CEPT ECC
Electronic Communications Committee

ECC Report 189

Future Spectrum Demand for Short Range Devices in the UHF Frequency Bands

Approved February 2014

0 EXECUTIVE SUMMARY

0.1 BACKGROUND TO THE DEVELOPMENT OF THE REPORT

Significant demand for additional UHF spectrum resources at 870-876 MHz and 915-921 MHz has been demonstrated by the request of five Systems Reference Documents from ETSI, covering the SRD applications:

- Generic SRD, RFID, Home Automation & Sub Metering and Automotive SRD, TR 102-649-2 [1];
- Smart Meters and Smart Grids, TR 102 886 [3];
- Metropolitan Mesh Machine Networks (M3N) applications, TR 103 055 [4];
- Alarm and Social Alarm systems, TR 103 056 [5] and
- Assistive Listening Devices, TR 102 791 [6].

These five ETSI System Reference Documents were accepted by WGFM. All five System Reference Documents requested spectrum be designated for their application in the bands 870-876 / 915-921 MHz. Some of the ETSI System Reference Documents expressed a preference for a designation in one of these two frequency bands. The WG FM SRD/MG was tasked with investigating the requests within the ETSI System Reference Documents, with a view to suggesting amendment of the Recommendation for Short Range Devices, ERC/REC 70-03 [2].

Therefore, this Report suggests possible SRD usage within the 870-876 / 915-921 MHz frequency bands. In the ITU-R Region 2, the band 902-928 MHz is identified as an ISM frequency band and commonly used for SRD. The alignment of SRD designations over part of this band was identified in the ETSI System Reference Document TR 102 649-2 [1] as a clear benefit of using the 915-921 MHz band, particularly in the case of UHF RFID.

To gauge the likelihood of national implementation of any subsequent recommendation, WGFM sent a questionnaire to CEPT member states. The result of the questionnaire, (set out in Annex 3 to this Report) indicates that while there are several administrations where implementation of the SRD Recommendation will be problematic or partial, there remain a number of administrations where full implantation is possible.

WG SE developed the sharing analysis published as ECC Report 200 [7]. The primary services considered in this sharing analysis were MFCN including GSM-R in adjacent bands along with ER-GSM and assorted government services within the 870-876 / 915-921 MHz bands. ECC Report 200 [7] found that

- sharing with non-governmental applications was possible under certain technical conditions;
- sharing with many governmental applications was not possible without any mitigation techniques and further restrictions such as a limitation in deployment figures.

That report also suggested that intra-sharing of all the proposed SRD applications was possible.

0.2 PURPOSE OF THE REPORT

This Report therefore has the purpose to determine a set of regulatory parameters for SRD in the 870-876 / 915-921 MHz bands. In determining these parameters, the principles of;

- CEPT Report 14 [8] SRD Strategy;
- CEPT Report 44 [9] CEPT Response to the 5th update of the European Commission's mandate on SRD;
- ECC Report 200 [7] Co-existence studies for proposed SRD and RFID applications in the frequency band 870-876 / 915-921 MHz and
- ECC Report 181 [10] Improving Spectrum Efficiency in the SRD Bands.

were observed. In consequence, this Report suggests a set of SRD parameters that are as application neutral as possible, while having the minimum, but sufficient, technical constraints that ensure the efficient use of spectrum.

These individual demands were assessed within this Report as groups of nine different SRD applications. These grouped applications are:

- Generic SRD;
- RFID;
- Home Automation and Sub Metering;
- Smart Meter;
- Smart Grid;
- Metropolitan Mesh Machine Networks;
- Surveillance Alarms, Fire/Smoke Alarms, Intruder Alarms, Social Alarms;
- Automotive Active Safety, Automotive Diagnostic Data Exchange, Automotive Freight Protection, Automotive Environmental & Safety Systems;
- Assistive Listening Devices.

These nine application groups were then assessed for their spectrum "needs". The preferred approach for SRD in the strategy is for generic designation, unless there is sufficient justification to do otherwise. The analysis of both the ECC Report 200 [7] and the analysis in this report suggest the majority of SRD can indeed operate within a set of generic designations. These are therefore suggested for inclusion in ERC/REC 70-03 [2] Annex 1. There were however some SRD that could be justified in having a more specific designation. These have therefore been suggested for inclusion in ERC/REC 70-03 [2] Annexes 2, 5, 10 and 11.

Finally, it should be highlighted that the set of regulations defined in this ECC Report is flexible in proposing alternative mitigation techniques. This is included in different notes in Recommendation ERC/REC/70-03 [2] and takes into account different primary services which are in operation in individual countries in the considered frequency bands. Therefore, this ECC Report proposes a set of regulation which constitutes a catalogue in which each country should accommodate its implementation with regard to the primary service operating in the frequency band under consideration.

0.3 CONCLUSIONS AND RECOMMENDATIONS OF THE REPORT

The proposed designations of SRD resulting from the requests, in all five ETSI System Reference Documents are listed at Annex 4. This Report suggests that the contents of Annex 4 to this report are transposed into ERC/REC 70-03 [2].

One set of devices, designated as Network Relay Points, operating within Metropolitan/Rural Area Networks were studied. The conclusion is that where two or more different networks are co-located there may be the need to ensure that higher duty cycle Network Relay Points do not interfere with each other as well as other users of the band, e.g. by means of individual authorisations or consideration of alternative frequency opportunities.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
AIDC	Automatic Identification and Data Capture
AFA	Adaptive Frequency Agility
ALD	Assistive Listening Device
APC	Adaptive Power Control
BR IFIC	ITU Radiocommunication Bureau International Frequency Information Circular
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations
DAA	Detect And Avoid
DC	Duty Cycle
EAS	Electronic Article Surveillance
ECC	Electronic Communications Committee
ECN&S	Electronic Communications Networks & Services
E-GSM-R	Extended GSM-R spectrum
EM	ElectroMagnetic
ERC	European Radiocommunications Committee
ER-GSM	Extended Railway GSM spectrum
ETSI	European Telecommunications Standards Institute
EVDO	Evolution Data Only
FM	Frequency Modulation
GFSK	Gaussian Frequency Shift Keying
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HSPA	High Speed Packed Access
IEEE	Institute for Electrical and Electronics Engineers
IoT	Internet of Things
ISM	Industrial, Scientific and Medical
ISO	International Organisation for Standardisation
ITS	Intelligent Transport Systems
ITU-R	International Telecommunication Union – Radio Sector
KNX	Konnex (Open Standards for Home and Building Control)
LAN	Local Area Network
LDC	Low Duty Cycle
LBT	Listen Before Talk
LTE	Long Term Evolution (4G)
M2M	Machine to Machine
M3N	Metropolitan Mesh Machine Network
MFCN	Mobile Fixed Communications Network
M/RAN	Metropolitan/Rural Area Network
NRP	Network Relay Points
NTFA	Nation Table of Frequency Allocations
PLT	Power Line Technology

PMR	Professional Mobile Radio
QoS	Quality of Service
RF	Radio Frequency
RFID	Radio Frequency Identification
SM/SG	Smart Metering/Smart Grids
SRD/MG	Short Range Devices Maintenance Group
TETRA	TErrestrial Trunked RAdio
TR	Technical Report
TRR	Tactical Radio Relay
TRS	Telecoil Replacement System
TPMS	Tyre Pressure Monitoring Systems
TTT	Transport and Traffic Telematics
UAS	Unmanned Aircraft System
UHF	Ultra High Frequency
UMTS	Universal Mobile Telecommunication System
WAN	Wide Area Network
WG FM	Working Group Frequency Management
WG SE	Working Group Spectrum Engineering
WLAN	Wireless Local Area Network
ZigBee	Zonal Intercommunication Global standard of the ZigBee Alliance

1 INTRODUCTION

The present Report describes the future spectrum demand for short range devices in the UHF frequency bands 870-876 / 915-921 MHz. The Report is based on information and the spectrum requests at 870-876 MHz / 915-921 MHz, made in five separate ETSI Systems Reference Documents[1] along with the compatibility analysis of ECC Report 200 [7]. Consequently the scope of this report is limited to the frequency bands 870-876 MHz and 915-921 MHz only.

ECC Report 200 [7] concluded that, under certain conditions, SRD could share with primary services and that intra-SRD sharing was possible. The report did however note that in several European administrations there remain existing government services and that there may be a need for differing SRD parameters to be set in different national regulations.

The present Report suggests a set of technical parameters that may be taken forward in ERC/REC 70-03 [2]. It does this with reference to the principles set out in CEPT Report 44 [9] which in itself was underpinned by ECC Report 181 [10]. As such, the suggestions within the conclusion of this Report are as application neutral as possible while having the minimum necessary, but sufficient, technical parameters to ensure the efficient use of these frequency bands.

As ECC Report 200 [7] clearly sets out, it will not be possible to have a simple harmonised set of regulations for SRD in the 870-876 / 915-921 MHz band across Europe. As such there are likely to be different sets of apparatus made available for different markets within Europe. In the European Union, this situation is referred to “Class II apparatus”. That is to say that there will be restrictions on where particular apparatus can be lawfully operated. Manufacturers of apparatus operating in the 870-876 / 915-921 MHz band will need to make it clear to users where apparatus may and may not be used.

Within the present Report there are several SRD specific applications that have been evaluated. The vast majority of these specific applications can be incorporated into a small set of generic or non-specific categories. There are however a couple of exceptions where there has been demonstrated sufficient justification to deviate from the preferred non-specific application designation. For example, in the 915-921 MHz band the distinctive operation of RFID interrogators requires a channelisation of the band.

ECC Report 200 [7] conclusions categorised the national sharing arrangements with primary services into four categories:

- Countries where bands 870-876 / 915-921 MHz are used for TRR and/or UAS;
- Countries where the bands 873-876 / 918-921 MHz may be used for ER-GSM;
- Countries that deploy Wind Profiler Radars and other than above mentioned services in 870-876 / 915-921 MHz;
- Countries that do not presently use the bands 870-876 / 915-921 MHz.

The present Report follows a similar methodology and the suggested SRD parameters are made with respect to any existing service within the bands. ECC Report 200 [7] compatibility studies recognised the existing adjacent band MFCN services including GSM, IMT and GSM-R. In all cases therefore, the parameters suggested by the present Report fully take account of those adjacent services.

The present Report takes a logical progression, first defining the request for spectrum access, then evaluating that request. The Report identifies the limitations on gaining spectrum access across differing European administrations and finally the report makes suggestions that are intended to be taken forward in the ERC/REC 70-03 [2].

[1] TR 102-649-2 Generic SRD, RFID and Automotive SRD, TR 102 886 Smart Meters and Smart Grid, TR 103 055 Metropolitan Mesh Machine Networks (M3N) applications, TR 103 056 Alarm and Social Alarm systems and TR 102 791 Assistive Listening Devices

2 DEFINITIONS

Term	Definition
Telecoil	Audio induction loop systems, also called audio-frequency induction loops (AFILs) or hearing loops are an aid for the hard of hearing[2]
Metropolitan/Rural Area Network	An intermediate scale network, for M2M data acquisition applications (no voice or video applications), serving a greater geographic area than a Local Area Network (LAN) but less than a Wide Area Network (WAN). An MRAN may use LAN-like technologies and network protocols in dense metropolitan locations with WAN-like operation in less dense rural locations. An MRAN will usually be operated by a single provider.
Network Relay Points	Device deployed by organisations, such as smart utilities, municipal, industrial, transport, logistics or other metropolitan/rural area network operators, to support wider area operations. NRPs provide connectivity for one or more otherwise isolated network devices by forwarding traffic in both directions between the network and the isolated device(s). Such devices will be limited in their deployment and will not be operated by the general public/consumers.

3 OBJECTIVES

Five ETSI Systems Reference Documents were developed, each proposing a spectrum designation for certain SRD and Low Power applications.

These five System Reference Documents contained nine application proposals:

- TR 102 649-2 [1] Generic SRD, RFID, Home Automation, Sub-metering and Automotive SRD;
- TR 102 886 Smart Meters and Smart Grids;
- TR 103 055 Metropolitan Mesh Machine Networks (M3N) applications;
- TR 103 056 Alarm and Social Alarm systems;
- TR 102 791 Assistive Listening Devices.

This chapter takes each of these nine groups of applications and discusses the motivation/benefit of each proposal in turn. A full explanation of each of the proposals is detailed in Annex 1.

3.1 GENERIC SRD

ECC Report 182 [11] [3] (the survey about the use of the frequency band 863-870 MHz) noted that the use of generic UHF SRD was likely to grow rapidly over the next 10-15 years. The objective of the ETSI proposal for generic SRD is to ensure that sufficient channel access is available to allow generic SRD to continue to provide an acceptable QoS by having a sufficient number of channels available that allow a good chance that an intended message will be received.

Full details of the objective can be found in Annex 1.1.

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[2] They are a loop of cable around a designated area, usually a room or a building, which generates a magnetic field picked up by a hearing aid. The benefit is that it allows the sound source of interest - whether a musical performance or a ticket taker's side of the conversation - to be transmitted to the hearing-impaired listener clearly and free of other distracting noise in the environment. Typical installation sites would include concert halls, ticket kiosks, high-traffic public buildings (for PA announcements), auditoriums, places of worship, and homes. In the United Kingdom, as an aid for disability, their provision where reasonably possible is required by the Disability Discrimination Act 1995, and they are available in "the back seats of all London taxis, which have a little microphone embedded in the dashboard in front of the driver; at 18,000 post offices in the U.K.; at most churches and cathedrals".

[3] http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP182.PDF

3.2 RFID

The objective for RFID to operate in the 915-921 MHz band is to improve the performance of RFID tags, e.g. in terms of both data rates and reading range. In this respect the benefits from the move to the 900 MHz bands are twofold.

- There is near worldwide harmonisation around 900 MHz for RFID logistics. E.g. in the USA the band 902-928 MHz is allocated to RFID. As a consequence, RFID tags are typically manufactured to have their point of maximum response (their Q-factor) from 900 MHz to 930 MHz. By interrogating the tag at its most responsive frequency, the signal received will be more robust and so a successful tag read becomes more likely.

- In the 915-921 MHz there presents an opportunity to better define the RFID interrogator signal than was previously permitted in the more limited bandwidth at 865-868 MHz. The wider bandwidth allows for the RFID signal to be widened to 400 kHz and the power increased by 3dB over the RFID allocation at 865-868 MHz. This better defined RFID signal allows for faster data rates and greater penetration into pallets containing high numbers of tagged goods and so a successful tag read becomes more likely.

These two benefits are both likely to improve the successful reading performance of RFID tags.

This is in line with the findings of ECO Report 01 [12] that had already concluded inter-alia:

- the existing UHF band at 865-868 MHz will also continue to be used for existing and future applications and should be sufficient for the short term;

Additional frequency band(s) in the UHF range should be considered in order to improve the functionality of future applications as foreseen in section 4.5 of ECO Report 01 [12]. Operation within globally accepted frequency bands for RFID at UHF is preferred. In conclusion, additional UHF RFID frequency opportunities will help to match global performance in terms of robustness, reading distance and reading speed.

Full details of the objective can be found in Annex 1.2.

3.3 HOME AUTOMATION AND SUB METERING

The European Home and Building Automation market includes the following (non-exhaustive) list of applications:

- Lighting control;
- Shutter control;
- Awnings and blinds control;
- Windows, doors and gates openers control, garage doors;
- Electrical door lock systems;
- Heating regulation;
- Air conditions control;
- Swimming pool surveillance and control;
- Ventilation;
- Combined scenarios;
- Presence simulation;
- Automatic controls for comfort energy saving and security purposes;

- Sensors (temperature, wind, light, rain);
- Presence monitoring;
- Energy consumption/use monitoring.

For the last decade, the above applications have mainly been used as stand-alone devices, where users controlled only a single device at a time - *e.g. up, down, stop for a shutter or an opening/closing a door*. Simple command protocols were used.

Now the need for more **comfort** with sub-metering functions for heating or electricity, more **security** with picture checking in case of intrusion and a strong emphasis on global **energy savings** require the use of systems with advanced control protocols. These protocols permit the use of dynamic functions that coordinate the operation of actuators though advanced automatic controls and sensors. Different type of data and data rates are now requested to be transmitted with the same hardware and frequencies.

Additional spectrum is required to support the use of these advanced system control protocols. Sub-metering devices are (non-exhaustive examples):

- Heat Cost Allocators;
- Water Meters;
- Heat- / Cold- Meters.

Today there is already a high number of sub-metering devices installed. The European legal framework on energy saving (e.g. Directive 2002/91/EC on the “energy performance of buildings” and Directive 2006/32/EC on “energy end-use efficiency and energy services”) and raising public awareness for the economical use of limited resources will together lead to a wider deployment of sub-metering devices in the future.

Sub-metering can be expected to evolve into energy data management, still increasing its socio-economic benefits. Value added applications, like consumption monitoring, control of the central heating etc. will, to a greater extent, become further services, in addition to the individual metering of energy and water consumption.

Although a high percentage of sub-metering devices in the market are already equipped with a radio, it is envisaged that basically all devices are going to be equipped with wireless communications and extended functionality in the future.

Full details of the objective can be found in Annex 1.3.

3.4 SMART METERS

The proposals for Smart Metering have the objective of securing spectrum for a technology intended to deliver significant savings in energy consumption. Smart Electricity Meters consumption is intended to give users information necessary to enable them to use energy more wisely. It is anticipated that this will educate consumers on the impact of their lifestyle choices on energy consumption and reduce the peak and overall demand. This better balancing of the Electricity load could potentially reduce the need for the generation capacity to meet peak demand. Smart gas meters consumption would allow for the smarter distribution of the supply where consumers could modify their consumption, particularly in periods of high demand. Smart Meters will also allow electricity network operators to understand supply outages (and restoration) in real time, as well as providing detailed information on the quality of the supply to individual homes. Finally, service restoration switches can allow electricity to be disconnected from properties that are unoccupied.

Full details of the objective can be found in Annex 1.4.

3.5 SMART GRID

The proposal for Smart Grid has the objective of enabling a robust end-to-end communication from household appliances through the Smart Meter to the electricity distribution network and even into national transmission networks. The benefits of smart metering are thereby enhanced by smart grid, as a further level of automation is added.

Full details of the objective can be found in Annex 1.5.

3.6 METROPOLITAN MESH MACHINE NETWORKS (M3N)

A M3N is a network composed of the following of elements: Endpoints (Sensors and Actuators), Routers and Gateways. The proposal for M3N has the objective of gaining sufficient spectrum access to allow a multitude of endpoints and the in-network routers to operate within a combined mesh network. The present SRD allocation 863-870 MHz is segmented to Audio, RFID and telemetry radio systems. As such it does not present sufficient contiguous spectrum for a distributed M3N.

Full details of the objective can be found in Annex 1.6.

3.7 SURVEILLANCE ALARMS, FIRE/SMOKE ALARMS, INTRUDER ALARMS, SOCIAL ALARMS

The proposal for alarm systems has the objective of securing a spectrum designation for radio signals that need a predictable sharing environment to operate successfully. Alarm signals are infrequent but when called for, it is essential that the alarm signal is received. Radio alarm systems are becoming popular both where a wired system is impractical, such as in a historic building, and also as a low-cost solution in domestic premises. A wireless link is essential for body-worn alarms.

Full details of the objective can be found in Annex 1.7.

3.8 AUTOMOTIVE ACTIVE SAFETY, AUTOMOTIVE DIAGNOSTIC DATA EXCHANGE, AUTOMOTIVE FREIGHT PROTECTION, AUTOMOTIVE ENVIRONMENTAL & SAFETY SYSTEMS

Proposals for Automotive SRD largely have the same objective as the generic SRD objectives detailed in section 3.1.1. There are however exceptions where the need for slightly higher power for vehicle to vehicle communications are detailed. Such communications are not presently possible in the existing SRD allocations. In this case the objective is to allow communication between vehicles to allow vehicles to act cooperatively leading to both safety and environmental benefits.

Full details of the objective can be found in Annex 1.8.

3.9 ASSISTIVE LISTENING DEVICES

The proposal for Assistive Listening Devices has the objective of gaining spectrum access for the Telecoil Replacement System (TRS). The current Telecoil works well in small rooms where it is practical to install the audio inductive loop. However, this becomes impractical in large public places such as museums, rail terminus and airports. The TRS replaces the inductive system with a radio system operating in the far field. As such, it is able to be successfully deployed over wide areas.

Full details of the objective can be found in Annex 1.9.

4 ASSESSMENT OF THE REQUEST (INCL. POSSIBLE MITIGATION TECHNIQUES, REQUIREMENTS)

In all cases of all five System Reference Documents, there is the request both for inclusion in the ERC Recommendation for SRD (ERC/REC 70-03 [2]) and for mandatory harmonisation within the EC, by inclusion in the EC Decision harmonising SRD use in the community EC Decision 2006/771/EC [23].

Annex 3 of this ECC Report indicates that a number of administrations may presently have a particular difficulty in agreeing to the use of SRD in these bands as envisaged by all the System Reference Documents. Therefore, it may be necessary to consider that certain mitigation techniques may be necessary to satisfy the requests. It may be necessary to include mandatory mitigation techniques in regulation, to ensure there is a reasonable opportunity for all the requested technologies to function successfully within the limited spectrum available and to allow sharing with the existing services noted by administrations. These pre-existing services may vary between administrations and so may the consequential SRD mitigation techniques.

Overview of the request for spectrum

The original vision for the frequency bands 870-876 / 915-921 MHz as defined in TR 102 649-2 [1] is given in Figures 1 and 2.

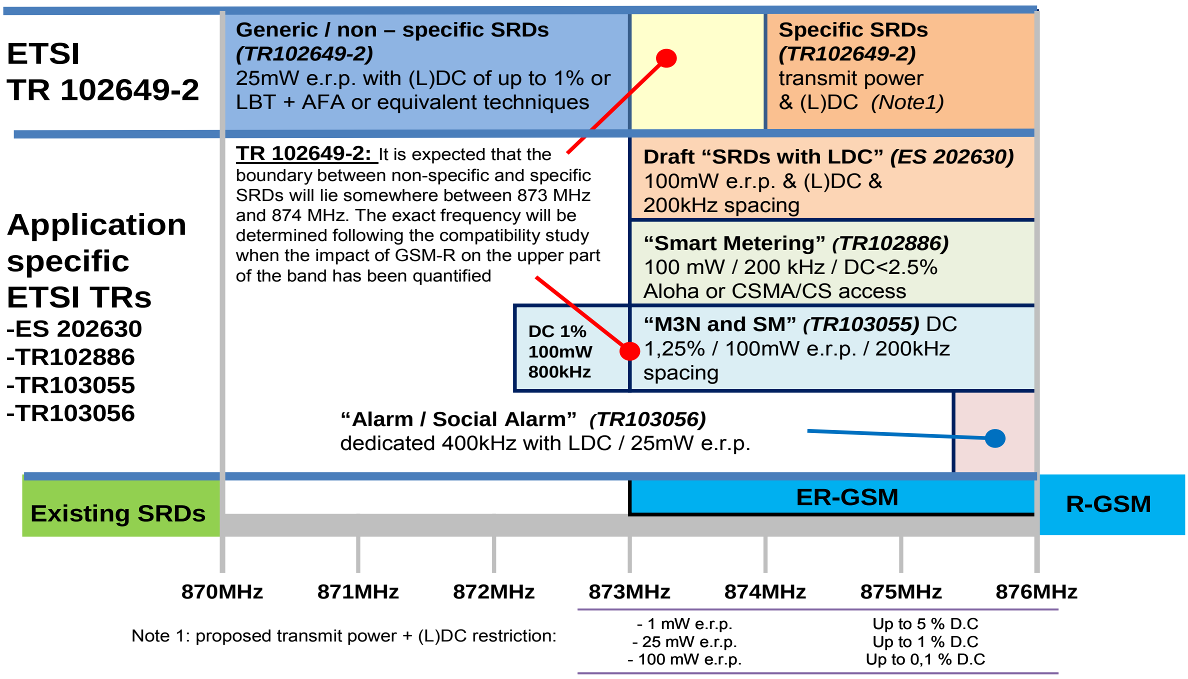

Figure 1: Summary of ETSI TRs outlining SRD tentative proposal in the band 870-876 MHz

Within the 870-876 MHz band the exact spectrum designation and associated technical parameters are not well defined in the ETSI TR 102 649-2 [1]. These parameters became apparent during the WGSE compatibility analysis WI 41 that led to ECC Report 200 [7].

Within the 915-921 MHz band the spectrum designation was well defined in the TR 102 649 [1]. However this also evolved during the WGSE compatibility analysis WI 41 that led to ECC Report 200 [7].

Intra-SRD interference case studies: In general the prospects of intra-SRD co-existence appear to be moderately good with interference probabilities between 3-10% at comfortably low levels, even for very dense urban deployment scenarios and **without assuming band segmentation** or any special co-existence requirements except the intrinsic operational DC limits of studied SRD devices.

However, it may be seen that especially the lower powered applications, such as non-specific SRDs or home automation/sub-metering devices with transmit powers on the order of 25 mW, might suffer interference from higher power SRD neighbours (typically around 100 mW). Therefore implementation of additional mitigation mechanisms would be helpful to drive the probability of interference towards zero.

4.1 GENERIC SRD

In their proposals (System Reference Documents), ETSI ERM Task Groups TG28 and TG34 concluded that it would be desirable to separate the high power transmissions of RFID from the low power levels associated with SRDs. ETSI TR 102 649-2 [1] therefore proposed that the band 870 to 876 MHz is designated for use by SRDs at less than 100 mW and the band 915 to 921 MHz is designated for high power devices such as RFID. As important requirement from the industry is that the new SRD bands should be an extension of the present SRD bands or close to them.

Users require improved functionality, features and performance. There is a demand for reliable performance proportionate to the application. Some applications require a very predictable sharing environment, some request even protection, e.g. safe harbour bands, priority applications, or to be treated as applications under the mobile service.

Many industry sectors indicated that they can share spectrum provided that the exact minimum technical criteria for sharing are identified in spectrum compatibility studies.

Segmentation of the spectrum by defining specific frequency spots for specific applications should be avoided as much as possible. New frequency band segmentation or exclusivity for specific applications cannot be the common target. There is a need to take into account the lessons learned from 863-870 MHz (see questionnaire results in Annex 3) and generate a broad regulation. Application terms are not always sharply defined. Application convergence / application innovation is also to some extent blocked by application segmentation.

For technical reasons it is proposed to divide the band into a limited number of sub-bands to cover:

- SRDs using duty cycle up to 1 % or LBT with AFA (or equivalent techniques);
- SRDs that transmit intermittent very short bursts of power and rely on duty cycle for mitigation;
- SRDs covering a number of services and functions with similar behaviour, technical parameters and mitigation techniques that would provide a more predictable sharing environment.

A non-exhaustive list of applications for SRDs using either duty cycle or LBT + AFA (or equivalent techniques) is provided below, based on information in A.2 of the ETSI TR 102 649-2 [1]:

Home and Building automation (some examples):
- Lighting control;
- Shutter, awnings and blinds control;
- Windows, doors and gates openers control, garage doors, electrical door lock systems;
- Heating, ventilation regulation and air condition control;
- Swimming pool surveillance and control;
- Combined scenarios;
- Sensors (temperature, wind, light, rain);
- Presence monitoring.

Telemetry and telecommand (some examples):
- Pumping station monitoring;
- Electricity network monitoring;
- Crane and machinery control.

Mixed speech and data (some examples):
- Wireless door entry;
- Alarm ambiance background scanning;

- Baby and elderly monitoring.

Access control (some examples):
- Disabled persons access;
- Security applications.

Machine to Machine (some examples):
- Remote data collection (state of machines);
- Remote control (management);
- Remote payment;
- Remote restaurant/bar customer orders data collection;
- Portable Bar Code Scanner.

Aviation and Maritime applications (some examples):
- Remote data maintenance collection (service information of aircraft downloaded while taxiing).

Table 1: Generic SRD request summary

Generic SRD				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
870-876 MHz	25 mW e.r.p.	Up to 1% or DAA	No spacing	APC as appropriate. Low cost. High reliability/low latency for some applications

- The vast majority of these applications are either fixed installed applications, nomadic use applications or used at very specific locations (e.g. aircraft taxiing). There are practically no fully mobile non-specific SRD applications provided in ETSI TR 102 649-2 [1] under the generic SRD proposal. Only some (not all) automotive applications indicate fully mobile use;
- The ETSI proposal in TR 102 649-2 [1] is focussing on the frequency range 870-873 MHz for generic SRD but leaves the upper limit subject to change depending on the outcome of the spectrum engineering studies;
- The use of APC and DAA may improve the coexistence situation;
- Spectrum fragmentation should be avoided as much as possible;
- Cost considerations may lead for generic SRD to limited receiver performance capabilities which are interlinked with a limited range of power capabilities.;
- Proposals for specific SRDs with the same power level of 25 mW are using the same duty cycle limit of 1% and may only differ in terms of deployment numbers and the assumed usage densities. These proposals can be bundled into one category;
- Many specific SRD applications for which the ETSI TR 102 649-2 is focussing on the frequency range 873-876 MHz are encompassed in the envelope parameters as indicated above:
    - Metering: 25 mW, channel BW of 200 kHz, DC up to 1%;
    - Alarms: 25 mW, channel BW of 200 kHz, DC up to 1%;
    - Portable Alarms (for personal security): 100 mW, channel BW of 25 kHz, DC up to 0.1%;
    - Automotive Devices[4]: 100 mW and more, channel BW up to 500 kHz, DC up to 0.1% (transmit power and DC are inter-linked as shown in Table 8).
- The minimum requirement indicated for the main specific SRD sectors above is to have a minimum of 2 MHz of usable spectrum;
- Some automotive, smart metering and M3N applications indicate the need for higher emissions than 100 mW with up to 500 mW.

[4] The requirements for Automotive family of SRDs may need revision, noting the revision of TR 102 649, where Automotive applications, such as Vehicle-to-Vehicle communications may require up to 500 mW transmit power and up to 1 MHz channel bandwidth, with TPC mitigation technique

There is also demand for an FHSS usage case option.

4.2 RFID

In their proposal (ETSI System Reference Document TR 102 649-2), ETSI ERM TG28 and TG34 concluded that it would be desirable to separate the high power transmissions of RFID from the low power levels associated with SRDs. The present document therefore proposes that the band 870-876 MHz is designated for use by SRDs at less than 500 mW, with low Duty Cycle. The band 915-921 MHz is designated for high power devices such as RFID.

To satisfy the perceived future market requirements for RFID, it is proposed that interrogators will operate in the band 915-921 MHz at power levels of up to 4 W e.r.p. in four channels of 400 kHz each. The remainder of the band will be used for the low level response from the tags. This will increase reading performance and potentially permit data rates that are four times faster than those currently possible.

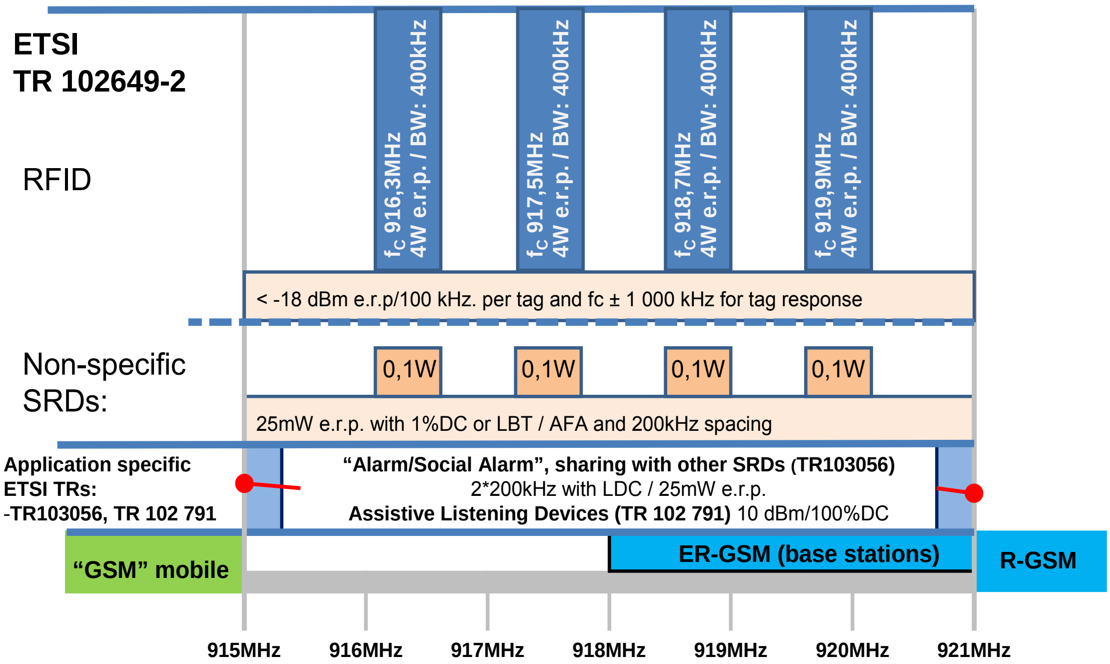

Figure 2: Summary of ETSI TRs Outlining SRD/RFID Requirements In the band 915-921 MHz

Table 2: RFID request summary

Frequency bands	Power	Duty cycle	Channel bandwidth	Notes
Interrogators: 915 MHz to 921 MHz Interrogator centre frequencies 916.3 MHz 917.5 MHz 918.7 MHz 919.9 MHz	4 W e.r.p. on a single interrogator channel for each individual interrogator	No mandatory limit for transmitter on-time. However interrogators will not be allowed to transmit longer than it is necessary to perform the intended operation	fc ± 200 kHz	Interrogators may operate in any of the four high power channels
Tags: Between 915 MHz to 921 MHz	< -10 dBm e.r.p. per tag		fc ± 1 000 kHz for tag response	
SRDs: 915 MHz to 921 MHz	0.1 W e.r.p. in RFID high power	0.1 % duty cycle or LBT + AFA	fc ± 200 kHz	Transmit levels outside of high

Frequency bands	Power	Duty cycle	Channel bandwidth	Notes
Centre frequencies for high power SRD channels 916,3 MHz 917,5 MHz 918,7 MHz 919.9 MHz	channels			power channels will not be allowed to exceed 25 mW e.r.p.
NOTE: fc are the carrier frequencies of the interrogators. SRD receivers should be category 2 or better as specified in EN 300 220 [18] To minimize the risk of interference from RFID, SRDs may use LBT with AFA or equivalent techniques in the high power channels. Suitable separation distances should be studied. To minimize the risk of interference from SRDs to RFID tag responses, SRDs should use LBT with AFA or equivalent techniques in the remaining 2.2 MHz. Suitable separation distances should be studied.				

4.3 HOME AUTOMATION AND SUB-METERING

The assessment of the Home Automation request for spectrum aligns with the requirement specified for Generic SRD in Section 4.1. As a consequence the parameters necessary for the delivery of Home Automation align with the parameters set out for Generic SRD.

The requirements for sub-metering are not fully in line with the requirements for Generic SRD and home automation but do not deviate greatly from those.

Table 3: Home Automation and Sub Metering request summary

Home automation				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
870-876 MHz	25 mW e.r.p.	Up to 1%	No spacing	DAA, APC as appropriate. Low cost. High reliability/low latency for some applications
Sub-metering				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
870-876 MHz	25 mW e.r.p.	<<0. 1% Up to 1% for data concentrators	200 kHz	Low cost. Data speed up to 100 kbps

4.4 SMART METERS

The TR 102 886 [3] makes the precise request for a spectrum designation for Smart Meters in the band 873 MHz to 876 MHz:

- a duty cycle of 2.5 % with no limit applied in any period;
- a power limit of not less than 100 mW e.r.p. (500 mW e.r.p. with APC assumed);
- the channelisation scheme proposed for SRD devices to correspond to the E-GSM-R scheme.

Smart metering:

- Data rate: Low, from 10 to 30 kbps;
- Latency: very diverse ranges cited, depending on technology, from approximately >1 second for distribution automation operations up to 24 hours;
- Availability: Range from 95% to 99.999%;
- Security: overwhelmingly high support;

- Coverage: Range from <95% of nationwide population to 99% of territory covering suburban and urban areas or100% population.

Table 4: Smart Meter request summary

Smart Meter				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
870-876 MHz	100 to 500 mW e.r.p.	Up to 2.5%	-	DAA, APC as appropriate. Low speed data from 10 to 30 kbps. Low cost. High reliability for some applications

4.5 SMART GRID

The respondents to a questionnaire from the EC[5] had a variety of views concerning the specific communications / data transfer related requirements for the "mission-critical" applications; some examples are shown below:

- The suggested minimum time for resiliency, or power supply independency, ranged from 8-12 hours (depending on services) up to 72 hours (for the most critical services and sites);
- The maximum allowed delay, or latency, suggested for the most critical (high voltage teleprotection) services varied from 3 ms to 10 ms, or to 'low-double-digit' milliseconds, and for other high priority services the variation was in general between 50 ms and 100 ms, some indicating the maximum delay for certain mission-critical applications to be even up to 1 second;
- The availability of the services should be better than 99.9% for any mission-critical service according to some of the respondents, while some indicated 99% availability to be sufficient. For the most critical services, the required level of availability was seen to be between 99.5% (some indicated only one value for all mission-critical services) and 99.999%;
- The bandwidth / data rate requirements for mission-critical applications were in general seen to be up to around few Mbps (megabits per second), ranging from some hundreds of kbps (kilobits/s) to 100 Mbps; however in the latter value the possible future needs for data concentration / aggregation points had already been considered.

Utilities indicate that they should be able to operate their own infrastructure for mission critical services, or at least request dedicated networks for part or overall smart grid systems, as resilient uniform nationwide coverage with a guaranteed quality of service (QoS) cannot be provided by commercial telecommunication networks, which are also not regarded as able to handle safely the mission-critical data. Even though certain commercial solutions are technically compliant, some utility companies do not want to rely on commercial operators due to the lack of level of control; these utilities are of the opinion that such solutions do not offer a complete end-to-end control or guaranteed QoS, and that the promised power autonomy, redundancy and availability can be insufficient.

Telecom operators and some equipment manufacturers stated that existing commercial telecommunication networks can deliver discrete or end-to-end solutions over shared or dedicated infrastructure meeting the negotiated Service Level Agreements (SLAs) on the required performances for the smart grid communication needs.

Regarding the question on the ownership and control of the communication networks, the respondents in general either indicated that there is no definitive answer applicable to all situations and that the answer depends on a number of factors. A number of respondents were in the opinion that the ownership of

[5] https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/20121804_energy_efficiency_public_consultation.pdf

communication infrastructure is not necessary and that shared infrastructure will typically be the most cost-optimised solution, while some stated that infrastructure fully owned and controlled by utilities would be required to handle mission critical services.

On the synergies between utilities companies and telecom operators, in general infrastructure (e.g. radio sites and masts, backhaul capacity, dark fibre, cable ducts and tunnels, utility poles) sharing is seen to improve cost-effectiveness and the use of existing resources as well as to extend geographical coverage. However, some respondents note that infrastructure sharing is also an issue subject to national regulations and circumstances, and the question remains how to deal with the limits of responsibility, commercial issues and competition. Some utilities indicated that shared infrastructure can be an option when the utility has a sufficient level of control over the solution.

4.6 M3N

The proposal investigates the use of M3N in the UHF Band:

- 0.1 % duty cycle is very low for M3N operation;
- Co-existence with permanently transmitting high powered RFID equipment will harm M3N reliability and battery lifetime;
- The distance between M3N devices in some deployments may be greater than the radio range achievable with 25 mW e.i.r.p.;
- M3N application may require data rates up to 100 kbps;
- Human acceptable / IP acceptable latency;
- A 25 ms transmit time limitation (Ton) is too short to comply with MAC mechanism needed by battery powered devices to prevent idle listening;
- A 200 kHz channelisation scheme (sub-divisible into 100 kHz or 50 kHz) consistent with E-GSM-R (between 873 and 876 MHz), is required for spectrum efficiency and coexistence with Smart Metering.

Therefore, the M3N requirements in the band 870 to 876 MHz are;

Power	100 mW e.i.r.p.
Channelisation	200 kHz (with 50 kHz and 100 kHz sub channel).
Duty Cycle	Overall 1.25 % measured over a specified interval without peak limit in any sub interval, when required for coexistence with existing services. Overall 1 % measured over a specified interval without peak limit in any sub-interval and without transmit time limitation (outside 873 to 876 MHz band to avoid coexistence issue with E-GSM-R).
Bandwidth	As Smart Metering is a part of M3N, requirement identified in TR 102 886 [3] for the 873 to 876 MHz band, in co-existence with E-GSM-R. 800 kHz outside E-GSM-R band for M3N devices requiring transmit time longer than 25 ms, situated as close as possible of the 873 to 876 MHz band.

The TR 103 055 [4] makes precise request for a spectrum designation for Smart Metering and Mesh Metropolitan Machine Network in the band 873 to 876 MHz:

- a duty cycle of 1.25 %;
- a power limit of not less than 100 mW e.r.p. (500 mW e.r.p. is assumed);
- the 200 kHz channelisation scheme proposed for SRD devices to correspond to the E-GSM-R scheme.

In addition there is a further request for a frequency band of 800 kHz immediately below 873 MHz for high performance UHF SRD systems for Smart Metering and Mesh Metropolitan Machine Network.

- a duty cycle of 1 % without transmit time limitation;
- a power limit of not less than 100 mW e.i.r.p. (to be compatible with other co-channel SRD);

200 kHz channelisation, sub-divisible in 100 kHz or 50 kHz channels.

Table 5: M3N request summary

M3N				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
872.8-876 MHz	100 to 500 mW e.r.p	Up to 1.25% (25 ms max single TX on)	200 kHz, sub-divisible in 100 kHz or 50 kHz channel	APC Low cost

4.7 SURVEILLANCE ALARMS, FIRE/SMOKE ALARMS, INTRUDER ALARMS, SOCIAL ALARMS

The ETSI TR 103 056 [5] makes request for a dedicated spectrum designation for Alarms in the band 875.6-876.0 MHz. This request does not mean exclusive spectrum but it means a suitable spectrum environment with spectrum access rules suited to alarms. The technical parameters are:

25 mW e.r.p.

The DC / LDC requirement to be defined during compatibility analysis

Band edges in compliant to GSM-R channel plan.

Indicative DC:

- Max Transmitter On Time / per single transmission: 700ms;
- Min Transmitter Off Time between two transmissions: 400ms;
- Sum of Ton times / minute = DC/min 2.5%/min;
- Sum of Ton times / hour = DC/hr: 0.1%/hr.

The ETSI TR 103 056 [5] also requests shared spectrum in the bands 915.0-915.2 MHz / 920.8-921.0 MHz. The technical parameters are:

25 mW e.r.p.

The DC / LDC requirement to be defined during compatibility analysis
Band edges in compliant to GSM-R channel plan.

Table 6: Surveillance Alarms, Fire/Smoke alarms, Intruder alarms, Social Alarms request summary

Alarms				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
875.6-876 MHz	25 mW e.r.p	Short term DC: 2.5% Long term: 0.1%	--	Low cost High reliability/low latency
915-915.2 MHz	25 mW e.r.p	To be defined	--	

4.8 AUTOMOTIVE ACTIVE SAFETY, AUTOMOTIVE DIAGNOSTIC DATA EXCHANGE, AUTOMOTIVE FREIGHT PROTECTION, AUTOMOTIVE ENVIRONMENTAL & SAFETY SYSTEMS

Table 8 contains the technical parameters included in TR 102 649-2 [1] for automotive applications.

Table 7: Automotive Active Safety, Automotive Diagnostic Data Exchange, Automotive Freight protection, Automotive Environmental & Safety Systems request summary

Automotive applications				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
873-876 MHz	25 to 500 mW e.r.p	0.1 to 1%	25 kHz to 1.2 MHz	Low cost. High reliability or low latency for some applications. Data rates vary between 1 to 100 kbps, or 600 kchips/s (DSSS)

4.9 ASSISTIVE LISTENING DEVICES

TRS is a new digital ALD system which incorporates a range of spectrum efficient technologies compared with the current 100% duty cycle FM devices:

- Up to 600 kHz channel bandwidth (20dB -bandwidth) (narrower bandwidth possible by using low data rate);
- 500kbit/s modulated data rate, using, e.g., 4GFSK modulation;
- 10mW transmitter e.r.p. for typical cases;
- 25% transmitter duty cycle or frequency hopping, no LBT;
- System can use fixed frequencies or frequency hopping;
- Minimum of six channels;
- Capable of spectrum sensing.

In addition the fixed “base” transmitters can have the transmit spectrum remotely controlled from a database or a local control (e.g. an airport frequency manager).

As TRS are designed as a worldwide “public” system common spectrum is required to maximize their effectiveness,. Investigation of currently available spectrum including all current SRD bands has failed to find spectrum for these low latency systems which require a very low level of potential interference(loud noises in the ear canal are both frightening and dangerous) and has generated the request within ETSI TR 102-791 [6] for additional spectrum access.Sharing: from work carried out in WI 41 the TRS can share with high power RFID based on the premise that these systems are unlikely to be physically in the same geographical location at the same time and place.

Table 8: ALD request summary

Assistive Listening Devices (ALD)				
Frequency bands	**Power**	**Duty cycle**	**Maximum occupied bandwidth**	**Notes**
6 channels within 915-921 MHz	10 mW e.r.p	25%	Up to 600 kHz	No LBT. 500kbit/s modulated data rate

5 BENEFITS OF HARMONISATION

5.1 GENERIC SRD

For generic SRD the benefits of further European harmonisation are discussed in paragraph 0.6.2 of the report into the “Study on the Legal, Economic & Technical Aspects of Collective Use of Spectrum (CUS) in the European Community” [20]. This report concludes that the benefits of harmonisation are “substantial”.

5.2 RFID

For 900 MHz RFID the benefits of harmonisation with the USA allow for greater probability of successfully reading a tag. Tags have a natural resonance (Q-factor) which is determined in manufacture. By sharing a common frequency with the USA, tags can be read nearer their point of maximum response. Harmonisation within Europe of RFID tags is essential to allow for the benefits in cross border trade in RFID tagged products. Harmonisation both throughout Europe and the USA will increase these benefits further.

In addition operation as proposed in the new band will permit the use of higher powers and faster data rates. This will provide important functional benefits.”

5.3 HOME AUTOMATION AND SUB-METERING

The benefits of harmonisation of Home Automation are twofold.

In common with Generic SRD, the economic benefits of a single European market have driven down costs for apparatus introduced in Europe under a common set of harmonised regulations.

Home automation and sub-metering are getting more importance for the European households. These systems will be installed increasingly in the coming 5-6 years. For example, EU countries have already agreed that the households in the EU should implement metering/sub-metering in most of the European households by 2020, which means that there will be a need for an immediate action when this agreement is fully implemented. For this purpose, European harmonisation is beneficial for economies of scale as detailed in the CUS Report [20].

However, beyond that, the introduction of advanced system protocols, necessary for the introduction of integrated Home Automation and Sub-Metering, require a level of harmonisation not previously necessary in stand-alone systems.

To ensure inter-operability of Home Automation and Sub-Metering devices, there is the necessity to harmonise both standards and the frequency of operation.

5.4 SMART METER

Smart Meter installations tend to be fixed. Therefore the technical reasons for harmonisation are less clear than for mobile SRD. However the economic benefits of scale detailed in the CUS Report [20] are once again substantial.

5.5 SMART GRID

Smart Grid devices tend to be fixed. Therefore the technical reasons for harmonisation are less clear than for mobile SRD. However the economic benefits of scale detailed in the CUS Report [20] are once again substantial.

The views on the existence of barriers that would impede co-investment are mixed. National administrations and telecom operators do not see any barriers that would hinder co-investment between utilities and telecom sectors. Utilities noted that the telecommunication legislation was fragmented in several Member States, causing restrictions, legal barriers or different approaches to cooperation between utilities and telecoms. Infrastructure companies' responses were more diverse; some indicate that national regulations could hinder co-investment, while others note that the lack of a dedicated spectrum for smart grid purposes could be inhibiting co-investment.

The vast majority of respondents to the EC call[6] supported the need for interoperability of various smart energy grid related areas or services. Responses cite various reasons for supporting the need for interoperability were given, including the creation of economies of scale and cost reduction, reduction in the risk of cross-border interference, and greater flexibility.

5.6 M3N

M3N installations tend to be fixed. Therefore the technical reasons for harmonisation are less clear than for mobile SRD. However, there are clear benefits in an economy of scale in the supply of products.

5.7 SURVEILLANCE ALARMS, FIRE/SMOKE ALARMS, INTRUDER ALARMS, SOCIAL ALARMS,

Alarm installations tend to be fixed. Therefore the technical reasons for harmonisation are less clear than for mobile SRD. However, there are clear benefits in an economy of scale in the supply of products.

The European Commission, DG Enterprise & Industry, has adopted a policy to help enable the EU security industry to meet the challenges of the twenty-first century[7]. The first priority will be to overcome the fragmentation of the EU security markets through the harmonisation of standards and certification procedures for security technologies. One of the first sectors which will be targeted by the Commission for their high potential is alarm systems. It goes on to say that divergent national building regulation standards pose a major obstacle for the creation of a true internal market for security, thus hindering the competitiveness of EU industry. Overcoming these national divergences is a quintessential step, if the EU wants to contribute significantly to the creation of global standards.

The safety and security of the wider population in commercial, public & private premises is necessary in order to enhance societal resilience. The overall aim is to enhance the competitiveness of the EU security industry, stimulate its growth and promote the creation of jobs. However, the main problem is the highly fragmented nature of the EU security market. Divergent approaches to certification and standardisation have effectively created at least 27 different security markets, which is a situation that needs addressing. Within this a number of purpose-defined categories stand out for priority attention, for which no pan-European regulations exist (hospitals, schools, theatres, stadiums, hotels, shopping centres, and commercial buildings).

In its position paper covering the EU initiative [8], the Alarm Industry Association, Euralarm, makes the point that progress depends first and foremost on the shared recognition by EU Member States and the relevant public authorities that a European and international view often better serve the public interest, rather than relying solely on national or sub-national action. This recognition is both necessary and urgent. While these initiatives can address the situation from a top level, the European Standards Organisations and the European Conference of Postal and Telecommunications Administrations (CEPT) can greatly assist progress by defining a regulation which supports the development of harmonised requirements, standards, certification and conformity assessment procedures for alarm systems and system components.

The wireless links for alarm systems of all types is a critical area which underpins the harmonisation and performance standards for alarm systems. Without harmonisation in standards and frequencies the whole top level objective will become more difficult. Thus it is essential for CEPT and ETSI to work together to create a harmonised environment where wireless alarms can operate on a reliable, high performance and secure basis for the future.

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[6] https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/20121804_energy_efficiency_public_consultation.pdf

[7] *"Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee, Security Industrial Policy, Action Plan for an innovative and competitive Security Industry"*, COM(2012) 417 final.

[8] "A Vision for a Competitive European Security Industry and Secure Society", Euralarm, WP-0101-1304-0101.

Euralarm also states [9] in relation to the 5th Update of the EU Decision on harmonisation of the radio spectrum [10] that it is absolutely essential that any changes in the allocation of the wireless alarm spectrum will continue to allow such systems to perform adequately, as they do today. It continues on to say, in relation to new external interference, that there here is also no guarantee that, even with increased performance of the wireless signalling, the overall performance will be adequate if the band is further shared with other devices. New frequency band(s) with Harmonised access parameters is a clear and easy way to provide a secure and robust solution.

Thus harmonised frequencies and standards are necessary for both existing and future systems. The additional benefit with new frequency bands is that it is easier to adopt a higher reliability regime within that concept, as no existing wireless alarm systems exist.

5.8 AUTOMOTIVE ACTIVE SAFETY, AUTOMOTIVE DIAGNOSTIC DATA EXCHANGE, AUTOMOTIVE FREIGHT PROTECTION, AUTOMOTIVE ENVIRONMENTAL & SAFETY SYSTEMS

For Automotive applications of, Freight protection, Environmental & safety systems, Remote key entry / keyless entry, In-car remote operation, Comfort systems outside the vehicle and Infotainment fitted to vehicles, there is a clear need for harmonisation, given the mobility of vehicles.

The increasing requirements for road-safety services which are often politically mandated increases the general spectrum requirement and in particular frequency bands with a more predictable sharing environment.

Unlike home automation, smart grids and smart metering applications, automotive SRD applications are not fixed installations. Vehicles can go across borders and this has to be taken into account, should the spectrum in 870-876 / 915-921 MHz not be available for SRD applications on a fully harmonised European basis.

5.9 ASSISTIVE LISTENING DEVICES

TRS is proposed as a public system for worldwide use for those with hearing impairment, due to the small physical size of the personal units a single receiver is necessary with no user intervention for channel changing.

6 MOST SUITABLE FREQUENCY OPTION

This part of the report deals with justifications for identifying frequency bands 870-876 /915-921 MHz as the most suitable frequency option for each category of SRD application.

The principles set out in ECC Report 181 [10] “Improving spectrum efficiency in SRD bands”, have been taken forward in the development of the most suitable frequency options for the 870-876 / 915-921 MHz bands. In particular, the conclusion that SRD Access Mechanisms are based on sound technical foundations, rather than simply dividing spectrum by application type.

Therefore, alternative sets of parameters should be set that allow SRD to operate across the 870-876 / 915-921 MHz bands. ECC Report 200 [7] sets out the compatibility requirements for alternative sets of Generic SRD parameters that allow compatibility with adjacent services (e.g. GSM) and co-channel services (e.g. E-GSM-R and other government services). Additionally, these alternative sets of parameters allow for the intra-SRD compatibility.

It should be noted that with regard to the in-band compatibility with many governmental applications, there is no identified set of parameters that permit a shared usage of the frequency band with certain types of SRD.

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9 “Euralarm position on the future of the Alarm Equipment operating in the 868.6 - 869.4 MHz Bands”, Euralarm, May 2012.

10 COMMISSION IMPLEMENTING DECISION of 8.12.2011 amending Decision 2006/771/EC [13] on harmonisation of the radio spectrum for use by short-range devices.

6.1 GENERIC SRD

The frequency band 870-876 MHz and its duplex pairing 915-921 MHz was the subject of a CEPT review in 2012. The frequency bands are duplex paired and the review revealed that there is very limited existing spectrum utilisation for digital land mobile applications (PMR/PAMR) in accordance with ECC/DEC/(04)06 [21] as is also indicated in the European Common Frequency Allocation Table. . The most common use of this duplex frequency pair or parts of it within Europe is for tactical military relays in about 11 countries..

In the lower and upper band most administrations were of the view that some sharing of part of the band would be possible following co-existence analysis and only if the existing services could be protected.

The German regulator awarded a licence to the Deutsche Bahn to operate GSM-R in the bands 873-876 / 918-921 MHz in line with ECC/DEC/(04)06 [21], however, ER-GSM is not standardised yet, i.e. a mobile band identifier is not assigned yet for E-GSM-R. It is therefore unclear at the present time whether ER-GSM will be implemented in these frequencies in the future.

OFCOM in the UK recently completed a consultation where it invited interested parties to comment on potential uses and licensing schemes for the frequency bands 870-876 / 915-921 MHz. The results of this consultation were clearly in favour of allocating this spectrum to SRD type apparatus.

Spectrum options should be considered in this most precious part of the UHF band. There is a clear need to evaluate the options with regard to the impact, since a final decision for new spectrum is likely to be irreversible. Improvements to achieve more efficient use in 863-870 MHz have also to be considered. Generic SRD presently operate in the spectrum listed in Annex 1 to ERC/REC 70-03 [2]. Within the UHF frequency bands the SRD currently operate in the 863-870 MHz band. ECC Report 182 [11], “Survey about the use of the frequency band 863-870 MHz”, concluded that “Worldwide harmonisation is seen as important in particular for UHF RFID applications; in particular studying frequencies in 915-921 MHz would support the idea of global harmonisation”. There is also the desire to operate in spectrum immediately adjacent to the 863-870 MHz band. The benefits being in lower incremental costs of SRD apparatus, as compared to other bands, particularly where both existing 863-870 MHz and the spectrum immediately above that band are used in the same apparatus.

Generic SRD, being application neutral should be allowed to operate within the bands allocated to SRD, where they are unlikely to cause harmful interference to other radiocommunications, including other SRD.

Therefore the most suitable frequency option for Generic SRD is to allow them to operate across both 870-876 / 915-921 MHz, but with sufficient technical constraints that they cause no harm to other users of that spectrum.

6.2 RFID

Operation by RFID in the proposed band 915-921 MHz will provide the following important benefits:

- **Harmonised frequency band.** RFID is a global business with more and more tagged items increasingly moving between the three ITU Regions. Outside Europe, the majority of the world’s trading nations operate RFID at UHF within the frequency range 902-928 MHz. This ensures that the performance of RFID is consistent across these countries, which is of big benefit for users. Already tags have been optimized for operation in the band 902-928 MHz. This development has simplified the international movement of goods – particularly for those items that are tagged at source. However it has left Europe in a position where the performance of RFID is inferior to what is being achieved in the rest of the world. Also the need to manufacture non-standard equipment for use in Europe is likely to lead to higher equipment costs. To ensure that RFID in Europe can compete on an equal basis, it will be important to designate global parameters for operating frequencies, power levels and spectrum masks.

- **Higher data rates.** Increased bandwidth will permit RFID in Europe to operate at the maximum data rate specified in the ISO standard 18000-6. This will have two important benefits. Firstly it will enable RFID interrogators to read faster moving tagged items as they pass monitoring points, which will allow the use of RFID on processes that have a requirement to track fast moving items. Secondly there is often a need to increase the number of tagged items on pallets while maintaining existing handling times. Higher data rates will make this possible.
- **Higher transmitted power.** Increased power levels will give the obvious advantage that some applications will be capable of operating at greater ranges. This is particular beneficial in certain logistics applications. However there is another less obvious benefit. Typically the reading performance for tagged cases on pallets is of the order of 98 – 99%. The reason for the missing 1 or 2 % of tags is due to them being positioned in the centre of the pallet where signal levels are much reduced. Higher power levels will permit these tags to be read. The consequent reduction in effort in handling such discrepancies will represent a substantial saving.
- **Simplified installation.** With the continued growth of RFID, it is inevitable that some users will wish to operate interrogators that are physically close together. This is particularly likely to apply to certain industrial and materials handling applications. However due to inter-modulation products, a minimum separation is required between interrogators operating on the same or adjacent channels. This can prevent interrogators from being positioned in optimum locations. The availability of additional channels with increased channel spacing will largely overcome this limitation.
- **Frequency diversity**. In applications where it is necessary to read stationary tagged items, this can lead to problems due to standing wave nulls. Such situations can arise in certain production and inventory applications. The use of frequency diversity can substantially eliminates such problems. Interrogators would be designed to switch their frequency of operation between the bands 865-868 MHz / 915-921 MHz.
- **Ranging** The ability to change the frequency of transmission of interrogators between the two RFID bands will make it possible to perform ranging. This will allow the position of tags to be determined. An example of where ranging can be of particular benefit is at the exit of a shop, which is fitted with a combined RFID/EAS system. The system would detect the position of suspect tags that are within the zone of the shop exit. A further important benefit of ranging is that it reduces the problems associated with unwanted reflections.

6.3 SMART METERS, SMART GRID, HOME AUTOMATION AND SUB-METERING

The SRD/MG received in March 2012 a presentation from the University of Dortmund outlining results of coverage simulations for deployment of smart meters, smart grids and ICT wireless components in urban and non-urban areas [16]. These studies were commissioned by the German administration, the ministry of economics and technology and the ministry for the environment, nature conservation and nuclear safety. These studies took into account outdoor, indoor and basement installations and the simulations were verified by laboratory and field tests.

The results of these investigations clearly show the importance of the choice of frequency range on coverage for outdoor, indoor and basement installations concerning the choice of frequency range:

- Lower frequency ranges below 1GHz show better performance to frequencies at around 2GHz (Coverage loss of about 75% for outdoor and 85 % for indoor/basement installations at household locations when using frequencies at 2 GHz, making practical deployments extremely difficult and costly);

- Technical installation details such as the accurate antenna alignment for indoor installations are required. The incidence angle has a strong influence on signal strength at higher frequencies such as 2 GHz;

- Transition loss for basement coverage can easily add up to 25 dB or more additional path-loss in individual cases at 2 GHz, so individual time-consuming installation solutions must be found;

In consequence, more economic and more efficient detailed network planning and optimisation methods for wireless applications for installation such as smart meters, smart grids, home automation are found at frequencies below 1 GHz as the preferred option.

6.3.1 Home Automation and Sub-metering

Given that the assessment of the Home Automation request for spectrum aligns with the requirement specified for Generic SRD, the most suitable frequency options also align with the Generic SRD options.

The electronic compartment of a typical home automation or sub-metering device is rather small and should accommodate the printed circuit board, battery and antenna. Both the metering circuit and the radio interface have to fit on the same printed circuit board. The limited space means that the device is not very well suited to frequencies below UHF.

As the metering devices will be distributed over the whole building, transmission through multiple walls is required in order to communicate with the data collectors. Due to the limited power available and the significant increase in attenuation with frequency, the required range cannot be achieved above 1 GHz. So, significantly higher frequencies are not suitable.

For efficient use the distance between devices is in the range of 15 meters to 25 meters, which corresponds to the distance across a typical residential building. A typical propagation path will pass through 3 to 5 walls. It has been found in practice, that 10 to 25 mW e.r.p. provides adequate propagation without overshooting into neighbouring dwellings.

However, many Home Automation and Sub-metering applications require a predictable sharing environment. One method of ensuring this is to segment a small portion of the spectrum allocated to Generic SRD to the more benign variants of Generic SRD. Typically, this could be segmentation to devices that are inherently polite, such as devices with a particularly low duty cycle.

Therefore the most suitable frequency options for Home Automation and Sub-Metering are for access to be granted across the frequency bands 870-876 / 915-921 MHz but with a safe harbour to provide the confidence of a predictable sharing environment where necessary. The safe harbour should be diverse in frequency for two reasons:

- To allow for a better chance of successful communication, by frequency diversity. This is particularly important, where the location of sensors/actuators cannot be relocated, due to building design constraints.
- If not all member states allocate in their national regulations, all of both frequency bands 870-876 / 915-921 MHz, there may be a need to ensure at least one safe harbour is available.

6.3.2 SMART METERS

The use of the frequency range 169.4-169.8125 MHz has been revised in 2012/2013 and will be available for smart metering / smart grids. The possible use of the about 400 kHz for smart metering / smart grid in this frequency range can however, only be considered only as a supplement, but is well suited because of the ideal propagation conditions to read meters in cellars.

The topic of metering is very complex and must be divided into different areas. It is in principle to distinguish between reading meters for electricity, but also gas, heat and water (metering), control of energy networks and the integration of intelligent electric appliances. This has caused the development of various interfaces and several techniques for data transmission. Trunked radio and mobile networks to wireless, nationwide read meters suitable within the existing terms and conditions and individual designations. The integration of renewable power generators and also intelligent electricity into the power grid could be realized with radio equipment of short range on the basis of a general designation. For purely in-house applications (smart home) already existing radio applications (WLAN, ZigBee) are generally available.

Sub-GHz bands between 400-500 / 800-1000 MHz are the most cited in the discussions for wireless metering technologies, offering a combination of large coverage area and low bit rates with smaller coverage distance and higher bit rates.

The results of detailed investigations performed [16] also confirm this view due to the propagation characteristics above 1 GHz limit drastically the possibility to reach all the endpoint / metering sensors in a network (often inside, or even in basements).

Therefore the most suitable frequency option for Smart Meter is the 870-876 MHz band as this gives the best balance of capacity (bandwidth) coupled with favourable propagation characteristics.

6.3.2 SMART GRID

Electricity generation from renewable and conventional energy, the efficient and reliable distribution of electrical energy are requiring solutions for decentralised small producers of electricity and operators of the electricity transport networks. Communication channels are required, which can be realised also wirelessly to some extent.

For this purpose, in particular to smart grids, there are already a number of frequency options available or under discussion to meet the requirements of intelligent electricity networks.

Frequency options:

For the realisation of wireless communications for smart grids are predominantly frequency bands below 1 GHz best suited.

- 450 MHz (PMR/PAMR);
- Mobile networks (PMR/PAMR elsewhere);
- Public networks (wireless access);
- 870-876 MHz (extension for SRD - applications, ETSI proposal).

Under frequency-regulatory aspects it is also decisive how far realisations are possible within the framework of the existing Regulation (individual allocations, general allocations). Also, some still pending requests outside of radio frequency regulation can affect the future spectrum requirements (security-related requirements, data protection, etc.).

Utilities generally favour using different technologies depending on technical and operational capabilities as well as strategy. Currently, only GSM/GPRS (at 900 MHz) and CDMA (at 450 MHz) can be considered. In the long term, other technologies such as UMTS, HSPA, LTE or RF meshed network solutions may also be considered. Other stakeholders generally supported the use of GSM and 4G/LTE technology in the short/long term respectively, but also included other technologies including EVDO, PMR(TETRA), WAN or other technologies associated to mesh routing protocol for shorter ranges.

National administrations and utilities overwhelmingly believe PMR networks could be implemented on a shared basis, but caution different requirements by public users and situations when utilities and 'blue light' services would want priority network access at the same time. Infrastructure providers' and telecom operators' responses were more varied. Some believe that current telecommunications networks are suitable and sufficient; others agree with PMR sharing but caution the challenges it would require, and some feel it must be a dedicated spectrum and should not be shared.

Utilities responses to the use of mission-critical services on a shared PMR network vary. Some are of the opinion that not all 'mission-critical' communications can be met by wireless technologies, while others feel that a shared network could work if Service Level Agreements are such that using a shared network is transparent for the utility. A couple of responses also favour the use of shared PMR as a back-up system during emergency situations. Responses from infrastructure manufacturers do not eliminate the possibility of using 'mission-critical' services on a shared PMR network, but cite various challenges (e.g. high costs, equipment compatibility, resilience, End Point Design complexity, built-in network management) as reasons for choosing other possibilities.

Sub-GHz bands between 400-500 / 800-1000 MHz are also the most cited in the EC call[11] for long and short range wireless technologies, offering a combination of large coverage area and low bit rates with smaller coverage distance and higher bit rates.

The results of detailed investigations performed by the University of Dortmund [16] also confirm this view due to the propagation characteristics above 1 GHz limit drastically the possibility to reach all the endpoint / sensors in a network.

Therefore the most suitable frequency option for Smart Grid is the 870-876 MHz band as this gives the best balance of capacity (bandwidth) coupled with favourable propagation characteristics.

6.4 SURVEILLANCE ALARMS, FIRE/SMOKE ALARMS, INTRUDER ALARMS, SOCIAL ALARMS,

The preferred future frequency designation is in the upper part of the 870 to 876 MHz because these applications may very likely coexist with GSM-R due to:

- low activity factor and
- low duty cycle and with
- short telegram bursts only in the case of an alert.

A second designation may be in the band 915-921 MHz.

The existing frequency allocation in the 868 MHz band (ERC/REC 70-03 [2] Annex 7) should be kept due to an installed basis of billions of devices and systems in CEPT countries. Otherwise the performance, reliability and functionality may decrease significantly due to competition with other applications in the same band which generates a less reliable, less predictable spectrum environment.

6.5 ASSISTIVE LISTENING DEVICES

ALD represent a niche deployment of SRD, albeit for a purpose vital to 25% of the population at some point in their lives. In developing the sharing studies in ECC Report 200 [7], it became clear that the relatively high duty cycle requirement necessary in ALD, made it difficult to share with many SRD applications. However, being a niche deployment, sharing opportunities were identified utilising the physical distance separation with other SRDs that are unlikely to be deployed ubiquitously. The clear option for co-channel using these criteria is RFID interrogators. It is extremely unlikely that RFID and ALD will be co-located. As such, the most suitable frequency option for ALD appears to be co-channel with RFID interrogators.

7 EXISTING NATIONAL SPECTRUM USE IN THE 870-876 / 915-921 MHz BANDS

7.1 GOVERNMENTAL USE IN 870-876 / 915-921 MHz

7.1.1 Tactical applications

There are several definitions for tactical radio but the main property for tactical radio in the discussed frequency bands is that these tactical radio applications may be deployed without notice in a particular geographical location when needed. The absolute link budgets for these applications are unknown but are usually chosen within borders for a reliable operation with a 99.5 % confidence.

Tactical applications are designed to cope with intentional interferers such as jammers but only in a single entry case. Most applications expect an average deployment of interferers or collocated applications near zero to guarantee their confidence level.

To illustrate the typical use, three different example scenarios are depicted below:

[11] https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/20121804_energy_efficiency_public_consultation.pdf

1 bomb disposal robot: The moment for its use is unplanned and also the location of deployment may be very diverse. Examples are an office environment, supermarket, school, apartment block, roadside, industrial location. All typical locations were RFID and / or other SRD use is depicted. The covered area itself is small so single interferers are the main source of interference, variations in the link budget for the wanted signal are usually a constant factor. Sharing with licence exempt applications is not considered possible. Typical average use in The Netherlands is 5 deployments / day.

2 tactical team helmet camera and radio link: The moment for its use may be planned or unplanned. The covered area is medium and the main source of interference is both the single interferer and the aggregate in a 50x50m square. The link budget has a strong location dependency but has a statistical confidence. When deployed in buildings the average link budget goes down. Sharing with licence exempt applications is not considered possible for indoor scenarios.

3 unmanned aerial vehicles: The moment for its use may be planned or unplanned. The covered area is large and the main source of interference is the aggregate. The armed forces are the only organisation in The Netherlands to operate above city areas and use the vehicles non line of sight. Link budgets are variable from high to very low. Sharing with licence exempt applications may be theoretically possible after a careful compatibility study but unlikely to be approved.

See Annex 3 for Replies to CEPT Questionnaire on the use in 870-876 / 915-921 MHz.

8 TECHNOLOGY STANDARDS

8.1 EQUIPMENT STANDARDS UNDER DEVELOPMENT IN ETSI ERM TG17, ERM TG28 AND ERM TG34 IN SUPPORT OF SRD DESIGNATIONS 870-876 / 915-921 MHz

The following Harmonised Standard revisions or creation of new harmonised standards are foreseen and the respective work items are already in progress in the responsible ETSI standardisation groups in ETSI ERM:

Table 8: List of SRD Standards under development in support of 870-876 / 915-921 MHz

ETSI ERM sub-group	Title of Standard
ETSI ERM TG17	Revision of EN 300 422 (proposed new entry in Annex 10 of ERC/REC 70-03)
ETSI ERM TG28	Revision of EN 300 220 (all new proposed entries in Annex 1 and Annex 5 of ERC/REC 70-03)
	Creation of a new Harmonised European Standard for alarm applications (870-876 / 915-921 MHz; proposed 0.1% DC entries in Annex 1 of ERC/REC 70-03)
	Creation of a new Harmonised European Standard for networked based SRDs (870-875.6 MHz)
ETSI ERM TG34	Revision of EN 302 208 (865-868 MHz and 915-921 MHz) as proposed for Annex 11 of ERC/REC 70-03

8.2 SRD RECEIVER PERFORMANCE

Receiver specifications

Introduction

Receiver specifications have been and are still the subject of a long debate in both ETSI and CEPT. Opinions of regulators and industry vary although the need for better receiver specifications is acknowledged by all. The source for discussion is partly the fact that receiver specifications may be defined for a number of technical and other reasons. The technical reasons are:

Defining EMC: Functioning of the receiver is influenced through EM radiation leaking through the cabinet or entering the cabinet trough cabling. EM energy does not necessarily enter the receiver through the antenna port or the integral antenna. Examples are Low Frequency Detection in the AF stages of the receiver or variations in the power Supply voltage as the result of an EM field but also the spurious radiation of the receiver itself.

Frequency management and planning: For the functional description of a radio system usually a link budget is defined consisting of a transmitting power and modulation type, a propagation path and the minimum sensitivity of the receiver. The receiver parameters are in this case related to sensitivity and selectivity such as blocking, LO phase noise, adjacent channel selectivity etc.

Improving spectrum efficiency: A receiver uses the spectrum just like a transmitter. If for example the IF filter is too wide (wider than necessary for the reception of the transmitted signal), spectrum is wasted since it could be used by another receiver transmitter combination. The parameters are the same as for Frequency management and planning but the values may differ. A radio system may function without problems but could still waste spectrum resources because its receiving bandwidth is relaxed.

Receiver category

In the 30 MHz -1000 MHz SRD standard EN 300 220 [18] receivers are classified in category 1, 2 and 3. Category 3 is the lowest and category 1 is the highest performance of a receiver. Each category contains one or more receiver parameters and its associated value. The values of the parameters are set by a mix of EMC, frequency management and spectrum efficiency reasons. In the SRD world restrictions are usually based on cost versus compatibility and these parameters are no difference.

For the customer/end user and industry the category are more useful than the actual parameters because they can be easily used to show the quality or suitability of the product. It is also easy for a regulator other than the spectrum regulator to make a receiver category mandatory for a particular application. Examples are safety and alarm applications.

Receiver categories vs Receiver parameters

Receiver parameters have an impact on intra SRD sharing, especially were high and low power and narrow and wide bandwidth systems need to work together in the same environment.

The existing categories contain parameters for blocking an adjacent channel selectivity. A balance of power in a sharing environment is supported by defining certain values for blocking all categories contain this value for blocking so a quality assessment in the environment based on power levels can be made. For selectivity however there is no value for the categories 2 and 3 which are the most used categories for equipment on the market. An assessment on spectrum efficiency and even establishing a predictable sharing environment cannot be made from a regulatory point of view. Existing industry seems to be happy with this situation but a newcomer may have problems with hidden receiver parameters limiting their access because the sharing environment is not that predictable. For the new frequency bands 915-921 / 870-876 MHz clear bandwidth parameters should be established for all equipment that wishes to use it. It is not necessary for these parameters to be very tight in all cases since there are 3, or in the future maybe more, receiver categories.

9 OUTCOME OF COMPATIBILITY STUDIES (ECC REPORT 200)

9.1 CONCLUSION OF ECC REPORT 200

The conclusion of the ECC Report 200 [7] addresses the need for co-existence studies identified within the CEPT Roadmap for designating additional spectrum for SRD/RFID applications in the UHF spectrum, notably in the 870-876 / 915-921 MHz bands.

ECC Report 200 has analysed a broad range of SRD and RFID uses that ETSI proposed to be deployed in the subject frequency bands alongside several governmental and non-governmental radiocommunications services and systems that are already in operation or proposed in CEPT countries. The ECC Report 200 also considers systems/services operating in adjacent bands. The studies have relied on a combination of methods including Minimum Coupling Loss link budget calculations to statistical Monte-Carlo based simulations performed with SEAMCAT.

The main goal of ECC Report 200 [7] was the assessment of the impact of the requested SRD and RFID uses in respect to the primary radio services used in the same and adjacent bands. Some consideration was given to intra-SRD investigations.

Analysis of trends (ECC Report 200 Annex 1) indicates that the pattern of current and planned use of the subject bands varies greatly across the CEPT region. This varied use has resulted in different sharing opportunities dependent on the type of systems studied and the results have been structured to enhance the sharing possibilities with each countries combination of services. In some cases SRD equipment will need to be class 2 to ensure the best spectrum efficiency whilst protecting the primary service.

Note that except for some explicit provisions mentioned below, all conclusions of ECC Report 200 [7] are based on SRD/RFID parameters (e.g. channel bandwidths, DC and transmit power ranges) as derived from respective ETSI System Reference Documents.

A. Countries where bands 870-876 / 915-921 MHz are used for TRR and/or UAS:

Countries where bands 870-876 / 915-921 MHz or parts of the band are used for TRR and/or UAS may consider introduction of SRD/RFIDs only with certain additional considerations, such as:

- For countries that in the time of peace restrict the use of TRR to designated military exercise areas, adequate physical separation between SRD/RFID and TRR must be ensured. Under these conditions sharing with SRD/RFIDs may be feasible and further aided by requiring SRDs to use APC;
- For countries that in time of peace allow the use of TRR anywhere across their territory, especially in urban areas:
  - sharing between SRD (band 870-876 MHz) and TRR may be feasible subject to specific conditions. In particular, these conditions must impose limitations on SRDs covering emitted power, DC and the density of SRDs per square km, as indicated in the studies. Irrespective, there will be some residual level of interference and the overall noise level to TRR will be increased;
  - sharing between RFID (band 915-921 MHz) and TRR will not be feasible;
- For countries that allow use of UAS anywhere across their territory, especially in urban areas:
  - co-frequency sharing between SRD (870-876 MHz) and UAS may be feasible subject to specific conditions. In particular, these conditions impose limitations on the emitted power of SRDs, their DC and the density of SRDs per square km, as indicated in the studies. Irrespective, there will be some residual level of interference and the overall noise level to UAS will be increased;
  - co-frequency sharing between RFID (915-921 MHz) and UAS will not be feasible in general;
- The countries that use the subject bands for TRR and/or UAS systems in the band 870-876 MHz may allow SRDs as Class 2 devices provided they comply with limits on power and duty cycle. Furthermore there must be certainty that the estimate for the density of devices is not exceeded;
- Sharing conditions may be improved if SRD/RFID could employ additional, more sophisticated mitigation mechanisms, such as DAA.

B. Countries where the bands 873-876 / 918-921 MHz may be used for ER-GSM:

- The subject bands include sub-bands 873-876 / 918-921 MHz that are allocated as an extension for pan-European GSM-R systems (referred to as the ER-GSM bands). They may be used by countries that have a heavy railways infrastructure requiring additional network capacity in addition to that provided by the main GSM-R bands 876-880 / 921-925 MHz;
- Co-frequency sharing with ER-GSM is not generally possible without addition mitigation. It is therefore proposed that countries with plans for using 873-876/918-921 MHz for ER-GSM, may consider the following regulatory arrangements for introducing SRD/RFIDs:
  - Within the bands 870-873 / 915-918 MHz the considered SRDs/RFIDs may be allowed with the parameters assumed in ECC Report 200 [7] (see Table 9;
  - Within the bands 873-876 / 918-921 MHz, administrations wishing to avoid harmful interference in both typical and worst case scenarios should introduce the option 1 and/or option 2 timing restrictions for SRDs in Table 9 below. Administrations willing to disregard the high risk of interference for worst case scenarios, and accepting interference probabilities in the average case simulations in the order of 5%, do not require these restrictions;
  - A further option to use ER-GSM bands for higher power applications could be a coordination procedure with the railway operator or a cognitive procedure in order to avoid the ER-GSM bands (see Option 3 in Table 9). ETSI has already created TS 102 902 [22] and TS 102 903 [25] on methods, parameters and test procedures for cognitive interference mitigation towards ER-GSM for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques. In addition, ETSI TR 101 602 describes the results of some verification tests of the DAA technique using modified RFID interrogators [24]. The feasibility and development of these techniques are also based on measurements performed in the Kolberg laboratory of the German regulator, Bundesnetzagentur, at Kolberg in June 2009 [26].

Table 9: Options for sharing with ER-GSM

	Option 1: For devices with high deployment figures	Option 2: For devices where low deployment is ensured by regulatory means (e.g. access points) (Note 2)	Option 3: Cognitive approach (Note 1 and Note 3)
DC limit in a bandwidth of 200 kHz	▪ Short term DC limit Max Ton 5ms, Min Toff 995ms and ▪ Long term DC of around 0.01%	Short term DC limit Max Ton 5ms, Min Toff 995ms	NA
Max Tx power	25 mW	500mW	For RFID at 36 dBm (4W) and SRD at 27 dBm (500 mW). A frequency offset of 100kHz from GSM-R channels is applicable

Option 1 and Option 2 should be considered as lower and upper regulatory boundaries.

Note 1: The requirements for this cognitive approach with ER-GSM are analysed for the band 918-921 MHz in Annex 6 and are provided in TS 102 902 V1.2.2 and ETSI TS 102 903 V1.1.1 (2011-08). The latter document also describes the various compliance tests necessary to verify proper operation of the proposed mitigation technique for inclusion in an ETSI standard. The effectiveness of this approach was not tested against non-GSM systems (e.g. 4G, 5G).
Note 2: Low deployment means about 1 device per km^2
Note 3: The DAA mechanism considered and tested for coexistence between ER-GSM and RFID devices in the 918-921 MHz band (see Annex6) could be also adapted to identify channels not being used by ER-GSM in the vicinity of SRDs in the 873-876 MHz band

C. Countries that deploy Wind Profiler Radars and other than above mentioned services in 870-876 / 915-921 MHz:

It was noted that UK and Isle of Man each have one remote site with a Wind Profiler Radar that are in constant use. However these administrations considered that the Wind Profiler Radars would be adequately protected from the assumed SRD applications (see Table 10). They also considered that any interference events could be managed due to the very low number of WPR in operation, their remote situation and if necessary, the size of any exclusion zone that would be required to provide protection to their WPRs.

D. Countries that do not use the bands 870-876 / 915-921 MHz:

The adjacent band co-existence between candidate SRD/RFIDs and GSM/GSM-R may be feasible with the SRD/RFID applications and parameter settings assumed in this report.

Other than consideration of coexistence with other services in the subject bands, this study also addressed the feasibility of intra sharing for the envisaged broad variety of SRD and RFID uses as requested by ETSI. This is of primary importance to countries that do not use the bands. Some consideration has been given to this exercise.

As a general conclusion, this study found that intra-SRD sharing of the investigated uses in the bands 870-876 MHz is feasible, assuming the SRD parameters set out in the relevant SRDocs (see Table 10).

A similar conclusion on the feasibility of general intra-SRD/RFID sharing of the investigated uses may be drawn also for the band 915-921 MHz assuming the following frequency arrangements:

- Higher-power SRDs and RFIDs are placed in four “high power” channels;
- Lower-power SRDs are interleaved between the “high power” channels;
- Assistive Listening Devices (ALD) with DC up to 25% is also placed in the four RFID channels, assuming co-location is unlikely.

However, manufacturers of devices using the band 915-921 MHz should be aware that the channels 916.3, 917.5, 918.7 and 919.9 MHz may be used by high power SRDs/RFIDs with channel bandwidths of up to 400 kHz.

For countries that do not use the bands 870-876 / 915-921 MHz, the summary of assessed technical assumptions and parameters for SRDs and RFIDs being deployed in 870-876 / 915-921 MHz bands is provided in the following table 10 as was set out in ECC Report 200 [7].

Table 10: Summary of assessed technical parameters for SRDs and RFIDs for countries that do not use the bands 870-876 / 915-921 MHz as set out in ECC Report 200

Frequency Band	SRD Category	Equivalent ETSI SRDoc	Max Power	Max DC	Channel arrangement	Bandwidth
870-876 MHz	Non-specific (low power)	TR 102 649-2	25 mW	1%	870-876 MHz	Up to 600 kHz
	Personal wearable devices (e.g. alarms)	TR 103 056	25 mW	0.1%	870-876 MHz	25 kHz
	Indoor stationary devices (e.g. low duty cycle Home Automation and Sub-Metering)	TR 102 649-2 TR 102 886	25 mW	0.1%	870-876 MHz	Up to 200 kHz
	Automotive	TR 102 649-2	500 mW (2) (3)	0.1%	870-876 MHz	Up to 500 kHz
	Infrastructure network nodes (4)	TR 102 886 TR 103 055	500 mW (3)	2.5%	870-876 MHz	200 kHz
	Infrastructure network access points (4)	TR 102 886 TR 103 055	500 mW (3)	10%	870-876 MHz	200 kHz
915-921 MHz	Non-specific (low power)	TR 102 649-2	25 mW	1%	915-921 MHz	Up to 600 kHz
	Non-specific (medium power)	TR 102 649-2	100 mW	1%	4 channels in 915-921 MHz (1)	Up to 400 kHz
	Indoor stationary devices (e.g. low duty cycle Home Automation and Sub-Metering)	TR 102 649-2 TR 102 886	25 mW	0.1%	915-921 MHz	Up to 200 kHz
	Indoor stationary devices (e.g. high duty cycle Assistive Listening Devices)	TR 102 791	10 mW	25%	4 channels in 915-921 MHz (1)	Up to 400 kHz (6)
	RFID (interrogators)	TR 102 649-2	4 W	2.5% (5)	4 channels in 915-921 MHz (1)	Up to 400 kHz

Note 1: four channels: 916.3, 917.5, 918.7 and 919.9 MHz.
Note 2: for Vehicle-to-Vehicle applications only; <100 mW for in-vehicle applications.
Note 3: APC always required for applications to reduce unnecessary emission levels.
Note 4: Installation only by professionals – e.g. operator of Smart Metering/M3N network.
Note 5: For RFID, a DC of 2.5% is assumed for the hot-spot scenario. In less dense scenarios higher DCs are possible.
Note 6: All ALD simulations were carried out with 200 kHz. If ALD share the channel plan with RFID, the bandwidth permitted may be 400 kHz.

Table 10 provides an example of a possible solution for SRD sharing in countries that do not use the bands 870-876 / 915-921 MHz and may not necessarily represent the final solution. Not considered were for example broadband SRDs using direct sequence or other spread spectrum techniques and sophisticated channel access techniques such as LBT and AFA.

Where the interrelationship between power, DC and deployment density has been used further consideration may be necessary in developing regulations.

9.2 COMMENTS ON THE CONCLUSION OF ECC REPORT 200

9.2.1 Network Relay Points

ECC Report 200 [7] also describes the use of network access points/network relay points forming part of metropolitan area networks such as for utilities or other applications for the purpose of data acquisition.

NRP is defined as a device deployed by organisations, such as smart utilities, municipal, industrial, transport, logistics or other metropolitan/rural area network operators, to support wider area operations. NRPs provide connectivity for one or more otherwise isolated network devices by forwarding traffic in both directions between the network and the isolated device(s). Such devices will be limited in their deployment and will not be operated by the general public/consumers.

The regulatory approach set out in ERC/REC 70-03 [2] should be reviewed in future, in case the actual deployment and attributes of such networks fall outside of that assumed in both ECC Report 200 [7] and this Report.

Annex 2 describes how such a network operates, typically in mesh configuration. Within the mesh it is essential to have Network Relay Points (NRP) to push/pull data into the network at appropriate locations or complete the mesh, where necessary. The number and location of NRP is very much dependent on the flow of data through the network. ECC Report 200 [7][6], in Note 4 states; "Installation only by professionals – e.g. operator of Smart Metering/M3N network".

ETSI is creating a new harmonised European standard for network based SRDs in support of clear definitions and sound regulatory framework for such networks to ensure that polite spectrum access mechanisms are employed to avoid spectrum overload situations. The scope and general requirements of the standard shall ensure that networked SRD effectively coordinate between differing networks to ensure the effective operation of all compliant networks.

ECC Report 200 [7] concludes that Network Access Points (NAPs) with up to 10% DC may be easily accommodated in most typical coexistence situations, because their higher DC may be compensated by lower deployment figures. However, in the case of NAPs, there is a probability that the density may potentially exceed assumptions, due to market growth, spectrum access and competition issues. Therefore, some form of review mechanism should be considered to investigate possible difficulties with regard to the compatibility of network relay point applications and other applications in the frequency band.

Such equipment can be operated by various providers in the same metropolitan area. This means that it may be difficult to maintain the low deployment figure. To address this issue, one possibility may be to monitor the deployment of NRP. This possibility has been investigated and the result is that this could be done by defining a notification procedure as part of a general authorisation framework. However, such a registration process is difficult to implement and the efficiency of such procedures is not proven (see experiences on light licensing regime). If the situation becomes critical (maximum deployment figure is reached and the likelihood of interference increases significantly), it may be too late to introduce new restrictions in order to mitigate interference. Therefore, it is recommended that NRPs are subject to individual authorisations or alternative frequency opportunities.

10 PROPOSED BAND PLANS

Some applications such as alarm applications are in a “low duty cycle/ high reliability device” category defined by the European Commission as equipment which rely on low overall traffic, low data rate, limited geographical density and overall low spectrum utilisation. Limited safe harbours are part of the proposed band plans to provide for last resorts where such applications can be operated with higher reliability. More than one safe harbour is included to provide frequency diversity and to allow for the fact that not all administrations may be in a position to implement the complete proposed frequency plans.

10.1 870-876 MHz BAND PLAN

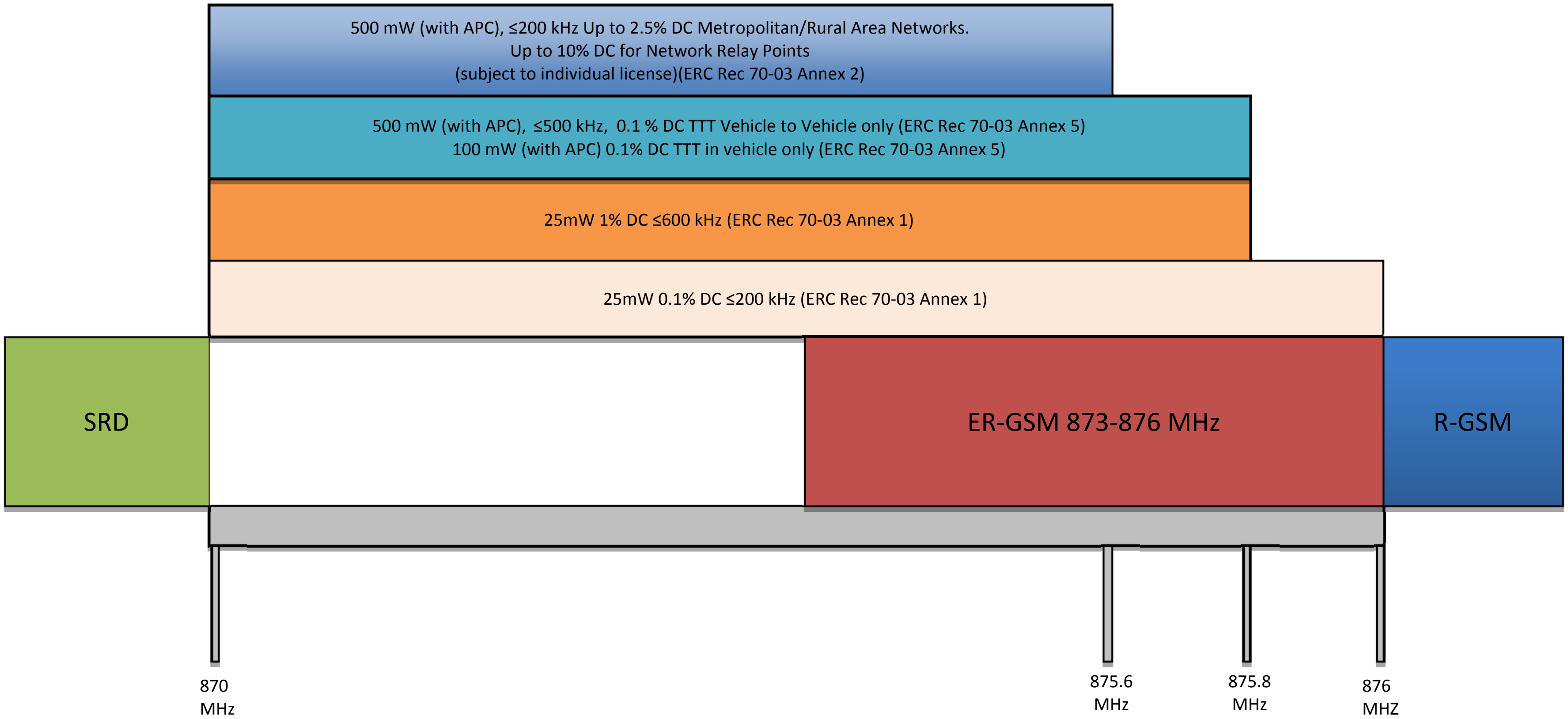

Figure 3: Band plan for 870-876 MHz

ERC/REC 70-03 Annex 1
870-875.8 MHz, 25 mW, 1% DC, max 600 kHz (plus GSM-R LDC option)
ERC/REC 70-03 Annex 1
870-876 MHz, 25 mW, 0.1 % DC, 200 kHz (plus GSM-R LDC option)
ERC/REC 70-03 Annex 2:
870-875.6 MHz, for Metropolitan/ Rural Infrastructure Networks, 500 mW (with APC), ≤200 kHz Up to 2.5% DC and 10% DC for Network Relay Points (NRPs subject to individual licensing). Metropolitan/ Rural Infrastructure Networks may be subject to individual licensing.
ERC/REC 70-03 Annex 5
870-875.8 MHz, TTT (vehicle to vehicle 500 mW APC of at least 20 dB range, 0.1 % DC, max. 500 kHz) and 870-875.8 MHz, TTT 100 mW APC, 0.1 % DC (in vehicle only)

10.2 915-921 MHz BAND PLAN

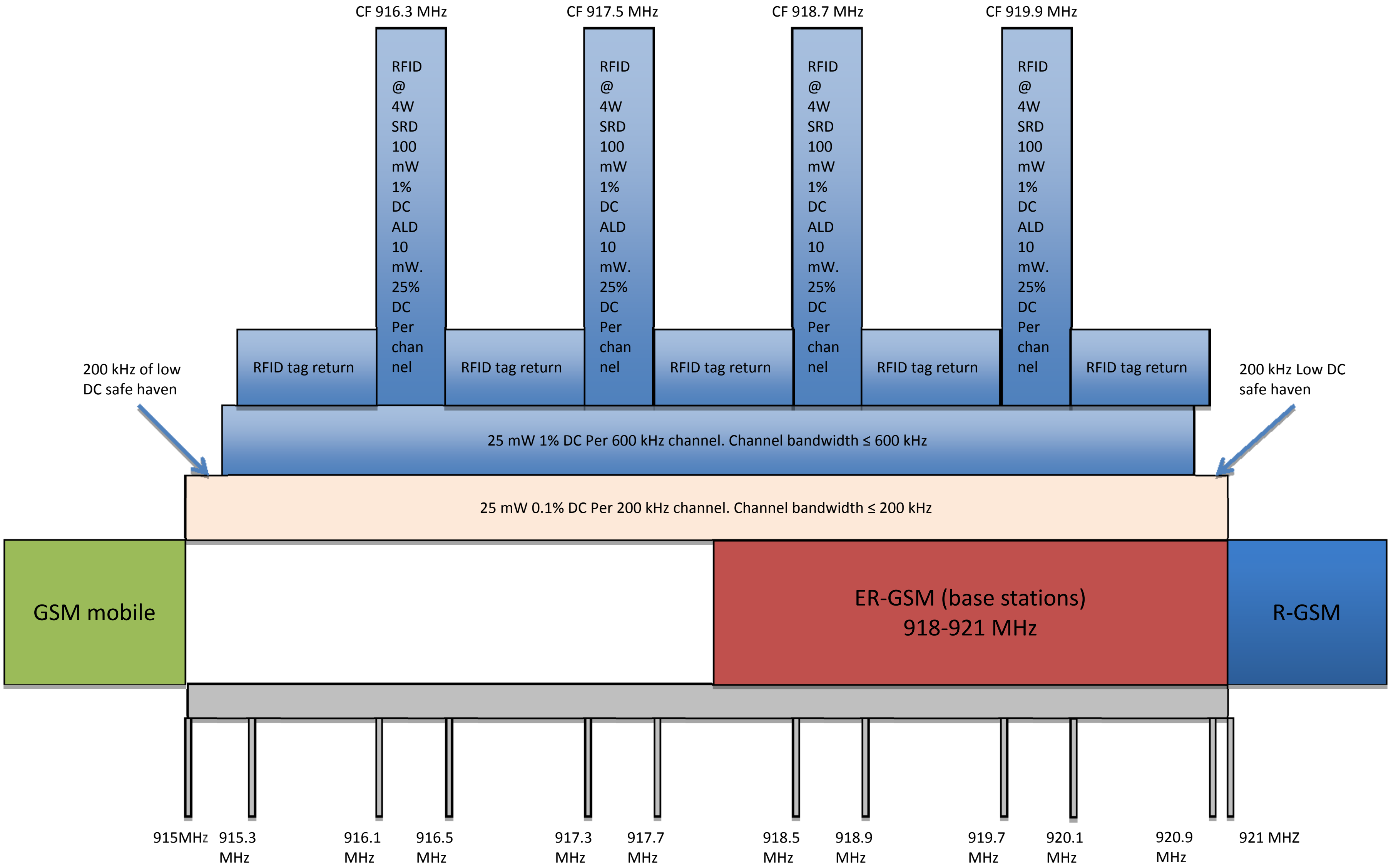

Figure 4: Band plan for 915-921 MHz

ERC/REC 70-03 Annex 1:
915.0-915.3 MHz, 25 mW, 0.1% DC (diversity, battery life, alarms and other devices needing similar predictable spectrum sharing).
920.9-921.0 MHz, 25 mW, 0.1% DC (diversity, battery life, alarms and other devices needing similar predictable spectrum sharing).
915.3-920.9 MHz, 25 mW, 1% DC 600 KHz.
916.1-916.5 MHz, 917.3-917.7 MHz, 918.5-918.9 MHz, 919.7-920.1 MHz 100mW, 1% DC.
Footnote on frequency hopping: accumulated dwell time per hop should fulfil the GSM-R: LDC option in 873-876 MHz 5ms/1s and 0.01/h.

ERC/REC 70-03 Annex 10:
ALD 916.1-916.5 MHz, 917.3-917.7 MHz, 918.5-918.9 MHz, 919.7-920.1 MHz, 10 mW, 25% DC 400 kHz channels (follows the RFID channel plan and restrictions to protect GSM-R).

ERC/REC 70-03 Annex 11:
RFID 916.1-916.5 MHz, 917.3-917.7 MHz, 918.5-918.9 MHz, 919.7-920.1 MHz, 4 Watt 400 kHz channels no DC. However, “operation only permitted when necessary to complete the intended operation, i.e. when tags are expected to be present” – plus the DAA option for countries having E-GSM-R.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 PROPOSED REGULATORY REGIME

For the majority of SRD in the 870-876 / 915-921 MHz, the proposed regulatory regime is licence exemption. This conclusion is based on the sharing analysis in ECC Report 200 [7] indicating that the proposed SRD meet the conditions, set in the introduction to ERC/REC 70-03 [2], that they have a low capacity to cause interference.

There is one exception to this. The Metropolitan Infrastructure Networks, when operating above a Duty Cycle of 2.5%, require some form of coordination to operate in the frequency band 870-875.6 MHz. Therefore, it is recommended that Network Relay Points (NRPs) of Metropolitan Infrastructure Networks should be subject to individual authorisations.

The ECC Report 200 [7] conclusions categorised the national sharing arrangements with primary services into four categories:

- Countries where bands 870-876 / 915-921 MHz are used for TRR and/or UAS;
- Countries where the bands 873-876 / 918-921 MHz may be used for ER-GSM;
- Countries that deploy Wind Profiler Radars and other than above mentioned services in 870-876 / 915-921 MHz;
- Countries that do not presently use the bands 870-876 / 915-921 MHz.

This necessitates that although the proposed SRD regulatory regime is licence exemption, the regulations in different administrations in CEPT may be different.

As such there are likely to be different sets of apparatus made available for different markets within Europe. In the European Union, this situation is referred to “Class II apparatus”. That is to say that there will be restrictions on where particular apparatus can be lawfully operated. Manufacturers of apparatus operating in the 870-876 / 915-921 MHz band will need to make it clear to users where apparatus may and may not be used.

11.2 RECOMMENDATIONS

The suggested SRD designations are set out in Annex 4. It is recommended that these suggested SRD designations are transposed into ERC/REC 70-03 [2].

ANNEX 1: DETAILED OBJECTIVES SET OUT IN ETSI SYSTEM REFERENCE DOCUMENTS

A1.1 GENERIC SRD

Generic SRD are already installed in large numbers across a wide range of applications within Europe in the 863-870 MHz band (see ECC Report 182 [11]) and their use is expected to grow rapidly over the next 10-15 years. It is anticipated that the current designations of spectrum for generic SRDs will be inadequate to meet their future needs.

The SRD industry has expanded considerably over recent years and has now developed into a number of different industrial sectors. It is anticipated that the present trend in diversification and expansion will continue.

Based on these predictions of market growth, it is very evident that additional spectrum or more efficient use of the existing spectrum will be necessary. These points were already identified in November 2006 in CEPT Report 14 [8] in response to the mandate from the European Commission to develop a strategy to improve the effectiveness and flexibility of spectrum designation for SRDs. The Report recommended that:

- "That CEPT ensures that only the minimum regulations are specified in ERC/REC 70-03 [2] and, where appropriate, the application-specific constraints to spectrum use are removed";
- "New bands should preferably be extensions of SRD bands or close to them";
- "Introduction of LBT and/or AFA in existing SRD bands is a first priority. However, any benefit from the introduction of LBT and/or AFA may be short lived if the anticipated growth in SRDs occurs. Therefore the identification of new spectrum for SRDs employing these techniques is a second priority".

Economic value of SRD/RFID/SM incl. their importance for the society has increased. Future proof solutions are needed, also with regard to SRD/RFID/SM as victims and changes in the adjacent spectrum (e.g. LTE). This may also include intra-SRD compatibility considerations.

Existing spectrum in 863-870 MHz is not currently overcrowded but it is evident that there is a strong device population growth and the noise environment may change as a result of new services in adjacent spectrum.

A1.2 RFID

It is anticipated that the current designations of spectrum for RFID will be inadequate to meet their future needs. RFID at UHF is currently one of the most promising and discussed automatic identification and data capture (AIDC) technologies. The range of applications is broadening rapidly and includes new applications which incorporate other technologies such as sensors.

Market analysis shows rapidly growing sales for RFID systems.

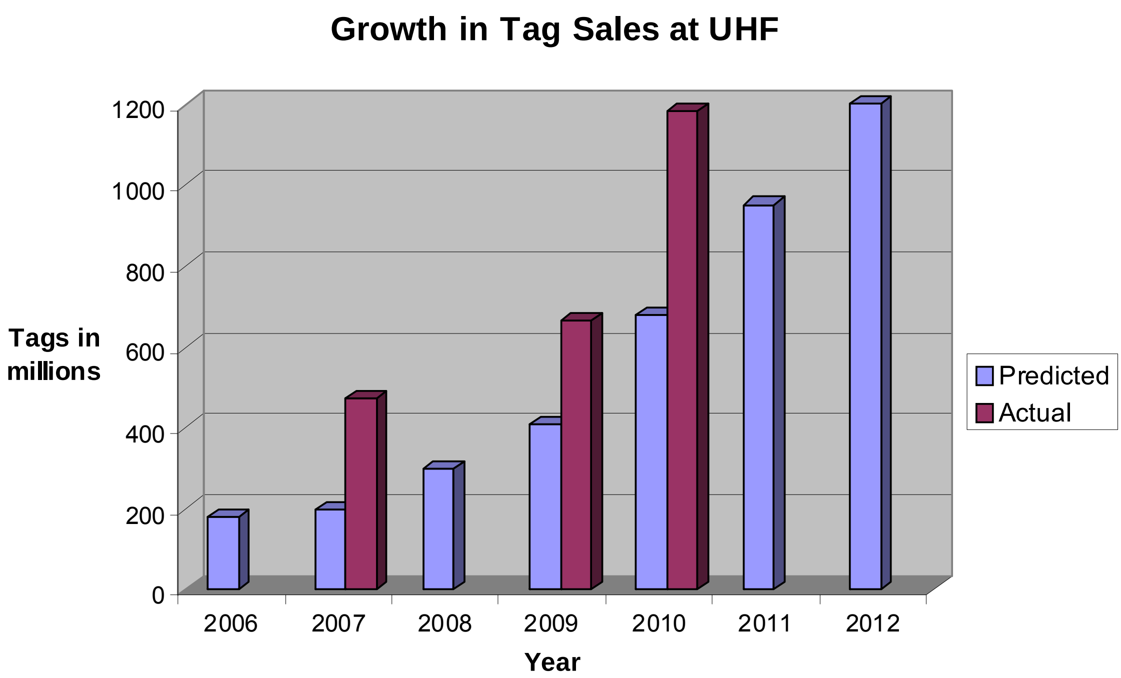

Figure 5: Growth in Tag Sales at UHF

The blue bars on the chart originated from EPCglobal and were included in CEPT Report 14 [8] of 2006. They show predictions for the annual growth in global tag sales at UHF from 2006 to 2012. Sales in 2006 were predicted at 200k rising to 1.2 billion in 2012, which represents a compound rate of growth of 35%.

The actual sales that were achieved over the same period are shown in red. These figures were provided by IDTechEx, who are an independent and respected source of marketing data. It will be seen that in each year for which they have records, sales have comfortably exceeded predictions.

There is a wide variety of different RFID applications and this number is growing at a rapid pace. This range of applications may be listed under the following broad categories.

- **Logistics and materials handling**: Mobile assets are frequently tagged to track their movement along the supply chain. Typical examples are RFID–tagged cartons, containers and pallets, which are used at different stages during the production process. The objective is to optimize the movement of goods and achieve improved levels of efficiency. Other materials handling applications include libraries, waste management and many other applications in daily life.
- **Asset monitoring and maintenance:** RFID is mostly used to tag fixed and high–value assets. The tags contain a range of data, such as expiry dates and other similar information used for maintenance purposes. Examples include tagged aircraft spares and tagged machines where the maintenance history is stored on the tag. Where data is stored directly on the tag and not on the companies' network, tags with large memories are often needed.
- **Processes control:** To improve management control RFID tags are attached to items, which move through a manufacturing process. Often information going beyond a simple ID number is stored on the tag to control the production processes. For example this is the case in the automotive industry where tags containing production information are attached to car bodies or smaller parts. The main benefit is the avoidance of costly errors during the production process.
- **Inventory audit:** A prominent application is the use of RFID for inventory audit. Examples include warehouses where pallets and sometimes cases are tagged to improve the speed, accuracy and

efficiency of stock control. In most cases, only an ID number and EPC code is stored on the tag, which is used subsequently by the host computer to control or monitor the handling of tagged objects. Inventory audit is also used in retail where individual items may be tagged to increase the efficiency of stock control at the point of sale.

- **Anti-theft:** RFID tags are used at item level to prevent theft along the supply chain or at the point of sale. This takes the form of electronic article surveillance devices (EAS), which are installed at the perimeter of a controlled area. Recently the RFID and EAS functions have been combined within a single tag. This informs the shop keeper about those items that are being stolen which has a significant impact on the cost/benefit analysis.

Note: some data available about growth of reader sales Tag/interrogator ratio is heavily dependent on the application. It can range from as little as one interrogator to 100 tags up to one interrogator to 10.000 tags

It is predicted that the use of RFID in Europe will grow dramatically over the next 15 years. As the commercial benefits of RFID become more widely recognized, the technology will be adopted by many new industries. Some of these applications will require improvements to existing RFID performance. Typical examples include greater reading range, improved reading performance, faster data rates and the use of sensors (e.g. temperature, pressure, etc.) within tags. These requirements can only be met by the provision of additional spectrum.

RFID operating in the 915 to 921 MHz band will give a twofold benefit over the present 865 to 868 MHz band. The benefit of harmonisation with the USA means that tags will be read at the frequency at which they are designed to give their maximum response. Tags have a natural Q factor and typical response curve. By operating near the ideal frequency the signal received from the tag should be stronger. The increase in power and bandwidth as compared with 865 to 868 MHz increases the reading performance and potentially permits data rates that are four times faster than those currently possible.

It is considered that designation of the band 915 to 921 MHz for use by RFID will satisfy the foreseeable market requirements of the industry for the next 10-15 years.

These requirements have been extracted from the recent technical proposals generated by ETSI (European Telecommunications Standard Institute). Their System Reference Document ETSI TR 102 649 [1] v1.3.1 requests the extension of the current UHF frequency band used in the European Community to include a second frequency band from 915 to 921 MHz.

Recently EPCglobal France completed a study, which was based on responses to a questionnaire from 16 French users. This questionnaire had been circulated to selected users in 2011. One aspect of the study was an analysis of the users' perception of the benefits of RFID technology and of the challenges faced in implementing an RFID installation. The first seven questions in the questionnaire covered the extent to which current RFID systems satisfy present and future market requirements. The two last questions enabled a comparison to be made between the needs of users over the short and medium term against the proposals in the SRDoc.

The responses to the questionnaire represent around 80% of the present French market for the UHF RFID technology and cover the following types of activity:

- Aeronautics (eg : Eurocopter, Airbus/EADS …) ;
- Automotive (eg: Renault …);
- Retail and distribution;
- Others (eg: Systerel, Check Point …).

The responses to the questionnaire showed that users expect a substantial increase in the number of applications within the next two years. This followed from the perception of end users that RFID technology is a tool that can facilitate applications in logistics and warehouse management. In addition RFID will be deployed in new applications such as customer services and transport. The responses to the questionnaire gave examples of current and emerging applications.

Table 11: RFID Applications

Applications deployed today	New applications
Anti-theft	Rail freight
Anti counterfeiting	Baggage's management
Access control	Vehicles fleet management
Airfreight	Cross-merchandising
Geo-positioning	Point of sale (Retail and Distribution)
Fleet management	Vehicles and Aircrafts records
Stock management	Maintenance
Inventories	Food traceability (" from plough to platter")
Customer services	
Containers traceability	
Logistics	
Production management	

Many of the future applications will involve item level tagging at source, which will require better reading performance than is presently possible at 865-868 MHz. ETSI proposes to reduce the time taken to read multiple tags by increasing the bandwidth. For logistic applications it is also proposed to double the maximum transmitted power. This will help in the reading of tags in the centre of pallets, which often suffer from shielding

An analysis of the answers received showed that users have six main requirements for RFID systems.

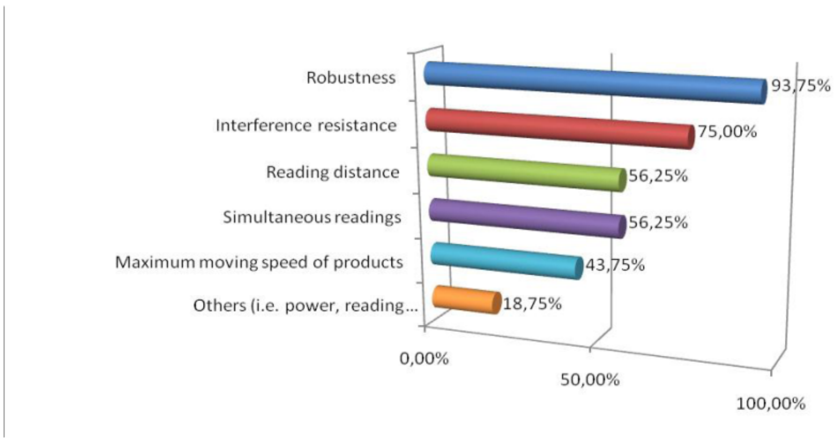

Figure 6: Analysis of users' requirements

The two most important requirements expressed by users are an increased resistance to interference (immunity) of the tag and adequate robustness of the interrogator, to read multiple tags, in situations where the RF environment is disturbed.

A substantial increase in the density of RFID interrogators is foreseen within the next two years. More precisely, the answers received showed that within the next two years, the demand for tags in France will increase by a factor of three and the sales of interrogators will double.

In many new applications there is a requirement to position interrogators in close proximity with each other. This can often lead to a reduction in performance due to the generation of inter-modulation products. The provision of additional high power channels with increased channel spacing as requested in the ETSI proposal will substantially allow this problem to be overcome.

The proposals in the ETSI System Reference Documents will help to solve the following limitations.

Table 12: Summary of Proposals of RFID as compared to the 865-869 MHz band

Needs expressed	Does the ETSI proposal cover the issue	How?			Comments
		Enlarging frequency bands (to 6 MHz)	Double power compared to 865-868 MHz	Double channel width compared to 865-868 MHz	
Robustness in a disturbed environment	YES	X		X	In case of double the maximum emitted power, coexistence of many interrogators must be managed by an adequate access technique
Interference résistance	YES			X	
Simultaneous reading	YES	X		X	Depending on how LBT is implemented, the reading speed may be reduced
Reading distance	YES		X		
Objects moving at speed in front of an interrogator	YES			X	
Others (maximum transmitted power,/reading efficiency/dense reader mode)	YES		X	X	

The study reached the following broad conclusions:

The adoption of a single global frequency band for RFID will assist in achieving market growth. This is exactly what is proposed by ETSI with their request for the designation of RFID in the frequency band 915-921 MHz. This band falls within the frequency range used in Northern America (902-928 MHz) and the frequency ranges being adopted in Asia.

UHF RFID is moving more and more towards warehouse applications where all products will be tagged. Taking into account the wide range of products stored in these warehouses typically a pallet may comprise 1000 different products. Using the present band 865-868 MHz, RFID will be incapable of reading all tags on a pallet within an acceptable length of time. Higher data rates will increase the number of tags that can be read.

This study showed a significant increase in the expected growth of the RFID market, in terms of geographic zones, devices deployed, and the number of applications using RFID. The needs expressed by users are focused on the requirement for improvements in the overall performance of RFID systems

In particular the study showed that implementation of the ETSI proposal will provide the following technical benefits:

- Increase in the reading distance by up to 35%;
- Reduction in the reading time where there are high tag populations;

- The ability to read tagged items moving at greater speeds;
- The ability to install an increased number of interrogators in close proximity with each other;
- Simplification in the installation of RFID systems.

The main economic advantages will be the followings:

- Only one type of tag operating at a harmonized frequency leading to simplified stock handling of tags, optimized costs, improved deliveries etc.;
- Reduced costs for the manufacture, installation and maintenance of interrogators;
- Reduction of running expenses;
- Improvement of stock management and logistic flows;
- Better customer service.

The analysis described in this study clearly shows that the ETSI proposal fits the expressed needs.

A1.3 HOME AUTOMATION AND SUB-METERING

The European Home and Building Automation market includes applications such as shutters, terrace awnings, blinds and curtains, electrical door locks, electrical windows, garage door and gate openers, heating control, lighting control, etc.

- Home and Building Automation (non-exhaustive examples):

Lighting control.

Shutter control.

Awnings and blinds control.

Windows, doors and gates openers control, garage doors.

Electrical door lock systems.

Heating regulation.

Air conditions control.

Swimming pool surveillance and control.

Ventilation.

Combined scenarios.

Presence Simulation.

Automatic controls for comfort energy saving and security purposes.

Sensors (temperature, wind, light, rain).

Presence monitoring.

For the last decade, the above applications have mainly been used as stand-alone devices, where users controlled only a single device at a time - *e.g. up, down, stop for a shutter or an opening/closing a door*. Simple command protocols were used.

Now the need for more **comfort**, more **security** and a strong emphasis on **energy saving** require the use of advanced system control protocols. These protocols permit the use of dynamic functions that coordinate the operation of actuators though advanced automatic controls and sensors - *e.g. a feature that is currently in high demand is the "indoor climate control" where the air inside the house remains healthy and fresh with a minimum of energy loss. When the humidity exceeds the desired level, specified roof and vertical windows are opened for a short period.*

The wide range of applications falling under Home and Building Automation represents the main market area for non-specific SRDs. Initially many devices, such as shutters and garage doors were mechanical. Today at least 50 % of shutters and 70 % of garage doors are controlled remotely using SRDs. With the arrival of low cost chip sets the industry has largely migrated to the use of LBT + AFA due to the superior performance of this technology and its ability to operate in congested environments.

By 2003/2004 the Home and Building Automation industry had already installed large volumes of first generation RF products based on unidirectional communication and Duty Cycle techniques. These first generation products provided simple and convenient control of electrical blinds, shutters, doors, etc.

Sales of Home and Building Automation devices in 2005 and 2010 are outlined in the CEPT Report 14 [8].

Table 13: Sales of Home and Building Automation

Parameters	2005	2010
SRD units supplied annually	5 million	10 million
Systems installed to date	10 million	70 million
Annual Turnover	€ 10 000 million	€ 15 000 million
Work force	1 million	2 million

As the market matures volumes will rise and functionality will increase. France, Spain, Italy and Benelux now represent mass markets where customers purchase sophisticated Home and Building Automation systems, In these countries home automation systems already exceed 50 % of electrical equipment in buildings. In 2006 the European SRD industry installed around 15 million Home and Building Automation devices and a further 20 million alarm systems. The growing density of these devices means that co-existence will become of increasing importance.

During 2007 Home and Building Automation manufacturers sold more than 17 million devices, which exceeded by 25 % the prediction in CEPT Report 14 [8]. This growth was achieved as a consequence of considerable investment by manufacturers. Market data shows that this trend will continue. Therefore the number of units installed by 2010 will exceed by 25 % the forecast of 70 million devices in CEPT Report 14 [8].

Nowadays the need for more **comfort**, more **security** and a strong emphasis on **energy saving** requires the use of sophisticated system control protocols. These protocols permit the use of dynamic functions that coordinate the operation of actuators though advanced automatic controls and sensors - *e.g. a feature that is currently in high demand is the "indoor climate control" where the air inside the house remains healthy and fresh with a minimum of energy loss. When the humidity exceeds the desired level, specified roof and vertical windows are opened for a short period.*

When a Home and Building Automation system is installed in a residential house, it typically comprises fifty nodes (15 shutters, 2 garage door opener, 1 gate opener, 2 electrical door locks, 2 terrace awnings, 4 roof windows, 2-5 electrical vertical windows (ventilation control), 1 intrusion alarm, 8 heating zones and a dozen lighting terminals) This represents a sophisticated control system requiring advanced two-way communications (see Figure 7).

Such a system allows a user, who is leaving the home, to close down the system by means of a single command. This command might for example lock the door, set the alarm, close the shutters and reduce the heating level.

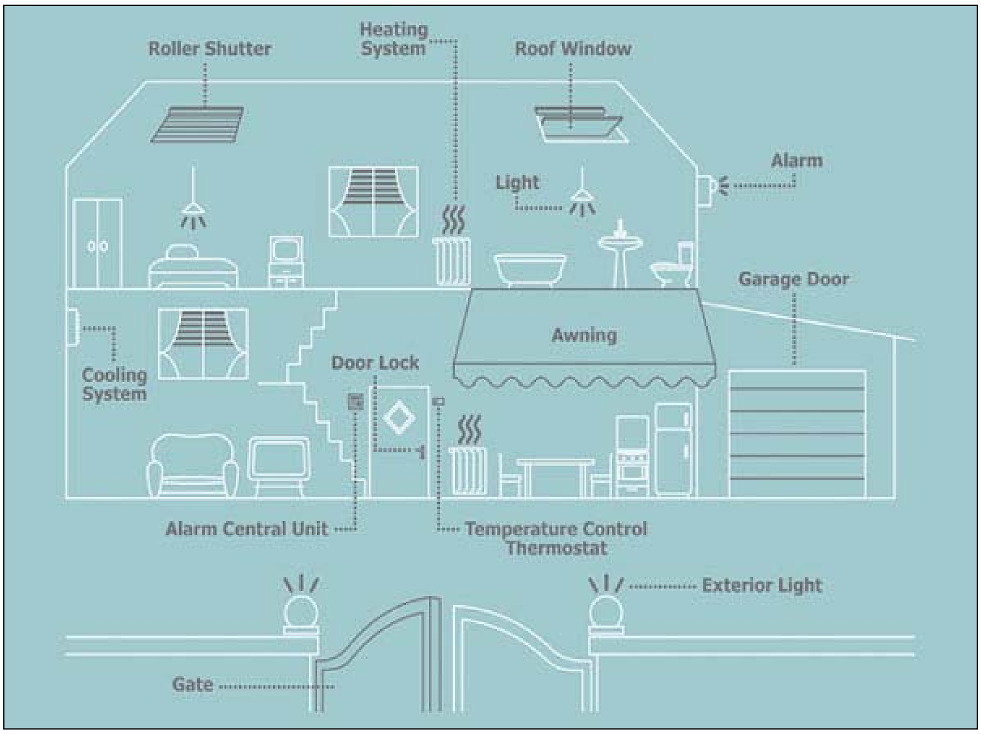

Figure 7: Home and Building Automation applications

Figure 8: Examples for Home and Building Automation

With growing interest in energy saving, home automation systems will place increasing emphasis on natural environmental control. This will include more use of automatic ventilation, solar panels and other similar techniques. Lighting will also form part of the home automation system since it can be used to provide energy savings and improved security.

The latest version of EN 300 220 [18] recognizes the continued need for low-end, low-cost products while also specifying advanced techniques for use in next generation products.

Technological facts

Home and Building Automation applications require:

1. **Short latency:** a rapid response to transmitted commands is essential.
2. **Signal transmission reliability:** the control address should be guaranteed to reach the target.
3. **Point-to-point communications** should be able to cover a whole building environment without recourse to the use of repeaters.
4. Control devices are mainly **battery powered** (or similar) with 5 years to 10 years lifetimes to virtually eliminate the need for regular maintenance (inside walls and ceilings).
5. A **medium data rate** in the range of a few tens of kilobits per second (kbps) e.g. 19.6 kbps to 38.4 kbps that represents a balanced compromise between acceptable current consumption, radio range and functionality.

6. **Duty cycle rules that ensure sharing** and allow a dialogue between the controllers (wall switches, remote control, IP gateway, etc.), the actuators (windows, heating boiler, lighting, etc.) and the sensors. While a usage pattern cannot be predicted, typically it would be low (< 1 %).

Technologies above 1 GHz are unsuitable due to the poor propagation inside buildings. An operating frequency in the 863 to 870 MHz and 433 MHz bands is therefore necessary.

Up to 2003/2004 home automation applications were mainly designed with one-way communication and a low duty-cycle (433.92 MHz). This provided only a limited set of controls for the application.

These old systems are being replaced by a new generation of bi-directional systems which offer increased benefits. Operation in the band 870 to 873 MHz using LBT and AFA brings the following benefits:

The ability to operate on any one of a number of channels provides greater reliability and low latency.

When combined with stringent transmission time control, LBT with AFA provides an efficient mitigation technique that allows coexistence between multiple systems.

Home and Building Automation systems are designed with an efficient link budget using at least category 2 receivers. Typically a transmitter power of less than 25 mW e.r.p. is adequate, requiring a receiver sensitivity is in the range of -105 dBm or better.

This allows the end-user direct point-to-point control of all actuators within his premises from his roof window to his garage door in the basement. This is necessary since customers are unwilling to pay the added cost for repeaters.

The sub-metering of buildings, particularly the allocation of heat and potable water consumption, have already proven the improvement of performance of new and existing buildings in several million flats across Europe. Sub-metering provides the operations and maintenance transparency necessary to enable more efficient management of energy and water resources. In addition, sub-metering drives behavioural changes related to energy conservation. Each of these potential benefits can dramatically improve building performance and lead to reduced resource consumption. For building operators, a detailed record of system performance data is critical not only to detect system malfunctions, but also to focus future design and retrofit activities on the most cost-effective energy and water system improvements.

- Sub-metering devices are (non-exhaustive examples):

Heat Cost Allocators

Water Meters

Heat- / Cold-Meters

Figure 9: Examples for sub-metering devices

Sub-metering systems can easily be integrated into building automation systems and are used to identify building system impairments or dysfunction, to improve operational procedures, drive behavioural changes that improve building energy efficiency and conservation, and augment building side automation systems that interface with the Smart Grid.

Sub-metering can benefit building owners and business operations managers in several ways. Buildings may be sub-metered to measure resource use of heating or cooling and reduce these loads in response to market drivers (e.g., utility costs) or regulation. Individual systems or pieces of equipment may be sub-metered to determine if they are “working efficiently” with regard to both economic and comfort considerations. There are also practical benefits in some cases—a building or campus currently served by one utility-owned master meter may be sub-metered for different tenants to promote more appropriate allocation of utility charges and to effect potential reductions in peak demand costs. Finally, sub-metered data can be used to provide feedback on energy consumption to tenants or building users to promote behavioural change that leads to energy conservation. These different uses of sub-metering may also be combined within a single building.

In summary; the major benefits of sub-metering can be summarised in four categories:

- Individual consumption based billing within premises;
- Enabling monitoring-based commissioning;
- Identifying and monitoring efficiency retrofits;
- Aligning incentives and enabling behavioural conservation.

Until recently, despite the potential benefits of detailed resource measurement in buildings, there have been relatively few instances where either building-level metering or sub-metering was specifically required by regulation in a number of countries. The other nations are expected to follow the same regulatory practices for the reasons given above.

Currently consumption based billing is applied in more than 25 million dwellings. According to an analysis by the Association for Energy Cost Allocation (EVVE), the total market size is about 49 million dwellings. The number of meters used for consumption based billing varies from region to region depending on climatic conditions, the services offered, building's standard, etc. At the moment about 125 million meters are used for heat and water cost allocation and this number is expected to double within the next 10 years. (from ETSI TR102 649-2 [1]).

A1.4 SMART METERS

Utility companies in the energy sector (such as electricity, gas, water, heating providers) have started deploying smart metering systems. These systems are capable of providing consumption information to the utility provider as well as to consumers in real time and generally allow utility providers to monitor and constantly optimise the supply chain of the given energy resource and ensure the resilient and efficient performance of their infrastructure. The roll-out of these smart meters is obligatory in many Member States. In most Member States the responsibility for the roll-out is placed upon the Distribution Service Operator (DSO).

Smart meters are devices that are able to communicate bi-directionally both with utility providers and customers. Being able to follow their actual electricity consumption in real time will give consumers stronger incentives to save energy and money. The customers will be able to retrieve information on their past consumption patterns to help them better understand their actual energy consumption and make decisions on future energy use. These communication possibilities will also make it possible for the consumer to allow the utility provider to switch on power to specific devices when demand is low or switch the power off when demand increases. This could be done for devices such as electrical cars and heating devices that store power in e.g. batteries that need to be charged for quite some time. This gives the utility provider the possibility to spread the load of the network and to offer consumers advanced tariff structures and remote tariff control to consumers to respond to the variation of prices in real time and create a basis for efficient competition in utility supply infrastructure.

Smart meters are bi-directional devices that are able to communicate both with utility providers and customers. Being able to follow their actual electricity consumption in real time will give consumers stronger incentives to save energy and money. The customers will be able to retrieve information on their past consumption patterns to help them better understand their actual energy consumption and make decisions on future energy use. Enabling advanced tariff structures and remote tariff control allows consumers to respond to the variation of prices in real time and create basis for efficient competition in utility supply infrastructure.

A European Standardisation Mandate M/441, to CEN, CENELEC and ETSI, "in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability" has been established.

The European Commission also issued a Recommendation in March 2012 on preparations for the roll-out of smart metering systems (2012/148/EU [27]) that sets common minimum functional requirements for smart metering systems for electricity for the customer, for the commercial aspects of energy supply, for security and data protection and for distributed generation.

Smart Metering primarily targets improvement of energy end-use efficiency as defined by Directive 2006/32/EC, thus contributing to the reduction of primary energy consumption, to the mitigation of CO2 and other greenhouse gas emissions.

There are in excess of 300 million gas and electricity meters alone which require replacing to meet the requirements of M/441 and a similar number of water and energy meters. There are approximately 157 million water meters installed in Europe and although there is no legislation driving the adoption of Smart Metering for water it is expected that 31 % of all new water meters installed will be Smart or Smart enabled meters by 2016.

Consumers are increasingly sensitive to resource consumption and in the case of power, their carbon foot print. Smart Metering is the first step in integrating consumers' wishes with the supply of these resources. It enables consumers to use resources more efficiently.

Key functionalities:

- Frequent updates of the readings provided directly to the consumer;
- Remote reading of meters by the utility network operator in order to help planning of network and utility resources, facilitate switching of suppliers as well as operational maintenance;
- Remote reading of meters (i.e. consumption, behaviour at the edges of the grid – Smart meters may be a part of a Smart grid network) supports network planning;
- Two-way communication support between the smart metering system and external networks for maintenance and control of the metering system.

Key operational requirements:

- Low capacity needs per individual metering device combined with use of aggregating devices (access points) to create hot-spot like flexible deployment of high density networks;
- Range from a few metres (urban environment) to a few kilometres (rural environment);
- Moderate requirements on robustness and latency;
- Very high density in urban environments;
- Low per-device cost solution;
- Meters are installed for a long period (>15 years) on customer premises.

Utility companies use several strategic criteria when assessing the options for the use of spectrum for communications with smart meters. Amongst these considerations are:

- standardised solutions with a mature ecosystem of different manufacturers and vendors;
- the price and lifecycle of available communication products that can be integrated in the meters; and
- the level of control which can be achieved over the solution.

Several spectrum options have been identified by RSPG and could be used by wireless metering and smart metering solutions, inter-alia such as:

- 169.4-169.8125 MHz (challenge: limited bandwidth compared with other spectrum options);
- 868-870 MHz ;
- 870-876 MHz and 915-921 MHz (challenge: uncertainty of availability of all or parts of the bands for SRD in some countries due to governmental uses).

The largest motive for harmonisation of Smart Metering frequency access in Europe (especially including possible alignment of European smart metering frequencies with those used in other regions, most notably in the USA) is economies of scale for these mass-market smart metering devices. To achieve this, an exclusive designation of spectrum to smart metering devices is not believed to be necessary.

Smart meters have a relation with smart grids. A utility company operating a smart grid and smart meters may very well wish to use the same frequencies for smart meters as for smart grids. A strict separation may lead to overseeing possible synergies between the two in the future.

A1.5 SMART GRID

Europe's integrated utility network will be subject to substantial restructuring in the coming years as a direct consequence of the on-going liberalisation and innovation of the energy market. The present electricity supply infrastructure, which is characterised by large, centralised power stations, will evolve into a system comprising both centralised and decentralised electricity supplies including micro generators and small and medium sized renewable sources. These could also be on consumer premises, where power is locally generated and supplied to the network. On the side of power consumption the introduction of new elements such as charging points for electrical vehicles will lead to new and geographical (urban area’s) peaks in power consumption in the network. These processes will place new demands on the engineering of these systems, including real time optimisation of overall network operation and centralised control of individual equipment.

Electrical power supply is done most efficiently when there is a constant demand. Fluctuations in demand need to be addressed by increasing or decreasing the power generation and distribution. These fluctuations can be the result of increased or decreased demand or of increased or decreased distributed power generation. Fluctuations in demand could increase considerably when equipment storing (large amounts of) energy in batteries or otherwise are becoming mainstream. Electrical cars or electrical heating are examples. When most these are being charged starting between 18:00 and 20:00 hrs. a massive peak will result. Fluctuations in distributed power generation is logical when the sun or wind comes up or decreases. These fluctuations also appear at different locations in the grid. To adapt to these fluctuations the utility operator needs to adapt the grid constantly. To do that, reliable real-time information on both power consumption and generation is needed. This can be done using meters in distribution points, but also and more precisely by using smart meters. In addition to measuring the power consumption and distributed power generation the operator needs the means to control his network constantly and in real-time. This could include new means to balance the supply and demand of energy, for example by remotely controlling micro power generators or charging devices.

This anticipated development, with a rapid growth in the numbers of decentralised micro generators require an advanced integration strategy to be developed. Part of this integration will be a supporting communication network to permit the monitoring and control of these generators. Trust and control over these mission-critical communications is pivotal for utilities. The stability of the grid is dependent on these communications.

A smart grid is made possible by robust, end-to-end communications technologies. These technologies, working alongside the electrical grid, pull in data from all over the grid. Sensing devices are placed throughout the electrical grid and in consumers’ homes and businesses (see the previous sub-section on Smart meters). Information from the devices is sent to utility operators that can constantly monitor and act upon the data. Smart energy grids could be thus described as an upgraded electricity network to which two-way digital communication between supplier and consumer, intelligent metering and monitoring systems have been added.

On this matter, a European Commission's Mandate M/490 was issued to CEN, CENELEC and ETSI for Smart grids standards in March 2011. Based on the content of the mandate, the Smart Grid Coordination Group (SG-CG) has been "requested to develop a framework to enable European Standardization Organizations to perform continuous standard enhancement and development in the field of Smart Grids, while maintaining transverse consistency and promote continuous innovation." Besides constituting an important step carried out at European level in order to pave the way for the widespread deployment of smart grids, significant achievements have been carried out in that context to the end of agreeing upon a common European view of the Smart Grids Conceptual Model (a common understanding of its major building blocks and how they interrelate) and Reference Architecture. In response to the above mandate, a final report was issued at the end of 2012 by the Smart Grid Coordination Group (SG-CG) Reference Architecture Working Group (SG-CG/RA) that addresses the M/490 mandate regarding the technical reference architecture. Its main outcomes could be assumed as starting point and basis for our current work.

The Smart Grids Communication Architecture, dealing with communication aspects of the Smart Grid, is outlined within the Smart Grid Architecture Model (SGAM) framework, considering generic Smart Grid use cases to derive requirements and to consider their adequacy to existing communications standards. The different networks playing a role in the overall communication architecture are also identified – e.g. neighbourhood networks, field area networks, intra and inter substation network, wide and metropolitan area network, etc. - and their scope is represented, using the SGAM model, along the 5 domains - bulk generation, transmission, distribution, distributed energy resources (DER) and customers premises – in which the energy conversion chain is partitioned. Properly identifying communication infrastructure related to smart grid deployment is crucial in order to identify suitable frequency options expected to be used for smart energy grids.

The requirements on the communication channels varies for the different levels of the Smart grid, with necessary customisation to fit different types, configurations and extent/density of utility networks as well as utility operators' specific operational and commercial needs. This sector has provided its requirements via the ETSI-CEPT process by delivering several ETSI system Reference Documents.

In particular in the medium to lower voltage parts of the grid, which require more intensive and more trusted communication, wireless solutions are needed. Given the numbers of assets, the geographical spread of these assets and the relatively lower demands concerning bandwidth and availability, wireless solutions are very cost-effective solutions compared to wired solutions. For many parts of the network, wireless communication is believed to be the most suitable solution, for example to allow the integration of large amount of smart meters and other smart grid assets. The criticality of these solutions for the management of the grid necessitates an adequate communication solution which provides a sufficient and trusted level of control. The necessity to be in control of these communications needed for grid management may call for private wireless network solutions.

The anticipated massive deployment of renewable and decentralised energy sources, as well as managing complex interactions between suppliers and customers present new challenges for the electricity networks and markets and means that more and reliable information is required.

Distribution automation, management and control of the smart grid network can been identified as the most mission-critical area where communication between the primary stations is very important for the stability and operational safety of the networks, and where high level requirements are needed.

Smart grids are using wired and wireless communication.

Due to the large scope of Smart Grid services and applications, multiple spectrum ranges may be a suitable answer to the relevant requirements.

"For this purpose, in particular to smart grids, there are already a number of technology and frequency options available or under discussion to meet the requirements of intelligent electricity networks. These range through PLT, GSM, ZigBee, KNX (EN 50090, ISO/IEC 14543, a multi-PHY communications protocol for intelligent buildings) and alternative low power radio systems." For the realisation of wireless communications for smart grid, they are predominantly using frequency bands below 1 GHz best suited:

- 450 MHz (PMR/PAMR);
- Mobile networks (PMR/PAMR elsewhere);

- Public networks (wireless access);
- 870-876 MHz (extension for SRD - applications, as proposed by ETSI).

Under frequency-regulatory aspects it is also decisive how far realisations are possible within the framework of the existing Regulation (individual allocations, General allocations). Also, some still pending requests outside of radio frequency regulation can affect the future spectrum requirements (security-related requirements, data protection, etc.).

Europe's integrated utility network will be subject to substantial restructuring in the coming years as a direct consequence of the on-going liberalisation of the energy market. The present electricity supply infrastructure, which is characterised by large, centralised power stations, will evolve into a system comprising both centralised and decentralised electricity supplies including micro generators, electric vehicles as well as small and medium sized renewable sources. This process will place new demands on the engineering of these systems, including equipment specification and control. The anticipated rapid growth in the numbers of decentralised micro generators requires an advanced integration strategy to be developed. Part of this integration will be a supporting communication network to permit the monitoring and control of these generators as they are switched on and off line. This same network can also be used to assist consumers to make informed choices on their consumption.

Hence.a smart grid is made possible by robust, end-to-end communications technologies. These technologies, working alongside the electrical grid, pull in data from all over the grid. Sensing devices are placed throughout the electrical grid and in consumers' homes and businesses. Information from the devices are sent to applications that can read and act upon the data.

Important objectives are:

- Improve Power Delivery and Quality;
  - Automated load balancing in the smart grid;
  - Power quality management;
  - Automated switching of components of the smart grid and related protection systems;
- Increase Operational Efficiency;
- Automation of asset monitoring and management;
  - Analytics for decision support;
  - Connected mobile workforce ;
- Monitor and control renewable energy sources everywhere;
  - Maintain grid stability as renewable energy sources are added;
  - Meet environmental targets and regulatory requirements;
- Engage Customers in Energy Management;
- Information and incentives for reduced or more intelligent energy usage;
- Direct load controls;
- Improved customer service.

The Smart Grid is the integration of technologies that permit inter alia the:

- coexistence of centralised and decentralised power generation;
- detection and resolution of emerging network issues;
- response to local and system wide inputs;
- rapid communication between peer devices and with centralised and distributed controllers;
- deployment of advanced diagnostics, feedback and control;
- co-ordination of attached loads and distributed resources.

In all the above cases, messages describing the situation need to be passed from the Smart Meter to the controlled or controlling entity. In circumstances which might compromise the grid reliability a real time response will be required.

Smart energy grids and smart meters are two areas which are very different and should not be treated in the same way.

Smart energy grids are ICT applications which help energy producers to gather information about the behaviour of suppliers and consumers in an automated fashion to improve efficiency, reliability, economics and sustainability and which allow for real-time adjustment of electricity production and distribution. National solutions may be possible and they need not necessarily to be wireless. Even though there are key requirements related to real-time aspects, reliability and robustness, commercial networks should be considered.

In particular from the utilities sector, the security of supply of energy distribution is critical for society and this is where smart grids and the related ICT infrastructure and service platform will have a key role in the future. It is considered that the load demand on distribution networks will increase as a result of the introduction of electric vehicles, heat pumps and decentralised energy resources, including renewables, and that the challenge to match demand and supply of energy flows within a grid will intensify.

Distribution automation, or management and control of the smart grid network, as the most mission-critical area where communication between the primary stations is very important for the stability and operational safety of the networks, and where wired communication solutions, such as fibre optic networks, are currently the preferred solution due to the high level of requirements. However, the general opinion is that wireless solutions will also play an important role in the future smart grid, especially in the lower voltage sections of the distribution grid, where mission-critical communication needs are foreseen to increase.

The existing views on the most suitable ICT infrastructure are diverse. Although some proponents promote their own (cable, radio or satellite based) solutions for part or most of the smart grid data communication purposes, many views were expressed in general in the opinion that the ICT infrastructure used for such purposes will be composed of a mix of different wired and wireless communications, including power line communication (PLC). This is because each transmission technology has its advantages and disadvantages and subsequently an appropriate combination will enable the market to deploy the services faster and improve the security aspects. However, some argued strongly that PLC is not suitable for any mission-critical kind of telecommunication, as high-frequency transmission on non-shielded lines can pick up external electromagnetic fields and might not work over long periods of time, or because data communication using PLC is not any more possible in case of electricity failure. PLC may also not suitable for gas and water metering purposes.

It is indicated that both wired (mainly fibre) and wireless communications will be very important components of the communications network to support the smart grid of the future. Fibre is appropriate to connect main locations and where high data rates are used (whether aggregated or not), while wireless technologies are needed to provide access to many dispersed end points. The views regarding the portion of communications in smart grids that can be handled via fixed connections are diverse; some say that this portion will be diminishing in the long term, while some others argue that biggest part of mission-critical smart grid communications might be handled by fixed connections in the long term.

From the utilities sector, as well as some equipment manufacturers, estimate that as communication between secondary substations and the associated systems is becoming more important, dedicated or exclusive spectrum for a specific utility application would be the necessity to have optimal control over the wireless solutions, especially as certain non-exclusive spectrum bands may not be appropriate for mission-critical applications. The reasons for the potential inappropriateness listed by some of the utilities include unfavourable licence conditions, inadequate nature or unpredictability of the applicable sharing conditions of available spectrum bands and unsatisfactory protection against (harmful) interference. The smart grid ICT infrastructure could also be in the responsibility of the utility / grid operator, so that it could operate and manage it, whether it was provided by a telecom operator, a competent third party, or the utility itself. The main issue in this respect is that the utility needs to trust the communications since it has to rely on it for all the critical grid management functions.

Most of the national administrations don’t see a justification for dedicated or exclusive spectrum for smart grid services, noting that there are very rare occasions when designating spectrum for a specific service is necessary and stating that any such justifications should be carefully considered, taking into account both technical and economic aspects. Many of them are also in the opinion that existing communication network infrastructures should be sufficient to cover any energy grid specific critical demands. However, a number of them admit that there is no universal answer to the issue of the 'ownership' of the necessary ICT infrastructure/platform; they indicate that this is a matter to be worked out in each market and that the solution may differ from country to country.

In the future, real time monitoring as well as remote measuring and control will increase significantly throughout the grid, partly due to the growing share of renewable energy sources (including private wind and solar plants) and electric vehicles (need for authorisation and billing in charging stations) as well as the increasing use of machine-to-machine (M2M) communications. This will increase the role of ICT/IoT in the process of controlling the network, as well as the need for wireless solutions.

However, the frequency management will focus on technology and application-neutral solutions to keep flexibility, avoid spectrum fragmentation and foster innovations. At the same time, some applications need very predictable sharing environments. The usage of the terminology M2M or IoT in this respect translates to the non-specific SRD type of use combined with application-neutral medium access conditions. This is in line with the concept stipulated in CEPT Report 44 [9].

When it comes to the potential problems or risks with the deployment of smart grids, majority of the respondents referred specifically to the issues of security and data privacy, where concerns have been expressed by end customers in several occasions.

Smart Grids may also support the future infrastructure for electric vehicles:

Many countries are encouraging the sale and promotion of electric vehicles by various means and in a number of European cities there are on-going activities to support their use.

The French government plans to acquire 50.000 electric cars for use by public companies and local authorities. In Germany, the Minister of Transport announced in November 2009 the support of development of electro-mobility by the German government with 1.4 billion Euros over the next few years.

In September 2009, a contract was placed for the delivery of 100.000 cars before 2016, to be sold in Denmark and Israel. A Danish energy supplier will establish the complete charging infrastructure in Denmark and the Danish government announced reduced taxes for electric cars to support this activity. Also in September, the Spanish government provided 10 million Euros for their program "Movelle" to introduce electrical cars in Spain.

Each of these initiatives to promote the manufacture, sale and use of electric vehicles places demands on the charging infrastructure and associated Smart Metering for customer billing. Although the charging infrastructure has not yet been standardised this is being actively pursued.

A1.6 SHORT RANGE DEVICE, METROPOLITAN MESH MACHINE NETWORKS (M3N) AND SMART METERING (SM), (M3N)

M3N combines to some extent the smart metering and smart grids by means of meshed networks. The introduction of meshed networks is intended so that utilities can operate more efficiently and cost-effectively than ever before.

A M3N is a network composed of the following of elements: Endpoints (Sensors and Actuators), Routers and Gateways.

Sensors and Actuators

Sensing nodes measure a wide range of physical data, including:

- Municipal consumption of gas, water, electricity, etc.
- Municipal generation of waste.
- Meteorological such as temperature, pressure, humidity, UV index, strength and direction of wind, etc.
- Pollution such as gases (sulphur dioxide, nitrogen oxide, carbon monoxide, ozone), heavy metals (e.g. mercury), pH, radioactivity, etc.
- Environment data, such as levels of allergens (pollen, dust), electromagnetic pollution (solar activity), noise, etc.

Sensor nodes run applications that typically gather the measurement data and send it to data collection and processing application(s) on other node(s) (often outside the Network). Sensor nodes are capable of forwarding data.

Actuator nodes are capable of controlling devices such as street or traffic lights. They run applications that receive instructions from control applications on other nodes. There are generally fewer Actuator nodes than Sensor nodes.

Routers and Gateway

Routers form a meshed network over which traffic between endpoints and gateways is dynamically routed. Routers are generally not mobile and need to be small and low cost. They differ from Actuator and Sensor nodes in that they neither control nor sense. However, a Sensor node or Actuator node may also be a router within the M3N.

A Gateway is a Router node which also provides access to a wider infrastructure and may also run applications that communicate with Sensor and Actuator nodes.

Benefits of M3N

M3N systems are intended to support a large number of applications around a metropolitan area including water meters, waste management, pollution management, parking management, public lighting and self-service bike rental, to name but a few. Wiring the assets of all of these devices would be costly, and so the available of a ubiquitous network, offering low incremental costs of connection to new applications as they come along, with make them commercially viable.

Cellular networks has previously been used to connect remote devices to private control network, and as long as the interconnected devices have a high value such as town information display and parking meters; the cost of embedded modules is a small proportion of the overall cost in these cases.

Many of the new Machine-to-Machine devices, however, are todays more and more often low cost, battery powered and transmits only small amounts of data. Cellular modules are consequently too expensive and consume too much power for such applications especially.

A1.7 SURVEILLANCE ALARMS, FIRE/SMOKE ALARMS, INTRUDER ALARMS, SOCIAL ALARMS

Alarm systems are typically telemetry systems that require a very low latency of operation when activated. They also need a very high probability of operational success. They therefore typically prefer to avoid heavily congested channels.

In most of the cases wireless alarm sensors are battery powered, which leads to a restricted operating time. To cope this restriction manufacturer try to find the optimum balance between transmission power, telegram length and duty cycle. To increase e.g. the transmission reliability by repeating the telegram 2 times will reduce the operating time by 70%.

Alarm systems include:

- Social alarms – alerting when a person with reduced capabilities is in distress;
- Fire/Smoke alarms – intended to protect life/property by alerting the early signs of fire;
- Intruder alarms – alerting the presence of unauthorised persons;
- Surveillance alarms – alerting when remote sensors trigger.

Wireless alarm systems are operated in general under the Short Range Devices (SRD) regulatory framework in SRD-bands (mostly at 868 MHz in Europe) under the following conditions:

1. SRDs in general operate in shared bands and are not permitted to cause harmful interference to radio services;

2. that in general SRDs cannot claim protection from radio services.

There is no dedicated frequency allocation in Europe for alarms other than in the SRD bands.

Alarm applications are a low duty cycle/high reliability device category that rely on low overall traffic, low data rate, limited geographical density and low duty cycle specific spectrum utilisation and/or spectrum access rules in shared bands to ensure highly reliable spectrum access and transmissions. Typical usage includes alarm systems that use of robust radio communication for indicating an alert condition at a distant location and social alarms systems that allow reliable communication for a person in distress.

In the case of an emergency alert several alarm devices in a certain location may become active depending on the type of alarm. Efficient use of spectrum could be defined of the undisturbed alert transmission during an alert situation and not in between.

There is an increasing demand for wireless alarm systems even due to on-going establishment of the legislation in the member states for safety reasons in new and existing buildings. Wireless alarms are preferred used in existing buildings (households, public buildings (schools, hospitals ...) historical buildings or environments).

While for new buildings wired solutions can be considered during planning and which offered a higher reliability, the existing buildings may not be equipped with these safety related systems by the owner due to e.g. economic constraints.

Social alarm devices are in general portable (body worn) or at least nomadic (adaptive environmental locations) and therefore have to be wireless.

Social Alarms - In a report issued by Eurostat, the Statistical Office of the European Communities it is projected that the EU27 population to continue to grow older, with the share of the population aged 65 years and over rising from 17.1% in 2008 to 30.0% in 2060, and those aged 80 and over rising from 4.4% to 12.1% over the same period.

By definition Telecare is responsive to incidents and occurrences that may prove dangerous for the client. It has been proved that it can reduce the consequences of falls of the elderly and help prevent adverse events in persons with Dementia. The use of Telecare can help deliver a range of benefits including:

- Reduce the requirement for residential/nursing care;
- Reduce the burden placed on carers;
- Reduce Intermediate care after hospitalisation;
- Reduce acute hospital admissions;
- Reduce the consequences of accidents and falls in the home;
- Support hospital discharge and intermediate care.

The result of using Telecare is substantial cost saving for the care provisioning services both in the socioeconomic community and in the hospital.

Fire/smoke Alarm - The total alarm time and the alarm transmission with a high reliability are very important.

The following key points are taken as arguments to install smoke / fire alarm systems.

1. To reduce the amount of loss (material);
2. To reduce the number of people killed by a fire.

Most victims in such fires die due to smoke poisoning. It is therefore essential that, in the event of a fire, all people in a building are warned within the first few minutes in order to evacuate the building within the time the fire brigade needs to get to the place of the fire. Smoke alarm devices are the best possible way to warn people in a very early stage of the fire. In countries like USA, UK and Sweden, where these devices have had to be installed by law for many years, the numbers of victims has been reduced by up to 50% since the introduction of these regulations.

Intruder Alarm - In the past years the number of crimes (domestic burglary / dwelling), and the damages by building insurance has been going down
(source http://epp.eurostat.ec.europa.eu/portal/page/portal/crime/data/database). But the financial cost of this is going up. The main reason therefore is the increase in value in the contents of private households.

Surveillance Alarms - Building surveillance is part of the global management of buildings including access control, temperature regulation, ventilation, electricity generation and consumption and also lifts and automated doors.

Building management is a set of functions like the management of vacancy, alert treatment in case of scenario, fire detection.

Typical building surveillance and technical alarms are comprised of centralized control panels which are connected to monitoring offices via wired IP, or wireless GPRS, GSM, KNX; a variety of sensor devices, and a wireless receiver for interfacing between the control panel and sensor devices. The monitoring office can be in the building or at a remote monitoring centre.

Technical alarms are typically:

- flooding or leakage alert;
- over temperature detection;
- lift failure detection;
- automated system failure alert;
- abnormal event;
- emergency door kept open;
- pressure failure detection.

Market information

Fire & Smoke

Fire and smoke detectors are mandatory for public buildings. Therefore installations for public buildings represent 93% of the market. The remaining installations are in residential areas. This market is growing 3.3% per year.

The European fire and smoke detectors market represents 1.2 billion € with roughly 9 Million detectors.

As there are approximately 220 million households in Europe, the listed countries represent already 120 million of them (54.5%). More will follow. Many of these regulations require smoke alarm devices in sleeping and living rooms, which makes approximately 4 devices resulting in a total of about 468 million devices in these countries only. In other European countries fire brigades advertising the benefits of such devices which creates an even higher demand for smoke alarms. Assuming that at least 20% will use wireless networking features, a total of more than 94 million wireless smoke alarm devices will be installed during the next 5 years. A market which will generate more than 5 billion Euros for wireless smoke alarm devices within the next 5 years.

Building Intrusion / Security

Security installations in Europe represent roughly 700.000 new installations per year including 8 to 10 devices as an average including as well public and residential installations. That represents an increase of 7 million of devices each year.

There are currently 30 million installations. 25% of these installations are based on wireless devices. Therefore the today installed basis of wireless security devices is 80 to 100 million devices.

The global European market of security represents a total turnover above 2 Billion € with a growth of 3.5% per year (average value over the past ten years). This turnover can be split into 1 Billion € for wireless devices and 1 Billion € for related services like remote control centre.

Social Alarm

The total Western European social alarms market in 2005 was estimated to be at $220.3 million. An estimated 734.000 units were sold and the market for social alarm applications is further expected to expand of 6.1 per cent over the period of 2005-2012. The penetration level for these applications, as part of health and social care services, stands at 4.5 per cent among people aged 65 and above.

The social alarms market in Europe is influenced by many drivers with the key one being the aging EU population. This is evident from the growth in the elderly segment which is estimated to grow at a CAGR of 1.46 per cent from 2003-2006 as opposed to the negative growth of 0.22 per cent between people aged 15-64. This demographic trend indicates a rise in the number of dependant people aged above 65, living longer and requiring more demanding health and social care services. Rising health and social care costs to meet the increasing needs of the elderly is a major issue across all EU countries. The population of informal carers are decreasing due to migration, smaller dispersed families and also due to the declining practice of caring for the elderly within the family setting.

This trend indicates rising opportunities for Information and Telecommunications infrastructure providers, social alarm equipment suppliers and community service providers in the future.

A1.8 AUTOMOTIVE ACTIVE SAFETY, AUTOMOTIVE DIAGNOSTIC DATA EXCHANGE, AUTOMOTIVE FREIGHT PROTECTION, AUTOMOTIVE ENVIRONMENTAL & SAFETY SYSTEMS

The general trend within the automotive industry is that short range communication services are developing rapidly and is expected to be expanded further over the next 10-15 years due to e.g. raw material economy, weight, vehicle integration, functionality on safety, security, environment and comfort. This includes new radio communication services and applications to meet the increasing regulatory requirement for improved road safety and sustainable driving but also a technology paradigm shift where wireless communication replaces in car wired systems and where comfort systems and integrated infotainment systems are required by the customers.

The automotive industry is operating with a lead time of 7 years and a 15+ year’s lifetime of vehicles. A long term and sustainable spectrum planning is important.

Automotive SRD applications include:

- Future comfort services in and outside of the vehicle such as activating vehicle facilities and status telemetry information;
- Road-safety/security applications where a predictable sharing environment is justified such as wireless sensors and vehicle alarms, diagnostic data exchange, freight, freight protection.

Short Range Devices currently perform a variety of important functions in modern automobiles including keyless entry/immobilisation. In accordance with information provided by the European Automotive Manufacturers Association (ACEA), the existing passenger car fleet in Europe (ACEA: "Vehicles in use" in 2005) [ref] consists of more than 250 million vehicles. By 2015 the number of vehicles in Europe is expected to increase to 400 million. Currently approximately 60 % of these vehicles are equipped with one or more SRDs. Approximately 6 million new vehicles are sold in Europe every year. 80 % of all new vehicles are currently equipped with SRD devices. Thus in future SRD equipment will be universally used by all vehicles on the roads in Europe.

In addition the variety of different SRDs used in vehicles is also increasing. This includes traditional remote keyless entry systems, which are developed further into passive entry systems and personal car communication systems. Also the adoption of safety related systems such as Tyre Pressure Monitoring Systems (TPMS) and Truck-trailer communication systems is increasing. In addition the deployment of security systems using SRDs is growing including vehicle alarm systems; diagnostic data exchange; freight protection and environmental systems. The adoption of short range communication services within the automotive industry is developing rapidly and is expected to grow further over the next 10-15 years. This is due to such factors as material savings, weight reduction, vehicle integration, safety, security, environment and comfort features. There is a general shift from car wired systems towards wireless communication, which offers improved comfort and convenience. This includes the introduction of integrated infotainment systems that are increasingly requested by customers.

The growing requirement for safety related devices, which are often mandated, increases the need for additional radio spectrum. To provide the increased reliability required for such applications, they should operate in a predictable sharing environment. This could be achieved by designating a sub-band of spectrum to a number of specified SRD services. This is applicable to both automotive and to other safety related services.

New active safety systems are required in vehicles and TPMS will be an integral part of measures required by the European Commission with the objective of achieving the EU policy targets for CO2 emissions. By November 2014 TPMS systems will be mandated in all new vehicles.

A considerable number of malfunctions of the keyless entry systems are reported by customers and this trend will further increase as a consequence of the increase in general SRD applications operating in the existing frequency bands.

A1.9 ASSISTIVE LISTENING DEVICES (ALD)

Hearing loss will affect some 1 in 4 people during their lifetime resulting in loss of communication and their quality of life. In education this disability, if not corrected by ALDs disadvantages children and reduces their life chances. In many countries babies from 6 weeks old are fitted with ALD also cochlear implants are increasing in use throughout Europe, an ALD is an integral part of wider communication for those with implants.

Whilst hearing aids where initially little more than an audio amplifier these have evolved into sophisticated digital devices with their communication links upgraded from a simple inductive Telecoil system to radio links for communication with teaching systems, mobile phones, entertainment centres and in the case of young children: their parents.

The current TR 102-791 [6] seeks to update the single channel inductive Telecoil system with its limiting physical installation constraints to a radio based digital system which can be effectively and simply used in a wide range of public arrears such as airports[12], train stations and theatres with multiple channels to enable features such as multiple translations.

The upgraded system is referred to at the Telecoil Replacement System (TRS).

In order to achieve TRS, given these systems will be used worldwide common spectrum is required.

[12] It should be borne in mind that public announcements in noisy sites involve both distortion of the PA and echo, resulting in a major lack of clarity to the hearer. Delivery of this information via an ALD located in the ear canal delivers intelligible information to the user

ANNEX 2: MESH TECHNOLOGIES

A2.1 MESH NETWORKS, HOW DO THEY HELP?

Ofcom UK [19] published in 2006 a research paper on Mesh Networks. The summary of this report is; Mesh networks have the potential to bring several advantages to wireless communications services, namely:

- They can allow the formation of a new type of network where users exchange information without the need for network infrastructure. As well as allowing a different commercial model it is often claimed these are more spectrum efficient;
- They can extend coverage of cellular and other networks by allowing terminals on the edge of the coverage zone to relay signals to those who do not have coverage.

An often quoted vision of mobile communications describes the future as the integration of all mobile and wireless nodes (e.g. cellular, WLAN, PAN etc) with an IP core. One potential application of mesh technology would be to provide another route, alongside WLAN and 3G etc, into such a core network.

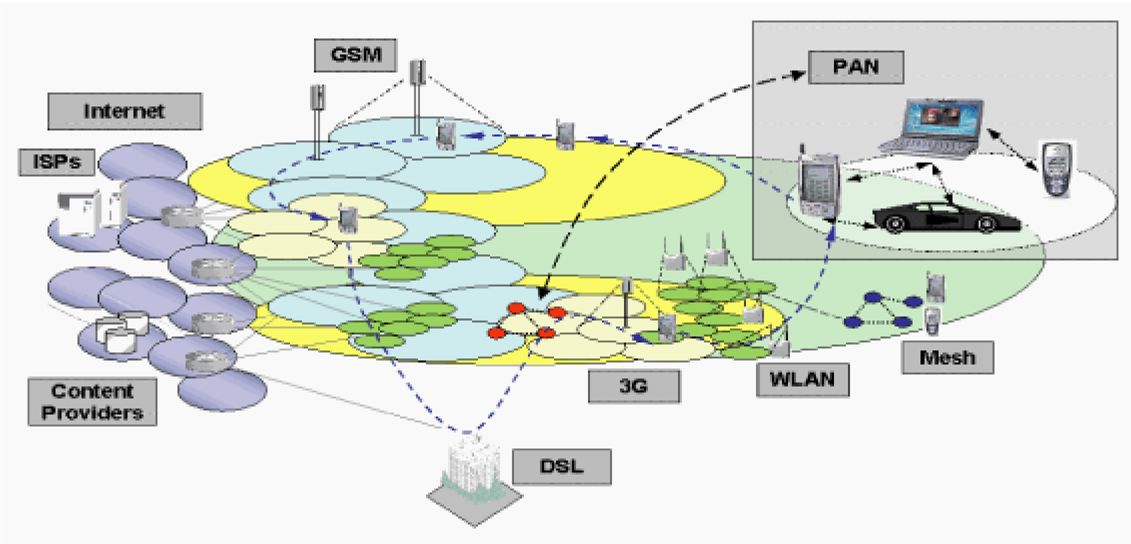

Figure 10: Mobile integrated vision using IP core

A2.1.1 Mesh Attractions

Perhaps the largest attraction of meshes is that they can be entirely unplanned. This is useful to the military and to disaster recovery teams who desire this ad-hoc networking capability for fast deployment and flexibility in situations with little fixed infrastructure. It is less clear what this benefit brings to the roll-out of a mass market mesh network, although for a service provider or regulator, the lure of a network which promises no planning phase must be high and thus merit investigation.

Another strongly attractive feature is in coverage, where they can offer complimentary performance to that of cellular systems. Meshes have the ability to provide coverage in cluttered environments such as the urban environment. A chain of mesh nodes can ‘hop’ around corners in an urban environment in a way the cellular P2MP systems cannot.

Ofcom researched mesh networks to:

- identify the theoretical determinants and metrics of spectral efficiency for both high frequency (line of sight) and low frequency (non-line of sight) mesh systems;
- investigate the capacity constraints of mesh networks and examine the hypothesis that for a mobile mesh the more consumers use a service, the more capacity the network has;

- investigate whether mesh systems have any regulatory impact, e.g. would the wider use of mesh systems imply that there should be more licence exempt spectrum?
- examine the key problems in the delivery of fixed and mobile mesh systems, understand what is required to resolve these and what the timescales for widespread adoption of mesh might be.

Ofcom investigated mesh networks to understand the true practical benefits that the technology might bring.

The work OFCOM commissioned in this area is addressing questions such as:

- are meshes more spectrally efficient than alternatives?
- can meshes enable the use of higher frequency bands, and/or support services-types that alternatives cannot?
- are meshes practical, and what are the enabling technologies?

Ofcom's work in this area covered both fixed and mobile mesh applications. The work presented here concentrates on mobile mesh applications, though some of what is said will apply to the fixed case also.

The work has shown that in discussing the performance of mesh systems care must be taken since the type of mesh used and its application can lead to very different conclusions regarding the performance that may be expected.

A2.2 CAPACITY AND SCALABILITY

A2.2.1 Do customers self-generate capacity in mesh?

There are huge attractions to having 'self generation of capacity' in a radio network. Notably, that the network is self-sustaining and that it could avoid the so-called 'tragedy of the commons'. Such a tragedy relates to the days when common land was used for the grazing of livestock with free access for all. The danger is that free access to a finite resource can result in that resource being fully consumed or compromised further such that it loses its usefulness to all. What then, if each user was somehow to add grazing capacity as they joined the common?

The hypothesis that in a mesh network the subscriber base self-generates capacity is crucial for understanding the likely applications and performance of mesh systems. To establish whether this hypothesis is valid in practical applications, four published approaches supporting this standpoint have been reviewed. Each presents a coherent argument based on its stated assumptions, however those assumptions do not translate well to practical applications. The assumptions were:

- unbounded latency for network traffic;
- unbounded requirements for spectrum;
- confinement of nodes into localised groups in a large mesh.

These assumptions place a significant limit on the applicability of the self-generating capacity. The work has concluded that for a pure mesh, subscribers cannot self-generate capacity at a rate sufficient to maintain a target level of per-user throughput regardless of network size and population. The only viable ways scalability can be achieved are by providing additional capacity either in the form of a secondary backbone (fixed) mesh network – so forming a "Hybrid Mesh", or an access network – so forming an "Access Mesh" as shown in Figure 11. In these two configurations scalability is possible and has similar characteristics to that of a cellular network.

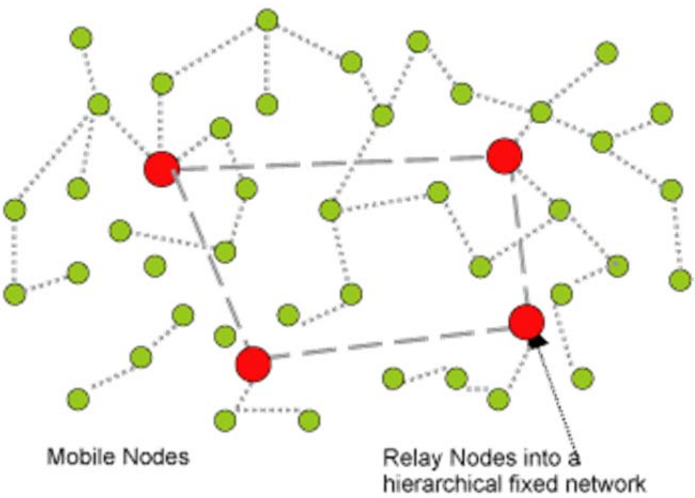

Figure 11: Hybrid Network: Intra-Mesh traffic with Infra-structure support

The conclusion from the Ofcom work undertaken is that meshes have no especially good properties with respect to scaling. In particular as node density and geographic size increase, the traffic rate available to any particular user decreases. The implication of this is that mesh networks should not be chosen over cellular networks on the basis of capacity alone.

This work shows that this lack of scalability can only be overcome by either adding additional capacity in the form of a hierarchical network or containing the end-to-end traffic flows to localised regions within the network.

All current theory and measurement of ideal, novel and practical meshes conclude that ad hoc mesh networks comprising only peer-to-peer communication links do not scale well with increasing node population unless there are specific limitations on the density of nodes; the propagation environment and the traffic models.

Additionally there exist practical MAC and routing challenges which further push for meshes which have a low hop count – and hence localised traffic flows.

A2.2.2 Underlying causes of limited capacity

Transmissions from nodes in a mesh extend beyond the wanted range to a wider ‘interference zone’, as shown below. Other nodes wanting to communicate within this interference zone must use other elements of time/bandwidth resource. Given that this is a finite resource this can lead to bottlenecks in communications across these interference zones, particularly as node density rises.

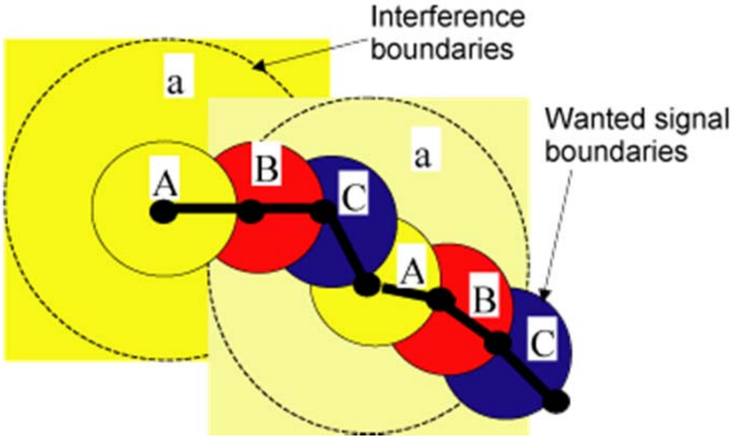

Figure 12: Mesh node interference (each colour represents a different frequency channel)

Clearly it is advantageous to keep this area, a, as small as possible. This confirms the conclusion of other researchers that short hop lengths and high propagation attenuation factor are conducive to high throughput capacity of the network.

A2.2.3 Project status

Ofcom's work in this area addresses the role that mesh networking will play in support of our vision of future wireless devices providing high bandwidth connections at home, in the office and outdoors.

The work concludes that meshes work best for the scenario of connections to extra-mesh services such as the telephone network and the Internet. This type of mesh will support applications such as extending hotspots to wider areas, provision of broadband networks and internet to rural communities, or provision of wireless networking at lecture halls or conventions.

Such mesh networks therefore will require infrastructure for deployment in the form of access points to connect to the external network. The work concludes that mesh networks can scale and provide a sustained level of service as new users join as long as the density of such planned access points is kept sufficiently high. This represents a form of ad hoc network in that users may join in an ad hoc manner, but the infrastructure itself must be planned and scaled, very much like cellular networks. Such meshes will not be as quick to deploy as pure intra-meshes, however will still be quicker to install than any new wired or cellular system, so will still have clear benefits as an alternative in some applications. An example application might be deployment to cover a new industrial park or a temporary conference event. Thus many view meshes as likely to play a role in the vision of increasingly mobile communications, supporting the ability for mobile devices to increasingly connect to broadband networks at any location.

For a pure mesh network where there is no infrastructure to provide connections to external networks such as the internet, the benefits of rapid set-up and tear down are accrued. It is in this area that meshes were originally used in defence applications and are likely to find further application in emergency service operations where planned infrastructure is unavailable. However, for this type of pure mesh subscribers cannot self-generate capacity at a rate sufficient to maintain a target level of per-user throughput regardless of network size and population. Thus this type of mesh is unlikely to find widespread commercial application.

The work has shown that meshes are not an improvement in spectrum efficiency in practical cases in comparison for example to cellular networks. Improvements in spectral efficiency of a mesh network can be made through the use of directional antennas; however this is likely only to be available to fixed mesh applications. In the mobile case small handset sizes preclude the benefits of spectral efficiency.

Improved utilisation of the spectrum is possible however since many of the applications for mesh networking can be efficiently deployed at the higher frequencies outside of the congested high demand spectrum.

ANNEX 3: REPLIES TO CEPT QUESTIONNAIRE ON THE USE IN 870-876 / 915-921 MHz

Replies were received from 43 administrations by 1 August 2012 (countries in bold).

Table 14: List of CEPT administrations that responded to the Questionnaire

Albania	**Luxembourg**
Andorra	**Former Yugoslavian Republic of Macedonia**
Austria	**Malta**
Azerbaijan	Monaco
Belarus	**Montenegro**
Belgium	**Moldova**
Bosnia Herzegovina	**Norway**
Bulgaria	**Poland**
Croatia	**Portugal**
Cyprus	Romania
Czech Republic	**Russian Federation**
Denmark	San Marino
Estonia	**Serbia**
Finland	**Slovak Republic**
France	**Slovenia**
Georgia	**Spain**
Germany	**Sweden**
Greece	**Switzerland**
Hungary	**The Netherlands**
Iceland	**The United Kingdom**
Ireland	**Turkey**
Italy	**Ukraine**
Latvia	**Vatican City**
Liechtenstein	
Lithuania	

Two questions were included in the questionnaire and all administrations which answered have provided responses to both questions.

A3.1 EXISTING USAGE IN 870-876 / 915-921 MHz

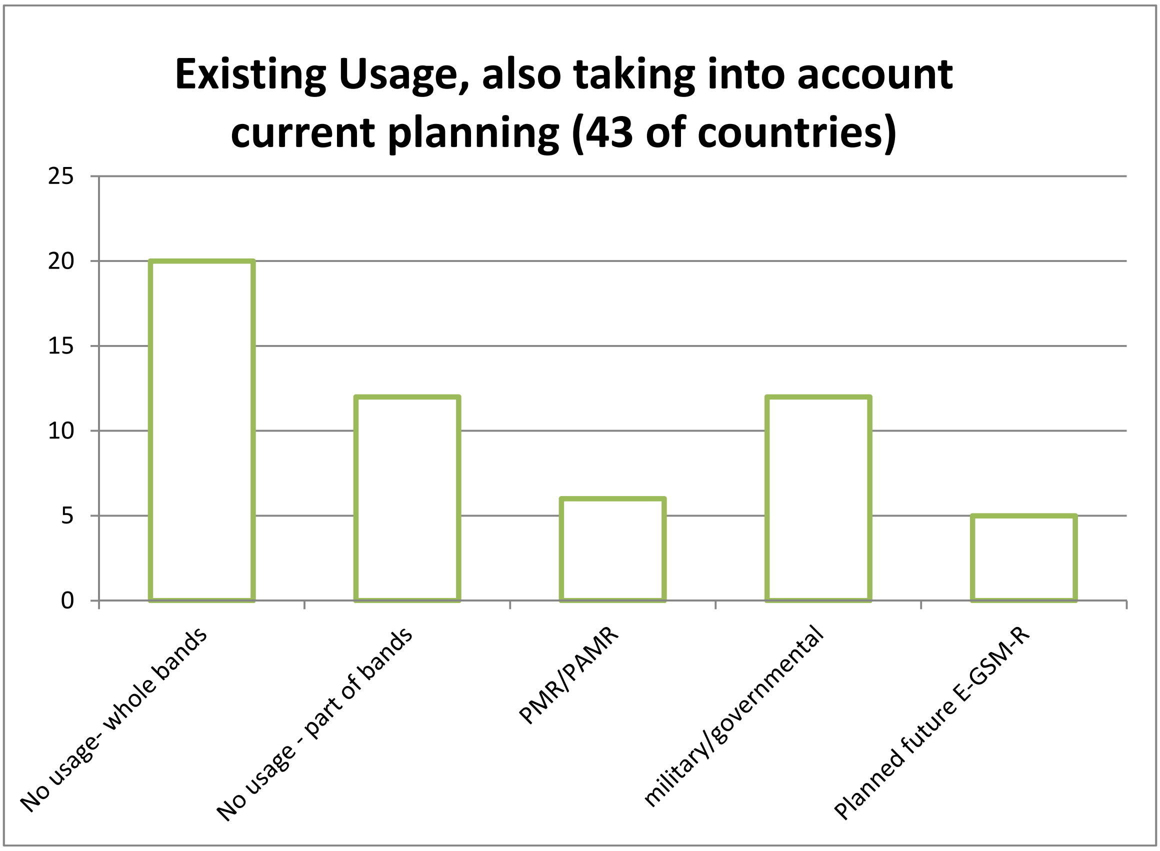

Figure 13: Existing Usage in 870-876 / 915-921 MHz

This overview shows that the real implementation of PMR/PAMR is not high in Europe, despite of having ECC/DEC/(04)06 [21] and reflection in the ECA table. PMR/PAMR systems are currently used in only six countries in this frequency band and several countries reported that PMR/PAMR has been allocation in their country but that network operation either has been terminated, or the network rollout being very limited, or network not fully put into operation, or either be simply unused (no licences awarded). One country plans to move from defence system usage towards PMR/PAMR usage. The PMR/PAMR usage is in some cases only in parts of the band (Georgia only 870-876 MHz, Poland 870-874.44 MHz, Spain: 4 local licenses. Ukraine reported to terminate usage by 1 January 2016.

There is considerable military usage in the band. Five countries (Austria, Belgium, Germany, Liechtenstein and Switzerland) are at mid-2013 also planning with E-GSM-R, although this needs still to materialise in the market.

The ARNS situation (time limited according to RR 5.323) may apply also to Azerbaijan who did not answer the questionnaire (this is not explicitly recorded since ARNS is being phased out).

A3.2 INDIVIDUAL COUNTRY RESPONSES

Table 15: Responses received by 1 August 2012

Country	What is the current use of the bands 870-876 / 915-921 MHz in your country?	What are your short, medium and long term plans with regard to the future
Albania	870-876 and 915-921 MHz bands are identified as the favourite for Tactical Radio Relay, especially for cross-border cooperation	No change plans.
Andorra	Usage PMR/PAMR designated but not implemented	No change planned
Austria	Currently, the sub band 873-876 / 918-921 MHz is used according to the amended ECC/DEC/(02)05 for the extension of the GSM-R band. The sub band 870-873 / 915-918 MHz is currently not used (foreseen for PMR systems). Any European harmonisation measures are welcomed	No changes are foreseen with respect to the extension band for GSM-R. Concerning the other part of this band the Austrian Administration can follow any additional harmonisation measures in principal.
Belarus	ARNS (time limited), PMR/PAMR allocated but not used	No further plans
Belgium	Governmental use (e.g. Unmanned Aeronautical Vehicle, Unmanned Ground Vehicle or Tactical Radio Relay)	E-GSM-R (also reflected in ECC/DEC/(04)06 and ECC/DEC/(02)05)
Bosnia Herzegovina	PMR/PAMR as per Rule 50/2010 which transponded stipulations of ERC T/R 25-05. However, No licensed issued nor planned	No plans for change at the moment
Bulgaria	The whole band 870-876 / 915-921 MHz (2x6 MHz) is used by governmental applications (defence usage). Governmental usage will stay in the future and will not change	No change
Croatia	Military services, PMR/PAMR/ E-GSM-R. No PMR/PAMR networks are implemented/in operation in the market and intention to close the governmental use in this band	Indicated that only E-GSM-R is planned. However, Croatia has not deployed GSM-R in the GSM-R core band yet
Cyprus	The frequency bands are currently being used according to the frequency plan by the government (TRR, lower half of duplex band) and by digital land mobile PMR/PAMR (no licenses awarded)	No future use planned yet.
Czech Republic	The guard bands 870-872 / 915-917 MHz are not used and are not designated for any application.	Short plans: There is no short plan until there is information about future plan from the licence holder.

Country	What is the current use of the bands 870-876 / 915-921 MHz in your country?	What are your short, medium and long term plans with regard to the future
	The bands 872-875.8 / 917-920.8 MHz are designated for applications in accordance with ECC/DEC/(04)06 (i.e. category 2). Current holder of block assignment has terminated operation of CDMA network however licence is valid until 2015. The bands 875.8-876 / 920.8-921 MHz are guard bands (no utilisation)	Medium plans and long term plans: The CTO has no specific plans; however, future utilisation will reflect European harmonisation, if required
Denmark	No use	SRD and RFID
Estonia	No use. Reserved until public competition	Waiting for results of international working groups. Will not decide plans with regard to the future use before decisions are made in international level
Finland	Governmental use until the end of 2013. Designated for PMR/PAMR according to ECC/DEC/(04)06 but no actual PMR/PAMR users on these bands. Other usage: test networks	Ficora supports CEPT studies on additional UHF spectrum for SRD, RFID and smart metering applications. Based on these studies these frequency bands may be considered for the above mentioned applications
France	Governmental use for several kind of applications such as unmanned systems (air, sea and ground), remote control and telemetry, data links, etc.	A governmental usage of those bands for the applications mentioned above will be maintained in the future. Sharing of the 870-873 MHz band with secondary SRD applications is not considered
Georgia	870-876 MHz band is used by CDMA-850 systems and radio-microphone devices. 915-921 MHz is currently used by SRD applications and radio-modems	No change planned
Germany	870-873 / 915-918 MHz. Governmental use (implemented, exclusive usage). 873-876 MHz / 918-921 MHz. E-GSM-R (license awarded), PMR/PAMR licenses possible but not awarded	No change planned
Greece	Exclusively Governmental Use (Tactical Communication System, Radio Relay)	No change planned
Hungary	Not used at present	2. 870-873 / 915-918 MHz planned for wide band PMR/PAMR land mobile radiotelephone systems. 2. & 3. 873-876 / 918-921 MHz planned for wide band PMR/PAMR land mobile radiotelephone systems, including E-

Country	What is the current use of the bands 870-876 / 915-921 MHz in your country?	What are your short, medium and long term plans with regard to the future
		GSM-R systems. However, deployment in GSM-R core band still in planning phase
Iceland	Fixed (point to point links)	Short term plan: Fixed (point to point links) No medium or long term plans
Ireland	The bands 872-876 / 917-921 MHz, are licensed within Ireland until December 2015 for Wideband Digital Mobile Data Services. The network has not yet been built up, and has minimal operation within Ireland (limited only to north county Dublin). The technology used is flash ofdm. 870-872 / 915-917 MHz are currently unused in Ireland	ComReg has not yet determined its plans with regard to future use within these bands; however, a review of future use of the bands has been included in ComReg's work programme for the period 2011 – 2013, for attention towards the end of this period.
Italy	MOBILE NETWORK by DEFENCE and SECURITY BODIES AND C2 UAV (whole 2 x 6 MHz)	No changes planned
Latvia	Identified for Wide Band Digital Land Mobile PMR/PAMR systems (according to ECC/DEC/(04)06) At this moment the band is not used	Short term (3-5 years): Wide Band Digital Land Mobile PMR/PAMR systems (according to ECC/DEC/(04)06). Long term (5-10 years): No changes or adjustment to harmonised use of the band in Europe
Liechtenstein	870-873 MHz: Until today no RIS and no use. 873-876 MHz: RIS RIR0501-01 and RIR0501-05. Land mobile/GSM; individual assignment due shortly 915-918 MHz: Until today no RIS and no use. 918-921 MHz: RIS RIR0501-03 and RIR0501-05. Land mobile/GSM; Individual assignment due shortly	Short and Medium term plans: 870-873 MHz: reserved for future use by SRDs. 873-876 MHz: Primary allocation to GSM-R and use by GSM-R. 915-918 MHz: reserved for future use by SRDs. 918-921 MHz: Primary allocation to GSM-R and use by GSM-R. Long term plans: 870-873 MHz: reserved for future use by SRDs. 873-876 MHz: Primary allocation to Railway mobile communication systems. 915-918 MHz: reserved for future use by SRDs. 918-921 MHz: Primary allocation to Railway mobile communication systems
Lithuania	No use	PMR/PAMR according to ECC/DEC/(04)06
Luxembourg	1. Although the frequency band is a shared civil/military band, no	In Luxembourg, there is a request for this band for smart metering

Country	What is the current use of the bands 870-876 / 915-921 MHz in your country?	What are your short, medium and long term plans with regard to the future
	military application (such as tactical radio relay) is currently in use. 2. The frequency band has been allocated to PMR/PAMR applications (in accordance with ECC/DEC/(04)06) for some years, but no licences have yet been granted. 3. Currently there is no intention to extend the GSM-R frequency range to include as well the band 873-876 / 918-921 MHz. 4. Luxembourg recently granted a temporary licence for the band 870-876 MHz to an energy utility company for utilisation of smart grid applications	applications, which is mainly intended for carrying out tests of the relevant radio equipment.
Former Yugoslavian Republic of Macedonia	The bands 870-876 / 915-921 MHz are allocated for Fixed and Land Mobile Service (no licenses awarded)	Plans for GSM-R / PMR/PAMR, however deployment in GSM-R core band still in planning phase
Malta	Not used	No plans
Moldava	870-876 MHz – SRD possible; 915-921 MHz in pair with 870-876 MHz for PMR/PAMR is provided by National Radiofrequency Table, but there are no registered or operating PMR/PAMR networks	No plans
Montenegro	Digital PMR/PAMR (no license awarded) and TRR (Tactical radio relay) in lower half of the band	In further planning of this band, the most recent technological trends shall be taken into consideration, as well as the experience of the CEPT member countries and realistic needs of Montenegrin users
Norway	870.5-876 / 915.5-921 MHz designated for individual service neutral license. No current use	Awaiting international harmonisation
Poland	870-874.44 MHz: individual licensed PMR/PAMR applications, 869.4-874.44 MHz (downlink) paired with 824.4-829.44 MHz (uplink), CDMA, CDMA 2000 1xEV-DO); 874.44-876 MHz not used; 915-921 MHz not used	Medium or long term plans: a) re-farming (release) of the frequency range 870-874.44 MHz - moving CDMA and CDMA 2000 1xEV-DO applications into another frequency band. b) introduction of harmonized frequency usage in the bands

Country	What is the current use of the bands 870-876 / 915-921 MHz in your country?	What are your short, medium and long term plans with regard to the future
		870-876 / 915-921 MHz in accordance with CEPT (and/or EU) regulations, e.g. extension of GSM-R band (E-GSM-R i.e. 873-876 / 918-921 MHz)
Portugal	870-873 MHz is being tested for a smart metering system, by the energy distribution operator; 873-876 MHz paired with 918-921 MHz is being used by military	Some adjustments might occur on the quantity of spectrum in use in the 870-876 / 915-921 MHz band in the short/medium term. GSM-R extension would be possible inside core GSM-R band since only 2x2 MHz being used currently
Russian Federation	Band 870-876 MHz ARNS on primary basis Band 915-921 MHz ARNS on primary basis Space operation service for telemetry, tracking, and control purposes Mobile, except aeronautical mobile on secondary basis Band 916-921 MHz RFID	Decommissioning of ARNS after the end of depreciation period and deployment same service in other bands
Serbia	Defence Systems	Medium term plan is to use the band for PMR/PAMR
Slovak Republic	872-876 MHz digital wideband cellular network - CDMA; (duplex +45 MHz). 917-921 MHz digital wideband cellular network - CDMA, duplex -45 MHz; (General license for terminals)	Yes, but only for frequency sectors 870-872 / 915-917 MHz and it also depends on results of study of compatibility.
Slovenia	Land military systems in 870-873 MHz (MS) / 915-918 MHz (BS). PMR/PAMR possible in upper half of the band but no licenses awarded	Extension of land military systems or PMR/PAMR for the upper half of the band
Spain	There are 4 local licences in Spain, broadband digital technology for applications as M2M, meter reading and data. Technologies could be LTE or WiMax	No change planned
Sweden	No use	No short term plans for this band. Awaiting the results of the EC Spectrum Inventory
Switzerland	870-873 MHz: Until today no RIS and no use.	Short and Medium term plans:

Country	What is the current use of the bands 870-876 / 915-921 MHz in your country?	What are your short, medium and long term plans with regard to the future
	873-876 MHz: RIS RIR0501-01 and RIR0501-05. Licences will be assigned shortly 915-918 MHz: Until today no RIS and no use. 918-921 MHz: RIS RIR0501-03 and RIR0501-05. Licences will be assigned shortly	870-873 MHz: reserved for future use by SRDs. 873-876 MHz: Primary allocation to GSM-R and use by GSM-R. 915-918 MHz: reserved for future use by SRDs. 918-921 MHz: Primary allocation to GSM-R and use by GSM-R. Long term plans: 870-873 MHz: reserved for future use by SRDs. 873-876 MHz: Primary allocation to Railway mobile communication systems. 915-918 MHz: reserved for future use by SRDs. 918-921 MHz: Primary allocation to Railway mobile communication systems
The Netherlands	Military	Military use for the foreseeable future, new equipment has recently been purchased
Turkey	870-876 MHz: Designated to PMR/PAMR and Fixed Links. No implementation yet 915-921MHz: Designated for PMR/PAMR. No implementation yet.	No plans yet
Ukraine	In accordance with the Plan of radio frequency resource usage in Ukraine the band of 870-876 MHz is actually used by REFs of CDMA-800 cellular communication systems, to organize of BS->AS communication links (deadline of technology usage – 1st January, 2016). Besides, both specified bands are used by special users REFs, relating to radio navigation and radiolocation service (for example, RSBN/PRMG), and will be used till the end of its operation term.	For a present day, there are no plans concerning conversion of the bands 870-876 / 915-921 MHz in future, after the termination of their use by above-mentioned REFs.
United Kingdom	The Met Service operates Wind Profiler Radar (1 site) in the 915 MHz band. The use of this technology will continue and further sites may be added in future.	The UK has consulted on the use of the bands and has subsequently decided to permit a range of SRD based on the forthcoming entries in ERC Rec 70-03.

Information received from the UIC WGFM Group:

This information shows that the planned E-GSM-R is likely to be used at local hotspots such as some metropolitan stations or big shunting sites only in the vast majority of cases. It should also be noted that recently in 2013 3GPP has assigned the Mobile Class Mark (identity for E-GSM-R capability in the GSM protocol for GSM equipment having implemented the E-GSM-R frequencies). Studies on intra-system compatibility impact of E-GSM-R on E-GSM900, UMTS900 and LTE900 have been finally agreed in 3GPP. The results include power reductions for E-GSM-R base station emissions which makes E-GSM-R implementations less economic. In addition, improved radio modules for GSM-R are specified in ETSI which are likely to be carried into the interoperability specifications agreed at the ERA for the GSM-R core band (but not covering the E-GSM-R frequencies).

According to latest information in 03/2013, collected in ETSI TC RT in ETSI TR 103 134 [14], GSM-R (voice and data bearer) is deployed and covers around 68 000 km of tracks in Europe and this approximate figure is confirmed by the answers received in response to this questionnaire. In Europe, where the total railway network taken into account is 221 025 km, GSM-R coverage was planned for 149 673 km according to ETSI TR 102 627 [15], published in 11/2008. It also explains that in September 2007 the network comprised 60 507 km equipped with GSM-R infrastructure, of which 40 918 were in operation by that date. This means that GSM-R network implementation has to some extent slowed down in recent years below the figures which have been forecasted about 5 years ago.

The situation set out above makes it at relatively unlikely that widespread implementation of E-GSM-R in Europe will occur.

Table 16: E-GSM-R plans

Land	Use Case	Assigned	Usage planed	Not planed
DB (DE)	shunting, Train Radio	x		
Network Rail (UK)	shunting, GPRS Monitoring		X	
Adif (Spain)	shunting, hot spot coverage etc.		X	
SBB (SUI)	Hot spot coverage		X	
ProRail (NL)	shunting, PMR/short range radio, local capacity enhancements for telemetry applications, migration to next generation radio services		X	
ÖBB (A)	shunting (yards), coverage of hot spots or disposed application areas		X	
Trafikverket (SE)	Possibly to use during and after migration to other technology for the railway		X	
FTA (FIN)	shunting, switch-man and train brake testing communications and during the migration period from GSM technology to the next generation radio technology			x
RFF (FR)	plans to use the ER-band in congested or subject to congestion areas, like Paris large railway stations or shunting areas, some important railway nodes etc.		X	

Military usage

The NATO JOINT CIVIL AND MILITARY FREQUENCY AGREEMENT (NJFA), defines the frequency range 790-960 MHz for essential military requirements. From 10 to 60 MHz is reserved for tactical radio relay of which 10 MHz should be harmonised spectrum for training in border areas, subject to bilateral/ multilateral agreements. Furthermore, based on present equipment, the deployment of a Corps-size Reaction Force requires 50 MHz of spectrum, although it is recognised that some countries will have problems fulfilling such a requirement.

The NJFA is going to be reviewed in the near future.

The CEPT ECC/WGFM civil/military meeting in November 2013 noted the approach taken by ECC WGFM for harmonisation of SRD applications in the UHF bands 870-876/915-921 MHz in ERC Recommendation 70-03 (used by 11 administrations for military applications in all or parts of the bands). This “soft-harmonisation” approach was considered appropriate. It provides a good example of the ECC's use of ‘soft harmonisation’, where existing services remain protected to the extent that national administrations deem it necessary, yet providing the opportunity for the harmonised development of new services in the majority of European countries. Administrations can freely decide which part of the ERC/REC 70-03 new entries they can implement – in line and in balance with incumbent use.

Table 17: Use of 870-876 MHz and 915-921 MHz as indicated by CEPT administrations

	870/915	871/916	872/917	873/918	874/919	875/920	876/921
Andorra							
Albania							
Austria				E-GSM-R			
Belarus	ARNS (phased out)						
Belgium				E-GSM-R			
Bosnia Herzegovina							
Bulgaria							
Croatia				E-GSM-R planned, however GSM-R not deployed in GSM-R core band yet.			
Cyprus							
Czech Republic			Usage terminated				
Denmark							
Estonia							
Finland	Governmental use terminates						
France[13]	Note: French comment from the WGFM #75 minutes Minsk[13]						
Georgia	870-876: CDMA-850 Network, 915-921 possible for SRD/RFID						

(green)	Not used or going to be unused
(orange)	Planned E-GSM-R
(blue)	Usage based on PMR/PAMR licenses
(red)	Governmental/military usage

[13] Germany emphasised during the WGFM#75 meeting in Minsk that the bands 870-873 MHz and 915-918 MHz are designated exclusively for military radio applications and that it cannot be expected that they can be made available e.g. for short range device applications in the foreseeable future. France has the similar situation in the band 870-873 MHz. Other sub-bands outside of these mentioned frequencies may be considered for partial implementations.

Germany[13]		E-GSM-R
Greece		
Hungary		E-GSM-R planned, however deployment in GSM-R core band still in planning phase
Iceland	Limited p-t-p links, time-limited	
Ireland		
Italy		
Latvia		
Liechtenstein		E-GSM-R
Lithuania		
Luxemburg	Request for Smart Metering	
FYROM		E-GSM-R planned but GSM-R in the care band only in planning phase yet
Malta		
Moldava		
Montenegro		
Norway		
Poland	870-874.44 MHz CDMA 2000 EV-DO, rest unused	
Portugal	Request for Smart Metering	
Russian Federation	RFID 916-921 MHz, (ARNS phased out), satellite TTC	

Serbia	Medium term plan to move from defence systems to PMR/PAMR	
Slovak Republic		CDMA Network
Slovenia		
Spain	4 **local** licenses for M2M, Metering based	
Sweden		
Switzerland		E-GSM-R
The Netherlands		
Turkey		
Ukraine	CDMA-800 systems, (deadline of technology usage – 1st January, 2016)	
UK	Plus Wind Profiler (a site) and unused military allocation	

The result may lead to a situation where many administration may have a spectrum usage opportunity for secondary applications in the band, however, some may not have in all or parts of the bands, mainly due to the unlimited in time military/governmental usage. A possible outcome after finalisation of the compatibility studies could therefore be to have entries in ERC/REC 70-03 [2] which could be implemented by administrations for those frequency opportunities where no military/governmental usage occurs.

Based on the preliminary indications from PT SE24 as well as the spectrum inventory information collected by means of the questionnaire for the bands 870-876 / 915-921 MHz, SRD/MG works on the basis of facing three different situations in the CEPT:

1. Some countries where all or parts of the bands could be used by SRD with rather simple spectrum access due to the underused or unused band situation;
2. In some countries, more sophisticated spectrum access is needed (e.g. E-GSM-R protection);
3. In some countries all or parts of the bands are used by governmental, mostly military usage. In some of these countries, this might be seen even as use on exclusive basis.

It is therefore necessary to keep the flexibility in the approach at the moment, and to avoid spectrum fragmentation by dividing spectrum over different applications. On the other side, some split may be unavoidable, also because there are applications needing a more predictable sharing environment than others.

ANNEX 4: PROPOSALS FOR ERC/REC 70-03 [2]

ERC/REC 70-03 Annex 1 new entries:

Table 18: ERC/REC 70-03 Annex 1 new entries

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Modulation / maximum occupied bandwidth	ECC/ERC Decision	Notes
g2	870-876 MHz	≤ 25 mW e.r.p.	≤ 0.1% duty cycle For ER-GSM protection (873-876 MHz, where applicable), the duty cycle is limited to ≤ 0.01% and limited to a maximum transmit on-time of 5ms/1s.	≤ 200 kHz		This frequency band is also identified in Annexes 2 and 5
g2.1	870.0-875.8 MHz	≤ 25 mW e.r.p.	≤ 1% duty cycle For ER-GSM protection (873-875.8 MHz, where applicable), the duty cycle is limited to ≤ 0.01% and limited to a maximum transmit on time of 5ms/1s.	≤ 600 kHz		The frequency band is also identified in Annexes 2 and 5
g3	915.000-921.000 MHz	≤ 25 mW e.r.p.	≤ 0.1% duty cycle For ER-GSM protection (918-921 MHz, where applicable), the duty cycle is limited to ≤ 0.01% and limited to a maximum transmit on-time of 5ms/1s.	≤ 200 kHz		The frequency band is also identified in Annexes 10 and 11
g3.1	915.200-920.8 MHz	≤ 25 mW e.r.p. except for the 4 channels	≤ 1% duty cycle (note 9) For ER-GSM protection (918-920.8 MHz, where	≤ 600 kHz except for the 4 channels identified		The frequency band is also identified in Annexes 10 and 11

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Modulation / maximum occupied bandwidth	ECC/ERC Decision	Notes
		identified in note 8 where ≤ 100 mW e.r.p. applies	applicable), the duty cycle is limited to ≤ 0.01% and limited to a maximum transmit on-time of 5ms/1s.	in note 8 where ≤ 400 kHz applies		

Note 8: The available channel centre frequencies are 916.3 MHz, 917.5 MHz, 918.7 MHz and 919.9 MHz. The channel bandwidth is 400 kHz.
Note 9: RFID tag emissions responding to RFID interrogators operating on centre frequencies 916.3 MHz, 917.5 MHz, 918.7 MHz and 919.9 MHz are not duty cycle limited.

Frequency Issues

Sub-bands g2) to g3.1)

Use of all or part of sub-bands g2) to g3.1) may be denied in some European countries that use all or part of these sub-bands for defence/governmental systems. In other countries that use sub-bands 873-876 / 918-921 MHz for GSM for railways, extended band (ER-GSM), access to the part 873-876 / 918-921 MHz by non-specific SRD applications require implementing additional mitigation measures such as transmission timing limitations as set out in ECC Report 200 [7]. See Appendix 3 for national implementation concerning ER-GSM and defence/governmental services.

The adjacent frequency bands below 915 MHz and above 876 MHz as well as 921 MHz may be used by high power systems. Manufacturers should take this into account in the design of equipment and choice of power levels.

<u>ERC/REC 70-03 [2] Annex 2 new entry:</u>

Add to the scope of ERC/REC 70-03 Annex 2, including “***sensors*** (water, gas and electricity; meteorological instruments; pollution measurement; environmental data, such as levels of allergens (pollen, dust), electromagnetic pollution (solar activity), noise) and ***actuators*** (controlling devices such as street or traffic lights).”

Table 19: ERC/REC 70-03 Annex 2 new entry

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing	ECC/ERC Decision	Notes
d	870.0-875.6 MHz	≤ 500 mW e.r.p.	≤ 2.5% duty cycle and APC required (note 1). For ER-GSM protection (873-875.6 MHz, where applicable) , the duty cycle is limited to	≤ 200 kHz		Individual license may be required for Metropolitan/Rural Area Networks. Adaptive Power Control (APC) required The APC is able to reduce a link’s

	Frequency Band	Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing	ECC/ERC Decision	Notes
			≤ 0.01% and limited to a maximum transmit on time of 5ms/1s (note 2).			transmit power from its maximum to ≤ 5 mW. The frequency band is also identified in Annexes 1 and 5

Note 1: a duty cycle of up to 10% may be allowed for network relay points forming part of metropolitan/rural area networks such as for utilities or other applications for the purpose of data acquisition. Network relay points should be individually licensed.
Note 2: except if a procedure with the railway operator is employed (e.g. coordination or cognitive techniques) in order to avoid interference into occupied ER-GSM channels.

Frequency Issues

Use of all or part of sub-band d may be denied in some European countries that use all or part of these sub-bands for defence/governmental systems. In other countries that use sub-band 873-876 MHz for GSM for railways, extended band (ER-GSM), access to the part 873-876 MHz by non-specific SRD applications require implementing additional mitigation measures such as transmission timing limitations as set out in ECC Report 200 [7]. See Appendix 3 for national implementation concerning ER-GSM and defence/governmental services.

ERC/REC 70-03 Annex 5 new entry:

Table 20: ERC/REC 70-03 Annex 5 new entry

	Frequency Band	Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing	ECC/ERC Decision	Notes
a	870.000-875.800 MHz	≤ 500 mW e.r.p. ≤ 100 mW e.r.p.	≤ 0.1% duty cycle For ER-GSM protection (873-875.8 MHz, where applicable), the duty cycle is limited to ≤ 0.01% and limited to a maximum transmit on-time of 5ms/1s	≤ 500 kHz		500 mW restricted to vehicle-to-vehicle applications. 100 mW is restricted to in-vehicle applications. Adaptive Power Control (APC) is required. The APC is able to reduce a link's transmit power from its maximum to ≤ 5 mW. The frequency band is also identified in Annexes 1 and 2

Frequency Issues

Use of sub-band (new) may be denied in some European countries that use all or part of this band for defence/governmental systems. In other countries that use sub-band 873-876 MHz for GSM for railways, extended band (ER-GSM), access to the part 873-876 MHz by automotive SRD applications requires implementing additional mitigation measures such as transmission timing limitations as set out in ECC Report 200 [7]. See Appendix 3 for national implementation concerning ER-GSM and defence/governmental services.

ERC/REC 70-03 Annex 10 new entry:

Table 21: ERC/REC 70-03 Annex 10 new entry

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing	ECC/ERC Decision	Notes
c1	916.1-916.5 MHz, 917.3-917.7 MHz, 918.5-918.9 MHz, 919.7-920.1 MHz	≤ 10 mW e.r.p.	< 25 % duty cycle	≤ 400 kHz		Indoor Digital Assistive Listening Device Systems. The frequency band is also identified in Annexes 1 and 11

Frequency Issues

Sub-band c1):

Use of all or part of sub-band c1) may be denied in some European countries that use all or part of these sub-bands for defence / governmental systems or, in some countries that use sub-band 918-921 MHz for GSM for railways, extended band (ER-GSM). See Appendix 3 for national implementation concerning ER-GSM and defence/governmental services.

ERC/REC 70-03 Annex 11 new entry

Table 22: ERC/REC 70-03 Annex 11 new entry

Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing	ECC/ERC Decision	Notes
c	915.0-921.0 MHz	≤ 4 W e.r.p. (note 1)	For ER-GSM protection (918-921 MHz, where applicable), DAA is required	≤ 400 kHz		The frequency band is also identified in Annexes 1 and 10. Operation only when necessary to perform the intended operation, i.e. when RFID tags are expected to be present.

Note 1: Interrogator transmissions in band c at 4 W e.r.p. is only permitted within the four channels centred at 916.3 MHz, 917.5 MHz, 918.7 MHz and 919.9 MHz; each with a maximum bandwidth of 400 kHz.

Frequency Issues

Sub-band c):

Use of all or part of sub-band c) may be denied in some European countries that use all or part of these sub-bands for defence/governmental systems. In other countries that use sub-band 918-921 MHz for GSM for railways, extended band (ER-GSM), access to the part 918-921 MHz by UHF RFID applications require implementing additional mitigation measures such as Detect-And-Avoid (DAA) as set out in ECC Report 200 [7]. See Appendix 3 for national implementation concerning ER-GSM and defence/governmental services.

ANNEX 5: LIST OF REFERENCE

[1] ETSI TR 102 649-2: Additional spectrum requirements for UHF RFID, non-specific SRDs and specific SRDs
[2] ERC Recommendation 70-03: Short Range Devices (SRD)
[3] ETSI TR 102 886: SRDs, Spectrum Requirements for Smart Metering European access profile Protocol (PR-SMEP)
[4] ETSI TR 103 055: Spectrum Requirements for Short Range Device, Metropolitan Mesh Machine Networks (M3N) and Smart Metering (SM) applications
[5] ETSI TR 103 056: Technical characteristics for SRD equipment for social alarm and alarm applications
[6] ETSI TR 102 791 V1.2.1 (revised version): Technical characteristics of wireless aids for hearing impaired people operating in the VHF and UHF frequency range
[7] ECC Report 200: Co-existence studies for proposed SRD and RFID applications in the frequency 870-876 MHz/915-921 MHz
[8] CEPT Report 14: Report from CEPT to the European Commission in response to the Mandate to: Develop a strategy to improve the effectiveness and flexibility of spectrum availability for Short Range Devices (SRDs)
[9] CEPT Report 44: Annual update of the technical annex of the Commission Decision on the technical harmonisation of radio spectrum for use by SRD (Fifth Update)
[10] ECC Report 181: Improving spectrum efficiency in SRD bands
[11] ECC Report 182: Survey about the use of the frequency band 863-870 MHz
[12] ECO Report 01: Dynamic Evolution of the RFID Market, 31 August, 2010
[13] EC Decision 2006/771/EC on the harmonisation of the radio spectrum for use by short-range devices
[14] ETSI TR 103 134: GSM-R in support of EC Mandate M/486 EN on Urban Rail
[15] ETSI TR 102 627: Additional spectrum requirements for PMR/PAMR systems operated by railway companies (GSM-R)
[16] University of Dortmund: Wireless Network Planning and Performance Analysis for Smart Grid Applications, as presented to SRD/MG in London, March 2012
[17] void
[18] ETSI EN 300 220: Short Range Devices (SRD);Radio equipment to be used in the 25 MHz to 1 000 MHz frequency range with power levels ranging up to 500 mW
[19] Ofcom UK published in 2006 a research paper on Mesh Networks
[20] CUS Report: Study on the Legal, Economic & Technical Aspects of Collective Use of Spectrum (CUS) in the European Community
[21] ECC/DEC/(04)06: ECC Decision of 19 March 2004 on the availability of frequency bands for the introduction of Wide Band Digital Land Mobile PMR/PAMR in the 400 MHz and 800/900 MHz bands amended 9 December 2011
[22] ETSI TS 102 902: Methods, parameters and test procedures for cognitive interference mitigation towards ER-GSM for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques
[23] Commission Decision of 9 November 2006 on harmonisation of the radio spectrum for use by short-range devices
[24] ETSI TR Technical Specification on Preliminary Tests and Trial to verify mitigation techniques used by RFID systems for sharing spectrum between RFID and ER-GSM
[25] ETSI TS 102 903: Compliance tests for cognitive interference mitigation for use by UHF RFID using Detect-And-Avoid (DAA) or other similar techniques".
[26] ETSI ERM TG34: ERM-TG34#23-03, Measurement Report, Feasibility Tests between E-GSM-R and UHF RFID at Kolberg, Germany, 25-26 June 2009.
[27] Commission Recommendation 2012/148/EU on preparations for the roll-out of smart metering systems