On the Design of Simulation Package for GPRS Network

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ABSTRACT

The main objective of this paper is to describe a new designed software tool to simulate the GPRS network. The proposed simulation technique shows how to connect the components together so as to achieve the correct network for the GPRS technology. While connecting the components, the user will be able to observe how these components interact with each other and how the Mobil ends and receives data. After constructing and running the developed simulation technique, we reach to a very important fact which states that GPRS network needs just two new hardware components: SGSN, GGSN and other components be achieved by software upgrading to the existing components.

1. Introduction

GPRS provides a packet radio access for Mobile Stations (MSs) and a packet switched routing functionality for the network infrastructure [1]. An MS may be a cellular phone or a laptop connected via a cellular phone. GPRS network belongs to a 2.5 Generation network, and it is viewed as the stepping-stone to the Third Generation (3G) network. GPRS employs a packet-switching technique to transfer high speed and low-speed data and signaling in an efficient manner over GSM radio networks. GPRS radio resources are used only when users send or receive data. Rather than dedicating a radio channel to a mobile data user for a fixed period of time, the available radio channels may be concurrently shared between several users [5]. Therefore, GPRS is designed to support transfers from intermittent and bursty data (e.g., web browsing) to occasional transmission of large volumes of data (e.g., file transfers). New GPRS radio channels have been defined. The allocation of these channels is flexible: up to eight radio interface timeslots can be allocated per Time Division Multiple Access (TDMA) frame, timeslots are shared by the active users, and uplink and downlink are allocated separately. Various radio channel coding schemes have been specified to allow bit rates from 9 to over 150 kbps per user [4].

An existing GSM network requires two additional network nodes to implement the new packet switched data transfer service: Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN). SGSN, being at the same hierarchical level as the Mobile Switching Center (MSC), keeps track of the location of a GPRS user, performs security functions, and handles access control. The SGSN is connected to the Base Station Sub-system (BSS) using Frame Relay. The GGSN provides interworking with external packet switched networks. It is connected to SGSNs via an Internet Protocol (IP) based GPRS backbone network [4]. General-Packet Radio-Services (GPRS) is a standard from the European Telecommunication Standard Institute (ETSI) for packet data in General System for Mobil Communication (GSM) systems. It is a set of new GSM services that provides packet mode transmission within a Public Land Mobile Network (PLMN) and inter works with external networks. Also, GPRS can be defined as a new non voice service that allows the information to be sent and received across a mobile telephone network using data packet transfer mode [6]. GPRS was developed due to the fact that network operators recognized that future revenue in competitive markets would not be generated solely form providing voice connections, but from data connection as well. Future revenues are expected to come from a range of next generation capabilities as: (1) Full range of services form narrowband voice up to wideband real time multimedia services; (2) Support of high speed packet data, including Internet applications such as: browsing, electronic commerce and information subscription such as news; (3) Messaging services; and (4) Real time audio/ video applications such as interactive video conferencing. GPRS is based on the Intellect Protocol (IP), so it forwards data packets through an internetwork. GPRS has various advantages among it: (1) It has a capability of fast access time since GPRS has the potential to offer a theoretical speed of 172.2 kb/s using 8 timeslots, this

is about three times as fast as the data transmission speeds across today's fixed telecommunication networks and ten times as fast as current circuit switched data services on GSM networks; (2) The ability to charge based on volume with GPRS, rather than time allows operators to offer a flexible service to subscribers; (3) Efficient use of radio resources since rather than dedicating a radio channel to a mobile data user for a fixed. period of time, the packet switching nature of GPRS allows the available radio resources to be concurrently shared between several users; (4) GPRS facilitates instant connections whereby information can be sent or received immediately as the need arises, subject to radio coverage; (5) GPRS fully enables Mobile Internet functionality by allowing internetworking between the existing internet and the new GPRS network, so that any service that is used over the fixed Internet such as Files Transfer Protocol (FTP), web browsing, chat email, and telnet will be available over the mobile network because of GPRS [7,8].

To achieve the goals of this paper in view of constructing a simulation technique that is satisfy the connection concepts of GPRS and its operation mechanism, we present this paper which organized from the following sections: section two describes the GPRS network architecture. In section three, we present the various applications of GPRS. Section four deals with the software tools that were used in constructing our simulator of GPRS. In section five, we analyze our proposed GPRS simulator. Finally, we enclosed this paper in section six with conclusions and future work.

2. Architecture of the GPRS Network

Before we describe the architecture of the GPRS network, we say that there are three classes of mobile stations to use with GPRS defined as: (a) Class A in which Mobile station supports GPRS and other GSM services simultaneously, so class A mobile can make and/or receive calls on two services simultaneously; (b) Class B in which a GPRS mobile of this class monitors GSM and GPRS channels simultaneously, but can only support one of these services at a time. Here customers can make or receive calls on either a packet or a switched call type sequentially not simultaneously; (c) Class C in which a GPRS mobile of this class supports only non simultaneous operations, such as A IT ACH. If both GPRS and GSM services are supported, a class C mobile can only make and or receive calls form the manually, or default selected service. The service that isn't selected is not reachable. As we have mention previously, a GPRS is a new GSM service, the existing GSM infrastructure is re-used with some modifications. The existing GSM network elements need only software upgrades the some hardware upgrades and adding's. The GPRS network architecture used by Ericsson is shown in figure 1 [1].

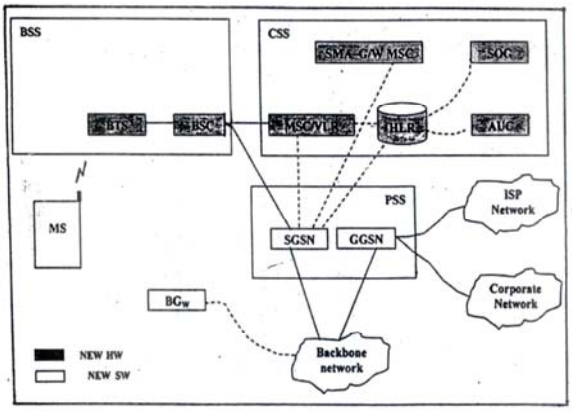

Figure 1 : Ericsson's GPRS Network Architecture

As shown form figure 1, GPRS network consists of four sections. The first section is represented by Base Station System (BSS), this BSS handles the transmission and reception of radio signals for speech / circuit data and packet data communication. The BSS which is used to separate circuit data and packet data consists of: Base Transceiver Station (BTS) which is used to send and receive signals (voice and data) to and from the mobile station. The second part of the BSS is the base station controller (BSC), this component receives signals from the BTS and checks the data type. If this received data is packet switched, it will direct it to the GPRS network, else it will be send to the GSM network.

The second of GPRS is the Circuit Switching System (CSS); this unit comprised of four nodes: (1) Mobile service switching center (MSC) / Visitor Location Register (VLR) which controls calls to and from other telephony and data system; (2) Home location register (HLR) which is the database that stores information for circuit and packet data communication; (3) Authentication Center (AVC) which is a GSM entity that provides authentication within the GSM system; (4) Short Message Service-Interworking MSC (SMS-IW-MSC); this part allows a GPRS mobile station to send and receive SMS over GPRS radio channel.

The third, section of GPRS is the Packet Switching System (PSS); it is designed for GPRS packet switching based on the Internet Protocol (IP), it includes the new packet switching nodes commodity known as GSN (G_RS Support Nodes), this unit has two types: the first is serving GPRS Support Node (SGSN) which performs similar function in GPRS as an MSC performs in GSM, that is it controls: attach, detach, location updates. Traffic form a mobile station (trying to connect to the internet) is routed

from the mobile station to' the BSC via BTS and onwards to the SGSN, in other words the SGSN provides packet routing to and from the SGSN service area. Also, SGSN performs the PDP contexts functions with the GPRS. PDP contexts deal with Allocation of IP addresses to the terminals / mobile station, and Quality of Service (QoS) parameters. The second type of the PSS is the gateway GPRS Support Node (GGSA) which is responsible for establishing a GPRS tunneling protocol (GTP) tunnel to the correct GGSN for further processing. The fourth section of GPRS is the billing gateway (BGw) which facilitates introduction of GPRS services in the mobile network by offering function that simplifies handling of GPRS charging in the billing system.

3. Various Applications of GPRS Technology

The key element of GPRS technology is that it uses packet switched data rather than circuit switched data, and this technique makes much more efficient use of the available capacity. This is because most data transfer occurs in what is often termed a "bursty" fashion. The transfer occurs in short peaks, followed by breaks when there is little or no activity. Using a traditional approach a circuit is switched permanently to a particular user. This is known as a circuit switched mode. In view of the bursty nature of data transfer it means that there are periods when it will not be carrying data. To improve the situation the overall capacity can be shared between several users. To achieve this, the data is split into packets and tags inserted into the packet to provide the destination address. Packets from several sources can then be transmitted over the link. As it is unlikely that the data burst for different users will occur all at the same time, by sharing the overall resource in this fashion, the channel, or combined channels can be used far more efficiently. This approach is known as packet switching, and it is at the core of many cellular data systems, and in this case GPRS.

There are various applications for the GPRS technology represented by the following: (a) Web Browsing, (b) Still images, (c) Moving images, (d) Corporate E-mail, (e) Internet E mail, and (f) Other applications. For the web browsing facility, mobile internet browsing is better suited to GPRS because of the slow speed of circuit switched data, so it takes a long time for data to arrive from the internet server to the browser For the still images; it will be possible with GPRS to post images form a digital camera connected to a GPRS radio device directly to an internet site. For the moving images, video conferencing applications are an application for moving images. For corporate E-mail, there are likely to be more corporate Email applications using GPRS than internet Email ones whose target market is more general. For Internet Email, the wireless E mail platform translates the message from SMTP, the Internet Email protocol into SMS and sends to the SMS center, or the E mails are actually stored and the user gets a notification on their mobile Phone and can retrieve the full Email by dialing in to collect it, forward it and so on. For the other applications it include: file transfer, remote' LAN access, chat, and vehicle positioning.

4. Supported Programs that are Used-in the Proposed Simulator

Our designed simulator was programmed using: Visual basic6 [2, 3], WML [41, ASP, [5] Access, Front Page HTML, Flash 6, Switch v2.0, Adobe photo shop 7. Firstly, visual basic (VB6) is used to edit the interface for the designed package because it offers an 'easy and powerful way to design any windows-based interface. Secondly, Wireless Markup Language (WML) is a markup language based on XML, and is intended for use in specifying content and user interface for narrowband devices, included cellular phones and pagers. Thirdly, Active server page (ASP) is dynamically edit change or add any contend of a page respond to user queries or data submitted from HTML, or WML from access any data or databases and return the results to a browser. Since ASP files are returned as plain HTML, they can be viewed in any browser. Fourthly, Microsoft Access is a relational database used on desktop computer to manage information on different levels for different purposes. Fifthly front Page (HTML) is used to create the GPRS simulator help. Sixthly, flash6 is used to create animated image to display in the simulator help. Seventhly, swish v2.0 is used for loading in the splash screen. Eighthly, Adobe Photoshop 7 is used to edit the image in this paper.

5. Description of the Proposed GPRS Simulator

The suggested simulation approach shows how to connect the comments together so as to achieve the correct network for the GPRS technology. While connecting the components, the user will be able to observe how these components interact with each other and how the mobile sends and receive data. The presented simulation tool comprises from six sections distributed according to the following:

I) Login form; through this section, you will be able to enter to GPRS simulation software in case of filling the correct user name and password.

2) Splash screen form; this screen displays information about this paper in general. After 3 seconds, this will disappear automatically and cell preview will be displayed as shown in Figure 2.

3) Cell preview; in this form, we have: (a) Combo list; form which you can select the number of BTS's

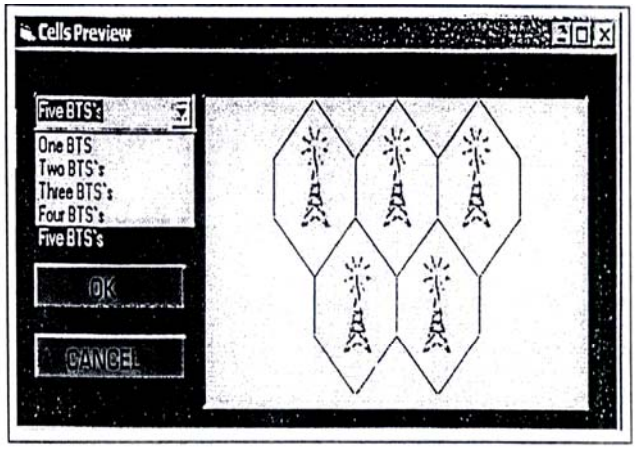

Figure 2 : Cell Preview Screen

you want in your network, and preview the cells design from the preview area. In mobile communication, the geographical area covered by the network is divided into logical cells, each BTS covers a cell. (b) Preview area; from which, you can see how the cells will like in the network depending on the number of BTS' s you select from the drop down list. (c) Two Button; OK button which when clicked, you will load your settings to the main form, cancel button which when clicked, you will close GPRS Simulator software.

4) Main form; after selecting the desired number of cells and pressing OK, the main form will be displayed. This from have the following items: (a) Menu bar; contains: file menu, action menu, help menu. (b) Tool bar; contains: connect button, refresh button, reload button, print button. (c) Icon bar; contains: serving GPRS support nodes (SGSN),

Figure 3 : WAP Browser

gateway GPRS support node (GGSN), home location register (HLR), backbone network, Internet service provider (ISP).

5) Mobile screens; using WML, ASP. We have designed the mobile screens and displayed them on WAP browser software. We used in our simulation the M3GA TE W AP browser as shown in figure 3.

When you right click the mobile from the visual basic main form, the W AP browser will open and display a link to the main menu screen Choosing MENU whether by clicking on it using the mouse or using the browser soft key, will take you to the main menu that contains four links as shown in figure 4: (a) Phone Settings (b) GPRS settings, (c) Go to address, (d) Disconnect.

Figure 4 Main Menu

Our main database is located on the HLR where this database component has communicated with other components such as the Mobile station and the SGSN. To proven this functionality, we use the E-R diagram shown in figure 5. The flowcharts that illustrate the previous six links is given by figure (6, 7).

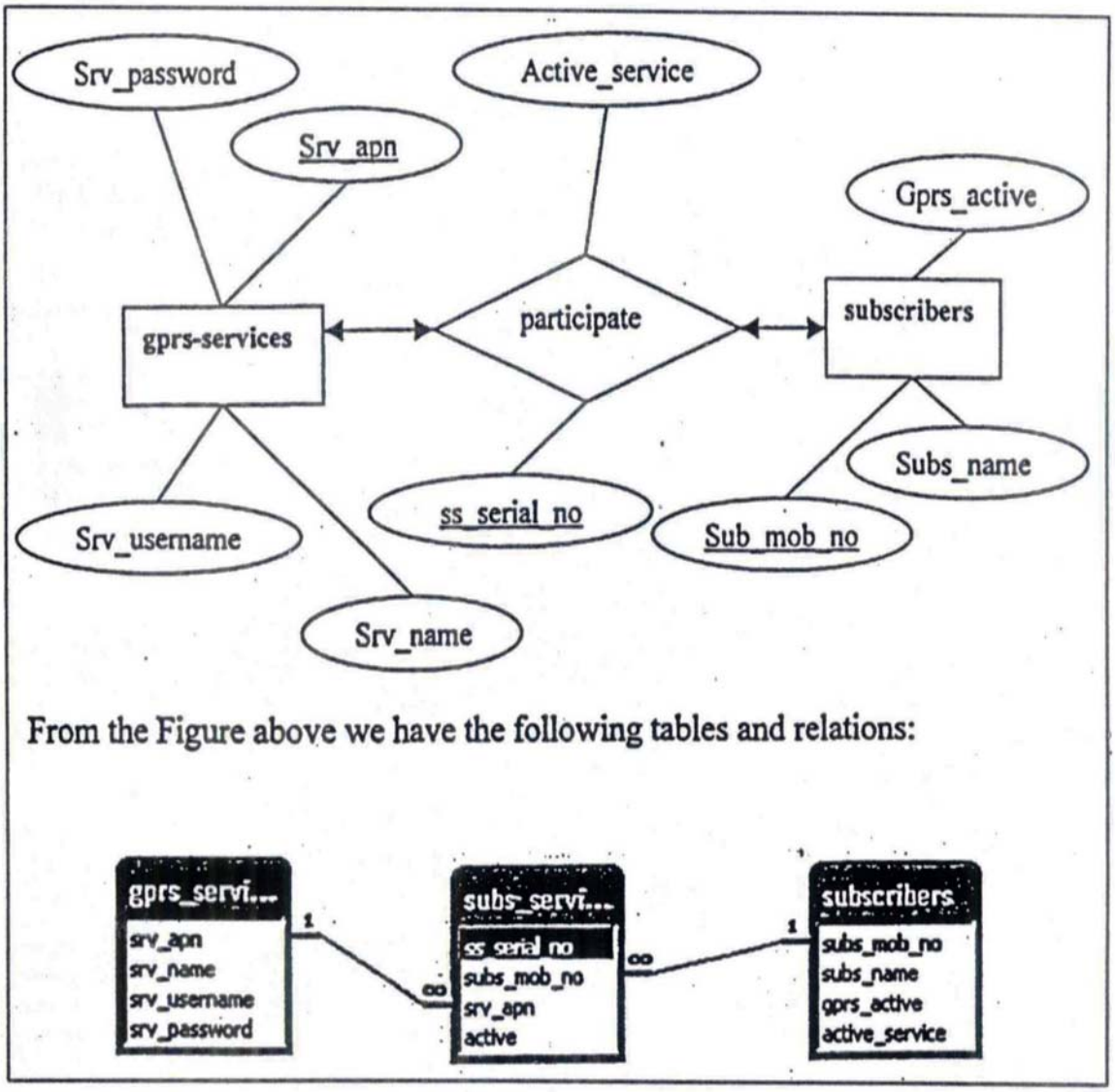

Figure 5 E-R Diagrams

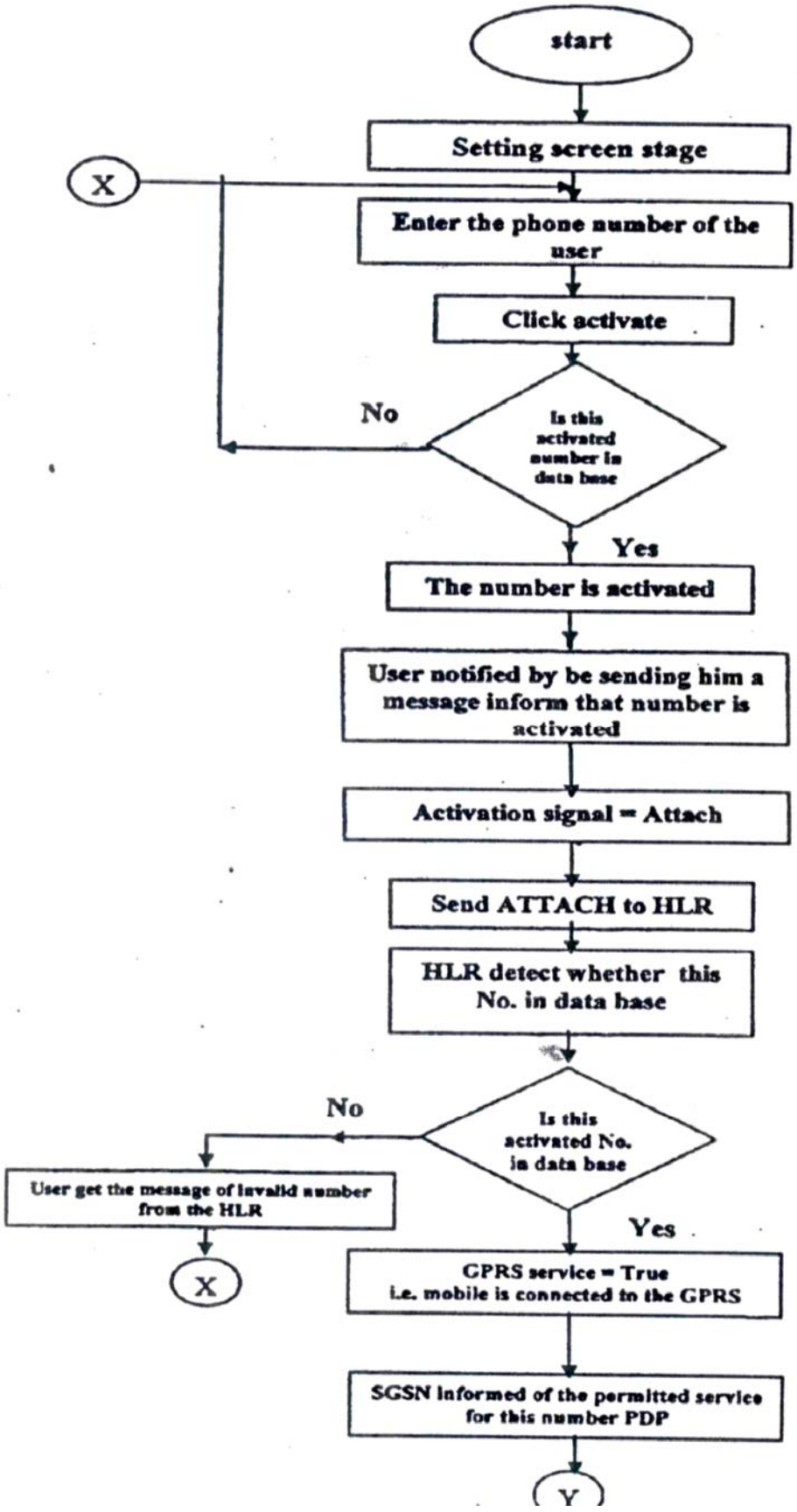

Figure 6 Flowchart illustrating the phone screen setting mechanism

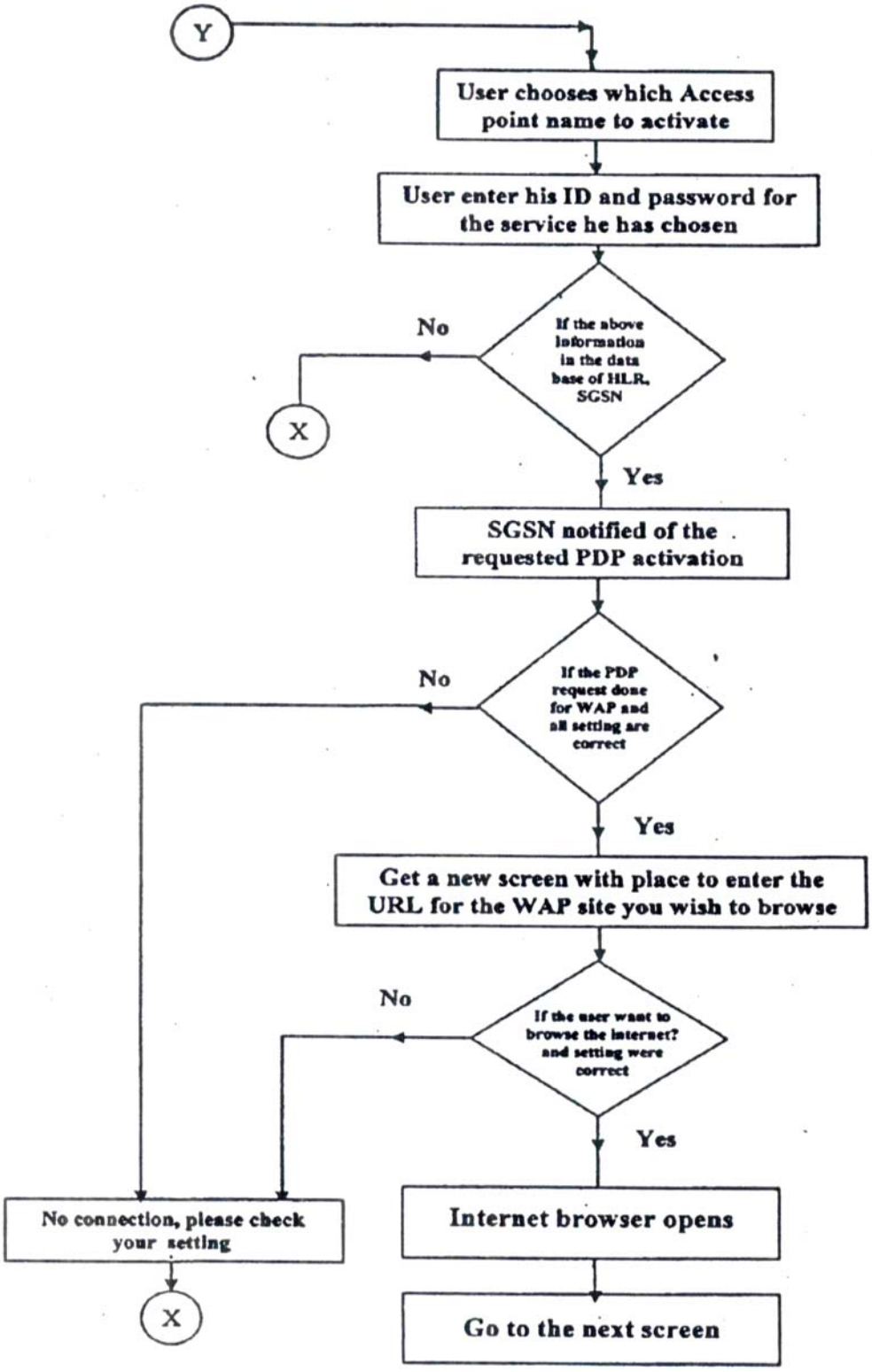

Figure 7 Flowchart illustrating the Setting Procedures of GPRS

Screen and Go to Address

As shown above, A GPRS user owns a Mobile Station (MS) that provides access to the wireless network. From the network side, the Base Station Subsystem (BSS) is a network part that is responsible

for the control of the radio path. BSS consists of two types of nodes: the Base Station Controller (BSC) and the Base Transceiver Station (BTS). BTS is responsible for the radio coverage of a given geographical area, while BSC maintains radio connections towards MSs and terrestrial connections towards the fixed part of the network (core network). The GPRS Core Network (CN) uses the network elements of GSM such as the Home Location Register (HLR), the Visitor Location Register (VLR), the Authentication Centre (AuC) and the Equipment Identity Register (EIR). HLR is a database used for the management of permanent data of mobile users. VLR is a database of the service area visited by an MS and contains all the related information required for the MS service handling. AuC maintains security information related to subscribers' identity, while EIR maintains information related to mobile equipments identity. Finally, the Mobile Service Switching Centre (MSC) is a network element responsible for circuit-switched services (e.g., voice call) [1].

6. Quality of Service

The Quality of Service QoS requirements of typical mobile packet data applications are very diverse (e.g., consider real-time multimedia, Web browsing, and e-mail transfer). Support of different QoS classes, which can be specified for each individual session, is therefore an important feature. GPRS allows defining QoS profiles using the parameters service precedence, reliability, delay, and throughput [9].

- The service precedence is the priority of a service in relation to another service. There exist three levels of priority: high, normal, and low.
- The reliability indicates the transmission characteristics required by an application. Three reliability classes are defined, which guarantee certain maximum values for the probability of loss, duplication, mis-sequencing, and corruption (an undetected error) of packets.
- The delay parameters define maximum values for the mean delay and the 95- percentile delay. The latter is the maximum delay guaranteed in 95 percent of all transfers. The delay is defined as the end-to-end transfer time between two communicating mobile stations or between a mobile station and the Gb interface to an external packet data network. This includes all delays within the GPRS network, e.g., the delay for request and assignment of radio resources and the transit delay in the GPRS backbone network. Transfer delays outside the GPRS network, e.g., in external transit networks, are not taken into account.
- The throughput specifies the maximum/peak bit rate and the mean bit rate.

Using these QoS classes, QoS profiles can be negotiated between the mobile user and the network for each session, depending on the QoS demand and the current available resources. The billing of the service is then based on the transmitted data volume, the type of service, and the chosen QoS profile.

7. Summary, Conclusions and Future Work

The General Packet Radio System (GPRS) is a service that provides actual packet radio access for mobile Global System for Mobile Communications (GSM) and time division multiple access (TDMA) users. The main benefits of GPRS are that it reserves radio resources only when there is data to send and it reduces reliance on traditional circuit-switched network elements. The increased functionality of GPRS will decrease the incremental cost to provide data services, an occurrence that will, in turn, increase the penetration of data services among consumers and business users. In addition, GPRS will allow improved quality of data services as measured in terms of reliability, response time, and features supported. In addition to providing new services for today's mobile user, GPRS is important as a migration step toward third generation (3G) networks.

GPRS technology offered a significant improvement in the data transfer capacity over existing cellular systems. It enabled many of the first email and web browsing phones such as PDAs, Blackberrys, etc to be launched. Accordingly GPRS technology heralded the beginning of a new era in cellular communications where the mobile phone capabilities allowed significantly more than voice calls and simple texts. GPRS enabled real data applications to be used and the new phones to become mobile computers on the move allowing businessmen to be always in touch with the office and domestic users to be able to use many more data applications. After constructing our simulator, we can use it to achieve various functions as:

First: Mobility management; this facility can be obtained through the following procedures: when the connection is established between the GPRS components, we can start tracing how these components interact with each other.

I) when the mobile station is switched on, it sends info about signal strength, so assuming that the strongest signal was BTS 1,

2) BSTI sends to MSC that subscriber is known to BSCI through BTSI,

3) MSC sends to BSCI info acknowledgement.

Second: PDP context; when the subscriber chooses to use the GPRS network, it sends an ATTACH. Request Then the request goes from the mobile station to the SGSN through the BTS, BSC and MSC. When the request reaches the SGSN, the SGSN check its database to check if the subscriber is allowed to connect using GPRS. If there's no data about this subscriber in the SGSN, it requests this information from the HLR. If the HLR didn't return any APN's that means that the subscriber is not allowed to use the GPRS which will end the attach request. If the subscriber is allowed to connect using GPRS, the HLR will return the Permitted APNs for the subscriber and it becomes attached to GPRS. Thirdly: Request PDP context activation; the mobile station sends a PDP context activation (IMSI), service ANP, user name, password to the SGSN. The SGSN checks for service requested (which APN) and it may contact the HLR if the SGSN has no data for the subscriber. If there's no data in the HLR and the SGSN, it will disconnect end the request. If there's data in the SGSN, it .will connect the GGSN. The GGSN checks for the authentication of this 'subscriber. If no authentication is given for the subscriber, it will end the request. If authentication was given an acknowledgement, an IP will be sent to the mobile station. Finally, our simulated results appear some facts. Adding and implementing GPRS components to the currently working mobile system needs 1ust two new hardware components the SGSN and GGSN, other components can be achieved by software upgrading to the existing components. The simulation allows the user to supervise how the GPRS technology works. Also the simulator shows components to make the correct connection. As a future work, we recommend to activate the internet service by opening a web browser building applications which support GPRS technology and connecting a real mobile device time our simulator.

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