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TECHNICAL REPORT

System Reference document (SRdoc);
Technical characteristics of
Multiple Gigabit Wireless Systems (MGWS)
in radio spectrum between 57 GHz and 71 GHz

Reference
DTR/ERM-575

Keywords
(57 to 66 GHz), ITS, radio, SRDoc

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Foreword

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

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document includes necessary information to support the co-operation under the MoU between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

The present document covers applications that require wireless systems delivering multiple gigabits of data throughput operating on license-exempt radio frequencies in the extended 60 GHz range including intelligent transport system and outdoor applications. These applications provide economic benefits to a variety of markets including communications, computing, consumer electronics and transport.

The purpose of producing the present document is, in particular, to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT), and the international harmonization of a class of innovative and useful products.

1 Scope

The present document describes the requirements for radio frequency usage for the following:

1) Multiple Gigabit Wireless Systems (MGWS) in radio spectrum between 57 GHz and 71 GHz including outdoor applications.

2) Millimetre Wave communication for Intelligent Transport Systems (mmW-ITS) and a proposal to move the existing mmW-ITS allocation to a single MGWS channel.

The present document is intended to update and replace ETSI TR 102 555 [i.1] and ETSI TR 102 400 [i.12].

The present document intended to provide necessary information to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

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

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

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

[i.1] ETSI TR 102 555 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Technical characteristics of multiple gigabit wireless systems in the 60 GHz range System Reference Document".

[i.2] ITU-R Report M.2227-2 (2017): "Multiple Gigabit Wireless Systems in frequencies around 60 GHz".

[i.3] Recommendation ITU-R M.2003-2 (2018): "Multiple Gigabit Wireless Systems in frequencies around 60 GHz".

[i.4] RP-182007: "New SID: Study on NR beyond 52.6 GHz".

[i.5] 3GPP TR 38.807: "Study on requirements for NR beyond 52.6 GHz".

[i.6] IEEE 802.11-2016 TM (December 2016): "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".

[i.7] IEEE 802.15.3-2016TM: "IEEE Standard for High Data Rate Wireless Multi-Media Networks".

[i.8] IEEE 802.15.3e-2017TM: "IEEE Standard for High Data Rate Wireless Multi-Media Networks Amendment: High-Rate Close Proximity Point-to-Point Communications".

[i.9] ETSI EN 302 567 (V2.1.1): "Multiple-Gigabit/s radio equipment operating in the 60 GHz band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".

[i.10] Wi-Fi Alliance ® Protocol Adaptation Layer (PAL) specifications:.

- WiGig® Display Extension Technical Specification Version 2.0, March 2015.
- WiGig® Bus Extension Specification v1.2, October 2014.
- WiGig® SD (WSD) Extension Specification v1.1, January 2015.

[i.11] P802.11ay™/D2.0: "Draft 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 7: Enhanced throughput for operation in license-exempt bands above 45 GHz".

[i.12] ETSI TR 102 400: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Intelligent Transport Systems (ITS); Road Traffic and Transport Telematics (RTTT); Technical characteristics for communications equipment in the frequency band from 63 GHz to 64 GHz; System Reference Document".

[i.13] ETSI EN 303 883: "Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".

[i.14] ECC Report 113: "Compatibility studies around 63 GHz between Intelligent Transport Systems (ITS) and other systems".

[i.15] ETSI EN 302 686: "Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 63 GHz to 64 GHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.16] ETSI EN 302 217-3: "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas; Part 3: Equipment operating in frequency bands where both frequency coordinated or uncoordinated deployment might be applied; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.17] ERC Recommendation 70-03: "Relating to the use of Short Range Devices (SRD)".

[i.18] ECC Decision 09/01: "Harmonised use of the 63.72-65.88 GHz frequency band for Intelligent Transport Systems (ITS)".

[i.19] ECC/REC/(05)02: "Use of the 64-66 GHz frequency band for fixed service".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 303 883 [i.13] and the following apply:

EIRP: product of the power supplied to the antenna and the maximum antenna gain relative to an isotropic radiator (absolute or isotropic gain)

roadside-to-vehicle communications: also includes vehicle-to roadside communications

roadside unit: roadside unit includes localized transmitters or receivers or both functions integrated into one unit

NOTE: roadside includes:

- single RSUs operating in a stand-alone fashion; or
- a group of RSUs connected together by an appropriate infrastructure, which may include an information network; or
- a single RSU connected to an information network.

3.2 Symbols

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

dB	decibel
GHz	GigaHertz
m	meter
s	second

3.3 Abbreviations

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

AES	Advanced Encryption Standard
AP	Acces Point
AR	Augmented Reality
ATPC	Automatic Transmit Power Control
BBU	Base Band Unit
BPSK	Binary Phase Shift Keying
CE	Consumer Electronics
CEPT	European Conference of Post and Telecommunications Administrations
DEC	Decision of Electronics Comminications Committee
DP	DisplayPort
ECC	Electronic Communications Committee
EIRP	Equivalent Isotropically Radiated Power
ERC	European Radiocommunication Committee
ERM	Electromagnetic compatibility and Radio spectrum Matters
FDD	Frequency Division Duplex
GCM	Galois/Counter Mode
HD	High Definition
HDMI	High Definition Multimedia Interface
IEEE	Institution of Electrical and Electronic Engineers
IMT	International Mobile Telecommunications
ISM	Industrial Scientific Medical
ITS	Intelligent Transport Systems
LAN	Local Area Network
LOS	Line Of Sight
MAC	Media Access Control
MGWS	MultiGigabit Wireless Systems
MoU	Memorandum of Understanding
NLOS	Non Line Of Sight
NR	New Radio
OFDM	Orthogonal Frequency Division Multiplex
PAN	Personal Area Network
PHY	PHYsical layer
PSD	Power Spectral Density
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RLAN	Radio Local Area Network
RRH	Remote Radio Head
RSU	Road-Side Unit
RTTT	Road Transport and Traffic Telematics
SC	Single Carrier
SISO	Single Input Single Output
SRD	Short Range Device
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TTT	Transport and Traffic Telematics
USB	Universal Serial Bus
VR	Virtual Reality

WAS	Wireless Access System
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network
WTTB	Wireless-to-the-Block
WTTH	Wireless-to-the-Home

4 Comments on the System Reference Document

Ericsson AB and Qualcomm UK Ltd. would like to make the following comments, which have been proposed to be included in the SRdoc, but could not be resolved.

- Wi-Fi offloading shall be replaced by WAS/RLAN offloading (or "Wi-Fi" shall be removed completely). This ensures a neutral approach without mentioning any specific technology.
- It shall be remarked in the SRdoc that 66 GHz to 71 GHz is a candidate band for IMT identification with associated services (many common with the applications listed in clauses 5.1.1 to 5.1.4).
- A harmonization of the channel plan between ITS and other users without restricting choice of technology/standard in the extended range 66 GHz to 71 GHz has to be ensured.

Ericsson AB, Qualcomm UK Ltd	9.1, 10	Bullet point 2	General	Add the text: without restricting choice of technology/standard in the extended range 66-71 GHz.	Harmonization of the channel plan between ITS and other users without restricting choice of technology/standard in the extended range 66-71 GHz.	Not resolved

5 Presentation of the proposed 60 GHz systems

5.1 MultiGigabit Wireless Systems (MGWS)

5.1.1 MGWS Overview

Multiple Gigabit Wireless System (MGWS) radiocommunication networks can be used in short-range, line-of-sight and non-line-of-sight circumstances with traditional WLAN topologies. MGWS systems can also be used in very short range high rate proximity communications where the radio range is a few centimetres with devices pairing point-to-point in close proximity of each other.

For WLAN, total communication range and performance will vary depending on system design (e.g. number of antenna elements) as well as the environment, but multiple gigabit performance is typically expected at ranges around 10 m for in-room use when devices typically possess a few (≤ 3) dozen antenna elements, to a few hundred meters for outdoor use when devices can be equipped with several (≥ 6) dozen antenna elements. These networks can be deployed with an access point as in existing WLAN deployments or without such an infrastructure such as in both WLAN in ad hoc mode and Wireless Personal Area Network (WPAN).

For close proximity communication topology is a pair of devices with performance up to 100 gigabit is expected with range of 10 cm or less (devices nearly touching) with transient connections (rapid setup and teardown); Close proximity devise typically will use a single antenna element and very low transmit power.

When access points are used, they are mounted indoor with service covering home or an office space with a nomadic user terminal typically also used indoor, i.e. the entire WLAN system would be used in indoor environment. To provide longer ranges and better capacity, the access point is typically equipped with a larger number of antenna elements than the user terminals.

When access points are not used, MGWS devices are allowed to communicate by setting up direct links for data exchange between the devices/equipment. Typical applications include equipment to equipment (e.g. laptop to projector) and a Consumer Electronics (CE) device to a kiosk (providing distribution of, and providing access to, electronic content such as movies, music, video, e-books, etc.) and it may be assumed that usage would predominantly be indoors. In some application, nomadic devices connect with stationary devices (i.e. kiosk, doorway, turnstile, vending machine) for very short duration to transfer large amounts of data, e.g. download 2 hours of HD video content in 250 ms while passing through an entry turnstile at a train station or airport. For the close proximity applications, a high density of devices and users may be concentrated in a small space, for example when passing through the entry ticket gates at train station or airport.

5.1.2 MGWS Applications

The following distinct applications are examples of services that can be delivered with Multiple Gigabit Wireless Systems (MGWS):

- Wireless video delivery; e.g. connectivity to monitors and head-mounted displays.
- Video streaming from source; e.g. machine vision, robotics, augmented reality.
- Low latency applications; e.g. inter-rack datacentre connectivity, augmented reality.
- Radio Local Area Network (RLAN).
- Kiosk to device; e.g. ticket turnstile to phone.
- Peer-to-peer; e.g. camera to computer.
- device to peripheral; e.g. set top box to monitor, laptop docking.
- Mesh networking.
- Augmented Reality (AR).
- Virtual Reality (VR).
- Location/Navigation.

It should be noted that these applications could be indoor or outdoor. Additional outdoor applications include:

- Backhaul/fronthaul in cellular and wireless systems.
- Point-to-point and point-to-multipoint connectivity.

5.1.3 Possible Outdoor Usage Scenarios

As existing technology gains traction in the marketplace, new applications are being envisioned using the same mass market technology. These new applications encompass usages in commercial and enterprise environments such as Point-to-Point and Point-to-Multipoint backhaul, front haul, outdoor access usage, mesh networks, etc. Backhaul and access examples are shown below in Figure 1 and Figure 2.

Such application are already common and used in this band within the regulatory frame of the Fixed service primary allocation; however, they can also be adapted in the WAS/RLAN technology.

Wireless backhaul could be used for small cell backhauling in lieu of expensive fibre networks to access networks, inter buildings, others. Single hop < 1 000 m, throughput multiple Gbps.

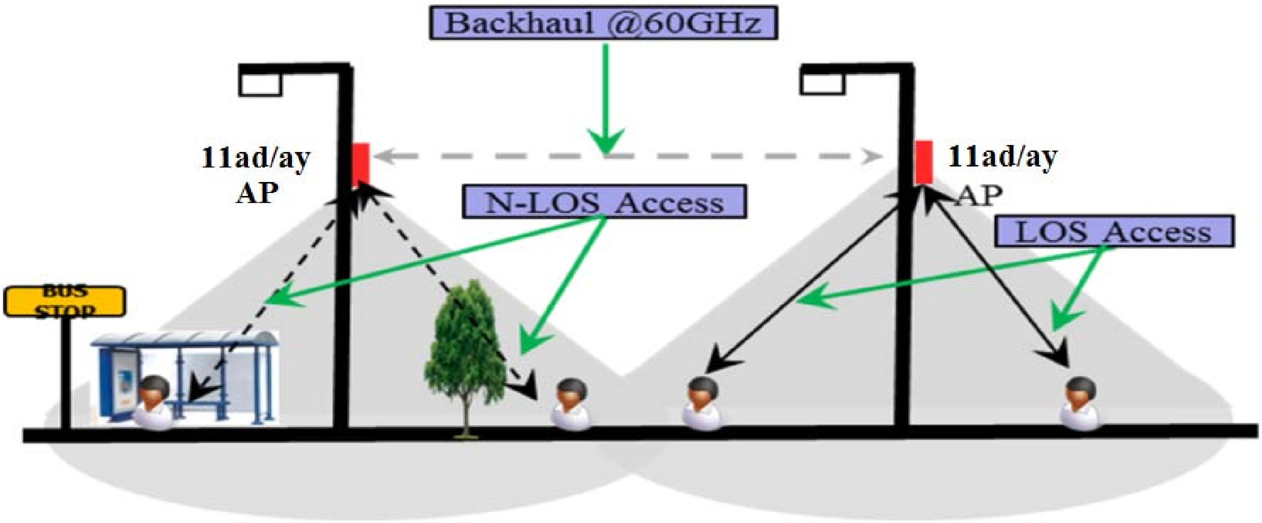


Figure 1: Backhaul with single hop

Wireless backhaul could be used for small cell backhauling in lieu of expensive fibre networks to access networks, inter buildings, others. Multiple hops, throughput multiple Gbps.

ETSI TC BRAN provides other examples shown below in Figure 3 and Figure 4.

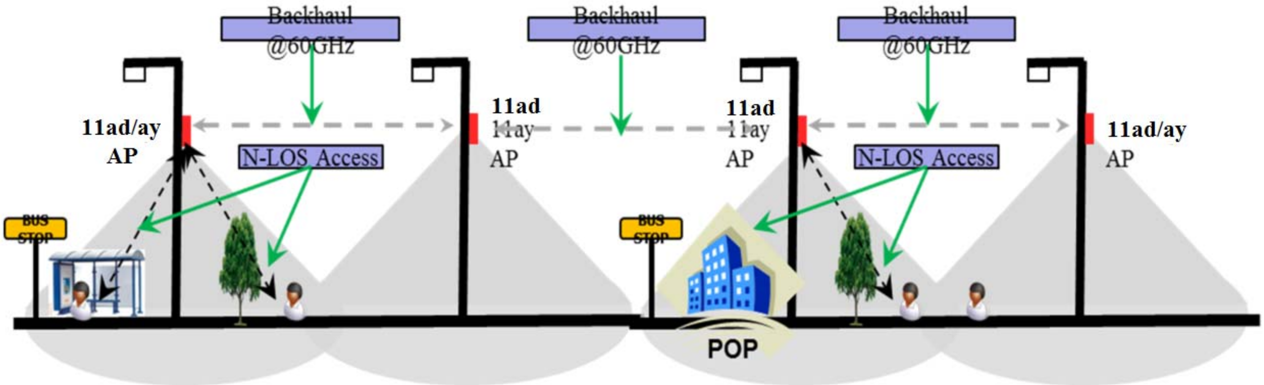


Figure 2: Backhaul with multiple hops

Base Band Unit (BBU) and Remote Radio Heads (RRH) are connected by optical fibres. In rural or disaster areas, optical fibres are unavailable. In such areas, cellular areas can be expanded by using 60 GHz links. Distance few hundred meters, throughput multiple Gbps.

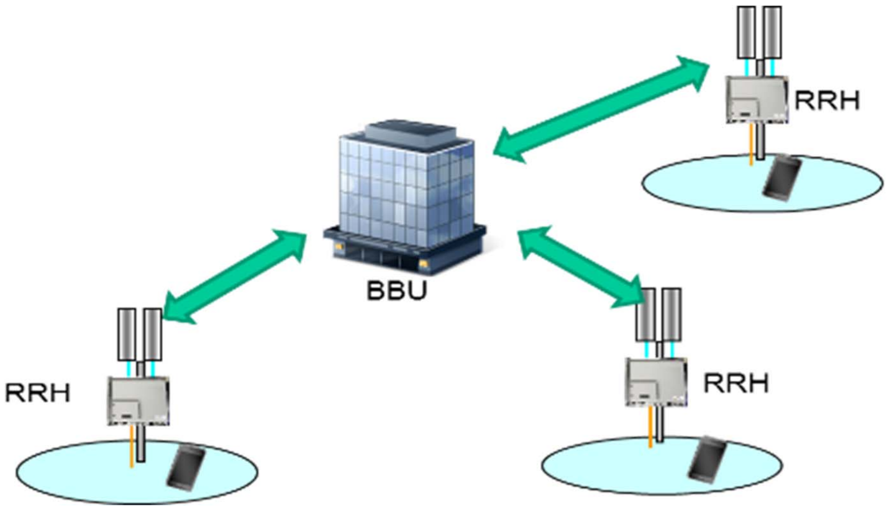


Figure 3: Mobile Front Hauling

Mobile device offloading video traffic from cellular interface to the high throughput 60 GHz interface. In a multi-band scenario, offloading can also occur with traffic being switched to higher throughput 60 GHz band for band efficiency. Mostly LOS links with distance < 100 m, throughput several Gbps.

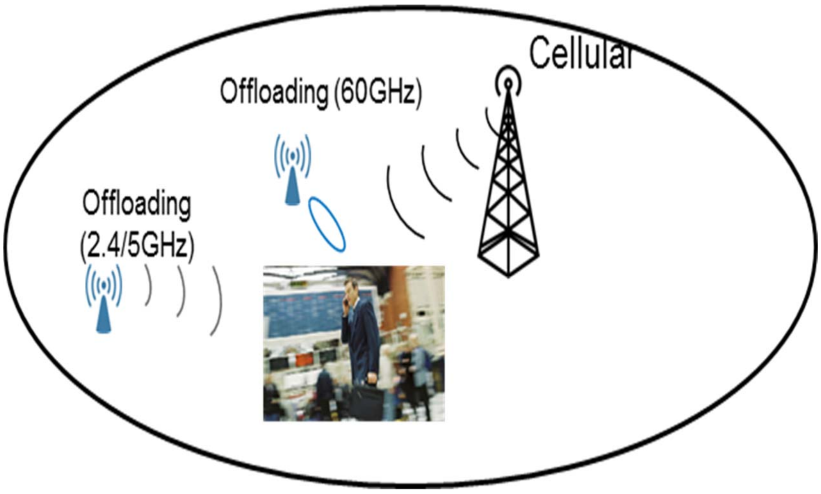


Figure 4: Wi-Fi Offloading

The IEEE 802.11ay [i.11] Task Group has recently expanded its use cases to include Mesh Networks with three applications: WTTH Access, WTTB Access, and WLAN AP/Small Cell Backhaul, as shown in Figure 5.

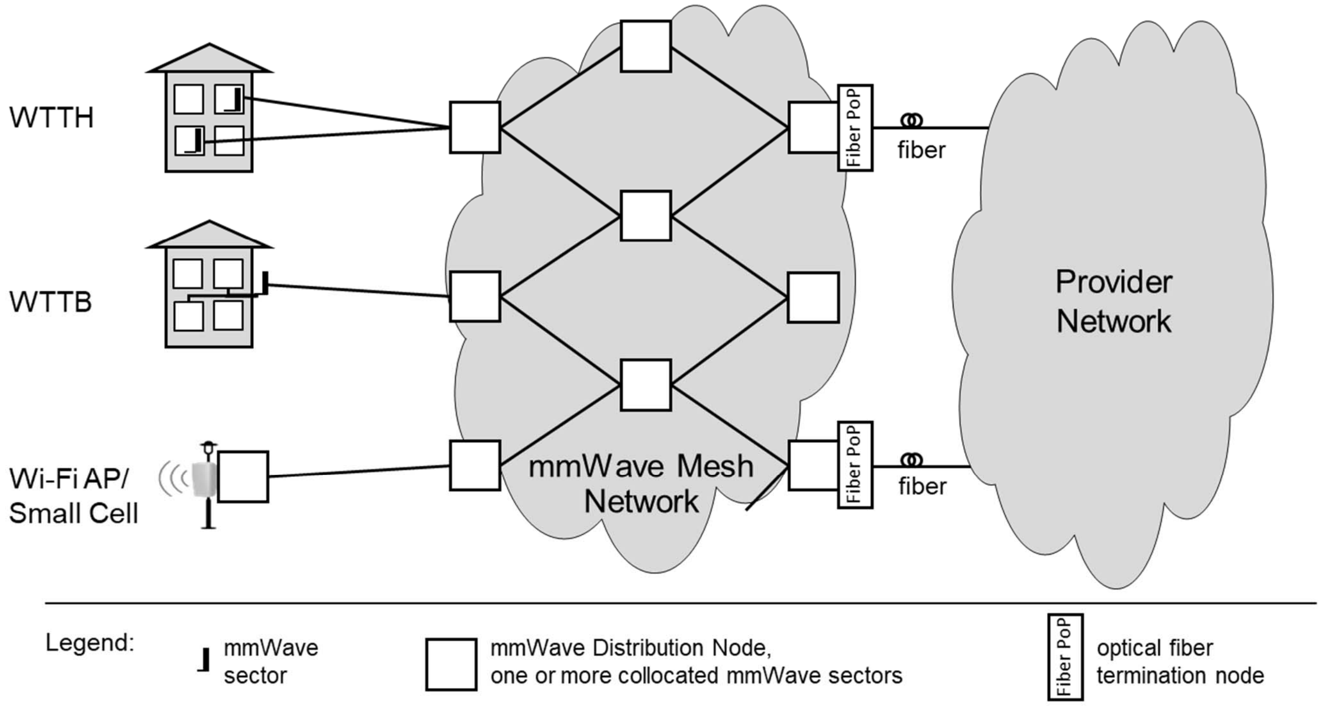


Figure 5: mmWave Mesh Network

In the WTTH application, the Mesh Network is used for backhauling of WTTH DNs, which are placed at street poles (e.g. lamppost). The WTTH DNs serve the individual homes/flats via a window AP at client side instead of deploying expensive fibre networks in the building branch and inhouse. The WTTH radio links can use the same frequency channel as the Mesh Network, or operate on a different channel.

In the WTTB application, the Mesh Network is used for backhauling of WTTB DNs, which are placed at street poles (e.g. lamppost)m on walls, or on rooftops. The WTTB links work on the same frequency channel as the backhaul links. If street poles are used, the WTTB DNs serve the buildings via an outdoor-wall AP. In case of Wall-to-Wall or Roof-to-Roof backhaul, it serves at the same time as the building access network without usage of additional street poles. The WTTB scenario requires an additional wireless or fixed inhouse network to serve the individual flats.

In the WLAN AP and small cell backhaul application, the Mesh Network is used for backhauling of Small Cells and Wi-Fi APs, which are typically placed at street poles. Traffic of mobile and nomadic services are aggregated and carried towards the mobile core. The sub-6 GHz NLOS operation of Small Cells and WLAN APs imposes less challenges compared to WTTH/B in reaching inhouse users, however it does not achieve the capacity level of WTTH/B solutions.

Backhauling, Front Hauling, Mesh Networks, and similar outdoor applications are among the key usage models for 60 GHz IEEE 802.11ad [i.6] and IEEE 802.11ay [i.11] standards (802.11ay is in early development phase).

5.1.4 Link Types

5.1.4.1 Overview

Link types are typed according to their role in the network. Fixed backhaul links connect network nodes to each other and to the core network. Fixed access links connect network nodes to customer premises equipment. Mobile access links connect network nodes to mobile or nomadic devices.

5.1.4.2 Fixed Backhaul

Fixed backhaul links fall into two subtypes:

- Point-to-point: a static link between two nodes.
- Point-to-multipoint/mesh: a dynamic link between multiple nodes.

When applied to point-to-point links, MGWS provide significant benefit in reduced installation time and maintenance cost. MGWS provide link management and channel access mechanisms that are essential for point-to-multipoint networks.

Fixed backhaul links exhibit distances between 100 m and 500 m and equivalent link densities of 10 to 200 links per square kilometre. Within these ranges, point-to-multipoint links typically exhibit shorter distance and greater density in order to achieve Line Of Sight between multiple nodes.

Fixed backhaul equipment is typically located at similar heights and limited vertical steering is required. MGWS designed for fixed backhaul employ high gain antennas with little or no vertical steering in order to achieve the required range. They typically have a wide vertical beam width to accommodate any difference in height.

5.1.4.3 Fixed Access

Fixed access links are point-to-multipoint. They typically provide access to between 4 and 32 endpoints. MGWS provide link management and channel access mechanisms for point-to-multipoint networks.

Fixed access links exhibit distances of 20 m to 150 m and equivalent link densities of 500 to 2 000 links per square kilometre.

Customer premises equipment will usually be mounted at a different height to the network node. A multiple-dwelling unit or commercial building of five floors with a floor separation of four metres can be serviced by a network node on the same side of the street (3 metre separation from building) with a vertical steering range of 150 degrees and across a 20 m wide street (23 metre separation from building) with a vertical steering range of 60 degrees. MGWS designed for Fixed Access employ antennas with wide vertical steering range and lower gain to achieve the required building coverage.

5.1.4.4 Mobile Access

Mobile Access links are point to multipoint or point to point. Point to multipoint access typically provide access to between 4 and 32 endpoints. MGWS provide link management and channel access mechanisms for point-to-multipoint networks.

Mobile access links exhibit distances typically up to 10 metres and equivalent link densities of 10 per 100 m^2 or more.

Links are either Line Of Sight or Non Line Of Sight through one or more reflections from a surface.

As there are potentially many paths between link nodes, a wide steering range of 100 degrees or more in vertical direction and 360 degrees in horizontal direction.

5.1.4.5 Personal Area Network (PAN)

PAN links are point to multipoint. They typically provide access to between 2 and 8 endpoints. MGWS provide link management and channel access mechanisms for point-to-multipoint networks.

PAN links exhibit distances of 1 to 10 metres and equivalent link densities of 1 to 10 per 100 m^2.

Links are either Line Of Sight or Non Line Of Sight through one or more reflections. As there are potentially many paths between link nodes, a wide steering range of 100 degrees or more in both horizontal and vertical directions is appropriate.

5.1.4.6 Close Proximity

Close proximity links are point to point, line of sight between two endpoints. Close proximity links exhibit distances of several millimetres to tens of centimetres.

A single antenna with a broad beam width is typically used. MGWS may provide link management.

5.2 Millimetre Wave Communication for Intelligent Transport Systems (mmW-ITS)

Intelligent Transport Systems (ITS) and Transport and Traffic Telematics (TTT) systems will depend for their implementation on a variety of communications and sensing systems. Most of these systems can be supported by appropriate use of the 60 GHz bands. The last decade has seen significant advances in manufacturing technology, component technology and compact integration. Standard solutions based on IEEE standards are available on the market. The use of frequencies in this range permits the development of wide-band, high data rate systems. In turn, this relieves system designers of a major constraint and enables flexibility in the realization of systems that can meet the expectations of all stakeholders. Both high data rates and multiple applications become possible. The short wavelengths also confer flexibility in design the design of antennas, enabling the use of many forms, from simple horns to complex dielectric structures. A range of beam sizes and shapes become possible ensuring that the desired properties are achievable in discrete or conformal physical arrangements. Systems limited to a single lane are possible and specific high precision based service can be implemented. The frequency band is close to a peak in the oxygen absorption, permitting these short range devices to re-use spectrum in quite short distances, again increasing the implementation choices while avoiding the constraints present at lower frequencies, for example at some complex motorway junctions.

Communications links expected to be implemented in this band include both vehicle-to-roadside and vehicle-to-vehicle (forward and reverse).

Specific applications in the band are intended to significantly improve the capabilities of fully autonomous vehicles. One of these applications is the exchange of sensor data for cooperative decision making or the Collective Perception Service where the position, dynamics and attributes of detected neighbouring road users and other objects are shared. Depending on the level of compression very high data rate and low latency is required. For these kinds of applications the 60 GHz ITS system can complement the 5,9 GHz band operation and can provide the required capacity.

6 Market Information

6.1 MGWS

60 GHz technology (e.g. IEEE 802.11ad [i.6] (WiGig)) is currently deployed predominantly in consumer devices such as laptop computers, tablets, etc. which are primarily used indoors. Applications include wireless docking, high speed device-to-device connectivity, cable replacement (HDMI, DP, USB, etc.) and other consumer applications. These products conform to the ETSI standard ETSI EN 302 567 [i.9]. The regulatory requirements as stipulated in ERC Recommendation 70-03 [i.17] require that products operating under the ETSI Harmonised Standard to be primarily used indoors as fixed outdoor use is currently precluded to protect the Fixed Service used outdoor. It should be noted that, regulations permitting, same technology can be deployed outdoors as well both for consumer and commercial use.

Noting the radio propagation; reducing cost of producing commercial products; the recent availability in various international markets of high power, license exempt spectrum in this range, the economies of scale in supporting commercial and scientific applications in the 60 GHz band has changed dramatically.

Products available in this range combine simple radio modulation techniques with high gain antennas to deliver low cost products for a variety of applications. These basic radio designs deliver gigabit-level data rates, taking advantage of the attenuation characteristics of the band and highly directional antennas to support scalability and a high level of frequency reuse.

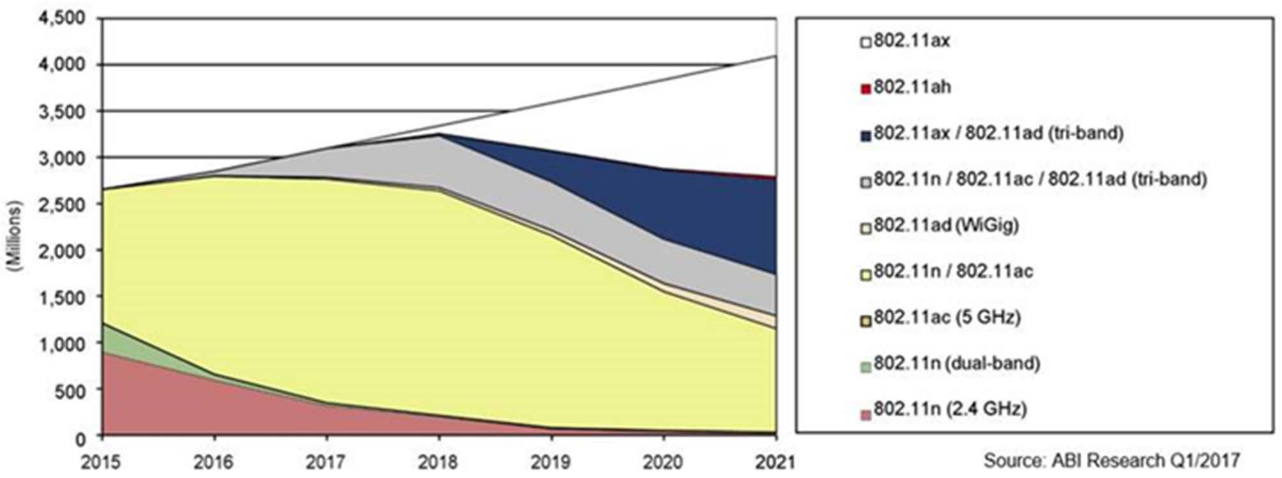


Figure 6

3GPP is currently studying the development of 5G NR systems operating in frequency bands beyond 52,6 GHz [i.4], and the 66 GHz to 71 GHz frequency range represents one of the target band for this study. In particular, 3GPP is working on physical layer channels including potential introduction of new waveform, procedures, and requirements specific to these frequencies [i.5].

7 Technical Information

7.1 Introduction

The following clauses provide technical information relating to current frequency allocations (clause 7.2), MGWS (clause 7.3) and ITS (clause 7.4).

7.2 Current ITU and European Common Allocations

7.2.1 Current ITU Allocations 57-71 GHz (Region 1)

More information available at https://www.efis.dk/.

Frequency band	Allocations
56.9 GHz - 57 GHz (5.547) (5.557)	EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED INTER-SATELLITE (5.558A) MOBILE (5.558) SPACE RESEARCH (PASSIVE)
57 GHz - 58.2 GHz (5.547) (5.557)	SPACE RESEARCH (PASSIVE) FIXED MOBILE (5.558) INTER-SATELLITE (5.556A) EARTH EXPLORATION-SATELLITE (PASSIVE)
58.2 GHz - 59 GHz (5.547) (5.556)	EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED MOBILE SPACE RESEARCH (PASSIVE)
59 GHz - 59.3 GHz	MOBILE (5.558) RADIOLOCATION (5.559) SPACE RESEARCH (PASSIVE) EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED INTER-SATELLITE (5.556A)
59.3 GHz - 64 GHz (5.138)	FIXED INTER-SATELLITE RADIOLOCATION (5.559) MOBILE (5.558)
64 GHz - 65 GHz (5.547) (5.556)	MOBILE EXCEPT AERONAUTICAL MOBILE FIXED INTER-SATELLITE
65 GHz - 66 GHz (5.547)	INTER-SATELLITE EARTH EXPLORATION-SATELLITE FIXED MOBILE EXCEPT AERONAUTICAL MOBILE SPACE RESEARCH
66 GHz - 71 GHz (5.554)	RADIONAVIGATION MOBILE-SATELLITE MOBILE (5.553) (5.558) INTER-SATELLITE RADIONAVIGATION-SATELLITE
71 GHz - 74 GHz	FIXED-SATELLITE (SPACE-TO-EARTH) FIXED MOBILE MOBILE-SATELLITE (SPACE-TO-EARTH)

7.2.2 European Common Allocations 57-71 GHz

More information available at https://www.efis.dk/.

Frequency band	Allocations	Applications
56.9 GHz - 57 GHz (5.547)	EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED INTER-SATELLITE (5.558A) MOBILE (5.558) SPACE RESEARCH (PASSIVE)	Passive sensors (satellite) Fixed
57 GHz - 58.2 GHz (5.547)	SPACE RESEARCH (PASSIVE) MOBILE (5.558) INTER-SATELLITE (5.556A) EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED	Wideband data transmission systems Fixed Passive sensors (satellite) Non-specific SRDs Radiodetermination applications
58.2 GHz - 59 GHz (5.547) (5.556) (ECA19) (ECA6)	EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED RADIO ASTRONOMY SPACE RESEARCH (PASSIVE)	Radiodetermination applications Non-specific SRDs Passive sensors (satellite) Radio astronomy Wideband data transmission systems Fixed
59 GHz - 59.3 GHz	SPACE RESEARCH (PASSIVE) RADIOLOCATION (5.559) INTER-SATELLITE (5.556A) MOBILE (5.558) EARTH EXPLORATION-SATELLITE (PASSIVE) FIXED	Wideband data transmission systems Fixed Passive sensors (satellite) Non-specific SRDs Radiodetermination applications
59.3 GHz - 64 GHz (5.138)	INTER-SATELLITE FIXED MOBILE (5.558) RADIOLOCATION (5.559)	Wideband data transmission systems Radiodetermination applications Non-specific SRDs ISM Fixed ITS
64 GHz - 65 GHz (5.547) (5.556)	MOBILE EXCEPT AERONAUTICAL MOBILE INTER-SATELLITE FIXED	Fixed Radio astronomy Wideband data transmission systems
65 GHz - 66 GHz (5.547)	INTER-SATELLITE EARTH EXPLORATION-SATELLITE FIXED MOBILE EXCEPT AERONAUTICAL MOBILE SPACE RESEARCH	Wideband data transmission systems Land mobile Fixed
66 GHz - 71 GHz (5.554)	RADIONAVIGATION MOBILE-SATELLITE MOBILE (5.553) (5.558) INTER-SATELLITE RADIONAVIGATION-SATELLITE	-
71 GHz - 74 GHz	FIXED-SATELLITE (SPACE-TO-EARTH) FIXED MOBILE MOBILE-SATELLITE (SPACE-TO-EARTH)	Fixed

7.3 MGWS

7.3.1 Detailed Technical Description

7.3.1.1 Transmitter parameters

7.3.1.1.1 Transmitter RF Output Power/Power Spectral Density

The maximum spectral power density is applicable to the system as a whole when operated at the highest power spectral density level (EIRP). The maximum spectral power density is indicated in Table 1.

Table 1: Power Spectral Density (PSD) limit

Usage	Maximum spectral power density (EIRP)
Indoor and Outdoor Mobile	13 dBm/MHz
Outdoor Fixed	Max EIRP from Table x2 minus 27 dB-MHz

The RF output power is the mean Equivalent Isotropically Radiated Power (EIRP) for the equipment during a transmission burst.

The maximum RF output power is applicable to the system as a whole when operated at the highest stated power level. For a smart antenna system, the limit applies to the configuration that results in the highest EIRP. In case of multiple (adjacent or non-adjacent) channels the total RF output power of all channels are less than or equal to the limits in Table 2.

The maximum recommended RF output power is indicated in Table 2.

Table 2: RF output power limit Usage

Usage	Maximum power level (EIRP)
Indoor & Outdoor Mobile	40 dBm
Outdoor Fixed	55 dBm for Gant ≥ 37,5 dBi 55 dBm - 2 × (37,5 dBi - Gant) for 37,5 dBi > Gant ≥ 30 dBi 40 dBm for 30 dBi > Gant ≥ 13 dBi

7.3.1.1.2 Antenna Characteristics

For outdoor fixed installations, a minimum 13 dBi antenna gain with the EIRP and EIRP spectral density reductions for antenna gains less than 45 dBi as given in Table 1 and Table 2, are appropriate to protect other links.

7.3.1.1.3 Operating Frequency

Using the ITU recommended frequency plan in Recommendation ITU-R M.2003-2 [i.3], 6 channels will be situated between 57 GHz and 71 GHz based on the standards listed in this recommendation.

The inclusion of other standards or parts thereof in a revision to Recommendation ITU-R M.2003-2 [i.3] is not precluded, but where these standards employ different channel plans a revision to Recommendation ITU-R M.2003-2 [i.3] may be needed.

7.3.1.1.4 Channel Plan/Bandwidth

A 2 160 MHz channel bandwidth is required for single channels and channel bonding is appropriate for some applications. The 2 160 MHz single channel bandwidth allows simpler modulation schemes to achieve multi-Gbit/s data rates, which is suitable for adoption by low power devices such as smartphones, tablets, netbook and notebook PCs. If single channels are bonded to achieve greater capacity, the bandwidth is defined as an integer multiple of 2 160 MHz to enable coexistence with 2 160 MHz systems.

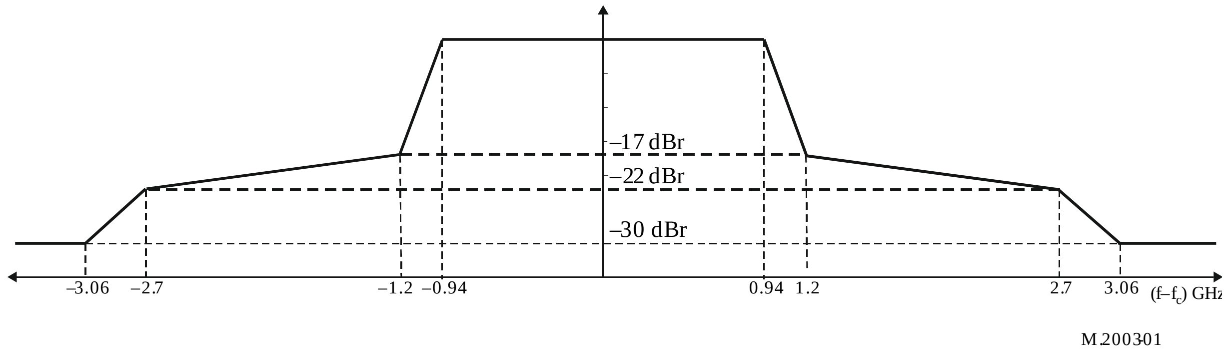
According to Recommendation ITU-R M.2003-2 [i.3] it is important that MGWS standards employ the same channelization in order to promote better coexistence. Centre frequencies for single channels are recommended to be at 58,32 GHz, 60,48 GHz, 62,64 GHz, 64,80 GHz, 66,96 GHz and 69,12 GHz. For bonded channels, centre frequencies depend on how many single channels are bonded but need to be uniformly spaced with respect to the single channel centre frequencies. Recommendation ITU-R M.2003-2 [i.3] is based on the IEEE standards IEEE 802.11-2016 [i.6], IEEE 802.15.3-2016 [i.7] and IEEE 802.15.3e-2017 [i.8] that define a channel bandwidth of 2 160 MHz.

Recommendation ITU-R M.2003-2 [i.3] notes that "MGWS are expected to encompass applications for wireless digital video, audio, and control applications, as well as multiple gigabit Wireless Local Area Networks (WLAN) and point-to-point close proximity mobile system". The 3GPP study item [i.4] is concerned with development of 5G NR systems operating in frequency bands beyond 52,6 GHz with the 66 GHz to 71 GHz frequency range representing one of the target bands. The channel bandwidths and channelization of these systems are yet to be confirmed and may be different from applications requiring the 2 160 MHz bandwidth. Coexistence between these different technologies/standards will need to be studied if they are different from the 2 160 MHz channel bandwidths since maintaining alignment with this channel bandwidth is regarded as important to promote better coexistence.

Examples of channel bandwidths used by 5G NR systems operating in licensed bands between 24 GHz and 43,5 GHz are multiples of 100 MHz Carrier aggregation (similar to channel bonding) allows bandwidths up to 1 200 MHz (contiguous) according to the current version of the 5G NR standard (as of December 2018). Similar channelization schemes are being considered for operations above 52,6 GHz, e.g. in the 66 GHz to 71 GHz range.

7.3.1.1.5 Transmit Mask

The following mask [i.3] is applicable to single channel operation.



NOTE: f_c is the carrier centre frequency.

Figure 7: Spectral mask for single channel operation

The following mask (Figure 8 and Table 3) is applicable when channel bonding of more than one contiguous channel is used.

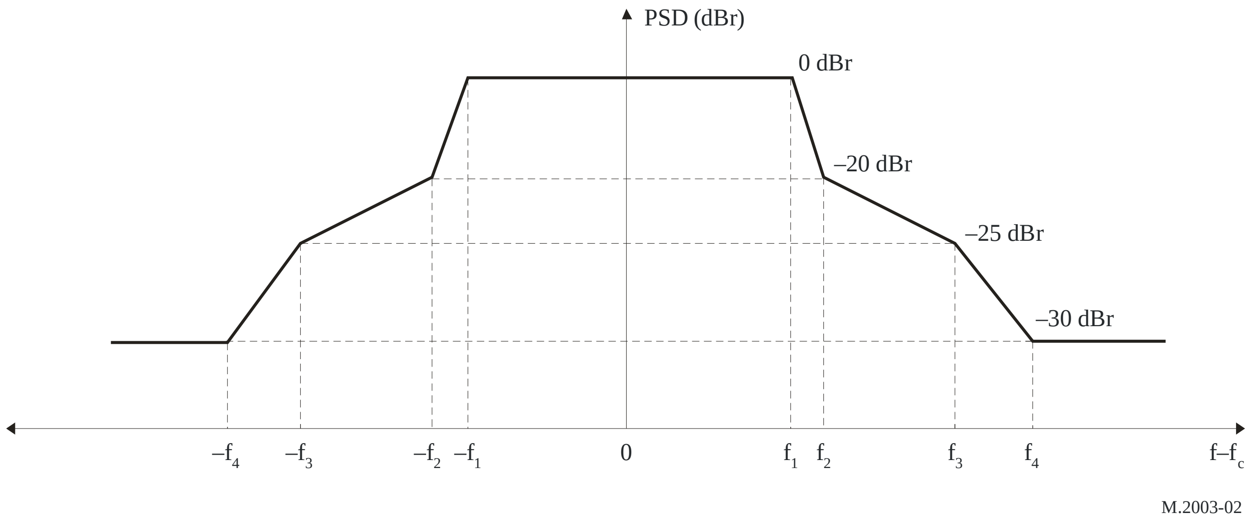


Figure 8: Spectral mask for more than one contiguous channel with channel bonding

Table 3: Transmit spectral mask parameters

Channel bonding	f_1 (GHz)	f_2 (GHz)	f_3 (GHz)	f_4 (GHz)
Two-bonded channel transmission	2,02	2,40	5,40	6,12
Three-bonded channel transmission	3,10	3,60	8,10	9,18
Four-bonded channel transmission	4,18	4,80	10,80	12,24

7.3.1.1.6 Modulation and Data Rates

To support the wide variety of usages envisioned for MGWS in both line-of-sight and non-line of sight channels, while providing a low cost and low power solution, the system should be scalable and support both Single Carrier (SC) and OFDM modulations.

SC modulations [i.2] include BPSK, QPSK and 16-QAM, 64-QAM offering data rates up to 8,6 Gbit/s for single channel and SISO operation. OFDM modulations include BPSK, QPSK, 16 QAM, offering data rates up to 8,3 Gbit/s for single channel and SISO operation.

7.3.1.2 Receiver Parameters

Receive sensitivity levels are typically between -48 dBm and -78 dBm [i.3].

7.3.1.3 Channel Access Schemes

The basic access scheme [i.2] is Time Division Multiple Access (TDMA), which is necessary to deal with the challenges of operation in 60 GHz, the directional nature of communication, and applications such as wireless display. TDMA can provide the necessary bandwidth guarantee to applications sensitive to quality of service given its reservation characteristics while being power efficient since devices do not need to stay awake when not communicating. Frequency reuse in this band is enabled by propagation characteristics, narrow beam widths and spatial diversity.

In addition, since TDMA is scheduled, stations know exactly to which other station they will communicate to and when, hence are able to steer the main lobe of their antenna towards the intended destination and obviate the need for omnidirectional communication needed for contention-based access.

Other access schemes could be adopted provided that the minimum coexistence requirements are met.

7.3.2 Information on relevant standards

7.3.2.1 ETSI

For the existing allocation (57 GHz to 66 GHz) ETSI has developed a harmonised standard ETSI EN 302 567 [i.9].

7.3.2.2 IEEE

The IEEE Std 802.11-2016 [i.6] provides a suite of features that can meet the demands of the new usages and applications envisioned for MGWS, including:

- Support to data transmission rates up to 7 Gbit/s.
- Supplements and extends the 802.11 medium access control (MAC), supporting both scheduled access and contention-based access.
- Enables both the low power and the high performance devices, guaranteeing interoperability and communication at gigabit rates.
- Supports beamforming, enabling robust communication at distances beyond 10 metres.
- Supports advanced security using the Galois/Counter Mode (GCM) of the AES encryption algorithm and advanced power management.
- Supports fast session transfer among 2,4 GHz, 5 GHz and 60 GHz, which is known as multi band operation.

7.3.2.3 3GPP

The 3GPP has begun standardization work for these bands.

7.4 mmW-ITS

7.4.1 Detailed Technical Description

Intelligent Transport Systems (ITS) and Transport and Traffic Telematics (TTT) systems will depend for their implementation on a variety of communications and sensing systems. Most of these systems can be supported by appropriate use of the band 63,72 GHz to 65,88 GHz (centre frequency: 64,680 GHz). These possible band offer several advantages to be described in later clauses.

The last decade has seen significant advances in manufacturing technology, component technology and compact integration. Such advances have reached the critical mass necessary to invest in the design and construction of these novel systems now entering the European market mainly based on ETSI EN 302 567 [i.9] and on the corresponding existing IEEE 802.11ad [i.6] and upcoming 11ay.

The use of frequencies in this range permits the development of wide-band, high data rate systems. In turn, this relieves system designers of a major constraint and enables flexibility in the realization of systems that can meet the expectations of all stakeholders including the upcoming redundancy requirements for highly autonomous driving applications in combination with the existing 5,9 GHz ITS allocation. Especially for low range application like cooperative manoeuvering and cooperative decision making the mmWave complementary deployment will significantly increase the reliability of the overall ITS communication system.

The high bandwidth allows for high precision positioning methods with resolutions down to the cm-range. This capability will facilitate a broad range of applications relying on high precision positioning including dense platooning, general charging (payment) application with in-out-detection.

The short wavelengths also confer flexibility in design the design of antennas, enabling the use of many forms, from simple horns to complex dielectric structures. A range of beam sizes and shapes become possible ensuring that the desired properties are achievable in discrete or conformal physical arrangements. Even lane-limited systems are possible.

Communications links expected to be implemented in this band include both vehicle-to-roadside and vehicle-to-vehicle (forward and reverse) up to a range of 250 m. The current, 63 GHz to 64 GHz ITS allocation overlaps two of the 2 160 MHz channels, specifically Channel 3 and Channel 4. Shifting the CEPT allocation such that it only overlaps with a single channel would significantly enhance sharing operation. The shift and the combined increasing of the allocated spectrum band by a factor of 2,16 MHz to 2 160 MHz would allow ITS applications to take advantage of existing MGWS technology. This would greatly reduce both cost and deployment time for ITS applications.

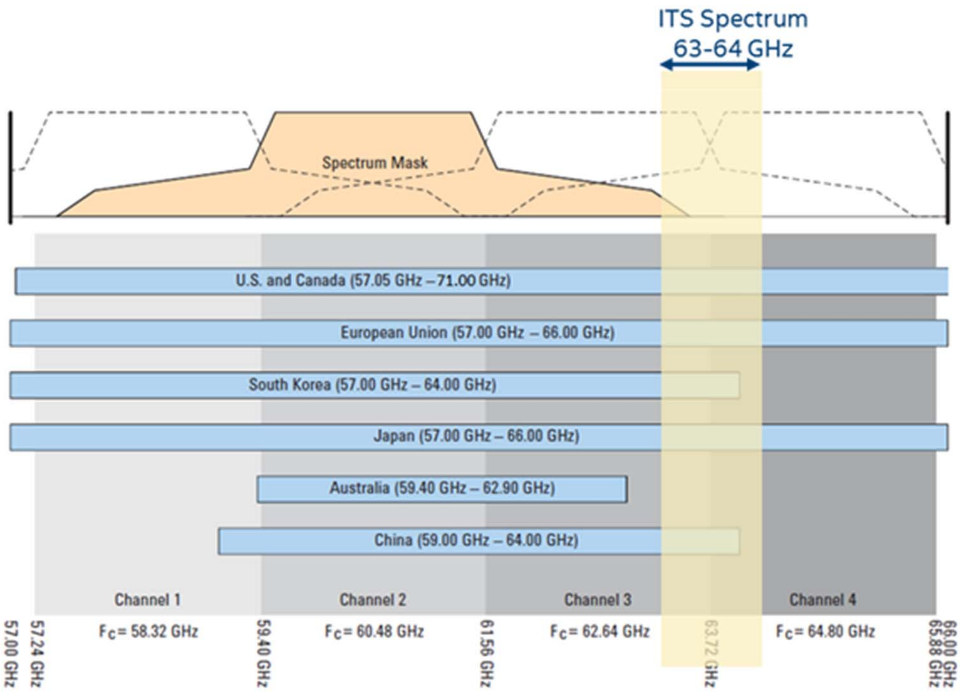


Figure 9: Existing ITS allocation in the 60GHz band in ECC DEC (09/01) and the actual channelization of Multi-Gigabit systems

7.4.2 Technical parameters and implications on spectrum

7.4.2.1 Status of technical parameters

7.4.2.1.1 Current ITU and European Common Allocations

For the complete allocation in the band 57 GHz to 71 GHz please see clause 7.2 of the present document.

7.4.2.1.2 Sharing and compatibility studies (if any) already available

In ECC Report 113 [i.14] the sharing conditions with different services and application around the band 63 GHz have been studied and published in 2009. The present document has led to the allocation of ITS in the band 63 GHz to 64 GHz as application in the Mobile Service in ECC Decision 09/01 [i.18].

7.4.2.1.3 Sharing and compatibility issues still to be considered

No specific sharing and compatibility issues are known at this stage.

7.4.3 Information on relevant standard(s)

For the existing allocation (63 GHz to 64 GHz) ETSI has developed a harmonised standard ETSI EN 302 686 [i.15].

8 Current regulations

8.1 MGWS

8.1.1 SRD

60 GHz technology (e.g. [i.10]) is currently deployed predominantly in consumer devices such as laptop computers, tablets, etc. which are primarily used indoors. Applications include wireless docking, high speed device-to-device connectivity, cable replacement (e.g. HDMI, USB) and other consumer applications.

These products conform to the ETSI standard ETSI EN 302 567 [i.9]. The regulatory requirements as stipulated in ERC Recommendation 70-03 [i.17] require that products operating under the ETSI Harmonised Standard to be primarily used indoors as fixed outdoor use is currently precluded to protect the Fixed Service used outdoor.

It should be noted that, regulations permitting, same technology can be deployed outdoors as well both for consumer and commercial use.

8.1.2 Non-SRD

Point-to-point links of the Fixed Service are regulated by ECC/REC/(05)02 [i.19] and ECC/REC/(09)01 [i.18] and the associated equipment is covered in ETSI EN 302 217. ETSI EN 302 217-3 [i.16] Annex UBa address the "frequency band 57 GHz to 66 GHz for point-to-point fixed" where conventional link-by-link coordination is not used. It covers Type B systems (i.e. equipment not required to have automatic RF-channel selection procedure) for both FDD and TDD operation. Two different categories of equipment are defined:

Category 1:

Equipment for flexible usage of spectrum (according ECC/REC/(05)02 [i.19] and ECC/REC/(09)01 [i.18]) where no channel or block arrangement is to be complied with. The declared transmitter bandwidth is referred to the nominal bandwidth as defined within the present document.

Category 2:

Equipment suitable also for fixed frequency arrangements (according annex 3 of ECC/REC/(05)02 [i.19] and ECC/REC/(09)01 [i.18]) where a single or a number of contiguous frequency slots of 50 MHz size are assigned to form a channel or a block. Category 2 conformance automatically implies conformance also to category 1 requirements.

The key UBa RF technical requirements are:

- Maximum channel bandwidth: 2 500 MHz
- Maximum EIRP: +55 dBm.
- Minimum antenna gain: +30 dBi.
- Maximum transmitter output power: +10 dBm.

To safeguard a fair and efficient use of the spectrum, UBa limits EIRP and maximum Pout as a function of antenna gain. For equipment without permanent ATPC (either lacking or can be disabled by the user), the EIRP is reduced by 1 dB for every dB the antenna gain is below 45 dBi over the range from 38 dBi to 45 dBi, and by 7 dB plus 2 dB per dB the antenna gain is below 38 dBi over the range from 30 dBi to 38 dBi. For equipment with permanent ATPC (enabled and cannot be disabled by the user), the EIRP is reduced by 1 dB for every dB the antenna gain is below 45 dBi.

8.2 mmW-ITS

Currently the band 63 GHz to 64 GHz is allocated to ITS applications as part of the mobile service allocation in ECC Decision ECC/DEC/(09)01 [i.18]. The maximum radiated power for ITS stations is limited to 40 dBm e.i.r.p and outdoor operation is permitted. The ITS application has to be protected by SRDs and also other mobile applications in the band.

9 Proposed changes to regulations

9.1 Introduction

The following regulatory changes are proposed:

- Removal of the fixed installation restriction and changes to EIRP and PSD for outdoor usage.
- Harmonization of the channel plan between its and other users.
- Extension of the existing allocation to 71 GHz.

9.2 Detailed regulation proposal

9.2.1 Outdoor Use for SRD under ERC Recommendation 70-03

Relating to the use of Short Range Devices (SRD) ERC Recommendation 70-03 [i.17] Annex 3, Table 3 stipulates the current regulation for Wideband Data Transmission Systems in particular Multiple-Gigabit WAS/RLAN in the band 57 GHz to 66 GHz. The regulations currently are:

- **Power/Magnetic Field:** 40 dBm mean e.i.r.p. This refers to the highest power level of the transmitter power control range during the transmission burst if transmitter power control is implemented.
- **Spectrum access and mitigation requirements:** *Adequate spectrum sharing mechanism* (e.g. Listen-before-Talk, Detect-And-Avoid) *shall be implemented by the equipment*.
- Fixed outdoor installations are not allowed.
- The maximum mean e.i.r.p. density is limited to 13 dBm/MHz.
- Point-to-point links of the Fixed Service are regulated by ECC/REC/(05)02 [i.19] and ECC/REC/(09)01 [i.18].

It is recognized that the current regulations in ERC Recommendation 70-03 [i.17] do not preclude the use of outdoor applications under the MOBILE allocation, better clarity in the regulations is necessary.

Although the indoor usage regulations may be sufficient for many consumer uses, ERC Recommendation 70-03 [i.17] does specifically preclude fixed outdoor installations limiting some consumer applications. While it is recognized that Point-to-point links of the Fixed Service are regulated by ECC/REC/(05)02 [i.19] and ECC/REC/(09)01 [i.18] there is likely significant societal benefits from a relaxation within the MOBILE allocation relating to the usage of SRDs.

Proposal: Implement revision to ERC Recommendation 70-03 [i.17], Annex 3: Wideband data transmission systems Table 3: "Regulatory parameters" and remove the "Fixed outdoor installations are not allowed" restriction.

9.2.2 Transmitter Output Power for SRD under ERC Recommendation 70-03

ERC Recommendation 70-03 [i.17] reflects the current regulation for Wide Band Data Transmission Systems in the 57 GHz to 66 GHz range which currently have an EIRP of 40 dBm with a channel bandwidth of 500 MHz to 2,5 GHz and a power spectral density limit of 13 dBm/MHz but as detailed in the previous Section the current regulation stipulates that "Fixed outdoor installations are not allowed".

It is useful to have an idea what power levels are allowed in other countries to better understand what additional relaxation in the transmit output power requirements could be considered under ERC Recommendation 70-03 [i.17] for SRDs. The following information relates to applicable regulations in other countries outside CEPT supporting power levels pertaining to indoor and indeed fixed outdoor use in all or part of frequency range 57 GHz to 66 GHz:

- US 82 dBm outdoor point-to-point (57 GHz to 71 GHz)
- Korea 57 dBm outdoor point-to-point
- Japan 57 dBm indoor/outdoor
- China 44 dBm indoor/outdoor
- Australia 52 dBm indoor/outdoor
- New Zealand 82 dBm outdoor point-to-point
- Brazil 40 dBm indoor/outdoor
- Canada 40 dBm indoor/outdoor
- South Africa 55 dBm outdoor point-to-point

It should be noted that above country specific regulations for outdoor use are fairly old with the exception of US and New Zealand where regulations were revised in 2013 and 2014, respectively, to increase the power for Point-to-Point use.

Proposal: Implement a revision to ERC Recommendation 70-03 [i.17], Annex 3: Wideband data transmission systems Table 3: "Regulatory parameters" to retain the current limit of 40 dBm EIRP for indoor and outdoor mobile applications while adding the following for outdoor fixed applications:

- 13 dBi minimum antenna gain
- **Maximum EIRP as Function of Antenna Gain (Gant)**
- 55 dBm for Gant ≥ 37,5 dBi
- 55 dBm - 2 × (37,5 dBi - Gant) for 37,5 dBi > Gant ≥ 30 dBi
- 40 dBm for 30 dBi > Gant ≥ 13 dBi

Also, retain the current limit of 13 dBm/MHz EIRP power spectral density for indoor and outdoor mobile applications while adding the following for outdoor fixed applications:

- Max EIRP minus 27 dB-MHz

9.2.3 mmW-ITS regulation

The proposed updated mmW-ITS regulation in ECC/DEC(09)01 [i.18] should consider moving the existing allocation in the band 63 GHz to 64 GHz as to not overlap with a MGWS channel. Using the same regulatory condition as pointed out in ECC/DEC(09)01. Alternative solution giving the same level of protection could also be envisaged.

Proposal:

mmW-ITS regulation ECC/DEC(09)01 [i.18] should be updated to move the current 63 GHz to 64 GHz allocation, taking into consideration the channel plan within Recommendation ITU-R M.2003-2 [i.3], clause 2.2 "channel bandwidth and centre frequencies. If the existing ITS allocation 63 GHz to 64 GHz is to be moved, the new channel should reside within a single channel (and not overlap with two channels as is the current situation) as this would significantly enhance sharing operation and allow ITS applications to take advantage of existing MGWS technology, greatly reducing both cost and deployment time for ITS applications.

9.2.4 Access to 66 GHz to 71 GHz

ERC Recommendation 70-03 [i.17] Annex 3, Table 3, row c, reflects the current regulation for Wide Band Data Transmission Systems in the 57-66 GHz range.

Proposal: Implement a revision to ERC Recommendation 70-03 [i.17] Annex 3: Wideband data transmission systems Table 3: "Regulatory parameters", row c, to change the frequency range from 57 GHz to 66 GHz to 57 GHz to 71 GHz.

10 Conclusions

The following regulatory changes are justified:

- Removal of the fixed installation restriction and changes to EIRP and PSD for outdoor usage.
- Harmonization of the channel plan between its and other users.
- Extension of the existing allocation to 71 GHz.

History

Document history		
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