May 01, 2007

GMS and SMS capabilities

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Abstract

The Global System for Mobile Communication (GSM) and the Short Message Service (SMS) are two technologies that the Remote Car Controller depend on in order to communicate. Because a major part of the project is being able to communicate between a mobile phone and a receiving station, this paper will discuss the properties of each of the technologies and how they will affect the overall product. It will go through the history up to the present day to show how each has had an impact on communications, and how each is used in the world today. It will also talk about how a call is made over the GSM network from a mobile phone, and how one can be received from the network to a mobile phone. This will help to understand how each service works, and how it can be used to benefit the ability for the Remote Car Controller to communicate.

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The first GSM network was conceived in Europe because of the quick growth of the single European market. The idea was to unite the communications over the continent to promote cross-border travel. Until that time, there existed a patchwork design of analog cellular services that became very congested with the fast population growth of the areas [1]. If they created a common digital standard, it would relieve the network traffic and allow a person to roam through the continent while still being able to use their current mobile phone. In 1992, the first GSM networks began to be launched in the area, and were available commercially in the second half of the year. By the end of 1994, the number of GSM subscribers worldwide had reached 5 million [1].

GSM is a cellular network where the mobile phones in the network can connect to the closest cells in the vicinity. The networks operate in four different frequencies. Most countries use the 900 MHz or 1800 MHz bands. Some countries, including the United States, already had these bands allocated for other uses, so they use the 850 MHz and the 1900 MHz bands. In the case of the 900 MHz band, the uplink frequency is set at 890-915 MHz, while the downlink frequency is 935-960. Each of these 25 MHz sections are then split into 124 evenly spaced carrier frequency channels. These are time division multiplexed to enable up to eight users to access each carrier. This makes it a TDMA (time division multiple access) and FDMA (frequency division multiple access) network. The speech channels have a data rate of 270.833 kbit/s [2]. Speech passes though a signal and is encoded at 13 kbit/s before it is sent over the network.

There are four different cell sizes in the GSM network. They can be macro, micro, pico, and umbrella cells. Macro cells have the base station antenna installed on a mast or a building above average rooftop level. Micro cells have an antenna height under the average rooftop level and so they are usually used in urban areas. Pico cells only have a diameter of a few dozen meters so they are used mostly indoors. Finally, umbrella cells are used to cover regions of smaller cells and to connect the gaps in between [2]. The cell radius depends on a few factors such as the antenna height, the gain, and the propagation conditions in the surrounding area. Some of the largest cells can extend out to about 35 km [1]. Indoor use of the GSM network can be utilized by using the small pico cell antenna or an indoor repeater. These are generally only needed in high traffic areas because any nearby cell signals will penetrate into the building and can then be used for normal communications.

The basic structural setup of an example network is shown below in **Figure 1: Structure of a GSM Network**. The network begins with some base transceiver stations (BTS) that are organized into small groups. Each of these groups is controlled by a base station controller (BSC) that is located closest to the corresponding BTS. The two items in a grouping is considered the Base Station Subsystem (BSS). The next block of the network is the main switching area known as the mobile switching center (MSC). It contains the location registers (home location register and visitor location register) which track the locations of mobiles and enables calls to be routed to them. Also contained in this are the Authentication Center (AuC) and the Equipment Identify Register (EIR) that are used to check the mobile phone and SIM card, before it is allowed to connect to the network [2]. The last section shown is the GPRS Core Network. This part provides mobility management, session management, and transport for Internet Protocol packet services in GSM networks. It is generally used to send the SMS text messages. GPRS will be discussed later in the paper.

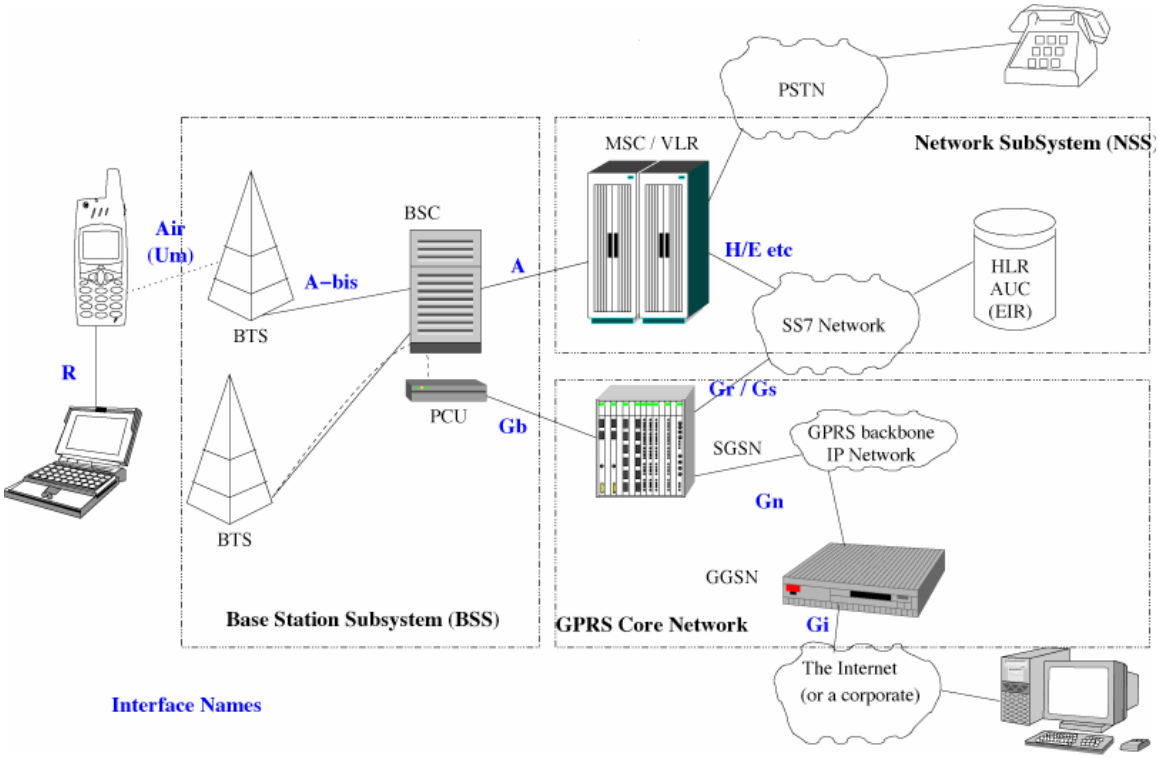

Figure 1: Structure of a GSM Network [2]

Connecting to a GSM network requires a Subscriber Identity Module (SIM) card. A SIM card is a detachable chip that contains a user's subscription information and can also store their phonebook as data. A user can then insert their SIM card into any capable phone and use that phone to access the network. When a subscription is created, the phone's identity and services are stored in a SIM record in the HLR of the "home" network. This is the area of the network the phone is associated with when it is first bought. When a mobile phone enters a different geographic area, it will then connect to a VLR. Whenever a new phone connects to a VLR, the VLR must contact the HLR of the

corresponding phone to keep track of where the client is now located. During this time, the VLR will also obtain the SIM record [2]. Once this is complete, a user is connected and can then use their cell to make phone calls.

When someone places a call from their mobile phone, it moves through the above structure to verify and route the call to the correct place. A user can make a call to anywhere on the Public Switched Telephone Network (PSTN), which comprises most phones today. To start, the user dials the number of the person they want to talk, and then they press send. The mobile phone sends a call request message to the mobile phone network through the BTS that it is currently in contact with. The request then reaches the MSC. Once the MSC has checked to see if the outgoing call is allowed (based on the SIM record), it then routes the call just like it would in a regular telephone exchange [2]. Once the connection is made, the two parties can then talk over a speech path.

It is a little more complicated when a call is going out to a mobile phone from the network. When the phone call going to a mobile client reaches the MSC, the MSC must first determine where the client phone is. In order to do this, it consults the HLR of this network to find out which VLR the phone is associated with. The next step is to determine how to route the call. If a user has placed a Call Forward Unconditional (CFU) number, then the number is stored in the HLR and the call returns to the MSC for routing to the new destination. The CFU will override other phone numbers but it has to be programmed in by the user. If the mobile phone that is being called is currently not associated with a VLR (the phone does not have service for example), then the HLR returns a Call Forward Not Reachable (CNFR) number to the MSC, and the call is then diverted there. Most of the time, the CFNR number is automatically set for the voicemail of the corresponding phone. Lastly, if the HLR finds the location of the phone in a VLR, it then requests a temporary number, called a Mobile Station Roaming Number (MSRN). This number is used to route the call to the correct Visiting MSC. When the call has reached the right Visiting MSC, the MSRN is used to find the phone's record in the HLR [1]. All mobile masts are then paged in order to find the mobile phone. When the phone responds, the location is sent back. If the user picks up, a speech path is created and the two users can then talk.

In order to control data services on the network, a packet-switched network was needed. This was called General Packet Radio Service (GPRS). The GPRS standardization was scheduled for the mid 1990s, in order to be released close to the GSM networks [3]. Delays in the deployment of the GSM networks, coupled with the increasing lack of confidence in the viability of digital cellular technologies left the packet-switched networks with very little priority. Everything began to change though in the second half of the 1990s. GSM experienced extremely rapid growth by the number of subscribers around the world, and the internet also broke into the mass market. This led to the obvious conclusion that a 'Mobile Internet' was coming next. This meant that plenty of data was going to have to be sent. People wanted to be able to download ring tones, news and sports updates, and even stream live video. With the beginning emergence of the new 3G technologies, the right combination of wideband and IP based services were available to give the technology that was needed. But, in 2001, when the

dotcom wave crashed, it began a period of uncertain transition. Now, there are 3G networks using GPRS that are beginning widespread deployment, but are coming three to four years later than anticipated [3]. With the lateness of the emergence of 3G networks, a host of alternative broadband access technologies have crept in. These seek to offer cheaper and superior solutions.

One of the new technologies to promote GSM networks is EDGE (Enhanced Data rates for GSM Evolution). EDGE technology introduces a new modulation technique and improved channel coding to increase the data rates of TDMA-based radio interfaces [3]. The most attractive application of this is to use EDGE to enhance GPRS. It allows an operator to triple the data rate or to have three times the amount of data service subscribers as before, when only using GPRS. EDGE can also be used for more than just enhancing the speed. The GSM/EDGE radio access network is now standardized to be able to allow multimedia applications to be supported. This provides significant opportunities for EDGE as a data transmission provider. It has a higher bandwidth that will allow the videos and other high data files to be sent across the network.

The most common way for people to send data messages today is with SMS. SMS is a service on almost all mobile phones that allows the sending of alphanumerical messages to a variety of other mobile devices. A message can be sent to and from a mobile phone, Pocket PC, desktop computer, and even landline phones [4]. SMS can be used for normal communication, ordering of ring tones, advertising, voting (for a reality TV show as an example), and many other things. In the case of the Remote Car Controller, the SMS messages are used as commands, status messages, and alerts.

The idea of sending text messages began being considered at the same time as the GSM network was being set up. The first commercial short message was sent on December 3, 1992 from a personal computer to the Vodafone GSM network in the U.K. [4]. In 1995, the average use of SMS messaging was only about 0.4 messages per GSM customer per month [5]. The reason for the low use was due to billing fraud as a user was able to disguise his message as being sent from another person. Over time, new features were added to make the billing more secure and stop the fraud. After this SMS use took off and by 2000, the average number of messages per user per month rose up to 35 [5]. That means that about 15 billion messages were sent over the GSM network in a month.

A user of a capable mobile phone has the ability to both send and receive SMS messages. When a message is sent, it goes to the Short Message Service Center (SMSC). The delivery of a message is by best effort, meaning there is no guarantee that the message will get to its recipient[6]. The success rate is still fairly high, however. The length of a SMS message is technically only 140 characters using 8-bit code. But, using a method that applies a lookup table to apply a 7-bit encoding for text based SMS, the length of a single SMS can then be 160 characters (140 characters x 8 bits = 1120 bits; 1120 bits / 7 bits = 160 chars) [6]. When a message exceeds this amount, the message will automatically be split into two separate messages, each one will be sent to the recipient, and then it will be reassembled and presented as one whole message again.

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Today there are over 2 billion users that connect to the GSM network throughout the world. Two U.S. cell phone companies that are on the GSM network are T-Mobile and Cingular. These two networks combine to serve about 76 million people [7] [8]. Both of these providers also allow for the use of SMS text messages. Many people like GSM systems because there is a higher quality of sound over the phone since it utilizes digital capabilities, and has created low cost alternatives to making a phone call such as the SMS text messaging [1]. It also has the added convenience of being able to use a mobile phone all over the world. A person can travel across network boundaries and still be able to easily connect to a GSM network using the same mobile phone.

With all of these in mind, it is easy to see why GSM and SMS are two important creations in the world today. Both are easy to use and are extremely popular. The GSM network will be used in the Remote Car Controller to send the necessary SMS messages across it. The SMS messages will be important as they will be the commands and alerts that will be necessary in order to control the vehicle. Without them, the mobile phone will not be able to communicate with the vehicle. The equipment needed such as the GSM modem and SIM card come included with the BieneRemote. With all of these set up together, it will provide the means to communicate between a mobile phone and a car, which is essential to the project.

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