



Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

**STRATEGIC PLANS FOR THE FUTURE USE OF THE FREQUENCY BANDS
862-870 MHz AND 2400-2483.5 MHz FOR SHORT RANGE DEVICES**

Helsinki, May 2002

INTRODUCTION

The frequency bands 862-870 MHz and 2400-2483.5 MHz has for many years been used for Short Range Devices (SRD) in accordance with the ERC Recommendation 70-03. A number of differen SRD applications have been introduced in those bands on request from industry and Harmonised Standards have been developed by ETSI. The use of those bands for Short Range Devices are license exempted and on a non interference and non protected basis. The number of users and applications have increased dramatically during the last few years and the sharing conditions in the bands are in some cases difficult.

Based on a recommendation of the Detailed Spectrum Investigation process (DSI Phase III) strategic plans have been developed for each of the bands on the future use of the bands.

This ECC Report contain the two strategic plans as adopted by the Frequency Management Working Group of the Electronic Communications Committee of the CEPT.

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STRATEGIC PLAN FOR THE FUTURE USE OF THE FREQUENCY BAND 862-870 MHz FOR SHORT RANGE DEVICES

Background

The frequency band 862-870 MHz has for some time been used for short range devices (SRD) in accordance with ERC Recommendation 70-03. The band 863-865 MHz is used for radio microphones and wireless audio applications in accordance with the ERC REC 70-03 Annex 10 and Annex 13 respectively. The band 868-870 is designated for different types of SRD applications with defined duty cycle and power levels in order to allow a particular type of application to develop within a particular subband. Thus Annex 1 to ERC REC 70-03 contains the regulations for NON-specific SRD applications within 868-870 MHz and Annex 7 contains subbands with technical parameters specifically designated for alarm systems including Social Alarms within the band 869.2-869.25 MHz.

In order to promote further harmonisation and stronger commitment from European Administrations the European Radiocommunications Committee has adopted ERC Decisions ERC DEC (01)04, (01)09 and (01)18 covering SRD applications within the frequency bands 868-870 MHz and 863-865 MHz .

The frequency band for Social Alarms is covered by ERC Decision (97)06.

The band plan for the existing use of the band 868-870 MHz can be found in Annex 1 and the status of implementation in accordance with the national restriction informed by administrations is indicated in Annex 2 to this document.

Other services and applications are using the band 862-868 MHz such as military tactical radio links coordinated on a national basis and Cordless telephones (CT2) within the band 864.1-868 MHz. Furthermore the band 862-863 MHz is used for security services in some countries.

The DSI Phase III consultation process covering the frequency band 862-870 MHz suggested that a strategic plan be developed for the use of SRD applications within the band 862-870 MHz and that general FHSS be introduced in the band for non-specific SRD applications without specific regulation with power levels and duty cycle for each type of SRD-application. Other recommendations from the DSI resulted in ERC Decisions suggesting the phasing out of CT2 equipment in Europe in order to allow expansion of SRD applications in the band.

The current strategic plan is developed based on the results of the DSI and contributions from the ETSI and EICTA organisations. These contributions are based on surveys and consultation with SRD industry within the organisations.

Future market and frequency requirements within the band 862-870 MHz

In general the information provided by industry indicates an expanded use of the frequency band 862-870 MHz for Short Range Devices. In particular traditional telemetry/telecontrol and building automation systems as well as different radio alarms seem to indicate expansion and require spectrum in future. The detailed market information for each category of SRD application is limited and therefore not described in this document.

The industry requests are focused on the operation of SRDs

- within wider bands to achieve higher bit rates
- with increased power levels and duty cycles
- with use of different techniques e.g. Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS) with low power density and low duty cycles, frequency agility and dynamic channel allocation with listen before transmit.

Industry in general requests the possibility to continue operation of existing narrow band channels within the range 868-870 MHz and the audio applications within 863-865 MHz. If major changes are decided upon a sufficient transition period should be agreed.

The following is an extract from indications by industry of the general and specific technical requirements:

Telemetry/telecommand

The professional telemetry is used in remote control and utilities plans, electricity networks, industrial process control and similar duties requiring stable high speed communications. Conventionally narrow band equipment and high duty cycles are required. A power level of 25 mW and a duty cycle of >25% has been indicated.

An increase in channel capacity using FHSS or frequency agile techniques favouring "look before transmit" or dynamic channel allocation is required. The currently available bands within 868-870 MHz are, however, not wide enough for FHSS. Further compatibility studies should be carried out with the aim to allow 25 mW with 100 kHz channels in an FHSS environment within the band 863-870 MHz. The number of hops/sec needs to be investigated within the compatibility study in particular to ensure sharing with wireless audio applications within the band 863-865 MHz.

Alarm systems industrial building automation

Building automation, fire and security alarms require long transmission ranges which lead to higher power levels and high duty cycles in the order of 10-25%. 150 kHz channels are required by industry within the existing subbands to achieve higher data rates. The band 869.3-869.4 MHz is required by industry with a 20 mW power level. It is suggested by industry to use intelligent systems using look before transmit techniques for those SRD-applications. The reason being 869.3-869.4 is not enough for a FHSS however, frequency agile systems could be considered.

As for Telemetry/telecommand the FHSS solution should be found and further studies should lead to a decision on the power level and hops/sec.

It is further indicated by industry that any networking should be limited to single owned use within his boundaries as WAN public service provision is not considered suitable by industry within the SRD bands.

Remote control and crane control

Narrow band channels with very high duty cycles and higher erp to control distant plant are required by industry. High data rates are not required. A further increase of the power level to 25 mW erp within the band 869.7-870 MHz with 100 % duty cycle is required to provide an alternative to the use of the 433 MHz band. It is also indicated by industry that a higher duty cycle will be required within the bands 868-868.6 MHz and 868.7-869.2 MHz.

It is proposed by industry to use FHSS.

Gate openers and access control

This category covers Gate openers, Access control, Radio Frequency Distributed Communication, Medical , Portable banking Terminals, generic SRDs. Higher power requested in 100% duty cycle band and higher duty cycles within the bands 868-868.6 MHz and 868.7-869.2 MHz would meet some of the requirements. A general spread spectrum FHSS with 100 hops/sec and 25-250 kHz channels or frequency agile systems across the band 862-870 MHz could meet the requirements. The technical parameters should be further investigated in a compatibility study in order to ensure compatibility with other services and applications in the band in particular the wireless audio applications.

Wireless Audio

The frequency band available for wireless audio/ radio microphones (863-865 MHz) should not be changed. A request for increased power level up to 25 mW and may be a definition of indoor/outdoor use in connection with the power levels (10 and 25 mW) could further improve the spectrum efficiency.

Strategies for the future use of the band 862-870 MHz for short range devices

The indications from industry surveys carried out seem to confirm that an expansion of the use of SRD applications within the 862-870 MHz band is envisaged in future in particular on non specific short range devices for telemetry and telecommand purposes. In some areas higher power levels and in particular higher duty cycles should be considered where justified from a user point of view.

The strategies adopted by the FM WG for the future development of SRD applications within the band should allow for continued use of the existing SRD applications. As an example a number of the subbands within the band 868-870 MHz as well as the wireless audio band 863-865 MHz has just been implemented and industry needs assurance that the existing services may continue for the lifetime of the equipment.

It is also assumed that the draft ERC Decisions on phasing out of existing CT systems will result in availability of the band 865-868 MHz for SRD applications in future.

To meet the future requirements for more spectrum in particular for non specific SRD-applications and in order to open the bands within the 862-870 MHz band for SRD applications without too rigid and detailed regulations further studies should be carried out to introduce spread spectrum technology including both FHSS and DSSS technology within the band. Frequency agile systems with listen before talk could also be introduced in parts of the band when allowing higher data rates.

As indicated in the description regarding networks and third party traffic the use of SRD-applications for public operated networks may dominate the spectrum in a given area and prevent especially the simplest SRD applications from using the band. Networks should therefore be limited to single owned use within the premises of the owner/operator.

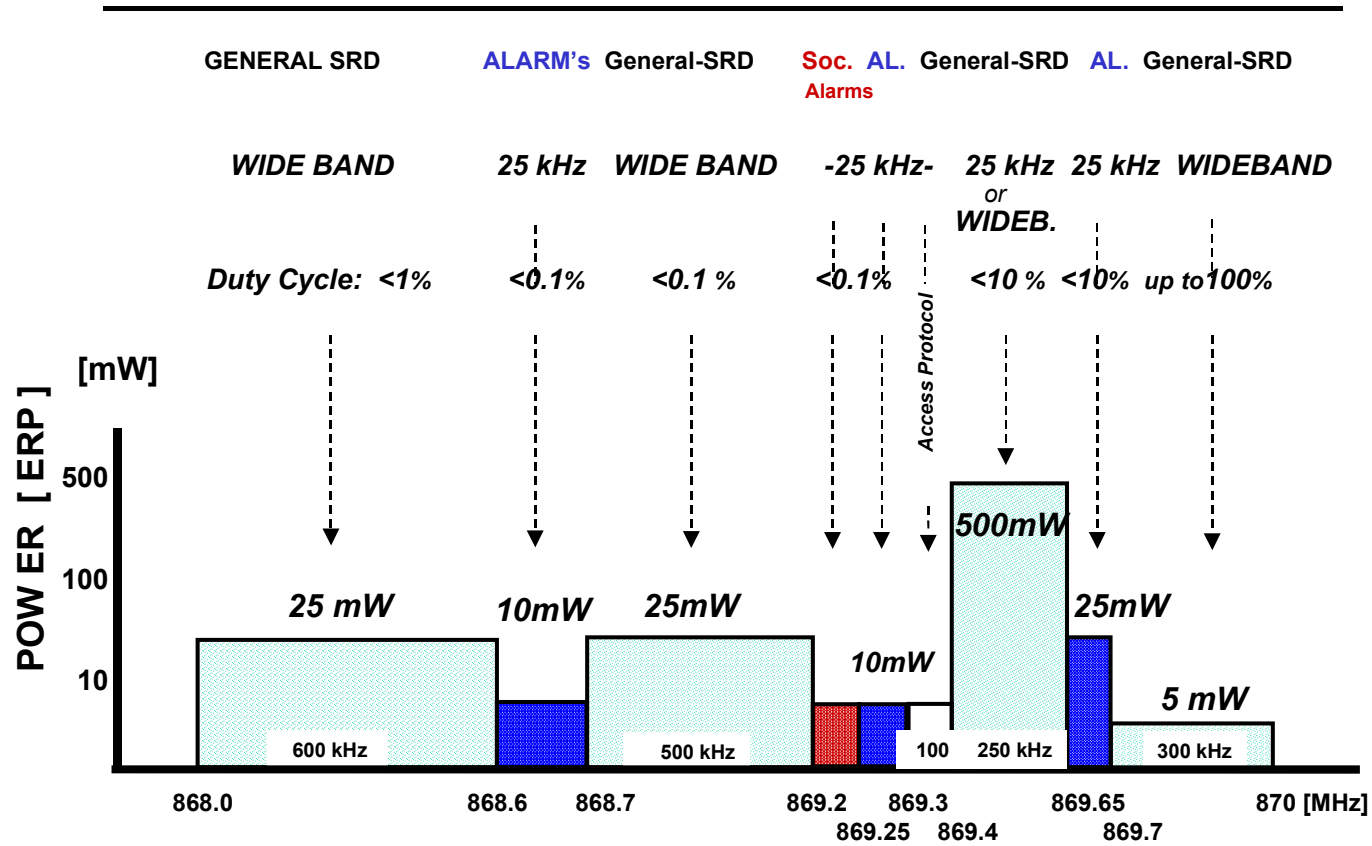
The SRD developments within the band 862-870 MHz should adhere to the following strategy:

- a. The band 863-865 MHz should continue to be available for wireless audio applications and wireless microphones as well as for narrow band analogue voice devices within the subband 864.8-865 MHz.
- b. The band 868-870 MHz should continue to be available for SRD applications within subbands as already introduced in ERC Recommendation 70-03. Following the market developments and requirements from industry consideration should be given to the power levels and duty cycle restrictions for particular subbands. The ongoing update of the ERC Recommendation 70-03 should consider such changes based on justified requirements from industry organisations.
- c. The frequency band 863-870 MHz should be considered for NON specific spread spectrum SRD applications by using Direct Sequence Spread Spectrum (DSSS) and/or Frequency Hopping Spread Spectrum (FHSS) with a power level of 25 mW. The technical parameters for the power density for DSSS and the channel scheme/power level/hopping system should be defined based on detailed compatibility studies in order to provide sufficient protection to other services in the band and in particular safety services such as the Social Alarms.
- d. The use of any technique such as frequency agility, dynamic channel assignment, listen before transmit protocol etc. able to ease spectrum sharing should be encouraged and as much as possible, stipulated in the ERC REC 70-03 and relevant ERC Decisions.
- e. The frequency band 862-863 MHz is currently used for security services in a number of countries and should not be designated for other radio services.
- f. Any networking and use of repeaters within SRD bands 862-870 MHz should be limited to single owned use.

862	863	865	868	870 MHz
Generic Spread Spectrum DS and/or FHSS				
	Wireless Audio Consumer Radio Microphones 300 kHz channels		Narrow band channels 25 kHz and up to 600 kHz	

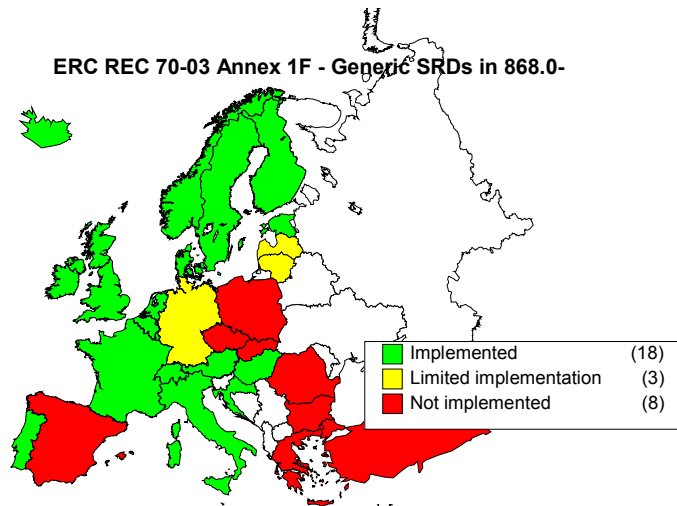
Annex 1 : Overview of the current use of the band 862-870 MHz

Existing use of the band 868-870 MHz (ERC REC 70-03)

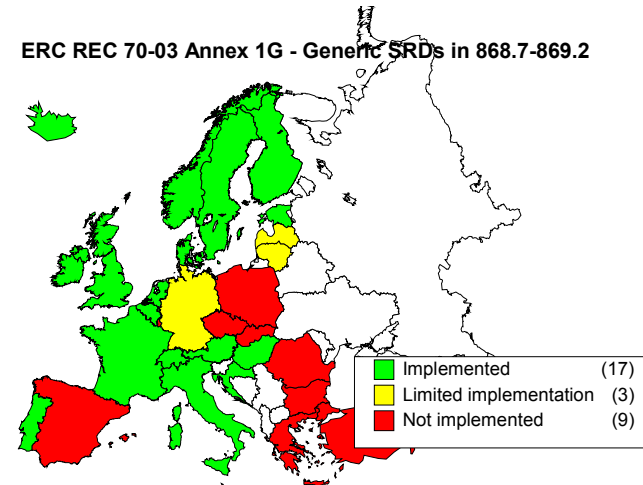


Annex 2 : Implementation of ERC REC 70-03 regarding the band 862-870 MHz

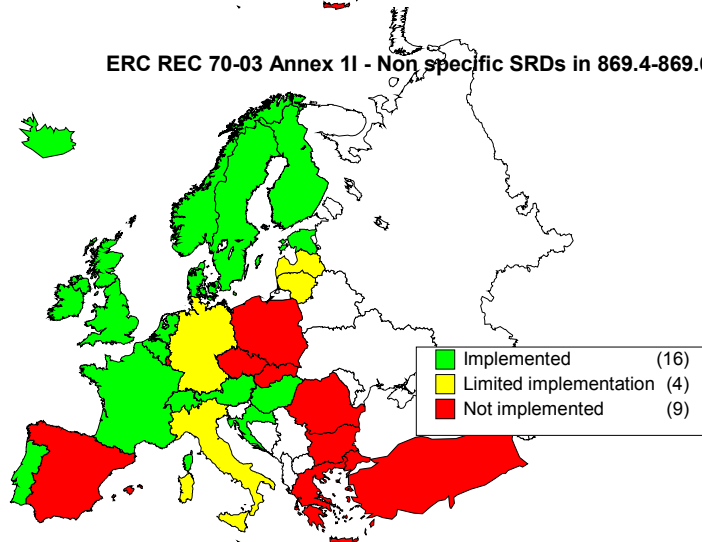
ERC REC 70-03 Annex 1F - Generic SRDs in 868.0-



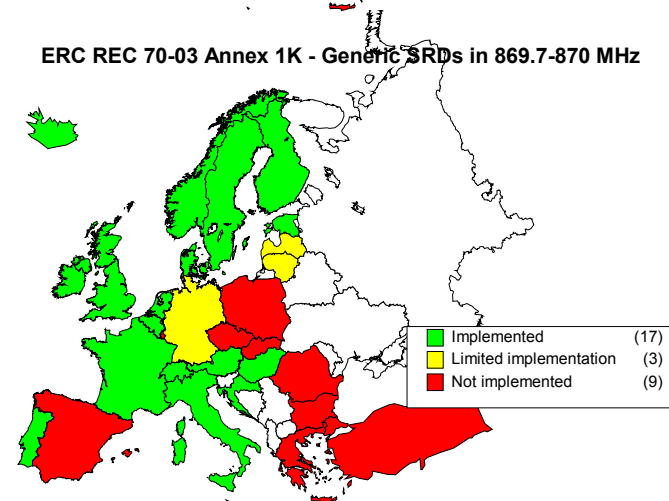
ERC REC 70-03 Annex 1G - Generic SRDs in 868.7-869.2



ERC REC 70-03 Annex 1I - Non specific SRDs in 869.4-869.65 MHz

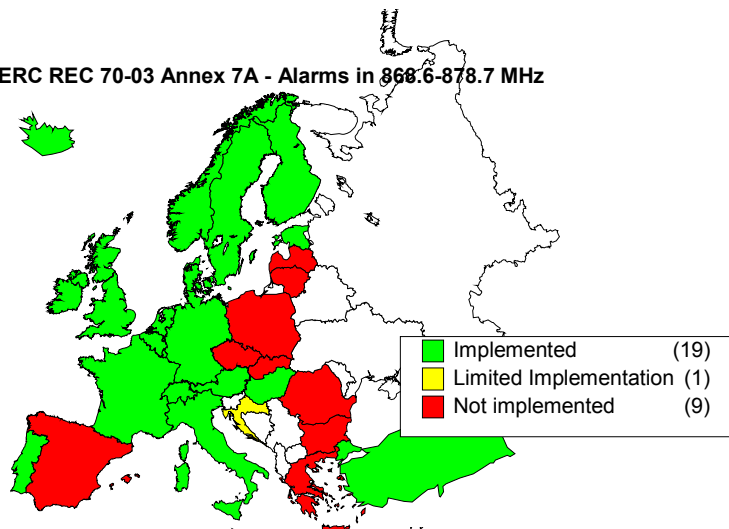


ERC REC 70-03 Annex 1K - Generic SRDs in 869.7-870 MHz

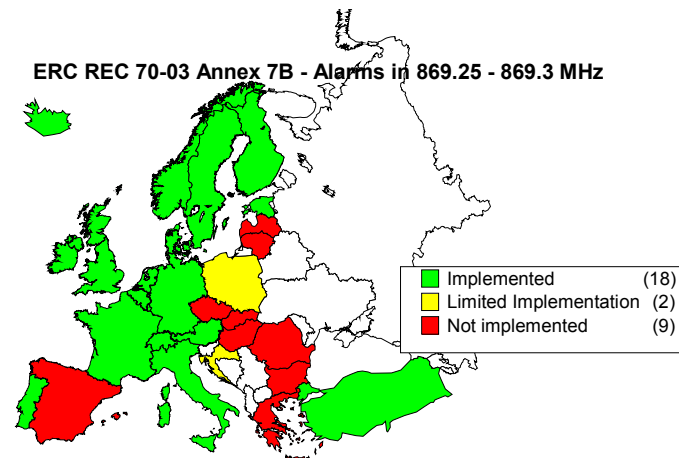


Implementation of ERC REC 70-03 Annex 7 within the band 868-870 MHz

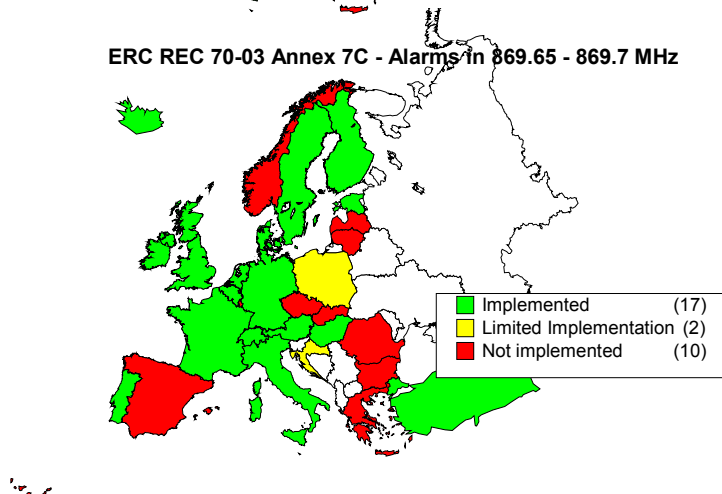
ERC REC 70-03 Annex 7A - Alarms in 868.6-878.7 MHz



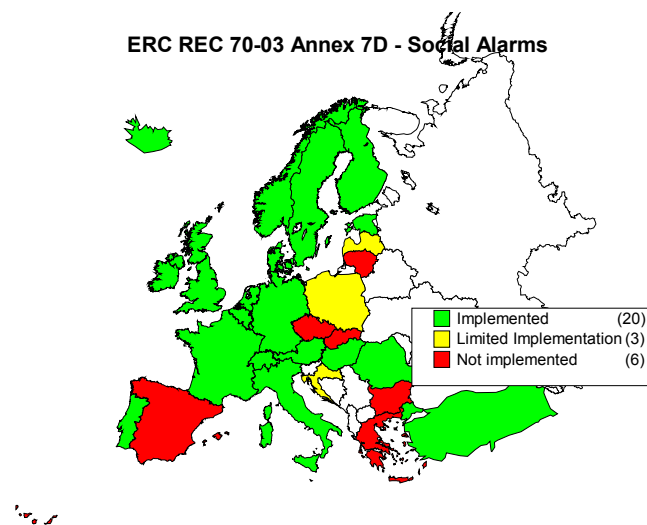
ERC REC 70-03 Annex 7B - Alarms in 869.25 - 869.3 MHz



ERC REC 70-03 Annex 7C - Alarms in 869.65 - 869.7 MHz

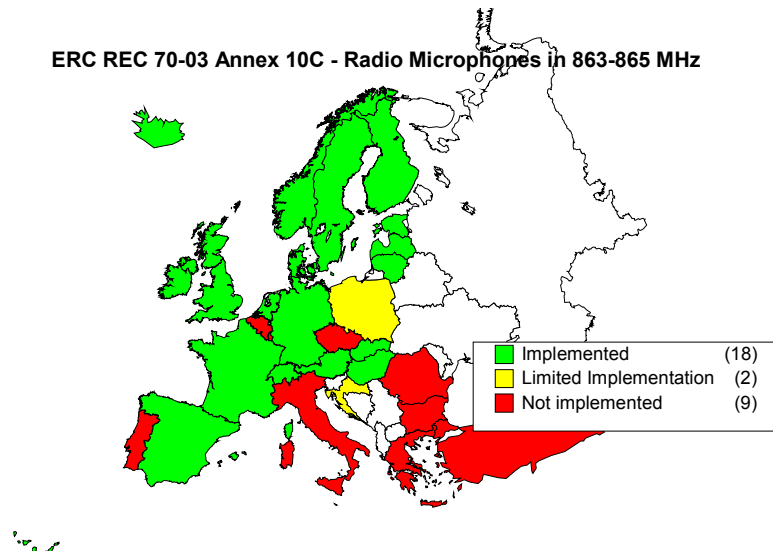


ERC REC 70-03 Annex 7D - Social Alarms

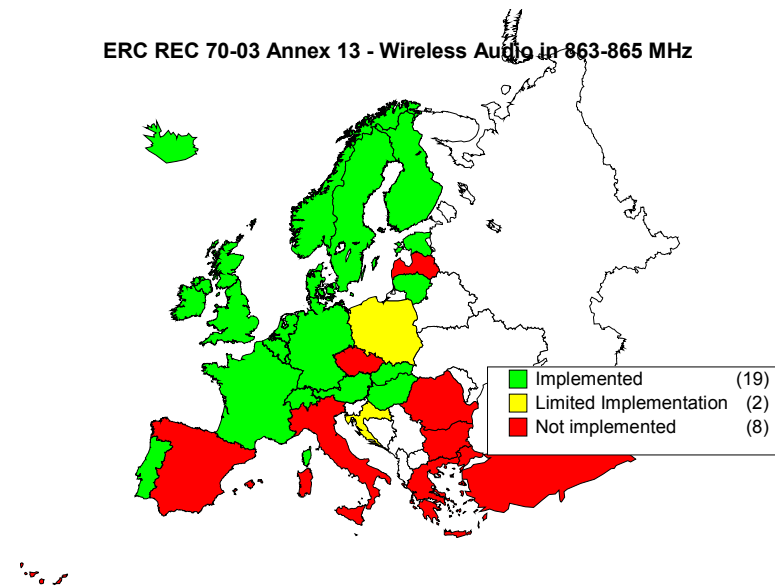


Implementation of ERC REC 70-03 Annex 10 and Annex 13 within the band 862-870 MHz

ERC REC 70-03 Annex 10C - Radio Microphones in 863-865 MHz



ERC REC 70-03 Annex 13 - Wireless Audio in 863-865 MHz



Annex 3 : Networks and third party traffic in SRD bands

Industry and operators have required network operations including the use of repeater stations in SRD bands to allow for private or public networks. Based on a questionnaire to ERC Administrations Spring 2001 the SRD/MG has collected information about the current and future regulation for the use of SRD applications for network operations or as part of networks including 3rd party traffic.

Country	868-870	2400-2483.5	5150-5350	5470-5725	5725-5850	Not allowed	Allowing 3 rd party t/c
Austria		x	x				Yes
Belgium		x					Yes
Denmark	x	x	x	x	x		Yes
Estonia	x	x	x	x	x		Yes
Finland	x	x	x	x	x		Yes
France						x	No
Germany		x (RLANs only)					Yes
Hungary	x	x			x		Yes
Ireland		x	x	x	x		Yes
Italy						x	No
Latvia		x					No
Liechtenstein		x	x				Yes
Luxembourg						x	No
Netherlands	x	x	x	x	x		Yes
Norway		x	x	x	x		Yes
Poland		x					Yes
Portugal	x	x	x	x	x		Yes
Slovakia		x	x				Yes
Slovenia	x	x	x	x	x		Yes
Spain						x	No
Switzerland		x	x				Yes
UK	x	x					Yes
Ukraine		x			x		Yes

Thus 19 European administrations accept the use of SRD applications for network operation within the band 2400-2483.5 MHz under the provisions of ERC REC 70-03. In the 862-870 MHz band only 8 administrations accept the use of network operation.

In countries where network operation and third party traffic is allowed in accordance with the above table a telecommunication license for network operation may be required in the following European countries:

Belgium Germany Slovakia
Estonia Ireland UK

Most European administrations have currently no legal means to prevent network operation in SRD bands. This also includes third party traffic.

It should be underlined that in accordance with ERC REC 70-03 :

- SRDs in general operate in shared bands and are not permitted to cause harmful interference to other radio services
- SRDs cannot claim protection from other radio services.

The use of SRD applications within operator driven networks and third party traffic may, however, occupy the band available, as the traffic loading capacity in a given area is limited. The use of genuine SRD-applications in cellular type networks may dominate the spectrum in a given area and prevent especially the simplest SRD applications from using the band. It is therefore suggested that any networking and use of repeaters within the SRD band 862-870 MHz should be limited to single owned use.

STRATEGIC PLAN FOR THE FUTURE USE OF THE FREQUENCY BAND 2400-2483.5 MHz FOR SHORT RANGE DEVICES

Background

The frequency band 2400-2483.5 MHz has for some time been designated and used for Short Range Devices (SRD). In accordance with ERC Recommendation 70-03 Annex 1, Annex 3, Annex 4 and Annex 6 the band 2400-2483.5 MHz or part of the band is designated for the following different applications:

- Annex 1 – Non-specific Short Range Devices with 10 mW e.i.r.p.
- Annex 3 – Local Area Networks, RLANs with 100 mW e.i.r.p.
- Annex 4 – Automatic Vehicle Identification for Railways with 500 mW e.i.r.p.
- Annex 6 – Movement detection and Alert with 25 mW e.i.r.p.
- Draft new Annex 11 – Radio Frequency Identification applications with up to 4 W e.i.r.p.

SRD equipment is developed and marketed in accordance with a list of harmonised standards including in particular the generic standard EN 300 440 and the standard EN 300 328 for Wide Band Transmission Systems.

In order to promote further harmonisation and stronger commitment from European Administrations the CEPT/ERC has adopted ERC Decisions ERC/DEC(01)05 on Non-specific SRD applications, ERC/DEC (01)07 on Local Area Networks and ERC/DEC (01)08 on Movement detection and Alert.

An overview of the current use of the band and designation of frequencies can be found in Annex 1 and the status of implementation in accordance with the national restrictions informed by administrations is indicated in Annex 2 to this document.

Other services and applications are using the band 2400-2483.5 MHz such as the Fixed Service, SAP/SAB and military services. It should be noted that the frequency band 2400-2483.5 MHz is also designated for Industrial, Scientific and Medical (ISM) applications in accordance with RR footnote S5.150. Radiocommunication services operating within this band must accept harmful interference, which may be caused by ISM applications.

The DSI Phase III consultation process covering the frequency band 862-3400 MHz suggested that a strategic plan be developed for the use of SRD applications within the band 2400-2483.5 MHz and that spread spectrum technology should in general be considered for short range devices.

The current strategic plan is developed based on the results of the DSI and contributions from the ETSI and EICTA organisations. These contributions are based on surveys and consultation with SRD industry within the organisation.

Future market and frequency requirements within the band 2400-2483.5 MHz

In general the information provided by industry indicates an expanded use of the frequency band 2400-2483.5 MHz for Short Range Devices. In particular Wide Band Data Transmission Systems are developing rapidly and new applications such as Bluetooth and HomeRF systems are emerging on the market.

The traditional telemetry and telecommand as well as alarm systems are developing under the framework of Non-specific Short Range Devices and Movement Detection and Alert. Those services are expected to be further developed in future.

The identification systems include Automatic Vehicle Identification (AVI) for Railways and Radio Frequency Identification Systems (RFID). In particular the RFID application is expected to develop dramatically over the coming years.

A more detailed description of each of the SRD applications can be found in Annex 3 to this document.

Strategies for the future use of the band 2400-2483.5 MHz for short range devices

The strategies adopted by the FM WG for the future developments of SRD applications within the band should allow for continued use and further development of the existing SRD applications as described in this report. At the same time it should create possibilities for the development of new services and systems.

Due to the anticipated rapid growth of the above applications the use of certain interference mitigation techniques will become inevitable to allow all the services and applications to co-exist within the band. The mitigation techniques may include the use of sophisticated access protocols, simple listen before talk protocols and restriction on frequency range, power density, duty cycle with sufficiently low averaging time over which duty cycle is measured, indoor/outdoor operation etc.

It is, However, underlined by industry that implementation of the various mitigation techniques should be chosen in a way not to hinder the development of new innovative SRD solutions and have to be well balanced with the cost implications in accordance with each foreseen application.

The possible mitigation techniques could include:

- a) Dynamic Frequency Selection (DFS)
- b) Adaptive frequency hopping techniques where frequency hopping systems avoid channels identified as occupied,
- c) System protocols covering a number of logical layers
- d) Co-existence protocols for transmitters associated with receivers based on “listen before talk” and protocols for stand alone transmitters
- e) New digital modulation techniques such as the Orthogonal Frequency Division Multiplexing (OFDM) technology

For stand-alone transmitters the associated parameters will have to be defined a priori for instance in terms of duty cycle and in order to achieve sufficient mitigation effect the averaging time in the definition of duty cycle.

Further band segmentation by type of application should be avoided and the present segmentation for RFID and AVI (2445-2454 MHz) should not be further expanded.

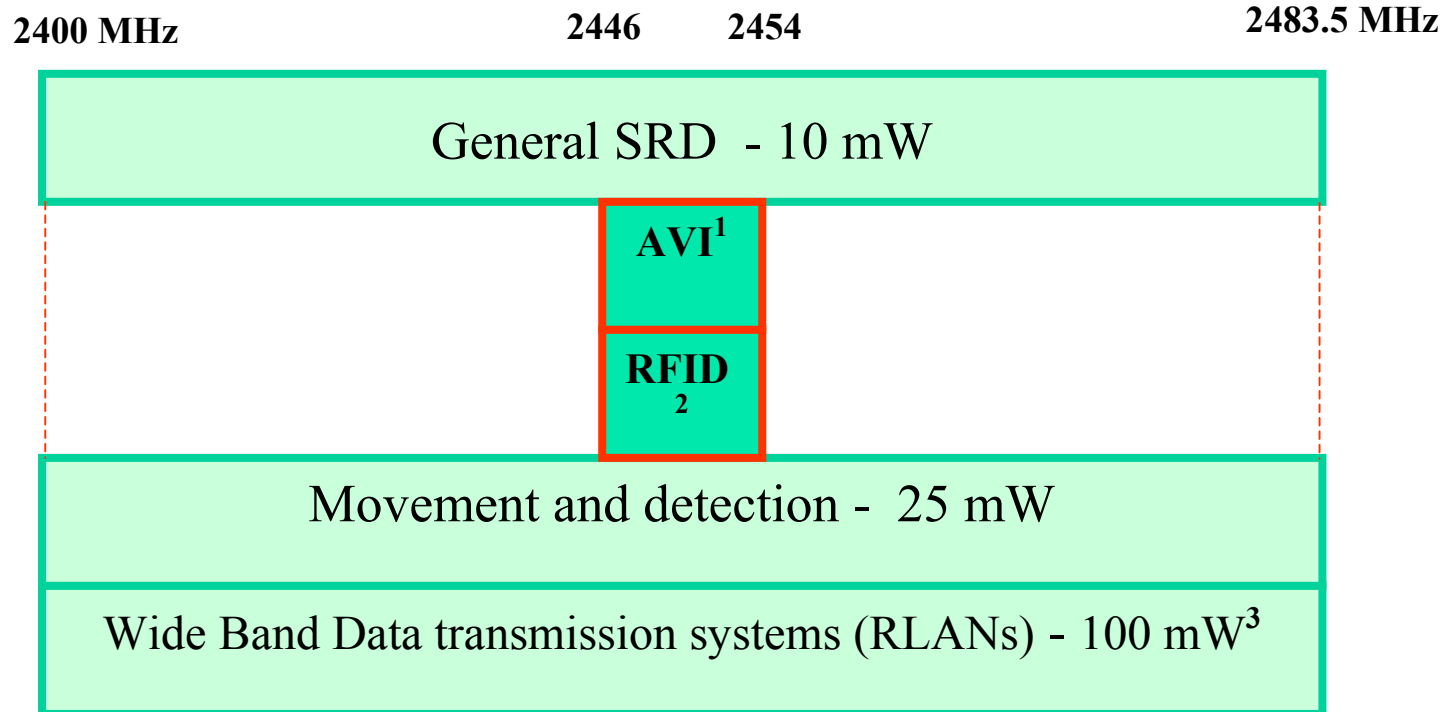
As indicated in the description regarding networks and third party traffic (Annex 4) the use of SRD-applications for public operated networks may dominate the spectrum in a given area and prevent especially the simplest SRD applications from using the band. It is underlined that Administrations have no legal means to prevent public networks in unlicensed Short Range Device bands including the band 2400-2483.5 MHz. The bands are, however, still made available on a non interference and non protected basis and the increased congestion in the band with public genuine cellular networks would lead to require agreements on mitigation techniques for the Short Range Device services in the band. It may, however, be expected that the major operators most likely will avoid the use of unlicensed bands for public services as these bands will not allow them to provide QoS to their customers.

The frequency band 2400-2483.5 MHz is used for Short Range Devices on a world wide basis and it is important that the use of the band is harmonised within Europe in principle without national restrictions. It is also important that world wide harmonisation is achieved as far as possible in order to achieve spectrum access for new innovative services in Europe and the detailed regulation of the band should therefore seek alignment with regulation in other regions of the world.

The SRD developments within the band 2400-2483.5 MHz should adhere to the following strategy:

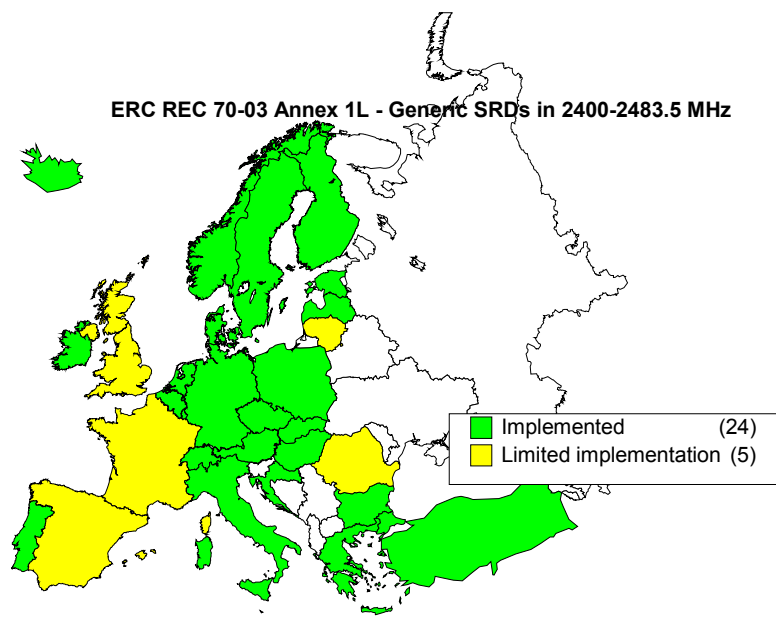
- a) The band should continue to be available for the existing services including
 - Low power Non specific Short Range Devices
 - SRD equipment for movement detection and alert
 - Automatic Vehicle Identification (AVI) for railways
 - RadioLANs.
- b) The RFID service should be introduced based on the new Annex 11 and the results of the compatibility studies included in ERC Report 109 .
- c) To meet a requirement for more services and applications different from the RadioLAN technology but using spread spectrum modulation the limitation of the services to bit rates above 250 kbit/s should be deleted.
- d) The RLANs should in future be called Wide Band Data Transmission systems to include the different applications which have been developed under the RLAN umbrella within the standard EN 300 328.
- e) It is important to achieve co-existence, improve the sharing possibilities and thus provide possibilities for new services and applications in the band. Mandatory requirements for use of mitigation techniques such as sophisticated access protocols, duty cycle requirements, frequency hopping schemes, user restrictions etc, should therefore be introduced in the detailed regulation for the different applications.
- f) To protect existing non-SRD services within the band 2400-2483.5 MHz and to provide possibilities for new and innovative SRD services in the band the close co-operation with industry should be further developed on technical and regulatory parameters for SRD applications.
- g) That the use of the band 2400-2483.5 MHz for short range devices is based on a non interference and non protected basis and it is important to achieve an efficient use of the spectrum available. A possible extensive use of the band for public networks access may, however, dominate the spectrum in a given area and prevent especially the simplest SRD applications from using the band.
- h) The future use of the band 2400-2483.5 MHz for Short Range Devices should as far as possible be harmonised within Europe in principle without national restrictions. Furthermore the regulation should seek alignment with the use in other ITU Regions in order to provide industry and user opportunities worldwide.

Annex 1 : Overview of the existing and future use of the band 2400-2483.5 MHz for SRD applicaitons

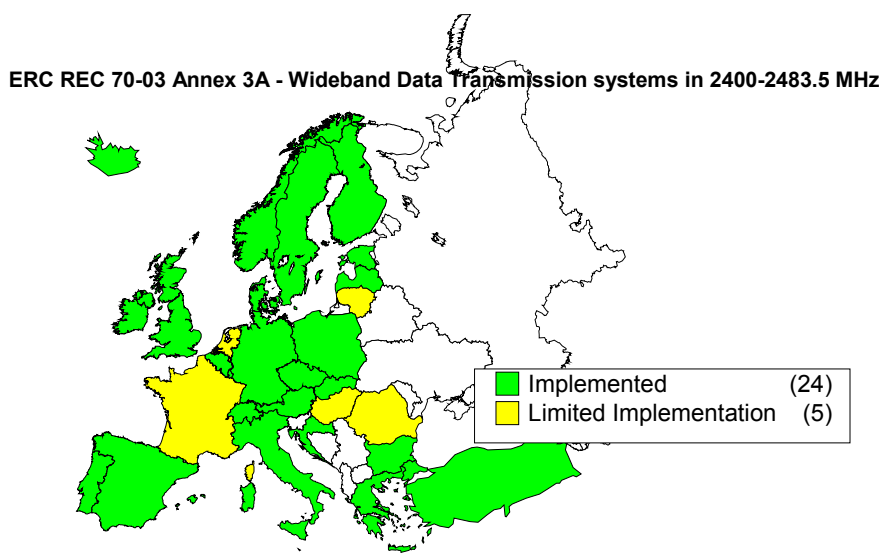


- 1) Automatic Vehicle Identification for Railways (AVI) use 5 channels 1.5 MHz wide within the band 2446-2454 MHz with 500 mW e.i.r.p. Transmission only in presence of train.
- 2) Radio Frequency Identification (RFID) use 2446-2454 MHz with
 - 500 mW e.i.r.p. indoor and outdoor using FHSS or un-modulated carrier (CW)
 - 4 W e.i.r.p. indoor only using FHSS only and with duty cycle limited to 15 %
- 3) For direct sequence spread spectrum (DSS) the maximum spectrum power density is limited to
- 4) -20 dBW/1 MHz. For frequency hopping spread spectrum (FHSS) the maximum spectrum density is limited to -10 dBW/100 kHz

Annex 2 : Implementation of ERC REC 70-03 regarding the band 2400-2483.5 MHz

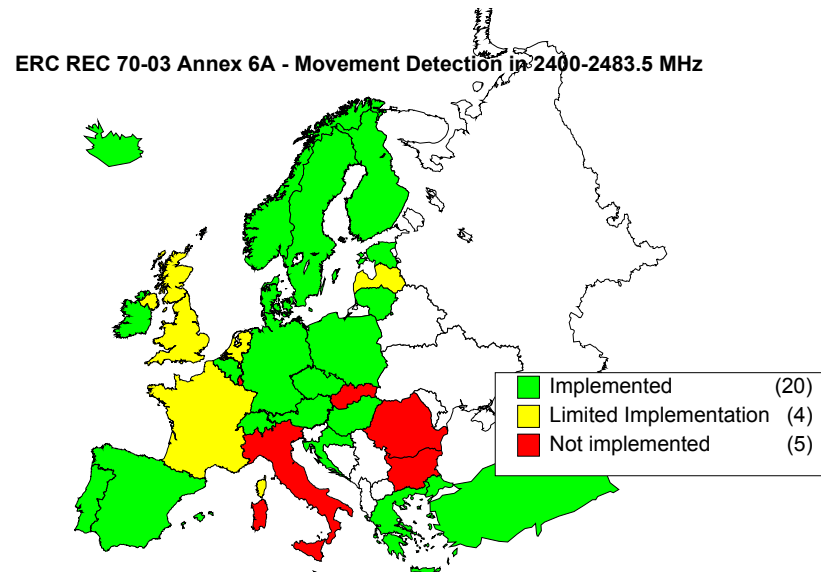


France	Indoor use limited to 10 mW Outdoor use limited to 2.5 mW
Romania	Secondary basis - individual license
Spain	Limited to 2445-2475 MHz
UK	Channels spacing >20 MHz where justified by modulation



France	Limited to 2446.5-2483.5 MHz with some geographical constrains and eirp < -20dBW/MHz Indoor: 10mW eirp in 2400-2446 MHz Inside private area: 2446-2483.5 MHz <100mW authorisation Outside private area: the band is not opened
Hungary	Processing gain min 10 dB, integra or external antenna with max gain 6 dBi
Romania	On a seconday basis - individual license required
Netherlands	10 mW license free indoor and outdoor. 100 mW license free indoor only 100 mW with licence outdoor within 2451-2471 MHz

Implementation by May 2002 of ERC REC 70-03 Annex 6 regarding the frequency band 2400-2483.5 MHz



France	Limited to 2446-2454 MHz with max eirp 500 mW
Latvia	< 10 mW erp
Spain	Limited to 2445-2475 MHz
Netherlands	Indoor use only
UK	Limited to 2445-2455 MHz

Annex 3 : Description of current and future SRD applications

The following information is provided by European industry following a consultation process within ETSI. The description of the different SRD applications also contains specific ETSI statements and proposals on required power levels, duty cycle restrictions and compatibility issues. The Annex should be seen as an informative annex as background for the strategic plan for the frequency band 2400-2483.5 MHz.

Non Specific Short Range Devices

General

Non Specific Short-Range Devices include building technology and alarms, metrology, time synchronized telemetry, high speed telemetry links, alarms, vehicle data downloads

Example of current and new non-specific SRDs’ foreseen in future:

- telemetry and high data rate systems (analogue and digital incl. spread spectrum)
- alarms
- wireless analogue and digital video as well as professional and amateur camera
- time synchronized telemetry
- detecting and movement
- metrology and high precision metrology systems
- vehicle data downloads
- building telemetry and alarms
- wireless data collection terminals (RFDC).

Detailed specifications are not available for all systems at present. To move forward it is anticipated that generic concepts covering several applications shall be considered in the same way as the current implemented SRDs.

To cover these new and other applications, three types of generic SRD types are foreseen in the 2,45 GHz band:

	Non-spread spectrum	Frequency hopping spread spectrum	Other spread spectrum systems
ERC REC 70-03	Annex 1	Annex 3	Annex 3
Standards	EN 300 440 – 1 &2	EN 300 328 –1 & -2	EN 300 328 –1 & -2
power/peak power density	10 mW e.i.r.p	100 mW/100 kHz e.i.r.p	10 mW/1MHz e.i.r.p
Frequency range	single or multiple frequencies within the 2,45 GHz band	entire band	entire band
Duty cycle/ access protocol	No restriction	Listen before talk under consideration	Listen before talk under consideration
Indoor/outdoor	No restriction	No restriction	No restriction
Antenna	Dedicated or integral	Dedicated or integral	Dedicated or integral
Technology type/bandwidth	< 20 MHz	FHSS	DSSS & other forms of digital modulation
Mitigation	the low power acts as its own mitigation	Spread spectrum, access protocol	Access protocol, possibly duty cycle

RFID

Radio Frequency Identification (RFID) technology promises a radical change and improvement in the productivity of the collection of data in the supply chain from suppliers to manufacturers, warehouses or retailers. The concept of RFID involves the placement of small transponder devices on merchandise or other items, which allows their identification and tracking by RF. RFID technology eliminates the need for the reader or data collection device to have an optical line-of-sight path to the item, as is the case with bar codes. In addition to the supply chain related applications, there are a host of other applications where RFID technology can be used to identify assets or people for a variety of reasons.

Since today's supply chains are global, it is desirable that the devices used to identify and collect transaction data operate on a global scale to facilitate the international flow of goods. The 2.45 GHz band is a practical place in the frequency spectrum where adequate bandwidth is available to accommodate multiple, licence exempt and unsynchronised systems.

RFID is divided into the following categories:

	Battery less tag systems	Battery tag systems	Special tag systems using SAW or other tag resonator elements
	Annex 11	Annex 11	Not yet included
Standards	EN 300 440 – 1 &2	EN 300 440-1&-2	EN 300 440-1&-2
power/peak power density	4W eirp indoor/500 mW outdoor	500 mW eirp within the band 2446-2454 MHz	10 mW/1MHz e.i.r.p
Frequency range	2446-2454 MHz	2400-2483.5 MHz	2400-2483.5 MHz
Duty cycle/ access protocol	15% for 4 Watt indoor 100% for 500 mW outdoor	No restriction	No restriction
Indoor/outdoor	4W indoor use only	No restriction	No restriction
Antenna	Dedicated or integral with focused beam	Dedicated or integral	Dedicated or integral
Technology type/bandwidth	FHSS	FHSS & CW	FHSS
Min data rate	> 70 kbit/s symbol rate in air	16 kbit/s	TBD
Mitigation	Duty cycle, FHSS, antenna beamwidth	Antenna beam with	FHSS and antenna beamwidth
User scenario	Anywhere in the supply chain < 1m	Limited applications < 7-10 m	Special applications for e.g., automotive manufacturing

AVI for Railways

AVI for railways is an RFID system to determine the position and movement of the railway rolling stock.

Current status in 70-03
included in Annex 4.

ETSI Standards
EN 300 761

Required power/peak power density
500 mW eirp

Frequency range
2446-2454 MHz

Duty cycle/ access protocol
100% duty cycle w/o access protocol in presence of a train

Indoor/ outdoor
outdoor only

Antenna
integrated antenna with gain and limited beamwidth

Bandwidth/modulation type technology
5 channels inside 2446-2454 MHz,

-other technical features:
dynamic frequency allocation option

Minimum data rate:
Actual data rate 65 kbit/s

Usage scenario
Transmitter mounted in the railway track

Wireless LAN (RLANs)

RLANs are Wide Band Data Communication Systems using Spread Spectrum modulation techniques as described by annex 3 of CEPT Rec. 70.03.

RLANs offer mobility and flexibility to an enterprise enabling users to have network and Internet access anywhere within a building or campus without the limitation of wires. Besides desktop and notebook computers in a wireless office, also hand-held terminals and vehicle-mounted computers can be equipped with RLAN devices for wireless data applications in warehouses and in the retail industry.

More recently RLAN devices have also been used for wireless private (on-site) IP telephony and for wireless home applications such as wireless access to the Internet.

Current status in 70-03:	annex 3
ETSI Standards:	EN 300 328
Required Power:	100 mW eirp omnidirectional
Peak Power Density:	DSSS : 10 mW/MHz (omni) FHSS: 100 mW/100 KHz (omni)
Frequency Range	2400 – 2483.5 MHz
Access protocol	IEEE 802.11b
Duty cycle	RLANs, by their nature can not accept an implementation of a duty Cycle. Issues of spectrum efficiency and sharing are achieved by using an access protocol.
Indoor/outdoor	both
Antenna	type 1 (integrated) and type 2 (dedicated)
Modulation / technology	Spread Spectrum / DSSS & FHSS

Co-existence ability

As victim

- FHSS has a certain level of immunity to interference due to its hopping nature.
- DSSS is more sensitive to interference from co-channel and co-located systems and users.

As interferer

- Access protocol for efficient use of the available spectrum.
- RLANs use spread spectrum modulation to improve sharing possibilities with other services which is in line with Rec 17.7 out of the DSI Phase III report
- DSSS : low peak power density
- FHSS: hopping entire band / dwell time is limited

Bluetooth

Introduction

Bluetooth is an Industry Standard for ad hoc wireless connectivity, created by the Bluetooth Special Interest Group (SIG) www.bluetooth.org. In the spring of 2001 the Bluetooth SIG released the version 1.1 of the Bluetooth Specification, which covers the protocol layers from radio to MAC and includes also Profiles, specifying how different services are set up on the Bluetooth protocol stack. The Bluetooth SIG currently has about 2500 members worldwide. Bluetooth is defined to be a low cost, low current consumption technology for mobile devices. The goal has been to create a “cable replacement” for cables between for instance mobile phones and PC’s.

Some popular user scenarios:

- Synchronisation of data (hidden computing)
- “Brief case trick” – automatic upload and download of emails etc from/to a portable PC to a mobile phone via Bluetooth.
- Headset
- E-commerce
- Cordless connectivity for mobile phones

and many, many others.

Current status in 70-03

Bluetooth is a system which combines both voice and data transmission with focus on mobile devices. In the context of regulatory categorisation Bluetooth is specified as a RLAN, i.e. following the ERC Recommendation 70-03 annex 3.

ETSI Standards

Within EU and many other countries worldwide the applicable normative standards are EN 300 328 and EN 301 489-17 for EMC. Other widely recognised standard applicable for Bluetooth products is FCC CFR part 15.247 and in Japan J-STD 66

Required power

The Bluetooth specification categorise devices into power classes 1,2 and 3 with 100 mW, 2.5 mW and 1 mW output power respective.

Frequency range

The Bluetooth system makes use of 79 channels, starting at 2402 MHz and stopping at 2480, with a channel bandwidth of 1 MHz wide. At each end of the spectrum there is defined a guard band (2 MHz at the low end and 3.5 MHz at the high end), thus the total used frequency range is 2400 – 2483.5 MHz.

Duty-cycle / Access protocol

A Bluetooth device that initiates communication becomes the “master” in a piconet. The piconet can have an additional 7 Bluetooth devices, which are then named “slaves”. Each Bluetooth device has a unique identifier Bluetooth Device Address (BDA), which is actually a 48-bit IEEE number. From this address an access code is derived for every device. Connections are set up through an Inquiry and Page scheme, in which the master send out short sequences of access codes on predetermined channels at which all Bluetooth devices will listen.

When a Bluetooth device responds to a Page and a connection is set up, the connection can bear a link with pure voice information, pure data or a mixture. The duty cycle on an active link will vary from 29 to 77 % depending on the packet type used. It shall be noted that the duty cycle of a Bluetooth device over a normal working day is far less, probably well below 10 % for most user scenarios (maximum data speed is 721 kb/s), since connections are only set up when data needs to be transmitted.

Indoor/outdoor

Bluetooth is a technology with focus on mobile devices. Even if most devices will be used indoors they will normally be carried outdoors by their owners (mobile phones, PDAs, Portable PCs, cameras, etc). The limitation to indoor use in some countries is a problem, which naturally is difficult to check if users comply with.

Antenna

If antennas with more gain than 0 dBi are used the feeding power (see required power section) must be reduced in accordance with the eirp power requirements in ETSI standards (and FCC requirements).

Bandwidth and modulation

Modulation used is GFSK (BT=0.5), with a modulation index between 0.28 and 0.35. –20dB bandwidth is 1 MHz in accordance with FCC requirements.

Minimum data rate

The gross over the air data rate is 1 Mb/s.

Mitigation techniques

As an interfered victim

A frequency-hopping scheme with 1600 hops/s with retransmission of corrupted packages is used. Forward Error Correction is applied to many packet types. A CVSD (Continuous Variable Slope Delta modulator) voice coding is used, which gives a graceful degradation of voice quality if the channel is interfered.

As a potential interferer

Power class 1 devices have a mandatory power of 20 dB (down to 0 dBm), depending on the Received Signal Strength Indicator (RSSI). Connections are only set up when data is to be transferred, resulting in low average spectrum usage.

Voice Access

Initially RLAN technologies were primarily intended for data applications. However with the advent of Voice over IP and specialist protocols, these technologies may be used to support real time speech traffic with toll quality voice. Examples of voice applications utilising these RLAN technologies are given below.

IEEE 802.11

The IEEE 802.11b RLAN infrastructure may be used to provide corporate voice services over traditional data networks. This enables corporations to utilise capacity over their existing Ethernet based data network. It also allows data connections on PABX's to be used for both data and voice as the demand changes without the need for re-wiring.

As these voice products use the same IEEE 802.11b protocols as existing RLAN products no changes are required to either CEPT recommendation 70-03 or ETSI standards EN 300 328-2 and EN 301 489-17. These products are intended to provide voice access to mobile workers, therefore omni-directional antennas are required and the current 100mW power limit is sufficient for the intended purpose.

The actual transmission format of the signal is no different whether the service carried is live speech or data exchange.

HomeRF

Outwardly similar in all respects to the IEEE 802.11b solution, the HomeRF voice solution is primarily aimed at the domestic market as an alternative for current domestic cordless telephones in the fully networked home. Higher level DECT protocols are used to provide a toll quality service that is both resistant to and does not cause interference to other users.

As with the IEEE 802.11b products, the existing CEPT recommendation and ETSI standards do not require any modification in order to place these products on the EU market.

However the latest version of EN 300 328 allows higher data rate within HomeRF which can be used to extend the number of simultaneous voice channels to eight.

Bluetooth

Certain Bluetooth products are intended to carry real time speech. The Bluetooth protocols and supporting standards have been designed with this function in mind.

Particular implications

Real time speech is more sensitive to breaks in the communication link and delay than data traffic. As a consequence the voice packets are required to arrive regularly.

Co-existence ability

For information on co-existence, please refer the relevant section for the base transmission technology.

Home Networking

General

HomeRF is a technology that has been developed to satisfy the growing needs of the home networking market. Some estimates are for more than 25% of US households to be networked by 2004. Similar growth can be expected in all regions of the world where broadband Internet access through such technologies as DSL and data over cable is being deployed.

HomeRF satisfies the home networking needs of the broadband Internet home by delivering

- a) 10 Mb/s peak data rate with fallback of 5 Mbs, 1.6 Mbs and 0.8 Mbs in a flexible topology
- b) 8 simultaneous prioritized streaming media sessions for one-way, two-way and multicast streaming– audio, video
- c) 8 toll-quality cordless voice connections
 - HomeRF, like DECT, uses 32K ADPCM on a 10 ms frame structure for high quality voice
 - All CLASS features such as Call Line ID, Call Waiting, Call forward, Intercom, 112 breakthrough etc.
- d) Industry-leading security capabilities
 - Powerful security measures against eavesdropping and denial of service

Current Status in 70-03

In the context of regulatory categorisation HomeRF is specified as an RLAN, i.e. following the ERC Recommendation 70-03, annex 3.

ETSI Standards

Within the EU and many other countries worldwide the applicable normative standards are EN 300 328 and EN 301 489-17 for EMC.

Required Power

The HomeRF specification defines two different power classes. The low power mode has a maximum power of 4 dBm, and the high power mode has a maximum power of 20 dBm.

Local regulations may further restrict these power levels, or they may permit increases in power. HomeRF can adapt its power level to these local regulations.

Under EN 300 328 the maximum power level allowed is 20 dBm for all devices.

Frequency Range

The HomeRF system uses 75 MHz of bandwidth, starting at 2403 MHz and stopping at 2477 MHz. The spectrum is used either as 75 hopping channels of 1 MHz each, or as 15 hopping channels of 5 MHz each for increased data throughput. At each end of the spectrum used there is a guard band defined, thus the total used frequency range is 2400 – 2483.5 MHz. In certain countries and regions, regulations further restrict the permitted frequency range. HomeRF can adjust to these restrictions

Duty Cycle / Access Protocol

HomeRF uses two basic protocols for accessing the medium.

Voice connections make use of the DECT protocol. TDMA time slots are reserved for both links of the call for its duration.

Data is sent using an Ethernet-like CSMA access protocol with collision avoidance. The duty cycle for data communications is dependent on the type of data being transmitted. This access methodology has been enhanced to provide priority access for streaming connections.

The descriptions above illustrate why HomeRF either cannot, or need not, be subject to a duty cycle restriction. The voice component of HomeRF transmits a real-time voice stream. In the current implementation each link (uplink and downlink) of the HomeRF voice protocol operates only 5% of the time. The data component of HomeRF uses CSMA to avoid interfering with other systems. A specific duty cycle limitation might prohibit the transfer of high burst rates of data, one of the characteristics of data communications.

Indoor / Outdoor

HomeRF, as a home networking technology, has a focus on indoor communications. However, the goal of these networks is to provide coverage throughout the home and yard, so these devices are also used in the exterior of peoples' homes.

Antennas

Antennas have 0 dBi of gain.

Bandwidth / Modulation / Technology

HomeRF products use either 1 MHz or 5 MHz in each hopping channel and conform to CEPT Rec. 70.03 Annex 3. The modulations for all bandwidths are 2-level or 4-level FSK modulation, depending on the data rate.

Minimum Data Rate

HomeRF supports data rates of 800 kbps, 1.6 Mbps, 5 Mbps, and 10 Mbps. Voice connections support 32 kbps streams in both the uplink and downlink directions.

Coexistence Ability

As Victim

HomeRF makes use of frequency hopping spread spectrum technology, spreading the transmissions over 75 MHz in the 2.45 GHz band. Whenever interference corrupts the signal, the devices can resume their data transfer after the next hop to a new frequency that is clear. The MAC level retry mechanism will ensure that data blocked by interference will be sent until it is successfully transmitted. Therefore, while bandwidth drops each time the device encounters a blocked frequency, interference does not break a connection. In the presence of interference, the connections do not fail and throughput will degrade gracefully. HomeRF also employs an adaptive hopping mechanism to avoid having two consecutive hops within a defined, static interference region. Adaptive hopping improves the latency and the bit error performance of all of the services, especially the voice and streaming services.

As Interferer

HomeRF uses frequency hopping spread spectrum technology at 100 hops per second to spread its signal over 75 MHz in the 2.45 GHz band. Frequency hopping technology is widely used in situations where many uncoordinated systems are expected to be operating. Because the emissions are spread over almost the entire available band, interference to other systems is minimized.

The hopset adaption mechanism discussed earlier avoids adjacent hops into an identified static signal. While this mechanism is designed to avoid interference from the static signal into HomeRF, this also helps avoid HomeRF interference into this static signal.

The access mechanism for data packets is CSMA with collision avoidance. This means that HomeRF will sense the medium for the presence of another signal before it attempts to send data packets. This also helps avoid HomeRF interference to other systems.

Fixed Wireless Access

General

Some European countries have licensed (or have plans to license) or has allowed licence exempt usage of the 2.45 GHz band for public fixed wireless access services. For example in UK , the operator currently needs to hold a telecommunications licence and an appropriate wireless telegraphy licence – for which the Administration can require the operator to use suitably robust equipment.

Such FWA operations comply with the Annex 3 of ERC Rec 70-03. The technology used typically conforms to the ETSI standard EN 300 328, which is the standard for 2.45 GHz Wide Band Data Communication Systems. Network topologies may either be point to multipoint (where a number of central base stations serve many subscriber stations each) or mesh (where each station interconnects with neighbouring stations which can act as repeaters to deliver traffic to the eventual addresses.)

In general, all FWA stations are outdoors – typically mounted on rooftops or at high points on the building. Services vary but typically include POTS telephony, basic rate ISDN, and data services for internet services. Typical customers may be either residential or small businesses. In many ways the delay characteristics of voice telephony place the most demanding

constraints on the technology – in contrast to most data applications, repeated retransmission of digitised speech packets corrupted by interference is not a practical proposition. However, in Frequency Hopping systems, retransmission of speech samples on vulnerable links on successive hops, well separated in frequency, offers significant extra immunity to unpredictable interference.

FWA systems offer an alternative to wired broadband solutions (e.g. xDSL and cable modems) enabling challenger operators a fair competition with the incumbent one, thus accelerating the local loop unbundling. FWA systems are being successfully deployed in urban areas, but the competitive advantage towards wired solutions becomes stronger the further we go into the rural direction. Thus it is expected that the FWA deployments will also be in rural scenarios, which should be taken into account when reviewing the future use of the 2.45 GHz band.

Current status in Rec 70-03

Current usage complies with Annex 3 of 70-03, and at this level each telecommunications link loosely resembles an RLAN apart from the nature of the traffic particularly if circuit switched telephony services are being delivered.

ETSI standards

Typically, FWA systems in the 2.45 GHz band comply with EN 300 328. Also they typically comply with one of the Fixed Radio Systems standards written by ETSI TM4. The Authority may require performance characteristics beyond those specified by these standards as a licensing condition for public telecommunications operation.

Required power

Compliance with EN 300 328 has restricted EIRP to 100mW in current systems, which limits the operational range to several hundred meters.

Similar technology has been deployed in other bands exclusively licensed to the operator at much higher power levels where base-subscriber ranges of over 15 km have been supported.

A study supported by practical experience, has shown that FWA systems can tolerate multiple indoor omni-directional RLANs compliant with EN 300 328. Although this study has not addressed the interference potential of 500mW eirp directional outdoor systems, it is believed that isolated or very low density deployment of such RLANs as bridges between buildings on a campus, would not significantly impact the operation of an FWA system in the vicinity.

In urban scenarios the link ranges constricted by the 100 mW power are sufficient, though in rural cases this is apparently not enough due to considerably lower subscriber densities. Thus future FWA systems may benefit from an EIRP rise to 500 mW to enable rural deployment and campus use.

Frequency range

Frequency hopping offers best benefits when the signal is spread as much as possible. Best advantage occurs when the FWA service is allowed to use the majority of the 2,45 GHz ISM band – but instantaneously any single communications link may only occupy a very small subset – perhaps as little as 1MHz channel – while other links in the same area occupy different channels to avoid mutual interference

Duty cycle/access protocol

Although an access protocol is used to organise the use of spectrum within an FWA network, no protocol or etiquette is currently used to enhance coexistence with other ISM band (licence exempt) applications.

Because of the nature of telephony traffic, prolonged periods of 100% duty cycle¹ (though locally a maximum of 50 % is anticipated) can be experienced, although the Frequency Hopping nature can reduce the duty cycle observed at any particular frequency. Data traffic is in general more random and thus will by its nature reduce the duty cycle.

Indoor/Outdoor

FWA systems are almost exclusively deployed out of doors.

Antennas

For point to multipoint FWA systems Central (Base) stations typically use sectored antennas, typically 60 or 90 degrees. Subscriber stations usually have more directional antennas directed towards the base station. In mesh FWA systems omni-directional antennas on the horizontal plane are preferred to directional ones especially in subscriber stations. Directional antennas or a set of them can also be used if some mesh topology benefits can be sacrificed (delay, coverage, redundancy).

Bandwidth/modulation/technology

Current regulations and knowledge of FH being the most robust choice for FWA operation sets the typical channel bandwidth to 1 MHz. Usually only 1- and 2-level modulation (e.g. GFSK, GMSK, 2/4-PSK) is used leading typically to 1 and 2 Mbit/s data rates.

¹ The actual duty cycle depends on the used protocol and network topology as well as the length of the inspection window.

Minimum data rate

Compliant to EN 300 328 and ERC Recommendation 70-03 Annex 3.

Co-existence ability

A co-existence CEPT study covering FWA on 2.45 GHz is currently lacking.

It is understood that theoretical and empirical studies assessing the potential congestion in the band, recommended that only one operator is licensed to offer public FWA services in the band in any area, and RA has accepted this advice in UK. These studies also concluded that outdoor RLANs are likely to be the most significant source of interference to FWA in the band in future and that increasing RLAN EIRP to 500mW could affect the viability of FWA systems in the band. This could represent a starting point for the CEPT work, however for understanding some brief considerations are offered below.

It is assumed that the FH spread spectrum characteristics of EN 300 328 minimises the interference inflicted on other services in the band, while providing a degree of robustness in the presence of other services.

As victim

FWA systems based on FH will momentarily loose bursts or packets. To ensure that there is not severe service degradation ARQ is usually deployed. This means in practice that, if needed, retransmissions are done later (time) and on another channel (frequency). Assuming the band is not completely crowded FWA services will be able to coexist with other applications with some service degradation.

Another aspect is the antenna beam form. The main beam is in the horizontal direction and thus interference from some sources will be suppressed. Also the placing of the antenna on a rooftop creates in some extent building isolation from indoor applications.

As interferer

FWA systems incorporate typically power control and thus operate with the lowest power possible. Another inherited factor is the antennas and their location. Antennas are installed mainly on rooftops. Their beam is concentrated in the horizontal direction meaning that vertically the isolation (=typically a negative antenna gain) easily exceeds 20 dB compared to the main beam. Adding isolation from the buildings themselves will already able some other applications to co-exist on the same frequency channel. Adding frequency hopping to this will enable the rest of the applications to co-exist.

FWA systems by default run an access protocol. This in conjunction with the fact that the interference mainly affect victims very close to the FWA transmitter or in the main beam of the transmission will further reduce the total effect of the interference. Vast majority of the FWA systems on 2.45 GHz work with TDD, thus creating a virtual duty cycle seen by the victims (it is extremely improbable that a single victim would be within interference range of all FWA devices sharing the same channel).

Additional techniques as adaptive frequency hopping or listen before talk can be considered to further reduce interference and enhance co-existence with other applications.

Non-SRD radio services

For radio services in the band 2400-2483.5 MHz other than Short Range Devices reference should be made to the existing and planned ERC Reports on the particular issues:

ERC Report 38	Handbook on radio equipment and systems video links for ENG/OB use
ERC Report 109	Compatibility of Bluetooth with other existing and proposed radio communication systems in the 2.45 GHz frequency band.
ECC Report 002	SAP/SAB (incl. ENG/OB) spectrum use and future requirements

Annex 4 : Networks and third party traffic in SRD bands

Industry and operators have required network operations including the use of repeater stations in SRD bands to allow for private or public networks. Based on a questionnaire to ERC Administrations Spring 2001 the SRD/MG has collected information about the current and future regulation for the use of SRD applications for network operations or as part of networks including 3rd party traffic.

Country	868-870	2400-2483.5	5150-5350	5470-5725	5725-5850	Not allowed	Allowing 3 rd party tfc
Austria		x	x				Yes
Belgium		x					Yes
Denmark	x	x	x	x	x		Yes
Estonia	x	x	x	x	x		Yes
Finland	x	x	x	x	x		Yes
France						x	No
Germany		X (RLANs only)					Yes
Hungary	x	x			x		Yes
Ireland		x	x	x	x		Yes
Italy						x	No
Latvia		x					No
Liechtenstein		x	x				Yes
Luxembourg						x	No
Netherlands	x	x	x	x	x		Yes
Norway		x	x	x	x		Yes
Poland		x					Yes
Portugal	x	x	x	x	x		Yes
Slovakia		x	x				Yes
Slovenia	x	x	x	x	x		Yes
Spain						x	No
Switzerland		x	x				Yes
UK	x	x					Yes
Ukraine		x			x		Yes

Thus 19 European administrations accept the use of SRD applications for network operation within the band 2400-2483.5 MHz under the provisions of ERC REC 70-03.

In countries where network operation and third party traffic is allowed in accordance with the above table a telecommunication license for network operation would be required in the following European countries:

Belgium Germany Slovakia
Estonia Ireland UK

Most European administrations have currently no legal means to prevent network operation in SRD bands.

This also includes third party traffic.

It should be underlined that in accordance with ERC REC 70-03 :

- SRDs in general operate in shared bands and are not permitted to cause harmful interference to other radio services
- SRDs cannot claim protection from other radio services.

The use of SRD applications within operator driven networks and third party traffic may, however, occupy the band available, as the traffic loading capacity in a given area is limited. The use of genuine SRD-applications in cellular type networks may dominate the spectrum in a given area and prevent especially the simplest SRD applications from using the band.