ASIA-PACIFIC INSTITUTE OF INFORMATION TECHNOLOGY

Computer Networks and Distributed Systems
(Research Paper)

WIRELESS NETWORK OF DEVICES:

GENERAL PACKET RADIO SERVICES (GPRS)

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1. Introduction

The topic which I have chosen for my research paper is the Wireless Network of Devices. Technology has advanced in the recent years and has made humans work and communication much simpler and more importantly is a necessity in today's technology age. One of which the technology I am about to touch is networking. Networking has made our lives simpler, much more convenient and thus efficient what more, wireless networking. Wireless networking is one of several ways to connect the computers in your home. It creates a network by sending radio-frequency signals between your computers to share information. This can make networking extremely easy, especially if you have computers all over your house. It also makes it a whole lot simpler to move computers around. For example, a laptop with a wireless network card is completely portable throughout the house!

Devices which uses radio frequency transmissions to replace medium-distance wired connections (such as Ethernet cables), to create what is sometimes called a WAN (wireless area network), or employed simply to replace short-distance cabling between digital devices. The most common current wireless network protocols are in the 802.11x family, sometimes referred to as Wi-Fi (Wireless Fidelity), and have a range of hundreds of feet. The shorter-range which is Bluetooth specification is intended for communications over tens of feet. These are all the wireless technology while the topic which I am going to touch is the General Packet Radio Service, also known as GPRS which is the networking and, the device for the technology is for example hand phone, Palmtop …etc.

The topic which I am going to specify on is the General Packet Radio Service (GPRS). GPRS is a wireless communication platform. In this research paper, I would also generally explain the uses of GPRS, GPRS terminals, the benefits of it and limitations. The architecture of the GPRS and a diagram on the evolution of mobile will be shown plus a little on GSM, EDGE and 3GSM which is related to GPRS. General Packet Radio Service (GPRS) enabled networks offer 'always-on', higher capacity, Internet-based content and packet-based data services. This enables services such as colour Internet browsing, e-mail on the move, powerful visual communications, multimedia messages and location-based services.

The GPRS is from the GSM family of wireless communication platforms which includes today's GSM, GPRS, EDGE and 3GSM.

2. Introduction to GPRS -
2.1 General Packet Radio Service

- GPRS is the abbreviation of General Packet Radio Service.
- It's an impressive growth of mobile communication industry.
- It is a new non-voice value added service that allows information to be sent and received across a mobile telephone network.
- Data rates increases as soon as the speed goes down.
- It supplements today's Circuit Switched Data and Short Message Service.
- GPRS utilizes packet switching technology where information is transmitted in short bursts of data over an IP-based network.
- GPRS is an important step in evolution towards big mobile network.
- Provides a quick session set up and fast data transmission speeds.
- Can use multiple time slots for data transfer as opposed to a normal single time slot.
- ~ is NOT related to GPS (the Global Positioning System)

Key features	**Details**
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	* 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. users are sometimes referred to be as being "always connected". * 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 for even 30 extra seconds.
New applications, better applications	* 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).

	* 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 & control in-house appliances & 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

Table 1: Key Features of GPRS (1)

Example: A GPRS mobile phone.

 Motorola Timeport T260 GPRS Mobile Phone	***The GPRS:*** The GPRS is an extension of the GSM network enabling data "packets" to be transmitted at high speed, in the same way as on the Internet. With rates up to eight times higher than GSM, the network offers virtually instantaneous connection. Thanks to GPRS, SAGEM mobile phones will enable you to surf the WEB as easily as you can today with a modem and PC, but with the added mobility. The first available GPRS phone, Motorola's Timeport 260, had three channels for downloading data and one for sending data back to the server, giving a maximum download speed of 36Kbit/s. Newer GPRS handsets have four down channels, and can reach speeds of 48Kbit/s. With improved compression technologies in future, data rates per channel could go considerably higher. .

Figure 1: Motorola Timeport T260 GPRS Mobile Phone

3. Key Network Features of GPRS

3.1 PACKET SWITCHING

GPRS involves overlaying a packet based air interface on the existing circuit switched GSM network. An option is given to the user to use a packet-based data service. Circuit switched network architecture is used to supplement with packet switching which is, quite major. 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 jumbled up. When the recipient empties the bag with all the pieces, they are reassembled to form the original image. The Internet itself is another example of a packet data network, the most famous of many such network types.

3.2 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.

GPRS should improve the peak time capacity of a GSM network since it simultaneously: allocates scarce radio resources more efficiently by supporting virtual connectivity immigrates 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. **(5)**

3.3 INTERNET AWARENESS

For the first time, GPRS fully enables Mobile Internet functionality by allowing inter-working between the internet and the new GPRS network. Because of GPRS, Any service that is used over the fixed Internet today like for example; File Transfer Protocol (FTP), web browsing, chat, email, and telnet, will be as available over the mobile network because of GPRS.

The World Wide Web is becoming the primary communications interface; people access the Internet for entertainment and information collection, the intranet however is for accessing company information and connecting with colleagues and the extranet is for accessing customers and suppliers. 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.

3.4 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.

4. The Evolution of mobile networks

Now, let’s take a look at the evolution of the mobile networks which has been progressing over the years. The mobile networks are progressing from the existing second-generation mobile networks to the third generation of networks that are able to handle **high-speed** multimedia traffic. The migration path to the third generation (UMTS)

is far from clear. There are several routes that may be taken as shown in the following diagram.

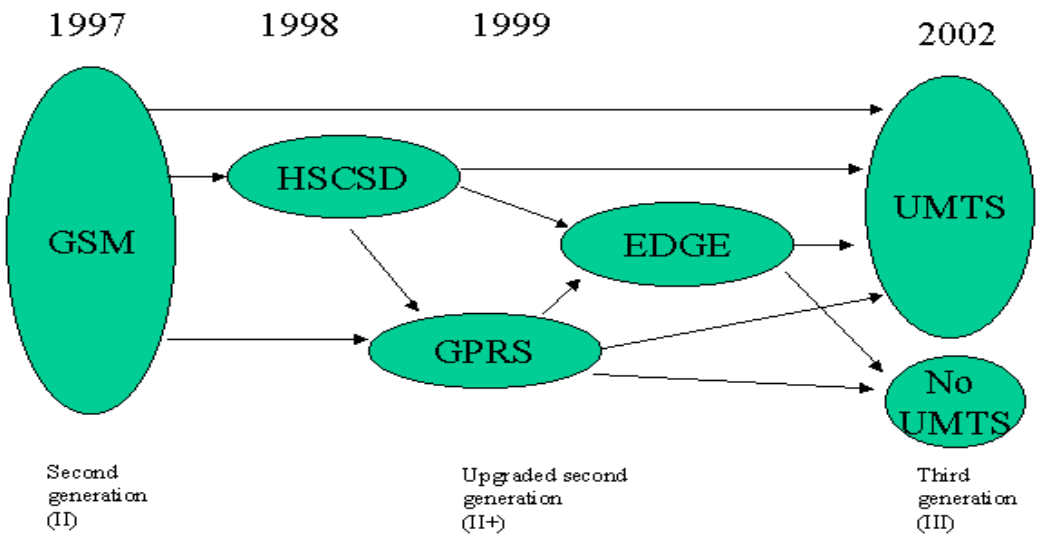


Diagram 1. GSM migration paths.

The GPRS services reflects the GSM services with an exception that GPRS will have a tremendous transmission rate which will make a good impact in the most of the existing services and a possibility of introduction of new services as operators and users (business/private) appreciate the newly introduced technology.

Services such as the Internet, videoconferencing and on-line shopping will be as smooth as talking on the phone; moreover we'll be able to access these services whether we are at work, at home or travelling.

In this new information age, the mobile phone will deliver much than just voice calls. It will become a multi-media communications device, capable of sending and receiving graphic images and video.

5. GPRS Architecture

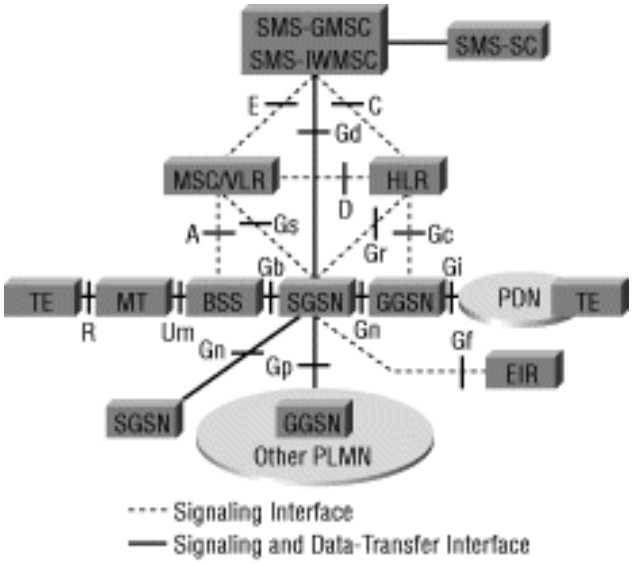
From a high level, GPRS can be thought of as an overlay network onto a second-generation GSM network. This data overlay network provides packet data transport at rates from 9.6 to 171 kbps. Additionally, multiple users can share the same air-interface resources.
GPRS attempts to reuse the existing GSM network elements as much as possible, but in order to effectively build a packet-based mobile cellular network, some new network elements, interfaces, and protocols that handle packet traffic are required. Therefore,

GPRS requires modifications to numerous network elements, as summarized in Table 1 and illustrated in Diagram 2.

GSM Network Element	Modification or Upgrade Required for GPRS
Subscriber Terminal (TE)	A totally new subscriber terminal is required to access GPRS services. These new terminals will be backward compatible with GSM for voice calls.
BTS	A software upgrade is required in the existing base transceiver site (BTS).
BSC	The base station controller (BSC) will also require a software upgrade, as well as the installation of a new piece of hardware called a packet control unit (PCU). The PCU directs the data traffic to the GPRS network and can be a separate hardware element associated with the BSC.
Core Network	The deployment of GPRS requires the installation of new core network elements called the Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN).
Databases (VLR, HLR, and so on)	All the databases involved in the network will require software upgrades to handle the new call models and functions introduced by GPRS.

Table 1: Modifications Required for GPRS

5.1 GPRS Reference Architecture



Source: ETSI

(Diagram2 : Generic GPRS Network)

5.2 GPRS Subscriber Terminals

New terminals (TE's) are required because existing GSM phones do not handle the enhanced air interface, nor do they have the ability to packetize traffic directly. A variety of terminals will exist, as described in a previous section, including a high-speed version of current phones to support high-speed data access, a new kind of PDA device with an embedded GSM phone, and PC Cards for laptop computers. All these TE's will be backward compatible with GSM for making voice calls using GSM.

6. Technology Of GPRS

6.1 How is data transferred?

The most common methods used for data transfer are circuit-switching and packet-switching. With circuit-switched transmission the dedicated circuit is first established across a sequence of links and then the whole channel is allocated to a single user for the whole duration of the call.

With packet switched transmission, the data is first cut in to small parts called packages which are then sent in sequence to the receiver, which again builds the packages back

together. This ensures that the same link resources can be shared at the same time buy many different users. The link is used only when the user has something to send. When there is no data to be sent the link is free to be used by another call. Packet switching is ideal for bursty traffic, e.g. voice.

6.2 Technology used by GPRS

The technology which is used by the GPRS are indeed advanced and is used almost globally. The main objectives to be reached by implementing GPRS are as follows.

• give support for bursty traffic
• use efficiently network and radio resources
• provide flexible services at relatively low costs
•possibility for connectivity to the Internet
• provide fast access time
• to have and support flexible co-existence with GSM voice

GPRS uses a packet-mode technique to transfer data and signaling in a cost-efficient manner over GSM radio networks and also optimizes the use of radio and network resources. New GPRS radio channels are also defined.

This allows GPRS to handle bit-rates from 9 to even up to 150 kbit/s per user. With these bit rates all types of transmissions can be handled: from slow-speed short messages to the higher speeds needed e.g. when browsing Web pages. GPRS will also permit the user to receive voice calls simultaneously when sending or receiving data calls. When the user switches on their phone, the message will be downloaded automatically.

7. Benefits of GPRS

• **3 TO 10 TIMES THE 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. **(2)**

• User benefits from shorter access times and higher data rates.

• **User can be online for long**; leave your phone connected all day, but only pay for the packets of information you use. Also, it only takes about 10 seconds to log on; unlike a circuit-switched GSM WAP connection, which typically takes 30 seconds to get online.

• Network based on IP and X.25 is supported.

• **Higher capacity Internet access** - Up to 171.2 kbps transfer rate (in theory), 40 kbps in practice

• **Quicker access to internet** - No set up time, Internet access all the time available.

• **Lower cost** -Flat rate or volume based billing; No charge for the idle time of the "connection".

• **Instant Connections ;Immediate transfer of data -** GPRS facilitates instant connections whereby information can be sent or received immediately as the need arises. Immediacy is one of the advantages of GPRS (and SMS) when compared to Circuit Switched Data. **(5)**

8. Limitations

8.1 Limitations of GPRS

- Limited Cell Capacity For All Users
- Speeds Much Lower in Reality
- Support of GPRS Mobile Terminate by Terminals is not Ensured
- Suboptimal Modulation
- Transit Delays
- No Store and Forward

9. Applications of GPRS

GPRS will enable a variety of new and unique services to the mobile wireless subscriber. These mobile applications contain several unique characteristics that enhance the value to the customers. Finally, localization allows subscribers to obtain information relevant to their current location. The core network components offered by Cisco enable seamless access to these applications, whether they reside in the service provider's network or the public Internet. A wide range of corporate and consumer applications are enabled by non-voice mobile services such as SMS and GPRS. This section will introduce those that are particularly suited to GPRS.

- Chat
- Textual and Visual Information
- Still Images
- Moving Images
- Web Browsing
- Document Sharing/ Collaborative Working
- Audio
- Job Dispatch
- Corporate Email

- Internet Email
- Vehicle Positioning
- Remote LAN Access
- File Transfer
- Home Automation

9.1 SERVICE ACCESS

To use GPRS, the user will 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).

Conclusion

From the research which I did on General Packet Radio Switching (GPRS), what I found was that GPRS is an important step in the evolution towards 3G mobile networks. Many customers and consumers will one day rely on GPRS to be connected all over the world without worrying about the cost as it is not charge for the idle time of connection but the information which you download so users could access and get connected the whole day. Eventhough there are transits delays, the access to the internet is available at all time thus making it so efficient.

What I predict in the near future is GPRS would play a major role in the future of cellular communications and hence, it is imperative to be aware of its importance. Even now, SMS is such a hit around the world because of the conveniences and hassle-free. Getting connected is what the technology and information age is about. It is much more cost effective when the billing of data transfer is done so and not the time spent online. Its packet switched transmission technology is optimized for bursty traffic Internet/Intranet services.

When it comes to mobile communication technology, there is usually more than one way to do it. Two years ago, buying drinks from a vending machine with a mobile phone was envisioned as a Bluetooth application. These days, SMS is used to achieve the same effect. A similar argument applies for the issue of CSD and GPRS. Although GPRS is starting to edge ahead in the argument of benefits, CSD is still good for certain uses. But as we move towards 3G (Third Generation), it is a matter of time before good old GSM data connections are finally phased out.

Well for the record, the GPRS takes only about 10 seconds to log on, unlike a circuit-switched GSM WAP connection, which typically takes 30 seconds to get online. Download speeds will not be the main issue, at least in the early days. At the moment, you can download at about 12Kbit/s per GPRS channel, or timeslot (the maximum number of channels is eight, including downloads and uploads). The first available GPRS phone, Motorola's Timeport 260(shown on page 5) , had three channels for downloading data and one for sending data back to the server, giving a maximum download speed of 36Kbit/s. Newer GPRS handsets have four down channels, and can reach speeds of 48Kbit/s. With improved compression technologies in future, data rates per channel could go considerably higher. **(2, 3)**

There is much debate today in the marketplace on the potential use of WLAN technology, especially in relation to other wireless access technologies such as GPRS and 3G. WLAN is clearly a complement to these access technologies, and together it provides greater flexibility, choice and convenience for end users.

From an operator's point of view, WLAN provides additional sources of revenue and a mechanism for promoting overall growth and uptake of wireless data access for the mobile Internet. Ericsson is leading the way in standardizing and developing WLAN solutions for GPRS and 3G networks. Today the company provides solutions for operators that integrate WLAN as part of their current GPRS and 3G services. This enables operators to provide seamless mobile Internet access service for their customers.

The market for packet-based cellular services is largely untested and uncertain. Major questions in the introduction of the packet networks are the level of customer acceptance and the degree of integration of service components for cellular data services. To succeed, cellular packet data will need to deliver more effective solutions than existing substitutes, or new applications where no effective substitute exists.

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 of technology.

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