# THE CURRENT STATE OF MOBILE COMMUNICATIONS IN EUROPE

*Tom Black*
*Smith System Engineering Limited,*
*Guildford, UK.*

## Abstract

*The last decade has seen unprecedented developments in land mobile communications in Europe. The introduction of analogue cellular networks in the early 1980's started a revolution in technologies and services which, even today, continues to gather pace. As mobile communications looks set to become a mass market, the range of options available to customers has never been greater. This paper briefly reviews each of the main systems which are, or are soon to be, available and discusses the key issues which will determine their success.*

**Keywords:**
mobile communications, communications networks

## 1. GSM

The take-up of analogue cellular telephones in most countries where they were introduced surprised even the most optimistic forecasters. Even in those areas where low penetration was achieved, the reasons for this are now understood and lessons have been learned. Capitalising on this success, a second generation of cellular telephones is now being introduced which are based on digital voice encoding.

GSM is undoubtedly set to become the leading second generation cellular standard in Europe if not the world. Although it has taken some time to finally arrive (the original GSM group was formed in 1982), GSM implementation is now well underway and there are approximately 400,000 subscribers in Europe. Most European states are expected to introduce GSM systems in the next few years (9 networks are already live) and market projections suggest that by 1997, more Europeans will use GSM than analogue cellular with an expected user population of 20 million predicted by the year 2000.

Improved service quality and enhanced features such as encryption and inter-network roaming are usually cited as the main attractions of GSM over its analogue predecessors. However, the main driver to rapid adoption is

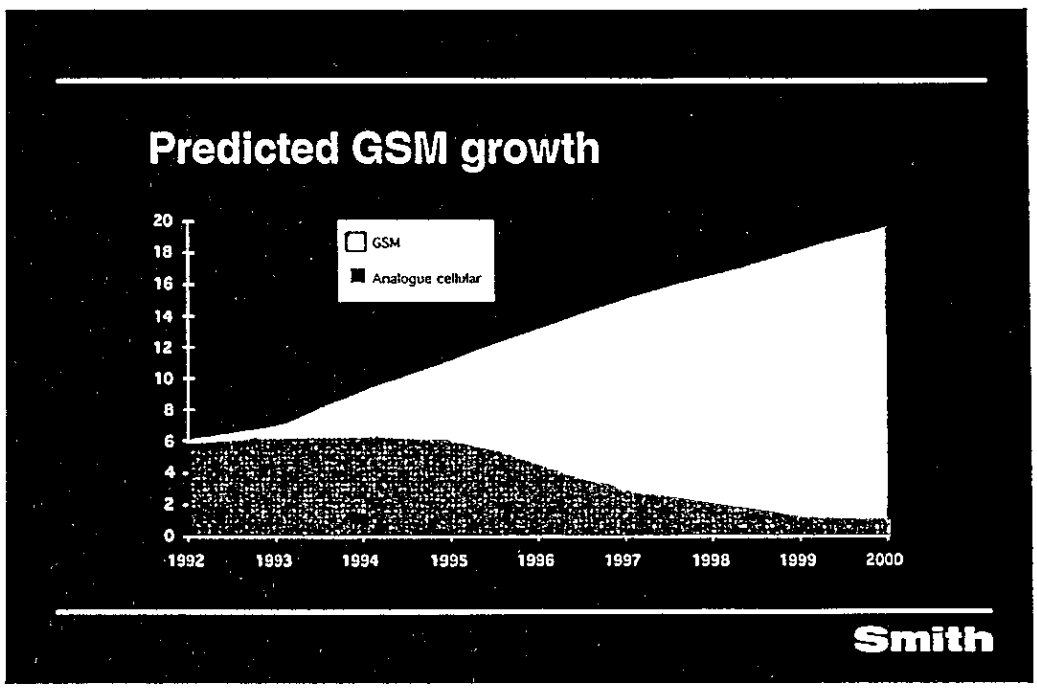


Figure 1
Significant growth is expected in the use of GSM over the next decade.

likely to be the expected lower costs of ownership to users which will result from the economies of scale of a single, large European market.

Although such economies are not yet being fully realised, GSM can already compete in those countries which previously experienced high cellular prices often due to their maintaining a monopoly on mobile services or to their employing purely national technical solutions. As the obvious example of rapid GSM adoption, Germany, with a relatively low analogue penetration on its C-Netz system, is leading other nations such as the Scandinavian countries and the UK where the large populations of analogue users will take some time to change over.

As the list of nations planning to introduce GSM in the near future continues to grow rapidly it is possible to see this European initiative living up to its "global" tag (GSM is now taken to mean Global System for Mobile communications rather than its original derivation from the Groupe Sp_cial Mobile). Hungary, Russia and the Baltic states are leading the way in Eastern Europe whilst Australia, India, Hong Kong and others promise to make South-East Asia an important secondary market after Europe. Notable exceptions are the USA and Japan where alternative standards are being pursued for digital mobile telephony. Although the leading contenders in these cases are also TDMA-based, the standards are not compatible with GSM and internetwork roaming will therefore be impossible.

One issue which still appears to threaten the adoption of GSM by countries outside Europe concerns the system's encryption capability. The A5 encryption algorithm will not be made available to all countries and a modified algorithm A5X (now A5/2) will be offered to some with yet others being forced to operate unencrypted. Although concerns remain about whether this will prevent roaming between these different classes of network, the solution which now appears likely to be adopted, whereby the handset modifies the algorithm it employs to suit the network on which it is operating, should ensure that full roaming remains possible. Despite this, there is still considerable concern within the industry that the confusion which has surrounded the encryption issue will inhibit GSM's adoption in some areas.

The other major problem surrounding GSM concerns the upgrade from the interim Phase 1 standard to the more complete Phase 2 which is expected to complete standardization by the end of 1993. The second phase is expected to offer users many additional features such as the transmission of data which will improve on those offered by the best of the current analogue networks. Also, the capacity of networks is to be doubled by the introduction of the half-rate codec, which will increase the number of traffic channels on each 200kHz RF carrier from 8 to 16. Despite the obvious advantages of these improvements, there is concern that Phase 1 users will not have access to them and that networks will have to support Phase 1 terminals for many years to come.

Despite these difficulties, there is no doubt that, with mobile telephony now an established part of everyday life throughout Europe, GSM will be successful and will play an important role in the establishment of a seamless Europe.

## 2. Personal Communications Networks

Inspired by the success of cellular, the UK DTI proposed the concept of Personal Communication Networks (PCNs) in the late 1980s. Since then the concept has been standardized by ETSI as the DCS1800 standard which, interestingly, is based upon GSM technology. When first proposed, PCNs were seen as a means of making mobile communications available to a mass market with macrocellular systems such as GSM remaining primarily a tool of business.

PCNs will operate at double the frequency (1800MHz) of GSM, and can therefore utilise smaller cells which may be as small as 20m across in urban environments. This, combined with the fact that more spectrum is available at the higher frequencies, means that the capacity of PCN networks is potentially much greater than that of the GSM networks.

Originally, PCNs were expected to exploit this high capacity, small cell environment by using cheaper, smaller handsets to appeal to the mass market of office-based or slow-moving users. However, with GSM handset costs lower than predicted and the low power class 5 unit competing with analogue handsets for size and weight, some GSM operators have announced plans to build "microcellular" extensions to their networks and so compete directly with PCN operators. The original distinction between the two systems has therefore almost completely disappeared, due in part to the decision to utilise GSM technology as the basis for PCN.

This has led to a major question mark over the viability of PCN outside major towns and cities given that most of its costs are similar to those of GSM networks, except for its infrastructure costs which could be between 2 and 4 times higher. It therefore seems likely that the GSM operators who face competition from PCN networks will compete vigorously on price during the early stages in an

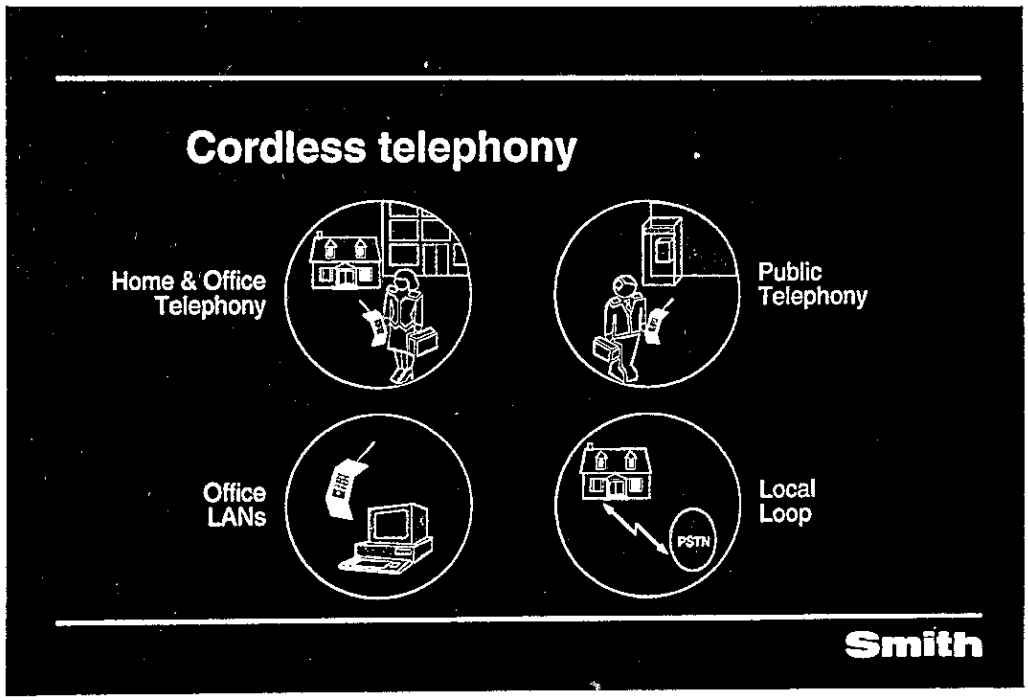


Figure 2
Cordless technology is expected to be employed in a broad range of application areas.

attempt to kill-off PCNs before their longer-term capacity advantages can tip the balance in their favour.

PCN is not being so widely pursued as its rival with only a handful of countries (all in northern Europe) expected to introduce services in the near future. The first of these will be Mercury PCN in the UK which is scheduled to launch in Summer 1993, closely followed by the E-plus network in Germany.

Even with this limited base, it is interesting to observe the marketing differences which look likely to arise. In the UK, Mercury is certainly focussing on the mass market for which PCN was always intended and its charges are set below those of the other cellular operators to reflect this. This has caused the other operators to introduce new tariff structures to compete with the new service. In Germany however, in an attempt to avoid a price war, E-plus is expected to charge broadly similar rates to the two GSM operators whose networks are already in service, and will therefore appear very similar to the average user.

It is not obvious which of these approaches will prove to be more successful but experience suggests that where three or more operators compete to provide similar mobile services, it is rare that more than two survive. The stakes are therefore high and in countries where three or more operators are planned, the distinction between those offering PCN and GSM may prove to be a secondary consideration with marketing approach, time of entry to the market and price competitiveness proving to be the dominating influences.

# 3. Cordless Telephony

Complementing the two cellular approaches above, there are also two digital cordless telephony standards, CT2 and DECT. Unlike cellular systems these are targeted more at providing limited mobility from a fixed base station either on a private site such as an office or home or in a public location where the base station is provided by a licenced network operator. This public option is generally referred to as "Telepoint".

Telepoint services based on the CT2 standard were first introduced in the UK and then in Germany. Although initially seen as competing at the low end of the cellular market, the fact that the system could not receive incoming calls, meant that it ended up unsuccessfully competing more with public payphones rather than cellular. The result has been extremely dissapointing and there is doubt over the long-term viability of these services. It remains to be seen whether the same outcome is experienced in France where the service has just been launched although early indications are that it is proving more popular than in the UK or Germany.

The precise reasons for the failure in the UK and Germany are complex. Some commentators have argued that the limited mobility and functionality of the service were its major problems whilst others blame the premature launching of the Telepoint option before domestic and office products were readily available.

Efforts to revive CT2 as a viable standard now focus around the merging of the domestic, business and public markets. The idea behind this concept is that a single handset can be used as a cordless home telephone (where it can support two-way communications since no roaming is involved), operate on the office exchange and also on the public networks. However, this is increasingly being seen as a forlorn hope and the most likely outcome is that CT2-based products will be limited to local private environments with public mobile telephony remaining dominated by cellular.

Despite this setback, the potential market for cordless telephony within domestic and business premises where it will replace conventional wire-connected telephone extensions is likely to be substantial. The DECT standard, which was finalised by ETSI in 1992, is expected to become the dominant standard in this area due largely to the strong support of several leading manufacturers.

Besides meeting the demand for cordless voice communications in the home and office, DECT is capable of supporting low data rate transmission for cordless LANs for office computer networks which could greatly increase its appeal. Furthermore, the recent announcement by the European Commission that it is to trial DECT as a candidate for local loop services (ie directly accessing the public fixed networks without the need for a cable connection into your home or office) suggests that its application may go far beyond the original plans.

# 4. Private Mobile Radio

As the longest established means of mobile communications, accounting for at least as many users worldwide as public networks, it is perhaps surprising that Private Mobile Radio (PMR) is not more widely discussed. PMR has traditionally been characterised by the fact that users of such systems own their infrastructure of base station equipment - hence Private Mobile Radio. More recently, systems based on PMR technology have started to be offered by public operators and this is discussed in the next section.

Figure 3
PMR continues to be used extensively despite the emergence of many more sophisticated options.

The technology of PMR has long been simple and hence inexpensive and has operated at low frequencies (typically VHF and low UHF) where longer ranges could be achieved from a single site. This meant that a typical small installation consisting of a single base station and, say, 10 mobiles could be procured for as little as £5,000 at today's prices and could meet the coverage requirements of many small businesses. Larger installations aimed at vehicle fleet management, though remaining based on analogue voice technology, have in recent years become software-based and have exploited trunking techniques (ie allocating channels on demand from the available pool). Although increasing the costs of the service, this was accepted by larger users who placed greater functionality and spectrum demands on their systems.

More recently, as the competing services such as cellular have become increasingly sophisticated, PMR has followed and digital options are now becoming available. These are capable of providing yet greater sophistication in terms of voice quality and functionality such as encryption. They are also expected to provide spectrum efficiency gains which is a major preoccupation in the PMR field.

Although PMR has exploited proprietary technologies so far, this has not caused major problems since air interfaces have been simple enough for interworking to be achieved between equipments from different manufacturers. With the advent of more sophisticated systems, this is changing and standardisation is now the major issue. The UK MPT 1327 standard for analogue systems was the first serious European attempt at this and has now been adopted by other countries.

However, ETSI is now the dominant standardisation body in Europe, and its digital Trans-European Trunked Radio (TETRA) initiative is the main focus of attention. Although still a long way from completion, the TETRA standard appears to offer the main hope of a seamless and large-scale European PMR market. One concern often voiced about TETRA is that, in its attempts to offer ever increasing levels of sophistication, it risks pricing itself out of the traditional PMR market. This is already leading to "cut down" versions being suggested by some companies and one German manufacturer has recently raised the prospect of a single channel version of TETRA for small users (TETRA is based on four TDMA channels in a 25kHz bandwidth).

In the absence of a mature standard, proprietary PMR solutions are still being pushed by many manufacturers. The more recent of these employ digital modulation techniques and some, like TETRA, provide improved spectrum efficiency over current generation analogue options. Others, such as the 5kHz single sideband technology which is soon to be introduced in the UK, continue to use analogue modulation. It remains to be seen how these proprietary solutions fare and in particular whether pan-European standards are now a prerequisite for success.

One final standard which could play a role in shaping future PMR is that of Digital Short Range Radio (DSRR). A recent decision by CEPT means that most European states are likely to allocate 4MHz of spectrum around 900MHz to DSRR which will pave the way for its introduction. Its attraction lies in the fact that no fixed infrastructure is required (although options which exploit fixed base stations will also be available) and licencing restrictions will be minimal. The inherent "intelligence" of the system means that calls can be managed by the two individual handsets involved and users will therefore be able to buy handsets from retail outlets and use them immediately without having to register on networks. The proponents of the system argue that this simplicity will ensure a sizeable share of the local area PMR market (eg for security guards on a local site) but this remains to be seen and interest from manufacturers has so far been extremely limited.

# 5. Fleet voice and data services

As indicated above, there are now systems available in some countries which, although based on PMR technology, are offered by public network operators. Often referred to as Public Access Mobile Radio (PAMR), these are a compromise between the lower costs of PMR and the benefits of managed public networks (eg wide-area roaming is possible and the responsibilty for infrastructure maintenance lies with the network operator).

Pioneered in the USA, the first European networks started operation in the UK in 1987 and were based upon the MPT 1327 standard identified above. Since then Germany, France and Portugal have also licensed operators and other European countries are thought to have such networks under consideration. In some cases operators have offered a service which allows users to roam nationally, and others have restricted their services to local regions and have charged lower prices.

The expected rapid adoption of PAMR by the PMR community has not yet materialised and in the 6 years since the UK networks were launched only around 40,000 users have been signed up. Given that the national services compete directly with the cellular networks and that most PMR users (at which PAMR is aimed) only require coverage over a limited area, it is perhaps not surprising to learn that the regional operators have proved the more successful so far.

Opinion is divided on whether PAMR has a real future over the next decade during which cellular prices are expected to continue to fall. Some optimistic market analyses indicate that future growth will outperform that seen to date with around 600,000 users predicted in the UK, France and Germany by 1996. However, ambitious growth for PAMR was predicted before and such forecasts are now treated with extreme caution in the industry. One thing is, however, generally accepted and that is that appreciable growth will only occur if a pan-European market can be established for equipment and, again, hopes in this area are pinned on TETRA.

Although the current PAMR networks can offer a limited data transmission service in addition to voice communications, more comprehensive data facilities are available from the dedicated mobile data networks which now operate in many countries in Northern Europe and Scandinavia. Sweden was first to introduce such a service in Europe in 1986 and the Ericsson Mobitex technology upon which that network was based has come to dominate the European mobile data market.

As with PAMR, the take-up of dedicated mobile data services has proved dissappointing to many who were expecting rapid growth. As data-only services are aimed primarily at dispatching operations such as haulage companies and emergency services, it must concern the operators that these sectors have not yet embraced the technology on a large scale. Nevertheless, new networks continue to be licenced and hopes are still high in the industry.

# 6. Satellite systems

No contemporary discussion of mobile communications can ignore the potential role of satellite systems. With their unrivalled coverage capabilities they are often regarded as the obvious choice for the provision of mobile services in areas where terrestrial infrastructures are sparse or non-existent. However, they have had limited success to date in Europe in competing for the land-mobile market (as opposed to the maritime or aeronautical market).

The two currently available systems are data-only offerings, namely Inmarsat C and Euteltracs. Providing low data rate services across all of Europe and beyond, it is perhaps surprising that they have not met with greater success. However, the high costs of terminal equipment and the relatively dense and well-developed terrestrial

Figure 4
LEO satellite systems are expected to offer voice services to mobile users by the end of the decade.

infrastructures with which they compete in much of Europe are probably the primary reasons for this.

Both of these systems are based on geostationary satellites which suffer from the disadvantage that their orbits are high over the equator. This means that screening by buildings can cause problems in cities in northern latitudes and, perhaps more significantly, the high powers required effectively prevent voice transmissions to and from small terminals.

To get around these difficulties, systems based on constellations of Low Earth Orbit (LEO) satellites are now being planned. The decision at WARC 92 to allocate LEO spectrum at 1.6GHz and 2.5GHz paved the way for their introduction and so far, 9 such LEO systems have been proposed, mostly by American consortia. The most prominent of these are the Motorola-led Iridium system and Inmarsat's Project 21. Both of these are so-called "big LEOs" offering real-time voice services and additional features such as localisation. Little LEOs, offering store-and-forward data messaging together with localisation have also been proposed.

As the services provided by these systems would be global, they will break new ground when launched. However, the big LEOs are not expected to be operational until 1998 at the earliest and the high price tags (over $3 billion for the space segment alone in the case of Iridium) make this date appear optimistic to many observers. Equally, much uncertainty exists about the viability and nature of these systems and concern has been voiced in Europe about US dominance of the industry.

Although they are expected to play a vital role in providing communications services to low population areas and developing countries, the impact of LEOs in Europe is expected to be less significant for the reasons outlined above. Nevertheless, their complementing of terrestrial options may prove important in a number of niche application areas.

# 7. The longer-term future

Most of the systems discussed in this paper are already in use or are expected to enter service within the next few years. Beyond this, future mobile communications needs in Europe are likely to be met by the Universal Mobile Telecommunications System (UMTS) which is expected to enter service early in the next century. This third generation system will encompass the diverse range of services offered by the second generation systems discussed above. As this is expected to be achieved on a global scale, the UMTS concept (which is being driven by ETSI) is effectively the same as the Future Public Land Mobile Telecommunications System (FPLMTS) being sponsored by the ITU.

The overall objective of UMTS is to provide a seamless mobile capability to subscribers by integrating the systems which are used in different areas and for different applications. In particular, it will integrate terrestrial and satellite-based solutions in a manner which is transparent to the user. In this way users will be able to roam widely and to employ a range of transport modes whilst still utilising the same equipment.

Besides the advantages which result from the transparency of UMTS, it is also intended that the services it offers to users will be superior to its second generation predecessors. One obvious example of this is the increased channel capacity which is expected to be in excess of 2Mbit/s and capable of supporting video-based applications.

Although the achievement of this seamless communications environment poses significant technology challenges for UMTS, it is worth noting that these are unlikely to be its major problems. Rather, it is becoming clear that the main hurdles which UMTS faces are more regulatory and commercial in nature. The success or otherwise of this global initiative will depend totally on whether the diverse interests of the different nations and major companies involved can be alligned sufficiently to ensure cooperation on such issues as IPRs and international network licensing.

Nevertheless, despite the immaturity of UMTS, it is clear that the concepts currently under discussion will revolutionize mobile communications to an even greater degree than the first cellular systems. To all involved in the industry, and more importantly, to the user of mobile communications, that has to be a most exciting prospect.

## About author, ...

Not available in time of publication.