

**Electromagnetic compatibility  
and Radio spectrum Matters (ERM);  
Intelligent Transport Systems (ITS);  
Part 2: Technical characteristics for pan-European  
harmonized communications equipment operating in the  
5 GHz frequency range intended for road safety and traffic  
management, and for non-safety related ITS applications;  
Draft System Reference Document**

---



---

**Reference**

DTR/ERM-RM-036

---

**Keywords**

RTTT, ITS, road, vehicle, CALM  
roadside-to-vehicle communications,  
vehicle-to-roadside communications,  
inter-vehicle communications,  
microwave communication

**ETSI**

650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex – FRANCE

Tel. : +33 4 92 94 42 00 Fax : +33 4 93 65 47 16

Siret N° 348 623 562 00017 – NAF 742 C  
Association à but non lucratif enregistrée à la  
Sous-Préfecture de Grasse (06) N° 7803/88

---

**Important notice**

Individual copies of the present document can be downloaded from:

<http://www.etsi.org>

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<http://portal.etsi.org/tb/status/status.asp>

If you find errors in the present document, send your comment to:

[editor@etsi.fr](mailto:editor@etsi.fr)

---

**Copyright Notification**

No part may be reproduced except as authorized by written permission.  
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute yyyy.  
All rights reserved.

---

# Contents

Intellectual Property Rights .....	4
Foreword .....	4
Introduction .....	4
1 Scope .....	5
2 References .....	5
3 Definitions and Abbreviations .....	6
3.1 Definitions .....	6
3.2 Abbreviations .....	6
4 Executive Summary .....	7
4.1 Status of the system reference document .....	7
4.2 Spectrum Requirement and Justification .....	7
4.3 Market Information .....	8
4.4 Technical System Description .....	8
5 Current Regulations .....	8
6 Proposed Regulation .....	8
6.1 Spectrum .....	8
6.2 Requested licensing conditions .....	9
6.3 Global usage .....	10
7 Main Conclusions .....	10
7.1 Business Importance .....	10
7.2 Expected timing for ITS to market in Europe .....	10
7.3 Expected ECC and ETSI Actions .....	11
<b>Annex A: Market Information .....</b>	<b>12</b>
A.1 Summary of Application Types .....	12
A.1.1 Overview .....	12
A.1.2 Situation outside Europe .....	12
A.1.3 Examples of Applications .....	12
A.1.3.1 Safety related and traffic management applications .....	13
A.1.3.2 Non-safety-related ITS applications based on IVC or R2V and V2R .....	14
A.2 Market Size and Value .....	14
A.3 Traffic Evaluation .....	15
<b>Annex B: Technical Information .....</b>	<b>16</b>
B.1 Technical Description .....	16
B.2 Technical Justification for Spectrum .....	16
B.3 Information on current version of relevant standards .....	16
<b>Annex C: Expected Compatibility Issues .....</b>	<b>18</b>
C.1 Coexistence Studies .....	18
C.2 Current ITU allocations .....	18
C.3 Sharing issues .....	18
History .....	20

---

## Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<http://www.etsi.org/legal/home.htm>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

---

## Foreword

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

The present document is part 2 of a multi-part deliverable covering Intelligent Transport System (ITS) equipment as identified below:

- Part 1: "Technical characteristics for pan-European harmonized communications equipment operating in the 5 GHz frequency range and intended for critical road safety applications; System Reference Document";
- Part 2: "Technical characteristics for pan European harmonized communications equipment operating in the 5 GHz frequency range intended for road safety and traffic management, and for non-safety related ITS applications; System Reference Document";**

---

## 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).

The proposal for frequency designation in part 2 of this TR – the present document - is closely related to the proposal for frequency designation in part 1;

- Part 1 covers the minimum requirements for road safety applications with focus on inter-vehicle inter-vehiclecommunications (IVC) with very low latency,
- Part 2 covers the required additional spectrum, with focus on roadside-to-vehicle communications (RVC) applying mobile networking based on the internet protocol IPv6 as well as other protocols.

It is recommended to have a contiguous band, or at least nearby bands, designated for parts 1 and 2.

In addition to the fundamental time critical road safety applications as described in part 1, part 2 extends the applicability of the communications equipment towards other road safety and traffic management tasks.

Furthermore, the present document also covers vehicle to vehicle and roadside to vehicle communications for non-safety related applications.

The reasoning for road safety and traffic management applications is provided in part 1 and will not be repeated here.

In addition, the present document also covers roadside-to-vehicle applications which are designed to increase the road traffic efficiency and traffic flow. Both types of applications indirectly enhance the traffic safety.

---

## 1 Scope

The present document describes the spectrum usage requirements for equipment related to

- primarily roadside/infrastructure to vehicle communications (RVC),
- inter-vehicle communications (IVC).

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 in annex A;
- Technical information in annex B;
- Expected compatibility issues in annex C.

---

## 2 References

For the purposes of the present document the following references apply:

- [1] Final report of the e-Safety Working Group on Road Safety  
[http://www.europa.eu.int/information\\_society/programmes/esafety/index\\_en.htm](http://www.europa.eu.int/information_society/programmes/esafety/index_en.htm)
- [2] CEPT ECC/DEC/(04)08 of 12 November 2004 on the harmonised use of the 5 GHz frequency bands for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs)
- [3] IEEE 802.11p: Wireless Access for Vehicular Environments – Draft standard.
- [4] FCC Rules and Regulations, August 3, 2004, Regulations governing the licensing and use of frequencies in the 5850 – 5925 MHz band for Dedicated Short Range Communications Service.
- [5] ISO 21210: Intelligent Transport Systems - CALM - Medium and long range, high speed, air interface parameters and protocols for broadcast, point - point, vehicle - vehicle, and vehicle -point communications in the ITS sector - Networking Protocol - Complementary element
- [6] ISO 21215: Intelligent Transport Systems - CALM -Medium and long range, high speed, air interface parameters and protocols for broadcast, point-point, vehicle-vehicle, and vehicle-point communications in the ITS Sector - Air interface using 5 GHz communications.
- [7] ISO 21217: Intelligent Transport Systems - CALM -Medium and long range, high speed, air interface parameters and protocols for broadcast, point-point, vehicle-vehicle, and vehicle-point communications in the ITS Sector - System architecture.
- [8] ISO 21218: Intelligent Transport Systems - CALM -Medium and long range, high speed, air interface parameters and protocols for broadcast, point-point, vehicle-vehicle, and vehicle-point communications in the ITS Sector - Medium Service Access Points.
- [9] ETSI EN 300 674: Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Dedicated Short Range Communication (DSRC) transmission equipment (500 kbit/s / 250 kbit/s) operating in the 5,8 GHz Industrial, Scientific and Medical (ISM) band; Part 1: General characteristics and test methods for Road Side Units (RSU) and On-Board Units (OBU)

---

## 3 Definitions and Abbreviations

### 3.1 Definitions

**on-board unit:** radio, transmitter and receiver, usually installed in a vehicle

**road-side unit:** radio, transmitter and receiver, usually fixed as part of the road infrastructure

- installed along the road, e.g. on gantries above the lane or at poles beside the lane.
- 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.
- internet access.

**inter-vehicle communications:** generic expression for bi-directional communications between vehicles

NOTE: May include multi-hop routing involving several vehicles,

**roadside-to-vehicle communications:** also referred to as downlink communications

**vehicle-to-roadside communications:** also referred to as uplink communications

**roadside-vehicle communications:** generic expression for communications between a roadside and a vehicle, which may include both downlink and uplink communications

NOTE: May include multi-hop routing involving several vehicles, may allow for internet access, may be based on handover between adjacent roadside units.

**WAVE:** the name of IEEE 802.11p group and technology

### 3.2 Abbreviations

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

CALM	Continuous Air interface Long and Medium range
CALM M5	CALM for the 5GHz Microwave range
C2C-CC	Car-to-Car Communication Consortium
dBm	Power in decibel relative to 1 mW
DFS	Dynamic Frequency Selection
DSRC	Dedicated Short Range Communication
ECC	Electronic Communication Committee
e.i.r.p.	Equivalent isotropically radiated power
IEEE	Institution of Electrical and Electronic Engineers
Ipv6	Internet Protocol version 6
ISO	International Standards Organisation
IVC	Inter-Vehicle Communications
ISM	Industrial, Scientific and Medical

ITS	Intelligent Transport Systems
LBT	Listen-Before-Talk
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
RLAN	Radio local Area Network
RSU	Road-Side Unit
RVC	Roadside-Vehicle Communications
RTTT	Road Transport and Traffic Telematics
TPC	Transmit Power Control
TR	ETSI Technical Report
WAS	Wireless Access System
WAVE	Wireless Access in Vehicular Environments
WLAN	Wireless Local Area Network

---

## 4 Executive Summary

### 4.1 Status of the system reference document

ERM RM#29 decided to forward working version 1.1.1\_0.0.6 of the present preliminary draft system reference document to ECC WG FM to provide preliminary information about ITS to the ECC. RM#29 also decided to split the document into a 3-part system reference document in order to clarify the individual requirements for the different ITS applications.

It is also to be noted that spectrum usage as proposed in the present document is no longer envisaged to be on a national basis but rather on a pan-European basis in order to avoid coordination/protection zone issues along borders. It also favours the usage by vehicles travel cross border and operate in countries other than their home country.

TG37 during its meeting in February 2006 decided to withdraw part 3 of the system reference document, which requested a higher maximum transmission power for the WAS/RLAN band from 5,470 GHz to 5,725 GHz as defined in ECC DEC(04)08 [2]. This decision was based on the fact, that the considered spectrum is not available for inter-vehicle communications due to the DFS requirements and communications between roadside units and vehicles can be operated at a lower level of transmission power.

It is intended to submit version 1.1.1\_0.0.14 after approval by TG37 to ERM RM#33 for approval and submission to WG FM.

The present document was revised by WG ERM RM and ...

#### 1.1 Spectrum Requirement and Justification

The spectrum requirement includes 30 MHz of bandwidth for road safety and traffic management related ITS applications mainly based on communications between roadside units and vehicles. Additional 20 MHz of bandwidth are required for non-safety related ITS applications based on inter-vehicle and roadside to vehicle communications. These services and applications should be Europe-wide available. Communications is supporting mobile networking using the internet protocol Ipv6 as well as other protocols.

Important conditions to note are:

- Road safety and traffic management services need a predictable sharing environment which is not available in the WAS/RLAN band from 5,470 GHz to 5,725 GHz and the ISM-band from 5,725 GHz to 5,875 GHz.
- Car manufacturers and their suppliers require that the same radio subsystem can be used in all cars. The usage of the same antenna in all regions is an important cost factor for the OEMs, because the shape of the car has a large influence on the antenna design.
- The spectrum for ITS services must be individual license free.

For cost reasons, it is recommended to assign spectrum contiguous to the pan-European harmonised 2(two)-10 MHz spectrum requested in part 1 of this Technical Report.

## 1.1 Market Information

The recent increase in maturity of WLAN technology and availability of high-performance, low-cost products caused commercial interest in practical systems for ITS applications based on this technology.

Mobile networking is an increased demand, thus WLAN technology was further developed for applicability in a highly dynamic traffic environment [3], based on mobile Ipv6 protocols, e.g. as used in ISO TC204 WG16 CALM [7, 6].

Further information is provided in annex A.

## 1.1 Technical System Description

This information is provided in annex B.

---

# 1. Current Regulations

The current regulation provides the frequency bands a) 5,795 – 5,805 GHz and b) 5,805 – 5,815 GHz for road to vehicle systems, particularly but not exclusively for road toll systems. For band b) some countries have restrictions on use. Because these bands are in the ISM band ranging from 5,725 GHz to 5,875 GHz, sufficient predictable sharing conditions as required for road safety and traffic management related RTTT/ITS services are not available.

The spectrum range from 5,470 GHz to 5,725 GHz is provided as an individual license free band for WAS/RLAN under the regulatory regime as presented in ECC DEC(04)08 [2], open for outdoor usage. Due to the required DFS procedure the applicability of the WAS/RLAN frequency band for ITS applications is limited to communications between roadside units and vehicles.

Another band assigned for RTTT, allowing for IVC and RVC is given from 63 – 64 GHz. The signal propagation in this band requires line of sight conditions, which significantly limits the communication possibilities. Stable omnidirectional antenna patterns are very hard to produce in the 63-64 GHz band. IVC can only be realized between vehicles in immediate vicinity. Also RSU operating at this frequency cannot provide large communications zones due to shadowing effects caused by trucks etc. Consequential not all the ITS applications considered for a communication system at 5 GHz can be implemented at 63 GHz. Furthermore system introduction is more critical, because with line of sight conditions the required penetration rate of equipped vehicles must be higher to provide sufficient communications.

Nevertheless the directivity and signal attenuation in the band from 63 – 64 GHz are features, which can be seen as an advantage for other ITS applications, that are not in the focus of this Technical Report.

---

# 1. Proposed Regulation

## 1.1 Spectrum

It is proposed to assign 50 MHz of spectrum contiguous to the pan-European harmonised 2(two)-10 MHz spectrum requested in part 1 of this Technical Report, preferably within the frequency range from 5,850 GHz to 5,925 GHz.

The reasoning for road safety and traffic management applications is provided in part 1 and will not be repeated here.

It is proposed to provide 30 MHz of spectrum for these road safety related applications and also for road traffic efficiency and traffic flow application in the spectrum above the ISM frequency band (i.e. above 5,875 GHz) in order to provide predictable sharing conditions. This is in addition to the request presented in part 1 of this Technical Report but with the focus on roadside-to-vehicle communications.

In addition, 20 MHz of spectrum are requested for non-safety related applications based on inter-vehicle and roadside to vehicle communications, which do not require predictable sharing conditions and may therefore also be provided within the ISM-frequency range (i.e. below 5,875 GHz).

Further, it is to note that Roadside-to-Vehicle Communications (RVC) can apply the DFS-mechanism as required below 5,850 GHz. Inter-Vehicle-communications (IVC) cannot apply the DFS mechanism because of the highly dynamic environment where e.g. DFS channel scanning is considered to be much too long. In RVC communications, the

roadside unit will always commence communications and therefore, would apply the DFS mechanism similar to the WLAN approach.

Figure 1 presents the preferred spectrum for part 1 and part 2 of this Technical Report.

Dedicated channel spacing is not proposed to be regulated. Typical channel bandwidth considered in IEEE 802.11p is 10 MHz to 20 MHz wide channels. In addition, ETSI standards will define the exact channelization and frequency usage prioritisation concept (safety and possibly efficiency applications as well as control channel will be prioritized on protocol level).

These channels will be open for the applications within the respective usage category (either road safety related or not, i.e. used for traffic management).

The required power levels (e.i.r.p.) range from 3 dBm to 33 dBm to achieve communication distances of up to 1000 m. The related maximum power spectral density (e.i.r.p.) is 23 dBm/MHz.

Transmitter Power Control with a dynamic range of 30 dB is used.

It should be noted that most roadside-to-vehicle applications will require a much shorter communications distance than 1000 m and therefore, lower power levels than 33 dBm are involved on average. If it is considered an average range of 300m in rural areas, one needs e.i.r.p not exceeding 19 dBm..

Due to the wide range of potential future ITS applications, an estimation of a typical duty cycle is difficult. However, many applications show characteristics of rather short message communications with low duty cycles.

The advantage of this proposal is to provide the best possible harmonisation with the FCC regulation [4].

As the present document is an extension of part 1 of this multi-part deliverable with regard to roadside-to-vehicle communications, see as well the reasoning provided in part 1.

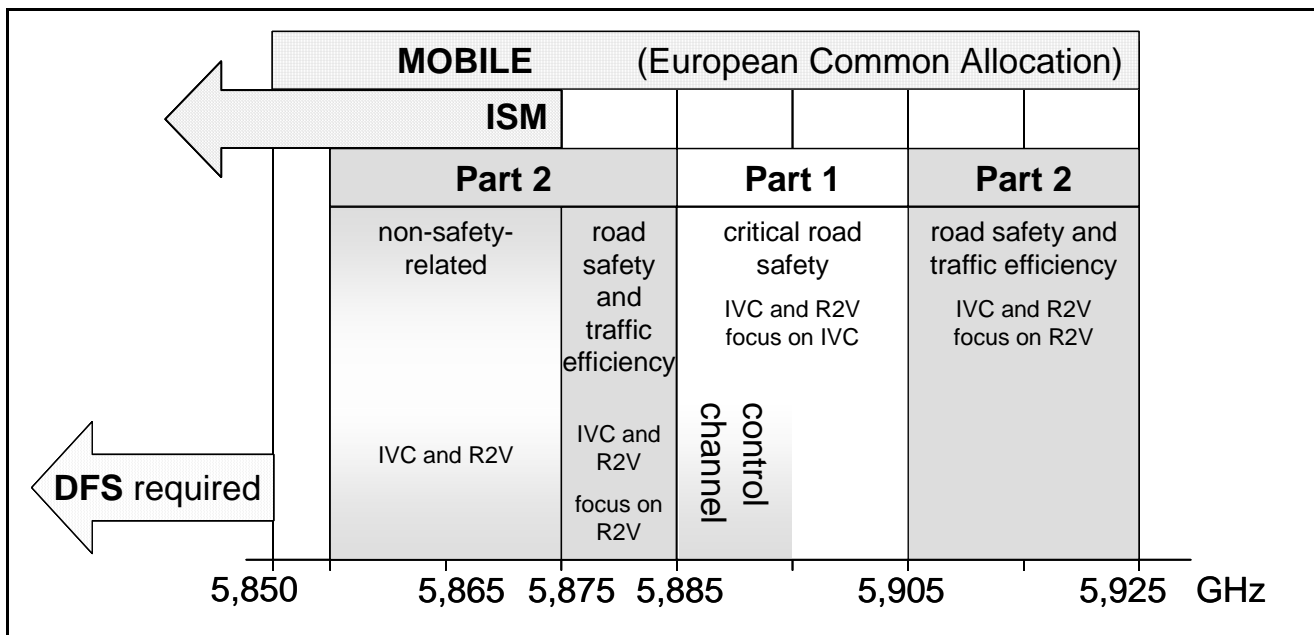


Figure 1: Preferred ITS spectrum

## 6.2 Requested licensing conditions

The spectrum for ITS services must be individual license free.

Important conditions to note are:

- It is a public concern to improve road safety and traffic flow, and as such politically prioritised.
- The practical problems of licensing in a global car market are immense.

- It is a common experience of the car manufacturers that neither drivers nor car holders are willing to pay for the operation of safety systems, e.g. data transmission fees.
- ITS services are expected to have a very slow take-off if there are costly licensing policies.

## 6.3 Global usage

As different types of safety and traffic management related communication system hinder safety and limit efficiency, and considering cost of equipment, usage of standardized components is a prerequisite. Thus, a high degree of harmonisation of frequencies on the global level is necessary, since needs for these applications throughout the world, and since vehicles are marketed in the global marketplace.

---

# 7 Main Conclusions

## 7.1 Business Importance

The need for ITS data communication and a suitable frequency designation has been recognised for several years. Europe was pioneering the use of microwave communication with the RTTT DSRC systems at 5,8 GHz, and is now working straight forward to more capable microwave solutions enabling mobile communications between vehicles, and between roadside units and vehicles, both for low latency applications, and for sophisticated networking applications using the internet protocol Ipv6 as well as other protocols.

A fast and versatile communication system platform is needed to support the large number of RTTT/ITS applications, including safety and traffic management applications.

The primary public objective is to reduce the number and severity of automobile accidents and to provide road operators a system to control and manage the traffic on their road network.

The ISO standards group TC204 WG16 prepared a specification for an architecture [7] 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 recognised that all bearers cannot support all applications, and that there will be circumstances which favour one over another.

The ITS functionalities as described in all three parts of this Technical Report will be implemented in one single system.

The ITS concept is therefore developed to provide a solution that is open for parallel communication sessions between vehicles and the infrastructure, or between vehicles, thus providing mechanisms that give the safety relevant applications all the time the highest priority.

Microwave systems in the 5 GHz range can offer communications with a high data rate, ranges up to 1.000 meters, low weather-dependence, and global compatibility and interoperability [3, 6].

Spectrum on a European- wide basis is needed as ITS systems should enable communications between vehicles and the infrastructure, and between vehicles, in an environment where the vehicle marketplace is global and manufacturers providing vehicle models on a global basis with the minimum of variation to meet local national requirements.

Vehicles frequently travel cross border and operate in countries other than their home country. This is particularly true for commercial vehicles, and for most vehicles within the North/Western part of Europe. Different national spectrum allocations with guard zones along the borders will be very hard to manage in this highly mobile environment. Vehicle manufacturers want to equip vehicles with a single global solution. They do not want the complexity, and risk, of too many uncoordinated communications systems providing different services.

## 7.2 Expected timing for ITS to market in Europe

It is intended to place commercial ITS products on the market, i.e. built into cars, by 2008. Under the assumption that it would take approximately 2 years for planning and preparing the incorporation of ITS in cars, a definite frequency decision from CEPT is required before the end of 2006/beginning of 2007 to support adequate and secure planning efforts.

## 7.3 Expected ECC and ETSI Actions

ECC already investigates in response to the already delivered part 1 of this Technical Report 1 x 10 MHz in the upper part of the ISM band (5865 – 5875 MHz) as proposed by SRDMG and 2 x 10 MHz channel (5875 – 5895 MHz) as proposed by ETSI.

Concerning this part 2, ETSI requests the ECC to perform the following actions:

- Investigate and identify suitable spectrum for ITS services and applications in addition and close to the frequency range already under investigation. As part of the ECC action, ECC should consider the recommendation in clause 6 of the present document.
- Perform necessary compatibility studies in the process of identifying the most suitable spectrum for ITS in Europe.
- Develop and adopt a CEPT ECC Decision that would allow for ITS to be introduced in the European markets by 2008. A frequency decision from CEPT is required before the end of 2006/beginning of 2007 to support the eSafety [1] initiative and enable adequate and secure planning efforts by authorities and industry.

ETSI actions:

- ETSI intends to develop standards for ITS in ERM TG37 to cover the technical operational specifications and measurement requirements for ITS devices that are the subject of the present document.
- Co-existence issues between ITS IVC units as interferer and RTTT DSRC (5,795 –5,815 GHz) OBU's [9] as victim, both installed in the same car, will be investigated. ETSI ERM TG37 members intend to address this concern by conducting measurements to investigate the situation. This item may be considered as an ITS/RTTT intra-applications issue and possible technical solutions will be investigated in ETSI ERM TG 37.

---

## Annex A: Market Information

---

### A.1 Summary of Application Types

#### A.1.1 Overview

Lists of applications for IVC and RVC have been investigated by various projects and groups, and the number of applications is still increasing.

The connectivity required by the applications can be summarised as:

- 1) Vehicle to roadside (uplink) and roadside to vehicle (downlink), (main focus of the present document):
  - OBU to one RSU.
  - RSU to one OBU.
  - RSU to many OBUs; broadcast.
  - RSU to selected OBUs; multicast.
- 2) Inter-vehicle (including multi-hop routing involving several vehicles):
  - Linear, e.g. for convoys of vehicles.
  - Vehicle cluster covering several lanes, co-directional.
  - Vehicle cluster including opposite direction of travel.
- 3) Communications cluster of vehicles including RSU.

#### A.1.2 Situation outside Europe

See part 1 of this TR for a detailed presentation.

#### A.1.3 Examples of Applications

The road safety and traffic efficiency applications are the driving interest in this technology from both car manufacturer and public authorities or road operators.

Road safety and traffic efficiency are global concerns, and the development in all countries shows that new technology is needed to make the grade. The worldwide ITS research has invested a lot of work in the analysis of accident reduction by IVC and RVC.

Due to economy reasons and not to overload vehicles with different communication systems the communication system should allow for both road safety related or traffic efficiency applications and non-safety related applications, which are in this part of the Technical Report based on inter-vehicle communications.

The distinction between traffic management applications and safety related applications is crucial, as finally every traffic management application, at least to some extend, contributes to road safety.

The following lists are neither exhaustive nor complete and continues to expand as ITS evolves. However, they give an indication of the types of applications that the present part of this Technical Report focuses on.

### A.1.3.1 Safety related and traffic management applications

Several applications of this category are listed already in part 1 of this Technical Report and are not repeated here.

Application	Description	V2V	V2R	R2V
Infrastructure-Based Intersection Collision Warning	This application warns drivers when a collision at an intersection is probable..		X	X
Vehicle-Based Intersection Collision Warning	Work zone safety warning refers to the detection of a vehicle in an active work zone area and the indication of a warning to its driver.	X		
Blind Merge Warning	This application warns a vehicle if it is attempting to merge from a location with limited visibility (either for itself or for the oncoming traffic) and another vehicle is approaching and predicted to occupy merging space.		X	X
Adaptive Headlight Aiming	This application allows vehicles to aim their headlights in the direction of travel and more effectively illuminate the road ahead			X
Intelligent Traffic Flow Control	This infrastructure application uses vehicle-to-infrastructure communication and thereby facilitates traffic light signal phasing based on real-time traffic flow.		X	
Enhanced Route Guidance and Navigation	Up-to-date and localized navigation information is sent to vehicles via roadside units.			X
GPS Correction	The roadside unit is pre-programmed with its precise location, and it gives this information to passing vehicles.			X
Pedestrian Crossing Information	This application provides an alert to vehicles if there is danger of a collision with a pedestrian or a child that is on a designated crossing			X
SOS Services	This in-vehicle application will send SOS messages after airbags are deployed, a rollover is sensed, or the vehicle otherwise senses a life-threatening emergency. The emergency message will be sent from the vehicle to a passing vehicle, which stores and then relays the message when in range of a roadside unit. It will then be forwarded to the nearest local authority for immediate assistance.	X	X	
Intelligent On-Ramp Metering	This infrastructure application uses vehicle-to-roadside communication to measure real-time traffic density on the highway and dynamically alters on-ramp metering signal phasing.		X	
Free-Flow Tolling	This infrastructure application works on toll roads and uses communications for toll collection without the need for toll plazas along the roadway and therefore without reducing the traffic flow.		X	X
Blind Merge Warning	This application warns a vehicle if it is attempting to merge from a location with limited visibility (either for itself or for the oncoming traffic) and another vehicle is approaching and predicted to occupy merging space.		X	X
Cooperative Adaptive Cruise Control	Cooperative adaptive cruise control will use inter-vehicle communication to obtain lead vehicle dynamics and enhance the performance of current adaptive cruise control (ACC)	X		
Blind Spot Warning	This application warns the driver when he intends to make a lane change and his blind spot is occupied by another vehicle.	X		

### A.1.3.2 Non-safety-related ITS applications based on IVC or R2V and V2R

Some IVC or R2V and V2R communications enabled non-safety-related ITS applications are shown below.

Application	Description	V2V	V2R	R2V
Cross Vehicle Messaging	People in different cars might like to chat with each other or children might play games with partners in different cars.	X		
Virtual Caravan	Support of drivers, who are heading to the same destination to stay together.	X		
Information Forwarding Provided By Roadside Units	Information, e.g. point of interest notification, provided by roadside units will be forwarded via multi-hop communications.	X		
Messaging Towards Roadside Units	Messages from a vehicle, which is not in the communication range of a roadside unit, will be forwarded via multi-hop communications towards the next roadside unit.	X		
Vehicle access control	Radio based access control at company gates or at park houses.		X	X
Fuel payment, Parking payment, Fast food payment, Other services payment	At certain locations this application enables the driver to pay via radio communications without leaving the car.		X	X
Rental car processing	Access data as well as travel data, petrol fill level at the car return etc. might be communicated at the premises of the rental company		X	X
Remote Diagnostics	This application transmits vehicle type and failure type data to a garage or the vehicle vendor via roadside units or multi-hop car-to-car-communication.	X	X	
Map Downloads and Updates	Maps can be downloaded to a vehicle and a vehicle's existing maps can be updated by a roadside unit.			X
In car internet	When nearby a stationary public internet access point (hotspot), application can use standard IP services for applications.		X	X
Parking management	Information about free parking space might be transmitted from a RSU to passing vehicles and possibly a parking slot might be booked.		X	X
Point of Interest Notification	A roadside unit will provide information to passing vehicles periodically via broadcast.			X
Vehicle and cargo tracking	Vehicle and or cargo information is collected via vehicle to roadside communications and forwarded to a centre office, which allows e.g. to detect stolen vehicles or cargo.		X	

While R2V and V2R communications based non-safety-related ITS applications might be operated in the WAS/RLAN band from 5,470 GHz to 5,750 GHz, IVC based non-safety-related ITS applications are only covered by the present document, because of the incompatibility with the DFS requirement.

---

## A.2 Market Size and Value

See part 1 of this TR for a detailed presentation.

---

## A.3 Traffic Evaluation

The functionality required of a high data rate communication system for next-generation RTTT/ITS is, that it shall support both IVC and RVC in a highly 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, multicast, point-to-point and vehicle cluster connectivity.

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

However, it is to note that:

- Only one ITS transmitting device uses a frequency channel at the same time using listen-before-talk and transmitter power reduction in congestion situations.
- The frequency re-use distance depends on the ITS transmitter power and varies between 15 meters to 1000 meters.
- The average conveyed ITS message duration can be assumed to be less than 1 millisecond.

---

## Annex B : Technical Information

---

### B.1 Technical Description

See part 1 of this TR for a detailed presentation.

In addition to the part 1 description further information about the radiated power is provided.

Scalability is an important feature of an ad hoc car to car communication network. The number of participating vehicles in these networks depends very much on the traffic density and the situation on the roads. If there is a high density of vehicles the communication range will be much below the maximum value to provide all nodes the required channel access and possibility to transmit data.

Furthermore the required communication range will be reduced with increasing the penetration rate of equipped vehicles. At the beginning, when only a few vehicles are equipped there is an increased probability for transmitting with a higher power to enable communications at all. But nevertheless also during the introduction phase vehicles will apply TPC and reduce the transmission power to the level needed for reliable communication. This is mandatory for efficient channel reuse and the link quality.

The typical communication range is expected to be below 500 m for rural areas. In suburban and urban areas the communication range is usually lower. Considering typical values of traffic density a proper value for an average communication range in rural and suburban areas is 300 m. Individually the required communication range is much lower, e.g. in the case of messaging between 2 consecutive vehicles driving on a motorway with 120 km/h the safety distance and therefore the required communication range is about 60 m and the applied power level will be 3 dBm, which is the minimum level.

RSUs will provide a communication zone. The required size of the zone depends on the services, which are provided by the RSU, and on the environment. A typical value for rural areas is 600 m and for urban areas 400 m. With the RSU in the centre of the communication zone the resultant communication range is 300 m for rural areas and 200 m for urban areas.

For the communication between vehicles and RSUs the required transmitted power can be asymmetric concerning uplink and downlink communications, because RSU will be deployed with directive antennas. This means that the average interference contribution from RSUs will be significantly lower than the EIRP value on its own would indicate

Based on the link budget calculations presented in the part 1 of this Technical Report following power levels should be considered for compatibility investigations.

Range (m)	1000	500	400	300	200	100	50	10
TP (dBm)	33	25	22	19	14	6	3	3

Considering TPC with a 30 dB range the minimum power level is 3 dBm.

---

### B.2 Technical Justification for Spectrum

See part 1 of this TR for a detailed presentation.

---

### B.3 Information on current version of relevant standards

Basic parameters and protocols for high-reliability road safety services are being developed as a co-operation between ETSI ERM TG37, ISO TC204 WG16, C2C-CC and IEEE 802.11p (WAVE) [3].

The C2C-CC is working out specifications taking into account European regulations, infrastructures, driving behaviour and government policies. Standards will be produced for the communication system and for the road safety applications to ensure interoperability between all cars.

The ISO standards group TC204 WG16 is developing a set of standards [7, 5, 8, 6] for architecture, for bearers and for the networking protocols. This CALM architecture will link applications to an appropriate bearer of a set of bearers, depending on what each has to offer at a given time in a given situation. It is recognised that all bearers cannot support all applications, and that there will be circumstances which favour one over another.

---

## Annex C: Expected Compatibility Issues

---

### C.1 Coexistence Studies

Coexistence studies with existing radio services in the 5,9 GHz range are needed. Part 1 of this TR presents relevant European allocations in the neighbourhood of the spectrum proposed for allocation in this document.

The ongoing studies in ECC include a full compatibility study (ITS versus other radio communication services/applications and other radio communication services/applications versus ITS) in the band 5,875 GHz to 5,895 GHz and may need to be extended to frequencies up to 5,925 GHz. In addition, studies for frequencies in the ISM band were decided to only study on the impact of ITS on other radio communication services/applications. Furthermore, the impact from ground radars below 5,850 GHz on ITS is also studied.

---

### C.2 Current ITU allocations

In ITU-R, WP8A is responsible for ITS. There are some recommendations related to the 5GHz band, mostly reflecting current RTTT DSRC allocations in Europe and Japan.

At the last World Radio Conference (WRC'03), the issue of a global allocation for ITS safety applications was brought up by Canada. This proposal received support from US and also from Europe. The proposal was withdrawn due to heavy opposition from some Asian countries.

---

### C.3 Sharing issues

The Road safety and traffic management applications considered in this document require a more predictable sharing environment than it is available inside spectrum where e.g. COTS WLAN or ISM equipment can tune directly. Major sharing issues and potential interference mitigation could be summarized in the following order as below:

- Minimum interference with currently allocated radio services.
- As far away from 5,8 GHz as possible to avoid interference with RTTT DSRC [9] since the devices ITS transmitter and RTTT OBU receiver will be located inside cars close to each other.
- Although the present document has its focus on roadside-to-vehicle communications, it also covers inter-vehicle communications. It must be noted that sharing with radar applications below 5,850 GHz might require an interference mitigation like DFS which is not compatible with highly mobile inter-vehicle applications. In consequence, all ITS inter-vehicle communications might only be considered for the frequency range above 5,850 GHz (note: the proposal in chapter 6.1 is in line with this consideration).
- By sharing the available bandwidth into different communication channels, a diversity factor could be integrated in the link budget which could also be used for interference mitigation.
- The integration of more directive antennas. One of the main impacts is given by radiation for high elevation angles (towards GSO satellite receivers). By focusing radiated energy horizontally towards infrastructure and vehicle interference towards GSO will be decreased.
- ITS uses TPC as well as LBT. Especially, roadside-to-vehicle communications uses average communication ranges of much less than the maximum of 1000 m and TPC will have a big effect on total aggregated power levels.

Concerning interference to RTTT DSRC it is important to note that DSRC OBUs can cope with statistical random interference. However, systematic interference from IVC or RVC ITS could cause unacceptable interference and could also cause premature end-of-life of the OBUs due to OBU battery drain, if both kind of equipment are installed in the same vehicle. A potential solution under study to avoid this could be the integration of the RTTT OBU and ITS in one equipment device as specified in the CALM architecture [7,8].

Possible interference mitigation factors (e.g. TPC, see chapter B.1.2. of part 1) and channel access mechanisms will be investigated by ERM TG37 in the course of the sharing studies to be performed within CEPT ECC WGSE provided that results will indicate the need for such measures.

## History

<b>Document history</b>		
<Version>	<Date>	<Milestone>
1.1.1_0.0.5	December 20, 2004	Approved preliminary draft of ERM TG37 for first submission to ERM RM#29
1.1.1_0.0.6	January 18, 2005	Output of initial review by ERM-RM.
1.1.1_0.0.7	March 17, 2005	Prepared by ESF GmbH on behalf of ERM TG37
1.1.1_0.0.8	May 26, 2005	Prepared by ESF GmbH on behalf of ERM TG37 as a result of the TG37 meeting #7 in May 2005.
1.1.1_0.0.9	June 14, 2005	Revision by Dieter Seeberger, member of ERM TG37
1..._0.0.10		TG37#8 version
1.1.1_0.0.11	November 29 <sup>th</sup> , 2005	Prepared at TG37#10
1.1.1_0.0.12	February 21 <sup>th</sup> , 2006	Prepared during TG37#11 by Thomas Weber
1.1.1_0.0.13	March 15 2006	Revised by Dieter Seeberger
1.1.1_0.0.14	March 23 2006	Agreed TG37 version
1.1.1_0.0.15	March 29 2006	Revised by WG ERM RM
1.1.1_0.0.16	March 30 <sup>th</sup> , 2006	Final Revision by ERM RM