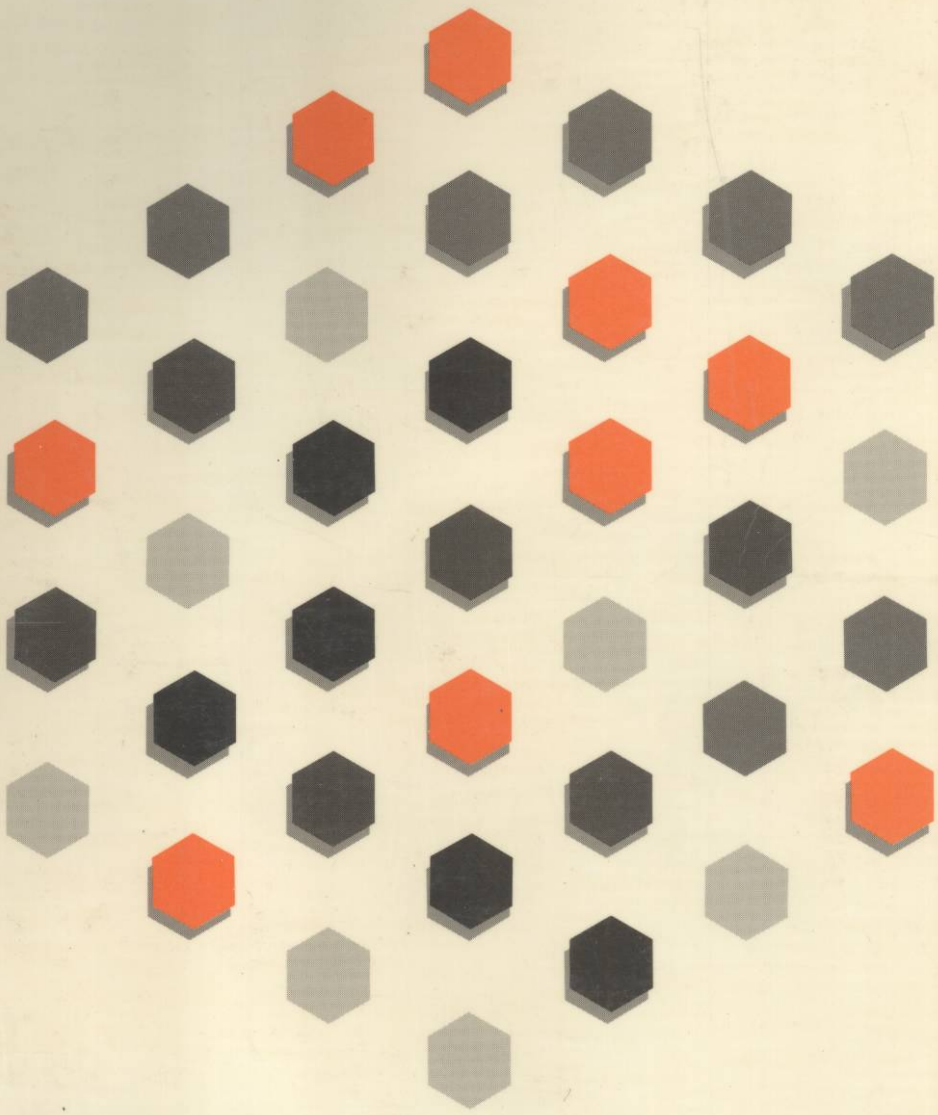
CELLULAR & MOBILE COMMUNICATIONS 88



Proceedings of the conference held in London, November 1988

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Phone: 01-868 4466 Telex: 923498 ONLINE G Fax: 018689933

Introduction

Against the background of rapid market development, the distribution and marketing of mobile communications has become highly volatile. The choice of services is multiplying and competition between service operators and equipment suppliers complicates long term planning and product launch.

Cellular and Mobile Communications 88 analyses the latest developments in the field, concentrating on the implications for long term strategic planning and tactical market issues. The opportunities in pan-European services and products – cellular, paging, cordless telephones, digital short range radio and satellite services are addressed providing a clear insight into how to exploit these developments.

The book is divided into four sections covering the strategic options for the 1990s, new trends in distribution and marketing, new services and the impact of emerging technologies. As a result this is a book of considerable strategic importance for all suppliers of mobile services and equipment. Those engaged in the administration and regulation aspects and organisations seeking to maximise the benefits to their business by making extensive use of mobile communications will also find this a very useful publication.

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GSM - commercial opportunities and threats for European industry

Heinz Pfannschmidt
Managing Director
Philips Kommunikations Industrie AG
Radio Communication Systems Division
Federal Republic of Germany

GSM (Group Spécial Mobile of CEPT) has succeeded to elaborate standards for a digital radiotelephone system, and hence built up a platform for European cellular operators and suppliers to set up a pan-European network in the coming 90s. Seventeen European countries have so far undersigned a Memorandum of Understanding which binds them to follow the GSM standard and to take the necessary precautions like reserving the defined spectrum in the 900 MHz band.

These GSM specifications have many implications for the European industry. This contribution outlines some key factors: the challenge of the large market to come, the need for increased speed of innovation, and finally the economical and technological risks involved, which have led European industry to form consortia in order to share resources.

Heinz Pfannschmidt (Dr. -Ing. from the Technical University of Brunswik) has been working in the field of telecommunications since 1973. In 1980 he joined Philips Kommunikations Industrie AG, Nürnberg, West Germany. Since then he has been working in the field of public radio communication, where he is at present responsible for the Radio Communication Systems Division.

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1. Introduction

In spite of some special features like "follow-me" which are normally restricted to PABX's in the private domain communication in public landline networks still ends at a socket in a wall identified by a name and a number in a telephone directory.
The phenomenal success of public mobile telephony since the introduction of cellular networks has shown that obviously many telephone subscribers have a natural demand to communicate independent from their fixed extension in the landline network. In most cases the real demand was higher than the original forecast which resulted in revised plans of the operators to accelerate the expansion of the infrastructure.

The degree of penetration in the continental countries (France, Germany, Benelux, Switzerland, Austria, Portugal, Spain and Italy) is still hampered by the incompatibility of the standards which restricts the use of subscriber equipment to the home country. From 1991 onwards systems based on the GSM standard will be introduced in most of the European countries and will open up the possibility to use the same subscriber equipment wherever coverage of a GSM compatible system exists.

This will open up a new dimension for the European cellular operators and consequently for the suppliers but it implies also a lot of threats and technological risks as will be shown in this contribution.

2. The European Cellular Market

2.1 Present Situation

Since 1971, when in the Federal Republic of Germany the first fully automatic network B started its service, it took some ten year before the first multinational cellular network of the second generation NMT 450 was brought into service in the four Nordic countries. The Nordic administrations proved the success of public radio telephony both from the technical and economical point of view. But looking to the rest of Europe, what happened in the meantime?

Over the past three years the number of cellular subscribers in second generation networks has increased by over six and a half times (figure 1). Early 1988 the total number exceeded the first time one million and continued to grow to almost 1.25 million by the end of August with a still accelerating rate of growth.

In the first three years to the end of 1984 the cellular subscribers were almost all in the NMT 450 network in Skandinavia but in the last three years the largest incease was contributed by the UK with some 400 thousand subscribers on the two national TACS networks. The breakdown of the number of subscribers to the different types of networks is shown in figure 2.

As a consequence of the different timeframes for second generation systems in the various countries market penetration is still very much different and varies from about 0.1 % in Germany and France to 3.5 % in Norway (figure 3).

2.2 Future Market Development

Simple extrapolations of the market penetration figures of today's analogue networks give some indication for the future Pan-European digital network. If Europe as a whole with a population of 340 millions would reach the same average penetration of 2 % as Skandinavia has today then there will be some 7 million digital subscribers in the GSM system. Figure 4 shows a demand forecast for the years 1991 to 1996 done by BIS MacKintosh. In the longer term 4 to 5 percent penetration or 14 to 17 million subscribers seem to be a reasonable forecast.

The author agrees with the general tendency shown in figure 4 but it is worth noting that some of the figures need upwards correction. Spain and Italy have good chances if their economy continues to develop on the level of the present high growth rates to reach much higher numbers of subscribers by the mid of the 90s. Furthermore there is no reason why Germany should fall behind France and UK and not achieve the same level of penetration.

Investigations have shown that the advent of digital systems might be less successfull in the first years of service in countries where well developed analogue systems are in operation. Therefore, it is doubtful whether GSM will achieve its major growth in countries like Nordic and UK which have already reached a high level of penetration with analogue systems and it seems more likely that the GSM type of systems will find their major potential in France, Germany, Italy and Spain.

But compared with present days analogue systems who opened up a completely new type of service the GSM system will have to compete against these analogue systems. This results in some critical factors which could hamper the success in the first years after introduction:

- National Coverage

This is one of the most important issues for subscribers. If coverage is restricted to capital cities and main transport routes in the first years, then subscribers may well continue to choose analogue service where possible. Therefore, a rapid expansion of coverage using existing cell sites of analogue 900 MHz systems is a key success factor for the GSM systems.

- Pan-European Roaming

Pan-European Roaming might be attractive to business users which use to travel by air to various places in Europe. But this clearly demands for attractive handheld portables which need heavy investments into technology and may be endangoured by floating standards. Therefore, the reduction of digital subscriber equipment to handportable size will not be easy and earlier versions of handportables may be more bulky than future generations of analogue handportables, and hence less attractive.

- Price of Enduser Equipment

Reductions in equipment prices have been dramatic during the past three years, and it is difficult to predict what prices will be in 1991/92. But it is very likely that the subscribers will have to pay more for digital mobiles and portables than for analogue equipment until the mid 1990s.

Of particular interest is the relation between the price of handportables and standard (transportable) mobiles. Since the price of portables has to cover the investment needed to achieve miniaturisation it could very well happen that the market share of portables will be low in the first years because subscribers will not accept an uplift of 50 percent or more for portables. A similar situation occured in the first years of the AMPS service in the US where the market share of portables stagnated at some 5 percent.

3. The Way to GSM Standards

In 1982 CEPT decided to start work specifying a system for use in a Pan-European public land mobile network (PLMN) to be established in CEPT countries. To deal with this task the GSM group was installed, which defined the following technical targets:

- Co-existence with other systems in the 900 MHz band
- Reservation of upper 10 MHz in the transmit and receive band (figure 5)
- Use of service in all participating countries
- Both telephone service and ISDN related services
- High level of frequency efficiency
- Reasonable investment costs in both urban and rural areas
- System parameters to be chosen to limit costs of coplete system
- Speech quality of telephony to be at least as good as that achieved in existing 900 MHz analogue systems
- Open, non-proprietary interfaces (MS-BS, BS-MSC, MSC-MSC) (abbreviations see figure 7)

and fixed the following time schedule

- Start of GSM work	1982
- Study of service aspects, network aspects and digital radio transmission methods	1982-1986
- Decision on basic parameters of radio subsystem	02.1987
- Further studies	1987
- Final draft of major recommendations	end 1987
- Final draft of all other recommendations	mid 1988

During the GSM meetings of February and June 1987 and after a long battle between the "broadband and narrowband camp" GSM decided on the basic parameters of the radio subsystem as "working assumptions" to be specified in more detail, some of them are listet below:

- GSM system to use digital voice transmission
- Use of Narrowband TDMA scheme with the following main working assumptions:
  - 8 channels per carrier
  - GMSK modulation
  - 20 µs (later reduced to 16 µs) delay spread to be catered for
  - Channel space 200 KHz
  - Speech coding: RPE/LPC codec **
  - Frequency hopping (mandatory in MS).

** was proposed by Philips (PKI) with a contribution from IBM, France.

Details of the system and equipment requirements will be described in the GSM Series of Recommendations. When complete there will be more than 130 recommendations, the structure of which is depicted in figure 6.

The European communication industry supported and is supporting the GSM specification work not only by providing trial equipment (e.g. Paris field tests, UK test bed, speech codec evaluation) but also by a lot of experts contributing to the GSM working parties and expert groups.

Nevertheless a strong risk remains that during the validation tests carried out in the coming month some deficiencies will be found and changes will have to be introduced into the recommendations. Since this requires a formalised change request procedure revised specification might come up rather late and, therefore, might have an heavy impact on development time schedules. Furthermore, it is not an easy task to guarantee consistency of all recommendations and to keep them consistent when changes will be made especially when the present workforce of GSM will be decreased and the task will be handed over to ETSI.

Not to be mistaken, industry representatives do not try to invent alibies for possible delays but we are pinpointing to a serious problem which could lead to a moving target situation during a very tight development time schedule.

4. Realisation of the GSM System

4.1 Infrastructure

The GSM work was also politically supported by the EEC, which in June 1987 issued a directive with regard to the "co-ordinated introduction of a Pan-European public land mobile radio service":

- the new PLMN will operate in the 900 MHz band
- the member countries have to take care of the availability of at least the upper part of the frequency band in 1991, when service will start
- the total band must be available by 2001 at the latest
- "radio subsystem multiple access method" is that defined by CEPT/GSM.

Introduction of the GSM system will not be restricted to EEC countries; in September 1987 13 of the 15 countries delegations working in GSM signed a Memorandum of Understanding (MoU) to start service in 1991 and a time schedule for achieving this goal. The time schedule set up is a consequent continuation of the GSM one:

- milestone 1: February 88 — Request for proposals
- milestone 2: June/July 88 — Letter of Intent
- milestone 3: December 88 — Clarification of requirements:
  - validation of interfaces
  - system validation
- milestone 4: June 90 — system validation
- milestone 5: March 91 — delivery of equipment
- milestone 6: June 91 — start of commercial service.

Milestone 1 and 2 have meanwile already been affected by a slippage to May 16th for the tender requests and to end of September e.g. for France and Germany as far as the issue of LOI's is concerned.

Whilst the procurement procedures will be in line with the different national regulations the technical requirements are the same (expect for some options, but nevertheless still leading to a compatible system) and described in GSM recommendations. Some 60 of these are essential for the procurement procedure.

Essential for the compatibility of the various system elements are the interfaces shown in figure 7. But it is worth noting that the GSM recommendations do no cover all functions required to assure a 100 % compatibility (for instance the operation and maintenance functions will not be harmonized). This could lead to an incompatibility between base stations and mobile switching centres of different supplier or on the other hand this could lead to extensive additional investments into development of variants for the different European countries where still local suppliers of public switching systems will dominate the operation and maintenance concepts.

The total effort for the complete infrastructure development has been evalued to amount to more than 1500 menyears for each of the established consortia. About 70 % of the design work will be software of software related.

Taking a total number of 10 million subscribers into account, which are expected to use GSM systems at the end of this century, and assuming that a logical traffic channel would serve 20 subscribers as an average this would lead to a total market of 500.000 logical channels to be installed from 1991 until 2000. If a menyear is assumed to cost about 100 thousand US $ one could easily calculate that each of possibly five manufacturers or consortia has to recover about 1500 US $ per channel with an average market share of 20 %.

This indicates that industry is forced into a situation, where larger market shares are required to recover investments and hence formation of consortia as it has happened in aircraft industry in the past is a logical consequence for the mobile radio manufacturers. This tendency is even more accelerated by the GSM standard which allows to multiplex 8 or in future stages of development 16 logical channels on one transceiver and, therefore, will lead to a significant price reduction per logical channel compared with present days conventional analogue systems.

4.2 Mobiles and Portables

Digital radio transmission techniques enable large parts of the radio equipment to be integrated (figure 8). A study about "handheld viability" found out that some 600 thousand transistor functions (excluding those in microprocessors, RAMs and ROMs of the controller part) are necessary to integrate a subscriber unit (figure 9).

Designing fully or semi-customized VLSI circuits is still cost and time consuming and requires as a prerequisit detailed frozen specifications. Before starting, design studies and optimisation procedures have to be done. These have to take into account the available technologies and available libraries for digital signal processors, standard microprocessors, gate arrays, RAM's, ROM's, etc. and have carefully to consider the appropriate compromises of space versus yield, and space versus number of chips and consequently level of power consumption. While the specification of "pure" voice coding is already fairly stable, and design could start, there is a danger it may become unstable again due to the ongoing discussions to introduce "voice activity detection". Another important system area is that of multiplexing and protocols where fundamental details are still under consideration and changes may occur after contracts are placed thereby affecting costs and time deadlines. While on one hand settled specifications are necessary, on the other hand it may well be that because of the time constraints imposed by the MoU milestones GSM may be forced make quick decisions. Under these conditions it may not be possible to take into account the following important GSM basic system requirements:

- high level of frequency economy
- competive cost prices already for first generation mobiles and portables

5. Conclusion

The challenge of providing a most advanced cellular communication service and in adressing a big market in and outside Europe are motivating and stimulating European industry and have already caused considerable involvement in the GSM specification and development work.

The stability and consistency of specifications is highly important for elaborating solid technical and commercial proposals. The complexity of the system and equipment, the remaining "gaps" in the specifications, the dense time schedule, the need to use new technologies, and the technical and economical risks are likely to result in pooling of resources and the formation of co-operations in development and production.

Major factors bringing about such cooperations are apart from the tremendous investments into development the requirements for expertise in the different techniques and technologies and the limited resources of the necessary qualified manpower available. This process has already resulted into various companies forming consortia and joint-ventures or at least signing co-operation agreements.

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