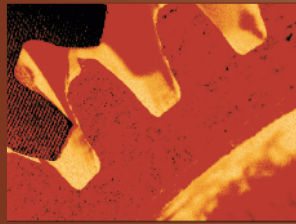


SMS: The Short Message Service

Jeff Brown, Bill Shipman, and Ron Vetter
University of North Carolina Wilmington



Although it is a widely used communication mechanism for cell phone users, SMS is far more than just a technology for teenage chat.

Cell phones have become an integral part of the modern world, providing human connectivity in a way never before possible. A recent United Nations report (www.cellular-news.com/story/25833.php) estimated that the total number of mobile phone subscribers in the world now exceeds 2.68 billion. Around 80 percent of the world's population has mobile phone coverage, with 90 percent coverage forecast by 2010 (www.textually.org/textually/archives/2006/10/013841.htm).

While most cell phones are used for their original intent—making telephone calls wirelessly—these devices are also loaded with other features that are often little used or even ignored. One feature that users have begun to fully exploit in recent years is the *short message service* or text messaging. This basic service allows the exchange of short text messages between subscribers. According to Wikipedia, the first commercial short text message was sent in 1992 (http://en.wikipedia.org/wiki/Short_message_service).

Although the popularity of text messaging is well established in many countries, in others, such as the US,

interest in the thumb-driven phenomenon has only recently skyrocketed. Consider these statistics from the Cellular Telecommunications & Internet Association (CTIA), the international association for the wireless telecommunications industry:

- In 1995, roughly 13 percent of the US population had cell phones; by June 2007, it was 80 percent.
- In 2000, 14.4 million text messages were sent per month; by June 2007, the number had increased to 28.8 billion per month, which represents a 130 percent increase over June 2006.
- In the second quarter of 2007, Verizon Wireless alone says it handled 28.4 billion text messages.

Based on these numbers, it is evident that SMS messaging is becoming a widely used communication mechanism for cell phone users. The “Typical SMS Applications” sidebar lists the variety of uses for this technology.

THE SMS SPECIFICATION

SMS technology evolved out of the Global System for Mobile Communications standard, an internationally

accepted cell phone network specification the European Telecommunications Standards Institute created. Presently, the 3rd Generation Partnership Project maintains the SMS standard.

SMS messages are handled via a *short message service center* that the cellular provider maintains for the end devices. The SMSC can send SMS messages to the end device using a maximum payload of 140 octets. This defines the upper bound of an SMS message to be 160 characters using 7-bit encoding. It is possible to specify other schemes such as 8-bit or 16-bit encoding, which decreases the maximum message length to 140 and 70 characters, respectively.

Text messages can also be used for sending binary data over the air. Typically, specific applications on the phone handle messages that contain binary data—for example, to download ring tones, switch on and off animation, exchange picture messages, or change the look and feel of the handset's graphical user interface. The system can segment messages that exceed the maximum length into shorter messages, but then it must use part of the payload for a user-defined header that specifies the segment sequence information.

SMSCs operate in either a store-and-forward or a forward-and-forget paradigm. In the store-and-forward paradigm, the system resends the message for some period of time until it is successfully received. In a forward-and-forget paradigm, the system sends the message to the end device without assurance of receipt or an attempt to redeliver in the case of failure.

The SMS protocol stack comprises four layers: the application layer, the transfer layer, the relay layer, and the link layer. Table 1 provides an example of a transfer protocol data unit.

SMS CONCEPTS AND SYSTEM ARCHITECTURE

To fully understand how the various components in the SMS system architecture interact, it is worthwhile to first discuss a few SMS concepts and the role of several independent system entities.

Short codes

A short code is an abbreviated number (four, five, or six digits) that is used as an “address” for text messages. Individual carriers can use short codes that are valid only on their network or are interoperable across network carriers (known as a common short code). For example, a carrier might need to send a text message to a subscriber concerning changes in policy or phone configuration, and it probably would send such a message from a short code only that carrier uses. On the other hand, common short codes can be used to send messages to and from users on multiple cellular networks.

In the US, one entity, the CTIA (www.usshortcodes.com), administers common short codes. Content providers can lease a common short code, thereby allowing subscribers to text a keyword to the provider’s short code, and the provider can respond with information specific to the keyword used. For example, texting the word “movie” to short code 90947 might result in a text message being returned to the sender that contains a list of movies showing at a local theater.

Google offers a variety of interactive SMS applications through its short code 466453 (<http://google.com/sms>).

Typical SMS Applications

CONSUMER APPLICATIONS

- Person-to-person messaging: (chat with friends)
- Interactive information services: (text to get today’s weather forecast)
- Entertainment services: (download a ring tone)
- Location-based services: (restaurant suggestions based on handset location)

CORPORATE APPLICATIONS

- Notification and alert services: (emergency broadcast messages)
- Managing contacts, correspondence, and appointments: (SMS integration with Microsoft Outlook)
- Vehicle location: (bus tracking)

CELL OPERATOR APPLICATIONS

- Subscriber identity module updates—network operators can remotely update data stored on a mobile phone’s SIM card: (remotely update customer service profiles or address book entries)
- WAP push—push a URL of the content to be displayed, and a browser on the mobile phone presents the content to the subscriber: (push a media-rich advertisement to a user and automatically display it within the mobile phone’s browser)

Because short codes also have premium billing capabilities, wireless subscribers can send text messages to short codes to access and pay for a variety of mobile content and services. For example, if a user sends a text to get a daily horoscope, a charge for the content will appear on the next phone bill.

E-mail gateways

In the US, most messages sent to applications or services are addressed to a short code instead of a standard phone number. It’s possible to offer a service through a cellular modem, which is, in effect, a cell phone hooked to a computer. However, cellular modems are quite slow and not

Table 1. Transfer protocol data unit: 07917283010010F5040BC87238880900F10000993092516195800AE8329BFD4697D9EC37

Octet(s)	Description
07	Length of the SMSC information (in this case, 7 octets).
91	Type-of-address of the SMSC (91 means international format of the phone number).
72 83 01 00 10 F5	Service center number (in decimal semi-octets). The length of the phone number is odd (11), so a trailing F has been added to form proper octets. The phone number of this service center is “+27381000015.”
04	First octet of this SMS-DELIVER message.
0B	Address length. Length of the sender number (0B hexadecimal = 11 decimal).
C8	Type-of-address of the sender number.
72 38 88 09 00 F1	Sender number (decimal semi-octets), with a trailing F (“+27838890001”).
00	Protocol identifier (00 = SME-to-SME protocol—implicit).
00	Data coding field (00 = 7 bit, 01 = 8 bit, 10 = 16 bit, 11 = reserved).
99 30 92 51 61 95 80	Time stamp (semi-octets) in order (YY, MM, DD, HH, MM, SS, TIMEZONE in relation to GMT in units of 15 minutes). So, 0x99 0x30 0x92 0x51 0x61 0x95 0x80 means 29 Mar 1999 15:16:59 GMT+2.
0A	User data length: length of message. The data coding field indicated 7-bit data, so the length here is the number of septets (10). If the data coding field were set to indicate 8-bit data or Unicode, the length would be the number of octets (9).
E8329BFD4697D9EC37	Message “hellohello,” 8-bit octets representing 7-bit data.

More details can be found at www.dreamfabric.com/sms

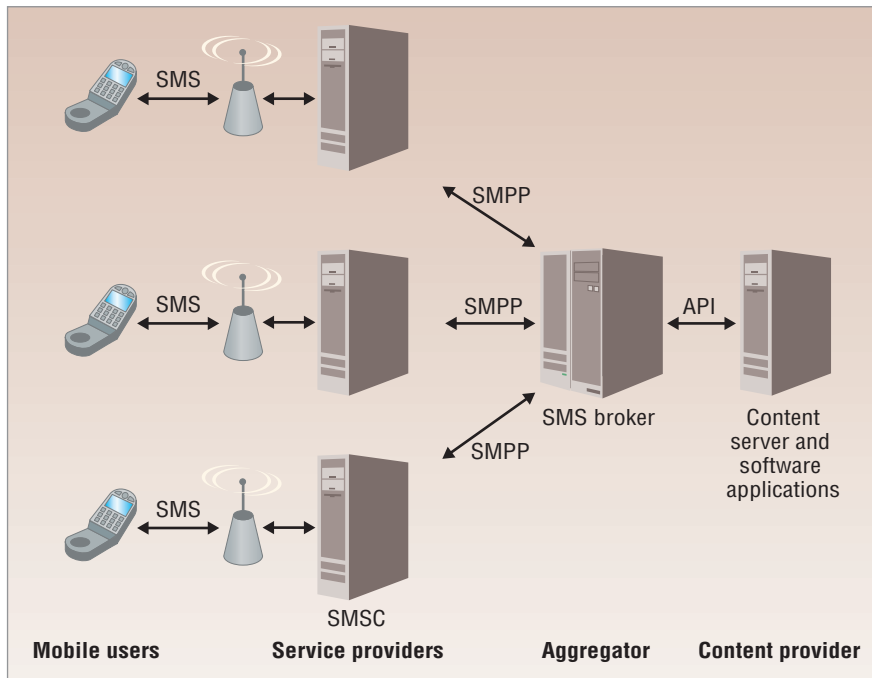


Figure 1. SMS system architecture. Rather than communicating directly with the various SMSCs, content providers go through a message aggregator. The message aggregator uses the SMPP to maintain connections with carrier networks.

intended for production environments requiring any significant volume. Most carriers provide e-mail-to-SMS gateways that receive e-mail messages and convert them to SMS messages. For example, an e-mail addressed to 1123551234@mycarrier.com could trigger an SMS message for 1123-5551234 on mycarrier's network.

Some companies offer bulk SMS services and deliver their messages through e-mail-to-SMS gateways. However, not only are these e-mail gateways one-way and unreliable, but carriers also actively monitor them and can block them at any time. Some gateways automatically block messages originating from an IP address when volume reaches a certain threshold. This could cause serious problems in the event of mass text messages being sent for emergency notification purposes.

SMS centers

When a user sends a text message to another user, the phone actually sends the message to the SMSC, which stores the message and then delivers it when the recipient is on the network.

This is a store-and-forward operation. The SMSC usually has a configurable time limit for how long it will store the message, and users can usually specify a shorter time limit if they want.

Figure 1 depicts the general system architecture for sending and receiving SMS messages. Each service provider operates one or more SMSCs. Mobile users' SMS messages are sent through a wireless link via a cell tower to the SMSC. The SMSC access protocols enable interactions between two SMSCs or interactions between external short-message entities (SMEs) and an SMSC. SMEs are software applications on network elements (such as a mobile handset) or hardware devices that can send and receive short messages. The SMS Forum has adopted the Short Message Peer-to-Peer (SMPP) protocol to enable interactions between external SMEs and service centers that the different manufacturers maintain and operate.

Message aggregators

Typically, content providers do not communicate directly with the various SMSCs, but instead go through a broker, or message aggregator, as

Figure 1 shows. An aggregator is a business entity that negotiates agreements with network providers to act as a middleman providing access to a cellular network for messaging services to third parties who have no direct relationship with the cellular network. The message aggregator uses the SMPP to maintain connections with carrier networks. Aggregators typically provide access to their servers either through SMPP or using custom APIs written in Java, PHP, Perl, and so on.

Most aggregators will also manage the rental of the common short code for clients who do not want to deal directly with the CTIA. Another important function of the aggregator is to assist with provisioning of the short code on the various carriers. Before a carrier allows the use of a short code on its network, it requires a complete description of how the code will be used, including how subscribers will opt in and opt out of subscription services. The provisioning process can take eight weeks or more.

Content providers

A mobile content provider is an entity that provides value-added content and applications for mobile devices. For example, when a mobile phone user sends an interactive text message to retrieve information, the content provider returns the information (in this case, a text message back to the user) through the aggregator. The aggregator is responsible for transmitting the message to the end user. This second transmission actually masks two transmissions: first a transmission from the aggregator to the cellular provider, and then a transmission from the cellular provider to the mobile handset.

BUILDING APPLICATIONS

We have established the hardware, software, and network infrastructure necessary to build and deploy advanced SMS applications. We have registered a short code and established a new company, Mobile Education, to develop two-way SMS-based applica-



tions. We have formed this company with the expressed intent of developing and marketing intellectual property that we are creating in partnership with the University of North Carolina Wilmington.

Mobile Education (www.mymobed.com) currently hosts the following SMS-based applications for UNCW students:

- a subscription service for daily campus activities and events;
- an interactive system to request and receive real-time shuttle bus information;
- an application that integrates with the student Banner system to allow students to request and retrieve a grade for a particular course;
- an interactive service to get campus activity and event information, specifically movie dates and times at the campus theater; and
- a broadcast text-message-based alert system for campus-originated emergency information.

We have learned some valuable lessons while establishing this new business.

Vanity code or random code

The process of obtaining a short code is different from country to country. In the US, obtaining a short code requires choosing between a “vanity” and a “random” code. Short codes that spell a name, such as Google = 466453 or Hawks = 42957, are known as *vanity short codes*. Vanity codes cost \$1,000 per month. *Random short codes*, which might or might not spell a word, generally cost \$500 per month. Being only five- or six-digit numbers, random short codes are still fairly easy to remember, so it might or might not be worth the extra \$500 per month cost to get a vanity code.

You can find out who has registered many of the short codes assigned in the US via the Common Short Code Administration Directory (www.usshortcodes.com) or the US Common Short Code WHOIS Directory (www.usshortcodeswhois.com).

Fees and the provisioning process

The fee to lease the common short code simply guarantees that no one else can use that code. A carrier must provision a code before the code can be used on its network. The provisioning process is complicated, expensive, and takes up to eight weeks.

During the provisioning process, the carriers examine how their users will interact with the applications associated with the short code. They are particularly interested in applications that involve users subscribing to receive messages on a regular basis. They require double opt-in, which means that the user requests the subscription and then confirms. Users must be able to send a message with the keyword “stop” to indicate that they do not want to receive any more messages.

Maintaining a common short code is an expensive, long-term commitment and should be thoroughly researched.

The cost of provisioning a short code will generally be between \$2,000 and \$4,000, including aggregator and carrier setup fees. The monthly fee to maintain service with an aggregator is generally between \$1,000 and \$1,500.

Working with aggregators

There are significant differences between aggregators, and you should look closely at more than one before choosing. Several companies that sell aggregator services do not actually maintain SMPP connections with carrier SMSCs, but go through another aggregator instead.

The custom APIs that aggregators provide differ widely—some require a constant socket connection, while others use XML over HTTP and do not rely on a constant connection. Some aggregators have relatively inexpensive testing programs and allow you to test their API on a demonstration

short code. This means that you can send messages that come from the demo code, and if a message sent to that code starts with a special keyword established for you, then the message is routed to your server. However, some aggregators do not allow any testing with their servers until you have signed a contract.

Message sending rates

There are also vast differences in the rate at which you can send messages. Some plans allow only two messages per second, and some claim rates of up to 100 per second. Some aggregators allow you to send a message to users knowing only their phone number, while some require that you also know their service provider.

Carrier rules and restrictions

Another important aspect of common short codes is that the mobile content providers who register them must agree to a long list of network operator rules and restrictions. For example, the following is a statement for text message content from a typical short code registration agreement:

The following content is not allowed: adult (swimsuit pictures are ok), or any unlawful, harmful, threatening, defamatory, obscene, harassing, or racially, ethically or otherwise objectionable content. Services that facilitate illegal activity, gambling, promote violence, promote discrimination, promote illegal activities, or incorporate any materials that infringe or assist others to infringe on any copyright, trademark, or other intellectual property rights are prohibited.

In many cases, network operators even provide lists of inappropriate words that cannot be used within the content that traverses their networks. They can decide to shut down your short code if you breach the agreement you signed to gain access to their network. These restrictions are considerably different from the Internet.

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HOW THINGS WORK

Policy issues

Maintaining a common short code requires working very closely with an aggregator and being bound by the limitations of its policies and software. It's an expensive, long-term commitment and should be thoroughly researched.

The short message service has emerged as one of the most popular wireless services. SMS is far more than just a technology for teenage chat. Mobile marketing campaigns are already a very profitable business and growing rapidly. Next-generation SMS applications will incorporate location-based capabilities that are now being incorporated into mobile handsets. This will enable a new set of innovative services that are targeted and personalized, further refining mobile advertising models and driving revenue growth for carrier operators, aggregators, and mobile content providers. ■

Jeff Brown is a professor of mathematics and statistics at the University of North Carolina Wilmington and cofounder of Mobile Education. Contact him at brownj@uncw.edu.

Bill Shipman is a graduate student in computer science and information systems at the University of North Carolina Wilmington. Contact him at wjs6797@uncw.edu.

Ron Vetter is a professor of computer science at the University of North Carolina Wilmington and cofounder of Mobile Education. Contact him at vetterr@uncw.edu.

Computer welcomes your submissions to this bimonthly column. For additional information, or to suggest topics that you would like to see explained, contact column editor Alf Weaver at weaver@cs.virginia.edu.