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Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference document (SRdoc); Mobile broadband services in the 2 300 MHz - 2 400 MHz frequency band under Licensed Shared Access regime

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Executive summary

The mobile industry is developing the next generation of mobile broadband communications networks based on cellular technologies. One of the main goals of these developments is more efficient and innovative radio resource management. Even if the traffic growth projections are adjusted for the benefits provided by the new technologies, the planned availability of licensed spectrum might not be sufficient to satisfy the increased demand for mobile bandwidth before the decade's end. Licensed Shared Access (LSA), as a new complementary regulatory framework, is a further measure that can improve, according to a number of market stakeholders, the efficient use of spectrum and thus help to relieve spectrum shortages in areas where LSA may be appropriate. The LSA framework enables coordinated shared access to spectrum that would otherwise be unavailable for mobile broadband use. This ETSI Technical Report outlines the LSA framework concepts and gives examples of the technical parameters that may be used as a basis for developing the necessary studies and EU regulatory regime to enable deployment of LSA in the 2 300 - 2 400 MHz frequency band.

The frequency range 2 300 - 2 400 MHz is currently being considered for application of the Licensed Shared Access framework. This band is allocated to the Mobile Service and is identified for IMT globally in the ITU Radio Regulations. The band is suitable for application of TDD technology and is standardized by 3GPP as LTE Band 40. Based on this standardization work, and driven by the growing developments in the Asia Pacific region, multi-band equipment is already available supporting this LTE band.

The addition of this frequency range for mobile broadband applications in Europe can boost the data handling capacity of current national mobile networks. In recent times many of these networks have come under increasing pressure from the rapid growth in data services and new applications. Therefore, there is significant interest in addressing the growing market for mobile broadband services in the 2 300 - 2 400 MHz band in Europe. However, there are concerns that there is no ECC regulatory guidance enabling broadband mobile usage for this band. Whereas in some CEPT countries, the 2 300 - 2 400 MHz frequency band can be exclusively licensed for mobile broadband services, in a number of other CEPT countries, exclusive licensing of this band for mobile services is not possible or will be complex and lengthy due to existing incumbent users.

The objective of the Licensed Shared Access framework for 2 300 - 2 400 MHz is to enable access to this band for mobile broadband services in the countries whose continuing incumbent usage is suitable for sharing. However, introducing the Licensed Shared Access framework may require changes in the present regulatory framework to enable harmonized mobile applications in the 2 300 - 2 400 MHz band. Therefore, development of an appropriate ECC deliverable is desired. In particular, there is a need for an ECC Decision harmonizing the 2 300 - 2 400 MHz frequency band and providing guidelines for countries wishing to introduce mobile Broadband Wireless Services in this band under the Licensed Shared Access framework to take into account incumbent use. Such an ECC Decision should include:

- Appropriate band arrangements and channelization scheme
- Guidance on the expected spectrum utilization by broadband mobile services under LSA regime

- Guidance on incumbent protection technical requirements under main LSA sharing scenarios
- Guidance on LSA spectrum sharing conditions
- Guidelines for assignment of rights of use for LSA licensees
- Guidelines for the incumbent's existing usage rights

The present document provides an overview of mobile broadband technologies that may be utilized in the 2 300 - 2 400 MHz band under a Licensed Shared Access framework. In particular, it presents system reference information, operational features and a summary of relevant technical parameters of the mobile broadband service to aid the necessary studies to enable harmonized use of this frequency band in an LSA framework.

Introduction

The present document has been developed to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

The document is intended to provide system reference information on the design and operational features of the mobile broadband service in the 2 300 - 2 400 MHz band under a Licensed Shared Access (LSA) regime. The information is provided for timely consideration within the relevant CEPT Working Groups and Project Teams and, in particular, to aid in necessary studies to enable harmonized use of this frequency band.

Table 0: Status of pre-approval draft

Target version	**Pre-approval date version (see note)**				
Vm.a.b	**a**	**s**	**m**	**Date**	**Description**
1.1.1	2.1.0			March 2013	Sent to internal enquiry
1.1.1				May 2013	Internal enquiry comments resolved.
NOTE: See EG 201 788 [i.46] (V2.1.1), clause A.2.					

1 Scope

The present document describes mobile broadband service in the 2 300 - 2 400 MHz band under Licensed Shared Access (LSA) regime. This band is allocated to the Mobile Service and identified for IMT globally in the ITU Radio Regulations. The objective of the LSA regime is to enable access to this band for mobile broadband services in those CEPT countries where access to the band is complex due to the incumbent uses. The LSA regime may require changes in the present regulatory framework for mobile applications in the 2 300 - 2 400 MHz band regarding either intended or unwanted emissions.

The mobile broadband service (MBS) technologies discussed in the present document may originate from more than a single standards development organization and therefore may exhibit characteristics from different MBS technologies.

The mobile broadband technologies considered are based upon traditional cellular deployment scenarios generally consisting of central Base Stations and mobile User Equipment.

The present document includes, in summary:

- Market information
- Technical information including expected sharing and compatibility issues

NOTE: The information on sharing and compatibility issues is required when new spectrum or new spectrum usage is requested.

- Regulatory issues

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] RSPG11-392: "Report on CUS and other spectrum sharing approaches", October 2011.

[i.2] CEPT WG FM #74: "Report on ASA concept". .

[i.3] Small Cell Forum: "Small Cell Benefits".

NOTE: Available at: http://www.smallcellforum.org/aboutsmallcells-small-cells-small-cell-benefits

[i.4] MOBILE BROADBAND: THE BENEFITS OF ADDITIONAL SPECTRUM, Federal Communications Commission (FCC), October 2010.

NOTE: Available at: http://download.broadband.gov/plan/fcc-staff-technical-paper-mobile-broadband-benefits-of-additional-spectrum.pdf

[i.5] ABIresearch® Research Report: Mobile Networks Mobile Network Offloading Free and Carrier Wi-Fi, Femtocells, Caching, Core Offloading, and Media Optimization, Joe Madden, Aditya Kaul, 2010.

[i.6] Cisco Visual Networking Index: "Global Mobile Data Traffic Forecast Update", 2011-2016.

NOTE: Available at: http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

[i.7] UMTS Forum Report 44, Mobile traffic forecasts 2010-2020 report, November 2011.

NOTE: Available at: http://www.umts-forum.org/component/option,com_docman/task,doc_download/gid,2537/Itemid,213/

[i.8] WiMAX Forum whitepaper: "A Review of Spectrum Requirements for Mobile WiMAX Equipment to support Wireless Personal Broadband Services" - September 2007.

[i.9] GSMA/Machine Research (2012): "The Connected Life: A USD4.5 trillion global impact in 2020".

NOTE: Available at:http://connectedlife.gsma.com/the-connected-life-a-usd4-5-trillion-global-impact-in-2020.

[i.10] ETSI TS 136 104: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104)".

[i.11] ETSI TS 136 101: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101)".

[i.12] ETSI TS 136 211: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211)".

[i.13] ETSI TR 102 837 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Broadband Wireless Systems in the 2 300 MHz to 2 400 MHz Range".

[i.14] ERC Report 25: "The European Table of frequency allocations and utilisations in the frequency range 9 kHz to 3000 GHz", Lisboa 02- Dublin 03- Kusadasi 04- Copenhagen 04- Nice 07- Baku 08.

[i.15] CEPT/ERC/Recommendation 74-01E: "Unwanted emissions in the spurious domain" (Siófok 98, Nice 99, Sesimbra 02, Hradec Kralove 05).

[i.16] CEPT/ERC Recommendation 62-02 e (Tromsø 1997): "Harmonised frequency band for civil and military airborne telemetry applications".

[i.17] ETSI EN 301 783: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Commercially available amateur radio equipment".

[i.18] Revised ERC Recommendation 25-10: "Frequency ranges for the use of temporary terrestrial audio and video sap/sab links (incl. ENG/OB)".

[i.19] ETSI EN 302 064 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless Video Links (WVL) operating in the 1,3 GHz to 50 GHz frequency band".

[i.20] ERC Report 038: "Handbook on radio equipment and systems video links for eng/ob use, Stockholm", May 1995.

[i.21] CEPT Report 019: "Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS".

[i.22] ECC Report 131: "Derivation of a block edge mask (BEM) for terminal stations in the 2.6 GHz frequency band (2500-2690 MHz)", Dublin, (January, 2009).

[i.23] ETSI EN 302 217: "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas".

[i.24] ERC/REC 70-03: "ERC Recommendation 70-03 (Tromsø 1997 and subsequent amendments) relating to the use of short range devices (SRD)".

[i.25] ETSI EN 300 440 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range".

[i.26] ERC/DEC(01)08: "ERC Decision of 12 March 2001 on harmonised frequencies, technical characteristics and exemption from individual licensing of Short Range Devices used for Movement Detection and Alert operating in the frequency band 2 400 - 2483.5 MHz".

[i.27] ETSI EN 300 761 (all parts): "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Automatic Vehicle Identification (AVI) for railways operating in the 2,45 GHz frequency range".

[i.28] ETSI EN 300 328: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive".

[i.29] ERC/DEC(97)03: "ERC Decision of 30 June 1997 on the Harmonised Use of Spectrum for Satellite Personal Communication Services (S-PCS) operating within the bands 1610-1626.5 MHz, 2483.5-2500 MHz, 1980-2010 MHz and 2170-2200 MHz".

[i.30] ERC/DEC(97)05: "ERC Decision (of 30 June 1997) amended by ECC 18 March 2005 on free circulation, use and licensing of Mobile Earth Stations of Satellite Personal Communications Services (S-PCS) operating within the bands 1610-1626.5 MHz, 2483.5-2500 MHz, 1980-2010 MHz and 2170-2200 MHz within the CEPT".

[i.31] ECC/DEC(07)04: "ECC Decision of 21 December 2007 on free circulation and use of mobile satellite terminals operating in the Mobile-Satellite Service allocations in the frequency range 1-3 GHz".

[i.32] ECC/DEC(07)05: "ECC Decision of 21 December 2007 on exemption from individual licensing of land mobile satellite terminals operating in the Mobile-Satellite Service allocations in the frequency range 1-3 GHz".

[i.33] CEPT/ERC/REC 25-10 E: "Frequency Ranges for the Use of Temporary Terrestrial ENG/OB Video Links During Events in Other CEPT Member Countries".

[i.34] Recommendation ITU-R SM.329-10 (2003): "Unwanted emissions in the spurious domain".

[i.35] ECC Report 172: "Broadband Wireless Systems Usage in 2 300-2 400 MHz", March 2012.

[i.36] IRIG DOCUMENT 106-11 PART I: "TELEMETRY STANDARDS".

[i.37] ETSI TS 137 104 (V9.3.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception (3GPP TS 37.104 version 9.3.0 Release 9)".

[i.38] Recommendation ITU-R F.1336: "Reference radiation patterns of omnidirectional, sectoral and other antennas in point-to-multipoint systems for use in sharing studies in the frequency range from 1 GHz to about 70 GHz".

[i.39] ITU-R Radio Regulations, Edition 2012.

[i.40] FM(12)017rev1/FM52(12)INFO2 "Results of the WG FM QUESTIONNAIRE to CEPT ADMINISTRATIONS on the current and future usage of frequency band 2 300-2 400 MHz".

NOTE: See http://www.cept.org/Documents/fm-52/7841/FM52(12)INFO2_Results-of-the-WG-FM-QUESTIONNAIRE-to-CEPT-ADMINISTRATIONS-on-the-current-and-future-usage-of-frequency-band-2 300-2 400-MHz.

[i.41] http://www.aptsec.org/sites/default/files/Upload-files/AWG/APT-AWG-REP-12Rev.1_APT_Report-Freq_arrangement_2 300_MHz.doc.

NOTE: Available at http://www.aptsec.org/sites/default/files/Upload-files/AWG/APT-AWG-REP-12Rev.1_APT_Report_Freq_arrangement_2300_MHz.doc.

[i.42] US Code of Federal Regulations. Title 47, Part 27, Section 53.

NOTE: See http://www.gpoaccess.gov/cfr/retrieve.html.

[i.43] Amending Parts 25 and 27 to Promote WCS and DARS Coexistence: A Presentation by the WCS Coalition November 10, 2009.

NOTE: See http://fjallfoss.fcc.gov/ecfs2/document/view?id=7020347748.

[i.44] Carrier Aggregation explained.

NOTE: http://www.3gpp.org/Carrier-Aggregation-explained.

[i.45] 4G Americas White Paper: "Developing & Integrating a High Performance HET-NET".

NOTE: See http://www.4gamericas.org/index.cfm?fuseaction=page&sectionid=428

[i.46] ETSI EG 201 788: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference document (SRdoc)".

[i.47] 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.

[i.48] Recommendation T/R 13-01 E: "Preferred channel arrangements for fixed service systems operating in the frequency range 1 - 2.3 GHz".

3 Symbols and abbreviations

3.1 Symbols

For the purposes of the present document, the following symbols apply:

$BW_{Channel}$	Channel bandwidth
F_C	Frequency of the carrier centre frequency
f_offset	Separation between the channel edge frequency and the centre of the measuring filter
f_offset_{max}	The maximum value of f_offset used for defining the requirement
N_{RB}	Transmission bandwidth configuration, expressed in units of resource blocks
Pmax	Maximum total output Power
Pmax, c	Maximum carrier output power
$P_{REFSENS}$	Reference Sensitivity power level
Δf	Separation between the channel edge frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency
Δf_{max}	The largest value of Δf used for defining the requirement
Δf_{OOB}	the frequency offset in MHz from the upper and lower assigned channel edge

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
ASA	Authorized Shared Access
CEPT	Commission Européenne des Postes et Télécommunications
BS	Base Station
BWS	Broadband Wireless System
DL	Downlink (BS to MS transmission direction)
DFT	Discrete Fourier Transformation
ECC	Electronic Communications Committee of the CEPT
EIRP	Effective Isotropic Radiated Power
E-UTRA	Evolved Universal Terrestrial Radio Access
FDD	Frequency Division Duplex
IMT	International Mobile Telecommunications (also IMT- Advanced)
ITU	International Telecommunications Union
LSA	Licensed Shared Access
LTE	Long Term Evolution
MBS	Mobile Broadband Service
MBW	Measurement Bandwidth
MFCN	Mobile/Fixed Communications Network
MS	Mobile (subscriber) Station
MVNO	Mobile Virtual Network Operator
OAM	Operation, Administration and Maintenance
OEM	Original Equipment Manufacturer
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OTT	Over-The-Top
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
RSPG	Radio Spectrum Policy Group
RB	Resource Block
SAP/SAB	Services Ancillary to Production / Services Ancillary to Broadcasting
SDO	Standards Development Organization
TDD	Time Division Duplex
TS	Terminal Station
UL	Uplink (MS to BS transmission direction)

4 Comments on the System Reference Document

The statements in clause 4.1 have been recorded.

4.1 Statements by ETSI Members

France Telecom Orange, Telecom Italia, Telefonica and TeliaSonera consider that the LSA could offer a complementary and streamlined approach to increase the amount of overall spectrum resources available to mobile services. Provided that compatibility among services/systems are proven feasible, LSA may be applied to share frequency bands that otherwise cannot be exploited for commercial purposes in the short term.

Consequently, France Telecom Orange, Telecom Italia, Telefonica and TeliaSonera consider the LSA could be an alternative and effective solution to access the 2 300 - 2 400 MHz band in the countries where clearing and/or refarming of the spectrum from legacy non-mobile services and users are not achievable in the short term, and therefore where subsequent spectrum allocation to mobile services/systems is not feasible in a timely way.

BWMi statement on Frequency utilization in Germany of the band 2 300 - 2 400 MHz:

The band 2 300 - 2 320 MHz is used for telemetry on a primary basis (including airborne and civil as well as military applications).

The telemetry applications were shifted from the band 1 474 - 1 481,5 MHz to the band 2 300 - 2 320 MHz some years ago because of the introduction of T-DAB. The band 2 300 - 2 320 MHz will also be used for telemetry in the future based on ERC Recommendation 62-02.

The band 2 320 - 2 400 MHz is used for cordless cameras on a primary basis (dedicated sub-bands for different user categories: PPDR, ENG/OB, industry) and also used by the amateur service on a secondary basis.

The band 2 320 - 2 400 MHz has to be considered as the core band for cordless cameras throughout Germany (for PPDR, ENG/OB, and industry). Because of the higher bandwidth required for HD cameras and because of the fact that additional spectrum is required for cordless cameras during major events, the band 2 320 - 2 400 MHz will be used for cordless cameras in the short, medium and long term future.

Cisco Systems' statement:

The 2 300 MHz to 2 400 MHz is adjacent to the 2 400 MHz to 2 483,5 MHz which is of key importance for Wifi and Bluetooth. Global sales of Wi-Fi-based equipment is expected to reach 3,5 billion in 2014. Wi-Fi supports an important share of overall internet traffic in Western Europe and this share is anticipated to grow to 60 % of total internet traffic by 2016. Wifi will play a crucial role to meet the goal (as laid down in the digital agenda) of having 50 % if households having access to the internet at 100 Mbps by 2020.

Therefore, a degradation of the 2 400 to 2 483,5 MHz band caused by unwanted emissions from devices or applications described in this SRDoc is not acceptable. The proposed limits for the Out-Of-Band Domain (inside the 2 400 - 2 483,5 MHz band) may not be sufficient to prevent such degradation.

The Netherlands likes to make the following statements:

At this moment LTE is deployed in the frequencyband adjacent to the 862 - 863 MHz, 863 - 870 MHz band. Experiments and practical experience show a negative impact on the devices using these frequencies. Since the interference is solely caused by mobile devices, and therefore time and location dependent, the effect is considered acceptable by most administrations.

The scenario in the 2 300 - 2 400 MHz band is different in the sense that both basestations and mobiles will occupy this frequency range and the adjacent band use is different.

Adjacent to this band is the 2 400 - 2 483,5 MHz ISM band. Although used by short range devices without status this band can be seen as the core band for licence exempt broadband wireless communication and as such an economical vital frequency band.

We like to state that degradation of this band caused by out of band, spurious and unwanted emissions caused by LTE (or other systems) is not acceptable for us.

The frequencyband below 2 300 MHz is used for defence applications in The Netherlands. The protection levels likely have to be much higher as in the 2 400 - 2 483,5 MHz case and to be determined trough compatibility studies.

As a starting point we like to suggest a minimum suppression of all emissions below 2 300 MHz and above 2 400 MHz relative to the carrier of at least 60 dB measured in the same bandwidth. If for this any guard band is required this should be realized inside the 2 300 - 2 400 MHz range. This statement has to be seen separate from the requirements from existing primary and secondary services inside the 2 300 - 2 400 MHz band.

5 Licensed Shared Access for Mobile Broadband Service

Consumers are increasingly embracing mobile access with predictable Quality of Service that is equivalent to fixed broadband access to meet their data demands. Consequently, there is a consequent increase in the need for mobile broadband services. In addition to traditional applications such as content-rich multi-media and remote connection to business networks for working and/or video conferencing, mobile computing has recently experienced exponential growth in scale and breadth of penetration, and this also fuels the demand for additional mobile broadband services. Furthermore, the delivery of governmental, social and commercial services is rapidly evolving to embrace mobile broadband services for a vast array of opportunities such as e-government, social networking, e-education (enabling remote access to educational content and knowledge information), e-health (providing remote health care) and e-Commerce services (allowing tele-shopping). Also fuelling the demand for mobile broadband services is the increasing popularity of affordable devices such as smartphones, dongles and tablets as well as other connected devices such as video games, embedded appliances and sensors.

Society as a whole will benefit greatly from increasing deployment of these new mobile broadband applications. European consumers, in increasingly larger numbers, are expected to demand low-cost access to the mobile Internet for receiving enhanced services with increasing quality of service expectations. However, administrations and industry stakeholders are confronted worldwide with the constant challenge of ensuring sufficient availability of spectrum to satisfy the growing demand for ubiquitous mobile broadband services and the related traffic surge [i.2], Introduction section.

The mobile industry is developing the next generation of broadband mobile communications networks using cellular techniques with even more efficient and innovative radio resource management technologies. These technologies include capabilities such as carrier aggregation [i.44], HetNet [i.45], small cells ([i.3], Public & rural section) and content optimization ([i.5], section 5.9). However, even if the traffic growth projections are adjusted for the benefits provided by the new system technologies, the planned availability of licensed spectrum might not be sufficient to satisfy the increased demand for mobile bandwidth before the decade's end. The US regulator (FCC), for example, has forecast that the broadband spectrum deficit is likely to approach 300 MHz by 2014 ([i.4], Introduction section).

As a solution to this challenge, the Licensed Shared Access (LSA), as a new complementary regulatory framework, can improve the efficient use of spectrum ([i.1], section 4.6). LSA provide access to spectrum that would otherwise be unavailable for mobile broadband use. Such a framework enables [i.2]:

- a predictable Quality of Service for all spectrum rights of use holders, network operators and for consumers ([i.2], Description of the ASA concept section);
- a guarantee that the incumbent has continuing access rights to their required spectrum and that spectrum in use by incumbents will not be used by others;
- the protection of incumbent systems from harmful emissions;
- the protection of the new users of the spectrum from harmful interference;
- the voluntary participation of main stakeholders in the LSA management process.

6 Market information

The growth of wireless technologies in the last decade has been beyond significant. The use of devices such as smartphones, tablets, etc. with access to mobile broadband data has become an increasingly indispensable part of everyday life. In 2011, global mobile data more than doubled for the fourth year in a row [i.6]. Further studies [i.6], [i.7] and [i.8] predict continuing tremendous worldwide growth in the market size of mobile broadband services. According to WiMAX Forum [i.8], the growth ranges from 1 billion users in 2012 up to 2,5 billion in 2015 or from 3 billion users in 2012 up to 8 billion in 2015 assuming a conservative or an aggressive growth scenario, respectively. The implementation of new wireless technologies will not only enhance current services, but also generate new revenue, leading to an estimated global business impact of up to 4,5 trillion USD by 2020 [i.9]. Harmonization of frequencies and technology standardization can provide additional benefits in terms of economies of scale for the equipment and consumer device manufacturers. In this respect, the launch of pan-European mobile data and value-added services brings considerable benefits to consumers, enterprises as well as Governments and, in general, results in improved economic well-being of the society.

It is of utmost importance to serve the growth in mobile broadband services in the 2 300 - 2 400 MHz frequency band, which is allocated to the Mobile Service and identified for IMT globally in the ITU Radio Regulations. The band is targeted for utilizing TDD technology by 3GPP as LTE Band 40. Driven by the growing developments in the Asia Pacific region, multi-band devices are already available supporting this band.

Current spectrum management ecosystems are divided between license-exempt and long term, renewable exclusive licensed spectrum. For some spectrum users the usage is not full-time or over the full license area. In a number of CEPT countries, it is possible for the 2 300 - 2 400 MHz frequency band to be exclusively licensed to network operators for mobile broadband services. However in a number of other CEPT countries, exclusive licensing of this band for mobile services will be complex and lengthy due to existing incumbent users. LSA [i.2] represents a new complementary regulatory framework that in some cases enables the more efficient usage of exclusive spectrum assignments through shared access. LSA can enable the availability of the 2 300 - 2 400 MHz frequency band for mobile broadband services within CEPT in a timely manner and with harmonized technical conditions, while taking into account the various incumbent uses throughout the CEPT countries. Under the LSA regime, the access to spectrum is possible through sharing between incumbents and a limited number of "LSA licensees" (e.g. mobile network operators). Alongside use of the spectrum by the incumbent, further "LSA licensees" can be granted rights by the national authorities to use the LSA band. The authorization and implementation of LSA by CEPT countries would be on a voluntary basis. Some CEPT countries already have plans to release the 2 300 - 2 400 MHz frequency band for licensed mobile broadband service. Other CEPT countries that are having difficulty making such a release on a timely basis due to incumbent usage, could apply the LSA framework to enable a timely release. This will allow the participating CEPT countries to reap the full benefits of the large of economies of scale in LTE TDD equipment and consumer devices.

One of benefits of LSA may be to allow mobile broadband service deployment with lighter network deployment costs than nationwide exclusive licensed spectrum. The possibility of lower cost, shorter-term, licensing options provided by the LSA regime could foster new innovative ideas and contribute to economic growth throughout the CEPT countries. The LSA regime may also provide a new way to collect an ongoing stream of revenue. For instance, the LSA regime could be used to generate new revenue from an incumbent's unused spectrum resources. The LSA regime will also allow mobile operators to provide services (particularly data-rich services) in new ways which could reduce overall costs and eventually increase spectrum efficiency. For instance, the LSA regime could allow operators to provide service in periods of high traffic (e.g. special events) in certain localized areas without the need for a long-term license in that specific area. This arrangement will avoid the cost associated with a local long-term license. Moreover, the LSA regime extends the range of market players that could provide pan-European mobile broadband services beyond the traditional electronic communications operators (e.g. MFCNs and MVNOs).

Since any market stakeholder, qualified according to national requirements, can become an LSA licensee, any provider of electronic communications services and market constituency (OEM, OTT and Vertical) may provide innovative pan-European bundles combining mobile broadband services with data communications access. As an example, consider an LSA licensee that has obtained rights to deploy an LSA network in multiple countries in the 2 300 - 2 400 MHz frequency band and foresees combining different radio access technologies and radio interfaces in a single device. This LSA licensee could offer a flat unlimited-data package to its premium customers. These customers could also have the opportunity to subscribe to other services including voice, video-on demand, internet access or e-commerce. Through the economies of scale provided by pan-European operation, the LSA licensee would be able to sustain its business efficiently.

7 Technical information

The LSA concept is technology neutral in the sense that the underlying mobile Broadband Wireless Systems can have a different technologies basis and originate from different standards bodies. The mobile Broadband Wireless Systems can be considered to encompass both IMT-2000 and IMT-Advanced technologies. The mobile broadband technology example considered in clause 7.3 is drawn from 3GPP E-UTRA technology based on ETSI Technical Specifications TS 136 104 [i.10], TS 136 101 [i.11] and TS 136 211 [i.12], which comprise TDD and FDD versions.

7.1 Expected usage scenarios

7.1.1 Overview

In this clause, some example use cases are proposed for the Mobile Broadband Service in the 2 300 - 2 400 MHz band under the Licensed Shared Access (LSA) regime. The list is not intended to be exhaustive and its purpose is illustrative.

- Use case "Bandwidth Expansion for Mobile Network Operator":
    - A detailed scenario is given in clause 7.1.2.

7.1.2 Use Case "Bandwidth Expansion for Mobile Network Operator"

A mobile network operator operating LTE in a licensed band in a region applies for an individual authorization to use radio frequencies within the 2 300 - 2 400 MHz frequency band in the same region to use a portion of this band under the LSA regime for LTE.

The application for the authorization may include (but are not limited to) the geographical region and the time period in which the mobile network operator plans to access the allowed portion of the band. The administration/National Regulatory Authority, which has the sole responsibility of granting such individual authorization, plays a key role in determining with relevant stakeholders (i.e. incumbent user and the mobile operator) the conditions of the LSA sharing framework including sharing options and modalities. The conditions to use the spectrum may be made available in an information repository that may be accessed by the mobile network operator's Operation, Administration and Maintenance system (OAM).

The mobile network operator also operates LTE in a licensed band in the said region and provisions the same or additional base stations to support the authorized portion of the 2 300 - 2 400 MHz band.

At the appropriate time indicated by the information repository, the mobile network operator's OAM system instructs the relevant base stations to enable transmission in the allowed portion of the 2 300 - 2 400 MHz band. With this availability of new spectrum, load balancing algorithms in the Radio Access Network will make use of these new resources and transfer devices to the new band based on need.

When the granted time period for the operation in the authorized portion of the 2 300 - 2 400 MHz band expires, the mobile network operator's OAM system instructs the relevant base stations to disable transmission in the allowed portion of the 2 300 - 2 400 MHz band. The load balancing algorithms in the Radio Access Network will ensure that devices are transferred back to the licensed band.

One of the technological aspects to be considered by the mobile network operator in the example use case described above is the choice of the topology to be used for the network deployment of the 2 300- 2 400 MHz band. The LSA regime is indeed applicable in the entire HetNet context. This LSA topology is described in more detail below.

- Macro Cell Deployment:
  - In this scenario, the mobile network operator decides to deploy its allowed portion of the 2 300 - 2 400 MHz frequency band based on a macro cell deployment using high power base station towers. The operator can either re-use the existing base station sites already deployed to support the operation of LTE in its licensed band, or it can decide to deploy additional high power base station towers to support the operation of LTE in the allowed portion of the 2 300 - 2 400 MHz frequency band.
- Micro-, Pico-, Femto- and other Cell Deployment:
  - In this scenario, the mobile network operator decides to deploy its allowed portion of the 2 300 - 2 400 MHz frequency band based on a deployment using low power base station sites. A mobile network operator may choose such deployment topology to ensure it can satisfy the incumbent's protection requirements over a larger coverage area.

LSA usage for Small Cells, a sub-set of the above mentioned Cell Deployments, is envisioned as follows:

- The term "small cell" should be understood as including all variants of deployments resulting in a coverage area smaller than the typical area covered by a macro cell deployment. This includes, but is not limited to, micro cells, pico cells and femto cells.
- The low transmit power of small cells, as well as their typical indoor and low height outdoor deployments have as corollary a smaller coverage area (compared to macro cell's coverage area) which provides a smaller geographical granularity to small cells. This allows a small cell deployment to better fully cover an authorized geographical area under the LSA regime, and so create the opportunity for sharing in areas where macro cell deployments would not be possible due to the need to protect the incumbent.
- The focus on heterogeneous networks (HetNet) in the 3G Partnership Project is an example of how technologies allowing this type of deployment are now made available to the cellular industry. Such local exploitation of spectrum will enable more spectrum sharing scenarios under the LSA regime.

Both topology deployments described above are not mutually exclusive and a mobile network operator may deploy both topologies in different parts of the allowed region.

7.2 Technical description of mobile BWS technologies

A high-level technical description of LTE technology that is relevant to the scope of the present document can be found in clause 7.1 of TR 102 837 [i.13].

7.3 Technical parameters and implications on spectrum

The technical parameters of LTE technology considered as an example in the present document are described in detail in this clause. Only those parameters relevant to compatibility between incumbents and mobile broadband systems utilizing the LSA regime are addressed. These parameters, which are under the 3GPP responsibility and purview, are taken from the latest version of relevant 3GPP specifications at the time of finalizing the present document. Please refer to the relevant 3GPP specifications as indicated in the reminders of this clause.

7.3.1 Common Parameters

7.3.1.1 Operating Frequency

For the technology example the nominal channel centre frequencies can be set in accordance with a 100 kHz step size. This brings flexibility to set the operating channel in accordance with national circumstances and band availability. The BS and MS will generally have a tuning range over the entire 2 300 - 2 400 MHz frequency range although BS equipment may be supplemented with band specific filtering arrangements to suit specific licences or national allocations.

7.3.1.2 Channel Bandwidth and Transmission Bandwidth

For the technology example, the channel bandwidth ($BW_{Channel}$) is measured in MHz and is used as a reference for transmitter and receiver RF requirements. $BW_{Channel}$ refers to the RF bandwidth supporting a single RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell. The transmission bandwidth configuration (N_{RB}) is the highest transmission bandwidth allowed for uplink or downlink in a given channel bandwidth, measured in Resource Block units. Figure 1 shows the relation between the channel bandwidth and the transmission bandwidth configuration. The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at $F_C \pm BW_{Channel} / 2$, where F_C denotes the carrier centre frequency.

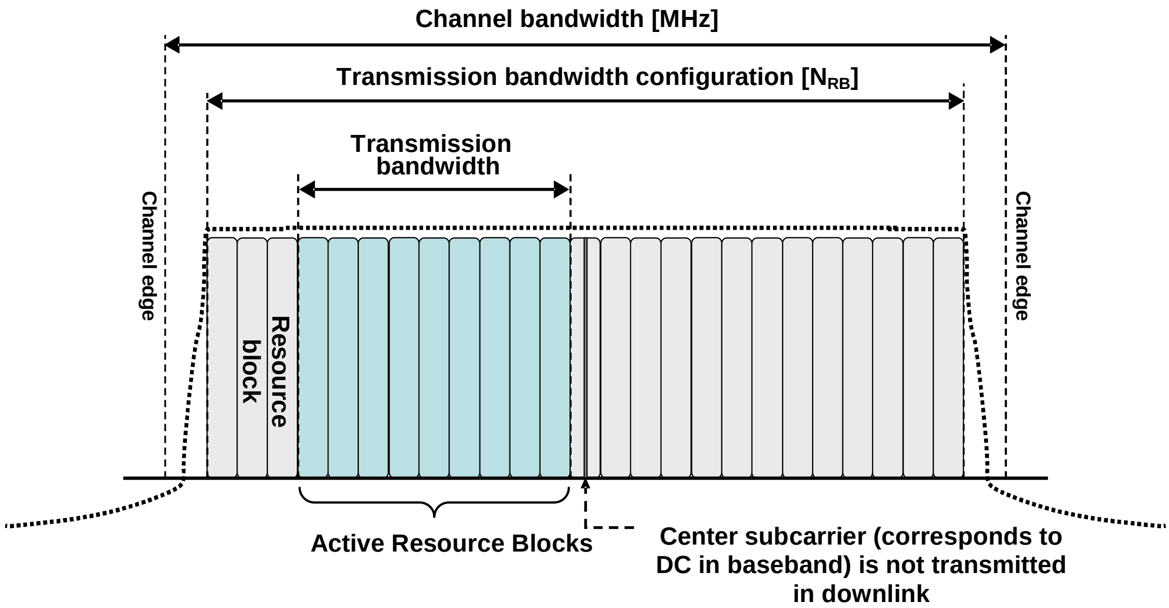

Figure 1: Definition of channel bandwidth and transmission bandwidth configuration for one carrier of the technology example

For the technology example, the channel bandwidths and corresponding transmission bandwidth configurations in the 2 300 - 2 400 MHz band are listed in table 1.

Table 1: Transmission bandwidth configuration N_{RB} in channel bandwidths of the technology example

Channel bandwidth $BW_{Channel}$ [MHz]	5	10	15	20
Transmission bandwidth configuration N_{RB}	25	50	75	100

NOTE: In addition to channel bandwidths given in the above table, the example technology specifies channel bandwidths of 1,4 MHz and 3 MHz with the corresponding transmission bandwidth configurations of 6 and 15, respectively. However, the requirements for band 40 (2 300 - 2 400 MHz) only support the figures in table 1.

7.3.1.3 Modulation Schemes

The technology example supports a range of modulation formats. Individual sub-carriers can be modulated using QPSK, 16-QAM and 64-QAM schemes under the dynamic control of the network in order to maximize data throughput efficiency.

7.3.2 Transmitter parameters

The following parameters are relevant to the technology example.

7.3.2.1 Transmitter Output Power / Radiated Power

7.3.2.1.1 Output Power - BS

Section 6.2 of [i.10] introduces several definitions for the output power of an E-UTRA base station:

- Maximum total output power (Pmax): the mean power level measured at the antenna connector during the transmitter ON period in a specified reference condition.
- Maximum output power per carrier (Pmax,c): the mean power level per carrier measured at the antenna connector during the transmitter ON period in a specified reference condition.
- Rated total output power: the mean power for BS operating in single carrier, multi-carrier, or carrier aggregation configurations that the manufacturer has declared to be available at the antenna connector during the transmitter ON period.
- Rated output power per carrier (PRAT): the mean power level per carrier for BS operating in single carrier, multi-carrier, or carrier aggregation configurations that the manufacturer has declared to be available at the antenna connector during the transmitter ON period.

The limits for the rated output power, PRAT, for different BS types are defined as given in table 2.

Table 2: Base Station rated output power

BS class	PRAT
Wide Area BS	(see note)
Local Area BS	≤ +24 dBm (for one transmit antenna port) ≤ +21 dBm (for two transmit antenna ports) ≤ +18 dBm (for four transmit antenna ports) < +15 dBm (for eight transmit antenna ports)
Home BS	≤ +20 dBm (for one transmit antenna port) ≤ +17 dBm (for two transmit antenna ports) ≤ +14dBm (for four transmit antenna ports) < +11dBm (for eight transmit antenna ports)
NOTE: There is no upper limit for the rated output power of the Wide Area Base Station.	

No upper limit for the rated output power of the Wide Area BS is defined in the above table. However, there are typical maximum transmitter RF powers specified at the BS antenna port averaged during the transmit burst. A typical value for the maximum RF power capability may be up to 43 dBm for the 5 MHz channel bandwidth. Therefore, the maximum BS EIRP spectral density assuming a typical 120 degree sector antenna (effective gain = 17 dBi) would be equivalent to 53 dBm/MHz in a 5 MHz channel.

For higher channel bandwidths, the transmitter power spectral density remains constant; therefore the overall power in the channel will increase accordingly.

See also clause 7.3.5 for additional information about typical deployment parameters for BS.

7.3.2.1.2 Unwanted Emissions - BS

Unwanted emissions consist of out-of-band emissions and spurious emissions. Out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

The out-of-band emissions limits for the BS transmitter are specified both in terms of operating band unwanted emissions and Adjacent Channel Leakage power Ratio (ACLR). The operating band unwanted emissions define all unwanted emissions in the downlink operating band plus the frequency ranges 10 MHz above and 10 MHz below the band. Unwanted emissions outside of this frequency range are limited by the spurious emissions requirement.

7.3.2.1.2.1 Operating Band Unwanted Emissions

The Operating band unwanted emission limits are defined from 10 MHz below the lowest frequency of the 2 300 - 2 400 MHz band to 10 MHz above the highest frequency of the 2 300 - 2 400 MHz band.

Maximum levels of operating band unwanted emissions are specified in the tables below, where:

- Δf is the separation between the channel edge frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency.
- f_offset is the separation between the channel edge frequency and the centre of the measuring filter.
- f_offset_{max} is the offset to the frequency 10 MHz outside the downlink operating band.
- Δf_{max} is equal to f_offset_{max} minus half of the bandwidth of the measuring filter.

For Wide Area BS, the limits in table 3 apply.

Table 3: Wide Area BS general unwanted emission limits for 5 MHz, 10 MHz, 15 MHz and 20 MHz channel bandwidth

Frequency offset of measurement filter -3 dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth
0 MHz ≤ Δf < 5 MHz	0,05 MHz ≤ f_offset < 5,05 MHz		100 kHz
5 MHz ≤ Δf < min(10 MHz, Δf_{max})	5,05 MHz ≤ f_offset < min(10,05 MHz, f_offset_{max})	-14 dBm	100 kHz
10 MHz ≤ Δf ≤ Δf_{max}	10,5 MHz ≤ f_offset < f_offset_{max}	-15 dBm	1 MHz

For Local Area BS, the limits in table 4 apply.

Table 4: Local Area BS unwanted emission limits for 5, 10, 15 and 20 MHz channel bandwidth

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (note 3)
0 MHz ≤ Δf < 5 MHz	0,05 MHz ≤ f_offset < 5,05 MHz		100 kHz
5 MHz ≤ Δf < min(10 MHz, Δf_{max})	5,05 MHz ≤ f_offset < min(10,05 MHz, f_offset_{max})	-37 dBm	100 kHz
10 MHz ≤ Δf ≤ Δfmax	10,05 MHz ≤ f_offset < f_offsetmax	-37 dBm (Note 4)	100 kHz

For Home BS, the limits in table 5 apply.

Table 5: Home BS unwanted emission limits for 5, 10, 15 and 20 MHz channel bandwidth

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (note 3)
0 MHz ≤ Δf < 5 MHz	0,05 MHz ≤ f_offset < 5,05 MHz	$-36dBm - \frac{6}{5}\left(\frac{f\_offset}{MHz} - 0.05\right)dB$	100 kHz
5 MHz ≤ Δf < min(10 MHz, Δf_{max})	5,05 MHz ≤ f_offset < min(10,05 MHz, f_offset_{max})	-42 dBm	100 kHz
10 MHz ≤ Δf ≤ Δf_{max}	10,5 MHz ≤ f_offset < f_offset_{max}	$\begin{cases} P-52dB, & 2\text{dBm} \le P \le 20\text{dBm} \\ -50dBm, & \text{P<2dBm} \end{cases}$ (Notes 4 and 5)	1 MHz

In addition to the above requirement, the following requirements may apply in certain regions to an E-UTRA TDD BS operating in the same geographic area and in the same operating band as another E-UTRA TDD system without synchronization. For this case the emissions are specified to not exceed -52 dBm/MHz in the downlink operating band except in:

- The frequency range from 10 MHz below the lower channel edge to the frequency 10 MHz above the upper channel edge.

The following notes are common to all BS types in this clause:

NOTE 1: Local or regional regulations may specify another excluded frequency range, which may include frequencies where synchronized E-UTRA TDD systems operate.

NOTE 2: E-UTRA TDD base stations that are synchronized can transmit without these additional co-existence requirements.

NOTE 3: As a general rule for the requirements in this clause, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE 4: The requirement is not applicable when Δf_{max} < 10 MHz.

NOTE 5: For Home BS, the parameter P is defined as the aggregated maximum power of all transmit antenna ports of Home BS.

7.3.2.1.2.2 Adjacent Channel Leakage Ratio (ACLR)

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

The ACLR is defined with a square filter of bandwidth equal to the transmission bandwidth configuration of the transmitted signal (BW_{Config}) centred on the assigned channel frequency and a filter centred on the adjacent channel frequency according to the tables below.

For Wide Area BS, either the ACLR limits in the tables below or the absolute limit of -15 dBm/MHz apply, whichever is less stringent.

For Local Area BS, either the ACLR limits in the tables below or the absolute limit of -32 dBm/MHz are specified, whichever is less stringent.

For Home BS, either the ACLR limits in the tables below or the absolute limit of -50 dBm/MHz apply, whichever is less stringent.

For operation in unpaired spectrum, the ACLR is specified to be higher than the value shown in table 6.

Table 6: Base Station ACLR in unpaired spectrum with synchronized operation

Channel bandwidth of E-UTRA lowest (highest) carrier transmitted $BW_{Channel}$ [MHz]	BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted	Assumed adjacent channel carrier (informative)	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit
5, 10, 15, 20	$BW_{Channel}$	E-UTRA of same BW	Square (BW_{Config})	45 dB
	2 x $BW_{Channel}$	E-UTRA of same BW	Square (BW_{Config})	45 dB
NOTE: $BW_{Channel}$ and BW_{Config} are the channel bandwidth and transmission bandwidth configuration of the E-UTRA lowest (highest) carrier transmitted on the assigned channel frequency.				

7.3.2.1.2.3 Transmitter Spurious Emission

BS transmitter spurious emission limits apply from 9 kHz to 12,75 GHz, excluding the frequency range from 10 MHz below the lowest frequency of the downlink operating band up to 10 MHz above the highest frequency of the downlink operating band. These limits are compliant with annex 2 of ERC Recommendation 74-01E [i.15] and Recommendation ITU-R SM.329 [i.34].

The power of any spurious emission is specified to not exceed the limits in table 7.

Table 7: BS Spurious emissions limits

Frequency range	Maximum Level	Measurement Bandwidth	Note
9 kHz ↔ 150 kHz	-36 dBm	1 kHz	Note 1
150 kHz ↔ 30 MHz	-36 dBm	10 kHz	Note 1
30 MHz ↔ 1 GHz	-36 dBm	100 kHz	Note 1
1 GHz ↔ 12,75 GHz	-30 dBm	1 MHz	Note 2
NOTE 1: Bandwidth as in ERC Recommendation 74-01E [i.15], Recommends 4. NOTE 2: Bandwidth as in ERC Recommendation 74-01E [i.15], Recommend 4. Upper frequency as in ITU-R SM.329 [i.34], s2.5 table 1.			

According to Section 6.6.4.3.1 of [i.10], there are additional spurious emissions requirements which may apply for the protection of specific E-UTRA equipment (MS and/or BS) or equipment operating in other systems (GSM, CDMA, UTRA, E-UTRA, etc.) as listed in table 6.6.4.3.1-1 of [i.10] for Wide Area BS type or in table 6.6.4.3.1-1x of [i.10] for Home BS type.

7.3.2.1.3 Transmitter Power and EIRP - MS

The maximum RF output power for any transmission bandwidth within the channel bandwidth is 23 dBm with a tolerance of ±2. Power control techniques are employed which can result in a spread of actual MS operating power levels across a deployment area.

The typical MS antenna gain is 0 dBi. See also clause 7.3.5 for additional information about typical deployment parameters for MS.

7.3.2.1.3.1 Power Control

For correct and efficient operation of a network, power control is employed in the mobile station as a dynamic function under the control of the Base Station.

The minimum controlled output power of the UE is defined as the broadband transmit power of the UE, i.e. the power in the channel bandwidth for all transmit bandwidth configurations (resource blocks), when the power is set to a minimum value.

The minimum output power is defined as the mean power in one sub-frame (1ms). The minimum output power is specified to not exceed the values shown in table 8.

Table 8: Minimum output power

	Channel bandwidth/Minimum output power/Measurement bandwidth			
	5 MHz	10 MHz	15 MHz	20 MHz
Minimum output power	-40 dBm			
Measurement bandwidth	4,5 MHz	9,0 MHz	13,5 MHz	18 MHz

7.3.2.1.4 Unwanted Emissions - MS

Unwanted emissions consist of out-of-band emissions and spurious emissions. The Out of band emissions are unwanted emissions immediately outside the assigned channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

The out-of-band emissions limits for the MS transmitter are specified both in terms of spectrum emission mask and an Adjacent Channel Leakage power Ratio (ACLR). The spectrum emission mask defines all unwanted emissions in the uplink operating band plus the frequency ranges 10 MHz above and 10 MHz below the band. Unwanted emissions outside of this frequency range are limited by the spurious emissions requirements.

7.3.2.1.4.1 Transmitter Spectrum Emission Mask

The spectrum emission mask of the MS applies to frequencies (Δf_{OOB}) starting from the ± edge of the assigned E-UTRA channel bandwidth. For frequencies greater than (Δf_{OOB}) as specified in table 9 the spurious requirements in clause 7.3.2.1.4.3 are applicable. The power of any UE emission is specified to not exceed the levels shown in table 9 for the specified channel bandwidth.

Table 9: General E-UTRA spectrum emission mask

Spectrum emission limit (dBm)/ Channel bandwidth							
Δf_{OOB} (MHz)	1,4 MHz	3,0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
±0 - 1	-10	-13	-15	-18	-20	-21	30 kHz
±1 - 2,5	-10	-10	-10	-10	-10	-10	1 MHz
±2,5 - 2,8	-25	-10	-10	-10	-10	-10	1 MHz
±2,8 - 5		-10	-10	-10	-10	-10	1 MHz
±5 - 6		-25	-13	-13	-13	-13	1 MHz
±6 - 10			-25	-13	-13	-13	1 MHz
±10 - 15				-25	-13	-13	1 MHz
±15 - 20					-25	-13	1 MHz
±20 - 25						-25	1 MHz

NOTE: As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. However, to improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth may be smaller than the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

7.3.2.1.4.2 Adjacent Channel Leakage Ratio (ACLR)

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency. For the technology example, ACLR requirements are specified for two scenarios for an adjacent E -UTRA and /or UTRA channel as shown in figure 2. However in this clause, only the ACLR requirements for adjacent E-UTRA are presented.

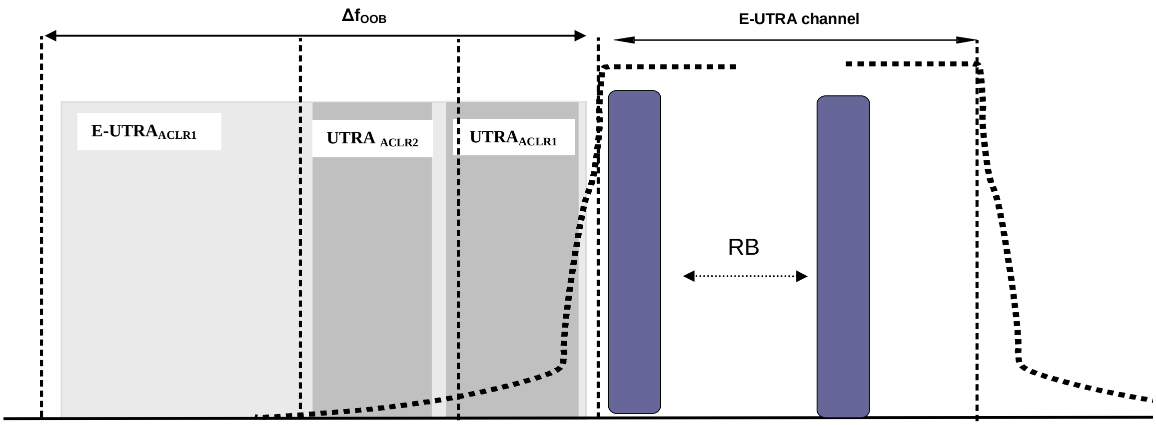

Figure 2: Adjacent Channel Leakage requirements

E-UTRA Adjacent Channel Leakage power Ratio (E-$UTRA_{ACLR}$) is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency at nominal channel spacing. The assigned E-UTRA channel power and adjacent E-UTRA channel power are measured with rectangular filters with measurement bandwidths specified in table 10. If the measured adjacent channel power is greater than -50 dBm then the E-$UTRA_{ACLR}$ is specified to be higher than the value shown in table 10.

Table 10: General requirements for E-UTRA$_{ACLR}$

	Channel bandwidth / E-UTRA$_{ACLR1}$ / Measurement bandwidth			
	5 MHz	**10 MHz**	**15 MHz**	**20 MHz**
E-UTRA$_{ACLR1}$	30 dB	30 dB	30 dB	30 dB
E-UTRA channel Measurement bandwidth	4,5 MHz	9,0 MHz	13,5 MHz	18 MHz
Adjacent channel centre frequency offset [MHz]	+5/-5	+10/-10	+15/-15	+20/-20

7.3.2.1.4.3 Transmitter Spurious Emission

MS spurious emission limits are specified in terms of:

- general requirements compliant with annex 2 of ERC Recommendation with 74-01E [i.15] and Recommendation ITU-R SM.329 [i.34]; and
- additional E-UTRA operating band requirement to address MS co-existence.

Unless otherwise stated, the general spurious emission limits apply from 9 kHz to 12,75 GHz for the frequency ranges that are more than Δf_{OOB} (MHz) in table 11 from the edge of the channel bandwidth. The spurious emission limits in table 12 apply for all transmitter band configurations (N_{RB}) and channel bandwidths.

Table 11: Boundary between E-UTRA Δf_{OOB} and spurious emission domain

Channel bandwidth	5 MHz	10 MHz	15 MHz	20 MHz
Δf_{OOB} (MHz)	10	15	20	25

NOTE: In order that the measurement of spurious emissions falls within the frequency ranges that are more than Δf_{OOB} (MHz) from the edge of the channel bandwidth, the minimum offset of the measurement frequency from each edge of the channel should be Δf_{OOB} + MBW/2. MBW denotes the measurement bandwidth defined in table 12.

Table 12: Spurious emissions limits

Frequency Range	Maximum Level	Measurement bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1 000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12,75 GHz	-30 dBm	1 MHz

Additional spurious emissions limits are specified for the E-UTRA band in [i.11] in order to guarantee coexistence with protected bands. For 2 300 - 2 400 MHz (E-UTRA Band 40), the limits in table 13 are specified. However this table does not contain such limits for the E-UTRA bands 7, 8, 20 and 38, because the 2 300 - 2 400 MHz band is not currently used for mobile applications in CEPT countries. The definition of E-UTRA bands and corresponding F_{DL_low} and F_{DL_high} can be found in table 14.

Table 13: Additional Spurious emissions limits

E-UTRA Band	Spurious emission						
	Protected band	**Frequency range (MHz)**			**Maximum Level (dBm)**	**MBW (MHz)**	**Note**
40	E-UTRA Band 1, 3, 22, 26, 27, 33, 34, 39, 42, 43, 44	F_{DL_low}	-	F_{DL_high}	-50	1	

Table 14: E-UTRA operating bands

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit F_{UL_low} - F_{UL_high}	Downlink (DL) operating band BS transmit UE receive F_{DL_low} - F_{DL_high}	Duplex Mode
1	1 920 MHz - 1 980 MHz	2 110 MHz - 2 170 MHz	FDD
2	1 850 MHz - 1 910 MHz	1 930 MHz - 1 990 MHz	FDD
3	1 710 MHz - 1 785 MHz	1 805 MHz - 1 880 MHz	FDD
4	1 710 MHz - 1 755 MHz	2 110 MHz - 2 155 MHz	FDD
5	824 MHz - 849 MHz	869 MHz - 894MHz	FDD
6[1]	830 MHz - 840 MHz	875 MHz - 885 MHz	FDD
7	2 500 MHz - 2 570 MHz	2 620 MHz - 2 690 MHz	FDD
8	880 MHz - 915 MHz	925 MHz - 960 MHz	FDD
9	1 749,9 MHz - 1 784,9 MHz	1 844,9 MHz - 1 879,9 MHz	FDD
10	1 710 MHz - 1 770 MHz	2 110 MHz - 2 170 MHz	FDD
11	1 427,9 MHz - 1 447,9 MHz	1 475,9 MHz - 1 495,9 MHz	FDD
12	699 MHz - 716 MHz	729 MHz - 746 MHz	FDD
13	777 MHz - 787 MHz	746 MHz - 756 MHz	FDD
14	788 MHz - 798 MHz	758 MHz - 768 MHz	FDD
15	Reserved	Reserved	FDD
16	Reserved	Reserved	FDD
17	704 MHz - 716 MHz	734 MHz - 746 MHz	FDD
18	815 MHz - 830 MHz	860 MHz - 875 MHz	FDD
19	830 MHz - 845 MHz	875 MHz - 890 MHz	FDD
20	832 MHz - 862 MHz	791 MHz - 821 MHz	FDD
21	1 447,9 MHz - 1 462,9 MHz	1 495,9 MHz - 1 510,9 MHz	FDD
...			
23	2 000 MHz - 2 020 MHz	2 180 MHz - 2 200 MHz	FDD
24	1 626,5 MHz - 1 660,5 MHz	1 525 MHz - 1 559 MHz	FDD
25	1 850 MHz - 1 915 MHz	1 930 MHz - 1 995 MHz	FDD
...			
33	1 900 MHz - 1 920 MHz	1 900 MHz - 1 920 MHz	TDD
34	2 010 MHz - 2 025 MHz	2 010 MHz - 2 025 MHz	TDD
35	1 850 MHz - 1 910 MHz	1 850 MHz - 1 910 MHz	TDD
36	1 930 MHz - 1 990 MHz	1 930 MHz - 1 990 MHz	TDD
37	1 910 MHz - 1 930 MHz	1 910 MHz - 1 930 MHz	TDD
38	2 570 MHz - 2 620 MHz	2 570 MHz - 2 620 MHz	TDD
39	1 880 MHz - 1 920 MHz	1 880 MHz - 1 920 MHz	TDD
40	2 300 MHz - 2 400 MHz	2 300 MHz - 2 400 MHz	TDD
41	2 496 MHz 2 690 MHz	2 496 MHz 2 690 MHz	TDD
42	3 400 MHz - 3 600 MHz	3 400 MHz - 3 600 MHz	TDD
43	3 600 MHz - 3 800 MHz	3 600 MHz - 3 800 MHz	TDD
NOTE: Band 6 is not applicable.			

7.3.3 Receiver parameters

7.3.3.1 Receiver Sensitivity - BS

For the technology example and channel bandwidths of 5 MHz and above, the BS reference sensitivity power level in tables 15 to 17 is the minimum mean power applied the antenna ports for a throughput that is ≥ 95 % of the maximum throughput of the reference measurement channel as specified in [i.10]. Values are given for Wide Area BS (for macro scenarios), Local Area BS (for pico scenarios) and Home BS (for femto scenarios) in tables 15 to 17 respectively.

Table 15: Wide Area BS reference sensitivity levels [i.10]

Channel Bandwidth (MHz)	Reference sensitivity power level, $P_{REFSENS}$ (dBm)
5	-101,5
10 (see note)	-101,5
15 (see note)	-101,5
20 (see note)	-101,5
NOTE: $P_{REFSENS}$ is the power level of a single instance of a 5 MHz reference measurement channel. This requirement is specified to be met for each consecutive application of a single instance of the 5 MHz reference channel mapped to disjoint frequency ranges with a width of 25 resource blocks each.	

Table 16: Local Area BS reference sensitivity levels [i.10]

Channel Bandwidth (MHz)	Reference sensitivity power level, $P_{REFSENS}$ (dBm)
5	-93,5
10 (see note)	-93,5
15 (see note)	-93,5
20 (see note)	-93,5
NOTE: $P_{REFSENS}$ is the power level of a single instance of a 5 MHz reference measurement channel. This requirement is specified to be met for each consecutive application of a single instance of the 5 MHz reference channel mapped to disjoint frequency ranges with a width of 25 resource blocks each.	

Table 17: Home BS reference sensitivity levels [i.10]

Channel Bandwidth (MHz)	Reference sensitivity power level, $P_{REFSENS}$ (dBm)
5	-93,5
10 (see note)	-93,5
15 (see note)	-93,5
20 (see note)	-93,5
NOTE: $P_{REFSENS}$ is the power level of a single instance of a 5 MHz reference measurement channel. This requirement is specified to be met for each consecutive application of a single instance of the 5 MHz reference channel mapped to disjoint frequency ranges with a width of 25 resource blocks each.	

7.3.3.2 Receiver Sensitivity - MS

For the technology example and channel bandwidths of 5 MHz and above, the reference sensitivity power level in table 18 is the minimum mean power applied to both the MS antenna ports for a throughput that is ≥ 95 % of the maximum throughput of reference measurement channels defined in [i.11]. This reference sensitivity is defined for the allocated uplink frequency resource given in table 19.

Table 18: Reference sensitivity QPSK [i.11]

Channel bandwidth					
Band	5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	Duplex Mode
2 300 MHz to 2 400 MHz	-100	-97	-95,2	-94	TDD

Table 19: Minimum uplink configuration for reference sensitivity [i.11]

Channel bandwidth					
Band	5 MHz	10 MHz	15 MHz	20 MHz	Duplex Mode
2 300 MHz to 2 400 MHz	4,5 MHz	9 MHz	13,5 MHz	18 MHz	TDD

7.3.4 Channel access parameters

In common with other cellular technologies, MS equipment will only transmit under the control of a BS within a valid network.

7.3.5 Typical Deployment Parameters

The deployment parameters of the systems can vary according to, for example, the geographical location, the market to be addressed and local constraints not necessarily associated with radio network planning. The ECC has carried out a number of studies requiring scenario and parameter assumptions in the 2 300 - 2 400 MHz band [i.35] and in the nearby 2 500 - 2 690 MHz band [i.21] and [i.22]. Therefore CEPT/ ECC Reports are available that can be consulted for typical deployment parameters that might be used in studies for the 2 300 - 2 400 MHz frequency range.

Based upon these references table 20 summarizes some additional typical deployment parameters which are not presented in clauses 7.3.1, 7.3.2 and 7.3.3 of the present document and may be requiredfor potential sharing and compatibility studies. This table is based on tables 6 and 7 of [i.35] with the deletion of those technical parameters which are defined in clauses 7.3.1, 7.3.2 and 7.3.3 of the present document. In addition, typical values for the cell size (from tables 4 and 5 of [i.22]) and the minimum BS separation distance for uncoordinated operation (from Annex IV of [i.21]) are added to table 20.

Table 20: Additional Deployment Parameters

Parameter	LTE TDD technology
Operating frequency (MHz)	2 350
Cell sizes (m)	500 to 1 000
Minimum BS separation for uncoordinated operation (m)	100
BS Antenna height (m)	Varies between 10 - 37,5 m above clutter height in studies
MS Antenna Height (m)	1,5
BS Antenna Gain (dBi)	17
MS Antenna Gain (dBi)	0 (omnidirectional)
BS Operating band unwanted emission mask	The requirements for general transmitter unwanted emission behavior in 2 290 - 2 300 MHz in [i.10] or the Multi Standard Radio (MSR) equipment requirements as specified in [i.37]
BS Feeder loss (dB)	3
BS Antenna tilt (degrees)	3 (giving 3 dB loss compared to the main lobe) [i.38]
Interference criterion I/N (dB)	-6
BS Noise figure (dB)	5
BS Thermal noise (F.k.T.B)	-102 dBm (LTE 5 MHz) -99 dBm (LTE 10 MHz) -96 dBm (LTE 20 MHz)
Imax (dBm) from BS	-108 dBm (LTE 5 MHz) -105 dBm (LTE 10 MHz) -102 dBm (LTE 20 MHz)
MS Noise figure (dB)	9
MS Thermal noise (F.k.T.B)	-98 dBm (LTE 5 MHz) -95 dBm (LTE 10 MHz) -92 dBm (LTE 20 MHz)
Imax (dBm) from MS	-104 dBm (LTE 5 MHz) -101 dBm (LTE 10 MHz) -98 dBm (LTE 20 MHz)

7.3.6 Sharing and compatibility studies

In general, sharing and compatibility studies in the 2 300 - 2 400 MHz frequency band can be performed in two areas. The first area addresses "inter-service" band usage scenarios where sharing and compatibility between mobile broadband services and other utilizations identified in the ECA [i.14] for this band will be studied. The second area addresses "intra-service" scenarios where sharing and compatibility between different mobile applications or mobile licence holders operating in the same band will be assessed. This general approach needs a closer examination in the LSA context.

Spectrum sharing under the LSA framework is binary by nature, as it permits spectrum use by either the incumbent or the LSA licensee. The LSA licensee enjoys exclusive spectrum rights of use where and when the spectrum is not used by the incumbent. In this context, the sharing and compatibility studies under LSA scenariosaim at defining technical conditions for the protection of incumbent in such scenarios. For this purpose, three different LSA scenarios need to be considered:

1) Incumbent and LSA licensee share the same spectrum in the same location on a time basis
2) Incumbent and LSA licensee use the same spectrum at the same time in different locations
3) LSA licensee uses in the same location and time a portion of the band not being utilized by the incumbent

In Case 1, sharing study is obviously not an issue due to the disjunctive use of spectrum. In Case 2, inter-service sharing studies are necessary for defining technical conditions (e.g. limits on mobile base station transmit power) and coordination measures (exclusion zone/separation distance) required to protect incumbent. In this case, intra-service compatibility studies might be necessary, too. In Case 3, incumbent and LSA licensee operate in adjacent spectrum lots, and therefore, inter-service compatibility studies need to be performed for protecting incumbent from harmful interference (out-of-band and blocking) caused by mobile service operation under LSA. Again, intra-service compatibility studies might be necessary in this case, too.

In addition to in-band (i.e. inter-service and intra-service) sharing and compatibility studies, adjacent band compatibility between mobile broadband services and other services/systems operating either below 2 300 MHz or above 2 400 MHz might be necessary. However, it doesn't seem that such studies are different in the LSA case compared to the exclusive usage right case.

7.3.6.1 Inter-Service Sharing and Compatibility

Examination of the ECA [i.14] table shows the following incumbents which could be subject to potential sharing and compatibility studies due to spectrum sharing with mobile broadband services under LSA framework:

- Aeronautical and terrestrial telemetry.
- SAP/SAB with specific applications including cordless cameras, portable video links and mobile video links which may also be airborne.

7.3.6.1.1 Telemetry Considerations

Section 5.2 of ECC Report 172 [i.35] introduces roughly aeronautical and terrestrial telemetry systems. Aeronautical systems are composed of ground stations and airborne stations, where telemetry signals are transmitted by airborne stations (e.g. aircraft, missile) to ground stations. Terrestrial systems are composed of ground stations only, where telemetry signals are sent from a ground station to another ground station.

According to ECC Report 172 [i.35], aeronautical telemetry utilizes the frequency range 2 310 - 2 400 MHz and terrestrial telemetry uses the frequency range 2 200 - 2 400 MHz.

Section 5.2 of [i.35] presents also some information about technical characteristics of aeronautical telemetry systems. Some of characteristics have been extracted from the IRIG STANDARD 106 [i.36] and some other are representative of French aeronautical telemetry systems.

7.3.6.1.2 Audio and Video SAP/SAB Links Considerations

Extracts from [i.18] in table 21 show the recommended frequency ranges for use by audio and video SAP/SAB links in the 2 300 - 2 400 MHz frequency band.

Table 21: Recommended frequency ranges in 2 300 - 2 400 MHz for SAP/SAB

Type of link	Recommended frequencies		Technical parameters
	Tuning ranges	Preferred sub-bands	
Cordless cameras	2 025 MHz to 2 110 MHz/ **2 200** MHz **to 2 500** MHz 10,0 GHz to 10,60 GHz 21,2 GHz to 24,5 GHz 47,2 GHz to 50,2 GHz	10,3 GHz to 10,45 GHz 21,2 GHz to 21,4 GHz, 22,6 GHz to 23,0 GHz and 24,25 GHz to 24,5 GHz	ERC Report 38 [i.20]
Portable video links	2 025 MHz to 2 110 MHz/ **2 200** MHz **to 2 500** MHz 2 500 MHz to 2 690 MHz (Note 4 of Annex 2 of [i.18]) 10,0 GHz to 10,60 GHz	10,3 GHz to 10,45 GHz	ERC Report 38 [i.20]
Mobile video links (airborne and vehicular)	2 025 MHz to 2 110 MHz/ **2 200** MHz **to 2 500** MHz 2 500 MHz to 2 690 MHz (Note 4 of Annex 2 of [i.18]) 3 400 MHz to 3 600 MHz (Note 5 of Annex 2 of [i.18])		ERC Report 38 [i.20]

ERC Report 038 [i.20] provides descriptions of typical usage scenarios and equipment/system characteristics. The report highlights the need for these applications to be used in a number of scenarios that may be varied according to the particular usage scenario at any time. Antennas range from omni-directional portable types that are likely to be used at the progamme material gathering scene to high gain P-P like antennas used to link signals back to remote production facilities.

Table 1 of ERC Report 038 [i.20] suggests that the most likely uses in the 2 300 - 2 400 MHz frequency band involve low to medium gain (3 dBi to 13 dBi) transmitting antennas and higher gain receiving antennas (13 dBi to 17 dBi) for mobile, portable and temporary links (as opposed to mobile camera applications). EN 302 064 (Parts 1 and 2) [i.19] indicate channel bandwidths up to 20 MHz for professional broadcast applications for digital link equipment and ERC Report 038 [i.20] identifies EIRP levels up to 40 dBW.

7.3.6.1.3 Inter-Service sharing and compatibility studies already available

ECC Report 172 [i.35] provides sharing and compatibility studies with respect to the potential use of the 2 300 - 2 400 MHz frequency band by mobile broadband wireless service. The report considers sharing scenarios within the 2 300 - 2 400 MHz frequency band between mobile broadband wireless service on one hand and, on the other hand, telemetry systems and SAP/SAB video links.

The studies demonstrated that sharing between broadband wireless service and Telemetry Systems is not ensured in a co-location configuration. Time sharing, geographical separation or adjacent channel operation (Cases 1 to 3 in clause 7.3.6) may help to ensure sharing and compatibility.

The results of worst-case sharing and compatibility analysis between broadband wireless services and SAP/SAB video links indicate that in cordless or portable camera scenarios, compatibility can be feasible in the adjacent and alternate channel case; it has to be decided on a case-by-case basis if additional protection mechanisms have to be employed. In the co-channel case, dedicated protection and interference mitigation mechanisms would be required if broadband wireless service and video links are used at the same time in the same geographical area. In a scenario involving a video link to a helicopter, the required coupling loss between the systems is higher, and a guard band between the broadband wireless service and video link systems is likely to be required if no further coordination measures are implemented.

It should be noted that the conclusions of ECC Report 172 [i.35] do not take the LSA framework into account, and therefore, there might be need for further studies for the usage of the 2 300 - 2 400 MHz frequency band for mobile broadband wireless service under LSA regime.

7.3.6.2 Intra-Service Sharing and Compatibility

This topic has been extensively studied in a number of fora generally to either evaluate the sharing and compatibility issues between similar mobile broadband applications using different technologies or to assist with the frequency band plan arrangements that might be used as the basis for licence award activities.

ECC Report 172 [i.35] considers scenarios within the 2 300 - 2 400 MHz frequency band between mobile broadband wireless systems operating in adjacent spectrum. The report concludes that for compatibility between various broadband wireless networks to operate in the band 2 300 - 2 400 MHz without guard band, the use of mitigation techniques is required. Examples of mitigation techniques to improve the adjacent channel operation of broadband wireless systems are (non-exhaustive list):

- Synchronization of networks operating in adjacent channels
- Extra filtering
- Site engineering
- Main lobe planning between frequency neighbouring licensees
- Site coordination between operators.

As the scenarios considered here are independent of spectrum sharing between the incumbent and broadband wireless service, the abovementioned conclusions should be valid for spectrum sharing under LSA framework, too.

7.3.6.3 Adjacent Band Compatibility

Tables 22 and 23 show the European common allocations according to ERC Report 25 [i.14] in the bands adjacent to 2 300 - 2 400 MHz.

Table 22: ECA [i.14] information for 2 200 MHz - 2 300 MHz

Utilization	ERC/ECC Documentation	European Standard	Comments
For 2 200 MHz to 2 290 MHz:			
Defence Systems			Radio Relay links 2 200 MHz to 2 245 MHz
Fixed Links	T/R 13-01 [i.48]	EN 302 217 [i.23]	
Radio Astronomy			Continuum line and VLBI observations
SAP/SAB		EN 302 064 [i.19]	See table C2 in [i.14]
Space Research			Satellite payload and platform telemetry
For 2 290 MHz to 2 300 MHz:			
Mobile applications			
Space Research			Satellite payload and platform telemetry for space research (deep space)

Table 23: ECA [i.14] information for 2 400 - 2 500 MHz

Utilization	ERC/ECC Documentation	European Standard
Amateur and Amateur Satellite		EN 301 783 [i.17]
Non- Specific SRD's	ERC/REC 70-03 [i.24]	EN 300 440 [i.25]
Radiodetermination applications	ERC/REC 70-03 [i.24] ERC/DEC(01)08 [i.26]	EN 300 440 [i.25]
Railway Applications	ERC/REC 70-03 [i.24]	EN 300 761 [i.27]
RFID	ERC/REC 70-03 [i.24]	EN 300 440 [i.25]
Wideband Data Transmitting Systems	ERC/REC 70-03 [i.24]	EN 300 328 [i.28]
IMT Satellite Component		
Mobile Satellite Applications	ECC/DEC(07)04 [i.31] ECC/DEC(07)05 [i.32] ERC/DEC(97)03 [i.29] ERC/DEC(97)05 [i.30]	
SAP/SAB	ERC/REC 25-10 [i.33]	EN 302 064 [i.19]

ECC Report 172 [i.35] provides compatibility studies with respect to adjacent band scenarios between broadband wireless service operating in the 2 300 - 2 400 MHz frequency band and other services/systems operating either below 2 300 MHz or above 2 400 MHz. As the scenarios considered in the studies are independent of spectrum sharing between the incumbents and broadband wireless service, the abovementioned conclusions should be valid for spectrum sharing under LSA framework, too.

7.4 Information on relevant standard(s)

ETSI will develop candidate Harmonized Standards covering essential requirements of article 3.2 of "the R&TTE Directive" [i.47] (the 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) or of future revisions of this directive.

7.5 Example of high-level architecture and related functions enabling the LSA concept

This clause describes an example of technical realization for the LSA concept. This realization is not meant to be the sole possible architecture enabling the LSA concept but rather one possible realization.

7.5.1 Design Principles

For the design of the architecture enabling the LSA concept proposed in this paper, a number of principles were used and are described as follows:

- Simplicity: In this proposed technical realization enabling LSA concept the goal has been to keep things simple and only focus on the necessary components which are sufficient to operate a network under the LSA regime.
- Ease and speed of deployment: One of the characteristics of the proposed technical realization design is to be network-centric, meaning that the user terminals do not require to support any new radio protocol or functionality that requires a lengthy development process (standardization, development, conformance and performance testing). This design choice will benefit from a significant time to market advantage. Of course, terminals will need to support additional bands on which LSA would be applied to support LSA however through careful consideration of such bands (e.g. the 2,3 - 2,4 GHz band which is already defined as an IMT band) the industry can leverage already existing network and terminal equipment.
- Technology Neutrality: A beneficial by-product of the LSA concept is the fact that it can apply indiscriminately for any cellular technologies. This is given by the fact that no new radio protocol or functionality is envisioned. However, it is not a guarantee that any cellular technology will satisfy the LSA requirements set by incumbent users (coming from e.g. CEPT coexistence studies).

7.5.2 Architecture enabling LSA concept

In this clause the components which constitute this example of technical realization of the architecture enabling LSA concept are described, Figure 3 will be used for illustration purposes.

- LSA Repository: This database contains the relevant information on spectrum use by the incumbent (in the spatial, frequency and time domains). Furthermore, the incumbent may choose to take steps ensuring that its confidentiality and information sensitivity requirements are met. Due to the sensitive nature of the incumbent's information, in some cases the repository would be country-specific and under the purview of the NRA (National Regulation Authority). There could be one or more repositories per country, depending on the LSA band and the incumbent's nature (public or commercial). The LSA Repository may be directly managed by the Administration, the NRA or the incumbent, or be delegated to a trusted third party.

- LSA Controller: The LSA Controller computes LSA spectrum availability in the spatial, frequency and time domains based on rules built upon LSA rights of use and information on the incumbent's use provided by the LSA Repository. It connects to the LSA Repository through a secure and reliable interface. There could be one or multiple LSA Controllers per country. The LSA Controller can interface with one or multiple LSA Repositories as well as with one or multiple LSA licensee's networks. The LSA Controller may be managed by the Administration, the NRA, the LSA licensee(s) or a trusted third party.

- Network OA&M (Operations, Administration and Maintenance): This corresponds to the OA&M of mobile broadband networks. The OA&M in the LSA licensee's network takes care of the actual management of the LSA licensed spectrum. In practical terms, the OA&M translates into Radio Resource Management commands the information on spectrum availability obtained from the LSA Controller. These commands are then transmitted to base stations in the LSA licensee's network. Based on this information, the base stations enable user devices to access the LSA spectrum or order them to hand off seamlessly to other frequency bands as appropriate subject to, e.g. LSA spectrum availability, QoS requirements, data rates or data plans. In addition, some reconfigurations and system information updates of the other networks managed by the operator that are deployed in the same geographical area and operating on its licensed band may be needed.

- In figure 3, an operator is depicted with base stations deployed in a first licensed band (henceforth known as underlying band) covering an area depicted in light blue. The LSA licensed band depicted in gold is available only in part of the area of the underlying band due to the presence of an incumbent's equipment which prohibits the usage of the LSA spectrum over the entire coverage area (another reason for the LSA licensed band to not be available over the entire coverage area may be that the operator didn't have a need for additional bandwidth in that area). The operator's OA&M is responsible for ensuring that only the appropriate base stations are transmitting in the LSA spectrum and can access this information from the LSA controller which collects the information relevant for this particular area, time and incumbent from the LSA repository. A user terminal located in the area where the LSA band is available such as terminal 1 can have access to either of the underlying band and the LSA band (or both bands if it has the appropriate carrier aggregation capabilities). A user terminal located in the area where the LSA band is not available such as terminal 2 will only have access to the underlying band.

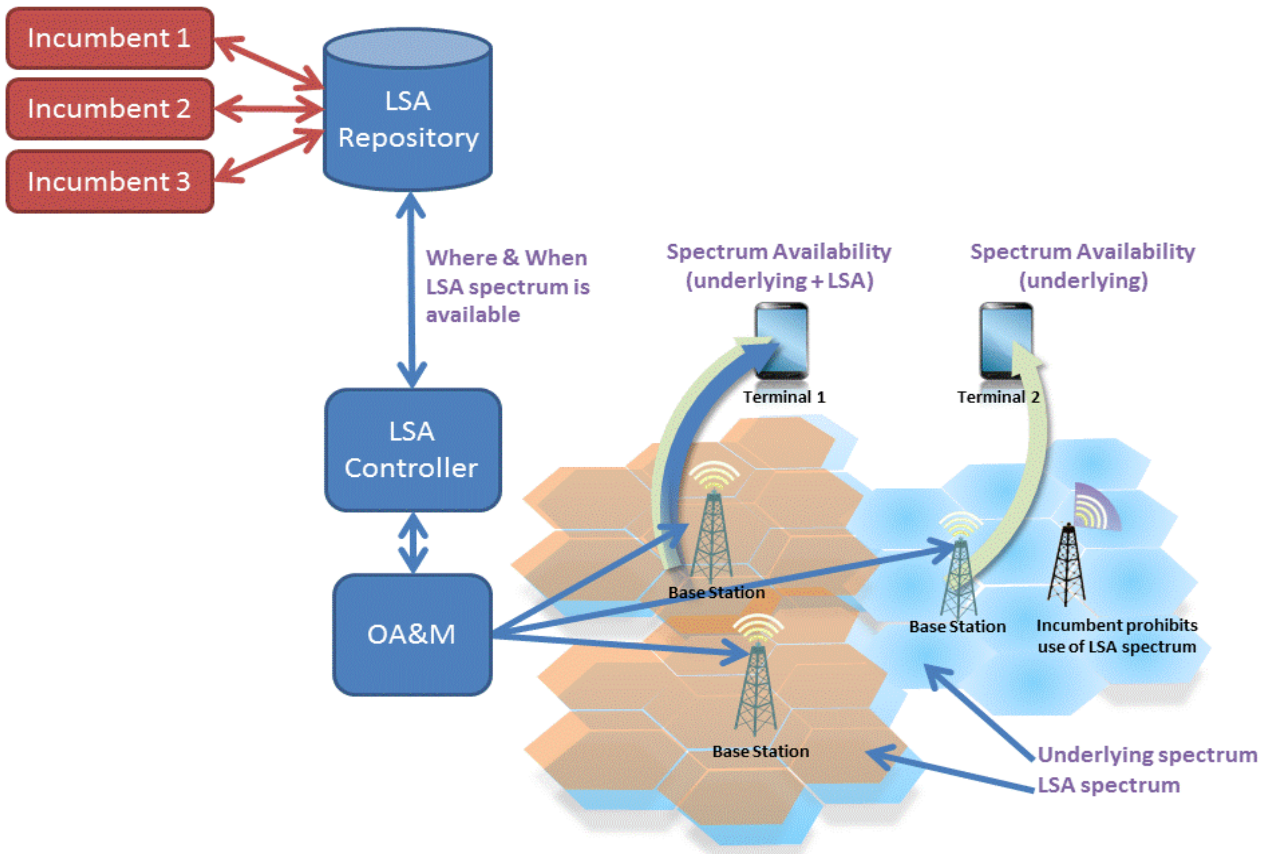

Figure 3: An example architecture for technical realization of the LSA concept

7.5.3 Entering and Vacating LSA spectrum

In this clause the operations of entering and vacating LSA spectrum will be described in more details.

From the view point of a mobile broadband operator, LSA introduces a variability in the amount of spectrum that can be utilized for its normal operation and in principle the heuristics required to utilize the LSA band are similar to the inter-RAT or inter-band load balancing heuristics which already exist in the OA&M and are widely deployed in today' cellular systems.

Entering the LSA spectrum will require the following steps:

- At the appropriate time indicated by the LSA Controller, the mobile network's operator OA&M instructs the relevant base stations to enable transmission in the LSA band.
- If needed, reconfigurations and system information updates of the other networks operating in the underlying band are performed.
- Existing load balancing algorithms in the Radio Access Network will make use of the newly available resources and transfer devices to the new band based on need.
- Transferring the devices can be achieved using different techniques depending on the considered technology (for illustration purposes LTE is assumed to be the technology in use) and it is important to note that none of these techniques are mutually exclusive, a mobile broadband operator can choose to use any of those simultaneously (also under area of the same base station):
    - Reselection procedures: User terminals in idle mode that migrate in and out of the coverage area of the LSA frequency may reselect on such frequency.
    - Inter-Frequency Handover procedures: The Radio Access Network initiates handover procedures to transfer user terminals in connected mode from the underlying band towards the LSA band.
    - Carrier Aggregation procedure: The Radio Access Network reconfigures appropriate user terminals (terminals supporting carrier aggregation between the underlying band and the LSA band) to start operating in a Carrier Aggregation mode.

Vacating the LSA spectrum will require the following steps:

- When the granted time period for the operation by LSA Controller in the LSA band expires or when due to emergency situations, the incumbent requires its spectrum back (e.g. public safety or other incumbents that require that stipulation), the existing load balancing algorithms in the Radio Access Network will ensure that devices are transferred back to the underlying band.
- Transferring the devices back can take the following forms (again LTE is assumed to be the technology in use):
    - Reselection procedures: User terminals in idle mode will start vacating the LSA frequency by reselection procedures.
    - Inter-Frequency Handover procedures: The Radio Access Network initiates handover procedures to transfer user terminals in connected mode back to the underlying band.
    - Carrier Aggregation procedure: The Radio Access Network reconfigures appropriate user terminals to stop operating in a Carrier Aggregation mode. The user terminal continues its normal operation within the underlying band.

8 Radio spectrum request and justification

The request to enable access to the 2 300 - 2 400 MHz frequency band for mobile Broadband Wireless Systems (BWS) under the Licensed Shared Access regime is driven by the following key developments:

- Deployments of mobile Broadband Wireless Systems in the 2 300 - 2 400 MHz frequency band are taking place in ITU-R regions outside the CEPT countries. Therefore, this band has a significant potential to be globally harmonized for mobile BWS providing the opportunity to maximize benefits from global developments.
- Furthermore, standardization activities have been performed in the IMT community for the 2 300 - 2 400 MHz frequency band. For example, in the 3GPP specifications this band is included as Band 40 on an unpaired basis. E-UTRA and LTE-TDD user equipment and base stations are already commercially available.
  The LTE-TDD market for this band is expected to significantly grow in the coming years driven by large deployments in some countries, especially, in Asia, see clause 9.3.
- In a number of CEPT countries, the 2 300 - 2 400 MHz frequency band will be available for BWS, whereas in a number of other CEPT countries nationwide availability of this band for BWS will be complex and lengthy due to incumbent uses such as wireless cameras and video links (ENG-links), public safety, amateur services, aeronautical telemetry, governmental use (including military) and fixed links.
- For those countries that cannot make available the 2 300 - 2 400 MHz frequency band fully for BWS, Licensed Shared Access (LSA) regime provides a complementary regulatory measure to open this band for Mobile Broadband Services in a timely manner while overcoming time, resource and constraints associated with band clearing.

Enabling access to the 2 300 - 2 400 MHz frequency band for Mobile Broadband Services under LSA will provide the opportunity for new content-rich mobile services to be implemented and for improving the QoS for consumers across the CEPT countries together with global harmonization. Furthermore, access to the 2 300 - 2 400 MHz frequency band might provide financial benefits to incumbents and governments. The LSA regime takes into account various incumbent uses in the CEPT countries having difficulties to release the band for Mobile Broadband Wireless Systems and allows the regulators, if they so choose, to enable access for BWS. The LSA regime provides a framework for national authorities to unlock 2 300 - 2 400 MHz frequency band across Europe, even if it is not available in all locations, at all times and/or for the entire frequency range.

9 Regulations

9.1 Current ITU-R Radio Regulations

Article 5 of the ITU Radio Regulations allocates the 2 300 - 2 400 MHz band as shown in the following table and the associated footnotes.

Table 24: Extracts from the ITU-R Radio Regulations [i.39]

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 300 - 2 450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	2 300 - 2 450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.393 5.394 5.396	

Footnotes taken from ITU-R Radio Regulations [i.39]:

5.150 *The following bands:*

13 553-13 567 kHz (centre frequency 13 560 kHz),

26 957-27 283 kHz (centre frequency 27 120 kHz), *40.66-40.70 MHz (centre frequency 40.68 MHz),*

902-928 MHz in Region 2 (centre frequency 915 MHz),

2 400-2 500 MHz (centre frequency 2 450 MHz),

5 725-5 875 MHz (centre frequency 5 800 MHz), and

24-24.25 GHz (centre frequency 24.125 GHz)

are also designated for industrial, scientific and medical (ISM) applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. ***15.13****.*

5.282 *In the bands 435-438 MHz, 1 260-1 270 MHz, 2 400-2 450 MHz, 3 400-3 410 MHz (in Regions 2 and 3 only) and 5 650-5 670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No.* ***5.43****). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No.* ***25.11****. The use of the bands 1 260-1 270 MHz and 5 650-5 670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.*

5.384A *The bands, or portions of the bands, 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution* ***223 (Rev.WRC-07)****. This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-07)*

5.393 *Additional allocation: in Canada, the United States, India and Mexico, the band 2 310-2 360 MHz is also allocated to the broadcasting-satellite service (sound) and complementary terrestrial sound broadcasting service on a primary basis. Such use is limited to digital audio broadcasting and is subject to the provisions of Resolution* ***528 (Rev.WRC-03)****, with the exception of resolves 3 in regard to the limitation on broadcasting-satellite systems in the upper 25 MHz. (WRC-07)*

5.394 *In the United States, the use of the band 2 300-2 390 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. In Canada, the use of the band 2 360-2 400 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. (WRC-07)*

5.395 *In France and Turkey, the use of the band 2 310-2 360 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service. (WRC-03)*

5.396 *Space stations of the broadcasting-satellite service in the band 2 310-2 360 MHz operating in accordance with No.* ***5.393*** *that may affect the services to which this band is allocated in other countries shall be coordinated and notified in accordance with Resolution* ***33 (Rev.WRC-97)****. Complementary terrestrial broadcasting stations shall be subject to bilateral coordination with neighbouring countries prior to their bringing into use.*

NOTE 1: Resolution 223 (Rev.WRC 07) was revised by WRC-12.

NOTE 2: Resolution 33 (Rev. WRC-97) was revised by WRC-03.

9.2 Current CEPT Utilizations

The ERC Report 25 [i.14] identifies the European Common Allocation of the band 2 300 - 2 400 MHz to Fixed, Mobile, Radiolocation and amateur services. The Fixed and Mobile services are identified on a primary basis while Radiolocation and amateur services are identified on a secondary basis. Table 25 refers to the ECC/ERC Decisions and Recommendations relevant to each particular radio application as a measure for the harmonized use of the band. An examination of these Recommendations shows that some of these services might not utilize the entire frequency band.

Table 25: ECA [i.14] information for 2 300 to 2 400 MHz

Utilization	ERC/ECC Documentation	European Standard
Aeronautical Telemetry	ERC/REC 62-02 [i.16]	-
Amateur	-	EN 301 783 [i.17]
Mobile Applications	-	-
SAP / SAB	ERC/REC 25-10 [i.18]	EN 302 064 [i.19]

There is currently no harmonization of the band for mobile applications across Europe. Some countries have issued licenses for applications including mobile broadband wireless services in some parts of the band (Norway for example). In addition, some other European countries have expressed interest in national licensing procedures for broadband wireless services (see [i.40]) for parts or the entire band.

The ECC has endorsed recently the initiative of a newly established CEPT Project Team (FM52) to develop a draft ECC Decision, aimed at harmonizing implementation measures for MFCN (including broadband wireless systems) in the frequency band 2 300 - 2 400 MHz. This may include developing regulatory provisions based on the LSA regime to ensure continuing incumbent use of the band for the administrations that wish maintain such use. A draft ECC decision is planned to be presented to ECC for consideration in 2014.

A more detailed description on the regulatory status of the 2 300 - 2 400 MHz frequency band in some of the CEPT countries can be found in clause 8.2 of TR 102 837 [i.13].

9.3 Current Utilizations in other Regions

As a result of the ITU-R framework, the frequency range 2 300 - 2 400 MHz is a significant band for mobile broadband wireless systems in a number of countries around the world. By Q1 2012, in the Asia Pacific region a number of countries (summarized in the table 26) have licensed, or are considering licensing, the band (or parts of the band) for mobile broadband wireless systems and applications. Licence blocks range from 5 MHz to 35 MHz and therefore can be considered useful for the delivery of broadband services.

Table 26: Asia Pacific Region Summary

Country	Frequency Range (MHz)	Block size (MHz)
Australia	2 300 to 2 400	7
Bangladesh	2 365 to 2 400	35
China (see note)	2 300 to 2 400	5
Hong Kong	2 300 to 2 390	30
India	2 300 to 2 400	20
Indonesia	2 300 to 2 360 (Mobile) 2 360 to 2 390 (Fixed)	15
Korea	2 300 to 2 390	27
Malaysia	2 300 to 2 390	30
Singapore	2 300 to 2 350	30/20
New Zealand	2 300 to 2 395	35/35/25
Vietnam	2 300 to 2 395	30
NOTE: Trial licenses for indoor use were issued in China.		

The Asia-Pacific Telecommunity (APT) Wireless Forum has published a report on Frequency Arrangements in the 2 300 - 2 400 MHz band examining the arrangements in several countries in that region and proposing options from a regional perspective. An update to the report was published in September 2012 [i.41] which contains band plan options based on sub-blocks of 5, 9 and 10 MHz and flexible band widths.

In the US, regional Wireless Communications Service (WCS) licences have been issued in the ranges 2 305 MHz to 2 315 MHz paired with 2 350 MHz to 2 360 MHz and in two unpaired blocks at 2 315 MHz to 2 320 MHz and at 2 345 MHz to 2 350 MHz. These licences are flexible to allow either FDD or TDD operation but due to the need to protect broadcast satellite radio operations in 2 320 MHz to 2 345 MHz range, there are technical constraints on the WCS systems identified in the national technical rules. These constraints can be found in 47 CFR 27,53(a) [i.42]. The US Federal Communications Commission is considering revision of the emission constraints, based on extensive analysis and testing of the interference environment. A summary of this analysis by the WCS licensees is available at [i.43].

9.4 Proposed regulation and justification

There is a need for an ECC Decision harmonizing the 2 300 - 2 400 MHz frequency band and to provide guidelines for administrations wishing to introduce mobile Broadband Wireless Services in this band under the LSA regime to take into account incumbent use. Such an ECC Decision should include:

- Appropriate band arrangements and channelization scheme
- Guidance on the expected spectrum utilization by broadband mobile services under LSA regime
- Guidance on incumbent protection technical requirements under main LSA sharing scenarios
- Guidance on LSA spectrum sharing conditions
- Guidelines for assignment of rights of use for LSA licensees
- Guidelines for the incumbent's existing usage rights

History

Document history		
V1.1.1	July 2013	Publication