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GPRS Tutorial

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1 Introduction

GPRS (General Packet Radio Service) is a packet based communication service for mobile devices that allows data to be sent and received across a mobile telephone network. GPRS is a step towards 3G and is often referred to as 2.5G. Here are some key benefits of GPRS:

Speed

GPRS is packet switched. Higher connection speeds are attainable at around 56–118 kbps, a vast improvement on circuit switched networks of 9.6 kbps. By combining standard GSM time slots theoretical speeds of 171.2 kbps are attainable. However in the very short term, speeds of 20-50 kbps are more realistic.

Always on connectivity

GPRS is an always-on service. There is no need to dial up like you have to on a home PC for instance. This feature is not unique to GPRS but is an important standard that will no doubt be a key feature for migration to 3G. It makes services instantaneously available to a device.

New and Better applications

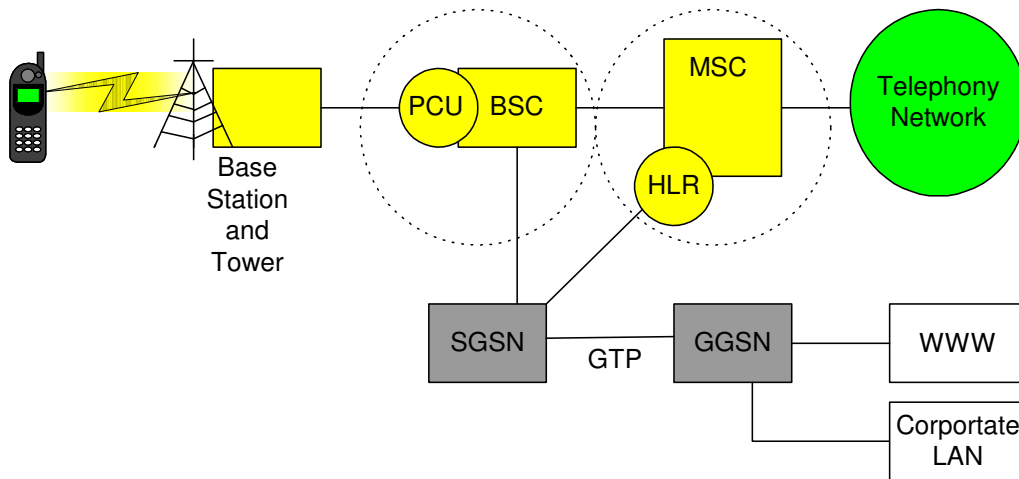
Due to its high-speed connection and always-on connectivity GPRS enables full Internet applications and services such as video conferencing straight to your desktop or mobile device. Users are able to explore the Internet or their own corporate networks more efficiently than they could when using GSM. There is often no need to redevelop existing applications.

GSM operator Costs

GSM network providers do not have to start from scratch to deploy GPRS. GPRS is an upgrade to the existing network that sits along side the GSM network. This makes it easier to deploy, there is little or no downtime of the existing GSM network whilst implementation takes place, most updates are software so they can be administered remotely and it allows GSM providers to add value to their business at relatively small costs.

The GSM network still provides voice and the GPRS network handles data, because of this voice and data can be sent and received at the same time.

2 Simple GPRS Technical Overview



As mentioned earlier GPRS is not a completely separate network to GSM. Many of the devices such as the base transceiver stations and base transceiver station controllers are still used. Often devices need to be upgraded be it software, hardware or both. When deploying GPRS many of the software changes can be made remotely.

There are however two new functional elements which play a major role in how GPRS works. The Serving GPRS Support Node (SGSN) and the Gateway GPRS support node (GGSN). These 2 nodes are new to the network with the other changes being small if any.

Before explaining what these 2 new members of our network do it is important to ask how does the network differentiate between GSM (circuit) and GPRS (packet)?

In simple terms there are in practice two different networks working in parallel, GSM and GPRS. In any GSM network there will be several BSC's (Base Station Controllers). When implementing GPRS a software and hardware upgrade of this unit is required. The hardware upgrade consists of adding a Packet Control Unit (PCU). This extra piece of hardware differentiates data destined for the standard GSM network or Circuit Switched Data and data destined for the GPRS network or Packet Switched Data. In some cases a PCU can be a separate entity.

From the upgraded BSC there is a fast frame relay connection that connects directly to the newly introduced SGSN.

2.1 SGSN

The Serving GPRS Support Node, or SGSN for short, takes care of some important tasks, including routing, handover and IP address assignment.

The SGSN has a logical connection to the GPRS device. As an example, if you where in a car travelling up the M1 on a long journey and were browsing the Internet on a GPRS device, you will pass through many different cells. One job of the SGSN is to make sure the connection is not interrupted as you make your journey passing from cell to cell. The SGSN works out which BSC to "route" your connection through.

If the user moves into a segment of the network that is managed by a different SGSN it will perform a handoff of to the new SGSN, this is done extremely quickly and generally the user will

not notice this has happened. Any packets that are lost during this process are retransmitted. The SGSN converts mobile data into IP and is connected to the GGSN via a tunnelling protocol.

2.2 GGSN

The Gateway GPRS Support Node is the “last port of call” in the GPRS network before a connection between an ISP or corporate network’s router occurs. The GGSN is basically a gateway, router and firewall rolled into one. It also confirms user details with RADIUS servers for security, which are usually situated in the IP network and outside of the GPRS network.

2.3 Connectivity Between the SGSN & GGSN

The connection between the two GPRS Support Nodes is made with a protocol called GPRS Tunnelling Protocol (GTP). GTP sits on top of TCP/IP and is also responsible for the collection of mediation and billing information. GPRS is billed on per megabyte basis unlike GSM. In practice the two GSN devices may be a single unit.

2.4 HLR

The HLR or Home Location Register is a database that contains subscriber information, when a device connects to the network their MSISDN number is associated with services, account status information, preferences and sometimes IP addresses.

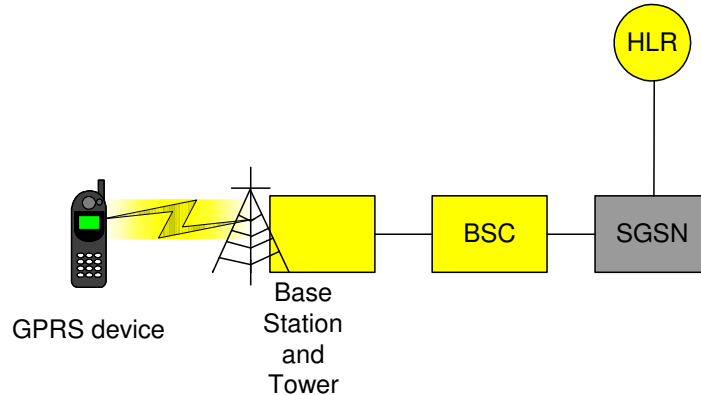
3 IP addressing

3.1 Allocating Addresses

There are 3 different ways in which a device can be assigned an IP address.

Fixed IP addressing:

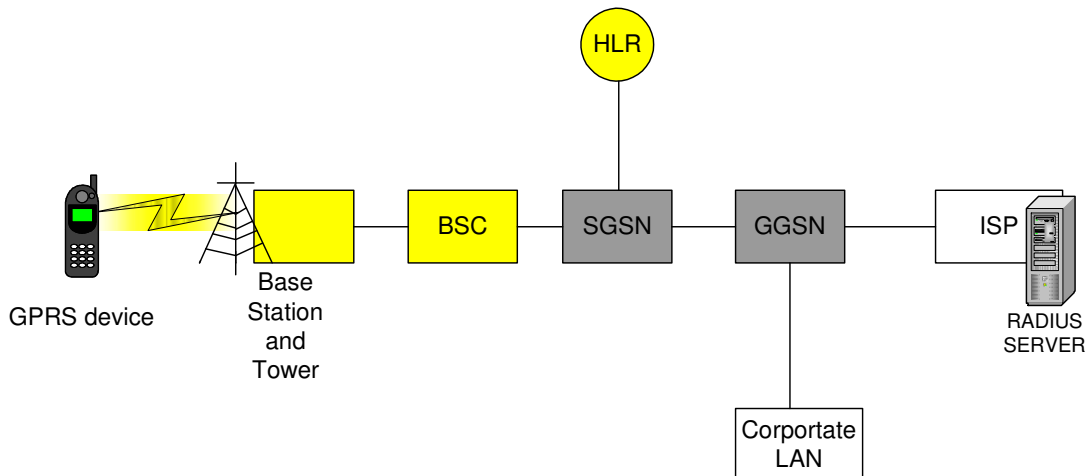
Fixed IP addresses for mobile devices are not widely used due to shortages of Ipv4 addresses (see below). This information is stored in the HLR.



Dynamic IP addressing:

The second means of addressing is dynamic addressing. This is where a mobile device does not have its own IP address stored in the HLR. Instead the IP address is assigned to the GGSN domain.

The third method is also a type of dynamic IP addressing in which the IP address is assigned by RADIUS servers normally situated inside an IP network outside the mobile network, an example of this being when you dial up to an ISP from your home PC.



3.2 How Does the SGSN know which GGSN to direct you to?

A mobile device is programmed with one or more Access Point Names which are commonly referred to as the APN's. An APN consists of a fully qualified DNS name e.g. morgandoyle.co.uk. When a GPRS device wants to talk to morgandoyle.co.uk's network, the SGSN does a DNS lookup and resolves the name to the correct GGSN. You could have multiple APN's programmed into your phone so you are not limited to a single service or GGSN.

3.3 IP Version 6

This new version of IP corrects unanticipated Ipv4 design issues that have come about because of the popularity of the Internet. In short we are running out of addresses.

IP version 4 is a 32-bit address that allows a maximum of around 4 billion IP addresses. It is estimated that by 2005 all the addresses in IP 4 will run out. Some say this will happen sooner - introduce millions of handheld devices all requiring IP addresses and suddenly there are none left.

To truly enable the Internet to such devices there has to be more addresses. This is where IP version 6 comes in. Instead of a 32-bit address, IP6 is 128 bit with a maximum number of:

340,232,366,920,938,463,463,374,607,431,768,211,456

possible IP addresses. This amount of address space is ample for future foreseeable growth.

At the moment there are around 1 billion addresses left for IP v 4 but many manufacturers of mobile devices especially in Asia are involving themselves heavily in IP v 6. This is mainly due to places like Japan having a fraction of the addresses allocated in comparison with other places like America.

4 GPRS Handset Classes

GPRS devices are not as straightforward as you may think. There are in fact 3 different classes of device.

4.1 Class A

Class A terminals have 2 transceivers which allow them to send / receive data and voice at the same time. This class of device takes full advantage of GPRS and GSM. You can be taking a call and receiving data all at the same time.

4.2 Class B

Class B devices can send / receive data or voice but not both at the same time. Generally if you are using GPRS and you receive a voice call you will get an option to answer the call or carry on.

4.3 Class C

This device only allows one means of connectivity. An example would be a GPRS PCMCIA card in a laptop.

5 GPRS QoS

Just because GPRS uses many of the components of a standard GSM network it would be foolhardy to assume that the same standards should apply. Things to be taken into account include provider general network architecture, radio interface and throughput. Here are some of the key elements briefly explained.

5.1 Network Architecture

Provider networks have to be upgraded. As mentioned earlier the GSN's are new to the standard GSM network. If GPRS is to stand-up to customer expectations network performance will be vital.

5.2 Radio Interface

The ETSI (European Telecommunications Standard Institute) has defined 3 new coding schemes for Radio Interface. When the GPRS device talks to the base station they can use 1 of the 4 schemes. The schemes are CS – 1 through CS – 3 where CS – 1 is the same as standard GSM. In simple terms CS – 1 is highly redundant but because of this is slow, 2 and 3 have less redundancy, whilst 4 has the least - removing all forward error control - but is capable of maximum throughput. If radio quality is bad then coding scheme 1 is used, as the quality improves less error control is needed.

5.3 Classes of GPRS services

Mobile devices can request different types of traffic to be prioritised in an attempt to give the user their desired level of connectivity. There are 4 types of class:

Precedence Class

An application can be assigned a Precedence Class 1, 2 or 3. If an application has a higher precedence (1) than another (3) then its traffic will be given a higher priority.

Delay Class

Applications can request predictive delay classes which guarantee an average and 95-percentile delay. There are 4 classes, 1 being the fastest.

Reliability class

Applications can request differing levels of reliability for its data depending on its tolerance to data loss.

Throughput Class

Applications can choose different profiles for throughput. There are 2 distinctions in class, peak and mean. Peak throughput class is used mainly for bursty transmissions with a variable in octets per second describing the throughput required for burst of specified size. Mean is the average data transfer rate over a period of time measured in octets per hour.

Other factors can affect QoS. Things like Radio quality, basic LAN / WAN and Internet congestion, faults on GSM and GPRS network' etc.

6 Problems with GPRS

Although GPRS has many benefits there have been a few problems. Connection speeds until the end of last year performed badly on some networks running at around 12Kbps, a far cry from the expected. This year however there do not seem to be as many problems, probably due to the fact that operators are improving due to trial and error. GPRS is after all a pretty new technology.

Another problem sometimes encountered is customer expectation. Many companies have applications running on a 10 megabyte LAN and expect the same performance from their GPRS devices. Although the connection speeds these days are pretty good it still is not as fast as ISDN or Local Area Networks. To a certain extent operators have themselves to blame for this, since in the past their marketing has tended to promote the speed aspects of 2.5 and 3G. Today, they are working hard to reduce expectation in this respect.

Earlier problems with things like mail servers not sending mail because of latency problems to GPRS devices have all been pretty much eradicated through optimisation programs. People running Citrix Thin Client have also encountered problems with latency although a few Thin Client forums suggest that Citrix are addressing the issue.

Deployment on some networks has been slow. There still is a major UK network provider who does not offer the service.

GPRS roaming has not been implemented in many countries on a lot of networks as yet. This is where a user can use the GPRS service from any network operator. At the moment although your GSM mobile will work, GPRS may not work at all. Accesses by third party application providers are having a lot of difficulty obtaining an APN from providers to offer their own GPRS services. This somewhat limits services to that provided by the GPRS operator.

7 GPRS European Coverage

This table shows when countries and networks are planning to deploy GPRS.

Country	Operator	Launch	Network Supplier
Aus	Maxmobil	Apr 6 2001	Siemens
Aus	Mobilkom	Aug 2 2000	Motorola-Cisco, Nortel
Aus	Connect Austria	Feb 26 2001	Nokia
Aus	Tele.ring	Jan 18 2001	Alcatel
Bel	Belgacom Mobile	Jul 5 2001	Nokia
Bel	Mobistar	Mar 1 2001	Noia, Nortel
Bel	KPN Orange	Q1 2002	Ericsson
Den	Orange	Jan 2001	Nokia
Den	Sonofon	Dec 5 2000	Nokia
Den	Tele Danmark Mobil	Jan 24 2001	Ericsson, Nokia
Den	Telia	Feb 2002	Ericsson
Fin	Radiolinja	Sept 26 2001	Nokia
Fin	Sonera	Nov 29 2000	Ericsson, Nokia
Fin	Telia	Oct 1 2001	Nokia
Fra	Bouygues Telecom	Q1 2002	Cisco, Ericsson, Nokia, Nortel
Fra	Orange	Q1 2002	Alcatel, Ericsson, Mot-Cisco, Nortel
Fra	SFR	Jun 15 2001	Alcatel, Nokia, Siemens
Ger	E-Plus	Mar 22 2001	Nokia
Ger	Mannesmann	Jan 28 2001	Ericsson, Siemens
Ger	T-Mobil	Jun 25 2000	Alcatel, Lucent, Motorola-Cisco
Ger	Viag Interkom	Jan 24 2001	Nokia, Nortel
Gre	Cosmote	Jan 18 2001	Nokia
Gre	Panafon	Mar 23 2001	Ericsson
Gre	Stet Hellas	Jul 3 2001	Ericsson
Ita	Blu	Dec 11 2000	Nokia, Nortel
Ita	Omnitel	Nov 24 2000	Nokia
Ita	TIM	Oct 5 2000	Ericsson, Siemens
Ita	Wind	Nov 2000	Alcatel, Ericsson, Siemens
Neth	Ben	Dec 3 2001	Nokia
Neth	Dutchtone	Q2/Q3 2002	Nokia, Nortel
Neth	KPN Mobile	Dec 11 2000	Nokia
Neth	Libertel	Apr 19 2001	Cisco, Ericsson
Neth	Telfort	Mar 30 2001	Ericsson
Nor	Netcom	Jan 31 2001	Nokia, Siemens
Nor	Telenor Mobil	Feb 1 2001	Ericsson, Nokia
Por	Optimus	Jul 9 2001	Ericsson, Motorola, Nokia
Por	Telecel	Apr 10 2001	Ericsson
Por	TMN	Nov 8 2000	Alcatel
Spa	Airtel	Nov 23 2001	Ericsson, Siemens
Spa	Amena	Jul 26 2001	Ericsson
Spa	Telefonica Moviles	Jan 15 2001	Motorola-Cisco, Nokia, Nortel
Swe	Europolitan	Dec 1 2000	Nokia
Swe	Tele2	Oct 9 2001	Motorola-Cisco, Siemens
Swe	Telia	Sept 11 2001	Ericsson
Swit	DiAx	Sept 29 2000	Nokia

Swit	Orange Communications	Sept 13 2001	Nokia
Swit	Swiscom	Feb 1 2002	Ericsson
UK	BT Cellnet	Jun 22 2000	Motorola-Cisco
UK	One2One	Q1 2002	Ericsson, Nortel
UK	Orange	Q2 2002	Ericsson
UK	Vodafone	Apr 2 2001	Ericsson

8 Contact Details

For further information or advice contact *MorganDoyle* Limited:

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