



Question 16/2: Preparation of Handbooks for developing countries

STUDY GROUP 2

SOURCE: THOMSON-CSF (FRANCE)

TITLE: PROFESSIONAL MOBILE RADIO (PMR)

1. Definition of Professional Mobile Radio (PMR)

Professional Mobile Radio or Private Mobile Radio as it used to be called, or sometimes Private Business Radio (PBR) is widely known by its acronym PMR.

A short definition of PMR can be a Two-way Mobile Radiocommunications Network carrying speech and/or data for Professionals. PMR systems are to meet the specific requirements of business or other organisations wishing to maintain direct contact with their staff in order to facilitate efficient and safe operation. Communication may be over a few hundred metres (on-site) or hundreds of kilometres (wide area). PMR systems are mainly privately owned and provide a service to a closed user group; access to PMR services are not open to the general public.

2. The Wider Background

The range of organisations using PMR is extremely wide, a hundred different categories could be listed. It includes such diverse operators as local government services, sports stadiums, oil refineries and supermarkets. The emergency services for police, fire and ambulance are large PMR users. It is worth noting that the coverage zones of PMR systems can vary from a small area within a company premises to a local zone or even a full national coverage.

PMR networks are invariably tailored to meet the individual communication requirements of each class of users so that the services offered to PMR users cover a wide range of applications.

Chapter 3 will present the major classes of PMR services.

It is important to distinguish between PMR and Public Cellular Mobile Radio Telephone systems such as GSM. A comparison of the offered features will be made in chapter 6 but we already stress the basic differences:

- The GSM digital cellular radio network in Europe is an extension into the mobile domain of the Public Switched Telephone Networks (PSTN). Any member of the public, willing to sign the necessary service contract and meet the obligations of that contract, has the right to access and use of the system. Such systems are therefore of necessity focused on the requirements of the

broad market rather than tailored to the specific requirement of individual organisations. They are viewed by their users as an extension of their normal telephone facility. They cannot exist without the PSTN. In contrast PMR networks operate without any automatic right to access by the public. They may allow the user organisation's mobile staff to have access to PSTN under the PMR network operator's strict control, if this is required by the nature of the business operation. This facility is called interconnect. PMR networks can operate without any connection to the PSTN and most do. A PMR network is not an extension of the PSTN.

- PMR and public cellular mobile radio telephone systems are complementary rather than competitive, as they meet the requirements of different sectors of the total mobile communications market. We could say they differ in a similar way as private and public exchanges differ: they offer the same basic service but PABX's provide on top the specific services adapted to each organisation.
- The methods of financing PMR networks and public cellular mobile systems are quite different. A PMR network operator can purchase his system outright and amortise the investment over many years. No call charges and monthly system rentals, which are normal with public systems, would be involved. Alternatively a PMR network known as a Shared Trunking PMR system can offer a tailored financial purchase matched to his business requirements. The financial package may again not incur any call charges.

PMI, therefore, not only offers a network with the operational features that the user requires to be optimised to the functions of his organisation but also a number of alternative financial packages. Confusion exists regarding a particular form of PMR, often described as Public Access Mobile Radio which in fact is a Shared Trunking System. Regrettably in the acronym PAMR the term Public is a misnomer as such systems are installed by a licensed operator who offers a mobile voice and/or data service to businesses and other organisations as an alternative to them owning and operating their own system. For the small user and some larger users, such PAMR systems offer financial and operational advantages. However, individual members of the public are not allowed to join such systems and neither is there any reason for them to wish to do so since access to a PAMR system is intended for closed user groups of organisation's working staffs and not to the general public. PAMR systems are therefore included within the definition of PMR.

3. Categories of PMR

Four major categories of PMR can be considered:

3.1. Dedicated PMR Networks

Dedicated PMR introduced over 40 years ago in its simplest form, comprises a single fixed base station (a combined transmitter and receiver) located at the organisations premises with an antenna erected on the premises roof as high as possible which communicates to a number of hand portable or vehicle installed mobile units. The coverage area increases with the transmitting power but not dramatically and tends to decrease at higher operating frequencies. It is also reduced in urban areas compared to open unwooded country. The coverage area for hand portable equipment is less than for vehicle installed mobiles. With a base station operating at say 5 Watts transmitter power; with an antenna height of 30 metres, a range of up to 10 km is achievable in an urban environment, which is more than adequate to cover a large airport, oil refinery or small town for example. Such system can be of interest to an organisation with only few mobile units.

For greater coverage the base station with its associated antenna may have to be located at a remote hill top site or multi-storey building. Under favorable circumstances, ranges up to 50km are feasible. The cost of linking the remote site to the organisation's operating premises via a leased telephone line or microwave link can be a significant cost factor. Usually organisations with tens of mobile units operating on this local area would adopt such systems.

For wide area coverage of a region or large cities, several base stations are required, all linked back to the organisation's operating premises. A city like Greater London needs five base stations for total coverage. Such systems are only economic for a larger user, operating say more than 100 mobile units or emergency services where the economic criteria are less important.

3.2. Dedicated Trunked PMR Networks

The term "Trunking" is used to describe the procedure whereby a user wishing to make a call can gain immediate access to whichever one of a number of radio frequency channels that is available at that time. The term has been borrowed from telephone practice introduced almost a century ago, when it was realised that a large number of telephone subscribers in two separate cities could be given a perfectly satisfactory service communicating between the cities via a small number of (trunked) telephone lines. This is possible because at any one time most of the subscribers do not want to make an inter-city call. Trunking of radio frequency channels can increase the traffic capacity of the channels by something like five times with the same quality of service in terms of waiting time for a channel. Systems with around one hundred mobile units per channel are frequently used.

A more recent development of PMR in the last ten years is the Dedicated Trunked Network which enables a PMR user to enjoy a wider range of operational features and makes better use of the frequency spectrum. Examples are Police or Utility companies networks.

Although built for their own usage, some of these networks may in fact be shared by different units who never communicate between themselves or only with the network owner. This is often the case for municipal networks.

In the future it is likely that external operators will often fund and operate such networks, which could be called shared dedicated trunked networks.

3.3. PAMR Networks

A further recent development of PMR in the last ten years is the PAMR Network. It is a network that permits a number of smaller PMR users to share the costs of a favourably sited base station or stations owned by an independent operator licensed to provide the services.

The financial terms under which the licensed trunking operator provides the services to the user can be tailored to the users requirements and may include all, part or none of the cost of the mobile equipment and possibly a monthly fee and/or a call charge. Such PAMR Networks are developing successfully in parallel with Dedicated PMR Networks, thus giving user organisations greater choice.

3.4. Short Range Radio PMR Networks

A very recent PMR development launched in European countries in 1995, is Short Range Business Radio (SRBR). CEPT has recognised the requirement for a harmonised European Frequency band (446.0 - 466.1 MHz) providing 8 x 12.5 kHz channels. These networks operate without a base station and comprise a number of mobile units, usually hand carried portables, intercommunicating over short distances of say 100 metres inside a building or up to 400 metres or more in open country. Short Range networks are ideal for a wide range of services such as hotel security systems, small airports, shopping centres, outdoor events, building sites,... etc. Unlike Dedicated and PAMR Networks that use base stations and so definite radio frequency allocation on an individual licence,

these Short Range networks can operate on the preassigned small number of single frequencies within a general licence. This linked with the high volume of demand provides a new low cost service to the smaller PMR user. The user purchases suitable equipments from a dealer, who also makes available the licensing application form for immediate completion and despatch to the national administration with the license fee, if any. The user can operate the equipment immediately.

3.5. PSTN interconnect

As for cellular systems, Dedicated and PAMR Networks may also give access to the Public Switched Telephone Network (PSTN); this is commonly described as "Interconnect". Presently this facility is not allowed in all European countries although it is certainly in high demand for at least a few users of these networks.

4. Economic impact

Over recent years, it has been shown that PMR makes a positive impact on the economy of a country which is brought about through:

- industry providing capital goods and services
- increased flexibility, responsiveness and productivity
- the creation of new business dependent on PMR communications
- economic benefits gained from risk avoidance and from services which improve the quality of life

Surprisingly, very few studies have been undertaken to investigate the principal areas of spectrum use in sufficient detail to provide an estimate of the contribution to the Gross National Product (GDP).

a) In the early 1990s the Hebrew University of Jerusalem and HOP Research conducted a study into the contribution of mobile wireless communications to the national economy of Israel (Hopp and Bar-el 1992). The study involved interviews with some 420 users of speech transmission PMR services. Due account was taken of the different ways in which the economic contribution is estimated in each area of economic activity.

The data collected indicated that the use of PMR communications increased a workers productivity from 17 % to 29 % with an overall average contribution to productivity of 22 %.

b) Similar results were obtained as a result of a study conducted in Ukraine (Ivanenko 1994). Here the emphasis was on the influence of PMR use on the efficiency of agricultural production. In this case, the detailed analysis lead to the conclusion that the use of mobile radio communication brought about:

- a reduction in the duration of sowing crops from 35 to 24 days, and of harvesting from 46 to 22 days
- the output of agriculture machinery increased by 18% on average, and for combined harvesters by 16%
- losses in agriculture production were reduced by 20 % to 30 %.

c) In 1995 an assessment of the input of the radio spectrum on the UK economy was undertaken on behalf of the Radiocommunications Agency (Smith-NERA 1995). A further study, (Smith-NERA 1997) covering the period 1995/6 was carried out in 1997 in order to update the earlier work which used data from the 1993/4 period. These studies included the following uses of spectrum: PMR, Public Mobile Telephony, fixed links, broadcasting, satellite services, aeronautical and

maritime communications, defence. The 1997 study shows that use of the radio spectrum contributes some 19 billion EURO per annum to the UK's GDP, which is equivalent to some 1.8 % of the total. The figures also indicate that the radio spectrum accounts for some 41 000 employments and contributes about 17,5 billion EURO in efficiency benefits, plus another 22 billion EURO in consumer surplus. Comparisons between the 1993/4 and the figures for 1995/6 show that in real terms the impact of the spectrum on the UK GDP increased by 11 % per annum. This compares to an overall growth in the UK's GDP of 3 % per annum. Over the two year period employment in the radio sector increased by 17 % which is equivalent to the creation of 1,000 jobs per week.

Another source for estimating the increases to workers productivity through the use of PMR, is a study of eight companies in the United Kingdom conducted by the University of Michigan Business School (University of Michigan 1997). The study estimates that PMR increases employee productivity in the order of 10 % to 20 % in the manufacturing, construction and security industries.

- d) Recently, RCF Economic and Financial Consulting Inc. completed a study into the contribution made by PMR to a country's GDP (RFC 1997). A new approach has been taken to develop an economic model to explain the market penetration of PMR as a function of a country's GDP and an index of national regulatory stringency.

RCF has calculated the contribution to GDP made in twenty developing countries where the PMR penetration is significant. Across the developing countries considered, RCF finds that the installed base of PMR, on average, contributes 0.2 % to the level of GDP. It is shown that by assuming the adoption of a more liberal regulatory climate, similar to that in Germany, the cross country average contribution to GDP rises to 0.29 %. Percentage gains of this magnitude represent an important contribution to a country's GDP since annual real growth in many of these developing countries is less than 2 %.

5. Europe market situation

Fost & Sullivan has issued a report (No 3346) in June 1997. This European PMR market study suggests a slowly decreasing total turnover until the year 2000 and an accelerated declining of the PMR market beyond 2000. This is mainly caused by the fact that TETRA will not raise the total turnover due to the expected relatively high equipment prices. Another reason for the prognosticated accelerated market decrease beyond 2000 might be the ongoing terminal price reductions at least partly caused by the major trend of the changeover from car mounted equipment to portable and handheld PMR radio sets. All this has to be regarded in the light of the current PMR market situation. In the end of 1996 in Europe there were 5.6 millions PMR users, including PAMR users for 22.2 % of the total turnover.

Another approach may be to compare with the situation of the US giving of the possible market development we could experience if the proper conditions are set.

	EUROPE		USA	
	Users(M)	Penetration(%)	Users(M)	Penetration(%)
PMR	6	1.7	26?	10.2?
Cellular	53	14.8	54	20.5
Paging	8	2.2	35?	13.3?
TOTAL	67	19.1	115?	43?

Mobile Communications Market Penetrations for 1997

(? Estimation)

(Source NC 1997)

The European PMR penetration figures presented in the table are based on the average for the western European countries. It should be noted that the national penetration levels are significantly lower in many of the CEPT countries. In most cases the lower level of PMR penetration can be linked with one or more of the following: insufficient spectrum allocated, restrictive regulations, complex licence procedures, long licence processing times and high licence fees.

There is recent evidence that Europe is gradually closing the gap with the United States in the Cellular and Paging sectors. Paging growth in Western Europe was 35% in 1996 compared with 22% in the USA, but the overall impact is small at this stage. The difference in PMR market penetrations has remained about the same over the last five years. It is clear that Europe has taken significant steps towards the development of the cellular mobile communication sector but at the same time is neglecting the complementary development of the PMR and public paging markets.

The more critical issues, which present impediments to the growth of the market can be broadly divided into three groups:

- **regulatory impediments** including differing national regulations, the lack of harmonised and adequate spectrum allocations to meet market needs, different licensing procedures and processes, the length of time taken to issue a licence, and high licence fees.
- **limits for wider market opportunities** which exist in the USA due to the trans-territorial access to certain PMR business segments which benefit through the increased volumes associated with the greater market scale. Those trans-territorial markets would include emergency services and harmonised spectrum, shared trunked networks (PAMR, DSMR), European-wide PMR systems, short range business radio and the family radio service.
- **spectrum limitations:** the spectrum allocations of some European countries and the United States are compared in the following table.

	France	Germany	Italy	UK	USA
Commercial systems	38.2	53.7	28.5	78.8 (1)	67.05 (2)(4)
Emergency services	13.3	9.9	6.3	17	23.25 (4)
TOTAL	51.5	63.6	34.8	95.8	90.3(3)(4)

Comparison of PMR Spectrum of some key European countries with USA

Notes : (1) Includes PMR, PAMR, Common Base Station (CBS) and National Date operator systems.

(2) Includes 2MHz for paging, 3MHz for advanced paging and 20.75MHz for SMR (Equivalent to PAMR)

(3) This can be extended by +6, 12 or 18MHz for PMR services by regional sharing with the TV Broadcast band in the range 410-512MHz, the amount varies by city in the top 11 urban areas.

(4) In the TV Broadcast band 746-806 MHz an additional 24 %Hz is to be made available for public safety services and 36 MHz for commercial use according to congressional legislation dated August 1997

The FCC will start licensing public safety in this band from september 1998. For commercial use the FCC is required to begin licensing after january 2001.

These moves will increase the total PMR allocation from 90.3 MHz to 150.3 MHz in the long term. In the top urban areas (see note 3 above) this may be extended to 156.3, 162.3 or 168.3 MHz.

From the standpoint of spectrum, the lack of European harmonised spectrum and the low allocation for PMR in many countries makes it extremely difficult to take those wider market opportunities which have played a major part in the successful development of the PMR market in the United States. In European countries the amount of spectrum allocated for PMR varies considerably from country to country due to national polity.

6. Evolution of PMR systems

The PMR market is characterised by a wide diversity of situations. PMR appears as a specific domain of radio communications owing to public cellular domain in a similar manner as PABX's are related to public telephone networks: indeed, PMR communications are intended to professionnals within organisations as PABX's and are basic and powerful tools to increase their productivity. On top, their benefits extend indirectly to all their customers and users and so are motors of the whole economy.

To that end, PMR systems are efficiently organised to meet the various needs of professionnals on the move, often working in teams and to control the operation, the coverage and the management of their networks. They offer a wide range of services adapted to each situation which are not usually available in public cellular networks, such as different types of group calls, priorities, preemption, direct mobile to mobile calls...

Such specific features are used for a large variety of PMR networks which can be differentiated by their organisational modes and licencing conditions.

The comparison of PMR features and functions with those of public mobile radio telephone systems cannot only be done based on the evaluation of a few obvious differencies. In the contrary a variety of different points have to be compared which will be done with the help of some more or less complete and **comprehensive tables**. This is necessary because the recent interest for public mobile telephones, cordless telephones and wireless PABX systems seems to project a shadow on PMR systems. However, those considerations are not always based on the comparison of hard facts, total

cost evaluation and operational requirements but very often only on general tendencies and undefined individual feelings.

Comparing different systems with respect to their technical features shows their strengths according to the design for their most important applications. In consequence their main weaknesses become only apparent when their application is in contrast to their original purpose.

It is very difficult to compare economical properties when market sizes, production figures and product life time cycles are very different.

Another difficulty comes from the different financing methods used. Hence economical and cost comparisons are very difficult to ascertain and the results have to be interpreted very carefully.

The **availability** of the systems in question is another important fact whenever a system decision has to be made by a user. Analogue PMR has a considerable market base and ETSI has developed a digital standard, TETRA, with full advanced functions. In parallel TETRAPOL is candidate to be converted into an ETSI deliverable pending the completion of a "Publicly Available Specification" procedure. Other digital technologies are proposed for an ITU recommendation (e.g. ASTRO, IDEN, APCO, EDACS, FHMA...). And now equipment according to the ETSI standard TETRA are available.
