

SECTION III

VIRTUAL REALITY IN COMMUNICATION: EMERGING TRENDS AND TECHNOLOGIES

If I were asked for an area of science and engineering that will most likely produce the breakthroughs of tomorrow, I would point to nanoscale science and engineering

Neal Lane, 1998

9 Universal Mobile Telecommunications System: terminals and applications

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Abstract. Burgeoning growth in the number of mobile customers is accompanied by extremely rapid terminal turnover, as around 70% of customers own a terminal which is less than a year old. There is thus an excellent opportunity for introducing new services based on the terminal's features. The signs of market evolution and the many and varied corporate agreements and movements clearly indicate that an increasingly important share of the innovations in the mobile systems and services sector arise as a result of evolving mobile data services. One of the main goals of UMTS is to make it possible to provide a wide range of voice, data and multimedia services in an extremely competitive and fast-moving environment.

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9.1 The evolution of mobility services

The signs of market evolution and the many and varied corporate agreements and movements clearly indicate that an increasingly important share of the innovations in the mobile systems and services sector arise as a result of evolving mobile data services.

This growth trend in services is apparent in terms both of differentiation and of quantitative impact. In this sense, mobile data services will in the near future be one of the high-growth and, presumably, high-profit sectors for service providers and operators, even if the overall volume of these services at the moment is insignificant by comparison with that of voice services. In a market setting of this kind, the main drivers for innovation spring from the close synergies between:

- The size and spread of mobile services
- The parallel development of Information Technology services and applications.

These synergies are fostered by the rapid advances made in mobile radio terminals and development tools, which in turn encourage continuing enhancement of services and applications. In this context, the opportunities provided by the introduction of UMTS third-generation mobile networks will be instrumental in ensuring fuller use of the services made available by greater mobile transmission bandwidth.

Consequently, the technical and market requirements for data applications will call for radical changes in how the radio resource (packet) is used and in overall network architecture.

In the fast-paced and hypercompetitive mobile radio market, the operator must be able to respond with solid strategic abilities in terms of innovation and customer care. Consequently, the development of application and systems-related solutions for the mobile environment will be ever more closely linked to the user's needs. Sky-rocketing growth in the number of mobile customers is accompanied by extremely rapid terminal turnover as customers replace their older units with new ones, thus creating a prime opportunity for introducing new services which are also based on innovative terminal characteristics. Even today, as regards access to value-added services, a distinction is arising between “voice centric” terminals or *smart phones* and “information centric” terminals, or *communicators*. This trend will gain strength in the third generation, with multimedia terminals for video services and advanced navigation.

For the GSM system, new application environments have recently become available for providing value-added services (VAS) for GSM mobility. Examples include the SIM (*Subscriber Identity Module*) Application Toolkit, which makes it possible to personalize the SIM with new applications, WAP (*Wireless Application Protocol*), a protocol stack developed in order to access Internet services via cellular telephone, and MexE (*Mobile Execution Environment*), an ETSI standard founded on WAP and the Java programming language.

This changes the outlook for developing and supporting data applications, or integrated data and voice applications, for both the horizontal market and for business customers.

The WAP services provide interactive access to Internet applications and information using only a GSM cellular phone. This is possible thanks to the introduction of a micro-browser in the cellular phone, so that value-added application services can be provided to businesses and to individual customers. These services, which range from economic or sports news to mobile banking and mobile commerce, are based on Internet protocols optimized for cellular phones' limited bandwidth and display capabilities. Connection takes place with data transmission (which in the future will be packet-based) to the mobile network, where a WAP server converts protocols between the GSM mobile environment and that of the IP application servers (Figure 9.1).

The services based on SIM Application Toolkit take advantage of the increasing processing and memory storage capacity offered by SIM cards (which currently provide 16 kbyte, of which 8 are dedicated to 3 or 4 applications available for the customer), and are an important means of reinforcing customer retention, given that the customer may perceive the SIM as a feature which

sets the operator apart from the rest. Value-added services such as home banking, e-commerce and location-based applications, moreover, can be customized through an over-the-air download mechanism whereby the applications are downloaded via the GSM network, and are an approach which complements WAP. Connection takes place by sending and receiving menu-prompted short messages to the mobile network, which forwards them to application servers.

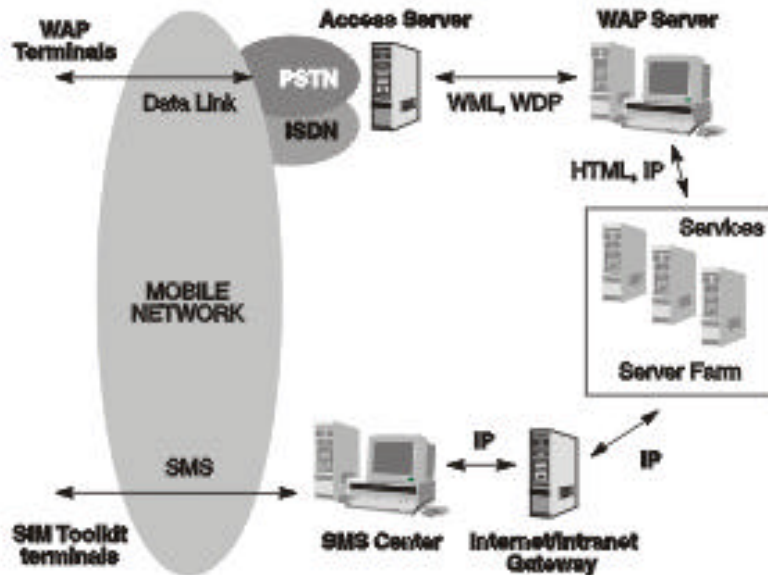


Figure 9.1. Value-added service architecture for the GSM network

The scenario is made even more complex by new GSM phase 2+ bearer services such as GPRS (*General Packet Radio Services*). Through these services, users will have a good preview of what they will be able to expect when today's GSM mobile network evolves towards broadband services suitable for the IP world. The gradual spread of GPRS will provide users with Internet-Intranet type communication capabilities (packetized data transmission at bit rates of 100 kb/s and over) and with advanced terminals with the kinds of display and keypad needed for these services.

As a result, there is a need to establish a “technological mix” for introducing each new service, considering the various alternatives for terminals, bearer services, support infrastructures (SIM Application Toolkit, WAP) and types of evolution towards UMTS.

As regards the application solutions which will be made available by the UMTS third-generation mobile network, the main trends will be guided by the development of new terminals (e.g., provided with high-definition color displays or integrated TV cameras) and by the availability of packet switched broadband access.

The biggest problem associated with implementing UMTS terminals, in any case, consists in being able to guarantee global roaming. This entails supporting the various CDMA techniques that will be used, as well as maintaining compatibility with second-generation mobile radio systems. At the moment, even the manufacturers themselves are by no means certain that this can be achieved, and expect that various classes of terminal will be available in the future. In their view, these classes will be distinguished on the basis of the second-generation techniques and networks they support, as well as by the services they provide. As the divisions between cellular phones and palm-top computers are expected to become increasingly indistinct, manufacturers are now looking into the possibility of tackling the problem with software rather than hardware solutions, and a few prototypes have already been produced.

9.2 Mobile terminal evolution and market prospects

Burgeoning growth in the number of mobile customers is accompanied by extremely rapid terminal turnover, as around 70% of customers own a terminal which is less than a year old. There is thus an excellent opportunity for introducing new services based on the terminal's features.

Yearly sales of cellular phones in Europe will pass the 100 million mark from the year 2002 onwards, while growth trends are expected to show substantially the same patterns on the Italian market (with a target of 20 million terminals for 2002) and the world market (over 500 million in the same year) (Figure 9.2).

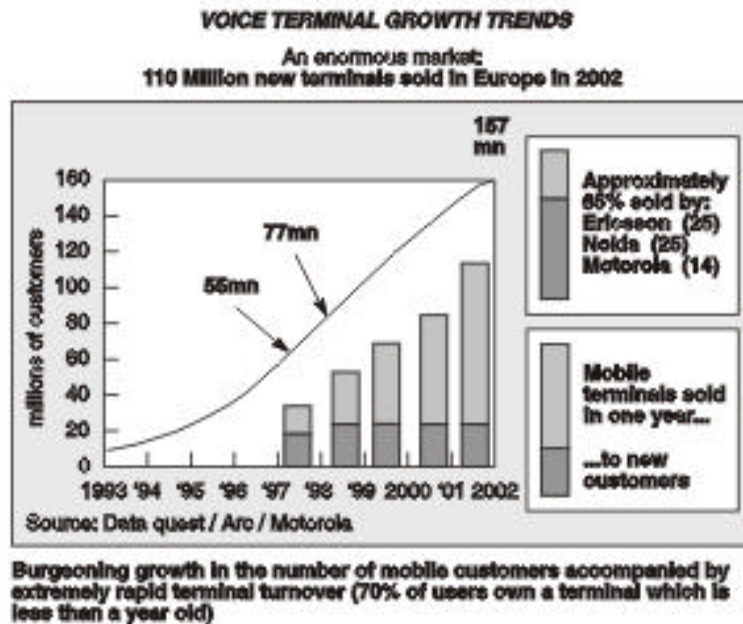


Figure 9.2. Sales of voice terminals

9.2.1 Second-generation terminals

Another issue to be borne in mind is that of the capabilities that have already been introduced by the major manufacturers, and which will characterize the new mobile terminals to an ever-increasing extent.

The differentiation in the types of mobile terminal, permitting more advanced operations and services, will take place at the point of convergence between the world of classic cellular phones and that of Personal Computers (PCs). Terminals will thus be classed in one of two families, according to which of the two “forebears” they are closest to:

- Information centric: communicator
- Voice centric: smartphone.

The major companies in the ICT (Information and Communication Technology) sector are already working along these lines, proposing the basic Operating System as a fundamental characteristic of the terminal, which they refer to specifically as an “information appliance”:

- Symbian (supported by Nokia, Ericsson, Motorola) with its EPOC Operating System.
- Microsoft with Windows CE (Consumer Electronics).
- 3Com with the Palm Operating System.

Even in the future, however, these devices will account for a limited percentage of the enormous

number of classic voice terminals.

9.2.2 Advanced third-generation terminals

The diversification of mobile terminals will be even more marked for the UMTS network. Given the emphasis on the multimedia services this network will provide, terminal manufacturers are working to ensure that these services are as user-friendly as possible.

The following figures show a series of WB-CDMA UMTS mobile terminals developed for the tests which the Japanese network operator NTT DoCoMo is conducting with a view to putting third-generation IMT2000 services on the market. At the moment, these terminals are prototypes, and it is not certain that they will be mass produced in the form shown. However, they give a good idea of what will be available in the future.

There will also be a market for terminals similar to today's cellular phones, which will be used essentially for voice communication but may also have messaging capabilities. One of the main objectives is that these third-generation mobile phones maintain the major attractions of their present-day confreres, or in other words, handiness and light weight. This goal can be summed up in the "four 100s rule":

- 100 gram weight
- 100 cm³ volume
- 100 hours stand-by
- 100 MIPS (Mega Instructions Per Second) (Figure 9.3)



Figure 9.3. UMTS mobile terminal prototypes

Multimedia terminals will be the real novelty for UMTS (though it seems that the GSM-GPRS network will provide a foretaste of their capabilities), and will be based essentially on integrating advanced technologies for the color display, audio and video recording using micro-TV cameras (Figure 9.4).



Figure 9.4. UMTS mobile terminal prototypes for multimedia services

The figure 9.5 shows European market forecasts for the different types of multimedia service

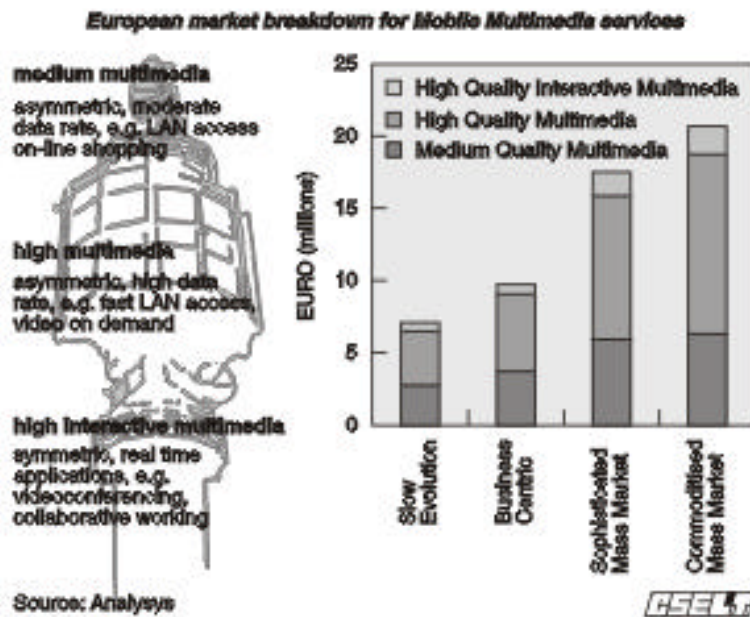


Figure 9.5. European market breakdown for mobile multimedia services

Naturally, there will also be data transmission terminals which will be integrated in normal PCs through the use of PCMCIA (*Personal Computer Memory Card International Association*) cards.

Given the high rate of growth for the “mobile Internet” phenomenon, forecasts for the sustained development of terminals for UMTS Web access are based on an evolutionary pathway which starts from WAP and, thanks to GPRS, takes a course which is already clearly outlined today (Figure 9.6).



Figure 9.6. UMTS mobile terminal prototypes for Internet services

The main problem associated with implementing third-generation terminals, however, consists in being able to guarantee global roaming, one of the stated objectives of the UMTS system. The situation is complicated by the fact that at the worldwide level the third-

generation solution will consist of a family of systems, each with its own radio features. At the same time, it will be necessary to guarantee backward compatibility with second-generation systems, as discussed in the preceding chapters. The problem is thus more complex than that, for example, of developing dual-band telephones, though even the latter called for enormous exertions on the part of manufacturing industries. Forecasts indicate that the market will probably be characterized by terminals which will also be differentiated on the basis of the radio interfaces they support and their compatibility with second-generation systems. Thus, not all terminals will be capable of supporting global roaming.

To solve this problem, a number of manufacturers have proposed a complementary solution. Given the difficulties in achieving convergence towards a single worldwide standard, they suggest that the largest possible portion of the standards be harmonized, and that the remaining differences be implemented in software rather than directly in hardware; subsequently, they believe, radio terminals should be developed whose radio part is controlled entirely by hardware. Though not all manufacturers agree with this approach, it should bring costs down and help reduce the problem's complexity.

This solution, which is known as software-radio, is in fact a new frontier in the development of mobile terminals. At the moment, several prototype solutions are already available which are able to implement part of the radio interface. The greatest obstacle to be overcome consists of these terminal's high consumption, particularly as regards the modules for controlling high-frequency radio signals. In any case, the expected convergence of mobile terminals with handheld computers (PDAs) could make this problem insignificant, given that radio interface management would no longer account for the largest share of power and processing capacity.

9.3 UMTS Services

One of the main goals of UMTS is to make it possible to provide a wide range of voice, data and multimedia services in an extremely competitive and fast-moving environment. This should pave the way to a scenario in which operators could decide to specialize in roles other than those they have traditionally covered, e.g., acting as service and content providers, and, at the same time, where other companies who have always been excluded from the mobile radio market could gain a foothold on it.

The objective will thus not only be that of offering an increasingly wide range of ever more innovative services, but also that of guaranteeing an integrated, personalized and homogeneous environment for the user independently of the type of terminal or network used to access the service. In particular, to use the terminology employed in the world of telecommunications, it will be necessary to guarantee what is commonly referred to as *terminal mobility*, *user mobility*, and *service mobility*.

The term *terminal mobility* means the ability to use the services that have been subscribed to regardless of the specific access network involved. *User mobility*, on the other hand, means the ability to use the services that have been subscribed to regardless of the type, make and model of terminal employed. Finally, *service mobility* refers to the user's ability to access personalized services independently of the terminal and network employed.

For these purposes, UMTS will use the smart card technology developed for GSM and will offer what is referred to as a Virtual Home Environment (VHE), or in other words, an environment in which the user will benefit from the same services with the same interface he originally chose, regardless of the specific location or terminal from which the service is requested

The following sections will provide a more detailed analysis of the VHE concept, its impact on UMTS service creation, and the main classes of third-generation services. These services will be chiefly characterized by their ability to support multimedia content and the large bandwidth at

their disposal, at least by comparison with today's second-generation mobile radio systems. Obviously, dividing the services into hard and fast categories is not possible, as the fact that varying technologies and market segments are integrated means that the applications tend by their very nature to cut across several classes. Consequently, we will attempt to characterize the services on the basis of their major features or of the customers to whom they are chiefly addressed.

9.3.1 *Virtual home environment*

As the name implies, the *Virtual Home Environment* is a virtual environment which UMTS establishes in order to guarantee that the user can access subscribed services using the same user-selected methods from any terminal or network.. The user thus has the impression of being on his or her own home network even while roaming on that of another operator, with clear advantages for all of the parties involved (e.g., operators, customers and service providers).

VHE must enable terminals to negotiate functions with the access network. and thus must also make it possible to download the software which provides functions and services from the home network, seamlessly and with complete security for the user.

In many people's view, seamless VHE mechanisms will be the major factor in achieving a mass market for UMTS services.

However, VHE does not limit itself to establishes methods and restrictions for using services, but also determines how they are developed. Accordingly, it includes a service creation environment to support the rapid growth of UMTS services. The basic concept is to make service creation, introduction on the network and portability as easy as possible by specifying a single communication interface with the UMTS system and a set of support tools for design and testing. The aim is thus to make service creation independent of the specific network, type of access or terminal that will then be used.

In this way, a standard development platform is established which enables independent groups to create or distribute services to their customers via UMTS, in some cases adapting information content which is already available through other types of access.

The flexibility introduced by VHE will not only increase the number of services that can be offered, but will also make it possible to characterize them on the basis of the market segment they target and, in the most optimistic view, on the basis of the individual customer's needs. Thus, it will not only be possible to use the desired service anytime and anywhere, but even to adapt to varying access conditions such as the type of terminal or network, or to specific user requirements.

9.3.2 *Multimedia services*

Multimedia services are one of the most attractive, and indeed fascinating, features of UMTS. Available bandwidth will make it possible to develop a wide range of services that can be used directly from the customer's mobile terminal. There is a multitude of conceivable applications, which could be supported by terminals with widely differing characteristics. In addition to video-communication or video-streaming applications, services such as messaging and navigation that already exist today, and which will be discussed in the following sections, could evolve and be integrated. The main applications based on transmitting video content could be as follows:

- Video conferencing applications, thanks to the use of videophones equipped with miniature video cameras. In addition to making audio and video calls, it will be possible for example to make an audio-video recording of a meeting and transmit it to coworkers, or to provide video support for remote training and collaborative working.
- Video-streaming applications, where films can be received by request directly on the cellular phone. The service will be characterized by the nature of the material involved, which

- could range from music video-clips, to sports films, movie trailers, etc.
- On-line video sales catalogues. For example, real estate agents could provide on-line access to their property listings so that potential buyers would not have to visit houses on sale personally.
- Telemedicine applications. It would be conceivable, for instance, to transmit accident victims' x-rays or photographs directly at the site of the accident.

9.3.3 Access to Internet – Intranet services

Mobile telephony and Internet access are the two technologies that have had the greatest impact on the market in recent years. Their growth, in terms of worldwide users, has been truly explosive. It is thus interesting to follow the course they are taking towards integration, which has already started on the GSM network with the introduction of WAP (*Wireless Application Protocol*, a protocol for adapting Internet accesses to the GSM network's limited bandwidth) technology and enhanced messaging services.

In this case as in that of multimedia services, having more available bandwidth opens new prospects which are far more interesting than the GSM system's offerings. At the moment, the Internet applications that are enjoying the greatest success are e-mail and access to information content such as sports news, financial bulletins, weather forecasts and so forth.

The goal is to make all of this information usable from the mobile environment. With bandwidth limitations a thing of the past, it will no longer be necessary to specify new access protocols. However, as the characteristics of mobile terminals will continue to be profoundly different from those of a desktop PC – as regards computing power as well as the size and features of the display and keypad – it will still be necessary to use entirely different methods for viewing information content. The basic problem thus becomes that of redistributing information on the basis of access type, without having to rewrite the service each time.

At the time of access, the user will inform the service provider of his terminal's characteristics (display dimensions, computing capacity, graphic processing capacity, etc.), and the provider will transmit the required information, adapting representation to the indicated characteristics. Consequently, the same information will be presented in different ways, according to whether access is from a desktop computer or from a mobile terminal. To this end, new languages for specifying information and representing it graphically will be introduced which overcome the limitations of those used today, together with software platforms for integrated profile and service management, and visual programming environments for fast application development. The major software producers (IBM, Microsoft and Oracle) are already working on platforms of this kind for making Internet services available with GSM terminals.

As regards messaging services, which are one of today's most widely used applications – as witnessed by the success of e-mail or of the GSM network's short message service – the goal is to associate multimedia content with transmitted messages. For example, messages could be transmitted directly in the form of film clips.

9.3.4 Voice services

Services based on voice recognition and voice activation will also have an extremely important role. Today, in fact, one of the most formidable barriers to the success of value-added services on GSM consists in the telephone terminal's limited practicality for these purposes, and the complexity of its man-machine interface, or MMI. This problem is not so much due to poor terminal design, as to the terminal's inherent nature.

Voice recognition technology could help overcome these limitations, at least for certain classes of service. For this purpose, the idea is now to develop a voice mark-up language called

VoXML which could provide a standard mechanism for controlling applications through voice commands.

Users would thus be able to access and control the various services (such as navigation-based services, for example) through voice instructions to the terminal or the network.. For instance, the user could say “Check my e-mail” to access incoming mail. Other similar services will become available. This would thus increase the usability of all of these applications, making them readily available even to the large group of customers who use the phone only for voice communication and are not well versed in the use of new technologies.

9.3.5 *User identification and security*

Smart card technology makes user identification possible. The basic concept is applied today in the GSM network, which uses an SIM module that can be placed in any terminal to identify the user to the network and permit access to services. A subscriber can use any GSM phone simply by inserting his or her SIM. This module thus makes it possible to introduce personalized features and security algorithms, thanks in no small measure to rapid advances in microchip construction and integration technologies that provide increased memory, interfacing and computing capacity. UMTS intends to make use of an identity module called a USIM, in which applications, certifications, digital signatures, encryption algorithms and any other type of data can be entered and stored. These cards could be contactless, which would make them easier to use and, above all, would extend their potential, as operations could be performed without necessarily having to insert or remove the card from the terminal.

Obviously, this will permit the large-scale introduction of commercial and financial transactions via UMTS for applications such as e-commerce, home banking, and so forth.

9.3.6 *Location-based services*

Services based on the concept of positioning are another sector of enormous interest, since mobility is the main characteristic of mobile radio systems and their principle source of added value. Even now, applications based on positioning systems are available on second-generation networks. In the current GSM network, a distinction can be made between two classes of application: those that use the mobile radio network only as a transmission medium, relying on specific systems such as GPS (*Global Positioning System*) for the actual positioning functions, and those that use the native techniques provided by GSM for locating the user (the cell identifier or, for higher accuracy, triangulation methods based on the different power levels received). The GSM system, however, is not organized to support positioning concepts on a complete, native basis. Consequently, despite concerted efforts and ongoing research, it has not yet been possible to develop applications of this second type which are in any way comparable in accuracy and reliability with the first type, which nevertheless have the disadvantage of requiring supplementary systems and equipment. UMTS should change this picture, and overcome this type of limitation. Some of the possible applications include:

- **Work Force Management.** A centralized system coordinates and monitors groups of geographically dispersed users (agents, repairmen, salesmen, etc.). At the moment, the GSM system is essentially limited to coordinating vehicles equipped with special on-board terminals that can interact with the GPS and GSM systems. With UMTS, the individual user will be able to utilize the terminal directly without additional equipment.
- **Navigation, traffic control and theft-deterrent services.** In addition to using UMTS to support on-board navigation, it would also be conceivable to monitor the movements of vehicles on which a UMTS positioning system has been installed. This would make it possible to transmit the vehicle's location to a service center, reporting any problems such as acci-

dents, calls for help, etc. By connecting this system to the vehicle's theft-deterrent system, moreover, it would be possible to track the position of stolen vehicles.

- Yellow pages services. A wide range of public services for everyday use could be provided. For example, users could request a list of pharmacies, restaurants and movie theaters in their area, together with additional information such as opening hours, prices, films being shown, etc. As another possibility, on-line tourist guides could be offered.