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Technical Report

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

Reference

DTR/ERM-RM-031

Keywords

CALM, EHF, radio, RTTT, short range,
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Contents

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Foreword

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

Introduction

The report 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) for amending the ERC Recommendation 70-03 [1].

1 Scope

The present document defines the requirements for radio frequency usage for RTTT and ITS equipment operating in the 63 GHz to 64 GHz frequency range.

It includes 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), including:

- market information (annex A);
- technical information (annex B);
- expected compatibility issues (annex C).

2 References

For the purposes of this Technical Report (TR), the following references apply:

[1] CEPT/ERC Recommendation 70-03 (2004): "Relating to the use of Short Range Devices (SRD)", annex 5.

[2] CEPT/ECC/DEC/(02)01: "Frequency bands to be designated for the co-ordinated introduction of Road Transport and Traffic Telematic Systems".

[3] ITU-R Recommendation SM.1538-1: "Technical and operating parameters and spectrum requirements for short-range radiocommunication devices".

[4] IEEE 802.11a: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications High-speed Physical Layer in the 5 GHz Band." Adopted by the ISO/IEC and redesignated as ISO/IEC 8802-11:1999/Amd 1:2000(E).

[5] Draft IEEE 802.11p: "Wireless Access for Vehicular Environments".

[6] CEPT/ERC Report 03: "Harmonisation of frequency bands to be designated for road transport information systems".

[7] CEPT/ERC Report 25: "The European Table of Frequency Allocations and Utilisations Covering the Frequency Range 9 KHz to 275 GHz", Lisbon January 2002 - Dublin 2003 - Turkey 2004".

[8] ITU Radio Regulations (2004).

3 Definitions, units and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

EIRP: product of transmitter power and maximum antenna gain, equivalent to an isotropic source radiating uniformly in all directions

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

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

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 Units

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

GHz	Gigahertz
s	second
m	metre
dB	decibel
dBm	dB relative to 1 milliwatt
dBW	dB relative to 1 Watt

3.3 Abbreviations

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

AFC	Automatic Fee Collection
BPSK	Binary Phase-Shift Keyed
CALM	Communications Air interface Long and Medium
CEPT	European Conference of Post and Telecommunications Administrations
CVO	Commercial Vehicle Operator
ECC	Electronic Communications Committee
EIRP	equivalent isotropically radiated power
GaAs	Gallium Arsenide
IEEE	Institution of Electrical and Electronic Engineers
IF	Intermediate Frequency
ISM	Industrial, Scientific and Medical
ISO	International Standards Organization
ITS	Intelligent Transport Systems
IVC	Inter-Vehicle Communications
MAC	Medium Access Control
MMIC	Monolithic Microwave Integrated Circuit
ppm	part per million
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keyed
RTTT	Road Transport and Traffic Telematics
RVC	Roadside-to-Vehicle Communications
SRD	Short Range Device
TBD	To Be Determined
TDMA	Time Division Multiple Access
WAVE	Wireless Access in the Vehicular Environment

4 Executive summary

The present document is based on previous CEPT/ECC decisions and recommendations relating to millimetric communications for transport telematics applications, and on "work in progress" which is building on this to provide a data link demonstrator for IVC and RVC that has the potential to be developed into a system for next generation road vehicle communications.

Some aspects of the design being produced are more mature than others, so the present document's objectives are necessarily limited, but it is intended to:

a) demonstrate that the need for high data rate communications in the millimetric band is a real and growing one;

b) provide justification for the continued designation in Europe of 63 GHz to 64 GHz;

c) indicate the technical topics on which work is being done and some of the options being considered for standardization.

Market information, technical information including the required spectrum, and a discussion of expected compatibility issues are presented in the annexes of the present document.

4.1 Status of the system reference document

ERM-TG37 discussed and approved draft version 1.1.1_0.0.6 at its 4th meeting, 22-23 November, 2004. Draft version 1.1.1_0.0.7 includes a reference to a relevant CEPT/ERC report [6].

ERM RM approved version 1.1.1_2.0.8 at ERM RM #29 in January 2005. Version 1.1.1_2.0.9 incorporates editorial enhancements. ERM#25 is expected to consider the present document for approval for publication.

4.2 Market information

This information is provided in annex A.

4.3 Technical system description

This information is provided in annex B.

5 Current regulations

The need for RTTT data links and a suitable frequency assignment has been recognized for several years. As a result of some EC-funded work in the early 1990's which investigated frequency and design options, CEPT recommended the band 63 GHz to 64 GHz for future inter-vehicle and (in a later amendment) roadside-to-vehicle communications.

The current regulation permitting RTTT devices in the frequency band from 63 GHz to 64 GHz is found in CEPT/ERC Recommendation 70-03 [1], annex 5 and is shown in table 1.

Table 1: Current regulation in annex 5 of CEPT/ERC Recommendation 70-03 [1] for the 63 GHz to 64 GHz band

Frequency Band	Power	Duty cycle	Channel spacing	ERC Decision	Notes
63 GHz to 64 GHz	--	--	No spacing	ECC DEC(02)01 [2]	Vehicle-to-vehicle and roadside-to-vehicle systems Power level to be determined

ERC Report 03 [6] envisaged an EIRP of 3 dBW to 16 dBW for communication ranges of up to 300 m, with antenna gains in the range 10 dBi to 30 dBi.

In addition, ITU-R Recommendation SM.1538-1 [3] provides information on the technical and operating parameters and spectrum requirements for short range radiocommunication devices.

In some countries, the band 63 GHz to 64 GHz is included in a wider range (e.g. 59 GHz to 64 GHz) for which no specific uses have been specified, and which is subject to a local power restriction. ITU-R Recommendation SM.1538-1 [3] contains further details.

6 Proposed regulations

It is proposed that CEPT adopt power levels for the 63 GHz to 64 GHz band as shown in table 2 and include these in annex 5 of CEPT/ERC Recommendation 70-03 [1].

Table 2: Proposed regulation for the 63 GHz to 64 GHz band

Frequency Band	Power	Duty cycle	Channel spacing	ERC Decision	Notes
63 to 64 GHz	55 dBm maximum peak EIRP	--	No spacing	ECC DEC(02)01 [2]	Vehicle-to-vehicle and road-to-vehicle systems 50 dBm average EIRP (measured in 1 MHz)

In addition, it is proposed that the title of annex 5 of CEPT/ERC Recommendation 70-03 [1] (currently "Road Transport and Traffic Telematics (RTTT)") and its scope be changed to include the term "Intelligent Transport Systems (ITS)".

7 Main conclusions

A fast and versatile ITS communication system is needed to support the large number of RTTT and other applications that have been identified. Systems are now being developed in support of this, making use of several bearer frequencies, including millimetre wave.

The ISO standards group TC204 WG16.1 is currently preparing a specification for an architecture which will link applications to an appropriate bearer or bearers, depending on what each has to offer at a given time in a given situation. It is recognized that all bearers cannot support all applications, and that there will be circumstances which favour one over another.

Millimetric systems in the 63 GHz to 64 GHz part of the spectrum can offer communications with a high data rate, typical ranges up to 1 km, a low reuse distance and minimal interference from and to other users, together with versatile frequency planning because of the available bandwidth. In addition, they can offer a method of obtaining redundancy when used with other systems for more safety-critical applications.

Prototypes are expected to be available by December 2005, though specialized short range demonstrators may be seen before then.

8 Expected ECC actions

ETSI requests ECC to consider the present document, which 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) for amending the CEPT/ERC Recommendation 70-03 [1].

ETSI requests that the ECC consider adopting the power levels in table 2 for inclusion in CEPT/ERC Recommendation 70-03 [1], annex 5 and also consider changing the title and scope of that annex to include the term "Intelligent Transport Systems (ITS)".

Annex A: Market information

A.1 Applications

A.1.1 Summary of application types

The connectivity required by the applications can be summarized as:

- Inter-vehicle:
  - linear (e.g. for convoys of vehicles);
  - vehicle cluster covering several lanes, co-directional (e.g. for lane management, overtaking assist);
  - vehicle cluster including opposite direction of travel.
- Vehicle to roadside (uplink) and roadside to vehicle (downlink):
  - one vehicle to beacon;
  - beacon to one vehicle;
  - beacon to many vehicles (broadcast, short range and long range);
  - beacon to selected vehicles.
- Cluster of vehicles communications including roadside beacon.

A.1.2 Examples of applications

Lists of applications for IVC and RVC have been investigated by various projects and groups, and the number of applications is very high, typically 100. Some examples of applications are:

Parking Payment

Access control (car and truck)

Fuel payment

Fast food payment

Electronic licence plate

Traffic information

Work zone safety warning

Intersection collision avoidance

Transit vehicle signal priority

Rollover warning

International border clearance

On-board safety data

Rail engine to grade crossing

Vehicle safety inspection

Railroad database transfer

Probe data collection

Toll collection

Pharmacy Drive-through payment

Repair-service record

Rental car processing

In-vehicle signing

Highway/rail intersection warning

Emergency vehicle signal pre-emption

Transit vehicle data transfer

Weigh-station clearance

Vehicle and cargo tracking

Unique CVO fleet management

Daily log

Truck tractor-trailer data transfer

Rail engine fuelling control

Table A.1

	Application	Description
1	Automatic Fee Collection (AFC) Access	Charges for use of roads at point of use / allows access to controlled area.
2	Traffic Information	Sends data to car advising of traffic congestion, poor visibility ahead.
3	Route Guidance	Advises driver on traffic flow problems ahead and alternative routes.
4	Traffic monitoring	Gathers information for traffic management.
5	Parking Management	Enables driver to check ahead on availability of parking and to pre-book.
6	Freight and Fleet Management	Efficient management of freight and fleet. For example, locates vehicles and transmits nature of cargo to save time at border controls.
7	In car internet / PC mobile office	Provides an internet style access of telematic data
8	Co-operative Driving	Alerts driver to other vehicles braking, changing lane etc.
9	Platoons / Road trains	Organizes a number of vehicles into convoys.
10	Emergency warning	Alerts driver to sudden manoeuvres or failures of nearby vehicles.
11	Intelligent Intersection Control	Alerts driver to other vehicles at intersections.

A.2 Market size and value

The European market for ITS and RTTT services is growing. At present, the number of applications implemented is small compared with the number considered to be valuable by analysts drawn from the automotive industry, road operators, road users, governmental and environmental bodies. Key requirements for growth are effective, multi-application communication systems and a set of service providers responsive to the users' needs and to the economic/commercial opportunities.

The 63 GHz to 64 GHz communication system outlined in the present document has the capability of meeting a wide range of the data link requirements, through its scope for a high data rate, time-division and/or channelized architecture. It is capable of interfacing with existing or developing MAC protocols devised for mobile and dynamic networks.

The anticipated roll-out is first through building on existing roadside infrastructures with the installation of a growing number of fixed units. These, in turn, provide services which will increase in number and complexity to vehicles equipped with an in-vehicle unit. As more vehicles are equipped, so the number and value of inter-vehicle services will grow.

It is expected that roadside units will eventually be present at regular intervals along all inter-urban trunk routes, at strategic locations (e.g. filling stations, car parks) for high capacity services, and at locations of opportunity (e.g. sides of buildings, lamp posts, traffic signs) in urban areas.

In-vehicle units will eventually be fitted to all new vehicles (domestic and commercial), and retro-fitted on an operator/owner-demand basis to a proportion of existing vehicles.

It is likely that a full take-up will take place in the next fifteen years, but the roadside data hotspots and associated in-vehicle units can be implemented much more quickly.

It is important that the use of the communication system is available both for official (i.e. safety, public information and road management) and for commercial purposes, so that viable business cases can be established.

The standards for operation must be developed such that an evolutionary roll-out is possible, so as not to disadvantage early adopters.

Although the road environment is the one which is mainly addressed in the present document, the techniques and benefits are equally relevant for multi-modal transport, for example light rail, inland water-borne and for aircraft ground movement applications.

A.3 Traffic evaluation

The functionality required of a millimetric, high data rate communication system for next-generation transport telematics is that it should support IVC and RVC in a dynamic traffic environment, in a range of weather conditions, and with communication ranges extending to several hundred metres. It must be capable of providing broadcast, point-to-point and vehicle cluster connectivity.

The communications traffic will be distributed over a wide area of a country, with a user density dependent on the scenario.

In an inter-urban situation, there could be 100 emitters per km in each direction for a multi-lane road, and up to 10 emitters per km on a single track rural road. In the urban environment, there may be 1 000 emitters per sq km.

Annex B: Technical information

B.1 Detailed technical description

B.1.1 Technical background

Technology to implement millimetric communications has been available for many years, but until recently it has been inherently expensive. The recent increase in maturity of GaAs MMIC techniques, along with low-cost antenna options, has meant that commercial interest in practical systems for transport telematics applications is rising, and experimental prototype systems are being developed, including MMIC chipsets for use in the 63 GHz to 64 GHz band.

It is now possible to manufacture in a GaAs MMIC form all of the key components needed for a front-end operating in the 63 GHz to 64 GHz band. These include up and down converters, switches, mixers, low noise amplifiers and power amplifiers, together with interconnection means. Work on the packaging of these components is developing fast. The significance of the use of MMIC techniques is that volume production can be achieved at a much lower unit cost than with earlier fabrication methods in this frequency band. For RTTT and ITS applications it is beneficial to have antennas with specified beam shapes along with methods for integration of such antennas with a suitable package. It is now possible to produce antennas in the millimetric band which have the desired properties, and whose beam pattern and coverage can be controlled. Work is proceeding on ways of integrating the communication sub-system in an automotive body shape.

Oxygen attenuation results in a range limitation allowing a frequency reuse distance of around 1 km (or less, depending on choice of operating parameters). At 63,5 GHz, the attenuation due to atmospheric oxygen is 11 dB/km.

The small wavelength (5 mm) means that relatively high gain antennas can be realized in a small physical space.

Directional data links can be established if required for some applications.

The spectrum usage is such that large amounts of bandwidth can be available to support high data rate applications and/or multiple applications simultaneously.

There are currently several options being investigated in how the frequency range can be used. Some applications require a very high data rate (e.g. a short range information hotspot), some are longer range with a medium data rate, and some have a low data requirement, but need to coexist with others.

This indicates a TDMA frame structure available on several channels of different widths, with a calling channel to manage frequency selection or negotiation. The number of channels may influence the cost of equipment, so that care must be taken in planning in this regard.

The MAC protocol needs to be chosen with care. An obvious contender is one of the IEEE 802.11 group (but with the microwave frequency being used as an IF in the millimetric system), although some studies point to the benefits of a bespoke MAC. There are advantages in IEEE 802.11a [4], as it is linked to the modulation and data structure scheme in a way that allows the basic connectivity to be realized, which provides automatic data rate and modulation scheme selection in cases of low received signal strength, and which has an inbuilt frequency offset compensation mechanism that will enable doppler compensation to be provided. Currently, IEEE 802.11p [5] is being defined (known as WAVE - Wireless Access in the Vehicular Environment) with IVC and RVC connectivity. This is a variant of IEEE 802.11a [4] which has, among other features, an architecture specified to allow faster real-time operation in a dynamic environment.

It will be beneficial for development, interoperability and cost reduction purposes if the MAC used for 63 GHz to 64 GHz systems can be the same as for at least one other ITS communications bearer.

It is relevant that ISO TC204 WG16 is working towards an architecture (referred to as CALM) that allows a range of applications to be matched to a set of communication bearers, with a management layer determining the linkage according to the requirements of the applications and the functionality of the bearer. A millimetric communication system is envisaged as being one of these bearers, and so an appropriate interface must be provided to allow interoperability with the CALM architecture.

International compatibility is important, and ETSI and ISO are already working in cooperation to advance this requirement.

B.1.2 Draft system parameters

Table B.1 summarizes some draft system parameters and is not exhaustive.

Table B.1: Several draft system parameters

Parameter	Value	Comments
Frequency stability	1 ppm	This figure takes account of the frequency tolerance allowed by IEEE 802.11a, together with the expected doppler variation from a vehicle closing speed of 400 km/h.
Maximum peak radiated power	55 dBm EIRP	Consideration must be given in any design to the human exposure limits and specific absorption rate, and so a limit to the erp has to be prescribed, in addition.
Antenna beam shape/gain	N/A	No beam shape is specified. The user will specify a beam shape in accordance with the coverage required by the set of applications to be supported, or the manufacturer will offer a number of antenna options. (Similar SAR considerations apply.)
Polarization	TBD	Circular and linear each have benefits. Some degree of rejection of emissions from oppositely travelling vehicles may be required.
Modulation scheme	BPSK QPSK 16QAM 64QAM	This is the standard set within IEEE 802.11a chip sets.
Data rates (per channel)	6/9/12/18/24/ 36/48/54 Mbit/s	This is the standard set within IEEE 802.11a chip sets. (A different set applies in the case of IEEE 802.11p, when half of these data rates apply.)
Channel options (IF)	TBD	These could include 4 of the channels defined by 802.11a or p (separated by an appropriate spacing).
Channel options (RF)	63,1 GHz 63,3 GHz 63,7 GHz 63,9 GHz	Examples only. These combine with the IF selectable channels to give a total of 16 available.
Communication mode	Half-duplex	Half-duplex is believed to be adequate for the applications considered to date. If full-duplex is required it will involve additional complexity and cost in both MAC and hardware.

B.2 Technical justification

B.2.1 Background

New spectrum is not required. CEPT has already identified the frequency range from 63 GHz to 64 GHz for IVC and RVC, with the intention of determining the required power level at a later stage [1].

The power level proposed in clause B.1.2 enables communication ranges up to 1 km to be supported, with a variety of data rates and in a range of weather conditions.

It is important to note that the use of frequencies in the 63 GHz to 64 GHz range requires higher transmitted power levels than do lower frequency systems to get a similar performance, not only because of the beam-spreading effects, but also because of the oxygen absorption in this band. It must be recognized that the latter effect is one of the reasons why this band is beneficial for high density IVC and RVC since transmissions are effectively limited beyond the designed range, thereby reducing interference and providing a short reuse distance so that complex frequency planning is unnecessary. It is of interest that the 77 GHz automotive long-range radar systems have a coverage that is similar to that of the communication systems considered in the present document, and that in both cases the effect of the installation environment of the antennas must be allowed for. ERC report 03 [6] envisaged that 3 dBW to 16 dBW (33 dBm to 46 dBm) would be required for a 300 m propagation range for 63 GHz to 64 GHz systems, and that 16 dBW to 20 dBW would be needed for a 200 m propagation range of automotive radar in the 76 GHz to 77 GHz band. (The limit for 76 GHz to 77 GHz equipment has been increased to 25 dBW (55 dBm) in annex 5 of CEPT/ERC Recommendation 70-03 [1].)

B.2.2 Link budget

In the following summary, the objective is to consider typical situations and requirements on the data link, to assess what maximum level of transmit power is required.

Communication in the boresight direction of a directional antenna is considered, a direction assumed to be parallel with the direction of travel. Because of the road geometry (i.e. long and thin), communication in directions that are not parallel with the road will be over much shorter distances, and so the link budget can be maintained in directions in which the antenna gain is reduced.

Analysis of the communication requirements of a range of applications results in the need for approximately 10 Mbit/s data rate at a range of up to 1 000 m. Some applications (the information hot-spots) need a greater rate than this, but over a very short range (e.g. 5 m).

For evaluation purposes, it is currently proposed that the MAC is the same as for IEEE 802.11a [4], while the PHY from a commercially available IEEE 802.11a card will provide the IF interface for the 63 GHz to 64 GHz millimetric system. Thus, the link budget assumes the data rates, modulation schemes and receiver characteristics for an IEEE 802.11a system. This results in the parameters given in table B.2.

Table B.2: Characteristics of a typical IEEE 802.11a card

Data Rate (Mbits/s)	Minimum receiver sensitivity (dBm)
6	-82
9	-81
12	-79
18	-77
24	-74
36	-70
48	-66
54	-65

The figures in the right-hand column give the minimum received power at the input to the card allowing for an implementation margin of 5 dB, a receiver noise figure of 10 dB and a BER of 10^{-5}. An allowance has been made in these figures for the change in modulation scheme associated with the change in data rate.

The atmospheric losses at 63,5 GHz can be listed as follows:

- Oxygen absorption 0,011 dB/m;
- Rain at 50 mm/hr 0,017 dB/m;
- Road spray 0,13 dB/m.

It is observed that heavy rain occurs in "cells" of limited extent, so that the loss figure given above is unlikely to scale above 100 m, but in the calculations a worst case has been assumed in which it does scale beyond this.

An assumption has been made of a maximum available RF power of 1 W, and of maximum antenna gains (both transmit and receive) of 20 dB. The former figure is above what is currently achievable with low-cost MMIC technology, but the trend is in that direction, while the latter is a reasonable upper limit from pointing and beamwidth considerations.

A margin of 10 dB is proposed to cover the additional noise figure of the RF and IF combination, and for implementation losses.

Table B.3 shows, for a single channel, the relationship between range and data rate when the RF parameters are as above.

Table B.3: Predicted range and data rate for conditions shown

Data Rate (Mbit/s)	Range (m) clear air	Range (m) rain at 50 mm/hr	Range (m) road spray
6	1130	626	187
9	1025	579	176
12	975	556	171
18	875	510	162
24	735	445	147
36	572	365	128
48	433	291	110
54	400	274	106

It is apparent that an assumption of an EIRP of 50 dBm, taken together with the component parameters noted, will lead to a combination of range and data rate that is consistent with the majority of the requirements in most weather conditions.

From a system perspective, it would be possible to increase the range by using multi-hop techniques through intervening vehicles. Ad hoc protocols are available to realize this function, if required.

B.3 Information on current version of relevant ETSI standard

A Harmonized Standard has not been adopted for these devices yet. However, a new ETSI work item for the creation of such a standard in ETSI ERM-TG37 has recently been adopted.

Annex C: Expected compatibility issues

C.1 Coexistence issues

From the European Common Allocation Table [7], the primary co-existence issue to consider is that of interference to the Mobile Service and to the Radiolocation Service.

Table C.1: Excerpt from the European Common Allocation Table [7]

Frequency band	European Common Allocation	Utilization	ECC ERC Document	Note
63 GHz to 64 GHz	INTER-SATELLITE MOBILE 5.558 (see note 1) RADIOLOCATION 5.559 (see note 2)	Short range non civil radiolocation (62 GHz to 64 GHz) RTTT	ECC DEC (02)01 [2] ERC REC 70-03 [1]	Road Transport and Traffic Telematic Vehicle to road/ vehicle to vehicle
NOTE 1: Footnote 5.558 states: "In the bands 55,78 GHz to 58,2 GHz, 59 GHz to 64 GHz, 66 GHz to 71 GHz, 122,25 GHz to 123 GHz, 130 GHz to 134 GHz, 167 GHz to 174,8 GHz and 191,8 GHz to 200 GHz, stations in the aeronautical mobile service may be operated subject to not causing harmful interference to the inter-satellite service (see No.5.43). (WRC-2000)".				
NOTE 2: Footnote 5.559 states: "In the band 59 GHz to 64 GHz, airborne radars in the radiolocation service may be operated subject to not causing harmful interference to the inter-satellite service (see No.5.43). (WRC-2000)".				

On account of the atmospheric absorption (approx. 10 dB/km) which provides a usefully low reuse distance, compatibility with the services above in the same band is expected to be less of a problem than it would be for lower frequency operation (e.g. in the microwave band). In addition, directional antennas are likely to be used, directed along the line of the road, so that the energy is effectively confined to a corridor with a restricted width and height.

C.2 Current ITU allocations

The ITU Radio Regulations [8] lists in Regions 1, 2, and 3:

Table C.2: Excerpt from the ITU Radio Regulations [8]

<table>
<tr><th>Frequency band</th><th>Allocation</th></tr>
<tr><td>59,3 GHz to 64 GHz</td><td>FIXED
INTER-SATELLITE
MOBILE 5.558 (see note 2)
RADIOLOCATION 5.559 (see note 3)
5.138 (see note 1)</td></tr>
<tr><td colspan="2">NOTE 1: Footnote 5.138 states: "The following bands:
• 6 765 kHz to 6 795 kHz (centre frequency 6 780 kHz);
• 433,05 MHz to 434,79 MHz (centre frequency 433,92 MHz) in Region 1 except in the countries mentioned in No.5.280;
• 61 GHz to 61,5 GHz (centre frequency 61,25 GHz);
• 122 GHz to 123 GHz (centre frequency 122,5 GHz); and
• 244 GHz to 246 GHz (centre frequency 245 GHz) are designated for industrial, scientific and medical (ISM) applications. The use of these frequency bands for ISM applications shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radiocommunication services might be affected. In applying this provision, administrations shall have due regard to the latest relevant ITU-R Recommendations. "</td></tr>
<tr><td colspan="2">NOTE 2: Footnote 5.558 states: "In the bands 55,78 GHz to 58,2 GHz, 59 GHz to 64 GHz, 66 GHz to 71 GHz, 122,25 GHz to 123 GHz, 130 GHz to 134 GHz, 167 GHz to 174,8 GHz and 191,8 GHz to 200 GHz, stations in the aeronautical mobile service may be operated subject to not causing harmful interference to the inter-satellite service (see No.5.43). (WRC-2000)".</td></tr>
<tr><td colspan="2">NOTE 3: Footnote 5.559 states: "In the band 59 GHz to 64 GHz, airborne radars in the radiolocation service may be operated subject to not causing harmful interference to the inter-satellite service (see No.5.43). (WRC-2000)".</td></tr>
</table>

C.3 Sharing issues

None expected.

History

Document history		
V1.1.1	April 2005	Publication