CHAPTER

4

Contents

The development of GSM standards and features

Throughout the remainder of this book we need to deal with phases, versions, releases, services, functions, and features; the abbreviations and fine distinctions can cloud the material. We have seen some of the terms in Chapter 2 and we will see more of them later. This chapter organizes all of GSM's services and features over time. New GSM services and features (teleservices, bearer services, supplementary services, the SIM card, and network improvements) appear in phases, versions, and releases of the standards. GSM's services and features are thoroughly explained in later chapters, but for now we can consider the following distinctions:

- *Teleservices* are those that people use directly; talking on the phone is an example.

- *Bearer services* are transport services that become useful to someone only if they attach some kind of contraption or software to his phone; Internet surfing is an example of an application that uses bearer services.

- *Supplementary services* (SS) are features resident in the network itself; the phone must have a way to use them. Putting a call on hold is an example of SS.

- The *SIM card* is the subscriber identity module; this stores subscriber-related data and identifies the subscriber in the network.

Back in 1982 when the *Groupe Spécial Mobile* was founded, the goal was to design a common Pan-European standard for mobile telecommunications to replace the chaos of sundry incompatible analog protocols that covered the continent, and which were seen as a barrier to the economic health of the European community. In the 15 years that followed, industry representatives coming from regulators, GSM operators, and manufacturers specified not only a common air interface for the future Pan-European system but a complete *public land mobile network* (PLMN) standard.

Initially, everybody wanted to introduce the best her or his own national standards could offer, be it NMT (Scandinavia), ETACS (United Kingdom), or the Net C protocol of Germany. It quickly became clear that even the most clever combination of all the early proposals could not meet the demands for the quality and features that everyone wanted, which is why the GSM standard has and still continues to evolve. The standards and features already defined for the *integrated services digital network* (ISDN) had a major impact on the proceedings and forced the participants to look to the latest technologies and radio techniques for relief. GSM eventually became a digital cellular standard based on a TDMA technique for the air interface that could offer ISDN services from a SS7 architecture [1,2].

Fueled by extraordinary efforts on specifications work, document revisions, and field tests, GSM became an elegant second-generation mobile phone system that was the topic of lectures, social conversations, and technical papers throughout the wireless industry. The sparkle was

dulled as the specification process took longer than anticipated; so much longer that in countries like France, Italy, and Austria some new cellular systems based on first-generation analog standards were introduced, or adapted to exiting systems, to cope with the pent-up demand for mobile telephony. In other countries where new, competing operators had already been licensed to build and operate whatever GSM was trying to complete, the demand for operational equipment based on GSM standards became urgent. The solution was to split the standardization work into phases, which leaves us with today's legacy of three phases: Phase 1, Phase 2, and Phase 2+.

As we saw in Chapter 2, the GSM Phase 1 specifications were frozen in 1991 to allow the operators to build their first commercial GSM networks. Unfortunately, creating a stable type approval process, including equipment and test suites, for mobile phones took much longer than expected so that the actual launch of GSM was delayed further to the summer of 1992. An *interim type approval* (ITA) procedure was introduced to move *some* mobiles onto the market. All other features and changes that were to be introduced after the 1991 freeze were moved into the Phase 2 specifications. Phase 2 was frozen in October 1995, and subsequent improvements and additions will automatically make their way into Phase 2+.

The history of GSM's phases is evident in the documents that are known as either *GSM* documents or *digital cellular telecommunications system* documents. The digital cellular telecommunications system title replaces the *European* banner on Phase 2+ publications to finally acknowledge the global impact of GSM that occurred in the past 5 years. We can also refer to different versions of GSM with version numbers. The version numbers for the Phase 1 documents are 3.X.X, Phase 2 documents have version numbers 4.X.X, and Phase 2+ documents have numbers 5.X.X. ETSI could have continued to work in *phases* forever incrementing version numbers with increasing numbers of phases, but many features added these days are increasingly optional ones for the operators rather than the mandatory features of early phases, and the demand for them cannot wait for a freeze of Phase 2+ work. ETSI, therefore, now distinguishes work packages that are released on a yearly basis. Starting in 1996 the Phase 2+ documents are referred to as *Release 96*, and we just saw a *Release 97* published [3].

4.1 Phase 1

More features were specified in Phase 1 than were actually implemented or working; this situation has recently reversed itself in later releases.

4.1.1 Phase 1 teleservices

The first network services and products that *finally* made it to the marketplace focused on plain voice communications, which was supported by the standard 13-Kbps full-rate speech codec. A tentative venture into auxiliary features was represented by *emergency calls,* which were accessible via the standard emergency number "112." Quick access or shortcut buttons, like "SOS," were offered too. The emergency services were available regardless of whether the subscriber was allowed access to the remainder of network services or not. Emergency calls worked, and still work today, without a SIM inserted in the handset. However, it is up to the network operator whether or not to accept emergency calls without a SIM present, because the emergency services authorities might demand an identity to call back to the subscriber. France and the United Kingdom, for example, do not allow emergency calls without a SIM present, whereas Germany does.

Even though Phase 1 specified *short message services* (SMSs) and some fax and data capabilities, these features were not available in the networks nor were they supported by the mobile phones when GSM appeared. Point-to-point mobile terminated SMS became more common only when mailbox servers started sending short notes to subscribers informing them of new voice mail messages awaiting the subscriber's attention.

4.1.2 Phase 1 bearer services

Table 4.1 lists the bearer services defined in Phase 1. We should highlight here the difference between the transparent and nontransparent services: *transparent* for GSM means that the GSM infrastructure (including mobile stations) pass on the data from data or fax terminals without any additional protocol to reduce the effect of errors introduced on the air interface. The *nontransparent* services, however, add error protection protocols that make data and fax transmissions much safer. A side effect, which is detailed further in Chapter 5, is that the effective speed of transmission is higher for the nontransparent service.

4.1.3 Phase 1 supplementary services

The first *supplementary services* (SS) were very basic in Phase 1.

Call forwarding (CF) enables subscribers to divert calls to other phone numbers. CF services distinguish unconditional forwarding of all calls from conditional call forwarding. Conditional CF applies to the subscriber who is busy, who cannot be reached, or who does not answer.

Call barring (CB) lets subscribers bar certain calls. There are five types of CB service:

1. Barring of all outgoing calls;
2. Barring of outgoing international calls;
3. Barring of outgoing international calls except those directed to the home country;
4. Barring of all incoming calls;
5. Barring of incoming international calls when roaming (to avoid hefty surcharges).

Table 4.1 lists the main features and services specified, but not necessarily implemented and working, for GSM Phase 1.

Table 4.1
Features Covered by GSM Phase 1

Service Category	Service	Comment
Teleservices	Telephony	Full-rate speech at 13 Kbps
	Emergency calls	"112" defined as a GSM-wide number to a local emergency service
	Short message service (SMS) point-to-point	Alphanumeric message exchange between two individual users via a dedicated service center
	Short message service (SMS) cell broadcast	Alphanumeric information to all mobile stations within one cell or area but not during a speech or a data connection
	Videotext access	

Table 4.1 (continued)

Service Category	Service	Comment
	Teletex transmission	
	Facsimile alternate speech and facsimile Group 3	
	Automatic facsimile Group 3	
Bearer Services	Asynchronous data	300, 1200, 1200/75, 2400, 4800, 9600 bps, transparent / nontransparent
	Synchronous data	2400, 4800, 9600 bps, transparent
	Asynchronous PAD access	300, 1200, 1200/75, 2400, 4800, 9600 bps, transparent / nontransparent
	Synchronous packet data duplex 2400 bps T/NT	2400, 4800, 9600 bps, transparent / nontransparent
	Alternate speech / data	
	Speech followed by data	
Supplementary Services	Call forwarding (CF)	All calls, calls when a subscriber is busy, not reachable, or not available
	Call barring (CB)	All outgoing calls, all outgoing international calls, all outgoing international calls except those to the home country, all incoming calls, all incoming calls when roaming

4.2 Phase 2

While Phase 1 networks were starting up and winning subscribers and admirers in Europe, curious attention came from Asia (primarily from Hong Kong and Singapore), Australia, and a wide variety of industry groups in other countries as specification work continued almost seamlessly within ETSI working groups. As the industry caught up with the Phase 1 specifications, the appetite and demand for advanced features grew.

4.2.1 Phase 2 teleservices

Phase 2 added the half-rate speech codec; Phase 1 already had provisions for implementing it on the air interface, but the delay was confined to the

speech coding process itself; the algorithms were not available as they were still being improved with further testing.

The *enhanced full-rate speech codec* (EFR) was a requirement from the U.S. market for its introduction of PCS 1900. The voice quality of the EFR approaches landline quality under good radio conditions and is superior to the normal full-rate codec under nonideal conditions. At the time of this writing the GSM EFR was not deployed in GSM networks (and terminals) outside North America and is only just appearing in the North American markets where most of the PCS 1900 phones have both types of full-rate coding schemes installed; the American networks tend to favor EFR channel assignments. The EFR was originally a Phase 2+ feature, but has been moved to Phase 2 by a GSM plenary meeting to allow earlier adoption and introduction into GSM networks in Europe.

4.2.2 Phase 2 supplementary services

Major additions were made to the supplementary services, which were heavily influenced by the ISDNs.

Calling line identification (CLI) allows the receiving party to get an indication of who is calling by displaying the calling party's phone number on the caller's display. Two different services are defined for CLI:

1. The *presentation* (CLIP) service is the normal option where the caller's number is shown in the phone's display.
2. The *restriction* (CLIR) service is an option that the calling party may wish to exercise that does not show the calling party's number to the called party.

Connected line identification (COL) is the opposite of CLI; it lets the calling party see the number to which he or she is connected. This is a helpful feature when a call is forwarded to a different number. Two different services are specified for COL:

1. The *presentation* (COLP) service shows the called number to the caller.
2. The *restriction* (COLR) service lets the called party block the display of the forwarded-to-number on the calling party's terminal.

Call waiting (CW) is an indication to a *busy* subscriber that another caller is trying to reach him. *Call hold* (CH) complements the CW service in that it allows the subscriber to put active calls on hold in order to answer waiting calls or set up multiparty calls.

Multiparty communication (MPTY) lets a subscriber set up calls to more than one party.

Closed user group (CUG) is a service borrowed from the trunking systems briefly described in Chapter 3, where a group of users, such as a fleet of taxi drivers, share the radio resources with short dialing numbers of only a few digits for each other.

Advice of charge (AoC) provides a subscriber with charging information. The subscriber is not only able to check on ongoing charges (in-call) but also accumulated call charges (previous calls).

Unstructured supplementary services data (USSD) provide the network operator with a tool to define proprietary supplementary services using simple control strings that only have meaning within the home network.

Operator-determined barring (ODB) is not a subscriber-accessible service. It lets the network operator control certain feature groups for individual subscribers. Think of someone who does not pay his or her phone bills.

4.2.3 Phase 2 network improvements

Phase 2 added new mechanisms to the infrastructure to handle the radio resource, location management, call control, and higher level functions throughout the network. They are completely transparent to the user and they let the network operator use his or her resources (e.g., the radio frequencies) more effectively.

Phase 2–compatible equipment, fixed and mobile, must support the Phase 2 features and its signaling. Compatibility is controlled by a type approval regime described in Chapter 2. The first real Phase 2 mobile equipment that supported both the signaling and the services appeared at the end of 1996. Before 1996, some Phase 1 mobile phones supported many of the Phase 2 supplementary services, thus giving GSM subscribers some benefits of Phase 2 before it was officially introduced. Phase 2 features require sophisticated support from the networks, but there are many differences in support details among the networks. Confusion appears in those countries that have legal restrictions against the

introduction of certain features like CLI. The reason for this was that some suppliers of infrastructure had the presentation (CLIP) implemented before the restriction (CLIR), but privacy concerns dictate that CLIP is not allowed to be introduced without CLIR. Table 4.2 gives an overview of the new Phase 2 services. The Phase 1 services are still valid but have been amended to the Phase 2 specifications. Terminal compatibility is maintained—any phase of network will accept any phase of terminal.

Table 4.2
Additional Features Covered by GSM Phase 2

Service Category	Service	Comment
Teleservices	Half-rate speech codec (HR)	Optional implementation, implying the use of dual rate (half rate and full rate) in one phone
	Enhanced full-rate speech codec (EFR)	Optional implementation, implying the use of dual rate (enhanced full rate and full rate) in one phone
Supplementary Services	Calling line identification (CLI)	Presentation and restriction of displaying the caller's ID
	Connected line identification (COL)	Presentation and restriction of displaying the called ID
	Call waiting (CW)	During an active call, the subscriber will be informed about another incoming call (offered together with call hold)
	Call hold (CH)	Put one call on hold in order to answer/originate another call (offered together with call waiting)
	Multiparty communication (MPTY)	Up to five ongoing calls can be joined to a multiparty communication
	Closed user group (CUG)	Similar to a feature known from trunking services
	Advice of charge (AoC)	On-line charge information
	Unstructured supplementary services data (USSD)	Allows operator-defined individual services
	Operator-determined barring (ODB)	Enables the operator to restrict certain features from individual subscribers

4.3 Phase 2+

As we explained in the introduction to this chapter, Phase 2+ includes all additional features specified for GSM after October 1995 (the freezing date for Phase 2). ETSI distinguishes yearly releases, thus we discuss here Release 96 and Release 97.

4.3.1 Release 96

As new *flavors* are added to GSM, such as railway operations and communications applications, special features required by particular users make their way into the specifications.

4.3.1.1 Release 96 teleservices

In the service group of the *teleservices* we find some examples. The *voice group service* (VGS) was introduced on behalf of the European railway organization and defines two services:

1. The *voice group call service* (VGCS) provides an effective way to set up a group call within a very short time to predefined groups; this is much faster than multiparty calls because multiparty calls are not predefined.
2. The *voice broadcast service* (VBS) enables the originator to make verbal announcements in a manner similar to broadcast announcements on a radio to a predefined group.

Extensions to the SMS alphabet became necessary as more Arabian and Asian countries joined the GSM community. Because these countries are already accustomed to paging services in their own languages and characters, the Roman-character-based GSM short message service is no longer acceptable. The introduction of the *Universal Coding Scheme 2* (UCS2) helps to cover Arabian and Chinese characters.

The *cell broadcast service* (CBS) was initially used for the transmission of local-area information and for tariff notifications. Operators wishing to implement new services based on CBS realized that the information capacity on a single-cell broadcast channel was not sufficient for the additional traffic. A second SMS cell broadcast channel introduced for Phase 2+ will help overcome the capacity problems.

4.3.1.2 Release 96 bearer services

Major improvements were achieved for the bearer services in Release 96. With more applications being accessible through GSM (e.g., Internet browsing), the bandwidth limitation of the 9600-bps data channel became apparent. The solution was *high-speed circuit-switched data* (HSCSD), which allows a combination of up to eight time slots for a single communications link. Combining eight time slots allows anyone to use eight times the capacity of a single slot, which could be up to 8 × 9.6 Kbps = 76.8 Kbps when using 9.6 Kbps for each traffic channel. In practice, the data rate will be limited to 64 Kbps, which is the maximum data rate on an ISDN channel.

Packet data on signaling channels (PDS) is an intermediate answer to the demand for data services. Because packet data services borrow signaling resources, the implementation effort in the networks is reduced and will be available sooner. The data rates for PDS range from 600 to 9600 bps. Modest data applications (downloading e-mail and other information packages) might be done more economically by using packet data services over the air rather than with normal Phase 1 data services and certainly more efficiently than with HSCSD.

The highest possible data rate on a single GSM data channel, defined as a time slot on an assigned frequency, is 9.6 Kbps. Implementations in the fixed network today can achieve much higher standard user data rates of up to 33.6 Kbps (PSTN) or 64 Kbps (ISDN). Work has been finalized on a new service offering 14.4 Kbps on a single time slot. The higher 14.4-Kbps rate data channel combined with HSCSD will improve the data rates when combining multiple time slots.

4.3.1.3 Release 96 supplementary services

Release 96 brought modest improvements to the supplementary services.

Explicit call transfer (ECT) allows a subscriber to pass a call on to another subscriber, a feature borrowed from the office PBX. This will be a very useful feature especially for business users, but its early introduction may be delayed until security provisions to avoid misuse are in place.

Enhanced multilevel precedence and preemption service (eMLPP) is another service introduced to meet the needs of the European railway organizations. The eMLPP service allows someone to assign priority to certain calls upon subscription. When high-priority calls meet limited resources the network will preempt other calls to free up the resources. This service is

dedicated to certain user groups that need to have this priority, for example, train personnel or security services. Therefore, the "standard" users of GSM will very likely never be able to subscribe to, or make use of, the eMLPP service.

4.3.1.4 Release 96 SIM

Though we did not mention it in the Phase 1 and Phase 2 reviews, the SIM has always followed the growth of GSM services. Phase 2+ swings a bright light onto the SIM's ability to bring unique—and portable—features to GSM. We call on four examples to illustrate how the SIM can enhance the portability of features, setups, and configurations from one mobile phone to another.

1. *Barred dialing numbers* (BDN) allow a subscriber who gives away his phone—or, more precisely, gives away his SIM card—to bar certain numbers from being called. This is a complementary feature to outgoing call barring or the barring of international calls.

2. There has been a tendency in Europe to subsidize mobile equipment in order to increase the number of subscribers; the cost of the phone is seen as an artificial barrier to the regular collections of subscriber fees from people who, save for the cost of the phone, are willing to pay for them. Because the subsidy is not the same in all countries and markets, operators wanted a way to protect their investment in their subscriber base by personalizing the mobile equipment. The *ME personalization* feature not only specifies an operator lock, but also the personalization of an ME to an individual SIM as a protection against theft. There is also a corporate lock and a service provider lock, which is used depending on who subsidizes the mobile equipment. This ME personalization is often referred to as *SIM lock,* which is a misnomer since it is the phone that is locked to a SIM and not the other way around.

3. The *service dialing numbers* (SDN) feature allows the operator to program dedicated service numbers into a write-protected area of the SIM card.

4. One major improvement is the *SIM application toolkit,* which provides the operator with a variety of possibilities to create new

features. These are completely network dependent and range from basic activation of the SIM over the air to changing parameters on the SIM to the introduction of elaborate packages of value-added services such as hotel or flight bookings.

4.3.1.5 Release 96 network improvements

Phase 2+ also introduced new features to the network itself. *Network identity and time zone* (NITZ) provides a new means to transfer the network identity, the network's name, to the mobile equipment. Before Phase 2+ the identities of known networks were programmed into the mobile equipment in the form of codes or numbers representing the network. As new networks opened up it took time for new mobiles to support the new names; older phones would only display the digits of the code identifying a new network; not its name. Consider the example of when a network changes its name for commercial, legal, or marketing reasons. NITZ not only provides the means to inform the mobile equipment about new network identities in plain characters but also about the local time and the time zone in which a mobile station is roaming [4].

Customized applications for mobile network enhanced logic (CAMEL) brings IN features to GSM. By leaving the implementation of new Phase 2 and Phase 2+ features exclusively to the operators, roaming customers accustomed to a certain service feature in their home country and network could not enjoy the same feature in another country. CAMEL provides the facilities that allow roaming subscribers the same features they enjoy in the home network. CAMEL will be introduced in two phases: Phase 1 of CAMEL is part of Release 96 and Phase 2 of CAMEL is part of Release 97.

A widely discussed opportunity for the deployment of GSM access and services is *radio local loop* (RLL). Particularly in remote areas with little or no fixed line coverage at all, RLL will provide efficient and economic solutions for providing wireless coverage as a substitute to traditional fixed lines [5]. RLL provides wireline service by using the GSM infrastructure, which could include all of its entities (MSC, BSC, BTS, etc.), or only the radio parts (BSC and BTS). It is much cheaper and faster to roll out telephone services by using radio access than wiring the whole countryside. An RLL may use GSM technology but would not necessarily be operated by GSM operators. There is a goal within the GSM community not to alter the GSM implementation, particularly in the area of mobility

management, just for RLL. Allowing changes would result in different dialects of GSM, which may raise the prices of equipment because of incompatibilities.

Call charges for roaming subscribers can become very expensive because calls are not necessarily routed in ideal ways. The *support of optimal routing* (SOR) feature enables GSM operators to clear most common routing problems. This will have a major impact on roaming call charges. Table 4.3 lists the additional GSM features introduced in Release 96 of Phase 2+.

Table 4.3
Features Covered by Release 96 of GSM Phase 2+

Service Category	Service	Comment
Teleservices	Voice group service (VGS)	Voice group call service (VGCS) and voice broadcast service (VBS), both defined for UIC applications
	Extension to the SMS alphabet	Allowing UCS2 with 16-bit character representation
	Second SMS cell broadcast channel	Increasing capacity for cell broadcast services (CBS)
Bearer Services	High-speed circuit-switched data (HSCSD)	Combination of up to eight time slots for a single link
	Packet data on signaling channels (PDS)	Reusing signaling resources for packet data traffic
	14.4-Kbps user data rate	
Supplementary Services	Explicit call transfer (ECT)	
	Enhanced multilevel precedence and preemption service (eMLPP)—Phase 1	Priority for certain calls defined for UIC applications
SIM Features	Barred dialing numbers (BDN)	Bars certain numbers from being called
	ME personalization	Allows restriction of phone usage to particular SIM cards (subsidy protection)
	Service dialing numbers (SDN)	Preprogrammed service numbers on the SIM, protected from erasure by subscriber
	SIM application toolkit	Vehicle for operators to define their own value added services

Service Category	Service	Comment
Network Features	Network identity and time zone (NITZ)	Simple "download" of network-related information and data to the MS
	CAMEL—Phase 1	IN features for roaming GSM subscribers
	Radio local loop (RLL)	GSM extension for fixed networks
	Support of optimal routing (SOR)	Reduced charging due to optimized routing

4.3.2 Release 97

At the time of this writing the following items were being considered for Release 97 of Phase 2+.

4.3.2.1 Release 97 bearer services

The hottest item in the group of bearer services is the *general packet radio service* (GPRS), which is a general packet service with a dynamic allocation of resources. Different channel coding (data rates of up to 21.4 Kbps per single time slot) and the option to use up to eight time slots will accommodate a wide variety of data rates up to 100 Kbps. GPRS affects the air interface and also specifies new network entities and functions; its deployment will be slow.

4.3.2.2 Release 97 supplementary services

The group of supplementary services gets more attention in Release 97.

One focus is on call completion services, *completion of call to busy subscriber* (CCBS), which enable the network monitor the called party for the caller rather than letting the caller tie up network resources trying to get through to a busy phone. When the network detects that the called party finally completed his phone call, it will first set up a call to the calling party and then try to connect the called party.

Support of private numbering plan (SPNP) will be interesting to large companies that tend to have their own internal numbering plans for outside numbers. This means that a number used internally will be mapped onto a PSTN or PLMN number inside the private switch. The advantage is that the internal number of a called party remains the same even as the

outside version in the PSTN or PLMN changes. An example illustrates the private numbering scheme. The sales force of the X Company, a grocery supply firm, uses dedicated mobile phone numbers that are grouped according to their product ranges. This helps the staff at the home office remember the numbers: people who sell fruits and vegetables always have numbers that start with a "1," and people who sell paper products always have phone numbers that start with a "2." This handy scheme would be very difficult to implement in a real network. It would be nice if each outgoing call, identified with a private numbering plan, could eventually find its way to a matching phone number through a database stored in the network. In our example the private numbering plan only works for staff from the X Company because they subscribed to the service. X Company's customers would still have to call the individual sales managers through their normal, outside phone numbers. A subscriber may be part of up to nine different private numbering plans in a SPNP scheme.

Multiple subscriber profile (MSP) gives a subscriber the ability to have multiple profiles, including multiple subscriber numbers: one for business and one for private use with different subscription options. This is the same as having two subscriptions with one SIM. This also implies that this specific user has the choice to forward incoming calls to different numbers depending on whether it is a private or business call, or it allows the subscriber to let private calls use a different ringing tone than business calls.

4.3.2.3 Release 97 network improvements

Another improvement intended for the network in Release 97 of Phase 2+ is provision for *hot billing*. This enables network entities to service ongoing charge records much faster, thus helping fight fraud. It also allows for additional services such as prepaid SIM cards, which we already have in Phase 1 networks, but with proprietary protocols in the network equipment. The proprietary systems are replaced with a standard procedure. Table 4.4 offers an overview of additional features and services likely to be introduced in Release 97.

4.4 Conclusion

This short overview of features shows that GSM has come a long way from a simple second-generation mobile phone system—the advanced

Table 4.4
Work Items in Release 97 of GSM Phase 2+

Service Category	Service	Comment
Teleservices	Emergency call with additional data transfer	Possible combination of GPS and GSM
	Voice group service	Voice group call service—Phase 2, defined for UIC applications
		Voice broadcast service—Phase 2, defined for UIC applications
Bearer Services	General packet radio service (GPRS)	Data rates of up to 21.4 Kbps per channel/time slot, up to eight time slots used per communication
Supplementary Services	Call deflection	Divert call to any not preprogrammed number without accepting the phone call
	Completion of call to busy subscriber (CCBS)	Network monitors the "busy" called party
	Support of private numbering plan (SPNP)	Individually assigned numbers (e.g., for large companies)
	Multiple subscriber profile (MSP)	Different profiles on one subscription
	User to user signaling	Direct exchange of smaller data packages
	Enhanced multilevel precedence and preemption service—Phase 2	
Network Features	CAMEL—Phase 2	Expansion of CAMEL
	Provision for hot billing	Immediate processing of call records

features will be accepted as standard telecommunications fare in third-generation systems. One big disadvantage of GSM remains: its lack of bandwidth. A third-generation system (even when it evolves from GSM) needs to have substantially greater bandwidth that can handle up to 2-Mbps data rates. These kinds of rates will be needed to keep up with the demand for new communications services. We will note a comment by

Friedhelm Hillebrand, chairman of ETSI SMG, that GSM Phase 2+ takes GSM to a *generation 2.5 system* [6].

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