



# CEPT Report **57**

Report A from CEPT to the European Commission in response to the Mandate

To study and identify harmonised compatibility and sharing conditions for Wireless Access Systems including Radio Local Area Networks in the bands 5350-5470 MHz and 5725-5925 MHz ('WAS/RLAN extension bands') for the provision of wireless broadband services

**Report approved on 6 March 2015 by the ECC**

## 0 EXECUTIVE SUMMARY

This CEPT Report has been developed within the European Conference of Postal and Telecommunications Administrations (CEPT) in the framework of the EC Mandate on the 5 GHz WAS/RLAN extension bands (see ANNEX 1:).

The mandate requests CEPT to study and identify harmonised compatibility and sharing conditions for a sustainable and efficient use on a shared basis of the frequency bands 5350-5470 MHz and 5725-5925 MHz ('WAS/RLAN extension bands') for wireless access systems including radio local area networks (WAS/RLANs).

**Task 1 – Identification of compatibility and sharing scenarios:** study and identify harmonised compatibility and sharing scenarios for WAS/RLANs to operate on a shared basis in an uninterrupted band from 5150-5925 MHz under the condition that (i) appropriate protection of EU priority applications, in particular the planned introduction of GMES<sup>1</sup> (Global Monitoring for Environment and Security) in the band 5350-5450 MHz and the use of safety-related ITS applications in the frequency band 5875-5905 MHz, is ensured and (ii) that coexistence of WAS/RLAN with other current civil and/or military radio systems to which the bands 5350-5470 MHz and 5725-5925 MHz and adjacent bands have already been assigned or designated is safeguarded.

**Task 2 – Development of compatibility and sharing conditions:** develop appropriate compatibility and sharing conditions to ensure a long-term spectrum access resource for WAS/RLANs to operate on the basis of a general authorisation as an essential wireless broadband infrastructure in the internal market.

It should be noted that although CEPT has carried out a significant amount of work and that this is a final Report from CEPT to the Commission to cover the description of work undertaken under tasks (1) and (2) of the Mandate, there are still a number of open issues related to further studies (particularly on possible mitigation techniques) that are still ongoing. In addition, at this point it is likely that there will be a no change decision at WRC-15 under agenda item 1.1 regarding any new mobile allocations for WAS/RLANs in the 5-6 GHz range.

Studies on mitigation techniques have not been completed in the timeframe for delivering Task (2) of the mandate and it is unlikely that these studies would be completed in time for consideration at WRC-15. These developments will have to be taken into account when reviewing the results of Task (2) of the mandate and the possible effect on the work being undertaken by CEPT under Task (3) of the mandate. The results of these studies could be reported in the expected CEPT Report under Task (3) of the mandate.

The results of the studies undertaken so far are presented in detail throughout this Report and a summary of the results for the bands covered under the mandate are presented below.

### Earth Exploration Satellite Service (Active) in the band 5350-5470 MHz

When considering the various technical studies in CEPT and ITU-R, concerns have been raised about the feasibility of RLAN usage in the band 5350-5470 MHz, as current studies show that there is a significant enough negative margin to conclude that sharing with EESS (active) is not feasible unless additional sharing/mitigation techniques are identified that can provide the necessary protection to EESS (active).

Studies have concluded that using either DFS or an e.i.r.p. mask is not effective and/or implementable in a way that can provide protection for EESS (active systems). Studies were also conducted on spreading and channelling arrangements as a mitigation technique and it was concluded that it does not provide, on its own, enough added mitigation to enable sharing between RLAN and EESS (active). Initial studies looking at further reducing the maximum power levels allowed by RLANs possibly down to 25mW including a minimum TPC range have not reached any firm conclusions. Further studies looking at appropriate power distributions as well as the effectiveness and the feasibility of implementing these power distributions in RLANs will need to form part of any further analysis. Spectrum access systems using geo-location databases as a means of sharing the band based on separate time and location sharing has been proposed. A number of

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<sup>1</sup> Also known as Copernicus

questions/issues on the feasibility, implementation and enforcement of this mitigation technique on an international basis to protect EESS operations have been raised. No conclusions could be drawn on this at this time without further analysis.

### **Radiolocation in the bands 5350-5470 MHz and 5725-5850 MHz**

With respect to sharing with Radiolocation services RLANs will also be required to demonstrate that coexistence between RLANs and radars not previously covered<sup>2</sup> by ITU-R Recommendation M.1638 [8] (in particular bi-static radars and radars that employ advanced and fast frequency hopping techniques) can be achieved. A number of additional mitigation techniques have been proposed for further study (i.e. DFS, e.i.r.p. mask, new spreading and channelling arrangements, spectrum access system using geo-location database and further restrictions on maximum RLAN power). In addition for Radiolocation services, future sharing and compatibility studies will have to concentrate on ensuring that any enhancement of the DFS mechanism can protect the operation of the types of radar systems mentioned above. Discussions on new radar test signals for the bands 5350-5470 MHz and 5725-5850 MHz for the possible inclusion in an appropriate European harmonised standard have been initiated. However, it should also be noted that the 5725-5850 MHz band is an ISM band and CEPT countries already allow generic SRD use (including RLAN) up to 25 mW in the band 5725-5875 MHz without DFS under ERC/REC 70-03 (annex 1) [5]. In addition a number of CEPT countries allow use of the band 5725-5875 MHz by BFWA up to 4W with the inclusion of DFS (up to 5850 MHz) to provide suitable mitigation under ECC/REC/(06)04 [14]. Therefore, when discussing appropriate mitigation techniques for RLANs, the impact of interference from ISM devices and these existing radio communication applications into radiolocation systems would need to be considered for comparison purposes.

### **Applications/Services in the band 5725-5850 MHz (except Radiolocation)**

CEPT have carried out sharing and compatibility studies between RLANs and other radio services/systems operating the band 5725-5850 MHz. These studies could not be completed for all the concerned radio services/applications at the time of finalising this report. Further studies are required to further examine coexistence issues, in particular with regard to analysing suitable mitigation techniques and parameters.

Studies looking at sharing between RLANs and FSS (Fixed Satellite Service) in this band have focused on the assessment of the interference from RLAN into FSS. These studies have had to consider a number of factors that may be taken into account when modelling interference on the Earth to space interference paths and as a result it was agreed to develop a sensitivity analysis covering various factors, such as the average RLAN antenna discrimination and consideration of clutter loss, number of active on-tune RLAN transmitters etc. CEPT is still in the process of carrying out these studies in particular regarding the RLAN deployment models. These deployment models and some additional material are currently under analysis with a view to producing a suitable way forward on estimating the possible number of active on-tune RLAN networks. It should be noted that the satellite allocation in this band only covers ITU-R Region 1.

Other applications/services that have been studied in this band include Road Tolling, BFWA and WIA. MCL calculations for both directions of interference have been performed and showed the need for significant separation distances. No studies have been conducted to analyse the actual effects due to intermittent interference. For WIA, it is expected that compatibility can be achieved through a coordination procedure within factory premises where WIA are expected to be deployed. For Road Tolling and BFWA, work on possible mitigation techniques has been initiated.

A comprehensive review of the studies carried out so far can be found later in this Report.

Due to lack of input no sharing and compatibility studies have been conducted for the following services:

- Compatibility between RLAN and non-specific Short range devices in the band 5725-5875 MHz;
- Compatibility between RLAN and the Amateur (5725-5850 MHz) and Amateur Satellite (Space to Earth, 5830-5850 MHz) services;

<sup>2</sup> This text refers to the new radars currently under consideration for inclusion in the next version of ITU-R Recommendation M.1638 [8].

### **Applications/Services in the band 5850-5925 MHz**

CEPT have carried out sharing and compatibility studies between RLANs and other radio services/applications operating the band 5850-5925 MHz band. These studies could not be completed for all the concerned radio services/applications at the time of finalising this report. Further studies are required to further examine coexistence issues, in particular with regard to analysing suitable mitigation techniques and parameters.

Results of studies for FSS, BFWA, and WIA operating in this band are the same as those for the 5725-5850 MHz band although it should be noted that the FSS satellite allocation in this band is worldwide hence the footprint of the satellites operating in this band may cover more than one ITU-R region. Other services that have been studied in this band include ITS and DA2GC.

For ITS, MCL calculations for both directions of interference have been performed and showed the need for significant separation distances. No studies have been conducted to analyse the actual effects due to intermittent interference. As a result, work on mitigation techniques has been initiated to enable compatibility between individual RLAN devices and ITS. These studies have focussed on "listen-before-talk" process and parameters, where the potential interferer tries to detect whether a channel is busy before transmitting a data packet.

For DA2GC, co-channel interference analyses were performed considering the RLANs both as victims and as interferers. The scenarios included consideration of interference to/from DA2GC Aircraft Stations and Ground Stations. Compatibility can be achieved in all scenarios when considering indoor RLANs. For some scenarios involving outdoor RLANs, worst-case MCL calculations show that some exceedances of the RLAN or DA2GC receiver protection criteria could potentially occur. However, compatibility is achieved, when taking into account a number of identified ameliorating factors such as separation distances, density of active co-frequency RLAN devices, clutter loss, use of power control and antenna discrimination.

A comprehensive review of the studies carried out so far can be found later in this Report.

### **General conclusions**

Overall, considering the results of the studies performed under Tasks (1) and (2) of the EC Mandate at the time of finalising this report, it is not possible to specify any appropriate mitigation techniques and/or operational compatibility and sharing conditions that would allow WAS/RLANs to be operated in the bands 5350-5470 MHz and 5725-5925 MHz while ensuring relevant protection of incumbent services in these bands. It should also be noted that some studies (in particular on mitigation techniques) have not been completed in the timeframe for delivering Task (2) of the mandate and additional studies are being conducted within CEPT, the results of these studies could be reported in the expected CEPT Report under Task (3) of the mandate.

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## LIST OF ABBREVIATIONS

<b>Abbreviation</b>	<b>Explanation</b>
<b>AMS(R)S</b>	Aeronautical Mobile-Satellite (Route) Service
<b>BFWA</b>	Broadband Fixed Wireless Access
<b>CCA</b>	Clear Channel Assessment
<b>CEN</b>	Committee for European Normalisation
<b>CEPT</b>	European Conference of Postal and Telecommunications Administrations
<b>CPM</b>	Conference Preparatory Meeting
<b>DA2GC</b>	Direct-Air-To-Ground Communications
<b>DAA</b>	Detect And Avoid
<b>DFS</b>	Dynamic Frequency Selection
<b>DSRC</b>	Dedicated Short Range Communication
<b>EBU</b>	European Broadcasting Union
<b>EC</b>	European Commission
<b>ECC</b>	Electronic Communications Committee
<b>ECCM</b>	Electronic-Counter-Counter-Measures
<b>ECO</b>	European Communications Office
<b>EESS</b>	Earth Exploration-Satellite Service
<b>EFIS</b>	ECO Frequency Information System
<b>EME</b>	Earth-Moon-Earth
<b>ERC</b>	European Radiocommunications Committee
<b>ESA</b>	European Space Agency
<b>ETSI</b>	European Telecommunications Standards Institute
<b>EU</b>	European Union
<b>FCC</b>	Federal Communications Commission
<b>FDD</b>	Frequency Duplex Division
<b>FSS</b>	Fixed-Satellite Service
<b>GDDN</b>	Ground Data Dissemination Network
<b>GMDSS</b>	Global Maritime Distress and Safety System
<b>GMES</b>	Global Monitoring for Environment and Security
<b>GNSS</b>	Global Navigation Satellite System
<b>GS</b>	Ground Station
<b>GSO</b>	Geostationary Orbit
<b>IEEE</b>	Institute of Electrical and Electronics Engineers
<b>I/N</b>	Interference-to-Noise ratio
<b>ISM</b>	Industrial, scientific and medical
<b>ITS</b>	Intelligent Transport Systems
<b>ITS-G5</b>	Intelligent Transport Systems operating in the 5GHz band
<b>ITU-R</b>	International Telecommunication Union - Radiocommunications sector
<b>LEO</b>	Low Earth Orbit
<b>MCL</b>	Minimum Coupling Loss
<b>OBU</b>	On-Board Unit
<b>P-MP</b>	Point-to-Multipoint

<b>RLAN</b>	Radio Local Area Networks
<b>RSPP</b>	Radio Spectrum Policy Programme
<b>RSU</b>	Road Side Unit
<b>RTTT</b>	Road Transport and Traffic Telematics
<b>SAR</b>	Synthetic Aperture Radar
<b>SRD</b>	Short Range Devices
<b>TDD</b>	Time Duplex Division
<b>TPC</b>	Transmitter Power control
<b>TR</b>	Technical Report
<b>TTT</b>	Transport and Traffic Telematics
<b>UNHCR</b>	United Nations High Commissioner for Refugees
<b>U-NII</b>	Unlicensed-National Information Infrastructure
<b>WAS/RLAN</b>	Wireless Access Systems including Radio Local Area Networks
<b>WG FM</b>	Working Group Frequency Management of the ECC
<b>WIA</b>	Wireless Industrial Applications
<b>WIFI</b>	Wireless Fidelity
<b>WMO</b>	World Meteorological Organisation
<b>WRC</b>	World Radiocommunication Conference

## 1 INTRODUCTION

CEPT ECC noted that the RSPB requires that the “European Commission shall, in cooperation with Member States, assess the justification and feasibility of extending the allocations of unlicensed spectrum for wireless access systems, including radio local area networks. Wireless access systems, including radio local area networks, may outgrow their current allocations on an unlicensed basis. The need for and feasibility of extending the allocations of unlicensed spectrum for wireless access systems, including radio local area networks, at 2.4 GHz and 5 GHz, should be assessed in relation to the inventory of existing uses of, and emerging needs for, spectrum, and depending on the use of spectrum for other purposes.”

In the light of the latter the European Commission mandated CEPT to study and identify harmonised compatibility and sharing conditions for Wireless Access Systems including Radio Local Area Networks in the bands 5350-5470 MHz and 5725-5925 MHz ('WAS/RLAN extension bands') for the provision of wireless broadband services.

CEPT ECC considered the various tasks (1, 2 & 3) as described in the EC Mandate on 5 GHz Extension Bands in order to respond to the mandate according to the time schedule of the Mandate.

This CEPT Report is providing the results of the work undertaken in response to Tasks 1 and 2 as outlined in the mandate (see annex 1).

## 2 INFORMATION ON SERVICES/APPLICATIONS IN THE BANDS UNDER STUDY

CEPT ECC has made an assessment of the services to be studied in the possible extension bands that have been identified for WAS/RLANs, 5350-5470 MHz, 5725-5850 MHz and 5850-5925 MHz.

The excerpt of the latest edition (May 2014) of ERC Report 25 [3] the European Common Allocation Table is provided in ANNEX 2: of this Report.

### 2.1 5350 - 5470 MHz

**Table 1: Allocations in 5350-5470 MHz**

Region 1	Region 2	Region 3
<b>5 350-5460 MHz</b>		
AERONAUTICAL RADIONAVIGATION 5.449		
RADIOLOCATION (5.448D)		
EARTH EXPLORATION-SATELLITE (ACTIVE) 5.448B		
SPACE RESEARCH (ACTIVE) 5.448C		
<b>5460-5470 MHz 5.448B</b>		
SPACE RESEARCH (ACTIVE)		
RADIOLOCATION 5.448D		
RADIONAVIGATION 5.449		
EARTH EXPLORATION-SATELLITE (ACTIVE)		

#### Relevant RR Article 5 footnotes:

**5.448B** The Earth exploration-satellite service (active) operating in the band 5 350-5 570 MHz and space research service (active) operating in the band 5 460-5 570 MHz shall not cause harmful interference to the aeronautical radionavigation service in the band 5 350-5 460 MHz, the radionavigation service in the band 5 460-5 470 MHz and the maritime radionavigation service in the band 5 470-5 570 MHz. (WRC-03)

**5.448C** The space research service (active) operating in the band 5 350-5 460 MHz shall not cause harmful interference to nor claim protection from other services to which this band is allocated. (WRC-03)

**5.448D** In the frequency band 5 350-5 470 MHz, stations in the radiolocation service shall not cause harmful interference to, nor claim protection from, radar systems in the aeronautical radionavigation service operating in accordance with No. **5.449**. (WRC-03)

**5.449** The use of the band 5 350-5 470 MHz by the aeronautical radionavigation service is limited to airborne radars and associated airborne beacons.

Table 2: Applications in 5350-5470 MHz

Frequency range	European Common Allocation	ECC/ERC Harmonisation measures	Application	European footnotes	Standard	Notes
5350-5450 MHz	AERONAUTICAL RADIONAVIGATION 5.449 EARTH EXPLORATION- SATELLITE (active) 5.448B RADIOLOCATION 5.448D SPACE RESEARCH (active) 5.448C Fixed EU2 EU22		Active sensors (satellite)			
			Defence systems			Tactical and weapon system radars
						Position fixing
		ERC/REC 70-03	Radiodeterminat ion applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
			Maritime radar			Shipborne and VTS radar
			Weather Radars			Ground based and airborne
5450-5460 MHz	AERONAUTICAL RADIONAVIGATION 5.449 EARTH EXPLORATION- SATELLITE (active) 5.448B RADIOLOCATION 5.448D SPACE RESEARCH (active) 5.448C EU2 EU22		Active sensors (satellite)			
			Defence systems			Tactical and weapon system radars
						Position fixing
		ERC/REC 70-03	Radiodeterminat ion applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
			Maritime radar			Shipborne and VTS radar
			Weather Radars			Ground based and airborne
5460 -5470 MHz	EARTH EXPLORATION- SATELLITE (active) RADIOLOCATION 5.448D RADIONAVIGATION 5.449 SPACE RESEARCH (active) 5.448B EU2 EU22		Active sensors (satellite)			
			Defence systems			Tactical and weapon system radars
						Position fixing
		ERC/REC 70-03	Radiodeterminat ion applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
			Maritime radar			Shipborne and VTS radar
			Weather Radars			Ground based and airborne

## 2.1.1 Existing users

### 2.1.1.1 Radiodetermination applications

The band is utilised for a variety of radiodetermination applications falling within the radionavigation and radiolocation services. This includes defence systems including tactical and weapon system radars, position fixing, ship borne and vessel traffic and coastal surveillance radars, ground based and airborne weather radars. The band is also used by tank level probing radars as specified in ETSI EN 302 372 [4] and ERC/REC 70-03 [5].

Recommendation ITU-R M.1638 [8] provides characteristics of radars operating under the Radiolocation service in the frequency range 5250-5850 MHz. Within this range, the band between 5350 MHz and 5470 MHz is used by many different types of radars on fixed land-based, ship borne and transportable platforms. It should be noted that most of these radars are designed to operate not only in the 5350-5470

MHz band but in a larger portion of the band 5250-5850 MHz. Recommendation ITU-R M.1638 is currently under revision within ITU-R Working Party 5B. The aim is to include updated technical characteristics for radars not previously studied within ITU-R (e.g. other frequency hopping radars and bi-static radars). Recommendation ITU-R M1849 [40] provides characteristics for ground based meteorological radar in the 5GHz range.

See also section 2.2.1.1 for additional information.

**2.1.1.2 Active sensors (Earth Exploration satellites)**

The band is used by the Global monitoring for environment and security (GMES) / Copernicus system, that is carried out in partnership with the Member States and the European Space Agency (ESA) for which COM(2012)218 [6] was agreed (not a regulatory text but an Intergovernmental Agreement for the operation of the European Earth monitoring programme (GMES) from 2014 to 2020).

Regulation No 911/2010 [7] of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013) applies.

The possible expansion for WAS/RLANs in the 5 GHz range concerns the band 5350-5470 MHz which is used by Sentinel-1 and Sentinel-3 for observation purposes. The space component is using this band on-board the series of SENTINEL satellites, such as for Synthetic Aperture Radar (SAR) (central frequency: 5405 MHz, with a bandwidth of 100 MHz) on Sentinel-1 satellites and Altimeter (central frequency 5410 MHz with a bandwidth of 320 MHz) on Sentinel-3 satellites.

The band is also used by EESS (active) instruments from other countries such as the Canadian constellation Radarsat.

**2.2 5725 - 5850 MHz**

**Table 3: Allocations in 5725-5850 MHz**

Region 1	Region 2	Region 3
5 725-5 830 FIXED-SATELLITE (Earth-to-space) RADIOLOCATION Amateur 5.150 5.451 5.453 5.455 5.456	5 725-5 830 RADIOLOCATION Amateur 5.150 5.453 5.455	
5 830-5 850 FIXED-SATELLITE (Earth-to-space) RADIOLOCATION Amateur Amateur-satellite (space-to-Earth) 5.150 5.451 5.453 5.455 5.456	5 830-5 850 RADIOLOCATION Amateur Amateur-satellite (space-to-Earth) 5.150 5.453 5.455	

**Relevant RR Article 5 footnotes:**

5.150 The following bands: 5 725-5 875 MHz (centre frequency 5 800 MHz), and are also designated for industrial, scientific and medical (ISM) applications. Radio communication 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.

5.451 Additional allocation: in the United Kingdom, the band 5 470-5 850 MHz is also allocated to the land mobile service on a secondary basis. The power limits specified in Nos. 21.2, 21.3, 21.4 and 21.5 shall apply in the band 5 725-5 850 MHz.

5.455 Additional allocation: in Armenia, Azerbaijan, Belarus, Cuba, the Russian Federation, Georgia, Hungary, Kazakhstan, Moldova, Mongolia, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan and Ukraine, the band 5 670-5 850 MHz is also allocated to the fixed service on a primary basis. (WRC-07)

Table 4: Applications in 5725-5850 MHz

Frequency range	European Common Allocation	ECC/ERC harmonisation measures	Application	European footnotes	Standard	Notes
5725-5830 MHz	FIXED-SATELLITE (E/S) RADIOLOCATION Fixed Amateur Mobile 5.150 EU2 EU22		Amateur		EN 301 783	
		ECC/REC/(06)04	BFWA		EN 302 502	Within the band 5725-5875 MHz
			Defence systems			Tactical and weapon system radars
			ISM			Within the band 5725-5875 MHz
		ERC/REC 70-03	Non-Specific SRD		EN 300 440	Within the band 5725-5875 MHz
		ERC/REC 70-03	Radiodetermination applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
		ERC/REC 70-03	TTT		EN 300 674	Within the band 5795-5805 MHz. TTT in the band 5805-5815 MHz on a national basis
	Weather Radars			Ground based and airborne		
5830-5850 MHz	FIXED-SATELLITE (E/S) RADIOLOCATION Fixed Amateur Amateur Satellite (S/E) Mobile 5.150 EU2 EU22		Amateur Satellite (S/E)	EU23		Within the band 5830-5850 MHz
		ECC/REC/(06)04	BFWA		EN 302 502	Within the band 5725-5875 MHz
			Defence systems			Tactical and weapon system radars
			ISM			Within the band 5725-5875 MHz
		ERC/REC 70-03	Non-Specifics SRDs		EN 300 440	Within the band 5725-5875 MHz
		ERC/REC 70-03	Radiodetermination applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
			Weather radars			Ground based and airborne

**Relevant EU footnote from the European Allocation Table (ECA Table):**

EU2: Civil-military sharing.

EU22: The band 5250-5850 MHz is utilised for a variety of radiodetermination applications falling within the radionavigation and radiolocation services. This band will be subject to further detailed consideration.

EU23 In the sub-bands 5660-5670 MHz (earth to space), 5830-5850 MHz (space to earth) and 10.45-10.50 GHz the amateur-satellite additionally operates on a secondary and non-interference basis to other services. In making assignments to other services, CEPT administrations are requested wherever possible to maintain these allocations in such a way as to facilitate the reception of amateur emissions with minimal power flux densities.

## 2.2.1 Existing users

### 2.2.1.1 Radiodetermination applications

The band 5725-5850 MHz is utilised for a variety of radiolocation applications. This also includes defence systems such as tactical and weapon radars as well as weather radars (ground based and airborne).

Recommendation ITU-R M.1638 [8] provides characteristics of radars operating under the Radiolocation service in the frequency range 5250-5850 MHz. Within this range, the band between 5725 MHz and 5850 MHz is used by many different types of radars on fixed land-based, ship borne and transportable platforms. It should be noted that most of these radars are designed to operate not only in the 5725-5850 MHz band but in a larger portion of the band 5250-5850 MHz. The band is also used by tank level probing radars as specified in ETSI EN 302 372 [4] and ERC/REC 70-03 [5].

The technical characteristics of representative systems deployed in this band include the characteristics of a subset of the radars contained in Recommendation ITU-R M.1638 [8], which are relevant for the frequency band 5725-5850 MHz (radars L, M, N, O and Q) and of three additional radars operated by administrations within CEPT (X, Y and Z). This information is generally sufficient for the calculation and to assess the compatibility between these radars and other systems. Recommendation ITU-R M.1638 is currently under revision within ITU-R Working Party 5B. The aim is to include updated technical characteristics for radars not previously studied within ITU (e.g. other frequency hopping radars and bi-static radars).

Frequency hopping is one of the most common Electronic-Counter-Counter-Measures (ECCM). Radar systems that are designed to operate in hostile electronic attack environments use frequency hopping as one of its ECCM techniques. This type of radar typically divides its allocated frequency band into channels. The radar then randomly selects a channel from all available channels for transmission. This random occupation of a channel can occur on a per beam position basis where many pulses on the same channel are transmitted or on a per pulse basis. This important aspect of radar systems should be considered and the potential impact of frequency hopping radars should be taken into account in the compatibility and sharing studies.

There are numerous radar types, accomplishing various missions, operating within the Radiolocation service throughout the whole range 5250-5850 MHz, and specifically within the 5725-5850 MHz band. Test range instrumentation radars are used to provide highly accurate position data on space launch vehicles and aeronautical vehicles undergoing developmental and operational testing. These radars are typified by high transmitter powers and large aperture parabolic reflector antennas with very narrow pencil beams. The radars have auto-tracking antennas which either skin-track or beacon-track the object of interest. Periods of operation can last from minutes up to 4-5 hours, depending upon the test programme. Operations are conducted at scheduled times 24 hours/day, 7 days/week.

Shipboard sea and air surveillance radars are used for ship protection and operate continuously while the ship is underway as well as entering and leaving port areas. These surveillance radars usually employ moderately high transmitter powers and antennas which scan electronically in elevation and mechanically a full 360 degrees in azimuth. Operations can be such that multiple ships are operating these radars simultaneously in a given geographical area. Other special-purpose radars are also operated in the band 5250-5850 MHz.

Tactical radars, mounted on mobile vehicles and used for providing airspace surveillance, are also operated in this band.

### 2.2.1.2 Fixed-Satellite Service (Earth to space 5725 - 5925 MHz)

FSS deployments use the whole band 5725-5925 MHz and it is used by transmitting earth stations in the Earth-to-space direction operating only to satellites in geostationary orbits. In the 125 MHz portion of the band up to 5850 MHz, this is a Region 1 allocation only (i.e. only Europe, Africa, and some of the northernmost countries in Asia). Above 5850 MHz the band is part of the heavily utilised FSS global uplink band and most of the currently operating satellites (INTELSAT and SES for instance) have receive transponders in this upper portion of the band (see ECC Report 206 [38]).

More than 55 satellites with C-band payloads operate over Europe<sup>3</sup>; another 7 are under procurement (status: end of 2013). In Europe, the C-band supports a number of critical services such as aviation (AMS(R)S), emergency (emergency.lu, UNHCR), navigation (GDDN), maritime (GMDSS), meteorology (WMO) and public (e.g. EBU) services.

### 2.2.1.3 Amateur Service and Amateur-satellite Service

The amateur and amateur-satellite (s-E) services have harmonised allocations in all three ITU Regions in the frequency range 5725-5850 MHz with secondary status as follows:

**Table 5: Allocations for Amateur and Amateur-satellite Services**

Frequency	Service
5725-5830 MHz	Amateur
5830-5850 MHz	Amateur Amateur Satellite (space-to-Earth)

The operational characteristics of amateur stations and amateur-satellite stations vary significantly. However based on the IARU Region-1 VHF Managers Handbook they can be categorised as:

- Weak signal reception of Narrowband Terrestrial and EME (Earth-Moon-Earth-Moonbounce) operation in the sub-band 5760-5762 MHz, including propagation beacons;
- Data and multimedia systems (point to-point links and area repeaters) in other parts of the band;
- Low-power satellite downlinks within 5830-5850 MHz (typically from LEO Cubesat satellites).

EU footnote 23 of the European Common Allocation Table states that in the sub-band 5830-5850 MHz, the amateur-satellite service (space to earth) additionally operates on a secondary basis. In making assignments to other services, CEPT administrations are requested wherever possible to maintain the sub-band in such a way as to facilitate the reception of amateur emissions with minimal power flux densities.

### 2.2.1.4 Non-specific SRDs

The frequency band 5725 MHz to 5875 MHz (25 mW e.i.r.p.) has been designated for non-specific SRDs for a very long time (some decades, i.e. even before the ERC/REC 70-03 [5]) and is the only SRD band having a quite large bandwidth capability, no duty cycle restriction and a reasonably transmit power of 25 mW e.i.r.p. vs. propagation for the foreseen operations.

Within the last ten years the 5 GHz band became highly attractive for SRDs due to various reasons, such as the extensive use of the 2.4 GHz band (i.e. for RLANs), the generation of pico-cells, thus having a higher frequency re-use ratio but still below 10 GHz and the availability of electronic components at low cost such as:

- a. A very widespread 5.8 GHz band usage of SRDs became progressively popular especially within the last years for outdoor/indoor alarm-security microwave sensors;
- b. Also a widespread 5.8 GHz band usage of SRDs happened for outdoor/indoor security wireless TVCC cameras, and in general for video wireless professional use;
- c. Similar use to b) above became popular for consumer video electronics too.

The 5725 to 5875 MHz band is a fully harmonised spectrum especially within the EU being implemented by the Decision 2006/771/EC [2] for non-specific SRDs by the original edition in 2006 and kept since without amendments for this band.

<sup>3</sup> Information provided by ESOA at the EC-ECC workshop on WRC-15, 10 December 2013, <http://cept.org/files/1051/Workshops/EC-CEPT%20work%20shop/Session%201.zip>

The band is also included in Recommendation ITU-R SM.1896 [9] on SRD global and regional harmonisation.

### 2.2.1.5 *Transport and Traffic Telematics (TTT - former RTTT)*

ERC/REC 70-03 [5] designates the frequency band 5795-5805 MHz, with possible extension to 5815 MHz, for TTT. The band 5795-5805 MHz is for use by initial road-to-vehicle systems, in particular road toll systems, with an additional sub-band, 5805-5815 MHz, to be used on a national basis to meet the requirements of multi-lane road junctions. The regulatory parameters (maximum power levels) for TTT are given in Annex 5 of ERC/REC 70-03 [5]. The TTT parameters are also specified in EN 300 674 [10] developed by ETSI and the EN 12253 [33] developed by CEN. It should be noted that the EN 300 674 [10] deals with both Road Side Units (RSU) and On-Board Units (OBU).

Directive 2004/52/EC<sup>4</sup> [11] lays down the conditions for the interoperability of electronic road toll systems in the European Union. The Directive requires that all new electronic toll systems brought into service shall use one or more of the following technologies: satellite positioning (GNSS); mobile communications (GSM-GPRS); microwave technology (DSRC). This equipment on-board of lorries shall therefore at least be interoperable and capable of communicating with all the systems operating in the Member States using one or more of the technologies named in this Directive. The on-board units installed in lorries have therefore bands 5a (5795-5805 MHz) and 5b (5805-5815 MHz) included.

It should be noted that the frequency usage for TTT DSRC was identified in the early 1990's and that no compatibility studies exist for this frequency identification. Therefore, CEPT has begun conducting compatibility studies between TTT applications using the additional sub-band 5805-5815 MHz and primary services recently.

Around 28 million DSRC OBUs are in use today, communicating with more than 20 000 transceivers (beacons) in Europe for tolling purposes. The majority of European countries have practical implementations of TTT DSRC systems either as nationwide road tolling systems or local road tolling systems (major bridges, individual toll roads or city toll system). The majority of such installations comply with ETSI EN 300 674 [10] and use all four 5 MHz wide channels up to 2 W e.i.r.p. per channel for the road site units. Some implementations only use the 5795-5805 MHz range such as the French national road tolling system. The use of 8 W road side unit systems is seldom and is an almost historic implementation option but maybe still in use at individual systems. State-of-the-art technology does not use higher power for multiple lane management. The Harmonised European Standard ETSI EN 300 674 [10] only identifies the frequency range 5795-5805 MHz as pan-European service frequencies.

There are also more than 1 000 small systems implemented throughout Europe over the last 15-20 years which are operated in individual buildings, pre-dominantly in parking garages, which are not strictly speaking "road tolling" systems. Other known implementations outside of pure road tolling are found at ferry operators. These applications operate under a more relaxed national regulatory regime.

### 2.2.1.6 *Broadband Fixed Wireless Access*

ECC Report 101 [12] indicated that Broadband Fixed Wireless Access (BFWA) is used here to refer to wireless systems that provide local connectivity for a variety of applications and using a variety of architectures, including combinations of access as well as interconnection. ECC Report 068 [13] depicts the different architectures of BFWA and provides the relevant information on these different kinds of networks including technical parameters to ensure compatibility with other systems. These reports also provide the main parameters for two BFWA architectures, Point to Multipoint (P-MP) and Mesh.

The latest CEPT questionnaire regarding the implementation of BFWA according to ECC/REC/(06)04 [14] (Use of the band 5725-5875 MHz for Broadband Fixed Wireless Access (BFWA)) had been sent out by the ECO in 2012. The responses to the questionnaire were discussed during the 75th WG FM meeting in Minsk in September 2012. According to the summary, 38 CEPT administrations had submitted a response. Until that point in time 14 countries had implemented BFWA in the whole frequency range from 5725-5875 MHz,

<sup>4</sup> The Digital Tachograph EU Regulation 165/2014 and of the Weights & Dimensions Directive is currently awaiting its legislative adoption (procedure 2013/0105 (COD)). Electronic road tolling systems share the same radio parameters, operates in the same 5795-5815 MHz frequency band and uses the same DSRC profile and verification standards as Digital Tachograph Systems.

whereas some other countries had implemented BFWA in parts of this frequency range, 14 countries had not at all implemented BFWA until that point in time. However, 4 of the latter planned the implementation of BFWA. The main reasons for not implementing BFWA, partly or completely, were given by the required protection of other radio applications. With that regard, TTT, ITS, FSS uplinks and radars were mentioned in the responses. According to the implementation status in the ECO document database as well as information in EFIS, three countries which did not submit an answer to the questionnaire had also implemented ECC/REC/(06)04 [14]. Altogether 27 countries had implemented BFWA in the whole frequency range 5725-5875 MHz or in parts of it until that point in time. Also the regulatory status of BFWA at 5.8 GHz was discussed. On national level, BFWA is considered as a radio application under the scope of a radio service, e. g. the Fixed Service in some countries, but in other countries, as a de facto non-protected radio application as it is the case for other radio applications which are exempted from individual licences. All except four countries which had implemented BFWA follow the ECC/REC/(06)04 [14] which recommends that administrations should consider applying simplified authorisation procedures for BFWA in this band, e.g. licence-exempt or light licensing regime. Several countries had already made use of registration/notification procedures (light licensing) which also make it necessary to provide location details about the central station or even clients. The majority which had implemented BFWA in that point in time, had done this based on ECC/REC/(06)04[14] and using exemption from individual licensing.

## 2.2.2 Proposals for new additional use

### Wireless Industrial Applications

Wireless Industrial Applications (WIA) is used for wireless links in industrial environments including monitoring and worker communications, wireless sensors and actuators.

ETSI described in TR 102 889-2 [16] the technical characteristics for SRD equipment for wireless industrial applications (WIA) and requested ECC to conduct studies. The results of these studies have been published in ECC Report 206 [17]. WIA is currently considered in ECC for inclusion in ANNEX 2: of ERC/REC 70-03 [5].

**Table 6: Preliminary parameters for WIA under consideration**

Frequency Band	Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing	ECC/ERC Decision	Notes
e 5725-5875 MHz	≤ 400 mW e.i.r.p.	APC required Adequate spectrum sharing mechanisms (e.g. DFS and DAA) shall be implemented (see note below)	≥ 1 MHz and ≤ 20 MHz		Wireless Industrial Applications (WIA) The Adaptive Power Control is able to reduce the e.i.r.p. to ≤ 25 mW

Note: DFS is required in frequency range 5725-5850 MHz for the protection of the radiolocation service, DAA is required in frequency range 5855-5875 MHz for the protection of ITS, in the frequency range 5725-5875 MHz for the protection of BFWA, and in the frequency range 5795-5815 MHz for the protection of TTT applications.

A Harmonised European Standard for WIA systems is under development.

**2.3 5850-5925 MHz**

**Table 7: Allocations in 5850-5925 MHz**

Region 1	Region 2	Region 3
5 850-5 925 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE  5.150	5 850-5 925 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Amateur Radiolocation 5.150	5 850-5 925 FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Radiolocation  5.150

**Relevant RR Article 5 footnotes:**

5.150 The following bands: ... 5 725-5 875 MHz (centre frequency 5 800 MHz), and ... 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.

**Table 8: Applications in 5850-5925 MHz**

Frequency range	European Common Allocation	ECC/ERC harmonisation measures	Application	European footnotes	Standard	Notes
5850-5925 MHz	FIXED  FIXED-SATELLITE (E/S) MOBILE 5.250	ECC/REC/(06)04	BFWA		EN 302 502	Within the band 5725-5875 MHz
			FSS		EN 301 443	Priority for civil networks
			ISM			Within the band 5725-5875 MHz
		ECC/DEC/(08)01	ITS		EN 302 571	Within the band 5875-5925 MHz. Within the band 5855-5875 MHz
		ERC/REC 70-03	Non-Specific SRDs		EN 300 440	Within the band 5725-5875 MHz
		ERC/REC 70-03	Radiodetermination applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application

**2.3.1 Existing users**

*2.3.1.1 Non-specific SRDs (up to 5875 MHz)*

See section 2.2.1.4

*2.3.1.2 Broadband Fixed Wireless Access (up to 5875 MHz)*

See section 2.2.1.6

*2.3.1.3 Fixed-Satellite Service (Earth to space, 5725-5925 MHz)*

See section 2.2.1.2

#### 2.3.1.4 *Intelligent Transport Systems (ITS)*

ITS means systems in which information and communication technologies are applied in the field of transport and traffic telematics, including infrastructure, vehicles and users, and in traffic management and mobility management.

Safety related applications have high requirements on robustness and latency, and may need to operate in a predictable interference environment. Non-safety related applications usually have lower requirements on robustness and latency. Decision 2008/671/EC [1] and ECC/DEC/(08)01 [18] harmonise 30 MHz of spectrum band for ITS applications in the 5875-5905 MHz band (possible expansion in 5905-5925 MHz). This spectrum is primarily for road-safety related features.

The general framework for the deployment of Intelligent Transport Systems is set out in Directive 2010/40/EU [19]. The standardisation mandate M/453 [36] on corporative ITS led to a set of standards and specifications to be used for ITS applications.

ETSI has also prepared a new ETSI systems reference document, ETSI TR 103 083 [34], in support of the scheduled update of the ITS spectrum regulation in ECC/DEC/(08)01 [18] and ECC/REC/(08)01 [20]. Two main topics are addressed by the ETSI systems reference document:

1. The inclusion of additional ITS station roles in the regulation in order to complement the existing role as mobile station only with infrastructure ITS stations and portable ITS stations. These ITS stations will be handled under the same ETSI harmonised standard EN 302 571 [21].
2. Update of the spectrum mask in order to allow for technical implementation of ITS stations by taking into account the fixed 10 MHz channel bandwidth. In this context, the ECC has developed a ECC Report 228 [39] containing compatibility studies between the unwanted emissions of ITS and the following services/systems:
  - Road tolling systems between 5795 MHz and 5815 MHz: it takes into account the mitigation techniques described in ETSI TS 102 792 [22] for the coexistence between ITS and road-tolling applications.
  - Fixed Service (above 5925 MHz).

Cooperative ITS systems based on the ETSI ITS standard will be deployed from 2015 onwards, in vehicles with initial infrastructure installation will appear in the course of 2014. 12 major car manufacturers recently signed a Memorandum of Understanding to signal their intentions to provide cooperative systems from 2015 on.

#### 2.3.1.5 *Other Systems that operate on a national basis in some CEPT countries*

Public transport automation systems (like subway) are in operation on a national basis in some European countries in the band 5915-5925 MHz. These systems provide primarily trackside/infrastructure to train communications, optionally train to train communications and operate in cities. Current activities are on-going in ETSI in response to EC mandate M/486 (Urban rail).

### 2.3.2 **Proposals for new additional use**

#### 2.3.2.1 *Broadband Direct-Air-to-Ground (BDA2G) Communications (5855 - 5875MHz)*

Two options have been considered as implementable for BDA2GC systems in the frequency range 5855-5875 MHz according to the compatibility and sharing studies:

1. A TDD system according to ETSI TR 101 599 [24];
2. A TDD system according to ETSI TR 103 108 [25].

The results of the compatibility studies for the 5.8 GHz band can be found in ECC Report 210 [23] on compatibility/sharing studies related to Broadband Direct-Air-to-Ground Communications (DA2GC) in the frequency bands 5855-5875 MHz, 2400-2483.5 MHz and 3400-3600 MHz.

Sharing and compatibility studies were conducted between Broadband DA2GC and the following services/systems in the band 5855-5875 MHz:

1. Broadband Fixed Wireless Access (BFWA);
2. Fixed-Satellite Service (E-s);
3. Non-specific Short Range Devices (SRD);
4. Intelligent Transport Systems / Transport and Traffic Telematics (ITS/TTT);
5. Radiolocation Service (radars).

The studies carried out in ECC Report 210 [23] show that operation of Broadband DA2GC according to ETSI TR 101 599 [24] and ETSI TR 103 108 [25] is possible in the 5855-5875 MHz band based on specific system parameters and if appropriate mitigation measures are applied.

The considerations on Broadband DA2GC in the CEPT have not been finalised yet and several frequency ranges are under investigations.

#### *2.3.2.2 Wireless Industrial Applications (5725-5875 MHz)*

See section 2.2.2.

### 3 PROPOSED WAS/RLAN CHARACTERISTICS FOR STUDY

#### 3.1 CURRENT WAS/RLAN CHARACTERISTICS AND USE IN 5 GHz BANDS IN EU, CEPT AND ELSEWHERE IN THE WORLD

EC Decision 2005/513/EC [26] complemented by EC Decision 2007/90/EC [27] addresses the designation of the frequency bands 5150-5350 MHz and 5470-5725 MHz for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs) in EU members states and ECC/DEC/(04)08 [28] addresses their designation within CEPT. At worldwide level these frequency bands have been allocated to the *mobile service except aeronautical mobile service* on a primary basis in all three regions by World Radiocommunication Conference 2003 (WRC-03). Furthermore Resolution 229 (WRC-03) [29] limits the use of this allocation to WAS/RLANs. Resolution 229 (WRC-03) [29] also requires that WAS/RLAN need to protect other specific primary services in these frequency bands.

In the EU/CEPT the following bands were identified for use by WAS/RLANs under prescribed conditions in the both the ECC and EC Spectrum Decisions:

- 5150-5350 MHz  
Only indoor use, mean e.i.r.p. limited to 200 mW, and above 5250 MHz; the use of mitigation techniques such as dynamic frequency selection (DFS) and transmitter power control (TPC).
- 5470-5725 MHz  
Indoor as well as outdoor use allowed, mean e.i.r.p. limited to 1 W, and use of mitigation techniques such as dynamic frequency selection (DFS) and transmitter power control (TPC).

The World Radiocommunication Conference 2003 (WRC-03) agreed on a new frequency allocation on a co-primary basis to the mobile service except aeronautical mobile service for the implementation of “wireless access systems including radio local area networks” (WAS/RLANs) in the bands 5150-5350 MHz and 5470-5725 MHz. This was subject to technical and regulatory provisions included in the radio regulations, given in Resolution 229 [29] (WRC-03) that makes the Annex 1 of Recommendation ITU-R M.1652 [31] mandatory. This decision noted however that in these bands the stations in the mobile service shall not claim protection from radiodetermination services. The decision includes specific provisions to protect the incumbent systems; including military and meteorological radars. China MIIT expanded allowed channels as of Dec 31 2012 to add UNII-1, 5150-5250 MHz, UNII-2, 5250-5350 MHz (DFS/TPC), similar to the European standard EN 301 893 V1.7.1. [30].

**Table 9: Existing WAS/RLAN regulations/use**

Frequency Band	CEPT	USA	Japan	Notes
5150-5250 MHz	Indoor	No restrictions	No restrictions	Additional regional variations for countries including Australia, Brazil, China, Israel, Korea, Singapore, South Africa, Turkey, etc. Additionally Japan has access to some channels below 5180 MHz. China expanded in 2012 to add 5150-5250 MHz, 5250-5350 MHz, similar to European regulation
5250-5350 MHz	Indoor/ DFS / TPC	DFS	DFS/TPC	
5470-5725 MHz	DFS/TPC	DFS	DFS/TPC	It should be noted that some administrations (notably Australia & Canada) do not allow WAS/RLAN to use the band 5600-5650 MHz with the objective to protect meteorological radar operations.  The FCC encouraged users of U-NII devices near the aeronautical meteorological radars to register in a voluntary database system as discussed in the guidance DA 12-459 [3] and took action in 2012 against operating devices that caused interference to meteorological radars maintained by the Federal Aviation Administration (FAA) operating in the 5600-5650 MHz band.  CEPT investigated the issue of 5 GHz DFS and published ECC Report 192 in 02/2014
5725-5850 MHz	Not available	No restrictions	Not available	

**3.2 CURRENT MITIGATION TECHNIQUES USED IN 5 GHz WAS/RLAN**

The current mitigation techniques used for WAS/RLANs which are operated in the bands 5150-5350 MHz and 5470-5725 MHz are defined in detail in the latest version of ETSI EN 301 893 [30].

CEPT ECC has published ECC Report 192 on the Current Status of DFS (Dynamic Frequency Selection) in the 5 GHz frequency range [37].

**3.2.1 Dynamic Frequency Selection (DFS)**

Dynamic Frequency Selection (DFS) is a mechanism to allow 5 GHz Wireless Access Systems including radio local area networks (WAS/RLANs) to operate without causing undue interference to terrestrial radars operating in the 5250-5350 MHz and 5470-5725 MHz bands. The same mechanism also enables 5.8 GHz BFWA systems to operate in the 5725-5850 MHz band, at least in those countries that have implemented the ECC/REC/(06)04 [14]. DFS is a politeness mitigation technique, intended to sense the presence of radar signals in a given channel and prevent any WAS/RLAN or BFWA device from transmitting on that channel.

The allocation of the 5150-5350 MHz and 5470-5725 MHz to the mobile service for the implementation of WAS/RLANs was made on a co-primary basis at the ITU World Radiocommunication Conference 2003 (WRC-03), under the conditions of the Radio Regulations Footnote N° **5.446A**:

“The use of the bands 5150-5350 MHz and 5470-5725 MHz by the stations in the mobile service shall be in accordance with Resolution **229 (WRC-03) [29]**.”

This Resolution 229 (WRC-03) [29] (see Annex 1) specifies the conditions under which this allocation was made.

- Considering j) highlights the need for using mitigation techniques such as DFS in order to enable sharing with Radiodetermination / Radiolocation services (i.e. radars);
- DFS is further specified in Resolves 8 that refers to Annex 1 of Recommendation ITU-R M.1652 [31] for the details of the DFS requirements;
- Resolves 6 and 7 contain other requirements that contribute to the protection of radars;
- Recognizing a) also states *‘that in the band 5600-5650 MHz, ground-based meteorological radars are extensively deployed and support critical national weather services, according to footnote No. 5.452’*.

The DFS principle is recognisant of the fact that WAS/RLAN operating co-channel with a radar may interfere with the radar and therefore there is a need to avoid co-channel operation. To do so, the WAS/RLAN DFS mechanism has to perform radar signal detection on the channel it intends to use prior to have any transmissions on that channel. If a radar signal is identified, then this channel becomes unavailable for use by the WAS/RLAN.

Following WRC-03, both the ECC and the European Commission translated this International regulation into European regulations, adopting respectively ECC Decision ECC/DEC/(04)08 (9 July 2004) [28] and EC Decision 2005/513/EC (11 July 2005) [26] on *“the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)”*. ECC/DEC/(04)08 [28] has been implemented by 41 CEPT administrations in May 2013.

The implementation of EC Decision 2005/513/EC [26] into national regulation has been mandatory and therefore has resulted in a general authorisation status for WAS/RLANs across the EU. Without derogation, Member States cannot impose additional requirements in their national regulations beyond those specified in the EC Decisions.

Within the context of the operation of the DFS function, a WAS/RLAN device shall operate as either a master or a slave device. RLAN devices operating as a slave shall only operate in a network controlled by an RLAN device operating as a master. A device which is capable of operating as either a master or a slave shall comply with the requirements applicable to the mode in which it operates.

The master/slave concept, where the master performs the radar detection on behalf of the slaves, was accepted with the assumption that the slave devices were in close vicinity to the master (e.g. an office type of indoor application, or an outdoor public hotspot application, where ‘slave’ devices like PCs, notebooks, tablets and WIFI equipment smart phones are just a few meters away from the Access Point that operates as a ‘master’). This is also reflected in the requirement for slave devices with more than 200 mW e.i.r.p. to perform their own DFS operation.

The master/slave concept cannot be applied in cases where the slave is further away from the master, e.g. outdoor point to point or point to multipoint applications where the master and slave devices can be separated by up to a few kilometres. In such a scenario, both devices should perform their own radar detection, even if the maximum power of the client is below 200 mW e.i.r.p.

A brief overview of the DFS related requirements associated with master and slave devices are provided below. Please see EN 301 893 [30]<sup>5</sup> for more details.

<sup>5</sup> At the time of writing this Report, version 1.7.1 of ETSI EN 301 893 was the latest published version.

**Master devices:**

- The master device shall use a radar detection function to:
  - Before normal operation: perform an initial check of the channel on which it intends to operate, to verify no radar is operating on that channel. This is a contiguous check for a certain period during which no transmissions are allowed;
  - During normal operation: continuous monitoring of the channel to verify no radar is operating on the channel.
- If a radar is detected on the channel, the master device shall stop normal operation on this channel and shall also instruct all its associated slave devices to stop transmitting on this channel. The channel shall be blocked for 30 minutes. After that a new initial check (check without transmissions) is required before it may consider this channel again for normal operation.

**Slave devices:**

- Slave devices shall not transmit unless being authorised by the master;
- Slave devices shall stop transmitting whenever instructed by the master;
- Slave devices with an e.i.r.p. of 200 mW or above, shall perform their own radar detection.

**3.2.2 Transmit Power Control (TPC)**

TPC is a technique in which the transmitter output power is controlled so that it is adjusted to the desirable signal level, thus avoiding unnecessary battery consumption. It also results in reduced interference to other systems.

In the previous sharing studies on 5 GHz WAS/RLAN, TPC was introduced as a technique to mitigate by 3 dB the interference from an aggregation of devices.

Resolution 229 (WRC-03, Rev. WRC-12) [29] state that, in the bands 5250-5350 MHz and 5470-5725 MHz, systems in the mobile service shall either employ transmitter power control to provide, on average, a mitigation factor of at least 3 dB on the maximum average output power of the systems, or, if transmitter power control is not in use, then the maximum mean e.i.r.p. shall be reduced by 3 dB.

This provision has been included in the European regulations as per ECC Decision ECC/DEC/(04)08 [28] and EC Decision 2005/513/EC [26].

This requirement is also translated in the standardisation framework through ETSI EN 301 893 [30]. The 3 dB mitigation factor for aggregate interference requires the WAS/RLAN device to have a TPC range from which the lowest value is at least 6 dB below the regulated values for mean e.i.r.p. for devices with TPC.

In the band 5725-5875 MHz, studies performed in Europe on Broadband Fixed Wireless Access (see ECC Report 068 [13]) also lead to the consideration of TPC as a mitigation technique. ECC/REC/(06)04 [14] recommends a TPC range of 12 dB with respect to the maximum permitted radiated output power of the station, to provide on average a mitigation factor of approximately 5 dB on the aggregate interference effect into the Fixed-Satellite Service (Earth-to-space). This is implemented in the corresponding EN 302 502 [32].

**3.2.3 Antenna discrimination**

Studies performed in the ITU-R in preparation to WRC-03 introduced antenna discrimination as a possible technique to mitigate interference into EESS in the 5250-5350 MHz band. This was supported by North-American countries.

Resolution 229 (Rev. WRC-12) [29] provides the option of WAS/RLAN use in the 5250-5350 MHz band with a maximum mean e.i.r.p. of 1 W under the condition that, when operating above a mean e.i.r.p. of 200 mW, these stations shall comply with the following e.i.r.p. elevation angle mask where  $\theta$  is the angle above the local horizontal plane (of the Earth):

- $-13$  dB(W/MHz) for  $0^\circ \leq \theta < 8^\circ$
- $-13 - 0.716(\theta - 8)$  dB(W/MHz) for  $8^\circ \leq \theta < 40^\circ$
- $-35.9 - 1.22(\theta - 40)$  dB(W/MHz) for  $40^\circ \leq \theta \leq 45^\circ$

- -42 dB(W/MHz) for  $45^\circ < \theta$ ;

This option has not been implemented in the European regulations as justified in CEPT Report 6 [46].

In the band 5725-5875 MHz, studies performed in Europe on Broadband Fixed Wireless Access (see ECC Report 68 [13]) lead to the consideration of e.i.r.p. spectral density limits in the elevation plane for BFWA installations to protect GSO satellite receivers in the fixed-satellite service. Recommended limits are contained in the ECC/REC/(06)04 [14], Annex 3, depending upon the BFWA topology.

### 3.3 ASSUMED WAS/RLAN CHARACTERISTICS

The assumption for the studies are that WAS/RLAN systems will only be operating under a general authorisation regime. Taking into account the current CEPT/ECC and EU regulations for WAS/RLAN in the bands 5150-5350 MHz and 5470-5725 MHz, the following characteristics have been assumed for the compatibility and sharing studies addressed in this Report.

#### 3.3.1 5350-5470 MHz

The basic assumptions have been derived from the current CEPT/ECC and EU regulations for the band 5150-5350 MHz: indoor use only, mean e.i.r.p. limited to 200 mW, and use of mitigation techniques such as dynamic frequency selection (DFS) and transmitter power control (TPC). Additional assumptions are outlined below.

The characteristics of the RLAN systems considered in the Report are derived from the IEEE 802.11ac standard [41] with the following assumptions related to power distribution and channel distribution:

**Table 10: WAS/RLAN power distribution in the band 5350-5470 MHz**

Tx power e.i.r.p.	200mW (omni)	80mW (omni)	50mW (omni)	25mW (omni)
Device Percentage	19%	27%	15%	39%

Notes: These e.i.r.p. values apply across the entire RLAN channel bandwidth. RLAN devices are assumed to be indoors only, based on the requirement to help facilitate coexistence. For the purposes of sharing studies, 5% of the devices should be modelled without building attenuation. Alternatively administrations may choose to carry out a parametric analysis in any range between 2% and 10%.

**Table 11: RLAN channel bandwidth distribution in the band 5350-5470 MHz**

Channel bandwidth	20 MHz	40 MHz	80 MHz	160 MHz
RLAN Device Percentage	10 %	25 %	50 %	15 %

WAS/RLAN antenna gain/discrimination for the compatibility studies.

The RLAN antenna is omnidirectional in azimuth for all scenarios.

In the elevation plane, it was agreed to consider for the studies in the band 5350-5470 MHz the RLAN antenna pattern on a parametric way with the two following options<sup>6</sup> as the two edges of a reasonable range:

- Omnidirectional in elevation (i.e. 0 dBi);
- An average 4 dB antenna discrimination applied to the e.i.r.p. level distribution above in the direction of the satellite.

<sup>6</sup> These options correspond to the options A1 and A3 as considered by the ITU-R JTG 4-5-6-7 in the studies performed in the context of WRC-15 Agenda Item 1.1

**3.3.2 5725-5850 MHz and 5850-5925 MHz**

The basic assumptions have been derived from the current CEPT/ECC and EU regulations for the band 5470-5725 MHz: indoor as well as outdoor use allowed, mean e.i.r.p. limited to 1 W, and use of mitigation techniques such as dynamic frequency selection (DFS) and transmitter power control (TPC).

The characteristics of the RLAN systems considered in the Report are derived from the IEEE 802.11ac standard [41] with the following assumptions related to power distribution and channel distribution:

**Table 12: RLAN power distribution in the band 5725-5925 MHz**

Tx power e.i.r.p.	1W (directional)	1 W (omni)	200mW (omni)	80mW (omni)	50mW (omni)	25mW (omni)	all
Indoor	0%	0%	18%	25.6%	14.2%	36.9%	94.7%
Outdoor	0.10%	0.20%	0.95%	1.35%	0.75%	1.95%	5.3%

**Table 13: RLAN channel bandwidth distribution in the band 5725-5925 MHz**

Channel bandwidth	20 MHz	40 MHz	80 MHz	160 MHz
RLAN Device Percentage	10 %	25 %	50 %	15 %

## 4 RESULTS OF SHARING AND COMPATIBILITY ANALYSIS

### 4.1 EESS IN THE 5350-5470 MHz

#### 4.1.1 Introduction

A number of sharing studies between RLANs and EESS (active) in the 5350-5470 MHz band were submitted to CEPT.

These studies used different parameters and assumptions and, consequently, the comparison and analysis of their results took into account these differences.

A3.1 contains the technical and operational parameters of RLAN systems used in the sharing studies with EESS (active) in the 5350-5470 MHz frequency range, resulting from lengthy discussions in the ITU and subsequently in CEPT and aim to provide a common set of parameters.

Specific options are proposed for the RLAN antenna pattern in elevation (2 options) and RLAN device density (3 options) on which parametric simulations should be undertaken.

Some of the studies submitted are presenting results for the whole set of parameters and options whereas some others are only concentrating on the lower density scenarios and higher discrimination antenna option for RLAN. There are also some studies looking at capping active RLANs/km<sup>2</sup> based on reasonable frequency re-use distances etc. in dense urban areas.

On the basis of the technical studies which were presented in CEPT, it is shown that when using the agreed RLAN parameters there is a significant enough negative margin to conclude that sharing with EESS (active) is not feasible unless additional sharing/mitigation techniques are identified that can provide the necessary protection to EESS (active).

#### 4.1.2 Additional mitigation techniques

The following additional mitigation techniques have been studied:

- Dynamic Frequency Selection (DFS): DFS has been studied and is not considered to be effective or implementable for the protection of EESS(active systems);
- e.i.r.p. mask: implementing an e.i.r.p. mask has been studied and is not considered to be effective or implementable for the protection of EESS(active systems);
- Spreading and channelling arrangements: the studies on Spreading and channelling arrangements as a mitigation technique show a potential mitigation gain in a range of 1.7 dB (no use of 20 and 40 MHz channels) to 4.9 dB (reduced RLAN allocation) and therefore it does not provide, on its own, enough added mitigation to enable sharing between RLAN and EESS (active);
- Restrictions on maximum RLAN power: initial studies looking at further reducing the maximum power levels allowed by RLANs possibly down to 25mW including a minimum TPC range have shown to achieve additional mitigation in the range of 3 to 5.6 dB. Further studies looking at appropriate power distributions as well as the effectiveness and the feasibility of implementing these power distributions in RLANs will need to form part of any further analysis;
- Spectrum access system using Geo-location database: spectrum access system using Geo-location databases as a means of sharing the band based on separate time and location sharing has been proposed. A number of questions/issues on the feasibility, implementation and enforcement of this

mitigation technique on an international basis to protect EESS operations have been raised. No conclusions could be drawn on this issue at this time.

#### 4.1.3 General comments

It should be noted that assuming that two outdoor RLANs in a 250 km<sup>2</sup> area simultaneously transmitting with the full e.i.r.p. of 200mW (i.e. without any antenna discrimination or obstruction towards the satellite) within the boresight of Sentinel-1 could be sufficient to exceed the threshold of the relevant EESS (active) protection criteria.

Although there would have to be a statistical analysis to show the probability of this situation actually occurring it does show that the means of controlling the outdoor use of RLANs transmitting at their full e.i.r.p. will be an important factor to consider when discussing any possible regulations. Therefore one of the assumptions for the studies so far is that the legal use of RLANs will be restricted to indoor. However, it will not be possible to prevent accidental outdoor usage so assumptions looking at different percentages of outdoor usage have been studied.

#### 4.1.4 Conclusions

When considering the various technical studies in CEPT, as well as in ITU-R, concerns have been raised about the feasibility of RLAN usage in the band 5350-5470 MHz, as current studies show that there is a significant enough negative margin to conclude that sharing with EESS (active) is not feasible unless additional sharing/mitigation techniques are identified that can provide the necessary protection to EESS (active).

Two additional mitigation techniques have been proposed (i.e. DFS, e.i.r.p. mask) and studies have concluded that they are not effective and/or implementable to provide protection for EESS (active systems).

Studies were also conducted on Spreading and channelling arrangements as a mitigation technique and it was concluded that it does not provide, on its own, enough added mitigation to enable sharing between RLAN and EESS (active).

Initial studies looking at further reducing the maximum power levels allowed by RLANs possibly down to 25mW including a minimum TPC range have not reached any firm conclusions. Further studies looking at appropriate power distributions as well as the effectiveness and the feasibility of implementing these power distributions in RLANs will need to form part of any further analysis.

Spectrum access system using Geo-location databases as a means of sharing the band based on separate time and location sharing has been proposed. A number of questions/issues on the feasibility, implementation and enforcement of this mitigation technique on an international basis to protect EESS operations have been raised. No conclusions could be drawn on this at this time without further analysis.

It has been noted that further studies on some possible mitigation techniques may be carried out in the ITU-R and CEPT but these studies would not be concluded in the timescales associated with the EC mandate Tasks 1) and 2), or most probably with WRC-15. Therefore, at the time of finalising this report, after consideration of the results of the current studies and without the conclusions of these further studies, it is not possible to specify any appropriate mitigation techniques and/or operational compatibility and sharing conditions that would allow WAS/RLANs to be operated in the bands 5350-5470 MHz while ensuring relevant protection of EESS (active) and the operation of GMES/Copernicus.

## 4.2 RADIOLOCATION IN THE BANDS 5350-5470 MHz AND 5725-5850 MHz

Various sharing studies between RLANs and Radiolocation in the 5350-5470 MHz band and 5725-5850 MHz were submitted to CEPT.

The studies used different parameters and assumptions and, consequently, any comparison of the results needs to take into account these differences. ANNEX 3: contains the technical and operational parameters

of RLAN systems used in sharing studies with Radiolocation in the 5350-5470 MHz and 5725-5850 MHz frequency range.

#### 4.2.1 Mitigation techniques

The band 5250-5850 MHz is used for terrestrial radiolocation systems. Studies have indicated that RLAN can harmfully interfere with radars if appropriate mitigation techniques are not implemented. It should be noted that the versions of DFS outlined in the ETSI standards (i.e. EN301893 [30] and EN302502 [32]) for the bands currently available for WAS/RLAN/BFWA use in 5250-5850 MHz do not include specific provisions for DFS to mitigate interference to radars not previously covered by ITU-R Recommendation M.1638 [8] (in particular bi-static radar and radar that employ advanced and fast frequency hopping techniques).

The following additional mitigation techniques have been proposed in the bands 5350-5470 MHz and 5725-5850 MHz and are still under study.

- Enhancement of current Dynamic Frequency Selection mechanism;
- Channelling arrangements;
- Spectrum access system using Geo-location for the case of Bi-static Radars.

It should be noted that meteorological radars as described in ITU-R Recommendation M.1849 [40] are also operated in the band 5350-5470 MHz. These radars would require the application of specific DFS conditions in this band, similar to those pertaining in the band 5600-5650 MHz band and specified in EN 301 893 [30].

It should also be noted that a spectrum access system using geo-location databases as a means of sharing the band based on separate time and location sharing has raised a number of questions/issues on the feasibility, implementation and enforcement of this mitigation technique.

#### 4.2.2 Conclusions

CEPT is of the view that in order to support the introduction of a mobile allocation for RLAN use in the frequency bands 5350-5470 MHz and 5725-5850 MHz, it will be required to demonstrate that coexistence between RLANs and radars not previously covered by ITU-R Recommendation M.1638 [8] can be achieved. Therefore future sharing and compatibility studies will have to concentrate on ensuring that any proposed mitigation techniques, particularly the enhancement of the DFS mechanism can protect the operation of these types of radar systems mentioned above. Discussions on new radar test signals for the possible inclusion in an appropriate European harmonised standard have been initiated. Future studies should also include a process to evaluate the operational effect of the mitigation techniques on both RLANs and radars not previously covered by ITU-R Recommendation M.1638 [8] within the 5GHz band. However the 5725-5850 MHz band is allocated as an ISM band and CEPT countries already allow generic SRD use (including RLAN) up to 25 mW in the band 5725-5875 MHz without DFS under ERC/REC 70-03, annex 1 [5]. In addition a number of CEPT countries allow use of the band 5725-5875 MHz by BFWA up to 4W with the inclusion of DFS to provide suitable mitigation under ECC/REC/(06)04 [14]. Therefore, when discussing appropriate mitigation techniques for RLANs, the impact of interference from ISM devices and these existing radio communication applications into radiolocation systems would need to be considered for comparison purposes.

### 4.3 SYSTEMS/SERVICES IN THE BAND 5725-5850 MHz EXCEPT RADIOLOCATION

#### 4.3.1 Compatibility with FSS (Earth-space)

The studies have focused on the assessment of the interference from RLAN into FSS and follow a two steps approach:

- Step 1: It consists in determining the maximum number of RLAN active on-tune transmitters in the footprint of the satellites under consideration in order to satisfy the relevant protection criteria;
- Step 2: it compares the maximum number of active on-tune RLAN transmitters derived from step 1 to the expected RLAN deployments in order to assess the potential compatibility.

Concerning step 1, initial results have been obtained considering 2 different values of building attenuation for indoor use (12 and 17 dB) and two values for the FSS protection criteria ( $\Delta T/T=1\%$  and  $6\%$ ).

In addition, considering the number of factors that may be taken into account when modelling interference on the Earth to space interference paths, it has been agreed to develop a sensitivity analysis covering various factors, such as the average RLAN antenna discrimination and consideration of clutter loss. The potential mitigation brought by the antenna discrimination at indoor RLAN access points or for outdoor 1 W RLANs is also under investigation.

With regard to step 2, due consideration has been given to the options for the RLAN deployment models and associated activity factors being discussed at the ECC and at the ITU-R for the band 5350-5470 MHz (see A3.1.7). These deployment models and some additional material are currently under analysis with a view to producing a suitable way forward on estimating the possible number of active on-tune RLAN networks.

There has been no study on the interference from FSS into RLAN.

#### **4.3.2 Compatibility with TTT (road-tolling applications) in the band 5795-5815 MHz**

MCL calculations for both directions of interference have been performed and showed the need for significant separation distances if compatibility is dependent upon protection to an I/N level of -6 dB. No studies have been conducted to analyse the actual effects of this I/N level being reached due to intermittent interference.

As a result, work on mitigation techniques has been initiated and the following approaches have been suggested to enable the coexistence between RLAN and road-tolling:

- Implementation in RLAN of a detection mechanism to detect road tolling applications based on energy detection. Preliminary analysis indicated that a detection threshold of the order of -100 dBm/500kHz would be required for a reliable detection of road tolling. Further consideration is required, including on the feasibility of such a detection threshold and its impact on the RLAN operation.
- Transmission from the road tolling applications of predefined signals (beacons) which indicate that the used channels are busy. It is noted that such an approach is under consideration for the coexistence between road-tolling and ITS.
- Ensure coexistence with the road tolling systems through the detection of ITS. This is based on the assumption that there will always be ITS systems in the close vicinity of road-tolling road-side units. Under this approach, once ITS have been detected by RLAN under the conditions described in section 4.4.2, the road tolling frequency band 5795-5805/5805-5815 MHz will also be considered as occupied and thus, not available for RLAN use.
- Use of geolocation database approach. The geolocation database should hold actual information from static and, due to construction sites, temporal tolling installations. The implementation of such a platform, its access, its maintenance should be addressed. In addition, the role and responsibilities of the stakeholders have to be clearly defined.

It has to be noted that time domain effects in regard to sensing procedures (e.g. listening time, dead time) or the effect of RLAN network deployments on POD (Probability Of Detection) and the associated aggregate interference environment have not yet been considered.

Further work is required to assess these approaches.

#### **4.3.3 Compatibility with BFWA (FS)**

MCL calculations for both directions of interference have been performed and showed the need for significant separation distances. No studies have been conducted to analyse the actual effects of this I/N level being reached due to intermittent interference.

As a result, work on mitigation techniques has been initiated. Preliminary analysis on detection mechanisms relying on energy detection indicated that a detection threshold of the order of 90 to -95 dBm/20 MHz would

be required either on the RLAN side or on the BFWA side. Further consideration is required, including on the feasibility of such detection thresholds.

Due to the similarity between RLAN and BFWA systems using TDD technology, it is also envisaged that more specific coexistence mechanisms may be relevant. This requires further work.

The above considerations on sensing procedures may not apply to FDD BFWA systems.

It has to be noted that time domain effects in regard to sensing procedures (e.g. listening time, dead time) or the effect of RLAN network deployments on POD (Probability Of Detection) and the associated aggregate interference environment have not yet been considered and may be an issue for further work.

#### **4.3.4 Compatibility with Wireless Industrial Applications (WIA)**

The MCL calculations lead to significant separation distances, in particular in the cases where both systems operate without wall or building separation.

Nevertheless, compatibility can be achieved through a coordination procedure within factory premises where WIA are deployed, taking into account that:

- It is expected that the operation of wireless devices (including WIA and RLAN) within the industrial premises would be controlled by the factory management;
  - Frequency separation can be applied considering that frequencies outside the 5725-5875 MHz band are available for RLAN;
- The sharing scenarios addressed in this section may benefit from the implementation in WIA of mitigation techniques as described in ECC Report 206 [38]. For example, detect and avoid mechanism is required in WIA for the compatibility between WIA and BFWA.

#### **4.3.5 Other compatibility scenarios**

Due to lack of input no studies have been conducted for the following services:

- Compatibility between RLAN and non-specific Short range devices in the band 5725-5875 MHz;
- Compatibility between RLAN and the Amateur (5725-5850 MHz) and Amateur Satellite (Space to Earth, 5830-5850 MHz) services.

### **4.4 SYSTEMS/SERVICES IN THE BAND 5850-5925 MHz**

#### **4.4.1 Compatibility with FSS (Earth-space)**

See section 4.3.1.

It should also be noted that most of the currently operating satellites have receive transponders in this upper portion of the band.

#### **4.4.2 Compatibility with ITS in the bands 5855-5875 MHz (non-safety ITS), 5875-5905 MHz (safety-related ITS) and 5905-5925 MHz (ITS extension band)**

MCL calculations for both directions of interference have been performed and showed the need for significant separation distances if compatibility is dependent upon protection to an I/N level of -6 dB. No studies have been conducted to analyse the actual effects of this I/N level being reached due to intermittent interference.

As a result, work on mitigation techniques has been initiated to enable the compatibility between individual RLAN devices and ITS. These studies have focussed on "listen-before-talk" process, where the potential interferer tries to detect whether a channel is busy before transmitting a data packet.

Two possible approaches are under study:

- Generic Energy Detection without any consideration of the interferer and victim signal frames: preliminary analysis indicated that a detection threshold of the order of -90 dBm/10 MHz would be required for a reliable detection of ITS. Further consideration is required, including on the feasibility of such a detection threshold and its impact on the RLAN operation.
- Combination of energy detection and carrier sensing, such as one of the Clear Channel Assessment (CCA) modes defined in 802.11 standards. Further studies are required to assess the applicability to ITS of the interference avoidance techniques currently employed in 5 GHz RLAN systems under dynamic multipath fading conditions.

In the further development of the detection mechanisms the mobile characteristics of the ITS environment have to be taken into account. This can be achieved by deploying dynamic multipath fading channel models in the evaluation process of the investigated mitigation techniques. These channel models are under development in ETSI TC ITS.

In face of the market deployment of ITS-G5 systems in 2015 the European channel allocation and the deployed bandwidth (10 MHz) in the ITS systems can no longer be changed at this point in time. All suggestions and mitigation techniques relying on reallocating spectrum or demanding the change of the channel bandwidth cannot be considered as a feasible solution.

It has to be noted that time domain effects in regard to sensing procedures (e.g. listening time, dead time) or the effect of RLAN network deployments on POD (Probability Of Detection) and the associated aggregate interference environment have not yet been considered and may be an issue for further work.

#### **4.4.3 Compatibility with public transport automation systems in the 5.915-5.935 GHz band**

Preliminary calculations have been performed for systems which had been introduced on national level, see section 2.3.1.5. They may need to be reviewed in the light of the recent developments in ETSI towards a new System Reference Document applicable to these systems (TR 103 111 V1.1.1) [47].

#### **4.4.4 Compatibility with BFWA (FS) in the band 5850-5875 MHz**

See section 4.3.3.

#### **4.4.5 Compatibility with Wireless Industrial Applications (WIA)**

See section 4.3.4.

#### **4.4.6 Compatibility with broadband Direct air to ground communications (DA2GC) in the frequency range 5855-5875 MHz**

A series of compatibility analyses between RLAN and DA2GC have been presented. Studies were performed in respect of the two proposed broadband DA2GC systems described in ETSI TR 101 599 [24] and ETSI TR 103 108 [25] and were based on common agreed assumptions regarding RLAN parameters, distribution densities and activity factors.

Co-channel interference analyses were performed considering the RLANs both as victims and as interferers. The scenarios included consideration of interference to/from DA2GC Aircraft Stations and Ground Stations.

Compatibility is clearly achieved in all scenarios when considering indoor RLANs. For some scenarios involving outdoor RLANs, worst-case Minimum Coupling Loss calculations show that some exceedances of the RLAN or DA2GC receiver protection criteria could potentially occur. However, compatibility is achieved, when taking into account a number of identified ameliorating factors such as separation distances, density of active co-frequency RLAN devices, clutter loss, use of power control and antenna discrimination.

It is observed that the outdoor rural RLAN scenarios are the most demanding but the probability of their occurrence is small.

It should be noted that the studies in this section assumed free space loss propagation conditions with clutter loss according to ITU-R P.452 [42]. The clutter loss has been used for the studies between DA2GC GS and RLAN for all scenarios including the rural environment with about 15 dB clutter loss. Under worst case conditions line of sight conditions without any clutter could happen especially in rural environments, which would increase the separation distances. However, the probability is expected to be low.

## 5 RESULTS FROM ITU-R STUDIES

### 5.1 STUDIES FOR THE BAND 5350-5470 MHz

The results of studies carried out in the ITU-R can be seen in documents [JTG 4-5-6-7/715 annex 34](#) and [annex 35](#).

The current draft CPM text only contains the “No change” option (Method A) for the band 5350-5470 MHz. Section 1/1.1/5.17 of the CPM text mentions (see document [JTG 4-5-6-7/715 annex 3](#)):

“No change due to unresolved issues:

- a. Results of studies show that with the RLAN parameters utilised, sharing between RLAN and EESS (active) systems in the 5350-5470 MHz range would not be feasible. Sharing may only be feasible if additional RLAN mitigation measures are implemented, but no agreement was reached on the applicability of additional RLAN mitigation techniques. Some additional RLAN mitigation techniques to enable sharing with EESS (active) are being studied by the ITU-R, but no conclusions can be drawn at this time.
- b. The regulatory provisions in the 5150-5350 MHz and 5470-5725 MHz frequency ranges contained in Resolution 229 (Rev. WRC-12) are insufficient to ensure protection of certain radar types in the 5350-5470 MHz frequency range. Some additional RLAN mitigation techniques to enable sharing are being studied by the expert groups in the ITU-R but no conclusions can be drawn at this time. Further study by ITU-R is required to determine if these additional mitigation techniques can be utilised to mitigate potential interference to these particular radar types.”

### 5.2 STUDIES FOR THE BAND 5725-5850 MHz

The results of studies carried out in ITU-R can be seen in document number [JTG 4-5-6-7/715 annex 34](#) (terrestrial radar).

The current draft CPM text only contains the “No change” option (Method A) for the band 5725 - 5850MHz. Section 1/1.1/5.18&3.2.12 of the CPM text mentions (see document number [JTG 4-5-6-7/715 annex 3](#)):

“No change due to unresolved issues:

Some administrations submitted contributions indicating that the study results for the 5350-5470 MHz frequency range are applicable to the 5725-5850 MHz frequency range to ensure protection of certain radars that operate across or in portions of the 5250-5850 MHz frequency range. Some other administrations raised concerns regarding these results because no RLAN characteristics were previously agreed for the 5725-5850 MHz frequency range and that the RLAN characteristics utilised for the 5350-5470 MHz frequency range cannot be applied similarly to the 5725-5850 MHz frequency range. Some administrations also highlighted that the sharing environment is significantly different between the two bands due to the ISM designation of the 5725-5875 MHz frequency band. There are current deployments of RLAN in the 5725-5850 MHz band in some countries in all three ITU Regions. Therefore, agreement was not reached on the conclusions in these documents”.

“No other sharing/compatibility studies were provided for this frequency band”.

## 6 RESULTS AND CONCLUSIONS

This CEPT Report has been developed within the European Conference of Postal and Telecommunications Administrations (CEPT) in the framework of the EC Mandate on the 5 GHz WAS/RLAN extension bands (see ANNEX 1:).

The mandate requests CEPT to study and identify harmonised compatibility and sharing conditions for a sustainable and efficient use on a shared basis of the frequency bands 5350-5470 MHz and 5725-5925 MHz ('WAS/RLAN extension bands') for wireless access systems including radio local area networks (WAS/RLANs).

It should be noted that although CEPT has carried out a significant amount of work and that this is a final Report from CEPT to the Commission to cover the description of work undertaken under Tasks (1) and (2) of the Mandate, there are still a number of open issues related to further studies (particularly on possible mitigation techniques) that are still ongoing. In addition, at this point it is likely that there will be a no change decision at WRC-15 under agenda 1.1 regarding any new mobile allocations for RLANs in the 5-6 GHz range.

Studies on mitigation techniques have not been completed in the timeframe for delivering Task (2) of the mandate and it is unlikely that these studies would be completed in time for consideration at WRC-15. These developments will have to be taken into account when reviewing the results of Task (2) of the mandate and the possible effect on the work being undertaken by CEPT under Task (3) of the mandate. The results of these studies could be reported in the expected CEPT Report under Task (3) of the mandate.

The results of the studies undertaken so far are presented in detail throughout this Report and a summary of the results for the bands covered under the mandate are presented below.

### **Earth Exploration Satellite Service (Active) in the band 5350-5470 MHz**

When considering the various technical studies in CEPT and ITU-R, concerns have been raised about the feasibility of RLAN usage in the band 5350-5470 MHz, as current studies show that there is a significant enough negative margin to conclude that sharing with EESS (active) is not feasible unless additional sharing/mitigation techniques are identified that can provide the necessary protection to EESS (active).

Studies have concluded that using either DFS or an e.i.r.p. mask is not effective and/or implementable in a way that can provide protection for EESS (active systems). Studies were also conducted on spreading and channelling arrangements as a mitigation technique and it was concluded that it does not provide, on its own, enough added mitigation to enable sharing between RLAN and EESS (active). Initial studies looking at further reducing the maximum power levels allowed by RLANs possibly down to 25mW including a minimum TPC range have not reached any firm conclusions. Further studies looking at appropriate power distributions as well as the effectiveness and the feasibility of implementing these power distributions in RLANs will need to form part of any further analysis. Spectrum access systems using geo-location databases as a means of sharing the band based on separate time and location sharing has been proposed. A number of questions/issues on the feasibility, implementation and enforcement of this mitigation technique on an international basis to protect EESS operations have been raised. No conclusions could be drawn on this at this time without further analysis.

### **Radiolocation in the bands 5350-5470 MHz and 5725-5850 MHz**

With respect to sharing with Radiolocation services RLANs will also be required to demonstrate that coexistence between RLANs and radars not previously covered<sup>7</sup> by ITU-R Recommendation M.1638 (in particular bi-static radars and radars that employ advanced and fast frequency hopping techniques) can be achieved. A number of additional mitigation techniques have been proposed for further study (i.e. DFS, e.i.r.p. mask, new spreading and channelling arrangements, spectrum access system using geo-location database and further restrictions on maximum RLAN power). In addition for Radiolocation services, future sharing and compatibility studies will have to concentrate on ensuring that any enhancement of the DFS mechanism can protect the operation of the types of radar systems mentioned above. Discussions on new

<sup>7</sup> This text refers to the new radars currently under consideration for inclusion in the next version of ITU-R Recommendation M.1638.

radar test signals for the bands 5350-5470 MHz and 5725-5850 MHz for the possible inclusion in an appropriate European harmonised standard have been initiated. However, it should also be noted that the 5725-5850 MHz band is an ISM band and CEPT countries already allow generic SRD use (including RLAN) up to 25 mW in the band 5725-5875 MHz without DFS under ERC/REC 70-03 (annex 1) [5]. In addition a number of CEPT countries allow use of the band 5725-5875 MHz by BFWA up to 4W with the inclusion of DFS (up to 5850 MHz) to provide suitable mitigation under ECC/REC/(06)04 [14]. Therefore, when discussing appropriate mitigation techniques for RLANs, the impact of interference from ISM devices and these existing radio communication applications into radiolocation systems would need to be considered for comparison purposes.

### **Applications/Services in the band 5725-5850 MHz (except Radiolocation)**

CEPT have carried out sharing and compatibility studies between RLANs and other radio services/systems operating the band 5725-5850 MHz. These studies could not be completed for all the concerned radio services/applications at the time of finalising this report. Further studies are required to further examine coexistence issues, in particular with regard to analysing suitable mitigation techniques and parameters.

Studies looking at sharing between RLANs and FSS (Fixed Satellite Service) in this band have focused on the assessment of the interference from RLAN into FSS. These studies have had to consider a number of factors that may be taken into account when modelling interference on the Earth to space interference paths and as a result it was agreed to develop a sensitivity analysis covering various factors, such as the average RLAN antenna discrimination and consideration of clutter loss, number of active on-tune RLAN transmitters etc. CEPT is still in the process of carrying out these studies in particular regarding the RLAN deployment models. These deployment models and some additional material are currently under analysis with a view to producing a suitable way forward on estimating the possible number of active on-tune RLAN networks. It should be noted that the satellite allocation in this band only covers ITU-R Region 1.

Other applications/services that have been studied in this band include Road Tolling, BFWA and WIA. MCL calculations for both directions of interference have been performed and showed the need for significant separation distances. No studies have been conducted to analyse the actual effects due to intermittent interference. For WIA, it is expected that compatibility can be achieved through a coordination procedure within factory premises where WIA are expected to be deployed. For Road Tolling and BFWA, work on possible mitigation techniques has been initiated.

A comprehensive review of the studies carried out so far can be found later in this Report.

Due to lack of input no sharing and compatibility studies have been conducted for the following services:

- Compatibility between RLAN and non-specific Short range devices in the band 5725-5875 MHz;
- Compatibility between RLAN and the Amateur (5725-5850 MHz) and Amateur Satellite (Space to Earth, 5830-5850 MHz) services;

### **Applications/Services in the band 5850-5925 MHz**

CEPT have carried out sharing and compatibility studies between RLANs and other radio services/applications operating the band 5850-5925 MHz band. These studies could not be completed for all the concerned radio services/applications at the time of finalising this report. Further studies are required to further examine coexistence issues, in particular with regard to analysing suitable mitigation techniques and parameters.

Results of studies for FSS, BFWA, and WIA operating in this band are the same as those for the 5725-5850 MHz band although it should be noted that the FSS satellite allocation in this band is worldwide hence the footprint of the satellites operating in this band may cover more than one ITU-R region. Other services that have been studied in this band include ITS and DA2GC.

For ITS, MCL calculations for both directions of interference have been performed and showed the need for significant separation distances. No studies have been conducted to analyse the actual effects due to intermittent interference. As a result, work on mitigation techniques has been initiated to enable compatibility between individual RLAN devices and ITS. These studies have focussed on "listen-before-talk" process and

parameters, where the potential interferer tries to detect whether a channel is busy before transmitting a data packet.

For DA2GC, co-channel interference analyses were performed considering the RLANs both as victims and as interferers. The scenarios included consideration of interference to/from DA2GC Aircraft Stations and Ground Stations. Compatibility can be achieved in all scenarios when considering indoor RLANs. For some scenarios involving outdoor RLANs, worst-case MCL calculations show that some exceedances of the RLAN or DA2GC receiver protection criteria could potentially occur. However, compatibility is achieved, when taking into account a number of identified ameliorating factors such as separation distances, density of active co-frequency RLAN devices, clutter loss, use of power control and antenna discrimination.

### **General conclusions**

Overall, considering the results of the studies performed under Tasks (1) and (2) of the EC Mandate at the time of finalising this report, it is not possible to specify any appropriate mitigation techniques and/or operational compatibility and sharing conditions that would allow WAS/RLANs to be operated in the bands 5350-5470 MHz and 5725-5925 MHz while ensuring relevant protection of incumbent services in these bands. It should also be noted that some studies (in particular on mitigation techniques) have not been completed in the timeframe for delivering Task (2) of the mandate and additional studies are being conducted within CEPT, the results of these studies could be reported in the expected CEPT Report under Task (3) of the mandate.

**ANNEX 1: EC MANDATE TO CEPT****MANDATE TO CEPT****TO STUDY AND IDENTIFY HARMONISED COMPATIBILITY AND SHARING CONDITIONS FOR WIRELESS ACCESS SYSTEMS INCLUDING RADIO LOCAL AREA NETWORKS IN THE BANDS 5350-5470 MHz AND 5725-5925 MHz ('WAS/RLAN EXTENSION BANDS') FOR THE PROVISION OF WIRELESS BROADBAND SERVICES****1. PURPOSE**

To mandate CEPT to study and identify harmonised compatibility and sharing conditions for a sustainable and efficient use on a shared basis of the frequency bands 5350-5470 MHz and 5725-5925 MHz ('WAS/RLAN extension bands') for wireless access systems including radio local area networks (WAS/RLANs). Based on the results of the necessary coexistence studies, the operational sharing conditions for WAS/RLANs should in particular ensure that protection is guaranteed for priority systems supporting EU policies, such as GMES (Global Monitoring for Environment and Security) and ITS (Intelligent Transport Systems) and that coexistence with other systems in these and adjacent frequency bands is safeguarded.

**2. Background**

Commission Decision 2005/513/EC as amended by Decision 2007/90/EC harmonises the use of radio spectrum in the 5 GHz frequency band (5150-5350 MHz and 5470-5725 MHz) for the implementation of wireless access systems including radio local area networks (WAS/RLANs)<sup>1</sup>. The Commission Recommendation 2003/203/EC on the harmonisation of the provision of public RLAN access to public electronic communications networks and services in the Community invites Member States to allow the provision of such services in the available 2.4 GHz and 5 GHz bands to the extent possible without sector specific conditions. In this regard, the use of the bands for the operation of WAS/RLAN systems shall be subject only to general authorisation and not to the grant of any individual right.

The value of this regulatory framework for WAS/RLAN systems has become evident in recent years through the success of Wi-Fi based wireless broadband usage which is based on bottom-up private infrastructure investments of citizens and the free availability in the internal market of a nearly-globally harmonised spectrum resource that underpins large economies of scale for equipment manufacturers. The low spectrum access barrier has led to a very widespread deployment of interoperable Wi-Fi-capable devices and access points. In addition to the private use of Wi-Fi, wireless broadband access provided via publicly accessible Wi-Fi access points has to be recognised as increasingly important internet connectivity infrastructure that is largely complementary to mobile internet services. Given the inherent limitation of coverage, mainly related to power limits and backhaul needs, such WAS/RLAN-based infrastructures can be considered as an essential

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<sup>1</sup> The parts of the 5 GHz range that are currently used in the EU for WAS/RLAN systems are subject to different usage conditions which reflect the results of previous coexistence studies. These conditions include the restriction of the use to indoor use only as well as the implementation of mitigation techniques, such as Transmitter Power Control (TPC) and Dynamic Frequency Selection (DFS). Pursuant to Art. 4(5) of Decision 2005/513/EC Member States shall keep mitigation techniques under regular review and report to the Commission thereupon. In this regard the Commission services are monitoring the investigations that are on-going in CEPT on the current status of DFS in the 5 GHz frequency range.

competitive element in wireless broadband markets to the extent that such services are used in either nomadic or static situations.

At the same time, they add to the utility of cellular mobile internet services by serving to ease congestion and increasing the attractiveness of smart devices also used for such mobile services, thus also sustaining the demand case for additional cellular network investment. A study<sup>2</sup> funded by the European Commission shows that most smartphone use in fact occurs at home, while relatively little is truly mobile and that the UK, France and Germany have among the highest household penetration of Wi-Fi in the world. The growing proliferation of Wi-Fi hotspots in private homes as well as the increased importance of publicly accessible Wi-Fi access points in Europe for public institutions (libraries, tourist bodies, etc.) and businesses underlines the socio-economic benefits of WAS/RLAN bands. Based on measured smart phone and tablet usage patterns<sup>3</sup>, it can be observed that in 2012 71% of all wireless data traffic was delivered over Wi-Fi and estimated that this figure will grow to 78% by 2016. In the same period, Wi-Fi traffic is estimated to grow by more than 850% to close to over 1900 PB/month. As such Wi-Fi traffic is supported by fixed line broadband connections to end users' premises, the convenience of such wireless consumption of online content and services with constantly expanding capacity requirements also serves as a major demand "pull" factor for the upgrading of such fixed-line broadband connections.

The socio-economic value of these bands can be compared to the cost for providing the same amount of data capacity with cellular technologies alone. While cellular traffic will itself continue to grow by an annual rate of 66% until 2016, it is estimated that delivering all the 2012 Wi-Fi data traffic in the EU via mobile networks would have required infrastructure investments of €35bn, while in 2016 around €200bn would be necessary to cope with the projected demand<sup>4</sup>. In reality, given that such costs would be likely to be passed on to consumers, that demand is probably rather elastic. In the absence of Wi-Fi-based connectivity it must be assumed that a significant part of the measured or projected traffic would either not occur or be delivered through fixed line broadband connections – hence the description of WAS/RLANs as a largely complementary technology. None the less, these estimates of the cost of provision of the same level of wireless connectivity and convenience through cellular technology alone can serve as an indicator of the scale of the direct benefits to citizens and other end users accruing through the availability of Wi-Fi based networks and of sufficient spectrum to sustain them.

In view of the Digital Agenda for Europe and considering the magnitude of the traffic delivered, the Commission is of the view that WAS/RLAN bands for wireless broadband appear to be an essential spectrum resource for the provision and uptake of internet-based services. It is therefore necessary to ensure that sufficient spectrum resources are available on a harmonised basis to support a long-term future for new generations of WAS/RLAN technologies that will provide increasing data capacity and speed, thereby supporting the convenient and ubiquitous use of high-speed broadband access and thus ultimately the achievement of the infrastructure targets set by the Digital Agenda which also depend on user demand.

However, such an additional harmonised spectrum resource would have to be made available on a shared basis with various other applications which are currently operating in the 5 GHz frequency range. Among these are EU priority uses such as safety-related ITS systems and GMES/Copernicus satellite systems that support EU policies and require protection. ITS systems will facilitate real-time vehicle-to-vehicle as well as vehicle-to-

<sup>2</sup> Study on the "Impact of traffic off-loading and related technological trends on the demand for wireless broadband spectrum", WIK/Aegis, 2013 (SMART 2012/0015)

<sup>3</sup> Based on the use of Android phones and tablet computers in France, Germany, Italy and the UK, see *ibid.*

<sup>4</sup> Annualised savings in network cost due to off-load, see *ibid.*

infrastructure communication in order to improve road safety, enhance traffic flows and reduce fuel consumption. The European Earth monitoring programme (GMES), now known as Copernicus, is an EU-lead initiative to provide satellite-based information services, inter alia, as a key tool to support biodiversity, ecosystem management, and climate change mitigation and adaptation. Moreover, there is also a need to ensure coexistence between WAS/RLAN and existing operations of military applications and meteorological radars as well as other primary services.

### 3. JUSTIFICATION

Pursuant to Article 4(2) of the Radio Spectrum Decision<sup>5</sup>, the Commission may issue mandates to the CEPT for the development of technical implementing measures with a view to ensuring harmonised conditions for the availability and efficient use of radio spectrum necessary for the functioning of the internal market. Such mandates shall set the tasks to be performed and their timetable.

Pursuant to Article 6 of the Radio Spectrum Policy Programme<sup>6</sup>, the Commission shall, in cooperation with Member States, assess the justification and feasibility of extending the allocations of unlicensed spectrum for wireless access systems, including radio local area networks. In 2012 the Commission has announced its intention to consider the designation of additional harmonised licence-exempt spectrum for RLAN (Wi-Fi) services at 5 GHz through a revision of Decision 2005/513/EC as amended by Decision 2007/90/EC, depending on the outcome of technical sharing studies and of the impact in the market<sup>7</sup>.

In addition, the RSPP requires Member States, in cooperation with the Commission, to take all steps necessary to ensure that sufficient spectrum for coverage and capacity purposes is available to achieving the target for all citizens to have access to broadband speeds of not less than 30 Mbps by 2020<sup>8</sup>. Pursuant to Article 8 of the RSPP, Member States and the Commission shall also ensure spectrum availability and protect the radio frequencies necessary for monitoring the Earth's atmosphere and surface, allowing the development and exploitation of space applications and improving transport systems.

The majority of RLAN devices in use today are still operated in the 2.4 GHz band (where, based on EC Decision 2006/771/EC, 83.5 MHz of spectrum is available to a large number of short range devices) because the vast majority of commercially available access points have until recently only been capable of operating there. While there is already 455 MHz of the 5 GHz band harmonised for WAS/RLAN, there is also evidence that an increasing number of client devices including smart phones and tablets now have dual-band capability and that large-scale public Wi-Fi networks are a significant driver of 5 GHz use today, particularly where outdoor coverage is being provided<sup>9</sup>. In this regard, providing an additional spectrum resource on a shared basis without refarming existing usage could provide additional socioeconomic benefits with limited opportunity costs if a sharing possibility can be identified under the applicable preconditions.

In addition, a new generation of RLAN systems (known as IEEE 802.11ac) will be able to achieve throughput rates sufficient to wirelessly extend high-speed fixed broadband infrastructures (of 30 or 100 Mbps or more) to a broad range of client devices without reductions in speeds if operating in 80 MHz and/or 160 MHz channels. This compares to the 20 MHz or 40 MHz channels supported by 802.11n which are typically used today. In

<sup>5</sup> Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJL 108 of 24.4.2002

<sup>6</sup> Decision 243/2012/EU of 14 March 2012, OJ L 81 of 21.3.2012

<sup>7</sup> Commission Communication on promoting the shared use of radio spectrum resources in the internal market (COM(2012)478)

<sup>8</sup> Article 3(c)

<sup>9</sup> See WIK/Aegis, 2013, current use of the 5 GHz band.

addition, the increased throughput rates can also support new applications that rely on uncontended channels for high-speed wireless data transfer between devices, such as for locally streaming HD video. In this regard users will have to rely on an uncontended (in geographic terms) 80 MHz channel to leverage new Wi-Fi generations to deliver what will most likely be on average between 63Mbps and 170Mbps<sup>10</sup>. In high-density residential environments a minimum of eight separate frequency channels are required to ensure that contention between neighbouring access points does not reduce the available bit rate for each user<sup>11</sup>.

In the light of these WAS/RLAN technology trends, it is appropriate to assess and study a possible extension of the 5 GHz band for WAS/RLAN usage that would result in WAS/RLAN devices being able to operate on a shared basis within one large uninterrupted block of frequencies starting from 5150 MHz up to 5925 MHz<sup>12</sup>. A recent industry study<sup>13</sup> has estimated that the potential of such a WAS/RLAN extension in improvements in speed for residential users and the increased potential for mobile data-offload alone would result in benefits for Europe of €16.3 billion. Designating an uninterrupted block of spectrum in the 5 GHz range for WAS/RLANs would result in a 70% increase in available spectrum (up to 775 MHz in the range at 5 GHz) but may also result in a 125% increase of possible available 80 MHz channels (from 4 to 9). Realising a beneficial sharing opportunity for WAS/RLAN to operate on a shared basis in an uninterrupted band from 5150 MHz to 5925 MHz would therefore ensure that sufficient spectrum capacity for private and public Wi-Fi deployments will be available throughout the internal market.

However, such an opportunity can only be realised if appropriate coexistence between WAS/RLAN and those civil and/or military radio applications<sup>14</sup> for which the bands 5350-5470 MHz and 5470-5725 MHz are already assigned or designated is duly safeguarded. In particular with regard to radio applications that represent priorities of EU spectrum policy as specifically outlined in the RSPP, such as the European Earth monitoring programme (GMES)<sup>15</sup> in the band 5350-5470 MHz as well as Intelligent Transport Systems (ITS)<sup>16</sup> in the harmonised 5875-5905 MHz band, it will be necessary to ensure full protection of the envisaged usage.

It will therefore be necessary to carry out the appropriate technical studies and identify suitable sharing conditions to fully safeguard the envisaged operation of GMES and of safety-related ITS applications as well as to study the compatibility of WAS/RLAN with all other radio applications currently operated in these bands as well as in bands adjacent to these bands.

In addition, the deliverables of this mandate should contribute to consolidating Member States' positions in the on-going activities at CEPT and ITU on defining the technical and regulatory conditions regarding the proposed allocation to the mobile service of additional bands for radio local area networks (RLANs). Taking into account the current activity in

<sup>10</sup> In comparison to the headline speeds, the average usable throughput is considered to be substantially lower in real deployments depending, inter alia, on the user's distance from the access point or the use of one or two streams, whereby most current battery-powered portable devices can only support a single spatial stream. Compare the current status of Wi-Fi technology and its capabilities in Study on "traffic off-loading" (SMART2012/0015).

<sup>11</sup> Ibid, see estimation of Wi-Fi spectrum demand in typical off-load scenarios.

<sup>12</sup> See: [http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core\\_Download&EntryId=525&PortalId=0&TabId=353](http://www.digitaleurope.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=525&PortalId=0&TabId=353)

<sup>13</sup> Williamson et al. (2013) Future proofing Wi-Fi – the case for more spectrum. A report for Cisco, [http://www.plumconsulting.co.uk/pdfs/Plum\\_Jan2013\\_Future\\_proofing\\_Wi-Fi.pdf](http://www.plumconsulting.co.uk/pdfs/Plum_Jan2013_Future_proofing_Wi-Fi.pdf)

<sup>14</sup> These include in some Member States various types of radars operating in the bands 5350-5470 MHz and 5725-5850 MHz for aeronautical and defence purposes.

<sup>15</sup> Based on Regulation (EU) No 911/2010 of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013) (OJ L 276, 20.10.2010, p. 1) and Article 8(1) RSPP.

<sup>16</sup> Decision 2008/671/EC

the United States to make available an additional 195 megahertz of spectrum in the 5350-5470 MHz and 5850-5925 MHz bands for RLAN, there is a possibility for global harmonisation that would further strengthen the economies of scale for manufacturers. In this context the likely use of an additional allocation in the requested bands to the mobile service by unlicensed WAS/RLAN devices and their potential proliferation across borders requires the detailed development of technical parameters in order to prevent EU priority applications such as GMES suffering interference from RLAN systems in large parts of the world.

The scope and schedule of the mandate therefore also reflects the need for the European Union and its Member States to develop a timely and common position on possible harmonised technical conditions in time for WRC-15. In addition and in order to ensure a possible global harmonisation when developing harmonisation measures on the basis of the response to this mandate, it will be necessary to review and/or reconfirm the results of the Mandate based on the relevant outcome of WRC-15.

#### 4. TASK ORDER AND SCHEDULE

The purpose of this Mandate is to (1) study and identify harmonised compatibility and sharing scenarios for WAS/RLANs to operate on a shared basis in an uninterrupted band from 5150 MHz to 5925 MHz under the condition that (i) appropriate protection of EU priority applications, in particular the planned introduction of GMES in the band 5350-5450 MHz and the use of safety-related ITS applications in the frequency band 5875-5905 MHz, is ensured<sup>17</sup> and (ii) that coexistence of WAS/RLAN with other current civil and/or military radio systems to which the bands 5350-5470 MHz and 5725-5925 MHz and adjacent bands have already been assigned or designated (see Annex) is safeguarded; to (2) develop appropriate compatibility and sharing conditions to ensure a long-term spectrum access resource for WAS/RLANs to operate on the basis of a general authorisation as an essential wireless broadband infrastructure in the internal market; and (3) to review and/or reconfirm the compatibility and sharing conditions developed under task 2 for the Final report after WRC-15 taking utmost account of the possibility of international harmonisation.

The CEPT is hereby mandated to undertake the following tasks:

##### **Task 1 – identification of compatibility and sharing scenarios**

Taking into account the relevant developments since the completion of the original studies carried out prior to WRC-03 for the bands 5150-5350 MHz and 5470-5725 MHz, to study and identify harmonised compatibility and sharing scenarios for WAS/RLANs in the bands 5350-5470 MHz and 5725-5925 MHz based on the latest generation of WAS/RLAN equipment (EN 301 893 v. 1.6.1. or 1.7.1.) and to define relevant protection parameters and conditions in close cooperation with all concerned stakeholders for:

- 1.1. Ensuring the planned operation of GMES/Copernicus (such as availability of proper satellite data based on SAR imaging systems) within the band 5350-5470 MHz<sup>18</sup>.

<sup>17</sup> In regard to the protection of the EU priority usages by GMES and ITS the Commission (DG JRC) will invite stakeholders to establish commonly accepted <sup>deployments</sup> assumptions for RLAN, ITS and GMES/SAR and where technically feasible to <sup>conduct laboratory tests with sample equipment to</sup> establish accepted interference protection limits.

<sup>18</sup> The <sup>c</sup>entre frequency of the SAR on Sentinel-1 is 5405 MHz with an operating bandwidth of 90 MHz and centre frequency of the Altimeter on Sentinel-3 is 5410 MHz with an operating bandwidth of 320 MHz.

- 1.2. Ensuring safety-related operation of ground-based ITS systems in the band 5875-5905 MHz in line with the provisions of Decision 2008/671/EC.
- 1.3. Facilitating coexistence between RLAN systems and other existing usage in various Member States in and adjacent to the bands 5350-5470 MHz and 5725-5925 MHz as listed in the annex, including FSS in the band 5725-5925 MHz and radiolocation applications in the bands 5350-5470 MHz and 5725-5850 MHz.
- 1.4. Assessing the impact, if any, of the future use of WAS/RLAN systems in the WAS/RLAN extension bands on SRDs operating in the bands 4500-7000 MHz, 5725-5875 MHz and 5795-5805 MHz according to the parameters harmonised in Decision 2006/771/EC<sup>19</sup>.

For each compatibility and sharing scenario, the risk of interference, the deployment assumptions of all applications and the operational footprint of the actual use of the protected services/applications should be identified<sup>20</sup>.

In addition, it should also be assessed whether and how coexistence can be ensured between the future WAS/RLAN usage, as an essential element of the wireless broadband EU priority, and other uses of the 5 GHz band that are currently considered on a shared basis, taking into account studies on-going in CEPT<sup>21</sup>.

## **Task 2 – Development of compatibility and sharing conditions**

Taking into account the expected development of WAS/RLAN technology and of the relevant standards until 2020, in particular the use of larger channel bandwidths, as well as the outcome of Task 1, appropriate mitigation techniques and/or operational compatibility and sharing conditions should be developed in close cooperation with all concerned stakeholders.

Based on the working assumption that WAS/RLANs would operate on a co-primary basis under an appropriate mobile allocation in the whole 5150 MHz to 5925 MHz band, and in the light of experience, the compatibility and sharing conditions should in particular identify the technical parameters that would be needed to ensure in the internal market consistent harmonised conditions and requirements for WAS/RLANs operating on a shared basis across the entire 5 GHz band.

To enable WAS/RLANs to operate on the basis of a general authorisation only those requirements should be implementable on the basis of harmonised standards and foster economies of scale in order to meet EU spectrum policy objectives, in particular taking into account sharing technologies and mitigation approaches implemented for existing WAS/RLAN equipment. These requirements should also take into account the regulatory and enforcement context of general authorisation. The compatibility and sharing conditions should also define the coexistence criteria

<sup>19</sup> Including bands agreed for inclusion in the forthcoming 5th update, such as those for road tolling.

<sup>20</sup> In particular where the use of the bands by primary radio services is not harmonised in the EU. Consistent with the approach to collect on a case-by-case basis comprehensive data for frequency ranges as proposed in CEPT Report 46, and with a view to lightening the administrative burden of individual Member States, the information on the operational footprint of the actual use of the relevant protected services/applications collected for the purposes of this mandate should be made available together with the Final Report in a machine readable format.

<sup>21</sup> Such as on Broadband Direct-Air-to-Ground Communications (DA2GC) in the band 5855-5875 MHz or Wireless Avionics Intra-Communications (WAIC) in the band 5350-5460 MHz as well as Wireless Industrial Applications in the band 5 725-5 875 MHz. This is without prejudice to the final decisions that may be taken on any such usage in this or any other band.

that need to be taken into account by any other potential future use of the 5 GHz band in order to avoid interference with WAS/RLAN usage of the 5 GHz band.

### Task 3 – Review of compatibility and sharing conditions after WRC-15

Taking utmost account of the possibility of international harmonisation<sup>22</sup>, to assess the need to review and/or reconfirm the compatibility and sharing conditions developed under task 2 for the Final report based on the result of WRC-15, in the event that this would have a material effect on the parameters chosen for completion of tasks 1 and 2.

In the work carried out under the Mandate, the overall policy objectives of the RSPP, such as effective and efficient spectrum use and the support for specific Union policies shall be given utmost consideration. In implementing this mandate, the CEPT shall, where relevant, take utmost account of EU law applicable and support the principles of service and technological neutrality, non-discrimination and proportionality insofar as technically possible.

CEPT is also requested to collaborate actively with all concerned stakeholders and the European Telecommunications Standardisation Institute (ETSI) which develops harmonised standards for conformity under Directive 1999/5/EC.

CEPT should provide deliverables according to the following schedule:

<b>Delivery date</b>	<b>Deliverable</b>	<b>Subject</b>
March 2014	Interim Report from CEPT to the Commission	Description of work undertaken and interim results under tasks (1) and (2) of this Mandate
November 2014 <sup>23</sup>	Final Draft Report A from CEPT to the Commission	Description of work undertaken and final results under tasks (1) and (2) of this Mandate
March 2015	Final Report A from CEPT to the Commission taking into account the outcome of the public consultation	Description of work undertaken and final results under this Mandate taking into account the results of the public consultation
March 2016 <sup>23</sup>	Final Draft Report B from CEPT to the Commission	Review and/or reconfirmation of the final results under this Mandate taking into account the results of WRC-15. Description and assessment of relevant results of WRC-15 regarding final results of the Mandate on tasks (1) and (2) and final results of task (3)

<sup>22</sup> Such as resolutions at the ITU WRC-15.

<sup>23</sup> Subject to subsequent public consultation

July 2016	Final Report B from CEPT to the Commission	Review and/or reconfirmation of the final results under this Mandate based on the results of WRC-15. Final results of task (3), taking into account the results of the public consultation.
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In addition, CEPT is requested to report on the progress of its work pursuant to this Mandate to all meetings of the Radio Spectrum Committee taking place during the course of the Mandate.

The Commission, with the assistance of the Radio Spectrum Committee and pursuant to the Radio Spectrum Decision, may consider applying the results of this mandate in the EU, pursuant to Article 4 of the Radio Spectrum Decision.

Annex:

**The RSPG has recently identified the following preliminary candidate bands and relevant considerations for an RLAN extension in the medium timeframe (beyond 2015)<sup>31</sup>**

Frequency band [MHz]	Size [MHz]	Current Use	Pros of WBB in band	Cons of WBB in band	Action to make band available for WBB
5350 - 5470	120	Active Sensors, Defence Systems, Position fixing, Radiodetermination applications, Shipborne & VTS radar, Weather radar	Potential band for Wi-Fi applications.  Allocating the band for Wi-Fi could be useful to mobile networks in providing data offload and indoor wireless connectivity.	New routers would be required to utilise this additional spectrum for Wi-Fi.  Existing harmonised Wi-Fi standards needs to be developed further.	Sharing studies underway in JTG 4-5-6-7.  Studies should be undertaken to see if band could be utilised for Wi-Fi.
5725-5875	150	Amateur, BFWA, Defence systems, ISM, SRDs, Radio determination applications, RTTT, Weather radars, Fixed links, FSS, UWB	Band identified by CEPT for Broadband Fixed Wireless Access (ECC/REC/(06)04).  See also ECC Report 68.	May not be available in all Member States due to e.g. defence systems or RTTT.	Studies should be undertaken to see if this band could be more widely available for wireless broadband including Wi-Fi, taking into account the to the need to protect services in the upper adjacent band.
5875-5925	50	RTTT (ITS), Fixed links, FSS, UWB	Potential for Wi-Fi.	Sharing with FSS Earth stations may impose geographical constraints on usage.  Decision 2008/671/EC on the harmonised use of radio spectrum in the 5875 - 5905 MHz frequency band for safety related applications of Intelligent Transport Systems.	Sharing studies underway in JTG 4-5-6-7.  Studies should be undertaken to see if band could be utilised for Wi-Fi.

<sup>31</sup> See Annex 1 and <sup>2</sup>, as well as section 9.7 of the RSPG Opinion on Strategic Challenges facing Europe in addressing the Growing Spectrum Demand for Wireless Broadband (RSPG13-521).

**ANNEX 2: EXCERPT OF THE EUROPEAN COMMON ALLOCATION TABLE (MAY 2014)**

<i>RR Region 1 Allocation and RR footnotes applicable to CEPT</i>	<i>European Common Allocation</i>	<i>ECC/ERC harmonisation measure</i>	<i>Applications</i>	<i>European footnotes</i>	<i>Standard</i>	<i>Notes</i>
<b>5150 - 5250 MHz</b>						
AERONAUTICAL RADIONAVIGATION MOBILE except aeronautical mobile	FIXED-SATELLITE (E/S) 5.447A		Aeronautical telemetry			
FIXED-SATELLITE (E/S) 5.447A	5.446A 5.446B		Feeder links			Feeder links for MSS. Aeronautical Radionavigation and FSS envisaged in some countries
MOBILE except aeronautical mobile	5.446A 5.446B	ERC/REC 70-03	Radiodetermination applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
5.446	5.446					
5.446C	5.446C	ECC/DEC/(04)08	Radio LANs		EN 301 893	WAS/RLANs within the bands 5150-5350 MHz and 5470-5725 MHz
5.447	5.447					
5.447B	5.447B					
5.447C	5.447C	ECC/REC/(08)04	BBDR		EN 302 625	Temporary use by PPDR users
<b>5250 - 5255 MHz</b>						
EARTH EXPLORATION-SATELLITE (active)	EARTH EXPLORATION-SATELLITE (active)		Active sensors (satellite)			
MOBILE except aeronautical mobile	MOBILE except aeronautical mobile		Defence systems			Tactical and weapon system radars
5.446A 5.447F	5.446A 5.447F					
RADIOLOCATION	RADIOLOCATION		-			Position fixing
SPACE RESEARCH 5.447D	SPACE RESEARCH 5.447D	ERC/REC 70-03	Radiodetermination applications		EN 302 372	Within the band 4500-7000 MHz for TLPR application
5.447E	5.448A EU2		Maritime radar			Shipborne and VTS radar
5.448	EU22					
5.448A		ECC/DEC/(04)08	Radio LANs		EN 301 893	WAS/RLANs within the bands 5150-5350 MHz and 5470-5725 MHz
			Weather radar			Ground based and airborne

**5255 - 5350 MHz**

EARTH EXPLORATION-SATELLITE (active)	EARTH EXPLORATION-SATELLITE (active)		Active sensors (satellite)		
MOBILE except aeronautical mobile 5.446A 5.447F	MOBILE except aeronautical mobile 5.446A 5.447F		Defence systems		Tactical and weapon system radars
RADIOLOCATION	RADIOLOCATION		-		Position fixing
SPACE RESEARCH (active)	SPACE RESEARCH (active)	ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
5.447E	5.448A EU2		Maritime radar		Shipborne and VTS radar
5.448	EU22				
5.448A		ECC/DEC/(04)08	Radio LANs	EN 301 893	WAS/RLANs within the bands 5150-5350 MHz and 5470-5725 MHz
			Weather radar		Ground based and airborne

**5350 - 5450 MHz**

AERONAUTICAL RADIONAVIGATION 5.449	AERONAUTICAL RADIONAVIGATION 5.449		Active sensors (satellite)		
EARTH EXPLORATION-SATELLITE (active) 5.448B	EARTH EXPLORATION-SATELLITE (active) 5.448B		Defence systems		Tactical and weapon system radars
RADIOLOCATION 5.448D	RADIOLOCATION 5.448D		-		Position fixing
SPACE RESEARCH (active) 5.448C	SPACE RESEARCH (active) 5.448C	ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
	Fixed				
	EU2		Maritime radar		Shipborne and VTS radar
	EU22				
			Weather radar		Ground based and airborne

**5450 - 5460 MHz**

AERONAUTICAL RADIONAVIGATION 5.449	AERONAUTICAL RADIONAVIGATION 5.449		Active sensors (satellite)		
EARTH EXPLORATION-SATELLITE (active) 5.448B	EARTH EXPLORATION-SATELLITE (active) 5.448B		Defence systems		Tactical and weapon system radars
RADIOLOCATION 5.448D	RADIOLOCATION 5.448D		-		Position fixing
SPACE RESEARCH (active) 5.448C	SPACE RESEARCH (active) 5.448C	ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
	EU2		Maritime radar		Shipborne and VTS radar
	EU22		Weather radar		Ground based and airborne

**5460 - 5470 MHz**

EARTH EXPLORATION-SATELLITE (active)	EARTH EXPLORATION-SATELLITE (active)		Active sensors (satellite)		
RADIOLOCATION 5.448D	RADIOLOCATION 5.448D		Defence systems		Tactical and weapon system radars
RADIONAVIGATION 5.449	RADIONAVIGATION 5.449		-		Position fixing
SPACE RESEARCH (active) 5.448B	SPACE RESEARCH (active) 5.448B	EU2 ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
	EU22		Maritime radar		Shipborne and VTS radar
			Weather radar		Ground based and airborne

**5470 - 5570 MHz**

EARTH EXPLORATION-SATELLITE (active)	EARTH EXPLORATION-SATELLITE (active)		Active sensors (satellite)		
MARITIME RADIONAVIGATION	MARITIME RADIONAVIGATION		Defence systems		Tactical and weapon system radars
MOBILE except aeronautical mobile 5.446A 5.450A	MOBILE except aeronautical mobile 5.446A 5.450A		-		Position fixing
RADIOLOCATION 5.450B	RADIOLOCATION 5.450B	ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
SPACE RESEARCH (active) 5.448B	SPACE RESEARCH (active) 5.448B	EU2	Maritime radar		Shipborne and VTS radar
5.450	EU22				
5.451		ECC/DEC/(04)08	Radio LANs	EN 301 893	WAS/RLANs within the bands 5150- 5350 MHz and 5470-5725 MHz
			Weather radars		Ground based and airborne

**5570 - 5650 MHz**

MARITIME RADIONAVIGATION MOBILE except aeronautical mobile 5.446A 5.450A	MARITIME RADIONAVIGATION MOBILE except aeronautical mobile 5.446A 5.450A		Defence systems		Tactical and weapon system radars
RADIOLOCATION 5.450B 5.450 5.451 5.452	RADIOLOCATION 5.450B 5.452 EU2 EU22	ERC/REC 70-03	- Radiodetermination applications Maritime radar	EN 302 372	Position fixing Within the band 4500-7000 MHz for TLPR application Shipborne and VTS radar
		ECC/DEC/(04)08	Radio LANs Weather radars	EN 301 893	WAS/RLANs within the bands 5150- 5350 MHz and 5470-5725 MHz Ground based

**5650 - 5725 MHz**

MOBILE except aeronautical mobile 5.446A 5.450A	MOBILE except aeronautical mobile 5.446A 5.450A		Amateur	EU17	EN 301 783	Within the band 5660-5670 MHz
RADIOLOCATION Amateur Space research (deep space)	RADIOLOCATION Amateur Amateur-satellite (E/S)		Amateur-satellite Defence systems	EU23		Within the band 5660-5670 MHz Tactical and weapon system radars
5.282 5.451 5.453 5.454 5.455	5.282 EU2 EU17 EU22	ERC/REC 70-03	- Radiodetermination applications Maritime radar	EN 302 372		Position fixing Within the band 4500-7000 MHz for TLPR application Shipborne and VTS radar
		ECC/DEC/(04)08	Radio LANs Weather radars	EN 301 893		WAS/RLANs within the bands 5150- 5350 MHz and 5470-5725 MHz Ground based and airborne

**5725 - 5830 MHz**

FIXED-SATELLITE (E/S)	FIXED-SATELLITE (E/S)		Amateur	EN 301 783	
RADIOLOCATION	RADIOLOCATION				
	Fixed	ECC/REC/(06)04	BFWA	EN 302 502	Within the band 5725-5875 MHz
Amateur	Amateur				
	Mobile		Defence systems		Tactical and weapon system radars
5.150	5.150	EU2	ISM		Within the band 5725-5875 MHz
5.451		EU22			
5.453		ERC/REC 70-03	Non-Specific SRDs	EN 300 440	Within the band 5725-5875 MHz
5.455					
5.456		ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
		ERC/REC 70-03	TTT	EN 300 674	Within the band 5795-5805 MHz. TTT in the band 5805-5815 MHz on a national basis
			Weather radars		Ground based and airborne

**5830 - 5850 MHz**

FIXED-SATELLITE (E/S)	FIXED-SATELLITE (E/S)		Amateur-Satellite	EU23	Within the band 5830-5850 MHz
RADIOLOCATION	RADIOLOCATION				
	Fixed	ECC/REC/(06)04	BFWA	EN 302 502	Within the band 5725-5875 MHz
Amateur	Amateur				
Amateur-satellite (S/E)	Amateur-satellite (S/E)		Defence systems		Tactical and weapon system radars
	Mobile		ISM		Within the band 5725-5875 MHz
5.150	5.150	EU2			
5.451		EU22	ERC/REC 70-03	EN 300 440	Within the band 5725-5875 MHz
5.453		ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application
5.455					
5.456			Weather radars		Ground based and airborne

**5850 - 5925 MHz**

FIXED	FIXED	ECC/REC/(06)04	BFWA	EN 302 502	Within the band 5725-5875 MHz
FIXED-SATELLITE (E/S)	FIXED-SATELLITE (E/S)		FSS Earth stations	EN 301 443	Priority for civil networks
MOBILE	MOBILE		ISM		Within the band 5725-5875 MHz
5.150	5.150	ECC/DEC/(08)01 ECC/REC/(08)01	ITS	EN 302 571	Within the band s 5875-5925 MHz and 5855-5875 MHz
		ERC/REC 70-03	Non-Specific SRDs	EN 300 440	Within the band 5725-5875 MHz
		ERC/REC 70-03	Radiodetermination applications	EN 302 372	Within the band 4500-7000 MHz for TLPR application

**ANNEX 3: TECHNICAL AND OPERATIONAL PARAMETERS TO USED FOR SHARING STUDIES BETWEEN 5 GHz RLAN AND EESS (ACTIVE) IN THE 5350-5470 MHz BAND AND BETWEEN 5 GHz RLAN AND RADIOLOCATION SYSTEMS IN THE 5350-5470 MHz AND 5725-5850 MHz BANDS**

The base material for this document is taken from the document agreed in ITU-R JTG 4-5-6-7 on “ Technical/operational characteristics to be used for sharing studies with RLAN in the 5 GHz band” (as given in JTG 4-5-6-7/584 - Annex 2 – Appendix 2A).

This document contains the technical and operational parameters of RLAN systems to be used in sharing studies in the 5350-5470 MHz frequency range.

*Note: RLAN parameters in the band 5725-5850 MHz band may have to be considered with the results of further discussions within CEPT.*

**A3.1 RLAN PARAMETERS FOR THE 5350-5470 MHz BAND**

**A3.1.1 E.i.r.p. level distribution**

**Table 14: WAS/RLAN power distribution in the band 5350-5470 MHz**

<b>Tx power e.i.r.p.</b>	<b>200mW (omni)</b>	<b>80mW (omni)</b>	<b>50mW (omni)</b>	<b>25mW (omni)</b>
Device Percentage	19%	27%	15%	39%

Notes: These e.i.r.p. values apply across the entire RLAN channel bandwidth. RLAN devices are assumed to be indoors only, based on the requirement to help facilitate coexistence. For the purposes of sharing studies, 5% of the devices should be modelled without building attenuation. Alternatively administrations may choose to carry out a parametric analysis in any range between 2% and 10%.

**A3.1.2 Channel bandwidth distribution**

**Table 15: RLAN channel bandwidth distribution in the band 5350-5470 MHz**

<b>Channel bandwidth</b>	<b>20 MHz</b>	<b>40 MHz</b>	<b>80 MHz</b>	<b>160 MHz</b>
RLAN Device Percentage	10 %	25 %	50 %	15 %

**A3.1.3 Building attenuation**

Gaussian distribution with a 17 dB mean and a 7 dB standard deviation (truncated at 1 dB). Alternatively administrations may choose to use a 17 dB fixed value.

**A3.1.4 Propagation model**

For aeronautical radar case

Recommendation ITU-R P.528 [43](as revised – see Document 3/36(Rev.1)) + angular clutter loss model from Recommendation ITU-R P.452 [42](as revised – see Document 3/52(Rev.1)) + building attenuation as described above.

For EESS (active) case

Recommendation ITU-R P.619 [44]+ angular clutter loss model from Recommendation ITU-R P.452 [42](see below) + building attenuation as described above.

Angular clutter loss model

The angular clutter loss model provided by the "RLAN User Defined Height" column of the table below should be used in conjunction with the antenna heights as described below. The clutter loss values calculated for the "sparse houses", "suburban" and "urban" clutter (ground-cover) categories should be applied in the rural, suburban and urban zones of the RLAN deployment model, respectively.

Theta max (°) provides the angle from the RLAN transmitter to the top of the clutter height. Therefore, if the aircraft/spacecraft is at an elevation angle at or below theta max (°), clutter loss should be added. If the aircraft/spacecraft is above theta max (°) of the respective clutter category, there is no clutter loss.

**Table 16: Angular clutter loss**

TABLE 4 Nominal clutter heights and distances																	
Clutter (ground-cover) category	Nominal height, $h_a$ (m)	Nominal distance, $d_k$ (km)	RLAN User Defined Height		UE any		Macro rural		Macro suburban		Macro urban		Small cell outdoor / micro urban		Small cell indoor / micro urban		
			$h=2$ (m)	$\theta_{max}$ (°)	$h=1,5$ (m)	$\theta_{max}$ (°)	$h=30$ (m)	$\theta_{max}$ (°)	$h=25$ (m)	$\theta_{max}$ (°)	$h=20$ (m)	$\theta_{max}$ (°)	$h=6$ (m)	$\theta_{max}$ (°)	$h=3$ (m)	$\theta_{max}$ (°)	
High crop fields	4	0,1	14,8 dB	1,1	17,3 dB	1,4	-3 dB	-14,6									
Park land																	
Irregularly spaced sparse trees																	
Orchard (regularly spaced)																	
Sparse houses	9	0,025	19,5 dB	15,6	19,6 dB	16,7											
Suburban																	
Dense suburban																	
Urban	20	0,02	19,7 dB	42,0	19,7 dB	42,8											
Dense urban	25	0,02	19,7 dB	49,0	19,7 dB	49,6											
High-rise urban	35	0,02	19,7 dB	58,8	19,7 dB	59,2											

↑ This Table is taken from Rec ITU-R P.452-14 ↑      ↑ dBs of clutter loss calculated using equations (47) and (47a) of Rec. ITU-R P.452-14. ↑  
 ↑ Maximum elevation angle of clutter,  $\theta_{max}$ , calculated using  $\arctan((h_a - h) / d_k)$ . ↑

**A3.1.5 RLAN antenna height**

**Table 17: WAS/RLAN antenna height**

RLAN Deployment Region	Antenna Height (meters)
Urban	1.5 to 28.5
Suburban	1.5, 4.5
Rural	1.5, 4.5

The antenna heights are randomly selected using a uniform probability distribution from the set of floor heights at 3 meter steps.

**A3.1.6 RLAN antenna gain/discrimination**

For terrestrial radar studies

Antenna gain relative to the radar received e.i.r.p. for RLAN is important in determining DFS threshold values. Received signals should be increased by 3 dB to account for antenna gain in the RLAN access points which will apply DFS.

For EESS (active) case

The RLAN antenna is omnidirectional in azimuth for all scenarios.

In the elevation plane, it was agreed to consider the RLAN antenna pattern on a parametric way with the 2 following options as the two edges of a reasonable range:

- Omnidirectional in elevation (i.e. 0 dBi);
- An average 4 dB antenna discrimination applied to the EIRP level distribution above in the direction of the satellite.

### A3.1.7 RLAN device density relevant to sharing studies

The following RLAN device densities options are to be used as simultaneously transmitting with the e. i. r. p. distribution as given above:

- Option D1: 5186 active devices per 20 MHz channel or 9871 active devices per 100 MHz channel per 5.25 million inhabitants (details and justification found in document 4-5-6-7/495);
- Option D2: From 0.0008 to 0.008 active devices per 20 MHz channel per inhabitant (0.004 to 0.04 per 100 MHz channel) (based on 3% to 30% activity factor) applied to any population size (details and justification found in document 4-5-6-7/430) (the 2 edges of this option are called option D2-low and option D2-High).

There are also some studies looking at capping active RLANs/km based on reasonable frequency re-use distances etc. in dense urban areas. The aim of this work is to provide some checks and balances on the activity factors that are being proposed for use in the sharing studies, particularly where there are high populations in dense urban areas.

## A3.2 TERRESTRIAL RADAR CHARACTERISTICS

The relevant radar to be studied should take account of ITU-R Recommendation M.1638 which is currently under review plus the FH radar type described in CPG PTD(14)12. The studies should only study the effectiveness of DFS with respect to any new radar not studied previously. Studies should also investigate further if RLANs approved to the FCC standard would be capable of detecting all of the types of FH radar that are to be studied. [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-06-96A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-96A1.pdf). There should also be a need to discuss how to ensure protection of FH radar through provision of proper test procedures in an ETSI standard.

## A3.3 EESS CHARACTERISTICS TO STUDY

### Satellites to study

It was agreed that studies relevant for the European context would be based on the characteristics of the Sentinel 1 Satellite system (CSAR instrument) as this is the most sensitive.

### EESS protection Criteria

Studies should be consistent with ITU-R Recommendation RS.1166-4 [45] .

It proposes using an  $I/N = -6$  dB (where  $N = kTBF$  with  $k = -228.6$  dB,  $T = 300$ K,  $F = 3.2$  dB,  $B = 100$  MHz), therefore  $N = -120.6$  dBW leading to  $I = -126.6$  dBW which are not to be exceeded for more than 1% of the time.

For the dynamic analysis the time and the area of the study may be variable but the 1 % criteria should apply to the whole track of the satellite (i.e. the whole area of the simulation). For the Static analysis, a single snapshot over a densely populated city would be considered to provide a worst case analysis.

**EESS Antenna pattern (Beam shape and coverage area)**

For the studies, a Peak (bore sight) antenna gain was confirmed to be 44 dBi and the Main Beam shape of the satellite footprint can be considered to be elliptical (cigar shaped) with a size of 75 x 4 km.

The following equations are used to model the CSAR instrument antenna:

$$G = \max(G_{\min}, G_{\max} + G_{\text{ver}} + G_{\text{hor}});$$

with :

$$G_{\text{ver}} = 10 \times \log (\text{sinc}(\text{coefV} \cdot \sin(\text{Elev}))^2)$$

$$G_{\text{hor}} = 10 \times \log (\text{sinc}(\text{coefH} \cdot \sin(\text{Az}))^2)$$

$$\text{coefV} = 9$$

$$\text{coefH} = 200$$

$$G_{\min} = -10$$

$$G_{\max} = 44$$

*Note : the cardinal sine function is here used in its form :  $\text{sinc}(x) = \frac{\sin(\pi x)}{\pi x}$*

**ANNEX 4: LIST OF REFERENCES**

- [1] EC Decision 2008/671/EC on the harmonised use of radio spectrum in the 5875-5905 MHz frequency band for safety-related applications of Intelligent Transport Systems (ITS)
- [2] EC Decision 2006/771/EC on the harmonisation of the radio spectrum for use by short-range devices
- [3] ERC Report 25, The European table of frequency allocations and applications in the frequency range 9 kHz to 3000 GHz (October 2013)
- [4] ETSI EN 302 372, Tanks Level Probing Radar (TLPR) operating in the frequency bands 5.8 GHz, 10 GHz, 25 GHz, 61 GHz and 77 GHz
- [5] ERC Recommendation 70-03 relating to the use of Short Range Devices (SRD)
- [6] European Commission COM(2012)218 on the establishment of an Intergovernmental Agreement for the operations of the European Earth monitoring programme (GMES) from 2014 to 2020
- [7] Regulation (EU) No 911/2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013)
- [8] Recommendation ITU-R M.1638 on Characteristics of and protection criteria for sharing studies for radiolocation, aeronautical radionavigation and meteorological radars operating in the frequency bands between 5 250 and 5 850 MHz
- [9] Recommendation ITU-R SM.1896 on Frequency ranges for global or regional harmonization of short-range devices
- [10] ETSI EN 300 674 on Road Transport and Traffic Telematics (RTTT)
- [11] Directive 2004/52/EC on the interoperability of electronic road toll systems in the Community
- [12] ECC Report 101, Compatibility studies in the band 5855-5925 MHz between Intelligent Transport Systems (ITS) and other systems
- [13] ECC Report 068, Compatibility studies in the band 5725-5875MHz between Fixed Wireless Access (FWA) systems and other systems
- [14] ECC Recommendation (06)04 on the use of the band 5725-5875 MHz for Broadband Fixed Wireless Access (BFWA)
- [15] ECC Report 173, Fixed Service in Europe: current use and future trends post 2011
- [16] ETSI TR 102 889-2, Technical characteristics for SRD equipment for wireless industrial applications using technologies different from Ultra-Wide Band (UWB)
- [17] ECC Report 206, Compatibility studies in the band 5725-5875 MHz between SRD equipment for wireless industrial applications and other systems
- [18] ECC Decision (08)01 on the harmonised use of the 5875-5925 MHz frequency band for Intelligent Transport Systems (ITS)
- [19] Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport
- [20] ECC Recommendation (08)01 on the use of the band 5855-5875 MHz for Intelligent Transport Systems
- [21] ETSI EN 302 571 V1.2.1: Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5855 MHz to 5925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive
- [22] ETSI TS 102 792, Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range
- [23] ECC Report 210, Compatibility/sharing studies related to Broadband Direct-Air-to-Ground Communications (DA2GC) in the frequency bands 5855-5875 MHz, 2400-2483.5 MHz and 3400-3600 MHz
- [24] ETSI TR 101 599 on Broadband Direct-Air-to-Ground Communications System employing beamforming antennas, operating in the 2.4 GHz and 5.8 GHz bands
- [25] ETSI TR 103 108 on Broadband Direct-Air-to-Ground Communications System operating in the 5.855 GHz to 5.875 GHz band using 3G technology
- [26] EC Decision 2005/513/EC on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)
- [27] EC Decision 2007/90/EC on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)
- [28] ECC Decision (04)08 on the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)
- [29] Resolution 229 (WRC-03, Rev. WRC-12) on the use of the bands 5150-5250 MHz, 5250-5350 MHz and 5470-5725 MHz by the mobile service for the implementation of wireless access systems including radio local area networks

- [30] ETSI EN 301 893, 5 GHz high performance RLAN
- [31] Recommendation ITU-R M.1652 on Dynamic frequency selection in wireless access systems including radio local area networks for the purpose of protecting the radiodetermination service in the 5 GHz band
- [32] ETSI EN 302 502, 5.8 GHz fixed broadband data transmitting systems
- [33] CEN EN 12253, Dedicated Short-Range Communication – Physical layer using microwave at 5.8 GHz
- [34] ETSI TR 103 083, Technical characteristics for road safety and traffic management, and for non-safety related ITS applications
- [35] Directive 1999/5/EC on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity
- [36] Standardisation mandate M/453 addressed to CEN, CENELEC and ETSI in the field of information and communication technologies to support the interoperability of co-operative systems for ITS.
- [37] ECC Report 192, The Current Status of DFS (Dynamic Frequency Selection) in the 5 GHz frequency range
- [38] ECC Report 206, Compatibility studies in the band 5725-5875 MHz between SRD equipment for wireless industrial applications and other systems
- [39] ECC Report 228: Compatibility studies between intelligent transport systems (ITS) in the band 5855-5925 MHz and other systems in adjacent bands
- [40] Recommendation ITU-R M.1849: Technical and operational aspects of ground-based meteorological radars
- [41] IEEE 802.11ac-2013: IEEE Standard for Information technology-- Telecommunications and information exchange between systems - Local and metropolitan area networks-- Specific requirements--Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications--Amendment 4: Enhancements for Very High Throughput for Operation in Bands below 6 GHz
- [42] Recommendation ITU-R P.452: Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz
- [43] Recommendation ITU-R P.528: Propagation curves for aeronautical mobile and radionavigation services using the VHF, UHF and SHF bands
- [44] Recommendation ITU-R P.619: Propagation data required for the evaluation of interference between stations in space and those on the surface of the Earth
- [45] Recommendation ITU-R RS.1166-4: Performance and interference criteria for active spaceborne sensors
- [46] CEPT Report 6 on Harmonised - RLANs in 5150-5350/5470-5725 MHz
- [47] TR 103 111 V1.1.1: ETSI SRdoc on Spectrum requirements for Urban Rail Systems in the 5.9 GHz range