A

Seminar report

On

GPRS

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Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

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Preface

I have made this report file on the topic **GPRS;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

CONTENTS

ABSTRACT

Today's mobile professionals need to stay in regular contact with important sources of information such as the Internet, email, corporate networks and remote databases. As demand for Wide Area Networking (WAN) connectivity continues to grow, users and organizations are seeking ways to make it more efficient and productive. One of the most promising new technologies for this purpose is General Packet Radio Service (GPRS). GPRS is a packet-switching data network that is overlaid on the existing cellular voice network, using the same radio frequencies and cellular towers. When combined with the existing Global System for Mobile communication (GSM), GPRS offers a complete voice and data solution with significant advantages over other solutions.

GPRS offers the flexibility and throughput of packet switching. GPRS uses packet switching to transfer data from the mobile device to the network and back. On a packet switched network a device can be always connected and ready to send information without monopolizing the channel. Channels are shared in packet-switched network, but in circuit-switched each channel is dedicated to one user. There are no call up or suspend delays.

By overlaying the GSM network, GPRS is able to take advantage of the world's leading digital phone system with a global subscriber base of over 646.5 million.Theoretical maximum speeds of up to 171.2 kilobits per second (kbps) are achievable with GPRS. 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.

INTRODUCTION

Wireless wide area cellular network solutions have been around for many years. Widespread adoption has been slow due to issues with coverage, cost, performance, and secure remote access to business networks. The deployment of the Global System for Mobile Communications (GSM) based General Packet Radio Service (GPRS) has the potential to change this situation and to provide connectivity any time and any where. GPRS is a packet based radio service that enables always on connections, eliminating repetitive and time consuming dial up connections. It will also provide real throughput in excess of 40 Kbps, about the same speed as an excellent land line analog modem connection.

Need For a Wireless WAN Solution

Mobile workers who need to access information while they travel can do so using one of two Wide Area Networking methods - wired or wireless. In the past, they relied mainly on wired methods such as analog modems to connect over the public switched telephone network (PSTN). However, users realized that using a dial up method to get a connection were relatively tedious and time consuming, and connections were sometimes difficult to maintain. In addition, as networking has progressed, the circuit-switched phone network has proved to have limitations for data transmission compared to packet-switched networks such as the Internet and corporate LANs. And finally, wired methods do not provide the same degree of mobility as wireless solutions. The advent of wireless data communication through the use of mobile phones and alphanumeric pagers have provided a higher degree of flexibility over wired mobile connections. Today, users are able to connect their notebook and handheld computers to data sources using mobile phone connection kits, and the data is sent over the mobile phone network. However, mobile phones are still relatively slow in terms of data throughput, and pagers can only display small amounts of information. Manufacturers are rapidly developing a wide variety of new client devices, and advanced transmission capabilities are also required. Mobile data users, businesses and other organizations have asked for the freedom of wireless, but with the performance of wired connections. One of the most promising technologies for meeting these needs is General Packet Radio Service (GPRS). This wireless data transmission technology can be used to send data over large geographic areas to create the next evolution of wireless WANs (WWANs).

Advantages of GPRS

GPRS provides faster data transfer rates, always on connection, robust connectivity, broad application support and strong security mechanisms.

Fast Data Transfer Rates

GPRS currently supports an average data rate of 115 Kbps, but this speed is only achieved by dedicating all eight time slots to GPRS. Instead, carriers and terminal devices will typically be configured to handle a specific number of time slots for upstream and downstream data. For example, a GPRS device might be set to handle a maximum of four slots downstream and two slots upstream. Under good radio conditions, this yields speeds of approximately 50 Kbps downstream and 20 Kbps upstream. This is more than three times faster than current 14.4-Kbps GSM networks and roughly equivalent to a good land line analog modem connection. The aggregate cell site bandwidth is shared by voice and data traffic. GPRS operators will vary in how they allocate the bandwidth. Typically, they will configure the networks to give precedence to voice traffic; some may dedicate time slots to data traffic to ensure a minimum level of service during busy voice traffic periods. Unused voice capacity may be dynamically reallocated to data traffic. With its faster data transfer rates, GPRS enables higher bandwidth applications not currently feasible on a GSM network.

Always-On Connection

An always on connection eliminates the lengthy delays required to reconnect to the network to send and receive data. Information can also be pushed to the end user in real time. GPRS allows providers to bill by the packet, rather than by the minute, thus enabling cost effective always on subscriber services.

Robust Connectivity

GPRS improves data transmission integrity with a number of mechanisms. First, user data is encoded with redundancies that improve its resistance to adverse radio conditions. The amount of coding redundancy can be varied, depending on radio conditions. GPRS has defined four coding schemes CS1 through CS4. Initially, only CS1 and CS2 will be supported, which allows approximately 9 and 13 Kbps in each time slot. If an error is detected in a frame received in the base station, the frame may be repeatedly retransmitted until properly received before passing it on to the GPRS core network.

Broad Application Support

Like the Internet, GPRS is based on packet-switched data. This means that all native IP applications, such as email, Web access, instant messaging, and file transfers can run over GPRS. In addition, its faster data transfer rates enable GPRS to accommodate higher-bandwidth applications (such as multimedia Web content) not suited to slower GSM dial-up connections. GPRS is particularly well suited for applications based on the Wireless Application Protocol (WAP). WAP has gained widespread acceptance in a new breed of micro browser enabled phones.

Security Support

GPRS builds on the proved authentication and security model used by GSM. At session initiation, a user is authenticated using secret information contained on a smart card called a Subscriber Identity Module (SIM). Authentication data is exchanged and validated with records stored in the HLR network node. GPRS enables additional authentication using protocols such as RADIUS before the subscriber is allowed access to the Internet or corporate data networks. GPRS supports the ciphering of user data across the wireless interface from the mobile terminal to the SGSN. In addition, higher level, end to end VPN encryption may take place when a user connects to a private corporate network.

A BIT OF HISTORY

First Generation Wireless Technology

The first generation of wireless mobile communications was based on analog signaling. Analog systems, implemented in North America, were known as Analog Mobile Phone Systems (AMPS), while systems implemented in Europe and the rest of the world were typically identified as a variation of Total Access Communication Systems (TACS). Analog systems were primarily based on circuit-switched technology and designed for voice, not data.

Second Generation Wireless Technology

The second generation (2G) of the wireless mobile network was based on low band digital data signaling. The most popular 2G wireless technology is known as Global Systems for Mobile Communications (GSM). GSM technology is a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). The first GSM systems used a 25MHz frequency spectrum in the 900MHz band. FDMA is used to divide the available 25MHz of bandwidth into 124 carrier frequencies of 200kHz each. Each frequency is then divided using a TDMA scheme into eight time slots. The use of separate time slots for transmission and reception simplifies the electronics in the mobile units. Today, GSM systems operate in the 900MHz and 1.8 GHz bands throughout the world with the exception of the Americas where they operate in the 1.9 GHz band. While GSM technology was developed in Europe, Code Division Multiple Access (CDMA) technology was developed in North America. CDMA uses spread spectrum technology to break up speech into small, digitized segments and encodes them to identify each call. The Second Generation (2G) wireless networks mentioned above are also mostly based on circuit-switched technology. 2G wireless networks are digital and expand the range of applications to more advanced voice services, such as Called Line Identification. 2G wireless technology can handle some data capabilities such as fax and short message service at the data rate of up to 9.6 kbps, but it is not suitable for web browsing and multimedia applications.

Second Generation Plus (2G+) Wireless Networks

The effective data rate of 2G circuit-switched wireless systems is relatively slow for today's Internet. As a result, GSM and other TDMA-based mobile system providers and carriers have developed 2G+ technology that is packet- based and increases the data communication speeds to as high as 384kbps. These 2G+ systems are based on the following technologies **High Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS)** and **Enhanced Data Rates for Global Evolution (EDGE)** technologies. HSCSD is one step towards 3G wide band mobile data networks. This circuit-switched technology improves the data rates up to 57.6kbps by introducing 14.4 kbps data coding and by aggregating 4 radio channels time slots of 14.4 kbps. GPRS is an intermediate step that is designed to allow the GSM world to implement a full range of Internet services without waiting for the deployment of full scale 3G wireless systems. GPRS uses a multiple of the 1 to 8 radio channel time slots in the 200kHz-frequency band allocated for a carrier frequency to enable data speeds of up to 115kbps. EDGE technology is a standard that has been specified to enhance the throughput per time slot for both HSCSD and GPRS.

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. .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.

Spectrum efficiency

Characteristic	Circuit Switching	Packet Switching
Need to establish a Connection	Yes	No
Dedicated Path	Yes	No
Bandwidth allocation	Fixed	Dynamic
Potentially wasted bandwidth	Yes	No
Same path for all data	Yes	No
Congestion can occur at	Setup time	Any time

Table 1 Circuit switching vs Packet switching

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.

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.. There is a trend away from storing information locally in specific software packages on PCs to remotely on the Internet .Each GPRS terminal can potentially have its own IP address and will be addressable as such.

GPRS ARCHITECTURE

GSM Network Overview

At a high level, GSM is a mobile telephony network based on the cellular concept. Users can place and receive calls without being fixed to a specific location or wired to a physical connection. To supply this capability, a GSM network consists of three basic components:

Subscriber Terminal Devices

Today, these devices are typically cell phones, but there are other devices such as personal digital assistants (PDAs) with various input/output capabilities. All have integrated radio transceivers.

Types of devices : GPRS devices are also classified by their ability to handle voice and data calls. There are three such classifications:

• **Class A** devices provide complete support of simultaneous voice and GPRS.

• **Class B** devices can be registered on both the GSM (voice) and GPRS (data) networks, but only one connection can be active at a time. The user can select to put data delivery on hold while they receive phone calls and vice versa.

• **Class C** devices require that voice calls must be cleared before GPRS can be used and vice versa. Thus, the device will not automatically switch between voice and data, a hard switchover is required.

Radio Base Station Network

Cellular networks are composed of small, low powered, terrestrial radio cells that typically range in coverage area from tens of kilometers in sparsely populated rural areas to less than 500 meters in densely populated urban areas. The frequencies used by the network are reused again and again in different cells throughout the network to increase network capacity.

Network Switching and Services Infrastructure

The traffic to and from the radio network is concentrated at a set of switching nodes that interface to other fixed public or private networks. These nodes handle the call setup, channel resource allocation, and the administration of subscriber services. These components allow the GSM network to provide coverage as a user moves from an area covered by one cell to an area covered by another cell. The network terminates the old cell connection and immediately establishes a new cell connection. This process is designed to be transparent to the user. In addition, users can roam or travel outside of a home coverage area to a new city, region, or country. The arrival of the visitor is detected by the new system through an automatic registration process. The new system informs the user's home system of the new location so that calls can be delivered.

Many registers are also maintained which contain information necessary for the smooth functioning of the network. The HLR (Home Location Register) stores information about the current location of all subscribers of the network. This information is necessary for routing all calls/messages to their intended destinations. A VLR (Visitor Location Register) covers one or more cells and stores information about the subscribers currently under its area of influence.

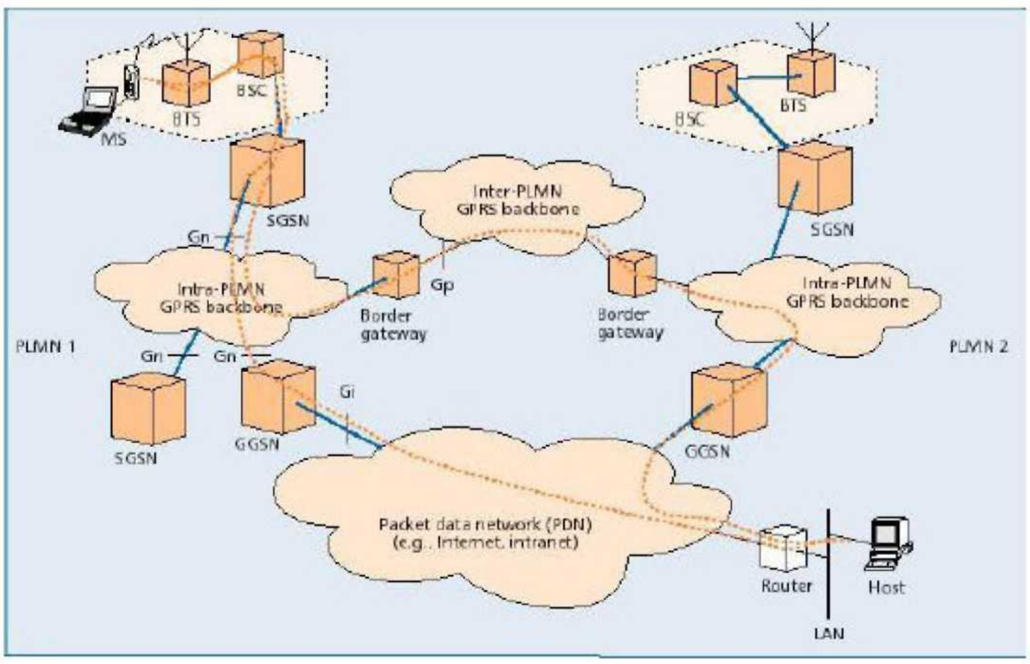

Fig 1 : GPRS Network Architecture

Additional Network Functionality

Although GPRS reuses existing GSM network elements, some new protocols, interfaces and other network elements are required (see Figure 1). These include two major core network elements, the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Node (SGSN).

Serving GPRS Support Node (SGSN): The SGSN is responsible for tracking the state of the mobile station and its movements as it roams in a geographical area. It also handles the data connection between the mobile device and the network. SGSNs send queries to Home Location Registers (HLRs) to obtain profile data of GPRS subscribers. SGSNs detect new GPRS mobile stations in a given service area; and, finally, SGSNs process registration of new mobile subscribers and keep a record of their location inside a given service area.

Gateway GPRS Support Node (GGSN): The GGSN handles the link
between the GPRS network and other data networks, i.e. the Internet and enterprise networks. Each of those networks is given an Access Point Name
(APN).

GSM Network Element	Modification or Upgrade Required for GPRS
Subscriber Terminal	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 2 Modifications on GSM Network

GPRS IN ACTION

When a user turns on a GPRS device, typically it will automatically scan for a local GPRS channel. If an appropriate channel is detected, the device will attempt to attach to the network. The SGSN receives the attach request, fetches subscriber profile information from the subscriber's HLR node, and authenticates the user. Ciphering may be established at this point. The SGSN uses the profile information (including the access point name, which identifies the network and operator) to determine which GGSN to route to. The selected gateway may perform a Remote Authentication Dial In User Service (RADIUS) authentication and allocate a dynamic Internet Protocol (IP) address to the user before setting up connections to outside networks. This process is called the packet data profile context activation and the setup may vary from one carrier to the next. It may include additional functions like QoS management. When the mobile device is powered off or moved out of a GPRS coverage area, its context is deactivated and the device is detached from the network.

How does a GPRS work?

Attachment and Detachment Procedure

Before a mobile station can use GPRS services, it must register with an SGSN of the GPRS network. The network checks if the user is authorized, copies the user profile from the HLR to the SGSN, and assigns a packet temporary mobile subscriber identity (PTMSI) to the user. This procedure is called GPRS attach. For mobile stations using both circuit switched and packet switched services it is possible to perform combined GPRS/IMSI attach procedures. The disconnection from the GPRS network is called GPRS detach. It can be initiated by the mobile station or by the network (SGSN or HLR).

Session Management

To exchange data packets with external PDNs after a successful GPRS attach, a mobile station must apply for one or more addresses used in the PDN, e.g., for an IP address in case the PDN is an IP network. This address is called PDP address (Packet Data Protocol address). For each session, a so called PDP context is created, which describes the characteristics of the session. It contains the PDP type (e.g., IPv4), the PDP address assigned to the mobile station (e.g., 129.187.222.10), the requested QoS, and the address of a GGSN that serves as the access point to the PDN. This context is stored in the MS,
the SGSN, and the GGSN.

With an active PDP context, the mobile station is "visible" for the external PDN and is able to send and receive data packets. The mapping between the two addresses, PDP and IMSI, enables the GGSN to transfer data packets between PDN and MS. A user may have several simultaneous PDP contexts active at a given time. The allocation of the PDP address can be static or dynamic. In the first case, the network operator of the user's home PLMN permanently assigns a PDP address to the user. In the second case, a PDP address is assigned to the user upon activation of a PDP context. The PDP address can be assigned by the operator of the user's home-PLMN (dynamic home-PLMN PDP address) or by the operator of the visited network (dynamic visited-PLMN PDP address). The GGSN is responsible for the allocation and the activation/

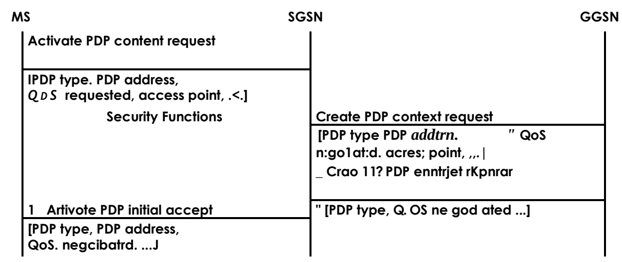

Fig 2 : PDP Context Activation Procedure

deactivation of the PDP addresses.

Figure shows the PDP context activation procedure. Using the message "activate PDP context request," the MS informs the SGSN about the requested PDP context. If dynamic PDP address assignment is requested, the parameter PDP address will be left empty. Afterward, usual security functions (e.g., authentication of the user) are performed. If access is granted, the SGSN will send a "create PDP context request" message to the affected GGSN. The latter creates a new entry in its PDP context table, which enables the GGSN to route data packets between the SGSN and the external PDN. Afterward, the GGSN returns a confirmation message "create PDP context response" to the SGSN, which contains the PDP address in case dynamic PDP address allocation was requested. The SGSN updates its PDP context table and confirms the activation of the new PDP context to the MS ("activate PDP context accept").

GPRS also supports anonymous PDP context activation. In this case, security functions as shown in Figure are skipped, and thus, the user (i.e., the IMSI) using the PDP context remains unknown to the network. Anonymous context activation may be employed for pre-paid services, where the user does not want to be identified. Only dynamic address allocation is possible in this case.

Data Packet Routing

The main functions of the GGSN involve interaction with the external data network. The GGSN updates the location directory using routing information supplied by the SGSNs about the location of a MS and routes the external data network protocol packet encapsulated over the GPRS backbone to the SGSN currently serving the MS. It also decapsulates and forwards external data network packets to the appropriate data network and collects charging data that is forwarded to a charging gateway.

In Figure 3 , three different routing schemes are illustrated: mobile-originated message (path 1), network-initiated message when the MS is in its home network (path 2), and network-initiated message when the MS has roamed to another GPRS operator's network (path 3). In these examples, the operator's GPRS network consists of multiple GSNs (with a gateway and serving functionality) and an intra-operator backbone network.

GPRS operators will allow roaming through an inter-operator backbone network. The GPRS operators connect to the inter-operator network via a boarder gateway (BG), which can provide the necessary interworking and routing protocols (for example, Border Gateway Protocol [BGP]). It is also foreseeable that GPRS operators will implement QoS mechanisms over the inter-operator network to ensure service-level agreements (SLAs). The main benefits of the architecture are its flexibility, scalablility, interoperability, and roaming.

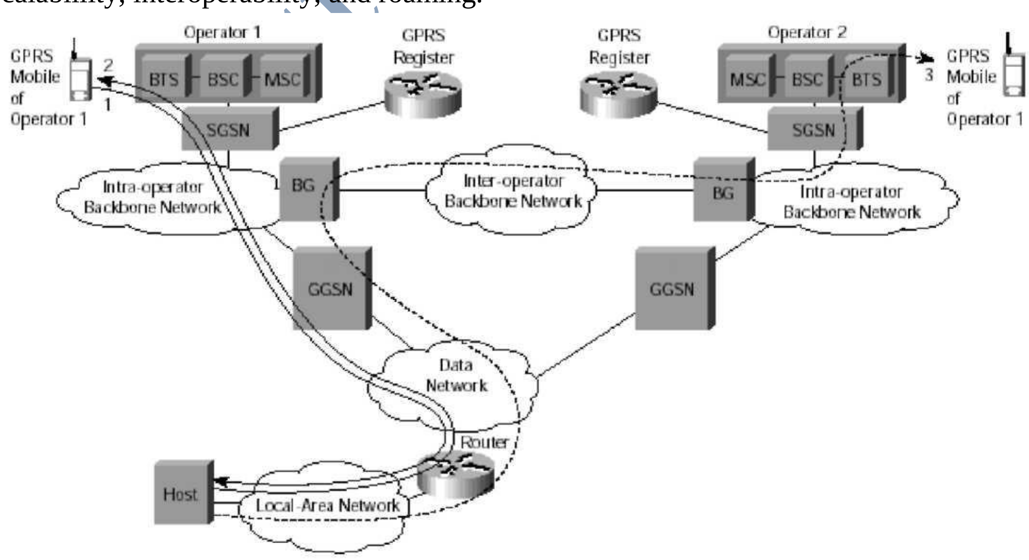

Fig 3 Routing of Data Packets between a Fixed Host and a GPRS MS

Location Management

The main task of location management is to keep track of the user's current location, so that incoming packets can be routed to his or her MS. For this purpose, the MS frequently sends location update messages to its current SGSN. If the MS sends updates rather seldom, its location (e.g., its current cell) is not known exactly and paging is necessary for each down link packet, resulting in a significant delivery delay. On the other hand, if location updates happen very often, the MS's location is well known to the network, and the data packets can be delivered without any additional paging delay. However, quite a lot of up link radio capacity and battery power is consumed for mobility management in this case. Thus, a good location management strategy must be a compromise between these two extreme methods. A state model shown in Figure 4 has been defined for location management in GPRS . A MS can be in one of three states depending on its current traffic amount.

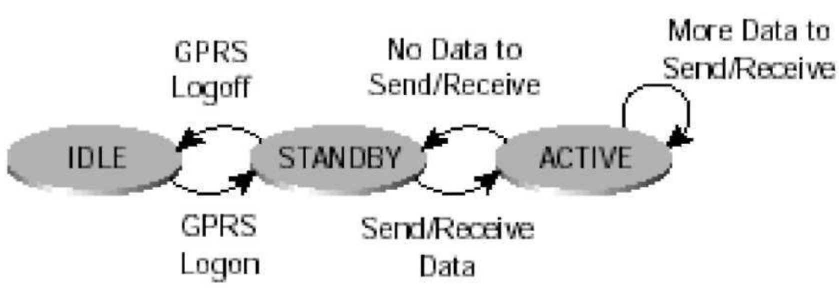

Fig 4 States of GPRS in a Mobile Station

In **idle state** the MS is not reachable. Performing a GPRS attach, the MS gets into ready state. With a GPRS detach it may disconnect from the network and fall back to idle state. All PDP contexts will be deleted.

The **standby state** will be reached when an MS does not send any packets for a longer period of time, and therefore the ready timer (which was started at GPRS attach) expires.In idle state, no location updating is performed, i.e., the current location of theMS is unknown to the network.

An MS in **ready state (active state)** informs its SGSN of every movement to a new cell. For the location management of an MS in standby state, a GSM location area (LA) is divided into several routing areas (RA). In general, an RA consists of several cells. The SGSN will only be informed when an MS moves to a new RA; cell changes will not be disclosed. To find out the current cell of an MS in standby state, paging of the MS within a certain RA must be performed . For MSs in ready state, no paging is necessary.

INTERFACE AND PROTOCOLS

The channel allocation in GPRS is different from the original GSM. GPRS allows a single mobile station to transmit on multiple time slots of the same TDMA frame (multislot operation). GPRS can combine multiple slots in a single transmission, the effective bandwidth is increased The theoretical limit for GPRS is eight time slots. GPRS assigns a .5-millisecond time slot to each data packet. The system is notified at the time of transmission as to how many time slots or kbps are needed on both the sending and receiving devices. The ability to combine only the required number of time slots for each transmission gives GPRS the flexibility to support both low-speed and highspeed data applications in a single network.

Time Slot Aggregation

In conventional GSM, a channel is permanently allocated for a particular user during the entire call period (whether data is transmitted or not). In contrast to this, in GPRS the channels are only allocated when data packets are sent or received, and they are released after the transmission. For bursty traffic this results in a much more efficient usage of the scarce radio resources. With this principle, multiple users can share one physical channel. A cell supporting GPRS may allocate physical channels for GPRS traffic. Such a physical channel is denoted as packet data channel (PDCH). The PDCHs are taken from the common pool of all channels available in the cell. Thus, the radio resources of a cell are shared by all GPRS and non-GPRS mobile stations located in this cell. The mapping of physical channels to either packet switched (GPRS) or circuit switched (conventional GSM) services can be performed dynamically (capacity on demand principle, depending on the current traffic load, the priority of the service, and the multislot class. A load supervision procedure monitors the load of the PDCHs in the cell. According to the current demand, the number of channels allocated for GPRS (i.e., the number of PDCHs) can be changed. Physical channels not currently in use by conventional GSM can be allocated as PDCHs to increase the quality of service for GPRS. When there is a resource demand for services with higher priority, PDCHs can be de-allocated.

Logical Channels in GPRS

On top of the physical channels, a series of logical channels are defined to perform a multiplicity of functions, e.g., signaling, broadcast of general system information, synchronization, channel assignment, paging, or payload transport. They can be divided into two categories

• traffic channels
• signaling (control) channels.

The packet data traffic channel (PDTCH) is employed for the transfer of user data. It is assigned to one mobile station (or in the case of PTM to multiple mobile stations). One mobile station can use several PDTCHs simultaneously.

The packet broadcast control channel (PBCCH) is a unidirectional point-to-multipoint signaling channel from the base station subsystem (BSS) to the mobile stations. It is used by the BSS to broadcast specific information about the organization of the GPRS radio network to all GPRS mobile stations of a cell. Besides system information about GPRS, the PBCCH should also broadcast important system information about circuit switched services, so that a GSM/GPRS mobile station does not need to listen to the broadcast control channel (BCCH).

The packet common control channel (PCCCH) is a bidirectional point-to-multipoint signaling channel that transports signaling information for network access management, e.g., for allocation of radio resources and paging. It consists of four sub-channels:

1. **The packet random access channel (PRACH)** is used by the mobile to request one or more PDTCH.
2. **The packet access grant channel (PAGCH)** is used to allocate one or more PDTCH to a mobile station.
3. **The packet paging channel (PPCH)** is used by the BSS to find out the location of a mobile station (paging) prior to downlink packet transmission.
4. **The packet notification channel (PNCH)** is used to inform a mobile station of incoming PTM messages (multicast or group call).

Channel Coding

Channel coding is used to protect the transmitted data packets against errors. The channel coding technique in GPRS is quite similar to the one employed in conventional GSM.. The selection of coding schemes is transparent to the user and determines the level of error correction the network uses to send the data. The better the link is between the user and the network, the less error correction is needed. Less error correction means higher throughput. (Coding scheme 1 has the highest level of error correction.)

Scheme	**Data rate (Kbps)**
CS-1	**91)5**
CS-2	**13.4**
CS-3	**15.G**
CS-4	**21.4**

Table 3 : Channel Coding Schemes

Protocol Architecture

Transmission Plane

GPRS Backbone: SGSN GGSN As mentioned earlier, user data packets are encapsulated within the GPRS backbone network. The GPRS Tunneling Protocol (GTP) tunnels the user data packets and related signaling information between the GPRS support nodes (GSNs). The protocol is defined both between GSNs within one PLMN (Gn interface) and between GSNs of different PLMNs (Gp interface). The signaling is used to create, modify, and delete tunnels. In the GPRS backbone we have an IP/X.25- over-GTP-over-UDP/TCP- over-IP transport architecture.

Sub network Dependent Convergence Protocol The Subnetwork Dependent Convergence Protocol (SNDCP) is used to transfer data packets between SGSN and MS. Its functionality includes:

- Multiplexing of several connections of the network layer onto one virtual logical connection of the underlying LLC layer. ○ Compression and decompression of user data and redundant header information.

Signaling Plane

The protocol architecture of the signaling plane comprises protocols for control and support of the functions of the transmission plane. Between MS and SGSN the GPRS Mobility Management and Session Management (GMM/SM) protocol supports mobility and session management when performing functions such as GPRS attach/detach, security functions, PDP context activation, and routing area updates.

GPRS SECURITY

GPRS is secure. It is an overlay on the existing GSM network. Hence it uses all security features of the GSM network, along with it's on options.

Subscriber Identity Confidentiality

The purpose of this function is to avoid an intruder to identity a subscriber on the radio path (e.g. Traffic Channel or signaling resources) by listening to the signaling exchanges . This function can be achieved by protecting the subscriber's IMSI (International Mobile Subscriber Index) and any signaling information elements. Therefore, a protected identifying method should be used to identify a mobile subscriber instead of the IMSI on the radio path. The signaling information elements that convey information about the mobile subscriber identity must be transmitted in ciphered form. And also a ciphering method is used.

Identifying method

The TMSI (Temporary Mobile Subscriber Index) is used in the method. Its a local number and only valid in a given location area. The TMSI must be used together with the LAI to avoid ambiguities. The network manages the databases (e.g. VLR) to keep the relation between TMSIs and IMSIs. When a TMSI is received with an LAI that does not correspond to the current VLR, the IMSI of the MS must be requested from the VLR in charge of the indicated location area if its address is known; otherwise the IMSI is requested from the MS. A new TMSI must be allocated in each location updating procedure. The allocation of a new TMSI corresponds implicitly for the mobile to the de-allocation of the previous one . In the fixed part of the network, the cancellation of the record for an MS in VLR implies the deallocation of the corresponding TMSI. When a new TMSI is allocated to an MS, it is transmitted to the MS in a ciphered mode. The MS stores its current TMSI in a non-volatile memory together with the LAI so that these data are not lost when the MS is switched off.

GPRS Authentication

The GPRS authentication procedure is handled in the same way as in GSM with the distinction that the procedures are executed in the SGSN. In some cases, the SGSN requests the pairs for a MS from the HLR/AUC corresponding to the IMSI of the MS.

GSM confidentiality

The signaling information elements related to the user, such as IMSI, and Calling subscriber directory number (mobile terminated or originated calls) need to be protected after connection establishment . The user information such as short messages, is transferred in a connectionless packet mode over a signaling channel. It should be protected. And also User information on Physical Connections (voice and non-voice communications) on traffic channels over the radio interface should be protected. In order to achieve those confidentiality, a ciphering method, key setting, the starting of the enciphering and deciphering processes, and a synchronization are needed.

A key setting completes a process that allows the MS and the network to agree on the key Kc using in the ciphering and deciphering algorithms .It is triggered by the authentication procedure and initiated by the network. Key setting must occur on a DCCH not yet encrypted and soon after the identity of the mobile subscriber is known by the network.

The transmission of Kc to the MS is indirect. A Kc is generated on both sides using the key generator algorithm A8 and the authentication process. At the network side, the values of Kc are calculated in the AUC/HLR. At the MS side, the Kc is stored by the mobile station until it is updated at the next authentication. The encryption of signaling and user data is performed at the MS as well as at the BSS. This is a case called symmetric encryption, i.e. ciphering and deciphering are performed with the same Kc and the A5 algorithm and start on DCCH and TCH. This process can be described as follows: First, the network (i.e. BSS) requests the MS to start its (de)ciphering process and starts its own deciphering process. The MS then starts its ciphering and deciphering.The first ciphered message from the MS, which reaches the network and is correctly ciphered leads to the start of the ciphering process on the network sides. The enciphering stream at one end and deciphering stream at the other end must be synchronized. GPRS confidentiality GPRS network still needs this security feature. However the ciphering scope is different. The scope of GSM is between BTS and MS. The scope of GPRS is from the SGSN to the MS. A new ciphering algorithm GPRS-A5 is used because of the nature of GPRS traffic. The ciphering is done in the

Logical Link Control (LLC) layer. The GPRS-Kc is handled by the SGSN independently from MSC .

IMPLEMENTATION

There are a number of different ways the mobile professional can be connected to the corporate network via a notebook computer, using the GPRS network. It will be up to the IS manager and telecom manager to decide which option serves their needs best. The following section provides information on the two most common scenarios: enterprise controlled connection, and connection through an ISP.

Enterprise Controlled Connection

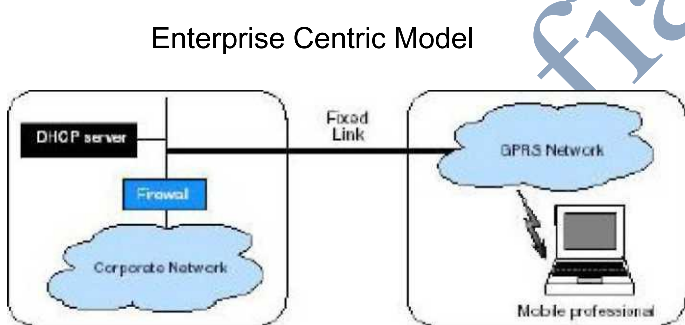

Fig 5 Enterprise Controlled Connection

This scenario allows for strong authentication and seamless allocation of IP addresses from the corporate network. The GGSN is configured with the IP address of the Dynamic Host Configuration Protocol (DHCP) server, the IP address of the Remote Access Dial-In User System (RADIUS) server, and the required radius key. The user's device will need to be configured with the desired APN and any relevant information about the DNS and Windows Internet Name (WINS) server. To become connected, the user provides all credentials required at the logon screens. The user will then be allocated an IP address and can gain access to the corporate network. The link between the corporate network and the GPRS network can be physically implemented using a variety of common methods such as leased T1/E1 lines.

Connecting Through an ISP

ISP Centric Model

•JPH Link

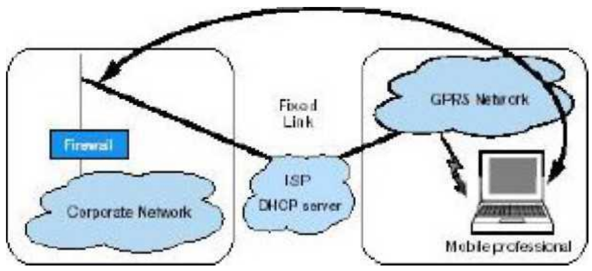

Fig 6 Connection Through ISP

Like the enterprise controlled connection, this method requires authentication before gaining access to the corporate network. The difference is that the connection is made by way of an Internet Service Provider (ISP). After connecting to the ISP by selecting its APN, and completing the ISP authentication process successfully, the user is allocated an IP address and obtains PDP context. Through this link to the Internet, the user is able to connect to the corporate network. Configuration of the DNS and WINS may involve client software tools. Once PDP context is activated, access is similar to any other link from the Internet to the corporate network.

GPRS APPLICATIONS

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. First among them is mobility , the ability to maintain constant voice and data communications while on the move. Second is immediacy, which allows subscribers to obtain connectivity when needed, regardless of location and without a lengthy login session. Finally, localization allows subscribers to obtain information relevant to their current location.

Communications

Communications applications include all those in which it appears to the users that they are using the mobile communications network purely as a pipe to access messages or information.

Intranet Access

The first stage of enabling users to maintain contact with their office is through access to e-mail, fax, and voice mail using unified messaging systems. Increasingly, files and data on corporate networks are becoming accessible through corporate intranets that can be protected through firewalls, by enabling secure tunnels.

Internet Access

As a critical mass of users is approached, more and more applications aimed at general consumers are being placed on the Internet. The Internet is becoming an invaluable tool for accessing corporate data as well as for the provision of product and service information. More recently, companies have begun using the Internet as an environment for carrying out business, through e-commerce.

E-Mail and Fax

E-mail on mobile networks may take one of two forms. It is possible for e-mail to be sent to a mobile user directly, or users can have an e-mail account maintained by their network operator or their Internet service provider
(ISP).

Unified Messaging

Unified messaging uses a single mailbox for all messages, including voice mail, faxes, email, short message service (SMS), and pager messages. With the various mailboxes in one place, unified messaging systems then allow for a variety of access methods to recover messages of different types. Some will use text-to-voice systems to read e-mail and, less commonly, faxes over a normal phone line, while most will allow the interrogation of the contents of the various mailboxes through data access, such as the Internet. Others may be configured to alert the user on the terminal type of their choice when messages are received.

Value-Added Services

Value-added services refer strictly to content provided by network operators to increase the value of their service to their subscribers.

E-Commerce

E-commerce is defined as the carrying out of business on the Internet or data service. This would include only those applications where a contract is established over the data connection, such as for the purchase of goods, or services, as well as online banking applications because of the similar requirements of user authentication and secure transmission of sensitive data.

Banking

Specific banking functions that can be accomplished over a wireless connection include balance checking, moving money between accounts, bill payment, and overdraft alert.

Location-Based Services

Location-based services provide the ability to link push or pull information services with a user's location. Examples include hotel and restaurant finders, roadside assistance, and city-specific news and information.

Advertising

Advertising may be offered to customers to subsidize the cost of voice or other information services. Advertising may be location sensitive where, for example, a user entering a mall would receive advertising specific to the stores in that mall.

CONCLUSION

In summary, GPRS presents an intermediate step in bring high speed Internet access to GSM users as the industry moves towards implementing 3rd Generation mobile services, known as UMTS (Universal Mobile Telephone Service). GPRS will thrive in both vertical and horizontal markets where highspeed data transmission over wireless networks is required. The deployment of GPRS networks will enable a plethora of new applications ranging from mobile e-commerce to mobile corporate VPN access. Deployment of GPRS will also have a great impact on the wireless data traffic volume by generating new sources of revenue for the service providers, especially since any current GSM network user can upgrade services to include high-speed data. 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.

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