



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

**STRATEGIES FOR THE EUROPEAN USE OF FREQUENCY SPECTRUM  
FOR PMR/PAMR APPLICATIONS**

**Stavanger, May 2003**

## EXECUTIVE SUMMARY

The PMR/PAMR market in Europe is undergoing substantial development requiring a review of the frequency management strategy for PMR/PAMR systems and services in Europe. Further harmonisation and reorganisation of the use of spectrum within the traditional PMR/PAMR bands would strongly support industry development of new and innovative services and systems for professional radio users.

This document is intended as a guide to CEPT Administrations on the frequency management issues for PMR/PAMR services in particular within the bands:

- 410-430 MHz
- 450-470 MHz
- 870-876/915-921 MHz.

The VHF band 146-174 MHz has been heavily used for analogue PMR. There is a probability that emerging digital technology will enable this band to be used for digital PMR/PAMR.

Several other bands are currently used for PMR systems and services including for systems with national coverage. These bands include 406.1-410 MHz and 440-450 MHz but further harmonisation and reorganisation initiatives are not foreseen in the bands. The frequency band 380-400 MHz is not included in the plan as part of this frequency band is a preference band for emergency services, ERC/DEC/(96)01. The ongoing studies relating to emergency systems (known as Public Protection and Disaster Relief) are not considered in this strategic plan. The conclusions and any subsequent decisions of the WG FM and the ECC on these issues should be taken into consideration as appropriate. It is also recognised that military usage of spectrum within frequency bands designated for PMR/PAMR is not considered in this strategic plan.

CEPT Recommendation T/R 25-08 (revised in 1999) gives the planning criteria and frequency co-ordination procedures for narrow band land mobile PMR/PAMR systems using frequency spacing equal to or less than 25 kHz. These procedures now need to be reviewed and updated to extend the flexibility in order to allow for migration to wide band systems.

PMR systems are typically self provided and self-owned by the user whereas PAMR systems offer similar functionality but are operator provided, commercially open networks. The definitions of these systems are linked to a long list of PMR/PAMR features and services.

It is expected that several smaller PMR users will continue to operate existing and cost effective analogue systems but there is a stated market requirement for more sophisticated PMR services that require digital technologies. Accordingly, it is generally expected that analogue users will continue to migrate to digital PMR/PAMR systems as analogue systems become more expensive to maintain and operate due to equipment shortages and increasing operational expense. This migration from analogue to digital narrow band systems will be followed in a second step by the deployment of additional wide band systems also able to provide the required high-speed data services.

The evolution of technologies is expected to follow the general evolution in the radio communication sector and may be described as digital narrow band, wide band and broad band systems. While the deployment of narrow band systems has already commenced and that of wide band systems is being planned for the near future, the broad band systems are only expected at a later stage in localised hot-spots.

The envisaged market growth and the evolution of technologies would normally require additional spectrum for PMR/PAMR applications. However, the closure of the analogue public land mobile networks, the expected migration of emergency users to dedicated systems in the 380 – 400 MHz band and the expected migration of the European Railways to GSM-R could provide some leeway for further development within existing European PMR/PAMR spectrum allocations. Moreover, the in-band migration of PAMR from analogue or narrow band digital systems to wide band systems may reduce spectrum consumption per operator substantially because of the spectral efficiency of such technologies for larger systems. This together with greater utilisation of the 870-876/915-921 MHz band should provide the spectrum required by civil PMR/PAMR in the short to medium term.

The current split between the privately operated and the operator driven networks is around 90/10 %. Given that spectrum for traditional narrow band analogue and digital systems will still be needed for a long time, the initial estimated spectrum requirements for wide band PAMR systems (in the order of 2 x 3 MHz per operator) are expected to increase the net general spectrum needs for PMR/PAMR within the bands mentioned. Accordingly,

further re-organisation of the frequency bands and agreement at a European level on ECC Decisions regarding frequency availability are required to support this development.

### **Strategies for the European use of frequency spectrum for PMR/PAMR applications**

The use of frequency spectrum to support the development of PMR/PAMR services for analogue and digital networks within the bands 410-430 MHz, 450-470 MHz and 870-876/915-921 MHz in the period until 2013 should adhere to the following strategies:

#### **General strategies and statements**

1. Frequency spectrum and dedicated bands are needed now and in the future to meet specific requirements for PMR/PAMR networks, services and features as described in this strategic paper;
2. A shift from analogue to digital technology has been initiated and will be developed further. ECC Decision (02)03 on Narrow Band Digital land mobile PMR/PAMR as well as the first in a series of ECC Decisions on Wide Band Digital land mobile PMR/PAMR (ECC/DEC(03)01 for 200 kHz systems) have been adopted. The ECC Decisions identify frequency spectrum for digital narrow band and wide band PMR/PAMR systems;
3. The number of on-site PMR systems is increasing, using either licensed or licence exempt equipment (e.g. PMR446);
4. In general, Administrations have to ensure an equitable access to all the users who need it and spectrum should be designated in accordance with market demands;
5. For some analogue users with limited networks, slow migration to the initially more expensive but more feature-rich digital networks and operator driven /shared systems but it is becoming apparent that some users are looking for alternatives for their communication needs;
6. In order to meet a requirement for high speed data services within the PMR/PAMR applications a shift of focus is expected from narrow band digital to wide band digital networks. Maximising CEPT allocation commonality will assist in the development of economies of scale for equipment;
7. Trends towards larger networks with better coverage and increasing number of users are expected to continue. Organisations are tending to consolidate their user groups onto large common private networks or PAMR networks.

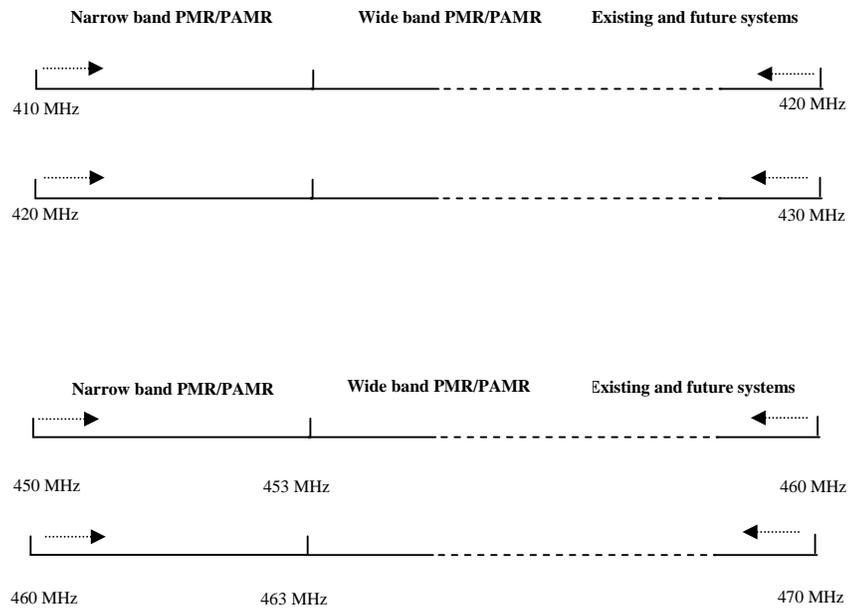
#### **PMR/PAMR spectrum management strategies**

- a. The CEPT should agree on a common approach across Europe in meeting the future requirements for PMR/PAMR services and applications;
- b. Refarming initiatives should be agreed on a national, multilateral or European basis;
- c. Frequency spectrum should be provided for the development of narrow band as well as for wide band networks;
- d. The migration should still preserve spectrum for small and large scale PMR systems.

### **Specific strategies for the duplex bands within 410-430 and 450-470 MHz**

CEPT Administrations should establish specific plans for re-farming and reorganisation of the use of the UHF bands to achieve:

1. migration from narrow band to wide band PAMR networks in accordance with market demand. This migration needs to take into account technical problems in border coordination between 25 kHz narrow band channels and wide band channels of 200 kHz or more not solved in either CEPT Recommendation T/R 25-08 or multilateral frequency border agreements. Thus Recommendation T/R 25-08 should be revised to include various frequency co-ordination scenarios i.e. between different wide band and narrow band systems;
2. from a technical point of view minimum availability of contiguous spectrum for wide band PAMR networks in the order of 2 x 3 MHz in response to market demand;
3. gradual harmonisation of the use of the frequency bands 410-430 MHz and 450-470 MHz according to market demands and providing national flexibility. It is recognised, however, that not all the spectrum within the bands is currently available for civil use in some Administrations. The Administrations should include designation of PMR/PAMR spectrum in the national frequency plans in one or more of the above bands. This would be achieved in the following way:
  - For the 450-460/460-470 MHz, narrow band PMR/PAMR - analogue as well as digital - should be introduced from the lower end of the band and wide band PMR/PAMR introduced in frequency bands above 453/463 MHz. The upper end of the band should in future be used for existing and future PMR/PAMR systems and allow for new technologies to be introduced. The spectrum to be used for wide band systems on the one hand and new technologies on the other hand should be defined by market demands;
  - The same concept should be used in the 410-420/420-430 MHz band providing spectrum for the wide band systems around the middle of the bands;
4. preservation of spectrum for small networks;
5. simplex channels e.g. within the bands 406.1-410 MHz, 440-450 MHz and 862-870 MHz, PMR and non-PMR, are used and designated according to CEPT/ERC Recommendation T/R 25-08.



**Figure 1: Indicative future use of the bands 410-420 / 420-430 MHz and 450-460 / 460-470 MHz bands**

#### **Specific strategies for the duplex bands within 870-876/915-921 MHz**

The frequency bands 870-876/915-921 MHz should be designated for wide band PMR/PAMR technologies. The bands should be used from the top end in order to ease compatibility with services below 915 MHz.

It is recognised that the band is identified as a preferred band for Tactical Radio Relays (TRR) in particular for cross-border operations. Shared use of the band between civil and military applications should be considered on a national basis. Due to existing frequency plans countries may need flexibility or more time to achieve harmonisation as shown in figure 1.

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## 1 INTRODUCTION

The PMR/PAMR market in Europe is undergoing substantial development particularly the trend towards deploying wider band systems, requiring a review of the frequency management strategy for PMR/PAMR systems and services in Europe. Currently, the frequency designation for PMR/PAMR services and systems is only harmonised in Europe to a limited extent and the availability of frequency bands for new digital services and systems is uncertain. This document provides a strategic plan for frequency management of PMR/PAMR in Europe. It has been developed in order to give guidance to the CEPT Administrations on the implementation of national frequency management initiatives within these bands. The document has been developed within FM PT 38 based on contributions and considerations within the group and on the ERO Report on PMR Market and Spectrum Requirements, December 1998.

The Plan first defines PMR and PAMR. Secondly, it gives an overview of existing frequency allocations for PMR/PAMR and the usage of these bands. Thirdly, it reviews market and technological developments in the PMR/PAMR sector in light of the development of wide band systems for PMR/PAMR and their impact on spectrum requirements. Finally, the plan concludes with a general strategy for PMR/PAMR in Europe for the next 10 years.

The strategic plan has the following major objectives:

1. Harmonisation of the frequency usage in Europe by digital narrow band and wide band systems for the benefit of users through regulatory bodies and operators;
2. Provision of comfort to the manufacturers of PMR/PAMR digital narrow band and wide band equipment that sufficient frequencies will be made available;
3. Identification of the frequency management issues needing to be addressed in CEPT.

In Europe, the main frequency allocations for PMR/PAMR systems, which today are almost exclusively analogue and digital narrow band systems, are in the sub-bands 68-87.5 MHz, 146-174 MHz, 380-400MHz, 406.1-470 MHz and 870-876/915-921 MHz. In line with the various decisions on TETRA and digital narrow band systems, the document focuses on the following UHF bands as these are most appropriate for the evolution of PMR/PAMR towards digital duplex narrow band and wide band technologies:

- 410-430 MHz
- 450-470 MHz
- 870-876/915-921 MHz

The VHF band 146-174 MHz has been heavily used for analogue PMR. There is a probability that emerging digital technology will enable this band to be used for digital PMR/PAMR. Given this opportunity, some Administrations have already started the refarming process in this band in line with the ECA and Recommendation T/R 25-08.

The 380-400 MHz frequency band is not included in the plan as this frequency band is viewed as the preference band for public safety PMR systems. However, the commonality between technologies used in this band and for PMR/PAMR supports in the long term the PMR/PAMR technology developments. Spectrum requirements may arise from the future development of wide band systems in the UHF range (380-470 MHz) designated to the PMR/PAMR and emergency networks.

Broad band PMR/PAMR systems are expected to serve as local high-speed data access networks in large blocks of frequencies above 2 GHz but are currently at an early stage of development and are therefore presently of less priority for European frequency management.

This document is limited to frequency management issues for PMR/PAMR. Licensing requirements and frequency assignment procedures for PMR/PAMR networks are not considered. Those issues are considered in detail within the ERO Report on PMR (1997).

It is also clear that the strategies for the future use of PMR/PAMR in Europe should follow international and community legislation. In particular, it should be noted that, under both international and Community legislation, exclusive spectrum allocation for a specific type of technology can only occur subject to specific conditions and where duly justified pursuant to essential requirements.

## 2 BACKGROUND

An ERO study on PMR market and spectrum requirements (Report released December 1998) described in details the market trends and spectrum solutions for the next 10 years. It was concluded that more spectrum would probably be required for PMR/PAMR applications in future and that strategies and timetables for designation of spectrum and implementation of ERC Decisions as relevant would be needed. The report was strongly supported by the PMR industry (ECTEL) and further action requested from the CEPT organisation to meet the requirements.

The WG FM noted the report and the conclusions and established a drafting group (e-mail group) to co-ordinate the activities. In January 2000, it was decided to create a project team (FM PT 38) with the task to develop proposals for a Strategic Plan for the future use of PMR/PAMR applications in Europe. The PMR industry has participated actively with expert contributions in order to reflect the latest technology and market developments in the plan.

The Strategic Plan does not cover licensing issues including those relating to market access, market delineation and competition, which are all the subject of national regulatory and licensing regimes, but rather focuses on the future spectrum strategies for PMR/PAMR in light of current and expected market developments and technology trends.

The Strategic Plan should give the background for the development and adoption of ECC Decisions in relevant areas. The ECC Decision (02)03 on frequency bands for Narrow Band Digital Land Mobile PMR/PAMR has already been adopted by the ECC and implementation of the Decision has started in Europe. A first ECC Decision (03)01 on Wide Band Digital land mobile PMR/PAMR (200 kHz channels) has also been adopted. Similar ECC Decisions for other Wide Band Digital land mobile PMR/PAMR are under development (e.g. 1.25 MHz channels) and are foreseen in line with the agreed strategies for the future use of PMR/PAMR applications in Europe. The final outcome depends on spectrum efficiency and compatibility studies, which are still ongoing within WG SE.

## 3 DEFINITIONS/DESCRIPTIONS

The following definitions/descriptions are used for PMR, PAMR and public land mobile networks based on the ERC Report 052 (Methodology for the assessment of PMR systems in terms of spectrum efficiency, operation and implementation, December 1997), ERC Report 073 (Investigation of the possibilities of harmonising (licensing and fees for) the PMR service within CEPT Administrations, April 2000) and ERO Report on PMR and PAMR licensing (July 1997).

### PMR

#### **Definition:**

PMR is part of the land mobile service based on the use of simplex, half and possibly full duplex modes at the terminal level in order to provide closed user group communications.

PMR can be either:

- traditional, self provided and self-owned by business users small area networks  
Example: network in an industrial plant;
- or
- tightly controlled set of inter-related closed user groups.  
Can either be outsourced, or can be owned by a dominant user who allows other related user groups to use the network.<sup>1</sup>  
Example: closed network of inter-related municipal organisations such as utility, public transportation, water supply and road maintenance.

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<sup>1</sup> Predominantly local networks but could be national.

**Description:**

Professional mobile radio (PMR) covers mobile radio systems used by an organisation to establish communications in support of its own activities. PMR products follow standards such as EN 300 086, EN 300 113, EN 300 392 and equivalent technical specifications. Typical PMR systems can be described as follows:

- Wide area, encompassing systems with a range of more than 1 km to regional or national coverage. Voice is used in majority but data is increasing.
- On-site (single, two and/or multi-frequency systems) systems for voice, voice and data or data only. They are typically used to provide communications with personnel on the move within the organisation's premises. These systems can be linked into a telephone system managed by an organisation (sometimes completed by other wireless devices). The range is less than 1-3 km, typically a few hundred metres. This includes short-range professional mobile radio, typically now PMR 446, covering a few hundred metres.

**PAMR****Definition:**

Operator provided, commercially open networks designed for business professional users, dedicated user groups but no limitation on the nature or type of the user groups and no need for these to be related. Not generally intended for these groups to communicate with each other.

**Description:**

PAMR is a type of service offered by an operator to subscribers over a large-scale network. The networks are operated to provide, on a commercial basis, professional communications facilities comparable to those available using dedicated PMR networks. PAMR operators provide such services to business professional user groups on a local, regional or national basis. Scale efficiencies allow for the provision of a cost effective solution to many users who prefer this to owning and/or operating their own PMR system.

Usually, PAMR operators provide radio services to a large variety of closed user groups over a wide coverage area (regional or national). However, they do not necessarily provide all PMR services, e.g. PAMR operators rarely offer Direct Mode Operation (DMO).

Subscription fees to a PAMR network are often based on a fixed price for a given number of services.

Dedicated mobile data networks offer specific services for data only transmission. These networks can be categorised either as PMR or PAMR.

**PMR/PAMR features and services**

The features and services provided by PMR and PAMR networks are areas where professional users have specific needs. The features are linked to the definitions. An extensive list of detailed features is given in Annex 1.

**Public land mobile networks****Definition:**

Completely open for all subscribers

**Description:**

This report deals with PMR and PAMR rather than public land mobile networks, such as GSM and terrestrial UMTS, which are open to all and address the mass-market. The services in public land mobile networks are typically:

- one-to-one voice (mobile to mobile and fixed / mobile),
- short messaging
- data.

The communication is in duplex mode and only a limited number of PMR/PAMR specific features are available, e.g. there is no priority call, the systems are not designed for "fast call set-up", emergency call is limited to the official emergency number (112), etc. However, public mobile networks fulfil the requirements of a large number of professional users and as such compete with wide area coverage PAMR networks.

#### **4 FREQUENCY PLANNING PRINCIPLES AND CURRENT STATUS OF USAGE**

The basic principle of PMR/PAMR frequency management is to serve the maximum of existing demands in a limited spectrum. Accordingly, where individual users for small PMR systems require frequencies, it makes sense that such systems use narrow band channels to maximise the number of users that can be served. Conversely, for regional/national PAMR systems, it is more efficient spectrally to license a dedicated block of spectrum so that the operator has flexibility to plan its network and tailor the capacity in line with variable demand across its coverage area and, ideally, take advantage of digital systems and those with wider channel widths to serve larger numbers of users more efficiently.

Existing PMR/PAMR systems are almost exclusively narrow band systems, including both analogue systems like MPT 1327 and digital systems such as TETRA and TETRAPOL. In the narrow band scenario, Administrations traditionally have given spectrum out in (25, 12.5, 10, 6.25, 5 kHz) portions to individual users. This has been relatively easy to do since each system does not require large amounts of contiguous spectrum to be made available. PMR/PAMR networks cover a wide range of configurations: PMR 446, single frequency networks with few or many hundred terminals, analogue and digital radio trunked systems (mono or multi-site), etc.

The recent evolution from analogue to digital and from small PMR networks to larger PMR/PAMR networks is expected to continue with the introduction of wider band PMR/PAMR systems. However, such wider band systems obviously require larger contiguous blocks to be available, for example several MHz for deployment of a large PAMR system. This requires a different frequency management approach and may require spectrum to be reformed or reallocated so that systems can be regrouped in a way that would facilitate release of contiguous blocks for wide band systems.

In addition, a few broad band PMR systems do currently exist to provide local high-speed access services in frequencies above 2 GHz. These networks share frequency bands with other categories of users (military, SRD etc).

PMR/PAMR spectrum needs detailed frequency co-ordination at borders. This is handled by bi- and multilateral frequency co-ordination MoU and agreements such as the Berlin Agreement (Vienna Agreement) and Recommendation T/R 25-08, in which channelling, pairing and agreed propagation curves to be used in frequency co-ordination within the range 29.7-960 MHz are set out. However, these frequency management procedures, and T/R 25-08 in particular, now need to be reviewed and updated to extend the flexibility in order to allow for migration to wide band systems. In addition, new spectrum management procedures for PMR/PAMR need to be considered to ensure the availability of contiguous spectrum.

Annex 2 contains a list of the commonly used frequency bands for PMR/PAMR with comments on the structure and use of the bands. Annex 3 provides the recommended use of sub bands for PMR/PAMR in accordance with ERC Recommendation T/R 25-08. An overview of implementation of ERC Recommendation 25-08 and of the ERC Decisions (96)04, (98)25 and (01)21 is provided in Annex 4.

#### **5 MARKET AND TECHNOLOGY TRENDS**

This strategic paper has been developed based on the market information and description of the current and future use of PMR/PAMR as indicated in the ERO study on PMR Market and Spectrum Requirements released in December 1998. In the process of the development of the strategic paper within FM PT 38 contributions has been received on the latest market developments in the PMR/PAMR area.

## 5.1 General market indicators

Market indicators for the future digital land mobile systems (PMR/PAMR) are guided by the following headlines:

- Increasing user requirements over the next 10 years
- Increased data requirements, including for High Speed Data and application independent interface
- Increased mobility/user demand for national coverage/roaming
- Acceleration in migration from analogue to digital
- Migration from narrow band to wide band.

Annex 5 provides further details on the market indicators and market requirements, which could be used in evaluating the frequency requirements.

## 5.2 Technology trends for digital PMR/PAMR

While several, smaller PMR users may continue to operate existing analogue systems, there is a stated market requirement towards more sophisticated PMR services that require digital technologies. The migration within the market for larger PMR and PAMR systems in some cases follows a two step process, initially migrating from analogue to digital narrow band systems and then in a second step to wide band systems to provide the additional required high-speed data services.

With the evolution of technologies, the digital PMR/PAMR technologies follow the general evolution in the radio communication sector and may be described, in line with the definitions used in ITU-R and CEPT for Public Protection and Disaster Relief (PP&DR), as narrow band, wide band and broad band systems with the following technical and operational description:

### Narrow band digital systems

Digital narrow band systems provide digital voice and low speed data applications (e.g. pre-defined status messages, data transmission of forms and messages, access to databases).

- Possible new services and new applications essentially due to the shift from analogue to digital terminals;
- More efficient systems availability (data query, AVL, data transfer, fleet management, etc.);
- Easier purchase conditions are fostering growth in use of PMR/PAMR terminals through standardisation of equipment and services;
- Due to operational and financial constraints users are expected to share large common rather than multiple independent networks;
- Migration of conventional local networks to digital starting in 2003.

### Wide band digital systems

It is expected that the wide band technologies will carry data rates of several hundred kilobits per second (e.g. in the range of 384-500 kbit/s). Since it is expected that networks and future technologies may require higher data rates, a whole new class of applications including wireless transmission of large blocks of data, video and Internet protocol-based connections in mobile PMR/PAMR communications systems will be introduced.

In line with the development of digital land mobile PMR/PAMR the need for high-speed data and other additional services increases. Already now and especially in the PAMR sector there is an expressed requirement for services that cannot be delivered over traditional narrow band technology. Users are looking for a delivery of services that can match the services of current cellular PSTN operators. In the PMR world there has always been a requirement for a high availability of the network. The wider band PAMR systems deliver this high availability enabling flexibility to change from many users at one moment in time to a high volume of data the next.

Systems for wide band PMR/PAMR applications are under development in various standards organisations with channel bandwidths dependent on the use of spectrally efficient technologies. For example, ETSI Project TETRA is currently working on TETRA release 2, of which the first technology option TAPS, a GSM/GPRS/EDGE based technology is about to be standardised; a particular CDMA platform is also

being developed as a wide band PMR/PAMR system; and the underlying technology to be used for TEDS, the second TETRA release 2 technology option, is currently being discussed in ETSI Project TETRA.

Further studies on proposed wide band digital systems are required in terms of efficient use of frequencies, compatibility and frequency planning. Wide band Spectrum Decisions for PMR/PAMR under development within the WG FM focus on the 410-430 MHz, 450-470 MHz and 870-876/915-921 MHz bands.

### **Broad band systems**

Broad band applications enable an entirely new level of functionality with additional capacity to support higher speed data and higher resolution images.

Several standards organisations are beginning work on systems for broad band PP&DR applications. Broad band systems are expected to provide high-speed local access networks operating in frequencies above 2 GHz.

## **6 FUTURE SPECTRUM REQUIREMENTS**

The review of the existing spectrum usage for PMR/PAMR and the market developments for PMR/PAMR user requirements and technologies allows for the following trends to be identified concerning the future spectrum requirements for PMR/PAMR:

- Spectrum availability in the traditional PMR/PAMR frequency bands varies widely from country to country, but the most likely frequency bands for wide band PMR/PAMR systems are 410-430 MHz, 450-470 MHz and 870-876/915-921 MHz;
- The introduction of the digital PMR networks for public safety in the 380-385/390-395 MHz band may free up some spectrum from 410 – 470 MHz;
- The establishment of the GSM-R systems in the 876-880/921-925 MHz band should release further spectrum to the 400 MHz bands as Railway users migrate out;
- Use of spectrum for PMR/PAMR in the 870-876/915-921 MHz band could relieve the more congested 400 MHz bands;
- The introduction of digital systems for emergency services and the extension of digital PAMR networks and the migration to wide band systems may over time lead to a migration of some of the traditional PMR users operating their own networks onto such shared networks, possibly reducing the spectrum demand for PMR systems;
- Encouraging in-band migration of PAMR from analogue or narrow band digital systems to wide band systems within the assigned spectrum for an operator may reduce spectrum consumption per operator substantially;
- Traditional analogue PMR networks will continue to exist as it may not be economical for many small area networks to migrate to digital technologies, and in particular wide band digital systems;
- An ECC Decision (02)03 on frequencies for Narrow Band Digital PMR/PAMR has been adopted and will provide the basis for development of Narrow Band Digital PMR/PAMR systems;
- PAMR operators and some large shared and local (e.g. airports) PMR networks have already migrated from analogue to narrow band digital systems over the last years and taken up part of the spectrum allocations for narrow band digital systems;
- A fast and clear path to wide band digital systems is key to future-proof the PAMR sector enabling the operators to attract additional investment and providing incentives for the manufacturers to develop wide band PAMR systems;
- This plan does not seek to specify the precise spectrum requirement of a wide band system for PMR/PAMR due to lack of complete information (studies regarding spectrum efficiency and

compatibility are currently under development within CEPT/ECC). However, practical wide area PAMR systems as deployed require approximately 2 x 3 MHz in order to start commercial operation<sup>2</sup>. The required spectrum depends – *inter alia* – on the technology, the size of the network, the network configuration and the number of users (mobile stations).

## 7 STRATEGIES FOR THE EUROPEAN USE OF FREQUENCY SPECTRUM FOR PMR/PAMR APPLICATIONS

The use of frequency spectrum to support developments of PMR/PAMR services for analogue and digital networks within the bands 410-430 MHz, 450-470 MHz and 870-876/915-921 MHz in the period until 2013 should adhere to the following strategies:

### General strategies and statements

1. Frequency spectrum and dedicated bands are needed now and in the future to meet specific requirements for PMR/PAMR networks, services and features as described in this strategic paper;
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3. The number of on-site PMR systems is increasing, using either licensed or licence exempt equipment (e.g. PMR446);
4. In general, Administrations have to ensure an equitable access to all the users who need it and spectrum should be designated in accordance with market demands;
5. For some analogue users with limited networks slow migration to the initially more expensive but more feature-rich digital networks and operator driven /shared systems but it is becoming apparent that some users are looking for alternatives for their communication needs;
6. In order to meet a requirement for high speed data services within the PMR/PAMR applications a shift of focus is expected from narrow band digital to wide band digital networks. Maximising CEPT allocation commonality will assist in the development of economies of scale for equipment;
7. Trends towards larger networks with better coverage and increasing number of users are expected to continue. Organisations are tending to consolidate their user groups onto large common private networks or PAMR networks.

### PMR/PAMR spectrum management strategies

- a. The CEPT should agree on a common approach across Europe in meeting the future requirements for PMR/PAMR services and applications;
- b. Refarming initiatives should be agreed on a national, multilateral or European basis;
- c. Frequency spectrum should be provided for the developments of narrow band as well as for wide band networks;
- d. The migration should still preserve spectrum for small and large scale PMR systems.

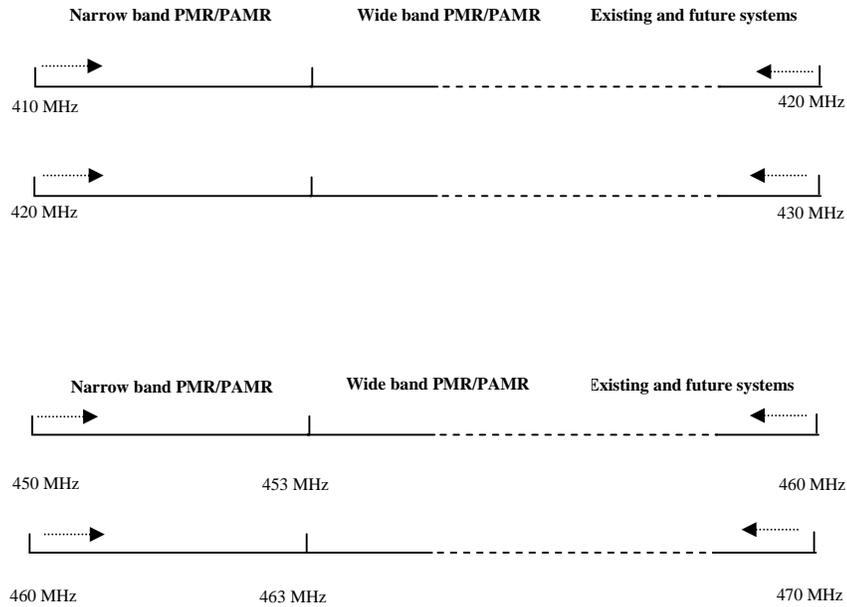
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<sup>2</sup> Information provided by industry indicates that a wide area PAMR system will require spectrum in the order of 2 x 3 MHz to 2 x 5 MHz. Using TAPS (GSM based) as a model; TAPS will require a reuse factor of 12 for a single carrier system. This will again require 12 x 0.2 MHz + 3 x 0.2 MHz (3 channels for infill coverage) = 3 MHz. Similarly in a city a two carrier TAPS system will require 2 x 12 x 0.2 MHz + 3 x 0.2 MHz (3 channels for infill coverage) = 5.4 MHz.

**Specific strategies for the duplex bands within 410-430 and 450-470 MHz**

CEPT Administrations should establish specific plans for refarming and reorganisation of the use of the UHF bands to achieve:

1. migration from narrow band to wide band PAMR networks in accordance with market demand. This migration needs to take into account technical problems in border coordination between 25 kHz narrow band channels and wide band channels of 200 kHz or more not solved in the CEPT Recommendation T/R 25-08 or multilateral frequency border agreements. Thus Recommendation T/R 25-08 should be revised to include various frequency co-ordination scenarios i.e. between different wide band and narrow band systems;
2. from a technical point of view minimum availability of contiguous spectrum for wide band PAMR networks in the order of 2 x 3 MHz in response to market demand;
3. gradual harmonisation of the use of the frequency bands 410-430 MHz and 450-470 MHz according to market demands and providing national flexibility. It is recognised, however, that not all the spectrum within the bands is currently available for civil use in some Administrations. The Administrations should include designation of PMR/PAMR spectrum in the national frequency plans in one or more of the above bands. This would be achieved in the following way:
  - For the 450-460/460-470 MHz, narrow band PMR/PAMR - analogue as well as digital - should be introduced from the lower end of the band and wide band PMR/PAMR introduced in frequency bands above 453/463 MHz. The upper end of the band should in future be used for existing and future PMR/PAMR systems and allow for new technologies to be introduced. The spectrum to be used for wide band systems on the one hand and new technologies on the other hand should be defined by market demands;
  - The same concept should be used in the 410-420/420-430 MHz band providing spectrum for the wide band systems around the middle of the bands;
4. preservation of spectrum for small networks;
5. simplex channels e.g. within the bands 406.1-410 MHz, 440-450 MHz and 862-870 MHz, PMR and non-PMR, are used and designated according to CEPT/ERC Recommendation T/R 25-08.



**Figure 1: Indicative future use of the bands 410-420 / 420-430 MHz and 450-460 / 460-470 MHz bands**

**Specific strategies for the duplex bands within 870-876/915-921 MHz**

The frequency bands 870-876/915-921 MHz should be designated for wide band PMR/PAMR technologies. The bands should be used from the top end in order to ease compatibility with services below 915 MHz.

It is recognised that the band is identified as a preferred band for Tactical Radio Relays (TRR) in particular for cross-border operations. Shared use of the band between civil and military applications should be considered on a national basis. Due to existing frequency plans countries may need flexibility or more time to achieve harmonisation as shown in figure 1.

**ANNEX 1****LIST OF PMR/PAMR FEATURES & SYSTEM CONSIDERATIONS**

The following is a list of features and system considerations that are relevant for PMR and/or PAMR. The first part lists PMR/PAMR services and service-related features that are required to meet the needs of professional users - these are largely common to both PMR and PAMR, with a few exceptions. The latter part lists system considerations related to the way in which PMR systems and PAMR networks are implemented.

**PMR/PAMR services and service-related features****Features those are common to PMR and PAMR:**

- Push-to-talk voice services
- One-to-many / group calls
- Instant and broadcast messaging
- Packet data
- Dispatch services
- Fast call set-up
- Automatic and priority call queuing when system busy
- Guaranteed access for emergency calls
- Dynamic group management
- Talking party identification
- Closed user groups
- Simultaneous voice and data
- Direct mode operation (DMO), typically PMR
- Talk-around / fall-back mode, typically PMR
- Ability to provide virtual private network (VPN) services to users
- Ability to directly interconnect with other public networks (e.g. PSTN, data networks, etc), typically PAMR

**System considerations****System considerations for PMR:**

- Spectrum efficiency primarily measured in terms of the number of users that can be supported in a given amount of spectrum/number of frequencies in a local area
- Possibility to share a frequency between a number of different small PMR systems with low occupancy
- Wide range of different quality of service requirements depending on users and operational conditions
- Flexibility to vary number of frequencies used in order to provide required grade of service, within frequency bandwidth allocated to the system
- Tailored networks and customised features, for example to allow hundreds of terminals to use a single narrow band frequency, or to provide system resilience for multiple level operations
- Ability to provide specific and tailored coverage in spectrum shared with other PMR systems
- Non-sensitive modulation allowing to share the co-channels and provide good adjacent channel compatibility
- Compliance with standards for (narrow band) frequency compatibility (e.g. EN 300-086, EN 300-113 and EN 300-392)
- Reliable use of frequencies in harsh RF environments (inter modulation, co-channel and adjacent channel interference)
- Different system lifetimes, introduction dates and system closures in the same band (few months to 10+ years)
- Command of the network
- Systems built according to the needs of specific organisations (typically for security and operational purposes).

**System considerations for PAMR:**

- Spectrum efficiency primarily measured in terms of the capacity that can be provided by a wide area network within a given amount of spectrum
- Ability to support different quality of service requirements for different users
- Resilience and availability requirements generally accommodated by the PAMR operator at a network level
- Networks generally designed to cover a wide geographic area as effectively as possible, rather than being customised for a specific user group
- Ability to give users suitable degree of control over their operational usage of the services and visibility of their billing information
- Subscriber management facilities, such as for billing and provisioning, that are capable of dealing effectively with large numbers of subscribers/users
- Ability to provide lawful call interception as required by national security authorities.

## **ANNEX 2**

### **LIST OF FREQUENCY BANDS FOR PMR/PAMR WITHIN THE FREQUENCY RANGE 40-921 MHz**

**(This list is not exhaustive and these bands are not all available in some CEPT countries).**

#### **40 MHz**

This band is still used for PMR in some countries but on a national basis. Further harmonisation of the use of the band is not envisaged.

#### **68-87.5 MHz**

This band was one of the first PMR bands. Important networks such as police, fire brigade, public utilities and taxi companies use the band extensively, especially for national coverage systems. The band has been attractive for national coverage networks due to the good propagation and resulting low cost of infrastructure.

Frequency usage is not harmonised across Europe. Different duplex separations and frequency bands are in use. In France, a national network for governmental use (RUBIS/TETRAPOL) has recently been digitised. Furthermore, analogue trunked systems, especially for utilities, exist in this band.

Given the heavy use of this band for traditional PMR networks and the large variety of frequency use it is unlikely that the usage of this band can be harmonised in Europe in the near future. However, in the longer term this band may be of interest for military use.

Typical issues with this band include:

- Not aligned in many countries with Recommendation T/R 25-08
- Adjacent to the FM broadcasting band (87.5-108 MHz)
- Heavy usage for PMR/PAMR.

#### **146-174 MHz**

This band has been designated to PMR/PAMR, mobile maritime service, emergency and military forces using analogue radio systems - conventional and trunked systems (MPT 1327/1343).

Administrations plan refarming initiatives in order to align the use with CEPT Recommendation T/R 25-08 by the end of 2008. The refarming initiatives are expected to ease implementation of new innovative digital technologies.

Typical issues with this band include:

- Heavy use for PMR/PAMR
- Radio Astronomy service
- Alignment with CEPT Recommendation T/R 25-08 (channelling and pairing).

#### **406.1-410 MHz**

This band has been designated to PMR/PAMR and is widely used by the military.

Typical issues with this band include:

- Radio Astronomy service
- Military use in some CEPT countries.

#### **410-420/420-430 MHz**

This band has been designated to PMR/PAMR for narrow band systems e.g. analogue trunked systems (MPT 1327/1343) and for digital systems (e.g. TETRA and TETRAPOL). The band is one of the preferred bands for digital land mobile systems in accordance with ERC Decision (96)04 and ECC Decision (02)03. In some countries the whole band is used by PMR/PAMR, in others only parts of the band are nationally designated to civil users. Usage/frequency availability in this band differs widely from country to country but many countries have made spectrum available for PAMR systems in this band.

Typical issues with this band:

- Compatibility with Radiolocation systems in 430-440 MHz band
- Used for narrow band PMR/PAMR systems
- Alignment with CEPT Recommendation T/R 25-08 (channelling and pairing)
- Military use in some countries.

#### **440-450 MHz**

In accordance with European Common Allocation (ECA) table and ERC Recommendation T/R 25-08 this band is designated for simplex PMR use. The band is used by or intended for single frequency radio systems (analogue or digital) and in some countries for trunked systems with 5 MHz duplex spacing. Administrations plan re-farming initiatives in order to align the use with ERC Recommendation T/R 25-08.

PMR 446 equipment is used within the band 446.0-446.1 MHz in accordance with ERC DEC (98)25 and DMO channels within the band 445.2-445.3 MHz are used in accordance with ERC DEC (01)21.

**Typical issues with this band:**

- Military use in some CEPT countries.
- Fast development of PMR 446 (one million terminals per year trend).

#### **450-460/460-470 MHz**

In general used for PMR applications in most European countries and for analogue trunked radio systems (MPT 1327/1343) and/or for digital narrow band systems in accordance with ERC Decision(96)04 and ECC Decision (02)03 (TETRA and TETRAPOL). Parts of the band have also been designated for analogue public land mobile networks (e.g. NMT 450) but most of those systems were closed down during 2001/2002 and the spectrum has been made available for PMR/PAMR services. Some countries have already designated spectrum for digital wide band PMR/PAMR systems.

There is still a need to reorganise the use of the band in some countries in order to align with the channel arrangements in ERC Recommendation T/R 25-08.

Typical issues with this band include:

- Compatibility with Radiolocation systems in 440-450 MHz
- Compatibility with the broadcasting service in the upper adjacent band
- Heavily used for PMR systems in some countries
- Alignment with CEPT Recommendation T/R 25-08 (channelling and pairing).

#### **870-876/915-921 MHz**

These bands should be designated for wide band PMR/PAMR technologies. The bands should be used from the top end in order to ease compatibility with services below 915 MHz.

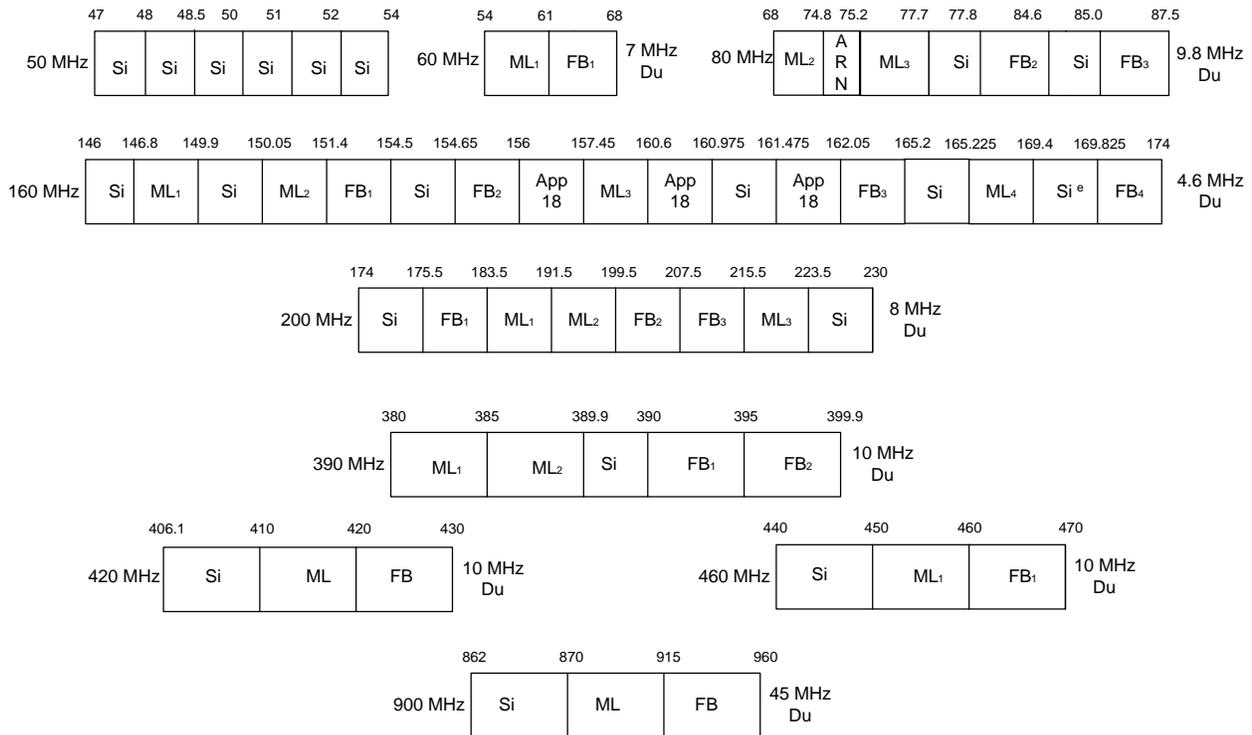
It is recognised that the band is identified as a preferred band for Tactical Radio Relays (TRR) in particular for cross-border operations. Shared use of the band between civil and military applications should be considered on a national basis.

Typical issues with this band include:

- Compatibility with GSM systems in adjacent bands
- Sharing with military systems (geographical and frequency sharing).

ANNEX 3

RECOMMENDED SPACING, USE AND LOCATION OF UPPER, LOWER  
AND SIMPLEX BANDS FOR PMR/PAMR (Source T/R 25-08, 1999)



Key to symbols:

ARN Aeronautical radionavigation (ILS/Marker beacons)

Du Duplex operation

FB Base station

ML Mobile station

Si Simplex operation

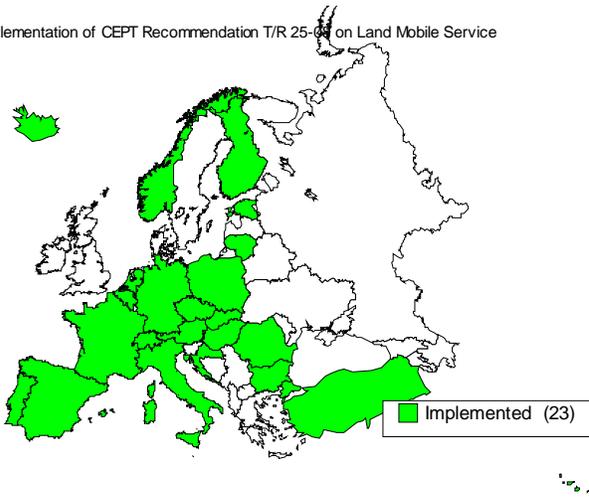
e ERMES in band 169.4125 - 169.8125 MHz

App 18 Use in accordance with RR Appendix S18 "Table of Transmitting Frequencies in the VHF Maritime Mobile Band"

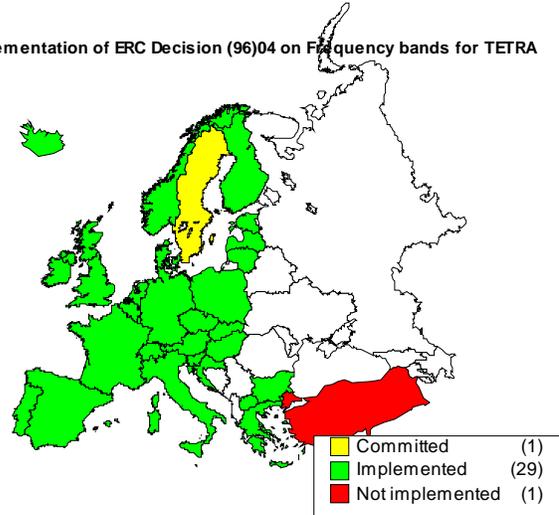
ANNEX 4

IMPLEMENTATION OF RELEVANT ERC RECOMMENDATIONS AND ERC DECISIONS - May 2003

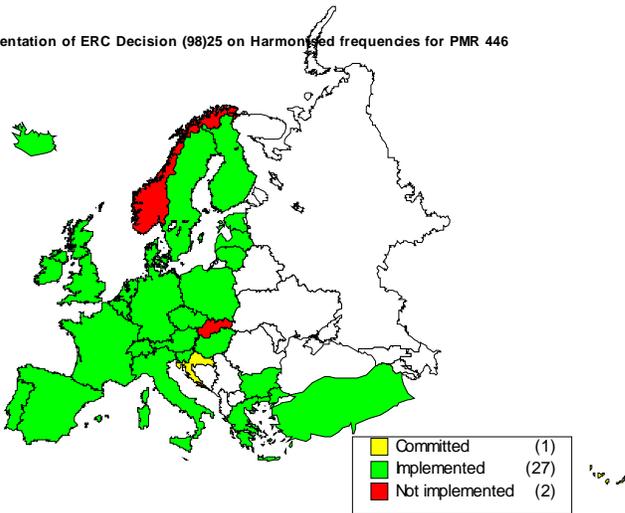
Implementation of CEPT Recommendation T/R 25-04 on Land Mobile Service



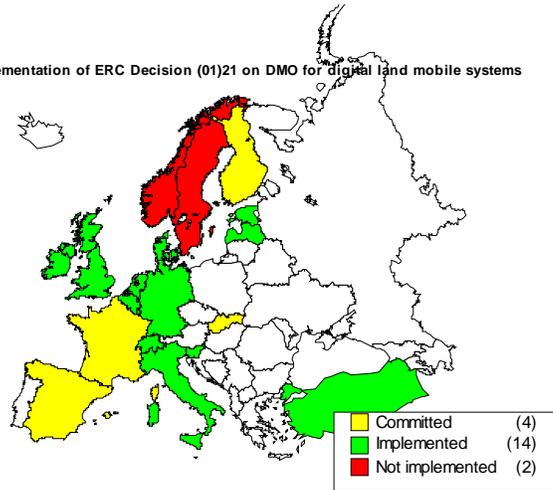
Implementation of ERC Decision (96)04 on Frequency bands for TETRA



Implementation of ERC Decision (98)25 on Harmonised frequencies for PMR 446



Implementation of ERC Decision (01)21 on DMO for digital land mobile systems



## ANNEX 5

## DETAILS ON GENERAL MARKET INDICATORS

**Introduction: PMR/PAMR user community**

PMR/PAMR solutions are primarily designed to meet the communications needs of the mobile workforce market and in particular those of blue and grey collar workers. Technological advances and changing operational needs have resulted in a shift in working practices within businesses in recent years, leading to the emergence of the mobile workforce. The size of the mobile workforce and its attendant communications needs are increasing strongly in Europe across almost all business sectors. Blue and grey collar workers form a substantial part of this large and growing mobile workforce.

**Market Indicators**

- **Substantial market potential exists for PMR/PAMR:** Telecommunications consultants Logical Strategy (February 2002) have estimated that approximately 50 million of Western Europe's 160 million workers can be classified as being "mobile workers", defined as those who are mobile for at least 20% of the time. Of these, in the region of 20 million are blue/grey collar mobile workers with specialised communications needs. One quarter of these 20 million potential PMR/PAMR users are currently using PMR/PAMR solutions, with the majority being served by ageing analogue PMR networks that no longer meet user requirements in terms of cost and functionality. Market research indicates that these analogue PMR users would consider migrating onto a suitable PAMR network offering integrated voice and data services.
- **Many PMR users continue to prefer their own systems but cost of ownership may be deterrent:** The IMS July 2001 survey indicates that 69% of sample surveyed would prefer to own the system, rather than to rent from an operator, due to 'the ability to maintain control of the system', although such preferences are often constrained when it comes to replacing existing systems at the end of their operational life by factors such as cost. This is supported by findings that PMR/PAMR users are now increasingly conscious that their operational and financial interests are best served by sharing large PAMR networks and abandoning their conventional PMR networks.
- **Improvement in voice quality and coverage is the no.1 issue:** Network coverage and reliability of infrastructure as well as ruggedness and price of handsets are the main areas where customers expect improvements when deciding upon a replacement for their existing PMR solution. 'Voice quality' is the most important factor when buying a future network or service, whereas price was the key determinant last time. Most respondents expect to transmit more data: from 20% of network traffic in 2000 to 39% in 2003 (47% for current Digital radio users) and accordingly would look for a solution able to meet this need.
- **Growing need for high speed data:** Market research by Logical demonstrates strong demand in the blue/grey collar sector for next generation PMR/PAMR services, in particular high speed data. The trend to increased use of data intensive applications on fixed line networks is being mirrored in the wireless world with blue/grey collar business interest in mobile data services growing strongly in the last few years. A range of efficiency-enhancing mobile applications is being demanded for blue/grey collar workforces, and many of these operate most efficiently over a wider bearer. Current PMR/PAMR users foresee an upsurge in data usage, and higher data speed is considered to be the most important advance in data functionality.
- **PMR/PAMR users have a wide range of requirements for data services:** The PMR/PAMR user specific requirements can be summarised as follows (ETSI Workshop Jan 2002):
  - Multiple applications need to be supported
  - Applications will be a combination of symmetrical, Uplink Asymmetric and Downlink Asymmetric in data transport demand
  - A minimum useable data rate of between 50-150 kbps required at cell edges with greater data rates being made available as signal levels increase
  - Terminals: single voice + data and high speed data (HSD) hand portable and mobile terminal is preferred. HSD only terminals will also be required
  - Some of the applications identified (high resolution real time video) could be supported using alternative solutions
  - Some applications can be supported on the existing SDS and packet data services
  - Voice priority over HSD required during busy periods.

- **Few users would relinquish the unique functionality provided by PMR/PAMR systems:** Even if most people are aware of alternative technologies (GSM-GPRS, GSM-R, cordless PBX), few users will consider replacing their radio system by one of them (preferred option: 3G cellular (32%), 2-way paging (31%)) in view of the unique and highly valued functionality provided by such radio systems.
- **Manufacturers expect robust demand for PMR/PAMR system equipment in EMEA\*:** IMS (July 2001) predicts a 20 % yearly € - 13% per year in 'Indirect business' and + 28% per year in 'Direct business'. West/Central Europe representing 70% of total EMEA market. Robust growth in the PMR/PAMR market is expected for the foreseeable future due to the potential for new services and applications realised by the shift from analogue to digital technology and from narrow band to wide band.
- **Shift from analogue to digital PMR/PAMR:** the **digital market** (IMS July 2001) is expected to grow from 45% of total (1999) to 87% of total in 2004. Analogue (radio & infrastructure) market is foreseen to decline 10.7% per year, However: -18% in West Europe and + 2 % in East Europe of compound average growth from 2000 to 2004. Overall, Digital migration has been slower than originally expected by the manufacturers. Public Safety & PAMR account for 68% of Digital radio units market. EMEA market showing nearly no growth in Units (+0.7% per year). However Units €market grows 14.5% per year due to Digital migration. EMEA Installed Base: By 2004 23 % of installed base will be Digital, less than previously expected (main barriers to be cost of system, lack of budget). It has been concluded that the slow pace of migration is due to the decision by many organisations not to upgrade their conventional networks but rather to migrate to a large digital trunked network.**Growth in the mobile workforce:** The size of the mobile workforce, with its specific communications needs, is increasing strongly across Europe in all business sectors. For instance, UK mobile workforce of 7.9m predicted to rise to 10.4m by 2010. Mobile communications will penetrate 95% of the mobile workforce by 2004 – many mobile workers carrying advanced mobile devices. (Logical analysis 2002).
- **Potential for growth in PMR/PAMR usage:** However license statistics show that use of PMR/PAMR has to-date reached less than 10% of the mobile workforce in the key European countries while in the USA more than 25% of the total mobile workforce is using two-way radio, either PAMR or PMR, indicating considerable growth potential for the European market. A recent EICTA Report on PMR/PAMR concluded that easier purchase conditions would foster growth in the use of PMR/PAMR terminals through standardisation of equipment and services and that considerable user productivity gains would be realised as a result of the availability of more efficient digital PMR/PAMR systems.
- **Increasing availability of cost-effective PMR/PAMR solutions:** the ongoing development of a pan-European PAMR network operator, combining large area coverage and cellular features with PMR services, is facilitating the availability of special application packages on a large regional scale. The network is also expected to provide the basis for European high-speed data availability for PMR/PAMR users. (EICTA Report)
- **Users are interested in standardised and compatible equipment:** it is a demand from PMR/PAMR customers to be able to reuse the same equipment from a region to another within a country or across borders.
- **A sustainable demand for national PAMR networks exists:** most PMR networks are local and regional in view of the prohibitive cost of deploying wide area systems. However, PMR/PAMR users often move from one area to another and could usefully take advantage of national coverage; these demands are especially pronounced for semi-public and government users. It is quite clear from recent market developments that national PAMR networks offering PMR features are highly valued by the core PMR/PAMR user community in view of their unique service proposition.

**Conclusion: future PMR/PAMR market**

A growing unmet demand for next generation PMR/PAMR services within the mobile workforce necessitates the consideration of alternative PMR/PAMR technology solutions. Neither existing nor currently planned mobile radio or cellular systems deliver all of the functionality required by blue/grey collar mobile workers. Analogue PMR and PAMR provide critical specialised services for the blue/grey collar sectors, such as dispatch operation, push-to-talk and priority calling, but are hindered by technical limitations and quality and coverage issues when used for wide area applications. Current generation digital PMR/PAMR solutions provide substantially improved service offerings, but do not satisfy all of the requirements of mobile workforces, in particular for high speed data. Accordingly, it is expected that further digital narrow band systems and new digital wide band systems will be required in the near future to meet these needs.

**ANNEX 6**

**THE CURRENT VERSION OF THE EUROPEAN COMMON ALLOCATION (ECA) TABLE**

See <http://www.ero.dk>