point-to-point radio links	Digital radio links	Integer multiple of 250 MHz Possibility of 250 MHz channel subdivision to 4 x 62,5 MHz or 2 x 125 MHz	According to ECC/REC/(05)07	Mandatory		EN 302 217	ECC/REC/(05)07 Use of FDD or TDD

According to this, an integer multiple of 250 MHz channels are allowed, enabling the deployment of an E3NETWORK solution.

4.3.2. Ministero dello Sviluppo Economico - MISE – ITALY

A recent public consultation has taken place in Italy, covering the whole fixed services frequency bands (PNRF).

In this public consultation, among other points, E3NETWORK suggested to adopt, in case of E-Band, a frequency plane according to the latest version of ECC/REC(05)07 (Radio frequency channel arrangements for Fixed Service Systems operating in the bands 71-76 GHz and 81-86 GHz).

In particular we suggested:

- To adopt only annex 3, so only systems working on 71-76 and 81-86 with 10 GHz of distance between RX and TX should be accepted. No restriction in number of channel aggregation will be applied
- Do not adopt the option, foreseen in annex 3, of subdividing the 250MHz channel into narrower 62,5 and 125MHz channels
- Do not adopt the TDD solution, currently foreseen in annex 3
- Do not adopt annex 1 (only 71-76 GHz bands)
- Do not adopt annex 2 (only 81-86 GHz bands)

  - E3NETWORK delegate had a face to face meeting with Italian administration in Rome in September 2014. Outcome: Italian administration opened in 2015 the E Band and adopted almost all our suggestions.

5. E3NETWORK CONTRIBUTION TO ETSI TM4

To be able to assess an equipment under the R&TTE directive, the usual way is to submit this equipment to the test foreseen in ETSI Harmonised standard for the specific “profile”. This is a mandatory step, that shall be done in such a way to obtain the CE mark.

In the specific case of E3NETWORK, what is missing today, is the relevant “profile” in the harmonised standard. This “profile” will be identified as Class 5 in 2 GHz channel. The reason of this lack is due to the fact that, such “profile” is still considered today beyond the state of art, and no one has asked, till now, a definition of this specific “profile”.

This “profile” consists of a list of limits the equipment shall meet in such a way to be considered fulfilling the main essential requirements defined by the R&TTE directive, in terms of use of the spectrum, and in particular the efficient use of the spectrum.

Some limits are “profile”-independent, and for this reason automatically defined for all possible profiles that will be defined in the future as well.

Other limits are “profile”-dependent, and as already explained in the project, for the specific E3NETWORK case, have been derived according to the ETSI rules.

The new limits are usually derived considering a simpler scaling of limits for existing and closer profiles, already into standard. A possible correction of these new limits is in general possible showing the results of either a measurements campaign on actual equipment and a theoretical justification of current limitations linked to a specific technological aspect or implementation or cost of the solution.

5.1 ETSI E3NETWORK PROFILE

In this section, we summarise the list of the profile specific limits that we have identified as objective for E3NETWORK. These limits were derived, following the common ETSI best practice, that is scaling them from the closer profiles already in the standard.

The following table reports the list of the essential requirements and phenomena for Digital Fixed Radio Systems.

Essential Requirement		
Parameters	**Relevance as standardized parameter for DFRS**	**Alternative ETSI and E3NETWORK terminology**
System at transmitting site		
Frequency error/stability, and designation of channels	As frequency error/stability only.	Radio frequency tolerance
Transmitter power	DFRS standards define only the maximum output power; in practice a radio link may be designed in order to transmit, with suitable power setting methods, the appropriate transmission power to fulfil the performance, availability and interference requirements. Therefore, for the essential requirements, what is relevant is the power tolerance on the nominal activation (licensed) value, within Remote and/or Automatic Transmit Power Control ranges, if any, to guarantee stable frequency co-ordination.	Nominal transmitter output power and its tolerance, or Transmitter power range
Adjacent channel power	Common practice for DFRS is to define a mask for spectral density relative to actual centre frequency ranging up to 2.5 times of the actual radio-frequency channel separation, from which adjacent channel interference may be derived in conjunction with the receiver selectivity.	Radio Frequency spectrum mask, Transmitter Spectrum Mask and Spectral lines at symbol rate Transmit power control.
Spurious emissions	They are relevant as defined by CEPT/ERC Recommendation 74/01	Spurious emissions-external
System at the receiving site		
(Maximum usable) sensitivity (inc. duplex)	This parameter is the base on which, through proper frequency co-ordination techniques to assure the efficient use of the spectrum, the required QoS and availability for DFRS may be assessed and calculated in presence of interference. This parameter is the only system parameter at the receive site, which enables to assess the co-channel rejection and the adjacent selectivity.	BER as a function of receiver input signal level (RSL)
Co-channel rejection	This parameter is required to define the amount of frequency reuse still assuring the required QoS for fixed radio. Therefore this parameter is mandatory to ensure the efficient use of the spectrum.	Co-channel interference sensitivity (*"external"*)
Adjacent channel selectivity	This parameter is required for frequency co-ordination among different DFRS. It defines the amount of frequency separation or the amount of geographical separation for adjacent channel, still assuring the required QoS for DFRS. Thus, this parameter is mandatory to ensure the efficient use of the spectrum.	Adjacent channel interference sensitivity
Blocking or desensitisation (inc. duplex)	This parameter is relevant to show the receiver capability of supporting interference at frequencies far away from the adjacent channel.	CW Spurious Interference
Spurious emissions	They are relevant as defined by CEPT/ERC Recommendation 74/01	Spurious emissions-external

Among these parameters, the “profile” specific parameters we have defined are:

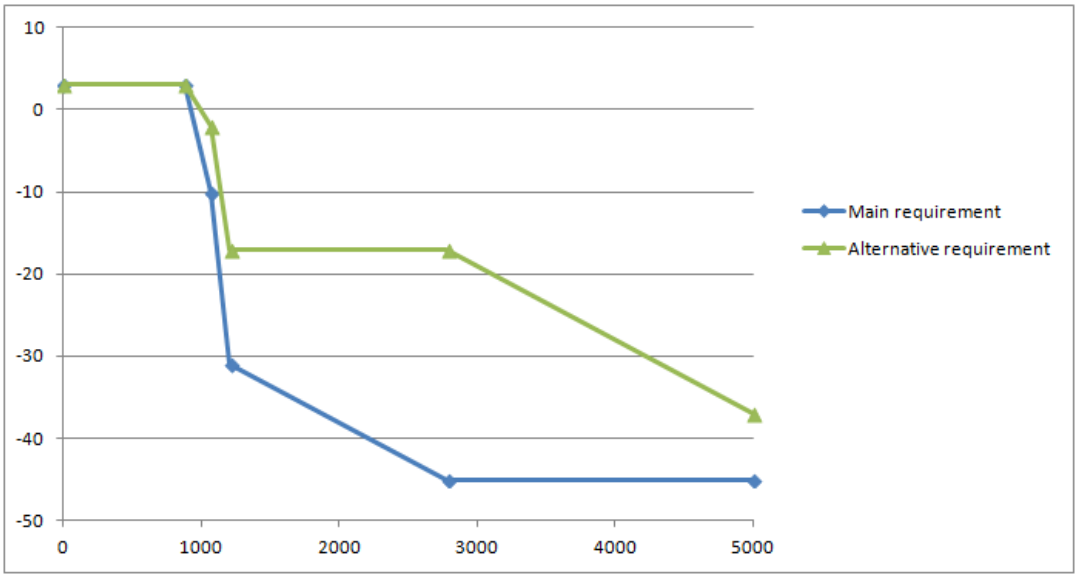
- The Transmitter Spectrum Mask
- The BER as a function of receiver input signal level (RSL)
- Co-channel interference sensitivity (*"external"*)
- Adjacent channel interference sensitivity

5.1.1. Limits defined for E3NETWORK

5.1.1.1. The Transmitter Spectrum Mask

Main requirement									
Requirement ID	**Traceability**	**Category**	**Tx Mask**	**Frequency points (MHz)**	**Attenuation**	**Units**	**Conditions/Comments**	**Transceiver Element**	**Prototype applicability**
[ReqEqu051]		M	5LA	880 (f1)	3	dB	ETSI EN 302 217-2-2 v2.1.1 (2013-07) -- pp. 35 N=CS/250 MHz For CS=2000MHz	TX	Yes
				1072 (f2)	-10	dB			
				1208 (f3)	-31	dB			
				2784 (f4)	-45	dB			
				3500 (f5)	-45	dB			
Alternative requirement									
[ReqEqu121]		M	2 and above	1000 (f1)	-25	dBW/MHz	ETSI EN 302 217-3 V2.0.0 (2014-04) --pp.55 Section UC2.3.1 Limits. Alternative option to [ReqEqu051] For CS=2000MHz	TX	Yes
				1000 (f2)	-30	dBW/MHz			
				1150 (f3)	-45	dBW/MHz			
				1400 (f4)	-45	dBW/MHz			
				2500 (f5)	-65	dBW/MHz			
				3500 (f6)	-75	dBW/MHz			

Graphically



5.1.1.2. The BER as a function of receiver input signal level (RSL)

The minimum receiver signal level for having:

- BER<10^6 is: -42.5 dBm
- BER<10^10 is: -38.5 dBm

[ReqEqu083]	[ReqEqu018] [ReqEqu022]	M	Minimum RSL	5LA/5LB	2	64QAM	10^{-6}	-42.50	RX	Yes
[ReqEqu084]	[ReqEqu018] [ReqEqu022]	M	Minimum RSL	5LA/5LB	2	64QAM	10^{-10}	-38.50	RX	Yes

It should be noted that, this is what is derived from ETSI. A different requirement, depending on Antennas gain and Transmitter power level at the antenna port provided could be also considered.

5.1.1.3. Co-channel interference sensitivity ("external")

The Co-channel interference sensitivity is expressed in terms of Carrier over interference C/I. The limits :

- C/I for 1 dB degradation of BER<10^6 threshold > 33 dBc
- C/I for 3 dB degradation of BER<10^6 threshold ≥ 29,5 dBc

[ReqEqu073]		M	Co-channel "external" interference sensitivity		33,5@1dB	dB	5LA Systems	C/I for BER=10^{-6} RSL degradation of 1dB or 3dB (1)	RX	Yes
					29,5@3dB	dB				

5.1.1.4. Adjacent channel interference sensitivity

The Adjacent channel interference sensitivity is expressed in terms of Carrier over interference C/I. The limits :

[ReqEqu074]		M	Adjacent channel interference sensitivity		3@1dB	dB	5LA Systems	C/I for BER=10^{-6} RSL degradation of 1dB or 3dB (1)	RX	Yes
					-1@3dB	dB				

- C/I for 1 dB degradation of BER<10^6 threshold > +3 dBc
- C/I for 3 dB degradation of BER<10^6 threshold ≥ -1 dBc

5.2 Proposal to ETSI ATTM TM4

During ETSI Meeting ATTM TM4 #55 a proposal “Adding Transmission Capacities to Systems operating in 71 GHz to 86 GHz” was submitted.

5.2.1. Proposal descriptions:

Introduction:

The current specification in ETSI HEN 302 217-2 for systems operating in 71 GHz to 86 GHz has missing transmission capacities for CS > 500 MHz for higher spectral efficiency reference index. This document proposes adding these higher transmission capacities and corresponding transmission and reception parameters. In the following we present in red, the new text that is proposed to be added.

Transmission capacities

Proposed Table for : Minimum RIC transmission capacity and system classes for various channel separation

Channel separation (MHz) →			**62,5**	**125**	**250**	**500**	**750**	**1 000**	**1 250**	**1 500**	**1 750**	**2 000**
Minimum payload RIC rate Mbit/s (note 2)	**Spectral efficiency ↓**		↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓	↓ ↓
	Reference index	**Class**										
	1	1	35	71	142	285	427	570	712	855	997	1 140
	2	2	71	142	285	570	855	1 140 (note 1)	1 425	1 710	1 995	2 280
	3	3	106	212	425	850	1 275	1 700	2 125 (note 1)	2 550	2 975	3 400
	4	4L	142	285	570	1 140 (note 1)	1 710	2 280 (note 1)	2 850	3420	3990	4560
	5	4H	219	438	875	1 750	2 625	3500	4375	5250	6125	7000
	6	5LA/5LB	262	525	1 050 (note 1)	2 100 (note 1)	3 150 (note 1)	4200	5250	6300	7350	8400
	7	5HA/5HB	306	612	1 225	2 450	3675	4900	6125	7350	8575	9800
	8	6LA/6LB	350	700	1 400	2 800	4200	-	-	-	-	-
NOTE 1: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid. NOTE 2: For equipment assessment with different base band interfaces see annex F.												

BER as a function of Receiver input Signal Level (RSL)

Proposed Table for : BER as a function of receiver input signal level RSL (upper bound)

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER ≤ 10^{-6} (dBm)	RSL for BER ≤ 10^{-10} (dBm)
Reference index	Class				
1	1	35	62,5	-72	-70
		71	125	-69	-67
		142	250	-66	-64
		285	500	-63	-61
		427	750	-61	-59
		570	1 000	-60	-58
		712	1 250	-59	-57
		855	1 500	-58	-56
		997	1 750	-57,5	-55,5
		1 140	2 000	-57	-55
2	2	71	62,5	-70	-68
		142	125	-67	-65
		285	250	-64	-62
		570	500	-61	-59
		855	750	-59	-57
		1 140 (note)	1 000	-58	-56
		1 425	1 250	-57	-55
		1 710	1 500	-56	-54
		1 995	1 750	-55,5	-53,5
		2 280	2 000	-55	-53
3	3	106	62,5	-67	-65
		212	125	-64	-62
		425	250	-61	-59
		850	500	-58	-56
		1 275	750	-56	-54
		1 700	1 000	-55	-53
		2 125 (note)	1 250	-54	-52
		2 550	1 500	-53	-51
		2 975	1 750	-52,5	-50,5
		3 400	2 000	-52	-50
4	4L	142	62,5	-64,5	-60,5
		285	125	-61,5	-57,5
		570	250	-58,5	-54,5
		1 140 (note)	500	-55,5	-51,5
		1 710	750	-53,5	-49,5
		2 280 (note)	1 000	-52,5	-48,5
		2 850	1 250	-51,5	-47,5
		3420	1500	-50.5	-46.5
		3990	1750	-50	-46
		4560	2000	-49.5	-45.5
5	4H	219	62,5	-61	-57
		438	125	-58	-54
		875	250	-55	-51
		1 750	500	-52	-48
		2 625	750	-50	-46
		3500	1000	-49	-45
		4375	1250	-48	-44
		5250	1500	-47	-43
		6125	1750	-46.5	-42.5
		7000	2000	-46	-42
6	5LA/5LB	262	62,5	-57,5	-53,5
		525	125	-54,5	-50,5

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	RSL for BER ≤ 10^{-6} (dBm)	RSL for BER ≤ 10^{-10} (dBm)
Reference index	Class				
		1 050 (note)	250	-51,5	-47,5
		2 100 (note)	500	-48,5	-44,5
		3 150 (note)	750	-46,5	-42,5
		4200	1000	-45.5	-41.5
		5250	1250	-44.5	-40.5
		6300	1500	-43.5	-39.5
		7350	1750	-43	-39
		8400	2000	-42.5	-38.5
7	5HA/5HB	306	62,5	-54	-50
		612	125	-51	-47
		1 225	250	-48	-44
		2 450	500	-45	-41
		3675	750	-43	-39
		4900	1000	-42	-38
		6125	1250	-41	-37
		7350	1500	-40	-36
		8575	1750	-39.5	-35.5
		9800	2000	-39	-35
8	6LA/6LB	350	62,5	-50	-46
		700	125	-47	-43
		1 400	250	-44	-40
		2 800	500	-41	-37
		4200	750	-39	-35
NOTE: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid.					

Co-channel "external" and adjacent channel interference sensitivity

Proposed Table for: Co-channel and adjacent channel interference sensitivity

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER ≤ 10^{-6} RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
1 or 2	1 or 2	35 or 71	62,5	23	19	0	-4
		71 or 142	125				
		142 or 285	250				
		285 or 570	500				
		427 or 855	750				
		570 or 1 140 (note)	1 000				
		712 or 1 425	1 250				
		855 or 1 710	1 500				
		997 or 1 995	1 750				
		1 140 or 2 280	2 000				
3	3	106	62,5	25	21	0	-4
		212	125				
		425	250				
		850	500				
		1 275	750				
		1 700	1 000				
		2 125 (note)	1 250				
		2 550	1 500				
		2 975	1 750				

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER ≤ 10^{-6} RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
		3 400	2 000				
4	4L	142	62,5	27	23	0	-4
		285	125				
		570	250				
		1 140 (note)	500				
		1 710	750				
		2 280 (note)	1 000				
		2 850	1 250				
		3420	1500				
		3990	1750				
		4560	2000				
5	4H	219	62,5	30	26	-2	-6
		438	125				
		875	250				
		1 750	500				
		2 625	750				
		3500	1000				
		4375	1250				
		5250	1500				
		6125	1750				
		7000	2000				
6	5LB	262	62,5 (ACCP)	33,5	29,5	-6	-10
		525	125 (ACCP)				
		1 050 (note)	250 (ACCP)				
		2 100 (note)	500 (ACCP)				
		3 150 (note)	750 (ACCP)				
		4200	1000(ACCP)				
		5250	1250(ACCP)				
		6300	1500(ACCP)				
		7350	1750(ACCP)				
		8400	2000(ACCP)				
	5LA	262	62,5 (ACAP)	33,5	29,5	+3	-1
		525	125 (ACAP)				
		1 050 (note)	250 (ACAP)				
		2 100 (note)	500 (ACAP)				
		3 150 (note)	750 (ACAP)				
6	5LA	4200	1000(ACAP)	33.5	29.5	+3	-1
		5250	1250(ACAP)				
		6300	1500(ACAP)				
		7350	1750(ACAP)				
		8400	2000(ACAP)				
7	5HB	306	62,5 (ACCP)	37	33	-3	-7
		612	125 (ACCP)				
		1 225	250 (ACCP)				
		2 450	500 (ACCP)				
		3675	750(ACCP)				
		4900	1000(ACCP)				
		6125	1250(ACCP)				
		7350	1500(ACCP)				
		8575	1750(ACCP)				
		9800	2000(ACCP)				
	5HA	306	62,5 (ACAP)	37	33	+6	+2
		612	125 (ACAP)				
		1 225	250 (ACAP)				

Spectral efficiency		Min. RIC rate (Mbit/s)	Channel separation (MHz)	C/I for BER ≤ 10^{-6} RSL degradation of 1 dB or 3 dB			
				Co-channel interference		Adjacent channel interference	
Reference index	Class			1 dB	3 dB	1 dB	3 dB
		2 450	500 (ACAP)				
		3675	750(ACAP)				
		4900	1000(ACAP)				
		6125	1250(ACAP)				
		7350	1500(ACAP)				
		8575	1750(ACAP)				
		9800	2000(ACAP)				
8	6LB	350	62,5 (ACCP)	40,5	36,5	0	-4
		700	125 (ACCP)				
		1 400	250 (ACCP)				
		2 800	500 (ACCP)				
		4200	750(ACCP)				
	6LA	350	62,5 (ACAP)	40,5	36,5	+9	+5
		700	125 (ACAP)				
		1 400	250 (ACAP)				
		2 800	500 (ACAP)				
		4200	750(ACAP)				
NOTE: RIC rounded down to closest multiple of 1 Gbit/s rate shall also be considered valid.							

5.2.1. Comparison between E3NETWORK objectives and current ETSI proposal

The contribution is proposing, for the E3NETWORK profile, the same value we have considered at the beginning of our work.

5.2.2. ETSI - Discussion results:

While no opposition and some support have been expressed, it was considered that to go forward with this proposal, ETSI procedure requires the opening of a new work item. Today, a new WI has not been considered timely appropriate due to overlap with the version of EN 302 217-2 [24] under approval phase. Moreover a possible need for some more careful analysis was pointed out by all members. It was noted that the capacity will be extended up to about 10 GHz and the limiting factor would become the too high RSL threshold, possibly posing some problem in the conventional planning methodology.

Conclusion: the document will be kept for consideration at next TM4#56 meeting.

6. E-BAND REGULATION STATUS IN EUROPE

The scope of this chapter is to provide an overview of the regulation status of E-Band in Europe. We observed a good and fast trend in the regulation of E-Band, proving, in a certain way, the huge interest this band has gained lately.

The figure presents the official situation, as depicted in the ECO official website [12], regarding the ECC/REC/(05)07 Fixed Service in the bands 71 - 76 GHz and 81 - 86 GHz implementation status.

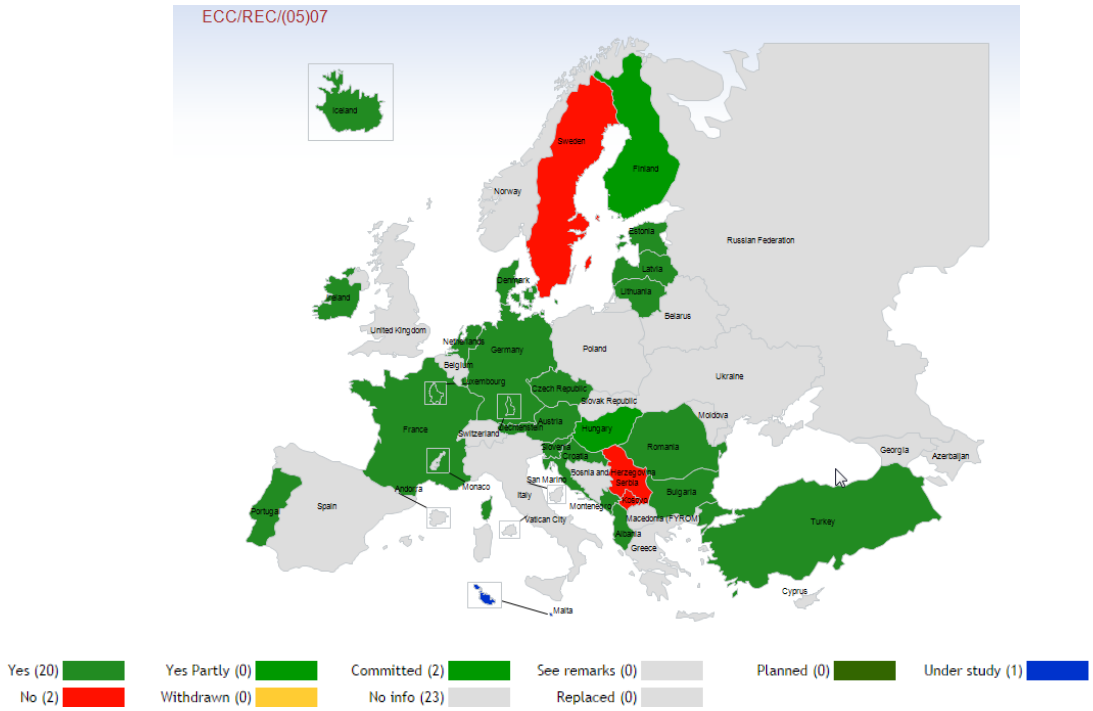


Figure 10. Implementation status of the ECC/REC/(05)07 in Europe

On this regards, we complement the figure with additional information taken from ETSI White Paper No. 9 E-Band and V-Band - Survey on status of worldwide regulation[17] and some other sources.

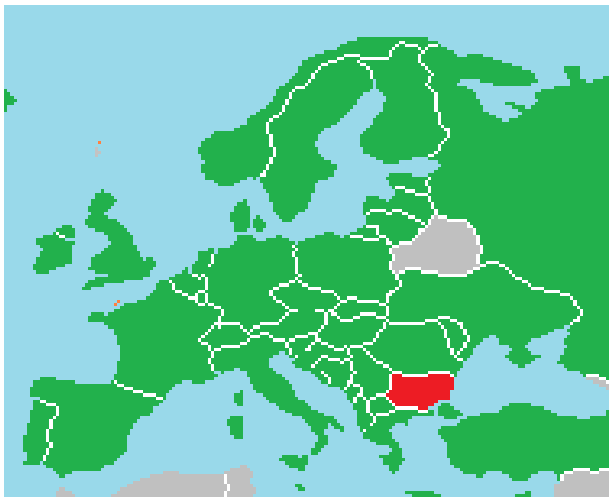


Figure 11. E Band in Europe

According to this ETSI document, and according to the last information received, the E-Band is available for fixed services, everywhere in Europe, expect in Bulgaria, where the band is still closed and with a doubt about Belarus, where the situation is still unknown.

The following table depicts the last updated situation in Europe, reporting the allocated frequency band, the type of license, and the regulation status.

Table 4: Regulation status of E-band in Europe

Country	Freq. Band [GHz]	Status of the band	Licence Regime
Albania	71-76;81-86	Open	Link by link
Austria	71-76;81-86	Open	Link by link and Block
Belgium	71-76;81-86	Open	Light licensing
Bosnia and Herzegovina	74-76;84-86	Open	Link by link
Bulgaria		Closed	
Cyprus	71-76;81-86	Open	Link by link
Croatia	71-76;81-86	Open	Light licensing
Czech Republic	71-76;81-86	Open	Unlicensed
Denmark	71-76;81-86	Open	Link by link
Estonia	71-76;81-86	Open	Link by link
Finland	71-76;81-86	Open	
France	71-76;81-86	Open	Link by link and block
Germany	71-76;81-86	Open	Licensed
Greece	71-76;81-86	Open	Link by link
Hungary	71-76;81-86	Open	Light licensing
Ireland	71-76;81-86	Open	Link by link
Italy	71-76;81-86	Open	Link by link
Latvia	74-76;84-86	Open	Link by link
Liechtenstien	71-76;81-86	Open	Link by link
Lithuania	74,6-75.8;84,6-85.8	Open	Light licensing
Luxembourg	71-76;81-86	Open	Block assignment
Macedonia	71-76;81-86	Open	Link by link
Malta	71-76;81-86	Open	Link by link
Montenegro	71-76;81-86	Open	Link by link
Netherlands	71-76;81-86	Open	Link by link
Norway	71-76;81-86	Open	Licensed
Poland	74-76;84-86	Open	Link by link
Portugal	74-76;84-86	Open	Link by link
Romania	71-76;81-86	Open	Link by link
Russia Federation	71-76;81-86	Open	Unlicensed
Serbia	72-76;82-86	Open	Light licensing
Slovakia	71-76;81-86	Open	Unlicensed
Slovenia	74-76;84-86	Open	Link by link
Spain	71-76;81-86	Open	Link by link
Sweden	71-74;81-84	Open	Link by link
Switzerland	71-76;81-86	Open	Link by link
Turkey	71-76;81-86	Open	Link by link
Ukraine		Open	
United Kingdom UK	71-76;81-86	Open	Double regime

The cases that don't fit with E3NETWORK requirements are highlighted in red. Reason for this could be that the band is closed or not enough band to accommodate 2 GHz channel. The cases where it is currently not foreseen to release up to 2GHz channel spacing are highlighted in orange. This means that the local administration, at the time being, does not foresee to receive such a request, but the possibility to get such a channel in future is not excluded.

Finally, in the cases indicated in yellow, it is possible in principle to obtain 2 GHz channel but, due to frequency band restriction (military usage), it should be unlikely to get a 2 GHz channel or to find a free 2 GHz channel.

7. CONCLUSIONS

The standardization bodies related with the E3NETWORK project are CEPT ECC, ITU, ETSI, and the National Administrations.

Within CEPT ECC, the working group SE19 Fixed Service has been identified as the most relevant for the project. They are currently revising the frequency channel arrangements for Fixed Service Systems operating in the bands 71-76 GHz and 81-86 GHz. E3NETWORK has been represented in the relevant meetings of this working group and the most interesting information has been reported to the E3NETWORK partners. The consortium has monitored the work done within this working group. Due to the close link between CEP ECC and ITU-R, the consortium considers that any contribution to CEPT ECC can be spread to ITU-R, when relevant.

Within ETSI, the working group ATTM TM4 “Fixed Radio Systems” is considered as the most relevant for E3NETWORK. They are in charge of the specifications of point-to-point radio systems, such as the one to be built in the project. Moreover, they are devising energy efficiency metrics and test procedures for point-to-point fixed radio systems that are interesting for the project. E3NETWORK has been represented in the meetings of this working group since the beginning of the project. The effective support to the introduction of the E3NETWORK profile, among those already part of the Harmonised Standard for R&TTE and now for the new directive, RE-D, is considered one of the our main standardization objectives achieved.

Inside the ETSI a new group has been established, the millimetre Wave Transmission (mWT) Industry Specification Group (ISG) with the scope to provide a platform and opportunity for companies and organizations involved in the microwave and millimetre-wave industry chain to address the challenges involved in using this spectrum. ALU is a funder member and ST a member. Main interest in this group is the chance to promote E3NETWORK solution and results.

Finally, the consortium of E3NETWORK has monitored the public consultations of the National Regulatory bodies, such as the one issued by OFCOM in UK about “Review of the Spectrum Management Approach in the 71-76 GHz and 81-86 GHz bands. Consultation on the future management approach for the 70 / 80 GHz bands”. A whole picture related to the current European situation is added.

E3NETWORK defined a complete set of parameters, as per current proposal under discussion in ETSI TM4, to be adopted as the new profile for systems able to transport 10Gbps into a channel of 2 GHz.

8. LIST OF ABBREVIATIONS AND ACRONYMS

ATTM	Access Terminals transmission and multiplexing
ATPC	Automatic Transmission Power Control
BER	Bit Error Ratio
CENELEC	Comité Européen de Normalisation Electrotechnique
CEPT	European Conference of Postal and Telecommunications Administrations
CPG	ECC's Conference Preparatory Group
CW	Continuous WaveCS Channel Spacing
DFRS	Digital Fixed Radio SystemsEEA European Economic Area
EEER	Equipment Energy Efficiency Ratio
EC	European Commission
ECC	Electronic Communications Committee
ECO	European Communications Office
EFTA	European Free Trade Association
EIRP	Effective Isotropic Radiation Power
EN	European Standard, telecommunications series
ESO	European Standardisation Organisations
ETSI	European Telecommunications Standards Institute
EU	European Union
FS	Fixed Service
FWA	Fixed Wireless Access
FWS	Fixed Wireless Systems
HS	Harmonized Standard
ICT	Information and Communications Technologies
ISM	Industrial Scientific and Medical
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union- Radiocommunication sector
MoU	Memorandum of Understanding
NSO	National Standards Organisation
P-MP	Point-to-MultiPoint
P-P	Point-to-Point
QoS	Quality of ServiceOJEU Official Journal of the European Union
QAM	Quadrature Amplitude Modulation
RSC	Radio Spectrum Committee
R&TTE	Radio equipment and Telecommunications Terminal Equipment and the mutual recognition of

RSL	Received Signal Level
RTPC	Remote Transmit Power Control
R&TTE	Radio and Telecommunications Terminal Equipment
SRDoc	System Reference Documents
TC	Technical Committee
TCAM	Telecommunication Conformity Assessment and Market Committee
WG SE	Working Group “Spectrum Engineering”
WRC	World Radiocommunication Conference
WG	TM4 Working group TM4 of ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (TC ATTM)
XPD	cross Polar Discrimination

9. RELEVANT WEBSITES AND REFERENCES

[1] ETSI: www.etsi.org

[2] ECC:www.cept.org/ecc

[3] EC Radio Spectrum Policy Group: http://rspg.ec.europa.eu/

[4] EC Radio Spectrum Committee: http://ec.europa.eu/information_society/policy/radio_spectrum/activities/rscwork/index_en.htm

[5] Radio Spectrum Decision 676/2002/EC: http://europa.eu/legislation_summaries/information_society/l24218a_en.htm

[6] R&TTE Directive: http://ec.europa.eu/enterprise/rtte/index_en.htm and

[7] http://europa.eu/legislation_summaries/information_society/l21003a_en.htm

[8] 98/34/EC Directive: http://europa.eu/legislation_summaries/internal_market/single_market_for_goods/technical_harmonisation/l21003_en.htm

[9] OFCOM UK http://www.ofcom.org.uk/

[10] EU legislation: http://eur-lex.europa.eu/en/index.htm

[11] R&TTE Compliance Association: http://www.rtteca.com/

[12] ECO documents repository: http://www.ecodocdb.dk/

[13] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

[14] ECC/ETSI brochure: “The European regulatory environment for radio equipment and spectrum”, 2001.

[15] ECC/REC(05)07 (Radio frequency channel arrangements for Fixed Service Systems operating in the bands 71-76 GHz and 81-86 GHz).

[16] Newspaper of the Government of Hellenic Democracy – 26 June 2014 (FEK 1713/B/26-6-2014) Regulation regarding the terms of use of individual radiofrequencies or radiofrequency bands.

[17] ETSI EN 302 217 serie

[18] ETSI White Paper No. 9 E-Band and V-Band - Survey on status of worldwide regulation. First edition – June 2015. http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp9_e_band_and_v_band_survey_20150629.pdf

[19] ETSI - MILLIMETRE WAVE TRANSMISSION INDUSTRY SPECIFICATION GROUP (mWT ISG). https://portal.etsi.org/tb.aspx?tbid=833&SubTB=833.

[20] ETSI White Paper 10 Field Proven Experience of millimetre wave transmission . First edition – September 2015 http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp10_field_proven_experience_of_mwt_20150923.pdf

[21] ETSI GS mWT 002 V1.1.1 (2015-08) - Applications and use cases of millimetre wave transmission

http://www.etsi.org/deliver/etsi_gs/mWT/001_099/002/01.01.01_60/gs_mWT002v010101p.pdf

[22] ETSI GS mWT 006 V1.1.1 (2015-12) - Analysis of antennas for millimetre wave transmission. http://www.etsi.org/deliver/etsi_gs/mWT/001_099/006/01.01.01_60/gs_mWT006v010101p.pdf

[23] ETSI TR 103 820 V1.1.1 (2015-11) - Energy efficiency metrics and test procedures for Point-to-point fixed radio systems http://www.etsi.org/deliver/etsi_tr/103800_103899/103820/01.01.01_60/tr_103820v010101p.pdf

[24] ETSI HS EN302 217-2 - Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 2: Digital systems operating in frequency bands from 1,3 GHz to 86 GHz; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

[25] E3NETWORK deliverables