

GSM Wireless Data

White Paper

Author:

Andrew Till

Technology Strategist

Andrew-Till@Psion.Com

Contributors:

Lionel Wolovitz

Andrew Morrow



CONTENTS PAGE

OVERVIEW	1
SUMMARY	1
INTRODUCTION	2
WORLDWIDE DEPLOYMENT OF GSM	3
<i>Regional overview</i>	3
Africa.....	3
Asia Pacific.....	3
Central and Eastern Europe.....	3
Indian Subcontinent.....	3
Middle East.....	4
North America.....	4
Western Europe and Southern Europe.....	4
WHY WAS GSM DEVELOPED?	5
WHAT IS ROAMING?.....	5
<i>National Roaming</i>	5
<i>International Roaming</i>	5
SUBSCRIBER IDENTIFICATION MODULE (SIM)	6
WHAT IS GSM WIRELESS DATA?	7
HOW DOES GSM DATA WORK?	7
TRANSPARENT MODE.....	7
NON-TRANSPARENT MODE.....	8
FAX.....	8
INTERWORKING WITH ISDN	8
USING YOUR GSM DATA SOLUTION ON DIFFERENT NETWORKS	8
THE BENEFITS OF USING GSM DATA	9
USE ANYTIME, ANYWHERE.....	9
EASE OF USE FOR INTERNATIONAL TRAVELERS	9
SECURE COMMUNICATIONS	9
QUICK CALL SET-UP.....	9
MINIMIZING THE COST OF USING GSM DATA	10
MOBILE TO MOBILE CALLS.....	10
HIGHER DATA SPEEDS	10
INTERWORKING WITH ISDN	10
USE THE RIGHT NETWORK	10
GSM DATA APPLICATIONS	11
MOBILE INTERNET ACCESS	11
REMOTE DATABASE ACCESS	11
E-MAIL	11
SHORT MESSAGE SERVICE (SMS)	11
FILE TRANSFER & REMOTE LAN ACCESS.....	12
GROUP 3 FAX.....	12
GSM DATA FOR HANDHELD COMPUTERS	13
LOWER POWER CONSUMPTION.....	13

PC CARD SUPPORT	13
EASY TO UPGRADE	13
KEY ISSUES FOR GSM DATA SOLUTION VENDORS.....	14
GSM DATA STACK	14
<i>Network implementation</i>	14
<i>Multi-country testing</i>	14
<i>Supporting and upgrading products</i>	14
PROVIDE A RANGE OF PRODUCTS	14
<i>PC Cards</i>	14
<i>Software solutions</i>	15
SUPPORTING A RANGE OF HANDSETS.....	15
<i>Co-operation of the handset manufacturer</i>	15
<i>Complex data interfaces</i>	15
<i>Handset protocols</i>	15
<i>Internal development skills and resources</i>	15
KEY ISSUES FOR GSM DATA USERS	16
GSM DATA INTERFACES	16
BENEFITS OF USING AN APPROVED PRODUCT	16
<i>Optimised performance</i>	16
<i>Feature rich capabilities</i>	16
<i>Future upgrades to new services</i>	16
<i>Future upgrades for new phones</i>	16
DRAWBACKS OF USING A REVERSE ENGINEERED PRODUCT	17
<i>Support</i>	17
<i>No future upgrade path</i>	17
SUPPORTING GSM DATA USERS.....	18
FUTURE DEVELOPMENTS FOR GSM DATA	20
DATA COMPRESSION	20
<i>Non transparent mode</i>	20
<i>Transparent mode</i>	20
INCREASED DATA SPEEDS.....	20
<i>14.4Kbps</i>	20
<i>High Speed Circuit Switched Data (HSCSD)</i>	21
<i>General Packet Radio Services (GPRS)</i>	21
CONCLUSIONS	22
FURTHER SOURCES OF INFORMATION	23
GSM MEMORANDUM OF UNDERSTANDING (GSM MoU).....	23
MOBILE DATA INITIATIVE (MDI).....	23
ERICSSON	23
NOKIA	23
MOTOROLA.....	23
GLOSSARY OF TERMS	24

TABLE OF FIGURES

FIGURE 1: WORLDWIDE GSM SUBSCRIBER FORECAST, 1992 - 2001	2
FIGURE 2: GSM NETWORKS LICENSED WORLDWIDE	3
FIGURE 3: ESTABLISHING A GSM DATA CALL.....	7

GSM Wireless Data - *White Paper*

Overview

This white paper provides an introduction to the concepts of using GSM for wireless data communications. The nature of this paper is to provide the user with a grounding in the benefits of and applications for GSM data, it does not intend to provide extensive information on the workings of the GSM network. For a more detailed explanation of the GSM network, the reader is advised to contact their GSM service provider.

Summary

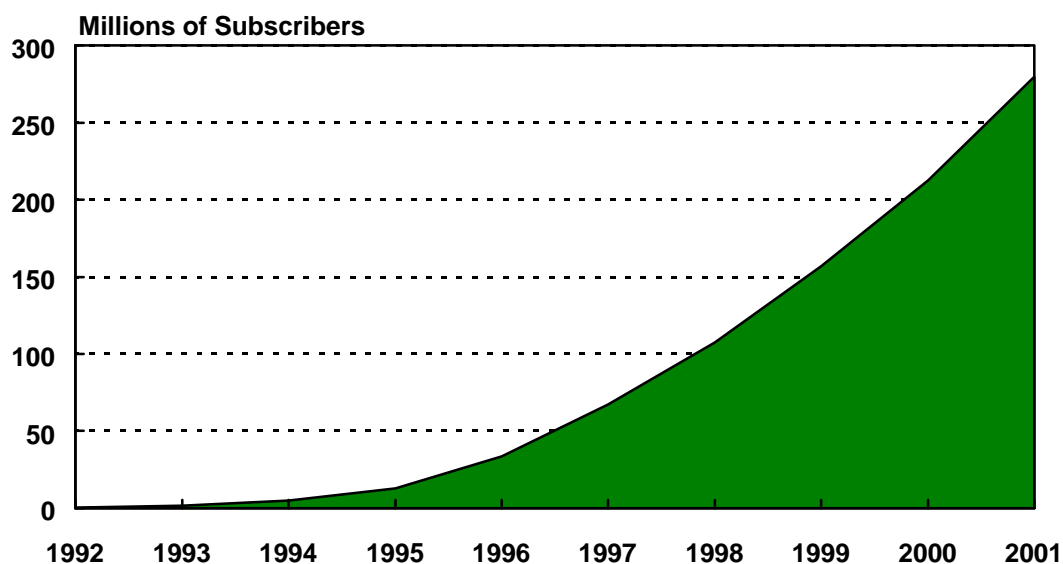
- GSM is a global standard for digital wireless communications, with extensive roaming capabilities for both voice and data services.
- GSM has been commercially available since 1992.
- GSM networks are currently operating in more than 100 countries worldwide.
- There are now in excess of 55 million GSM subscribers worldwide.
- GSM offers advanced mobile data capabilities, previously unavailable on analog cellular networks.
- GSM data offers mobile workers a use anytime, anywhere capability, unmatched by fixed telephone networks.
- Wireless GSM data can be used for a wide range of applications including Email, Facsimile, Internet access and Remote LAN Access.
- GSM is uniquely positioned to meet the mobile data needs of handheld computer users.
- Co-operation between the GSM handset manufacturer and data solutions providers is key to developing reliable, robust products.
- Users should select a GSM data solution vendor with developed expertise and experience in GSM data.
- The cost of using GSM data is reducing over time.
- GSM data solutions work with all GSM networks (GSM 900, DCS 1800 and PCS 1900).
- In the near future, high speed data services will be available, which will provide both circuit switched and packet based services.

Introduction

Since the introduction of the mobile phone in the early 1980's it has become a vital tool for the modern businessperson. As organisations continue to become increasingly internationalized, the need for effective mobile voice and data communications continues to grow. Increasingly data is being seen as a key service alongside the traditional voice services offered by wireless network operators. Whether mobile workers want to connect to their corporate LAN, manage their e-mail, send a fax or surf the web for the latest news stories, they have an increasing need to access information, and remain "In Touch" from any location.

With the deployment of PCS 1900 networks in the United States, GSM is now the first truly global standard for wireless communications¹. Since its original development GSM has grown rapidly to emerge as the leading standard for digital wireless communications worldwide. Currently there are more than 200 licensed networks in over 110 countries around the world. This makes GSM the only digital wireless standard with a proven track record for quality and reliability worldwide.

Figure 1: Worldwide GSM Subscriber Forecast, 1992 - 2001



Source: Dataquest (October 1997).

Owing to the unprecedented growth in the number of cellular subscribers worldwide, network capacity and the available radio frequencies in different countries, the original GSM 900 MHz standard has been extended to operate at three frequencies, these are:

- **GSM 900** The most widely implemented version of GSM. The 900MHz frequency is reserved across Europe for GSM.
- **DCS 1800** Often referred to as Personal Communications Network (PCN), DCS 1800 operates in the 1.8GHz frequency range. To date DCS 1800 is licensed for use in 20 countries worldwide.
- **PCS 1900** Operates in the 1.9GHz frequency range. PCS 1900 is the standard for GSM in North America (also referred to as North American GSM).

¹ PCS (Personal Communications Services) refers to a range of 2nd generation digital wireless standards. In 1995 the Federal Communications Commission held auctions to license network operators. GSM (Global System for Mobile Communications) was the natural choice for many of the licensed network operators.

Worldwide deployment of GSM

The first GSM network went live in 1992, since then, the installed base of subscribers has grown at an astonishing rate, faster than any other wireless technology. By the end of 1997, the market research company Dataquest estimates that there will be 67 million GSM subscribers worldwide, with over 1 million in the United States. This number is expected to exceed 280 million by the year 2001 (see figure 1), accounting for approximately 60% of all digital wireless users. Today, GSM is licensed for operation on every continent of the world.

Figure 2: GSM Networks Licensed Worldwide

Region	Countries	GSM -900	DCS-1800	PCS-1900	Total
Africa	23	29	0	0	29
Asia Pacific	19	31	11	0	42
Central and Eastern Europe	19	39	2	0	41
Indian Subcontinent	5	24	0	0	24
Middle East	14	22	0	0	22
North America	2	0	0	18	19
South America	2	1	0	2	2
Western & Southern Europe	26	44	10	0	54
Total	110	190	23	20	233

Source: GSM MoU (October 1997).

Regional overview

Africa

The development of GSM in Africa has increased rapidly over the last 2 years, with 23 networks now licensed for operation within the region. Africa holds a lot of potential for mobile communications, with many areas being difficult to cover with traditional landline communications. GSM also offers high quality international calling capabilities, which are currently limited within the region. Coverage is currently focused around metropolitan areas, to service the business community.

Asia Pacific

The Asia Pacific region has widely embraced the concept of GSM. Despite strong competition from existing cellular technologies, GSM operators continue to see their subscriber base increasing rapidly. Specifically the markets in Australia, China, India and Thailand are exhibiting strong signs of dynamic growth, as GSM brings mobile communications to a much larger audience. Altogether 24 countries in the Asia Pacific region now operate GSM networks including, Hong Kong, Singapore and Taiwan.

Central and Eastern Europe

Central and Eastern Europe is now moving over to GSM technology, as it strives to develop its telecommunications infrastructure. GSM is viewed as a key enabling technology in helping the countries in this region to develop their economies, such as Czech Republic, Poland and Russia. With a shortage of landline based communications, GSM allows quick network set-up and service delivery, as well as providing increased international communications capabilities. Furthermore GSM is helping to bring communications to areas previously inaccessible by normal landline communications.

Indian Subcontinent

The Indian subcontinent is expected to be a fertile region for GSM. With poorly developed fixed line networks, GSM provides for quick deployment of service combined with high quality voice and data services. With a very small number of international telephone lines, GSM data services could quickly become vital for developing businesses with the region. GSM services are now available in India and Pakistan.

Middle East

Many countries in the Middle East are now rolling out GSM networks, as they move to improve both internal and external communications infrastructures. It is anticipated that these markets will grow strongly, both in terms of business and consumer users over the next decade. GSM services are currently available in 13 countries, including Egypt, Saudi Arabia and the United Arab Emirates.

North America

In North America, GSM has been introduced in the 1900MHz frequency band. The first North American GSM networks became commercial operational during the middle of 1996, confirming GSM's position as a truly global standard. With the establishment of the GSM Alliance, network operators are now able to provide coverage throughout the United States and Canada following the establishment of roaming agreements between different operators². The number of GSM subscribers in North America is also expected to grow rapidly, with the appeal of nation-wide and global roaming capabilities expected to attract users. Currently, there are almost 1million subscribers in the United States. Many industry experts expect this number to surpass 5 million by the turn of the century.

Western Europe and Southern Europe

Western Europe is the largest market for GSM, with over 30 million subscribers, and ubiquitous coverage throughout the region. Many of the first commercial GSM systems were based in Europe, as intense competition lead to an early adoption of digital cellular technology. Already within Europe, certain areas such as Scandinavia have penetration rates (GSM phones per 100 population) in excess of 30%.

² The GSM Alliance was founded in August 1997. The initial members of the Alliance are Aerial Communications Inc., BellSouth Mobility DCS, Microcell Telecommunications Inc., Omnipoint Communications Services Inc., Pacific Bell Mobile Services Inc., Powertel Inc. and Western Wireless. More network operators will be invited to join the alliance during 1998.

Why was GSM Developed?

GSM was developed as a response to the experiences of the early 1980's with analogue cellular systems. Although these first generation networks experienced strong growth, they were limited by a number of factors. Typically each country's cellular network only worked within national boundaries. Coverage also tended to focus on transport infrastructure as many early wireless systems were developed for in car use. It was recognized that this presented several limitations in terms of both mobility and cost, in addition infrastructure and handset manufacturers could not realize large economies of scale, and hence equipment costs remained high.

From the start, GSM was designed to be a personal service for individual use by both business and consumer users. GSM also provides for interworking with the existing fixed networks such as the POTS³ and ISDN⁴ networks, as well as other GSM networks around the world. This allows for the provision of a wide range of services for both business and consumer user alike. GSM offers higher quality speech (owing to its digital nature) and integrated data services for a wide range of applications, which can be used both domestically and internationally.

What is roaming?

The provision of roaming services has undoubtedly been one of the key drivers behind the success story of GSM.

Roaming is the ability for a subscriber to make and receive calls outside their home network. This is one of the key differences between the first generation analog cellular networks and second generation digital cellular networks such as GSM. Before roaming is possible network operators must first establish and implement a roaming agreement.

Today some GSM network operators have in excess of 60 international roaming agreements, spanning GSM 900, 1800 and 1900 networks. This allows network operators to provide their customers with A worldwide service⁵ unmatched by any other cellular technology.

When users are roaming either nationally or internationally, all their call and service charges are billed to their home network⁶.

National Roaming

Following the establishment of the GSM Alliance, affiliated network operators can offer their subscribers nationwide roaming services through the United States and Canada. The alliance provides for seamless roaming of both voice and data services.

Apart from the 7 founder members of the GSM Alliance, other GSM network operators in North America have shown support for the Alliance, and will be invited to join the Alliance during 1998.

Another benefits of the Alliance, is the implementation of "611" as a customer support number. This allows users can gain support regardless of the network they are using, or their location.

International Roaming

Outside North America, GSM users can roam seamlessly throughout Europe, and in more than 60

³ Plain Old Telephone System

⁴ Integrated Services Digital Network.

⁵ Users should always check with their service provider to ensure that they have the relevant roaming agreements. Many network operators will charge a premium for offering roaming services.

⁶ Users should consult their network operator for advice on roaming call charges.

other countries around the world. This provides a level of mobility unmatched by any other cellular technology.

As stated previously, GSM networks operate at different frequencies outside North America, and as a result users roaming internationally may need to change the phone that they are using. All a user needs to do is simply hire or buy the appropriate phone, and insert their existing SIM card in to the phone (for an explanation of a SIM card see the following section), this is referred to as "SIM Card Roaming". Users will then be able to make and receive calls, as they would using their normal phone. Many network operators now operate hiring schemes for their subscribers who wish to roam internationally.

Advances in phone technology will soon see the availability of phones that can work on different frequencies. This will eliminate the need to change phones when travelling outside North America.

Subscriber Identification Module (SIM)

The SIM card or "Smart Card" is a small card that fits inside a GSM phone, and contains an individual subscriber's personal information. The information contained on the SIM card is used for identification and authentication of a subscriber by the GSM network, and hence acts as a security key. The SIM card provides a high level of security, making it extremely difficult to make fraudulent calls using GSM. To date, there have been no known cases of fraudulent use.

The SIM card also provides personal mobility for an individual, allowing them to access all of their personal services (such as voice mail, call forwarding etc.) regardless of the phone that they are using. The SIM card also provide a limited amount of local storage, which can contain names and telephone numbers, missed call, SMS text messages and notification information from their network operator.

Because a SIM card can be moved from phone to phone, this allows users to easily change or upgrade their phone, whilst retaining all of their personal information and phone number. As outlined above, this is a very important feature for subscribers who wish to roam outside North America, where GSM operates at different frequencies.

The rest of this white paper will now focus on GSM's data capabilities.

What is GSM Wireless Data?

Put simply it is the ability to send data or fax information over the GSM network. Over the last year, data over GSM has become a “Hot” topic within the GSM industry. Data over GSM offers new opportunities for both GSM network operators and mobile workers alike. By using GSM to send and receive data or faxes, mobile workers have access to a level of geographic mobility previously unobtainable.

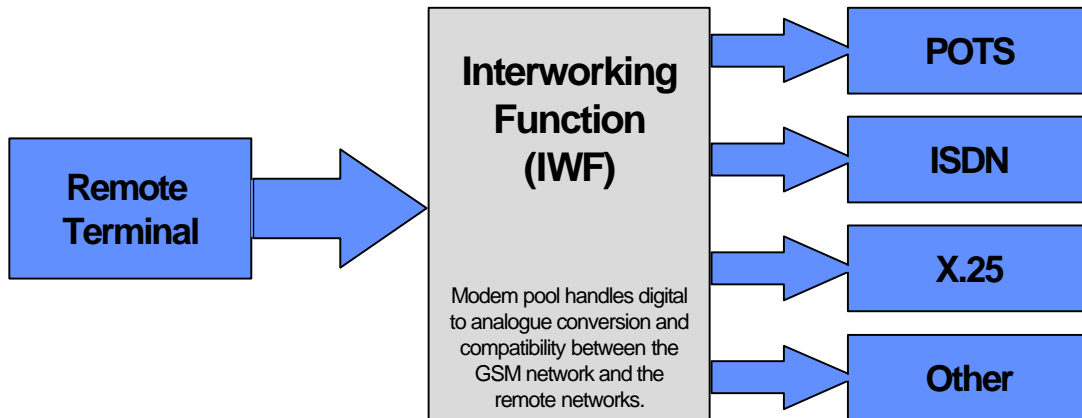
At present a user can send data over the GSM network at speeds of up to 9.6 Kbps per second. Although this is notably slower than today’s land line modems, ETSI⁷ is continuing to develop the GSM standard. A more detailed explanation is provided in the section entitled “Future Developments for GSM Data”.

How Does GSM Data Work?

This section will give a brief overview of how GSM data works.

When a user wishes to make a data call, they simply dial the number they wish to send information to. The GSM network connects the user’s call to its Interworking Function (IWF), which then completes the call to the remote terminal. In effect the user is dialing the IWF, and then the IWF is dialing the remote terminal. The IWF acts as a gateway, translating between the GSM set of protocols, and the protocols used by different types of networks. This allows a GSM network to connect to a range of different network types, such as a POTS, ISDN or X.25 network. This is illustrated in figure 3.

Figure 3: Establishing a GSM Data Call



Once a connection between the mobile user and the remote terminal has been established data can then be transmitted. Data can be sent over the GSM network using one of two modes, these are known as transparent mode and non-transparent mode.

Transparent mode

In transparent mode, a non error corrected connection is established between the user and the remote terminal. Data is then sent asynchronously. Because no error correction is taking place, there is little delay (latency) in transmitting data over the link.

⁷ European Telecommunications Standards Institution. ETSI is the organization that developed the GSM standard and is responsible for its continuing development.

Non-transparent mode

In non-transparent mode, a secure error corrected link is established between the mobile terminal and the remote modem. The connection between the mobile terminal and the GSM network uses the Radio Link Protocol (RLP) for error correction. The IWF then establishes a connection to the remote modem.

Apart from having an error corrected link, there are two other main benefits to using non-transparent mode, these are:

- An increase in data throughput of approximately 20 percent⁸.
- Better call handling by the GSM network.

Fax

Sending a fax is very similar to sending data. To send a fax, an initial call is made to the network. The call is then routed through the network to the IWF. The IWF then establishes a connection to the remote fax machine. The fax protocols are then passed end to end between the mobile terminal and the remote fax machine.

Fax data is transmitted synchronously and is not tolerant of any latency; therefore transparent mode must be used

Interworking with ISDN

One of the key advantages that GSM can offer users, is the ability to interwork with ISDN. This is a core feature of the GSM standard, which has been developed to fully interwork seamlessly with ISDN.

Interworking between the ISDN and GSM networks is made possible by using a technique known as rate adaptation. If the ISDN terminal adapter being called by the GSM terminal is capable of supporting V.110⁹ it will be able to adapt the 9.6Kbps data from the GSM terminal, into 64Kbps ISDN data. This is achieved by adding additional bits to the GSM data, effectively packing out the data.

By using the interconnection feature of ISDN, GSM users can utilize ISDN's fast set-up feature. This will allow data calls to be established in less than 5 seconds, this can offer significant time and cost savings over dialing into traditional modems, where call set-up can take from 40 seconds upwards.

Many Internet Service providers and remote access equipment vendors are now providing support for GSM data users.

Using your GSM data solution on different networks

As stated in the introduction, GSM, DCS and PCS networks are all based on the same core set of GSM standards, but are implemented at different frequencies. A GSM data solution will be able to work on all of these networks¹⁰, as they all use the same set of data protocols. However the user will need a compatible handset for use on each type of network. Many leading handset manufacturers are now developing Dual-Band and Tri-Band handset products¹¹, providing for increased roaming capabilities between the different types of GSM networks.

⁸ This is a result of using RLP for error correction. RLP converts the asynchronous PC originated data into synchronous data for transmission across the GSM network. This is done by stripping out the stop and start bits of the asynchronous data.

⁹ ITU standard for rate adaptation for ISDN terminals.

¹⁰ For other manufacturers products, you will need to consult the individual manufacturers.

¹¹ Dual-band means that the handset is capable of working on 2 different Radio Frequency bands such as GSM 900 and DCS 1800. Dancall, Ericsson and Motorola have already announced Dual-Band handsets. Ultimately tri-band products or GSM "world phones" will be available that operate with all 3 GSM standards.

The Benefits of Using GSM Data

Use of GSM's data capabilities is now emerging as a key tool for business, but for many companies understanding the true benefits derived from using GSM data remains a key issue. For many years cellular communications have only been associated with voice communications, hence for many, using the GSM network for data is a new concept. Many of the benefits derived from using GSM data are similar to the benefits of using mobile phones. Below some of the key benefits are outlined.

Use anytime, anywhere

The major benefit of using GSM data is that you can use it from any location at any time. There is no need to rely on being able to gain access to a POTS line, or wasting time trying to find one. Using GSM provides for a faster response time for mobile employees. This is becoming an increasingly important factor in countries where the POTS network is underdeveloped.

If used in this way, GSM can provide a real competitive advantage to an organization. For example, sales people out in the field can send information to relevant parties immediately. This can allow a company to differentiate itself from its competitors, by its ability to be respond to their customers needs in a time frame that meets (or exceeds) their customers' requirements.

Ease of use for international travelers

Using the POTS in a foreign country can often prove to be a daunting and complex operation, both for the technically adept and techno-phobics. For example, the user needs to select the correct telephone connector, ensure that the modem is approved for connection to the POTS within that country, and deal with potential line quality and integrity issues for use over long distances. All this can be side stepped by using GSM, where the user is able to use their equipment in the way they normally would.

Using GSM in a foreign country can also prove to be a more cost-effective solution for mobile data than the fixed network. Typically when staying in hotels, calls are charged at a premium rate making data communications excessively expensive. By using GSM users can actually achieve a cost advantage through bypassing the premium charged by the hotel.

Secure communications

A company's information is sensitive and hence it is important that the integrity of the information is not compromised. Sending data over the POTS network in its analogue form is not secure. Only a very small number of modems are capable of encrypting data, and these carry a significant price premium.

Because GSM is a digital technology, it is inherently more secure. As part of the GSM standard, both data and voice transmissions are encrypted for transmission across the network. This has been a key strength for GSM providing piece of mind for users, without the need for additional expenditure on expensive hardware and software.

Quick call set-up

GSM was developed to interwork with the Integrated Services Digital Network (ISDN). ISDN uses a technique known as rate adaptation to convert the slower GSM data up to 64Kbps ISDN data¹². As a result when a data call is made from a GSM handset to an ISDN terminal adapter, the quick call set-up capability of ISDN can be utilized.

Typically, the call set-up time dialing into an ISDN TA is 3-4 seconds, as compared with dialing into a V.34 modem, which will average 35-40 seconds.

¹² Using the ITU V.110 rate adaptation protocol

Minimizing the Cost of Using GSM Data

Cost is one of the key barriers to the uptake and wide spread use of GSM data within an organization. Today GSM calls are comparatively expensive compared to using the fixed network. However, this issue is now starting to be addressed.

Mobile to Mobile Calls

Many GSM network operators offer cheaper calls between two mobile phones connected to their network. This eliminates the need for interconnection to the fixed telephone network, as takes place when a call is made from a mobile phone to a POTS phone. Several leading remote access equipment vendors are also working to integrate GSM access into their products, in order that users can dial directly into the corporate LAN using GSM.

Higher Data Speeds

The speed at which data can be sent across the GSM network will increase over the next 3 years. This will help to significantly drive down the cost of using GSM data (more information on this is provided in the section "Key Developments for GSM Data"). It is also important to ensure that the correct mode is selected for data transmission. For example in poor line conditions, non-transparent mode should always be selected.

Interworking with ISDN

GSM can interwork with ISDN to provide quick call set-up times (see previous section). Many GSM network operators are now providing direct ISDN connections to corporate LANs and Internet Service Providers. As GSM is now almost universally billed by the second, this feature can significantly reduce the cost of using GSM.

Use the right Network

The use of GSM for mobile data applications should not replace the use of other data networks, but provides enhanced connectivity where fixed networks can not provide services. Mobile workers require a combination of POTS and wireless based communications. The choice of POTS or wireless will be based on such factors as geographical location (home, branch office, on the road), ease of access¹⁰ a POTS connection and cost. Selectively using GSM and POTS connections can help to minimize the cost of using mobile data.

In conclusion, while call charges are higher for GSM than the POTS, if the technology is used correctly, the efficiency and productivity of mobile employees can be improved. Many companies are starting to realize that this is an acceptable trade off.

GSM Data Applications

With today's relatively low data rate for GSM, the range of applications has been limited. However as GSM's data capabilities are enhanced, the range of applications for which it can be used will increase. At present Email, fax and mobile Internet access are among the more popular applications. To receive fax and data services to a handset, you will need to obtain a separate fax and data number from your network operator.

Mobile Internet access

The Internet is becoming increasingly important in the commercial world. Having the ability to access the Internet from any location will become a vital tool for mobile workers. Many GSM network operators are now developing dedicated Internet access services, allowing users to dial into a virtual point of presence. Connection to the Internet is typically over an ISDN link, which provides for quicker call set-up and clear-down.

Although Internet access over GSM may be slower than traditional landline Internet access, many web pages now offer text only versions. Alternatively, users can normally configure their web browser not to receive graphical images, thus decreasing the amount of time required for downloading web pages.

Remote database access

Remote database access is becoming an increasingly popular application in the mobile data environment. Often sales people out in the field need up to the minute information, such as pricing, stock details or financial information etc. By enabling remote access to databases over GSM, information can be accessed almost immediately by people away from the office. Many companies are now moving to provide access to databases via the Internet, to take advantage of its local call rates.

E-mail

The ability for mobile workers to send and retrieve electronic mail while away from the office is now a necessity. GSM data users are able to send and receive E-mail in the same way as they would, using a standard modem.

Short Message Service (SMS)

SMS is the method by which short text messages can be sent or received by a GSM handset (in effect users can send GSM's own version of E-mail to each other). To use SMS, the user types the message by pressing the number pad of the phone to correspond with a given letter (i.e. to type the letter b, you would press the number 2 twice).

There are 2 main types of SMS services, point to point and cell broadcast. Point to point is, as would be expected for sending a short message of up to 160 characters to an individual subscriber. Cell broadcast messages are up to 93 characters long, and are typically broadcasts from the network operator to a number of subscribers.

Instead of typing the message on the handset itself, many users find it easier to use software that allows them to type the SMS message using the PC keyboard.

As with the general data services, ETSI has made a number of revisions to the original SMS specification allowing a range of new services to be offered to users. These include concatenated short messages, which provides for the sending of multiple short messages to a user, who can then reassemble the messages to create a large message.

File transfer & remote LAN access

Mobile users can use GSM to remotely connect to their corporate LAN. As GSM is a digital technology, it can be more secure to use GSM as opposed to traditional analogue modems, especially if logging to the corporate LAN from a different country. By default, all voice and data traffic sent across the GSM network is encrypted. GSM uses special encryption keys, which are synchronized between the Subscriber Identification Module (SIM) card and the GSM network.

Most network operators will provide corporate customers with dedicated connection into the corporate LAN, thus bypassing the POTS network, and interconnection charges. If this connection is ISDN, then the benefits of quick call set-up and tear-down can be utilized.

Group 3 Fax

Using fax software, mobile users can send and receive faxes, as if they are actually in their office.

GSM Data for Handheld Computers

So far, this paper has focused on using GSM data for mobile computer users. This next section will look at GSM data for the handheld computer user.

Handheld computers (HC) such as the Psion Series 5 and Windows CE products add an extra level of portability for mobile users. Users can literally travel anywhere and take important data with them. However, providing communications for these devices can prove difficult because of both the form factor, and power limitations of these devices.

To address this market, Psion Dacom developed a range of passive GSM data solutions. This means that instead of using a PC card device as a mobile PC user would, the data processing is performed in software, using the host processor on the HC. The user will still need to connect their HC to their GSM handset using a connector cable. By using a software based GSM data solution, HC users can utilize the same advantages as mobile PC users.

Following are some of the main advantages to using a software based GSM solution, as opposed to a PC Card for handheld computers.

Lower power consumption

Over the past 5 years, PC Cards have established themselves as the main form factor for adding peripheral devices such as modems to a mobile PC. However PC Card products draw a significant amount of power from the PC. This is fine for mobile PCs that come equipped with heavy duty batteries.

For HC users, battery life is at a premium. Using a PC Card with a HC significantly reduces the battery life, typically to less than 30 minutes. Therefore, PC Cards do not provide an efficient solution for HC communications. Using a software-based GSM solution will provide substantially improved battery performance for handheld devices.

PC Card support

A number of HC do not currently support a PC Card slot. Thus adding communications involves connecting an external device to the HC. This goes against the concept of using a HC device, which is designed for portability, ideally to fit in the pocket. By using a software-based solution the HC retains its form factor, and overcomes the limitations of supported expansion capabilities.

Additionally, if there is a PC Card slot available on the device, this can be left free for using with other devices such as memory cards, or hard disk drives.

Easy to upgrade

A software solution will allow for ease of installation and upgrading of software. As the GSM standard is developed, it will offer enhanced data rates and services. It is important for users to be able to upgrade their equipment to support these new features as and when they become available. This will allow HC users to simply install new software to upgrade the device.

In the long term, mobile PC users may also start using software based GSM data solutions. However Psion Dacom believes that multi-function PC card technology currently provides the best solution for mobile PC users.

Key Issues for GSM Data Solution Vendors

So far this white paper has examined the issues related to GSM data for the end user. However it is also important to understand the requirements of developing a GSM data solution for a vendor, in order to fully understand the key issues of buying a GSM data solution. Developing a GSM data solution is highly complex, and requires the vendor to possess a unique set of skills and experience. The following is an outline of the main issues involved for a vendor in developing and maintaining GSM data products.

GSM data stack

A GSM data protocol stack is the software that translates between devices' operating system and the GSM handset and network, facilitating the transmission of data across the network. It is key that any GSM data solution vendor understands this core set of protocols for several important reasons.

Network implementation

Each GSM network worldwide is implemented to its own operators specification. As a result each network will retain its own unique characteristics such as network timing or varying signal quality. It is therefore important to work with network operators to fully understand the intricacies of their network, and to develop products that are robust enough to handle different network characteristics.

Multi-country testing

Because of the reasons stated above, to ensure true interoperability worldwide the vendor must conduct extensive testing. This is vital for GSM data users who will be travelling internationally and using GSM as their primary communications link. It is not enough for a vendor to simply test their solution in their home country, as this will inevitably lead to problems for the end user.

Supporting and upgrading products

The vendor must provide a stable, finely tuned and tested GSM data code to be able to offer suitable data solutions. This is also important for a vendor to be able to keep abreast of the latest developments in GSM data technology and offer users timely product upgrades.

Provide a range of products

It is no longer enough for a vendor to be able to provide part of a solution. The mobile communications market is changing at an ever increasing pace. Both mobile PC and handheld PC users should be supported with dedicated products. It should also be recognized that with these markets different users will have different requirements.

PC Cards

The vendor should be able to support a range of PC Card solutions. In particular, multi-function GSM and modem PC Cards are becoming a key product in the market, as this provides a turnkey solution for mobile communications. The following PC card products are offered by Psion Dacom;

- GSM
- GSM + Modem
- GSM + Modem + Ethernet
- GSM + Modem + Ethernet + ISDN
- GSM + ISDN

Software solutions

Software based GSM data products will be ideally suited to the handheld PC market, as it provides for better battery management than using PC Card or external communication devices. Mobile PC users will also be able to benefit from developments in this market, although the benefits of multi-function PC Card products are expected to remain key in this market. Support for the following software platforms is recommended

- Windows CE
- EPOC 32 (Psion plc. 32Bit Operating System)
- Windows 95
- Windows NT
- Others

Supporting a range of handsets

Once a vendor has developed their hardware and software to offer a GSM data solution, they then need to develop support for a wide range GSM handsets. There is a common misconception that this is a simple matter of developing individual drivers for different handsets. However, this is far removed from the truth. Outlined below are some of the key issues involved in developing support for a handset.

Co-operation of the handset manufacturer

First and foremost is the support of the handset manufacturer. With support from the handset manufacturer, quality and compatibility are assured. Backward engineered solutions without support from the handset manufacturer are often of poor quality and are normally not supported or recommended by handset manufacturers or network operators.

Complex data interfaces

There is no official specification for the physical data interface of a GSM handset. As a result, each handset manufacturer has a different data interface (differences may also exist between different models from the same handset manufacturer). For a vendor to provide support for a handset, they must understand and develop support for the data interface.

Handset protocols

As well as having a unique data interface, each manufacturer uses proprietary software protocols within the handset. Again a vendor wishing to support a handset must first learn the protocols of that handset. Often handset vendors will implement upgrades to their phones (such as new feature support). For a data solutions vendor to support such modifications requires an intricate knowledge to the handset protocols.

Internal development skills and resources

As illustrated above, to develop support for a handset requires fundamental understanding of how the handset actually works, along with the co-operation of the handset vendor. Only by developing the skills and resources internally, can a vendor initially offer and subsequently support a product as it matures in the market. With upgrades being a common feature of the communications industry it is key that development be in-house in order for a vendor to react and supply software upgrades for products in a timely manner.

Key Issues for GSM Data Users

GSM data interfaces

There are currently a wide range of products available that support different GSM handsets from different manufacturers, such as PC cards and software solutions. When selecting a solution, it is important to ensure that it has been fully tested and approved by the manufacturer of the GSM handset to which it will be attached. All Psion Dacom GSM data solutions are developed with full co-operation of the GSM handset manufacturer.

Using a non approved solution (known as reverse engineered¹³.) has a number of significant drawbacks for users. Below is an overview of the key benefits and drawbacks of using approved and non approved products.

Benefits of using an approved product

There are many benefits to using a GSM data solution that has been developed as a result of close collaboration between a GSM data solution vendor and the GSM handset manufacturer. The key to this kind of product, is that it has been developed with the intention of providing the end-user with a product that is simplistic and easy to use, while being able to meet all the requirements that will be placed upon it.

Several handset manufacturers have now started an approval scheme to identify products that are approved for connection to their handsets. By displaying an approved logo, such as the "Nokia OK" logo, users can be assured that if they should have any problems in using the product, they will be able to obtain support from both the GSM data solution provider and handset manufacturer.

Optimised performance

Because the GSM data solution vendor and the handset manufacturer have worked together to develop a solution, the product will be optimised to give the user the highest possible performance. The product will have been subjected to rigorous testing to ensure that it meets performance expectations, even under poor line conditions or in areas where only a weak signal is available.

Feature rich capabilities

Through working in co-operation with the handset manufacturer, the data solution vendor will have been able to access the full specification of the handset data interface. This will allow the vendor to support the full range of services that the handset can support. For example being able to manage the handsets' phone book on the PC. This allows for easier data manipulation, and maintenance.

Future upgrades to new services

As and when new features are introduced for GSM, the data solution vendor in co-operation with the handset vendor will be able to develop software applications that take advantage of these new services (such as 14.4Kbps data speeds). This will normally be done via a software upgrade¹⁴. In the long term, this can lead to significant cost savings, as the initial investment will be protected.

Future upgrades for new phones

Handset vendors are continuing to develop new handsets that offer enhanced features and capabilities,

¹³ The PC card vendor has developed a cable (with handset connector) and software driver, without the approval or assistance of the handset manufacturer.

¹⁴ Modern PC Card products should support flash memory, which can be upgraded when the manufacturer releases new software for the PC Card.

such as longer talk /standby time. The data solution vendor will work with the handset vendor, to develop support for new handsets as and when they are introduced. This will normally be done via a combination of a new connector for the handset, and a software upgrade to support drivers for the new handset.

Drawbacks of using a reverse engineered product

As stated previously reverse engineered products are developed in isolation and not through collaboration and co-development with the handset vendor. This can result in a product that does not deliver all the benefits of a fully approved product, and can present the user with a number of problems when using the product. Some of the key drawbacks to using reverse engineered solutions are detailed below.

Support

One of the most important issues for any network manager is how to support their users. This is extremely important for mobile data users, who may not have access to hands on help from support personnel. If a problem is experienced, it is paramount that it can be easily identified and resolved.

Using an unapproved product can invalidate the warrantee of the handset, and may result in the manufacturer or service provider refusing to provide support to the user. Additionally, network operators may not be willing to provide support for an unapproved product being used on their network.

No future upgrade path

Because the vendor is working independently and without the support of the handset manufacturer, will not be kept informed of future handset developments. Ultimately users of reverse engineered products could find that their products do not support new data services and features.

Supporting GSM Data Users

For any organization, supporting its information technology users is a key issue. This is especially true for mobile workers who do not have full time access to hands on help. This next section will assess the key issues for supporting GSM data users.

Many of the support issues for GSM data users will be the same as those for PC Card modem users. However because GSM data involves a number of different technologies working together, if problems arise, there are a number of different companies who you may wish to turn to for support, such as;

- GSM network operator
- Airtime service provider
- GSM handset manufacturer
- PC Card manufacturer
- Notebook manufacturer
- Software vendor

This underlines the importance of purchasing GSM data solutions from manufacturers that have worked together with GSM handset vendors and network operators (see key issues for GSM data users) in order to ensure true interoperability between products. This also enables manufacturers to provide a comprehensive level of support for their products.

There are three key areas where problems are likely to be encountered for first time GSM data users, these are

- ***Installing the PC Card***

As with any PC Card product, problems can be experience when first installing the PC Card.

- ***Supporting the PC application***

It is important to ensure that the software you wish to use with GSM data is capable of working with GSM. Today the most popular software applications will work with GSM data.

- ***Is data enabled for the handset?***

GSM data users will require a separate data and fax number from their voice number, to enable them to receive data and fax calls. It is therefore important to check with your airtime service provider/network operator that data has been enabled for the handset.

One of the key benefits to using GSM data, is the ability to 'roam' internationally. However this can also present unique support issues for users. Please not that it is important to ensure that roaming agreements are for both voice and data, as some network providers have agreements that are for voice only roaming. When selecting a GSM data solution, if it will be used for roaming, it is important to ensure that the vendor can provide a level of worldwide support for the products¹⁵. This will help to reduce the amount of time it takes to resolve any problems that may occur when roaming.

When selecting your GSM data products, it is advised that you look for the following from your equipment supplier.

- Product has a lifetime warranty
- Vendor provides free technical support for the products lifetime.
- Worldwide support centers.
- Solutions are developed in co-operation with handset manufacturers.
- Offers an upgrade path.

¹⁵Psion Dacom has a number of worldwide support offices, including USA, Japan , Singapore, South Africa and extensive European coverage.

Future Developments for GSM Data

As stated previously, ETSI is continuing to work on developing the GSM standard. The developments are for both voice and data applications, and will bring significant benefits to data users.

Data Compression

The use of data compression is key for data users. The ability to compress data allows for increased throughput of data, and hence reduced costs. There are two alternative methods for implementing data compression for use with GSM.

Non transparent mode

This is the same as non-transparent data transmission, but implements V.42bis¹⁶ data compression standard over the error corrected link between the mobile terminal and the remote modem. GSM network operators do not currently implement this. It is anticipated that support for V.42bis on a non-transparent link will become available from 1998 onwards.

The benefit of this method will be improved data throughput. V.42bis typically yields between 2:1 and 4:1 data compression, thus providing for a much higher data throughput rate. In addition, the link retains all the benefits of using network implemented error correction.

Transparent mode

In transparent mode, the mobile terminal will establish an error corrected link with the remote modem, implementing either the V.42bis or MNP5 data compression standard over the link.

It is important to note that when using this method the user is reliant upon the remote modem supporting the necessary error correction negotiation protocols. If the remote modem is not compatible, a non error corrected link is established between the two modems, with no data compression. Transparent mode should only be used where optimal line conditions can be achieved.

Once data compression is implemented in non-transparent mode, there will be very little argument for using transparent mode. Additionally the data throughput of a transparent link will be approximately 20 per cent slower than that of a non-transparent connection (see "How Does GSM Data Work?" for a full explanation).

Increased data speeds

At present the maximum data rate for GSM without implementing data compression is 9.6 Kbps. Recognizing the need for higher speed data rates, ETSI is currently working on developing three key enhancements to the data capabilities of GSM.

14.4Kbps

ETSI is currently in the process of finalizing a specification that will increase the data channel rate from 9.6Kbps to 14.4 Kbps. It's anticipated that network operators will begin implementing 14.4 Kbps data capabilities from late 1997 onwards.

The increase to 14.4 Kbps will be achieved by implementing a new channel coding technique. Users may find that they need to upgrade or purchase a new handset to take advantage of this development.

¹⁶An ITU standard for data compression.

High Speed Circuit Switched Data (HSCSD)

HSCSD is the first of two new data services that will take advantage of a technique known as “Multi Slotting”¹⁷. Multi-Slotting dynamically combines between 2 and 8 time slots, to give a maximum data rate of up to 64 Kbps for a single user.

HSCSD is connection orientated¹⁸ and will be ideally suited for delivering services where data latency is important, such as video-conferencing. Ultimately if network operators reduce their tariffs, companies may opt to use GSM for these services even when a fixed connection is available.

New HSCSD services are not expected to be offered by network operators until 1998. To implement HSCSD, operators will need to make changes to the network infrastructure, and this will inevitably delay the roll out of this service.

General Packet Radio Services (GPRS)

GPRS is another service that will offer significantly enhanced data rates. As with HSCSD, GPRS also uses multi slotting to increase the available bandwidth. GPRS will offer data rates up to a maximum of 170 Kbps. Essentially GPRS is a packet based technology, and thus will be ideally suited for TCP/IP¹⁹ environments and will allow the user to establish a “permanent” connection to the Internet or corporate LAN.

GPRS is expected to be widely used to provide services such as World Wide Web browsing, where data is received in sporadic bursts. Interconnection to other packet based networks such as X.25, is also expected to be a key application for GPRS.

Unlike HSCSD, GPRS is not connection orientated. This means that a user wanting to send data does not need to first establish a call. Additionally, the user receiving data does not need to have their phone turned on, as the network will store the data for them. When the user connects to the network, they will be notified that they have data waiting.

It's anticipated that GPRS will become popular in the corporate environment, as virtual connections can be established. Unlike traditional voice and data services, GPRS will be charged on a per bit basis. Hence users will be charged for sending or receiving data, as opposed to connection orientated services where the user is charged for the amount of time that they are connected to the service.

A standard for GPRS should to be finalized by the end of 1997. Commercial services could potentially start in the 1998 / 1999 time frame. As with HSCSD, network operators will need to implement changes to their network to offer GPRS services.

Although both HSCSD and GPRS will be introduced within the next 3 years, the next major mile stone in data rates will be 28.8 Kbps, using just 2 time slots. Both HSCSD and GPRS will require new handset technology for using more than 2 time slots simultaneously.

The initial introduction of multi-slotting data techniques will inevitably present challenges to network operators. Network operators will have to develop new tariffing structures for multiple channel access. Operators will also need to ensure that a single user does not use all the available capacity of the network in a given area. Each additional channel that a given individual uses reduces the available channels for all other users.

¹⁷ GSM use a technique called Time Division Multiple Access (TDMA) to divide the radio channel into 8 different time slots, 7 for voice or data calls, and 1 channel for call progress and control information. Under normal operation a voice or data call would use one of these time slots. Multi slotting allows a single user to gain access to 2 or more of these time slots for the transmission of data.

¹⁸ A connection must first be made before data can be transmitted over the network.

¹⁹ Transmission Control Protocol/Internet Protocol (TCP/IP).

Conclusions

GSM has now fully developed as a global standard for digital mobile communications, offering an unrivalled level of coverage and services matched by no other mobile communications standard.

Wireless GSM data will play a key role in enabling enterprises to become more flexible and responsive to the needs of their customers. Using GSM data is no longer a novelty but is quickly becoming a key strategic tool for improving the level responsiveness of an organization, providing productivity and efficiency benefits that can only be achieved by strategic use of wireless technology.

An increasing number of companies around the world are starting to see the true benefits of providing their mobile employees with a 100% connectivity solution. Effective use of GSM data is becoming a key factor in providing an organization with a realizable competitive advantage.

Today the key drivers behind wireless GSM data are remote email and fax. Over the next year remote LAN, database and Internet access will also develop as primary applications. As the cost of using GSM continues to fall, and data rates increase, it may pass that it is those mobile data users who use the POTS quickly become a small minority.

“Today’s competitive advantage is tomorrow’s requirement”

Ultimately, the challenge is for organisations to realize the opportunities that wireless GSM data presents to them, and for them to seize those opportunities before their rivals.

Further Sources of Information

For more information on GSM, the following websites are recommend.

Psion Dacom plc

<http://www.psiondacom.com>

Psion Dacom is the European market leader for PC Card connectivity products, including modem, GSM and Ethernet technology. The Gold Card series is Europe's number one PC Card product. Psion Dacom's website provides information on its range of PC Card and software based GSM data solutions.

GSM Memorandum of Understanding (GSM MoU)

<http://www.gsmworld.com/gsmworld.htm>

The GSM MoU is the office association for GSM network operators. The GSM MoU website provides a wide range of information on the geographic coverage of GSM around the world. Information is also provided on the services and tariffs of each GSM operator worldwide.

Mobile Data Initiative (MDI)

<http://www.pcsdata.com>

To demonstrate the commitment of the PC industry to mobile data, Intel has formed the mobile data initiative (MDI). The MDI provides GSM hardware manufacturers with a forum for discussion on how to promote the concept of GSM data, as well as hosting regular "Plug Fest" events for testing GSM data products to ensure interoperability.

The MDI web site provides a range of information on using and selecting your GSM hardware as well as case studies for companies already using GSM data

Ericsson

<http://www.ericsson.com/>

Ericsson is a leading developer of GSM products, and has a strong position in many different geographic markets. Ericsson's website is full of useful information on current developments for GSM. You can also subscribe to the Ericsson news service, which automatically emails you the latest Ericsson press releases for mobile communications.

Nokia

<http://www.club.nokia.com/>

Nokia is one of the worlds leading GSM handset and infrastructure manufactures. Nokia's website provides a wide range of information on GSM, and current developments within the GSM industry. Nokia also publishes a range of white papers and conference speeches on GSM.

Motorola

<http://www.mot.com/>

Motorola is one of the worlds large GSM phone manufacturers, with a presence in all geographic regions. Motorola's website provides a wide range of information on their last phones, as well as press

releases on the latest GSM developments.

Glossary of Terms

Analog	A method of signalling used to represent an infinite range of numbers. The most analog devices are POTS telephones, and modems.
AT Command set (Hayes AT)	A set of instructions used to control modems (and increasingly ISDN terminal adapters), normally beginning with AT.
AT Command	An instruction sent to a modem, beginning with AT
bps	Bits Per Second. A measurement of transmission speed.
Data over GSM	The ability to transmit digital data over a GSM network.
Digital	A method of signalling that can only represent integers. For computers these are 0 and 1.
Dual-band Phone	A GSM phone that can work on two different bands such as 900/1800 or 900/1900.
Error Correction	A method for identifying errors during the transmission of data and requesting re-transmission of the corrupted data.
ETSI	European Telecommunications Standards Institute. Responsible for defining and maintaining the GSM standard.
GPRS	General Packet Radio Services. A proposed packet data standard for GSM, capable of providing data speeds up to 170Kbps.
Group 3 Fax	An ITU standard for controlling facsimile communication.
GSM	Global System for Mobile Communication. An ETSI standard for digital wireless voice and data communications.
GSM Data Interface	The interface on a GSM phone for connecting a serial cable to a PC or PC Card.
HSCSD	High Speed Circuit Switched Data. A standard for providing access to multiple GSM channels to provide data speeds up to 64Kbps.
ISDN	Integrated Services Digital Network. A replacement for the POTS system, providing digital voice and data services. ISDN can provide simultaneous voice and data calls to different locations.
ISDN TA	ISDN Terminal Adapter also referred to as an ISDN Modem. A device used to connect to an ISDN telephone line.
ITU	International Telecommunications Union. Sets many of the worldwide telecommunications standards including those for modems and ISDN.
IWF	Inter-working function. An essential part of any GSM network, which handles interconnection between the GSM network and fixed networks such as POTS or ISDN.
Modem	MODulator/DEMODulator. A device that allows computers to communicate over POTS lines.
MoU	Memorandum of Understanding. The GSM organisation that oversees the implementation of GSM networks around the world.
Non-transparent data	A method of transmitting data over a network, whereby the network is able to identify the data being sent, and can control the data session. In a GSM network the RLP protocol for error correction is implemented for a non-transparent data session.
Packet Mode	A method of transferring data between two devices without the need to establish a direct connection.
PC Card	Formally known as PCMCIA. A device for connecting peripheral devices to a mobile computer.
PCS	Personal Communications Services. Refers to a range of

	standards for digital wireless communications operating in the 1850-1990MHz frequency range. Services included high quality digital voice, data, fax and two-way messaging services.
POTS	Plain old Telephone System
RLP	Radio Link Protocol. Error correction protocol used by GSM.
Roaming	The ability to make and receive calls outside a users home cellular network.
SIM	Subscriber Information Module also referred to as "Smart Card". Stores information about the subscriber, such as their telephone number.
SMS	Short Message System. A text based, 160 character, two way messaging system for GSM.
Transparent data	A method of transmitting data over a network, whereby the network does not recognise the data being sent, and is not able to control the data session. For GSM, this method is best for suited to situations where the data being sent can not tolerate any latency, such as facsimile applications.
V.42bis	An ITU standard for data compression.
V.110	An ITU standard for rate adaptation. Allow slow speed terminals (up to 19.2Kbps) to connect to an ISDN terminal Adapter.
World Phone (Tri-band phone)	A term used in the GSM world to represent a phone that can work at 900, 1800 and 1900 MHz.
X.25	A standard for packet switched data networks.