www.gsmworld.com/techn September 2000

An Overview of GPRS

The General Packet Radio Service (GPRS) is a new nonvoice value added service that allows information to be sent and received across a mobile telephone network. It supplements today's Circuit Switched Data and Short Message Service. GPRS is NOT related to GPS (the Global Positioning System), a similar acronym that is often used in mobile contexts.

GPRS will provide a massive boost to mobile data usage and usefulness. That much seems assured from its flexible feature set - its latency and efficiency and speed. The only question is how soon it takes off in earnest and how to ensure that the technical and commercial features do not hinder its widespread use.

Introduction to General Packet Radio Service

An Introduction to the General Packet Radio Service

Written by Simon Buckingham, Mobile Lifestreams Limited - Issued January 2000

Table of Contents

1. Key User Features of GPRS

The General Packet Radio Service (GPRS) is a new nonvoice value added service that allows information to be sent and received across a mobile telephone network. It supplements today's Circuit Switched Data and Short Message Service. GPRS is NOT related to GPS (the Global Positioning System), a similar acronym that is often used in mobile contexts. GPRS has several unique features which can be summarized as:

SPEED
Theoretical maximum speeds of up to 171.2 kilobits per second (kbps) are achievable with GPRS using all eight timeslots at the same time. This is about three times as fast as the data transmission speeds possible over today's fixed telecommunications networks and ten times as fast as current Circuit Switched Data services on GSM networks. By allowing information to be transmitted more quickly, immediately and efficiently across the mobile network, GPRS may well be a relatively less costly mobile data service compared to SMS and Circuit Switched Data.

IMMEDIACY
GPRS facilitates instant connections whereby information can be sent or received immediately as the need arises, subject to radio coverage. No dial-up modem connection is necessary. This is why GPRS users are sometimes referred to be as being "always connected". Immediacy is one of the advantages of GPRS (and SMS) when compared to Circuit Switched Data. High immediacy is a very important feature for time critical applications such as remote credit card authorization where it would be unacceptable to keep the customer waiting for even thirty extra seconds.

NEW APPLICATIONS, BETTER APPLICATIONS
GPRS facilitates several new applications that have not previously been available over GSM networks due to the limitations in speed of Circuit Switched Data (9.6 kbps) and message length of the Short Message Service (160 characters). GPRS will fully enable the Internet applications you are used to on your desktop from web browsing to chat over the mobile network. Other new applications for GPRS, profiled later, include file transfer and home automation- the ability to remotely access and control in-house appliances and machines.

SERVICE ACCESS
To use GPRS, users specifically need:
a mobile phone or terminal that supports GPRS (existing GSM phones do NOT support GPRS) a subscription to a mobile telephone network that supports GPRS use of GPRS must be enabled for that user. Automatic access to the GPRS may be allowed by some mobile network operators, others will require a specific opt-in knowledge of how to send and/ or receive GPRS information using their specific model of mobile phone, including software and hardware configuration (this creates a customer service requirement) a destination to send or receive information through GPRS. Whereas with SMS this was often another mobile phone, in the case of GPRS, it is likely to be an Internet address, since GPRS is designed to make the Internet fully available to mobile users for the first time. From day one, GPRS users can access any web page or other Internet applications- providing an immediate critical mass of uses.
Having looked at the key user features of GPRS, lets look at the key features from a network operator perspective.

2. Key Network Features of GPRS

PACKET SWITCHING

GPRS involves overlaying a packet based air interface on the existing circuit switched GSM network. This gives the user an option to use a packet-based data service. To supplement a circuit switched network architecture with packet switching is quite a major upgrade. However, as we shall see later, the GPRS standard is delivered in a very elegant manner- with network operators needing only to add a couple of new infrastructure nodes and making a software upgrade to some existing network elements.

With GPRS, the information is split into separate but related "packets" before being transmitted and reassembled at the receiving end. Packet switching is similar to a jigsaw puzzle- the image that the puzzle represents is divided into pieces at the manufacturing factory and put into a plastic bag. During transportation of the now boxed jigsaw from the factory to the end user, the pieces get jumbled up. When the recipient empties the bag with all the pieces, they are reassembled to form the original image. All the pieces are all related and fit together, but the way they are transported and assembled varies. The Internet itself is another example of a packet data network, the most famous of many such network types.

SPECTRUM EFFICIENCY

Packet switching means that GPRS radio resources are used only when users are actually sending or receiving data. Rather than dedicating a radio channel to a mobile data user for a fixed period of time, the available radio resource can be concurrently shared between several users. This efficient use of scarce radio resources means that large numbers of GPRS users can potentially share the same bandwidth and be served from a single cell. The actual number of users supported depends on the application being used and how much data is being transferred. Because of the spectrum efficiency of GPRS, there is less need to build in idle capacity that is only used in peak hours. GPRS therefore lets network operators maximize the use of their network resources in a dynamic and flexible way, along with user access to resources and revenues.

GPRS should improve the peak time capacity of a GSM network since it simultaneously allocates scarce radio resources more efficiently by supporting virtual connectivity imigrates traffic that was previously sent using Circuit Switched Data to GPRS instead, and reduces SMS Center and signalling channel loading by migrating some traffic that previously was sent using SMS to GPRS instead using the GPRS/ SMS interconnect that is supported by the GPRS standards.

INTERNET AWARE

For the first time, GPRS fully enables Mobile Internet functionality by allowing interworking between the existing Internet and the new GPRS network. Any service that is used over the fixed Internet today- File Transfer Protocol (FTP), web browsing, chat, email, telnet- will be as available over the mobile network because of GPRS. In fact, many network operators are considering the opportunity to use GPRS to help become wireless Internet Service Providers in their own right. The World Wide Web is becoming the primary communications interface- people access the Internet for entertainment and information collection, the intranet for accessing company information and connecting with colleagues and the extranet for accessing customers and suppliers. These are all derivatives of the World Wide Web aimed at connecting different communities of interest. There is a trend away from storing

information locally in specific software packages on PCs to remotely on the Internet. When you want to check your schedule or contacts, instead of using something like "Act!", you go onto the Internet site such as a portal. Hence, web browsing is a very important application for GPRS.

Because it uses the same protocols, the GPRS network can be viewed as a sub-network of the Internet with GPRS capable mobile phones being viewed as mobile hosts. This means that each GPRS terminal can potentially have its own IP address and will be addressable as such.

SUPPORTS TDMA AND GSM

It should be noted right that the General Packet Radio Service is not only a service designed to be deployed on mobile networks that are based on the GSM digital mobile phone standard. The IS-136 Time Division Multiple Access (TDMA) standard, popular in North and South America, will also support GPRS. This follows an agreement to follow the same evolution path towards third generation mobile phone networks concluded in early 1999 by the industry associations that support these two network types.

3. Limitations of GPRS

It should already be clear that GPRS is an important new enabling mobile data service which offers a major improvement in spectrum efficiency, capability and functionality compared with today's nonvoice mobile services. However, it is important to note that there are some limitations with GPRS, which can be summarized as:

LIMITED CELL CAPACITY FOR ALL USERS

GPRS does impact a network's existing cell capacity. There are only limited radio resources that can be deployed for different uses- use for one purpose precludes simultaneous use for another. For example, voice and GPRS calls both use the same network resources. The extent of the impact depends upon the number of timeslots, if any, that are reserved for exclusive use of GPRS. However, GPRS does dynamically manage channel allocation and allow a reduction in peak time signalling channel loading by sending short messages over GPRS channels instead.

RESULT: NEED FOR SMS as a complementary bearer that uses a different type of radio resource.

SPEEDS MUCH LOWER IN REALITY

Achieving the theoretical maximum GPRS data transmission speed of 172.2 kbps would require a single user taking over all eight timeslots without any error protection. Clearly, it is unlikely that a network operator will allow all timeslots to be used by a single GPRS user. Additionally, the initial GPRS terminals are expected be severely limited- supporting only one, two or three timeslots. The bandwidth available to a GPRS user will therefore be severely limited. As such, the theoretical maximum GPRS speeds should be checked against the reality of constraints in the networks and terminals. The reality is that mobile networks are always likely to have lower data transmission speeds than fixed networks.

RESULT: Relatively high mobile data speeds may not be available to individual mobile users until Enhanced Data rates for GSM Evolution (EDGE) or Universal Mobile Telephone System (UMTS) are introduced.

SUPPORT OF GPRS MOBILE TERMINATE BY TERMINALS IS NOT ENSURED

At the time of writing, there has been no confirmation from any handset vendors that mobile terminated GPRS calls (i.e. receipt of GPRS calls on the mobile phone) will be supported by the initial GPRS terminals. Availability or not of GPRS MT is a central question with critical impact on the GPRS business case such as application migration from other nonvoice bearers.

By originating the GPRS session, users confirm their agreement to pay for the delivery of content from that service. This origination may well be performed using a Wireless Application Protocol (WAP) session using the WAP microbrowser that will be built into GHPRS terminals. However, mobile terminated IP traffic might allow unsolicited information to reach the terminal. Internet sources originating such unsolicited content may not be chargeable. A possible worse case scenario would be that mobile users would have to pay for receiving unsolicited junk content. This is a potential reason for a mobile vendor NOT to support GPRS Mobile Terminate in their GPRS terminals.

However, there is always the possibility of unsolicited or unwanted information being communicated through any media, but that does not mean that we would wish to preclude the possibility of any kind of communication through that means altogether. A network side solution such as GGSN or charging platform policing would be preferable rather than a non-flexible limitation built into all the GPRS handsets.

When we asked Nokia about this issue, it commented: "Details of the Nokia GPRS terminals are not available at this time. It is too early to confirm whether MT will be supported in the first Nokia GPRS terminals". The company's policy is not to make details available about products before they are announced. Readers should contact the GSM Association, Mobile Lifestreams Limited and/ or the vendors directly to encourage them to incorporate support for GPRS MT in their initial terminals.

RESULT: GPRS usability and therefore business case is threatened if GPRS MT is not supported by
GPRS terminals.

SUBOPTIMAL MODULATION

GPRS is based on a modulation technique known as Gaussian minimum-shift keying (GMSK). EDGE is based on a new modulation scheme that allows a much higher bit rate across the air interface- this is called eight-phase-shift keying (8 PSK) modulation. Since 8 PSK will also be used for UMTS, network operators will need to incorporate it at some stage to make the transition to third generation mobile phone systems.

RESULT: NEED FOR EDGE.

TRANSIT DELAYS

GPRS packets are sent in all different directions to reach the same destination. This opens up the potential for one or some of those packets to be lost or corrupted during the data transmission over the radio link. The GPRS standards recognize this inherent feature of wireless packet technologies and incorporate data integrity and retransmission strategies. However, the result is that potential transit delays can occur.

Because of this, applications requiring broadcast quality video may well be implemented using High Speed Circuit Switched Data (HSCSD). HSCSD is simply a Circuit Switched Data call in which a single user can take over up to four separate channels at the same time. Because of its characteristic of end to end connection between sender and recipient, transmission delays are less likely.

RESULT: NEED FOR HSCSD.

NO STORE AND FORWARD

Whereas the Store and Forward Engine in the Short Message Service is the heart of the SMS Center and key feature of the SMS service, there is no storage mechanism incorporated into the GPRS standard, apart from the incorporation of interconnection links between SMS and GPRS.

RESULT: NEED FOR SMS.

4. Timescales for GPRS

When a new service is introduced, there are a number of stages before it becomes established. GPRS service developments will include standardization, infrastructure development, network trials, contracts placed, network roll out, availability of terminals, application development, and so on. These stages for GPRS are:

Date	Milestone
Throughout 1999 – 2000	Network operators place trial and commercial contracts for GPRS infrastructure. Incorporation of GPRS infrastructure into GSM networks
Summer of 2000	First trial GPRS services become available. Typical single user throughput is likely to be 28 kbps. For example, T-Mobil is planning a GPRS trial at Expo2000 in Hanover in the
Start of 2001	Basic GPRS capable terminals begin to be available in commercial quantities
Throughout 2001	Network operators launch GPRS services commercially and roll out GPRS. Vertical market and executive GPRS early adopters begin using it regularly for nonvoice mobile communications
2001/2	Typical single user throughput is likely to be 56 kbps. New GPRS specific applications, higher bitrates, greater network capacity solutions, more capable terminals become available, fuelling GPRS usage
2002	Typical single user throughput is likely to be 112 kbps. GPRS Phase 2/ EDGE begins to emerge in practice
2002	GPRS is routinely incorporated into GSM mobile phones and has reached critical mass in terms of usage. (This is the equivalent to the status of SMS in 1999)
2002/3	UMTS arrives commercially

Like the GSM standard itself, GPRS will be introduced in phases. Phase 1 is expected to be available commercially in the year 2000/1. Point to Point GPRS (sending information to a single GPRS user) will be supported, but not Point to Multipoint (sending the same information to several GPRS users at the same time). GPRS Phase 2 is not yet fully defined, but is expected to support higher data rates through the possible incorporation of techniques such as EDGE (Enhanced Data rates for GSM Evolution), in addition to Point-to-Multipoint support.

5. Applications for GPRS

A wide range of corporate and consumer applications are enabled by nonvoice mobile services such as SMS and GPRS. This section will introduce those that are particularly suited to GPRS.

CHAT

Chat can be distinguished from general information services because the source of the information is a person with chat whereas it tends to be from an Internet site for information services. The "information intensity"- the amount of information transferred per message tends to be lower with chat, where people are more likely to state opinions than factual data. In the same way as Internet chat groups have proven a very popular application of the Internet, groups of likeminded people- so called communities of interest have begun to use nonvoice mobile services as a means to chat and communicate and discuss.

Because of its synergy with the Internet, GPRS would allow mobile users to participate fully in existing Internet chat groups rather than needing to set up their own groups that are dedicated to mobile users. Since the number of participants is an important factor determining the value of participation in the newsgroup, the use of GPRS here would be advantageous. GPRS will not however support point to multipoint services in its first phase, hindering the distribution of a single message to a group of people. As such, given the installed base of SMS capable devices, we would expect SMS to remain the primary bearer for chat applications in the foreseeable future, although experimentation with using GPRS is likely to commence sooner rather than later.

TEXTUAL AND VISUAL INFORMATION

A wide range of content can be delivered to mobile phone users ranging from share prices, sports scores, weather, flight information, news headlines, prayer reminders, lottery results, jokes, horoscopes, traffic, location sensitive services and so on. This information need not necessarily be textual- it may be maps or graphs or other types of visual information.

The length of a short message of 160 characters suffices for delivering information when it is quantitative- such as a share price or a sports score or temperature. When the information is of a qualitative nature however, such as a horoscope or news story, 160 characters is too short other than to tantalize or annoy the information recipient since they receive the headline or forecast but little else of substance. As such, GPRS will likely be used for qualitative information services when end users have GPRS capable devices, but SMS will continue to be used for delivering most quantitative information services. Interestingly, chat applications are a form of qualitative information that may remain delivered using SMS, in order to limit people to brevity and reduce the incidence of spurious and irrelevant posts to the mailing list that are a common occurrence on Internet chat groups.

STILL IMAGES

Still images such as photographs, pictures, postcards, greeting cards and presentations, static web pages can be sent and received over the mobile network as they are across fixed telephone networks. It will be possible with GPRS to post images from a digital camera connected to a GPRS radio device directly to an Internet site, allowing near real-time desktop publishing.

MOVING IMAGES

Over time, the nature and form of mobile communication is getting less textual and more visual. The wireless industry is moving from text messages to icons and picture messages to photographs and blueprints to video messages and movie previews being downloaded and on to full blown movie watching via data streaming on a mobile device.

Sending moving images in a mobile environment has several vertical market applications including monitoring parking lots or building sites for intruders or thieves, and sending images of patients from an ambulance to a hospital. Videoconferencing applications, in which teams of distributed sales people can have a regular sales meeting without having to go to a particular physical location, is another application for moving images.

WEB BROWSING

Using Circuit Switched Data for web browsing has never been an enduring application for mobile users. Because of the slow speed of Circuit Switched Data, it takes a long time for data to arrive from the Internet server to the browser. Alternatively, users switch off the images and just access the text on the web, and end up with difficult to read text layouts on screens that are difficult to read from. As such, mobile Internet browsing is better suited to GPRS.

DOCUMENT SHARING/ COLLABORATIVE WORKING

Mobile data facilitates document sharing and remote collaborative working. This lets different people in different places work on the same document at the same time. Multimedia applications combining voice, text, pictures and images can even be envisaged. These kinds of applications could be useful in any problem solving exercise such as fire fighting, combat to plan the route of attack, medical treatment, advertising copy setting, architecture, journalism and so on. Even comments on which resort to book a holiday at could benefit from document sharing to save everyone having to visit the travel agent to make a decision. Anywhere somebody can benefit from having and being able to comment on a visual depiction of a situation or matter, such collaborative working can be useful. By providing sufficient bandwidth, GPRS facilitates multimedia applications such as document sharing.

AUDIO

Despite many improvements in the quality of voice calls on mobile networks such as Enhanced Full Rate (EFR), they are still not broadcast quality. There are scenarios where journalists or undercover police officers with portable professional broadcast quality microphones and amplifiers capture interviews with people or radio reports dictated by themselves and need to send this information back to their radio or police station. Leaving a mobile phone on, or dictating to a mobile phone, would simply not give sufficient voice quality to allow that transmission to be broadcast or analyzed for the purposes of background noise analysis or voice printing, where the speech autograph is taken and matched against those in police storage. Since even short voice clips occupy large file sizes, GPRS or other high speed mobile data services are needed.

JOB DISPATCH

Nonvoice mobile services can be used to assign and communicate new jobs from office-based staff to mobile field staff. Customers typically telephone a call center whose staff take the call and categorize it. Those calls requiring a visit by field sales or service representative can then be escalated to those mobile workers. Job dispatch applications can optionally be

combined with vehicle positioning applications- such that the nearest available suitable personnel can be deployed to serve a customer. GSM nonvoice services can be used not only to send the job out, but also as a means for the service engineer or sales person can keep the office informed of progress towards meeting the customer's requirement. The remote worker can send in a status message such as "Job 1234 complete, on my way to 1235".

The 160 characters of a short message are sufficient for communicating most delivery addresses such as those needed for a sales, service or some other job dispatch application such as mobile pizza delivery and courier package delivery. However, 160 characters does require manipulation of the customer data such as the use of abbreviations such as "St" instead of "Street". Neither does 160 characters leave much space for giving the field representative any information about the problem that has been reported or the customer profile. The field representative is able to arrive at the customer premises but is not very well briefed beyond that. This is where GPRS will come in to allow more information to be sent and received more easily. With GPRS, a photograph of the customer and their premises could, for example, be sent to the field representative to assist in finding and identifying the customer. As such, we expect job dispatch applications will be an early adopter of GPRS-based communications.

CORPORATE EMAIL

With up to half of employees typically away from their desks at any one time, it is important for them to keep in touch with the office by extending the use of corporate email systems beyond an employee's office PC. Corporate email systems run on Local Area computer Networks (LAN) and include Microsoft Mail, Outlook, Outlook Express, Microsoft Exchange, Lotus Notes and Lotus cc:Mail.

Since GPRS capable devices will be more widespread in corporations than amongst the general mobile phone user community, there are likely to be more corporate email applications using GPRS than Internet email ones whose target market is more general.

INTERNET EMAIL

Internet email services come in the form of a gateway service where the messages are not stored, or mailbox services in which messages are stored. In the case of gateway services, the wireless email platform simply translates the message from SMTP, the Internet email protocol, into SMS and sends to the SMS Center. In the case of mailbox email services, the emails are actually stored and the user gets a notification on their mobile phone and can then retrieve the full email by dialing in to collect it, forward it and so on.

Upon receiving a new email, most Internet email users do not currently get notified of this fact on their mobile phone. When they are out of the office, they have to dial in speculatively and periodically to check their mailbox contents. However, by linking Internet email with an alert mechanism such as SMS or GPRS, users can be notified when a new email is received.

VEHICLE POSITIONING

This application integrates satellite positioning systems that tell people where they are with nonvoice mobile services that let people tell others where they are. The Global Positioning System (GPS) is a free-to-use global network of 24 satellites run by the US Department of Defense. Anyone with a GPS receiver can receive their satellite position and thereby find out where they are. Vehicle positioning applications can be used to deliver several services

including remote vehicle diagnostics, ad-hoc stolen vehicle tracking and new rental car fleet tariffs.

The Short Message Service is ideal for sending Global Positioning System (GPS) position information such as longitude, latitude, bearing and altitude. GPS coordinates are typically about 60 characters in length. GPRS could alternatively be used.

REMOTE LAN ACCESS

When mobile workers are away from their desks, they clearly need to connect to the Local Area Network in their office. Remote LAN applications encompasses access to any applications that an employee would use when sitting at their desk, such as access to the intranet, their corporate email services such as Microsoft Exchange or Lotus Notes and to database applications running on Oracle or Sybase or whatever. The mobile terminal such as handheld or laptop computer has the same software programs as the desktop on it, or cut down client versions of the applications accessible through the corporate LAN. This application area is therefore likely to be a conglomeration of remote access to several different information types- email, intranet, databases. This information may all be accessible through web browsing tools, or require proprietary software applications on the mobile device. The ideal bearer for Remote LAN Access depends on the amount of data being transmitted, but the speed and latency of GPRS make it ideal.

FILE TRANSFER

As this generic term suggests, file transfer applications encompass any form of downloading sizeable data across the mobile network. This data could be a presentation document for a traveling salesperson, an appliance manual for a service engineer or a software application such as Adobe Acrobat Reader to read documents. The source of this information could be one of the Internet communication methods such as FTP (File Transfer Protocol), telnet, http or Java- or from a proprietary database or legacy platform. Irrespective of source and type of file being transferred, this kind of application tends to be bandwidth intensive. It therefore requires a high speed mobile data service such as GPRS, EDGE or UMTS to run satisfactorily across a mobile network.

HOME AUTOMATION

Home automation applications combine remote security with remote control. Basically, you can monitor your home from wherever you are- on the road, on holiday, or at the office. If your burglar alarm goes off, not only do you get alerted, but you get to go live and see who are perpetrators are and perhaps even lock them in. Not only can you see things at home, but you can do things too. You can program your video, switch your oven on so that the preheating is complete by the time you arrive home (traffic jams permitting) and so on. Your GPRS capable mobile phone really does become like the remote control devices we use today for our television, video, hi-fi and so on. As the Internet Protocol (IP) will soon be everywhere- not just in mobile phones because of GPRS but all manner of household appliances and in every machine- these devices can be addressed and instructed. A key enabler for home automation applications will be Bluetooth, which allows disparate devices to interwork.

6. Optimal Bearer by Application

Currently, corporate applications that use the Short Message Service are few and far between. The reasons are the relatively older age of corporate mobile phone users and their lower price sensitivity, particularly since the employer usually pays mobile phones bills. Corporate users are less willing to learn how to and make the effort to send a short message- they tend to use voice as their primary communications method. Instead, the vast majority of SMS usage is accounted for by consumer applications. It is not uncommon to find 90% of the total SMS traffic accounted for by the consumer applications that have been described. Until GPRS terminals are consumer oriented, SMS will continue to be bearer for most consumer applications. However, since GPRS will be incorporated into high end mobile phones initially, it will be used more for corporate applications.

Whatever the application, the Internet will become the primary communications interface. Previously, application developers wrote proprietary applications that worked with proprietary host terminals and often proprietary rugged terminal operating systems. For example, instead of corporate applications such as service engineering using platform and software specific interfaces, the mobile workers such as service engineers will access an intranet page using their GPRS capable terminal and fill in an electronic form. People increasingly use a web browser to access publicly available data on the Internet itself, the extranet for access to the data of business partners and other external collaborators and the intranet to access internal employee information. As such, all work will be carried out through the web interface.

Often, by designing applications to minimize the effects of the limitations of existing mobile services such as the length of a short message or the speed of a Circuit Switched Data call- existing nonvoice mobile services can be successfully used for mobile working. However, many nonvoice applications are graphics intensive and the new faster data services will allow BETTER VERSIONS of today's existing nonvoice applications. For example, instead of occasional information messages with SMS, information services via GPRS or UMTS will be more akin to the "push" Internet channels we see on Active PC Desktops today. Instead of the slow transmission of small video images, real-time broadcast quality images will be transmittable. Instead of using SMS to notify Internet users of new email, the whole email will be sent, and full-blown Internet access will be possible. The same applications will be more immediate and convenient for users.

The use of SMS has prepared customers for nonvoice applications using GPRS and other nonvoice services and most of the applications envisaged for GPRS already exist in some form today. It is therefore an important question to consider what the preferred bearer for each application will be- GPRS, Circuit Switched Data or SMS.

7. Ranking of Initial GPRS Traffic Generators

With any new service, it is an important part of the business case to estimate what the applications for that technology will be. We believe that the business case for any network operator for GPRS is compelling- it confers a huge increase in capability for a relatively small investment. The more popular applications using GPRS are expected to be:

Ranking	Application	Bearer
1.	Corporate email	GPRS
2.	Internet email	GPRS/ SMS
3.	Information Services- Qualitative	GPRS
4.	Job Dispatch	GPRS
5.	Remote LAN Access	GPRS
6.	File Transfer	GPRS
7.	Web browsing	GPRS
8.	Still Images	GPRS
9.	Moving Images	GPRS / HSCSD
10.	Chat	GPRS / SMS
11.	Home Automation	GPRS
12.	Document Sharing/Collaborative Working	GPRS
13.	Audio	GPRS

The first of the applications listed will be popular partly because they are widespread over fixed telephone networks but have previously not been readily or fully available over GSM networks. The Internet and email are already in place today- GPRS will allow them to be made fully wirefree and available everywhere. The applications ranked further down the list lack current popularity in the fixed communications world and lack widespread availability of specific software solutions.
Whilst these applications are technically feasible or high speed mobile data services such as GPRS, the volume of usage is dependent upon commercial factors such as pricing. It is expected that GPRS will incorporate volume-based charging such that only the data sent will be charged for, paving the way for widespread usage amongst customers with GPRS capable devices.

8. GPRS Network Nodes

Enabling GPRS on a GSM network requires the addition of two core modules, the Gateway GPRS Service Node (GGSN) and the Serving GPRS Service Node (SGSN). As the word Gateway in its name suggests, the GGSN acts as a gateway between the GPRS network and Public Data Networks such as IP and X.25. GGSNs also connect to other GPRS networks to facilitate GPRS roaming. The Serving GPRS Support Node (SGSN) provides packet routing to and from the SGSN service area for all users in that service area.
In addition to adding multiple GPRS nodes and a GPRS backbone, some other technical changes that need to be added to a GSM network to implement a GPRS service. These include the addition of Packet Control Units; often hosted in the Base Station Subsystems, mobility management to locate the GPRS Mobile Station, a new air interface for packet traffic, new security features such as ciphering and new GPRS specific signalling.

9. GPRS Contracts Awarded

EUROPE

Country	Carrier	GPRS Vendor	Core Infrastructure Vendor	Contact Value	Date announced
Austria	Mobilkom	Nortel (TRIAL)	Motorola/ Nokia BSS and Nortel NSS	NA	JULY99
Austria	TELE.RING	Alcatel	Alcatel BSS + NSS + Microwave	NA	20MAY99
Belgium	Belgacom	Motorola	Siemens switches, Motorola, Alcatel and Nokia base stations	NA	15MAR99
Denmark	Sonofon	Nokia	Nokia		2JUNE99
Finland	Radiolinja	Nokia	Nokia	NA	NA
Finland	Sonera	Nokia	Nokia	NA	23FEB99
Finland	Sonera	Ericsson	Nokia	NA	JUNE99
France	France Telecom	Alcatel (TRIAL)	Alcatel and Ericsson Mobile Switches. Alcatel, Nortel and Motorola Base Stations.	NA	2APR99
France	France Telecom	Motorola (TRIAL)	As above	NA	MAR99
France	SFR/ Cegetel	Alcatel	Alcatel and Ericsson mobile switches. Alcatel, Motorola, Nokia base stations	NA	21OCT98
France	Bouygues Telecom	Nortel (TRIAL)	Nortel and Nokia BSS, Ericsson NSS	NA	JUL99
Germany	T-Mobil	Ericsson	Alcatel and Siemens switches. Alcatel,Motorola and Lucent base stations.	NA	26JAN99
Germany	T-Mobil	Alcatel	As above	NA	23FEB99
Germany	Mannesmann D2	Siemens	Siemens	NA	JUNE99
Netherlands	Telfort	Ericsson	Ericsson	NA	23FEB99
Poland	PTC/ Era	Siemens	Siemens	NA	JUNE99
Poland	Polkomtel	Nokia	Nokia	NA	NA
Scandinavia		Siemens*			
UK	BT Cellnet	Motorola	Motorola	US$50m	9FEB99
UK	One2One	Ericsson	Ericsson	US$45m	18MAR99

*This contract with major Scandinavian operator has not yet been publicly announced.

NON-EUROPE

Country	Carrier	GPRS Vendor	Core Infrastructure Vendor	Contact Value	Date announced
Australia	C&W Optus	Nortel	Nokia BSS, Nortel NSS	US$33m	12MAY99
Hong Kong	Sunday	Nortel	Nortel NSS, Nortel BSS	NA	JULY1999
Hong Kong	Hongkong Telecom	Nokia		HK$ 40-50m	MAY99
Hong Kong	Smartone	Ericsson	Ericsson	NA	MAR99
Singapore	Mobile One	Nokia		NA	6JUL99
Taiwan	KGTelecom	Nokia		US$ 100m	NA
USA	Omnipoint	Ericsson (TRIAL)	Ericsson	NA	
					8FEB99

NB: New GPRS contracts are being awarded all the time and this information is regularly updated on www.mobileGPRS.com

10. GPRS Suppliers Market Share

EUROPE

Vendor	Number of GPRS customers
Ericsson	4
Nokia	4
Alcatel	4
Motorola	3
Siemens	3
Nortel Networks	2
TOTAL	20

NON-EUROPE

Vendor	Number of GPRS customers
Nokia	3
Ericsson	2
Nortel Networks	2
TOTAL	7

GLOBAL

Vendor	Number of GPRS customers
Nokia	7
Ericsson	6
Alcatel	4
Nortel Networks	4
Motorola	3
Siemens	3
TOTAL	27

Please note that:
Too few contracts have been awarded to express percentages These figures include trial sites NB: New GPRS contracts are being awarded all the time and this information is regularly updated on www.mobileGPRS.com

Having looked at the nonvoice mobile applications, let us look at other network operator issues relating to GPRS.

11. Related GPRS Challenges

BILLING

GPRS is a different kind of service from those typically available on today's mobile networks. GPRS is essentially a packet switching overlay on a circuit switching network. The GPRS specifications stipulate the minimum charging information that must be collected in the Stage 1 service description. These include destination and source addresses, usage of radio interface, usage of external Packet Data Networks, usage of the packet data protocol addresses, usage of general GPRS resources and location of the Mobile Station. Since GPRS networks break the information to be communicated down into packets, at a minimum, a GPRS network needs to be able to count packets to charging customers for the volume of packets they send and receive. Today's billing systems have difficulties handling charging for today's nonvoice services. It is unlikely that circuit switched billing systems will be able to process a large number of new variables created by GPRS.

GPRS call records are generated in the GPRS Service Nodes. The GGSN and SGSN may not be able to store charging information but this charging information needs to be processed. The incumbent billing systems are often not able to handle real time Call Detail Record flows. As such, an intermediary charging platform is a good idea to perform billing mediation by collecting the charging information from the GPRS nodes and preparing it for submission to the billing system. Packet counts are passed to a Charging Gateway that generates Call Detail Records that are sent to the billing system.

However, the crucial challenge of being able to bill for GPRS and therefore earn a return on investment in GPRS is simplified by the fact that the major GPRS infrastructure vendors all support charging functions as part of their GPRS solutions. Additionally, a wide range of

other existing non-GSM packet data networks such as X.25 and Cellular Digital Packet Data (CDPD) are in place along with associated billing systems.

It may well be the case that the cost of measuring packets is greater than their value. The implication is that there will NOT be a per packet charge since there may be too many packets to warrant counting and charging for. For example, a single traffic monitoring application can generate tens of thousands of packets per day. Thus the charging gateway function is more a policing function than a charging function since network operators are likely to tariff certain amounts of GPRS traffic at a flat rate and then need to monitor whether these allocations are far exceeded.

This is not to say that we will end up with the free Internet Service Provider model that has become established on the fixed Internet in which users pay no fixed monthly charge and network operators rely on advertising sales on mobile portal sites to make money. There is a premium for mobility and there is frankly a shortage of mobile bandwidth that limits the extent to which that bandwidth is viewed as a commodity. And given the additional customer care and billing complexity associated with mobile Internet and nonvoice services, network operators would be ill advised to reduce their prices in such a way as to devalue the perceived value of mobility.

TARIFFING

Decisions on charging for GPRS by packet or simply a flat monthly fee are contentious but need to be made. Charging different packets at different rates can make things complicated for the user, whilst flat rates favor heavy users more than occasional ones.

We believe that the optimal GPRS pricing model will be based on two variables- time and packet. Network operators should levy a nominal per packet charge during peak times plus a flat rate, no per packet charge during non peak times. Time and packet related charging will encourage applications such as remote monitoring, meter reading and chat to use GPRS overnight when spare network capacity is available. Simultaneously, a nominal per packet charge during the day will help to allocate scarce radio resources and charge radio heavy applications such as file and image transfer more than applications with lower data intensity. It has the advantage that it will automatically adjust customer charging according to their application usage.

As such the optimal charging model could well be a flat rate charge during off-peak times along with a per packet charge during peak times.

CUSTOMER SERVICE

Value-added network services such as mobile data, mobile Internet and unified messaging all generate certain specific customer problems and requirements, thereby requiring customer service personnel to be aware of these issues and know how to solve them.

Nonvoice services are surprisingly complex- involving unique configurations of phone types, data cards, handheld computers, subscriptions, operating systems, Internet service providers and so on. Some network operators require customers to opt into certain value added services rather than including them as part of the core subscription- necessitating a customer service process. It is even possible to write a 350 page book about the SHORT message service (it is called "YES2SMS")!

In theory, the need for dedicated customer service for Circuit Switched Data, SMS and other nonvoice mobile services will decrease in the future as terminals and services become easier to use and as the services themselves are used more widely for customer service purposes.

The reality in the short and medium term is that the need for customer support for value-added services will increase not decrease as awareness of services and their usage increases, and as new services and terminals come onto the marketplace.

Rather than keeping everything in-house or outsourcing everything, we are a proponent of an approach that keeps first line support and customer contact in-house, whilst outsourcing the difficult specific customer service problems arising from connectivity issues and so on. In this way, the network operator is aware of and in control of the kinds of questions and problems its customers are asking.

It is well worth incurring the cost to get the customer aware, educated and initially set up with data services, because, for example, once the PC data card has been successfully connected to the laptop to the Internet software and so on, the same configuration can be repeatedly used. The one-off customer requirement leads to ongoing usage.

12. The Mobile Value Chain

The nonvoice mobile value chain shows the various parties, along with their interdependence and activities, that are involved in realizing the full potential of nonvoice mobile services. There will be differences between the voice and nonvoice value chain-need for IT channels. These parties are network operators, customers, IT/ mobile channels, terminal and infrastructure vendors and application developers. All of these players in the value chain are essential to deliver the overall success of the nonvoice services- if any one is underdeveloped or not present, the entire value chain can break down. Each has a distinct role to play, which will now be discussed.

CUSTOMERS

Without customer interest in the nonvoice mobile services, there is little need for any of the other players in the value chain to be present. If customers don't see a compelling requirement for a nonvoice service such as GPRS that can be delivered at a reasonable cost to them, there is little point in network operators offering services, GPRS terminal vendors manufacturing product, channels for product purchase being established or applications developed. Customer interest is the business case that supports any investment in the nonvoice market, as in any other.

Customers tend to interface with network operators to buy service- either directly or indirectly through designated channels depending on the size of the business and importance of the customer to the network operator. Customers may also have links with application developers if their application requires some specific software.

TERMINAL/ INFRASTRUCTURE VENDORS

Terminal and infrastructure vendors supply the equipment and technology that turns a service such as GPRS that has been set down on paper as a standard in theory into something that can be implemented in practice. Clearly, without network infrastructure to

enable the service in a cost effective way, it cannot be widely implemented in practice. Equally, availability of terminals in commercial quantities at reasonable prices can hinder or halt market take up. There is little point in a network supporting a service if the clients to connect to that network are not available. Delays in widespread terminal availability have often hindered the successful deployment of new technologies and initiatives- most recently with SIM Application Toolkit and the Wireless Application Protocol.

Terminal and infrastructure vendors need to have links to the people who buy their products such as network operators to buy the network infrastructure and mobile channels that distribute and sell their terminals. Terminal and infrastructure vendors may well also have links to application developers to encourage applications to be ported to their infrastructure and terminal solution and interfaces and operating systems. The vendors may also have direct contact with large corporate end users- helping enable the nonvoice mobile opportunity in a network independent way.

APPLICATION DEVELOPERS

Application developers- software developers, systems integrators and the like- are an essential part in the nonvoice mobile value chain. Customers are interested in what the nonvoice services can be used for GPRS and other such services are a means to an end and not and end in themselves- they facilitate applications.

Applications are the end that will generate high usage of nonvoice services. They will generate regular and ongoing use of the nonvoice mobile services. Even given standardized elements in the other parts of the mobile value chain, some systems integration is likely to be necessary to deploy the application, such as integration with the host systems. However, once deployed, these applications will rapidly become an indispensable part of the daily life of the user that they will be loath to give up and keen to use frequently. Because they will make that person's life easier- they will help that person get their job done well and keep in touch with their family, friends, colleagues and customers.

Application developers may develop off the shelf shrink-wrapped nonvoice products such as a chat software program designed for volume sales, customized products developed specifically to meet one customer's requirement, or a hybrid in which a generic product such as a database is customized with application specific data. Some products or services have a "killer application" that is overwhelmingly popular- such as spreadsheets for PCs or desktop publishing for the Apple Macintosh- or a raft of different applications that all build on the underlying technology.

Application developers may have links to terminal and infrastructure vendors- in many cases, these vendors have application development forums and programs such as the GPRS Application Alliance from Ericsson and the Nokia Developer's Forum. Application developers should also have contacts with the network operators since networks have different levels of tariff plans, hardware and network infrastructure and services

availability. This interface between application developers and network operators is ideally in the form of a business partners program. Application developers may also sell their products directly to mobile channels by concluding packaging and bundling deals with those channels.

IT/ MOBILE CHANNELS

The customer needs to be able to find out about and sign up for a service in a convenient and easy way. The market channels are what facilitates this- different customer groups prefer

to use different channels. For example, if you only sold a product through Internet channels, you would preclude all those people who are not connected and those who are unwilling or uncomfortable to purchase online. In some cases, customers for nonvoice services such as GPRS will contact and contract with the network operator directly to purchase service- this could be a retail outlet or sales person or telesales type operation. In other cases, they will buy from an Information Technology (IT) channel such as a computing magazine or retail outlet. Just as consumer oriented propositions such as prepay are available from chemists and newsagents, corporate oriented IP based services such as GPRS are likely to lead to a further evolution in channels for mobile telephony products. Such smart terminals and other devices will be available from IT superstores such as Office World, management consultancies such as Anderson Consulting,business facilities outlets such as Mailboxes Etc., in airline business lounges and the like.

The channels have links to the customers that buy from them, the vendors who supply terminals to them and the network operators who try to get them to sell equipment connected to their particular network. The channels may also connect with application developers if their customers require a specific software solution.

NETWORK OPERATORS

Clearly, the sum of activities that a network operator carries out is essential in determining the success of nonvoice services. From fundamental prerequisites such as deciding to invest in network infrastructure to support nonvoice services to investing resources in educating customers about their availability and uses, network operators are an essential part of the process.

Network operators tend to have links with customers that are managed by account managers and customer service staff, channels such as service providers and retailers, application developers through business partner programs and network infrastructure and terminal suppliers who they contract with for the underlying technology. As such, given its central role and relations with all of the other players in the value chain, network operators are of central importance and need to systematically and deliberately manage relations with these different groups through setting up concrete programs and mechanisms to communicate with them.

We can therefore see the various parties that make up the nonvoice mobile services value chain and the importance of each. If any one of the five core elements of network operators, customers, application developers, terminal and infrastructure vendors and channels was NOT present, the entire value chain would be damaged and the success of the nonvoice service delayed or entirely precluded.

13. Summary

GPRS will provide a massive boost to mobile data usage and usefulness. That much seems assured from its flexible feature set, its latency and efficiency and speed. The only question is how soon it takes off in earnest and how to ensure that the technical and commercial features do not hinder its widespread use.

This guide is a cut down version of a book called "Data on GPRS" which is 250 pages long and contain detailed GPRS vendor profiles, application profiles, comparisons of GPRS to SMS, Circuit Switched Data, HSCSD, EDGE, UMTS and so on, plus case studies from around the world. The full 275 page "Data on GPRS" costs just 250 US dollars. The book contains full vendor profiles, application profiles, case studies from Europe, the USA and Japan, explanations of using GPRS with WAP and lots more important information. To order your copy for just 250 US dollars, visit www.mobileSMS.com/ordering.asp or contact the author by any of the methods listed below

Written by Simon Buckingham, Managing Director

Mobile Lifestreams Limited
9 The Broadway, Newbury
Berkshire, RG14 1AS, UK

Tel. +44 7000 366366
Fax +44 7000 366367
GSM +44 831 664144
Web www.mobilelifestreams.com

GSM Association, Avoca Court, Temple Road, Blackrock, Co. Dublin, Ireland.
Phone:+353 1 269 5922 Fax:+353 1 269 5958 Contact Us

GSM Association, 6 - 8 Old Bond Street, London, United Kingdom, W1S 4PH
Phone:+44 207 518 0530 Fax:+44 207 518 0531 Contact Us

Last Updated September 18, 2000