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A Study on GSM and GPRS Architecture and Design

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***Abstract*—** The General Packet Radio System (GPRS) is a new service that provides actual packet radio access for mobile Global System for Mobile Communications (GSM) and time-division multiple access (TDMA) users In addition, GPRS will allow improved quality of data services as measured in terms of reliability, response time, and features supported The main benefits of GPRS are that it reserves radio resources only there's information to send and it reduces reliance on ancient circuit-switched network components. GPRS stands out mutually major development within the GSM normal that edges from packet switched techniques to supply mobile subscribers with the abundant required high bit rates for bursty data transmissions. It is potential on paper for GPRS subscribers to use many time slots (packet information channels) at the same time reaching a touch rate of concerning 170kbit/s. Volume-based charging is possible because channels are allocated to users only when packets are to be sent or received. Bursty knowledge applications create it attainable to balance a lot of expeditiously the network resources between users as a result of the supplier will use transmission gaps for different subscriber activities.

***Keywords*-** Mobile telephony; Mobile data communications, GSM, GPRS,Packet radio, Telecommunications

I. INTRODUCTION

In the past few years, fixed networks have witnessed a tremendous growth in data traffic due in good part to the increasing popularity of the Internet. Consequently new data applications are emerging and are reaching the general public. At the same time the market is witnessing a remarkable explosion of cellular and mobile technologies leading to demand that data applications become available to mobile users. GSM (Global System for Mobile communications) [1] is the European standard for cellular communications developed by ETSI (European Telecommunications Standards Institute). Throughout Europe and the rest of the world (including North America), GSM has been widely adopted. It has already been implemented in over 100 countries [2]. The most important service in GSM is voice telephony. Voice is digitally encoded and carried by the GSM network as a digital stream in a circuit-switched mode. GSM offers data services already but they have been constrained by the use of circuit switched data channels over the air interface allowing a maximum bit rate of 14.4 Kbit/s. For this reason, the GSM standard has continued its natural evolution to accommodate the requirement for higher bit rates. The HSCSD (High-Speed Circuit-Switched Data) is one solution that addresses this requirement by allocating more time slots per subscriber and thus better rates. It remains however insufficient for burst data applications such as Web browsing. Moreover, HSCSD relies on circuit-switching techniques making it un attractive for subscribers who want to be charged based on the volume of the data traffic they actually use rather than on the duration of the connection. In turn, service providers need effective means to share the scarce radio resources between more subscribers. In a circuits witched mode, a channel is allocated to a single user for the duration of the connection

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Understanding GPRS: The GSM Packet Radio Service 2 This exclusive access to radio resources is not necessary for data applications with the use of packet switched techniques. GPRS stands out as one major development in the GSM standard that benefits from packet switched techniques to provide mobile subscribers with the much needed high bit rates for bursty data transmissions. It is possible theoretically for GPRS subscribers to use several time slots (packet data channels) simultaneously reaching a bit rate of about 170kbit/s. Volume-based charging is possible because channels are allocated to users only when packets are to be sent or received. Bursty data applications make it possible to balance more efficiently the network resources between users because the provider can use transmission gaps for other subscriber activities. This paper aims to provide a comprehensive yet simple overview of the GPRS system from the user's and from the architectural perspectives. It addresses itself particularly to people who have some knowledge of the GSM system, however it tries to be self-contained as far as possible. This paper is based on the GPRS service description documents stage 1 [3] and stage 2 [4] proposed by ETSI. Additional information on GPRS can be found in [5] and [6].

II. GPRS SERVICES

GPRS Services are defined to fall in one of two categories: PTP (Point-To-Point) and PTM (Point-To-Multipoint) services. Some of the GPRS services are not likely to be provided by network operators during early deployment of GPRS due in part to the phased development of the standard. Market demand is another factor affecting the decision of the operators regarding which services to offer first.

III. PTP (POINT-TO-POINT) SERVICES

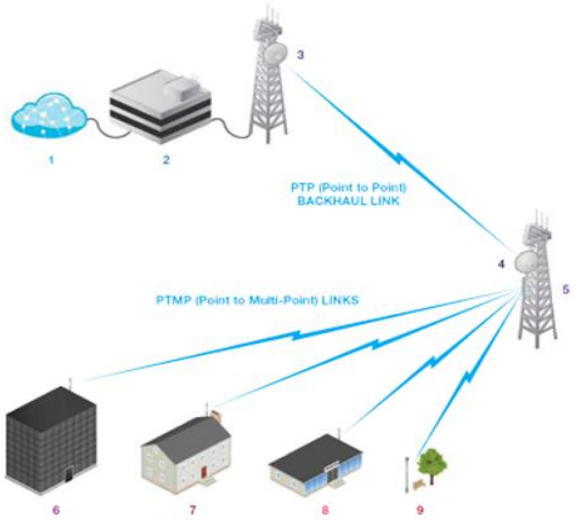

Fig.1

GPRS will support applications based on IP. Applications based on the Connection Oriented Network Protocols are also defined to be supported. The X.25 protocol was initially mentioned but has been dropped in recent standard developments. Table 1 illustrates the general description of the PTP services and some possible applications.

IV. PTM (POINT-TO-MULTIPOINT) SERVICES

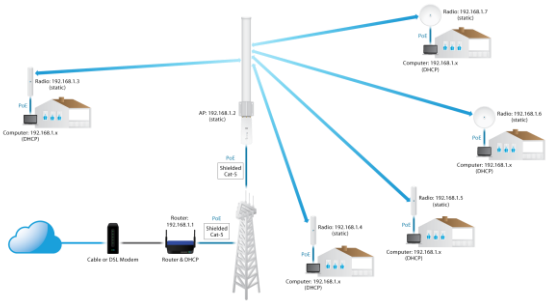

Fig.2.point to point

The PTM services provide the subscribers with the capability to send data to multiple destinations within one single service request. Table 2 shows a general description of these services and some possible applications. With the exception of PTM-M (Point-To-Multipoint Multicast) services, groups must be defined and members are required to join an ongoing call to become participants. A PTM-G (Point-to-Multipoint Group) call is usually restricted to members located within a specific geographical area. An IP-M (IP-Multicast) call is on the other hand independent of the geographical area of the participants and can be internal to the network or distributed across the internet. Understanding GPRS: The GSM Packet Radio Service 3 PTM services are not emphasized in this paper because the main effort revolves around IP-based PTP services in current GPRS standard releases. Some work is being done however in the PTM services area and concerns IP-multicast. Service Description Applications PTP-CONS Point-To-Point Connection Oriented Network Service

• Bursty transitive or interactive applications.
• A logical relation is established between users
• Multiple packets are sent between a single source and a single destination Credit card validations Electronic monitoring Telnet applications Data base access and information retrieval PTP-CLNS Point-To-Point Connectionless Network Service
• Datagram type service for burst applications
• No logical link required between users
• Packets are sent between a single source and a single destination
• Each packet is independent of its predecessor and successor Electronic mail Internet's World Wide Web TABLE 1. PTP (Point-To-Point) GPRS Services Service Description Applications PTM-M Point-To-Multipoint Multicast
• Messages are transmitted to a specific geographical area and optionally to a specified group within that area
• The recipients are anonymous
• Delivery time is scheduled
• Uni-directional transmission News Weather and traffic reports PTM-G Point-To-Multipoint Group Call
• Messages are transmitted to a specific group within a specific geographical area
• Group members must join the PTM-G call to become participants
• Delivery in real time
• Uni-directional, bi-directional and multi-directional transmission Conferencing services IP-MIP Multicast
• Messages are transmitted to a specified group
• Group members must join the IP-M call to become participants
• Delivery in real time
• Multi-directional transmission

Live multimedia transmissions Corporate messages to employees ZTABLE 2. PTM (Point-To-Multipoint) GPRS Services Understanding GPRS: The GSM Packet Radio Service 4

V. BASIC OVERVIEW OF THE GSM NETWORK

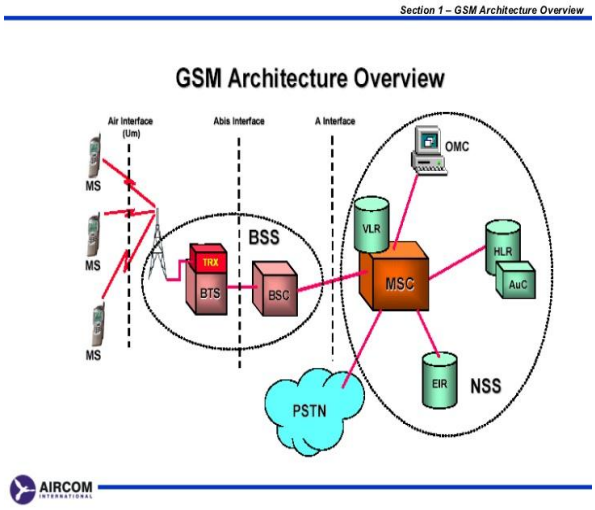

Figure3.GSM Network

In order to understand the GPRS network architecture, some fundamental GSM terminology is necessary. This section describes some of the main components of the GSM network (Figure 1). The GSM PLMN is divided into two major subsystems: the BSS (Base Station Subsystem), and the NSS (Network Switching Subsystem). A GSM subscriber requires a terminal called MS (Mobile Station) to connect to the network using the radio interface (Um).

VI. THE NETWORK SWITCHING SUBSYSTEM

The NSS is responsible for call control, service control and subscriber mobility management functions.

HLR (Home Location Register)
The HLR is a database used to store and manage permanent data of subscribers such as service profiles, location information, and activity status.

MSC (Mobile Switching Center)
The MSC is responsible for telephony switching functions of the network. It also performs authentication to verify the user's identity and to ensure the confidentiality of the calls. The Authentication Center (AuC) provides the necessary parameters to the MSC to perform the authentication procedure. The AuC is shown as a separate logical entity but is generally integrated with the HLR. The Equipment Identity Register (EIR) is on the other

Hand a database that contains information about the identity of the mobile equipment. It prevents calls from unauthorized, or stolen MSs.

VLR (Visitor Location Register)

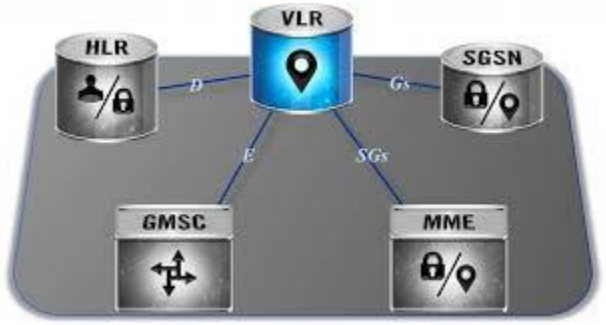

Figure.4 VLR

The VLR is a database used to store temporary information about the subscribers and is needed by the MSC in order to service visiting subscribers. The MSC and VLR are commonly integrated into one single physical node and the term MSC/VLR is used instead.

When a subscriber enters a new MSC area, a copy of all the necessary information is

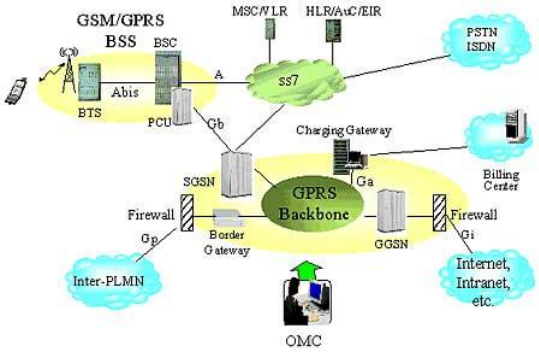

Figure5.MSC

1. HLR
2. PSTN, CSPDN,
3. PSPDN, ISDN
4. BTS
5. BSC
6. GMSC
7. MSC
8. Um
9. VLR
10. EIR
11. AuC
12. BTS
13. BTS

BSS: Base Station Subsystem NSS: Network and Switching Subsystem Understanding GPRS: The GSM Packet Radio Service 5 downloaded from the HLR into the VLR. The VLR keeps this information so that calls of the subscriber can be processed without having to interrogate the HLR (which can be in another PLMN) each time. The temporary information is cleared when the mobile station roams out of the service

area. GMSC (Gateway Mobile Switching Center) A GMSC is an MSC that serves as a gateway node to external networks, such as ISDN or wire line networks.

GPRS BSS

GPRS has minor impact on the existing GSM BSS making it easy to reuse existing component and links without major modifications. This is possible because GPRS uses the same frequency bands and hopping techniques, the same TDMA frame structure, the same radio modulation and burst structure as GSM. A new functional component, called PCU, (Packet Control Unit) was added to the BSS in the GPRS standard to support the handling of data packets. The PCU (not shown in Figure2) is placed logically between the BSS and the GPRS NSS. Unlike the voice circuit connections however, connections in GPRS have to be established and released between the BSS and the MS only when data needs to be transported over the air interface. Therefore ETSI has defined new procedures to adapt such connections.

GPRS NSS

The GPRS NSS can be viewed as an overlay network ensuring the link between mobile users and data networks. GPRS introduces a new functional element to the GSM infrastructure (Figure 2): GSN (GPRS Support Node) which can be either a SGSN (Serving GSN) or a GGSN (Gateway-GSN). This addition is necessary for the GSM network in order to support packet data services. The network is generally divided into several service areas controlled by separate SGSNs. Only one SGSN serves a MS at a given time pro HLR

1. VLR
2. PDN
3. BTS
4. BSC
5. SGSN
6. GGSN
7. MSC
8. SGSN
9. Um
10. Gi
11. Gb
12. Map-D
13. Gn
14. Gr
15. Gs

Understanding GPRS: The GSM Packet Radio Service 7 vided it is located in its service area. The SGSN is primarily responsible for keeping track of the MSs it serves, and for access control to data services. The GGSN on the other hand provides the interface to external PDNs (Packet Data Networks). The SGSN is connected to the BSS by Frame Relay and to possibly several GGSNs via a GPRS backbone network. The HLR database is updated to contain GPRS subscriber information. Adaptations to an existing MSC/VLR are not required but the GPRS standard suggests some enhancements to coordinate between the SGSN and the MSC/VLR if the optional interface between the two is to be supported. Several interfaces have been introduced in GPRS to define entity-to-entity interactions. For instance, the Gb interface is required between the BSC and the SGSN. Two GSNs communicate through a Gn interface, and the SGSN sends queries and receives subscriber information to/from the HLR through the Gr interface. The Gs interface between the

SGSN and the MSC/VLR was left optional while the Gi interface which connects a GGSN to a PDN was not specified in the standard to allow implementation preferences. As mentioned, GPRS standard activities focused mainly on PTP connections to IP PDNs at the Gi interface. An example of such IP PDN can be a corporate Intranet where access is restricted to authenticated corporate employees allowing them to access for instance the corporate web and mail servers. Another example is connectivity to an Internet Service Provider (ISP) offering Internet access and related services.

VII. CONCLUSION

In existing cellular systems, GPRS technology provides a significant improvement of data transfer capacity. GPRS technology announces the beginning of new generation of cellular communication. This technology is much faster than GSM and CDMA. GSM can support only the voice or call. But, GPRS supports both voice and data Push-to-talk is a "walkie-talkie-type" service implemented over mobile networks. US operator Nextel first introduced the service on their iDen network almost ten years ago. The service has since its introduction steadily grown in popularity and has created quite a buzz in the industry. So far, European mobile operators have offered no such service, and there has been skepticism regarding the feasibility of providing Push-to-talk over GPRS networks. When Push-to-talk solutions are compared and evaluated, it is important to use strict and comparable terminology and concepts, and to keep in mind the inherent characteristics of packet radio. GPRS, WCDMA and CDMA2000 networks can all, if tuned correctly, meet the PoC technical demands. However, end-to-end expertise for tuning the individual parts of the service execution chain is the critical step to success. North stream sees clear advantages with Push-to-talk solutions based on the evolving OMA specifications

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