



SMS Messaging in SS7 Networks: Optimizing Revenue with Modular Components

Intel in
Communications

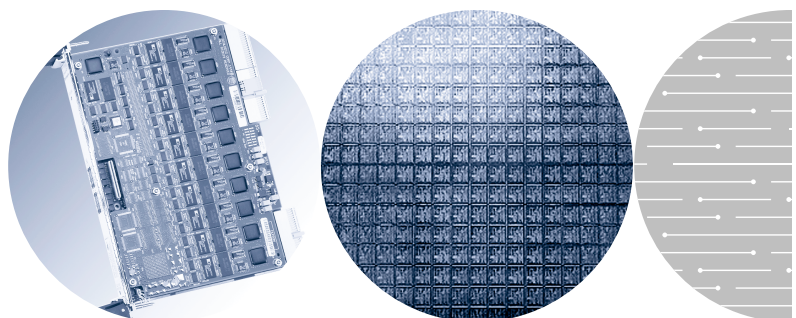


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Executive Summary

Telecom equipment manufacturers (TEMs) and service providers are searching for ways to generate revenue from new services. Applications utilizing enabling short message service (SMS) can be an ideal way for these businesses to increase income without making a major infrastructure investment.

Signaling System 7 (SS7) is the technology used in the core network to transmit SMS messages, which share the same channels and infrastructure as call control messages. Cost-effective modular components from Intel can be added easily and quickly to an SS7 network to handle increased traffic and generate income from SMS messaging services.

Increasing Revenue with SMS Services

The introduction of new ways to communicate has resulted in flat or declining call rates, prompting TEMs and service providers to look for innovative ways to grow revenue with value-added services. Applications using SMS can rapidly provide additional revenue for these businesses.

Usage models for SMS seem to be limited only by the human imagination, and range from frivolous to serious. Although to date the rest of the world seems to be more excited about SMS than the United States, major mobile providers in North America are putting their marketing muscle behind SMS, extolling its advantages and pricing it competitively.

Today, service providers can choose to upgrade closed, proprietary systems or add modular, standards-based components to enhance an SS7 network for SMS services. A modular approach allows faster time to market and reduced development costs, permitting TEMs and service providers to react quickly in the lucrative SMS marketplace. A modular strategy can also ultimately reduce overall total cost of ownership (TCO) since it allows solutions to be reused, enhanced, scaled, and administered more easily and cost-effectively.

What Exactly Is SMS?

SMS messages are an alternative to voice communication over the telephone when silent, private, or very brief communications are best. Since they are somewhat non-traditional, SMS messages have an element of playfulness that often encourages creativity, and customers can find such novelty addictive.

SMS messages can be sent between users or to and from an application, which gives service development an extra flexibility that encourages innovation.

Here are some of the ground rules for SMS set down in the Global System for Mobile Communications (GSM) standard:

- **Length and type** — Each message can contain up to 160 alphanumeric characters. Some non-text-based formats, such as binary, are also supported for specialized uses such as ringtones and images.
- **Storage and forwarding** — Messages can be stored and forwarded because they are not sent directly from sender to receiver, but pass through an SMS message center.
- **Confirmation** — Message delivery is always confirmed, whether the message is delivered or not.
- **Simultaneous traffic** — Because the mechanism for transmitting SMS messages is part of the SS7 control channel, which is separate from the voice path of any particular call, short messages can be sent and received at the same time as voice, data, and fax calls. For this reason, SMS users usually do not receive busy signals.
- **Increased length** — Methods for concatenating several short messages and compressing messages are defined and incorporated in the standard.

Any mobile subscriber with a phone and a service that support SMS can send or receive SMS messages.

Types of SMS Services

Although launched in 1992, SMS only recently become a popular wireless data service.

Text-to-text messages were the initial offering, but new applications are being added quickly.

SMS applications can be divided into a number of categories:

- **User-to-user text messaging** — Examples are innumerable: notes to friends about dinner reservations, to family about being caught in traffic, and to business associates asking for a last-minute statistic just before an important meeting.
- **Informational messaging** — Usually a one-way message that is time-sensitive. Banks can send overdraft notices, or parents can be notified if their teenagers are not in class.
- **Notification services** — Messages can tell users that they have voice mail, fax, or email messages waiting or that they have a meeting or appointment.
- **Premium-based services** — Short news, sports, traffic, weather, stock market quotes, movie times, and more can be provided on request. Other applications such as televoting fall under this category.
- **Mobile commerce** — Users can hire cabs and buy goods and services, such as movie tickets or meals to be picked up or delivered.

Clearly opportunities for new revenue from SMS exist. Only the ability of service, content, and application providers to develop services that subscribers see value in, and are willing to pay for, will determine the continued success of SMS around the world.

Modular SS7 Components Optimize SMS Revenue

SS7 is the technology used in the core network to transmit SMS messages, which share the same channels and infrastructure as call control messages. For operators, this is some of the most expensive bandwidth in consumer applications, because it is subject to strict operational requirements for reliability and traffic management. Because SMS services do

not have such stringent requirements, cost-effective modular components from Intel can be added easily and quickly to handle the increased traffic generated from SMS. These components include SS7 interface boards, protocol stacks, and signaling gateways that utilize the Internet Protocol (IP) to transport SS7 messages.

The initial capacity necessary to begin providing SMS services is small compared to the capacity needed to offer a full range of SMS services. Modular components provide a way to upgrade the SS7 network as traffic increases and to handle spikes in traffic flow that may occur. User-to-user services generally grow at a predictable rate, but the new applications that are gaining popularity can easily overwhelm a network that is not properly prepared.

For example, a national TV event with televoting can generate significant income, and SMS messages seem well on their way to becoming the vehicle of choice for such voting. Not only is the amount of data in such a message very small, but many more SMS messages can be handled in a short time because overhead is significantly smaller. Voice calls have to ring at a service center, the caller must be greeted, and the vote recorded. Even if an interactive voice response (IVR) system handles the calls, the physical processing of a voice call is much slower than that of an SMS message.

Nevertheless, a sudden, temporary increase in SMS traffic numbering in the millions of messages could paralyze an SS7 network not provisioned for such usage spikes. Modular components allow a network to be protected from such daunting peak flows while providing customer satisfaction because many more SMS messages can be counted in a short timeframe. Modular components with their high capacity and low cost, compared to traditional SS7 equipment, are ideal for optimizing revenue in such situations.

Worldwide Growth of SMS Services

Because SMS messages are initiated over a mobile network, the number of mobile users is important in sizing the demand for SMS services.

Today, mobile penetration rates vary widely by geography, and so does the appetite for SMS services. In the United States, for example, the adoption rate for cell phones is lower than in Europe and Japan, and, not surprisingly, the popularity of SMS services has lagged also. However, as cell phone use increases, the demand for SMS services can also be expected to rise.

In this section, we will look at the mobile penetration rates in several geographies and the current popularity of SMS services.

Europe

In terms of SMS adoption and usage, the European market segment has long been considered one of the most advanced. This is not surprising, considering the high rate of current mobile penetration as seen in Table 1 [iGillottResearch], with modest increases in mobile penetration expected in the future.

(000s)	2001	2002	2003	2004	2005	2006	CAGR
Total Subscribers	327,416	342,036	353,320	359,165	371,945	392,200	3.7%
Population	495,100	498,566	502,554	506,575	510,627	514,712	0.8%
Penetration Rate	66.1%	68.6%	70.3%	70.9%	72.8%	76.2%	

Table 1. Cellular Penetration Rates in Europe

User-to-user text messaging has been in use for almost 10 years, and subscribers vote for a favorite sports star, hire cabs, and order theatre tickets via SMS. At the same time, service providers are working overtime to develop innovative ways to increase usage and revenue.

Because Europe is a mature market segment [Forrester] for SMS services and people feel comfortable using them, premium or high-value services such as gaming, information alerts, and advertising are expected to find easier acceptance. Applications that download ringtones and use animation have already increased in popularity.

Service providers in less mature market segments, such as the United States, can learn a great deal about how to encourage SMS usage and deal with increasing network demands from the European experience.

Japan

Mobile penetration rates in Japan are second only to Europe, and are expected to grow and reach about the same level as Europe in 2006. See Table 2 [iGillottResearch].

(000s)	2001	2002	2003	2004	2005	2006	CAGR
Total Subscribers	67,100	73,700	79,700	85,100	91,350	98,500	8.0%
Population	127,100	127,316	127,533	127,749	127,966	128,184	0.2%
Penetration Rate	52.8%	57.9%	62.5%	66.6%	71.4%	76.8%	

Table 2. Cellular Penetration Rates in Japan

Sophisticated messaging usage is very high. For example, J-Phone's Sha-mail picture messaging is used by over half of its 12 million subscribers [Probe].

North America

Mobile penetration rates in North America are currently about 15 percent lower than in Europe, but are expected to slightly exceed European and Japanese levels by 2006. See Table 3 [iGillottResearch] for current and predicted mobile penetration rates in North America.

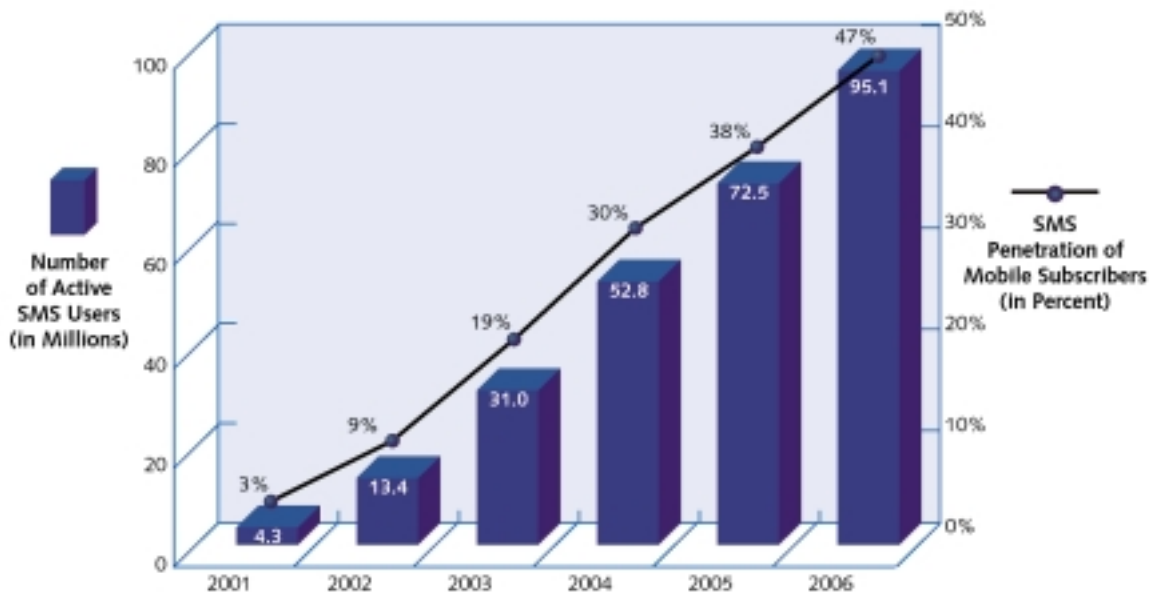
(000s)	2001	2002	2003	2004	2005	2006	CAGR
Total Subscribers	134,800	153,200	174,200	199,900	224,000	250,800	13.2%
Population	311,000	313,022	315,213	317,419	319,641	321,879	
Penetration Rate	43.3%	48.9%	55.3%	63.0%	70.1%	77.9%	

Table 3. Cellular Penetration Rates in North America

SMS usage has also lagged behind Europe and Japan, but industry analysts anticipate that it will catch up quickly. See Figure 1 [Barrabee]. Active SMS users are expected to rise sharply from 9 percent in 2002 to 47 percent in 2006.

Active SMS Users in the United States

Source: the Yankee Group, 2002



Note: Active SMS users are defined as users that initiate at least one text message per month or billing cycle.

Figure 1. Active and Projected SMS Users in the United States

The Canadian market segment is already showing great promise, and increased SMS activity. In November 2002, for example, subscribers sent more than 20 million mobile-to-mobile text messages. Since the introduction of inter-carrier text messaging in 2002, the volume of messages sent by Canadians has increased by 98 percent [CWTA].

Clearly the United States and Canada are large potential market segments for SMS services as mobile penetration rates continue to rise.

Asia Pacific

Asia Pacific is something of an anomaly. Mobile penetrations rates are growing but are still very low. See Table 4 [iGillottResearch]. However, SMS messaging is extremely popular.

	2001	2002	2003	2004	2005	2006	CAGR
Total Subscribers (000)	207,212	296,025	397,651	521,643	648,734	751,277	29.4%
Population (millions)	3,100	3,147	3,191	3,235	3,281	3,326	1.4%
Penetration Rate	6.7%	9.4%	12.5%	16.1%	19.8%	22.6%	

Table 4. Cellular Penetration Rates in Asia Pacific

Text-to-text messaging has been established as part of the Asia Pacific lifestyle for several years and continues to grow more sophisticated. Ringtone downloads, animated characters, consumer product purchases, and news/stock updates are all very common SMS uses in the region. The messages sent by subscribers in other regions are usually measured in multiples of ten per month. In Asia Pacific, it is not unusual for subscribers to send hundreds of SMS messages in the same time period.

SMS use in China is especially interesting. The number of SMS messages was expected to triple from 19 billion in 2001 to 60 billion in 2002. By 2007, SMS revenues in China are expected to surpass US\$17 billion [Pyramid].

Cost-Effective Deployment Strategies

Since it can represent a major growth area for revenue-generating services, SMS messaging has become a key focus for operators and equipment vendors worldwide. In this section, we will take a quick look at the basic way in which SMS messages are processed in SS7 networks, and suggest several strategies that utilize modular components.

SMS services can be deployed quickly and economically with modular components because such components are designed to be flexible and scalable and integrate easily into existing systems. And modular components can also be reused in different kinds of applications if the initial application becomes obsolete or is underutilized.

How Is an SMS Message Processed in SS7?

When an SMS message is sent from an SMS-capable cell phone, the message is handled no differently than a normal call setup: it moves from the cell phone to a base station to a Mobile Switching Center (MSC).

From the mobile switching center, the SMS message moves inside the SS7 network to the Short Messaging Service Center (SMSC), a standard part of the network. The SMSC queries the Home Location Register (HLR) to find out where the recipient of the message is and whether or not he or she is switched on to receive a message. If not, the SMSC stores the message until it can be delivered. See Figure 2.

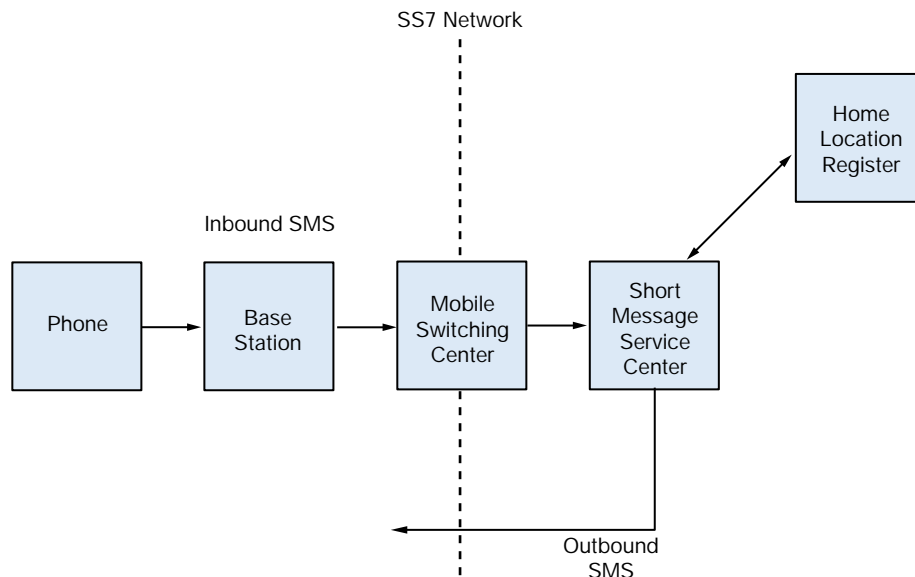


Figure 2. Movement of SMS Message

Provisioning SMS Economically

Because SMS messages are handled in the same way as other messages in the SS7 network, the basic infrastructure is already in place for SMS services. However, a service provider who wants to increase revenue by encouraging SMS usage will need to increase capacity in both the SMSC and the HLR or add more SMSC and HLR nodes.

Modular components, such as the high-density SS7 interface boards and protocol stacks provided by Intel, are an easy, cost-effective way to ready an SS7 network for increased SMS traffic at a relatively low cost compared to adding traditional SS7 components.

Adding Profitable SMS Applications Easily

Initially service providers and their customers may think of SMS as a user-to-user service, a kind of silent text “call” sent, for example, from

the “quiet car” on a commuter train where voice calls on cell phones are prohibited. Americans, who seem to find email more natural than voice calls, can think of SMS as short email messages sent conveniently and quickly by phone.

However, as has been seen in geographies where SMS usage is pervasive, customers can quickly be moved to applications such as televoting, purchasing goods and services online, and using cell phones as a source of information. Such SMS applications can be very lucrative for service providers, potentially generating million of messages per day. Fortunately, such applications can be added simply to an existing SS7 network with an application platform that consists of a standard off-the-shelf server equipped with the same type of modular SS7 interface boards and protocol stacks from Intel that were used to add capacity. See Figure 3.

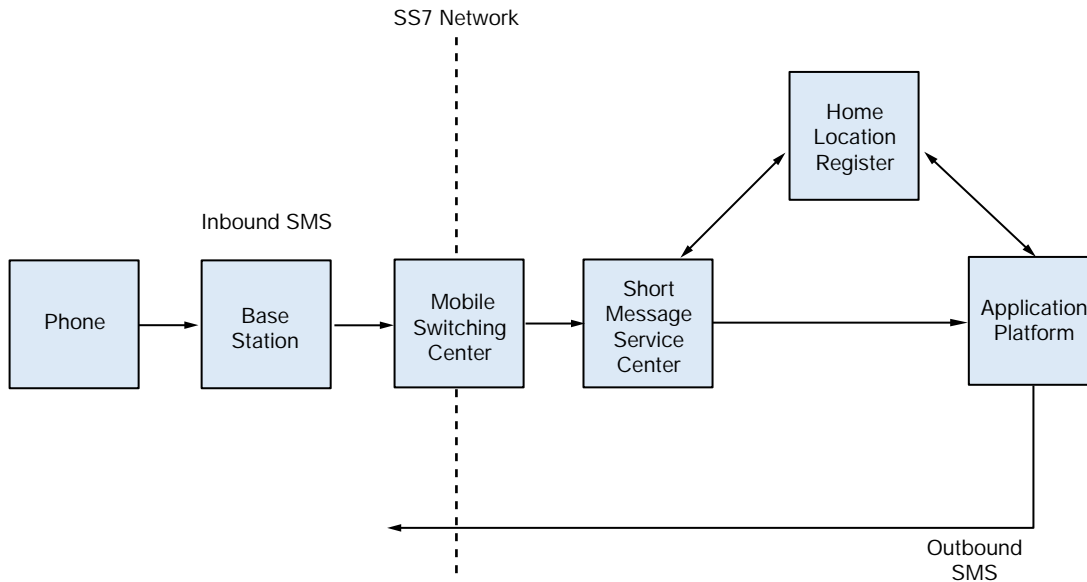


Figure 3. Adding an SMS Application

Because modular components are employed in these network upgrades, TEMs can create solutions with enticing applications and SS7 boards and software from Intel that can simply be “slotted” into an existing SS7 network. For example, an application can be created to allow a user to send an SMS message requesting that information be emailed to a PC, and the information can be sent directly from the application platform within the SS7 network.

Reducing Costs with IP

Even when SMS capacity is increased within an SS7 network with cost-effective modular components, SS7 signaling remains relatively expensive, partly because it is designed for high-availability five-nine service.

Since SMS-related services need to be very reliable to encourage usage but are not as critical as core SS7 network services, the use of modular IP-based components added to the

SS7 network is an ideal solution for increased usage at a much lower cost.

To make deployment as easy as possible, Intel provides the Intel® NetStructure™ SG430 SS7 Signaling Gateway, which is a platform consisting of a carrier-grade server, interface boards, and protocol stacks that enables IP within an SS7 network. Together these modular components can augment an existing SS7 network, and provide very reliable service while cutting the cost of providing the service.

Figure 4 illustrates a simplified deployment. The SG430 can be used for a wide variety of applications, including an SMS router as in this case. When two routers are used, alternative paths to the nodes are created over IP. The SMS router can decide on the application level to route SMS messages to the most appropriate destination (the SMSC or the application platform), making the system in this example more robust and efficient.

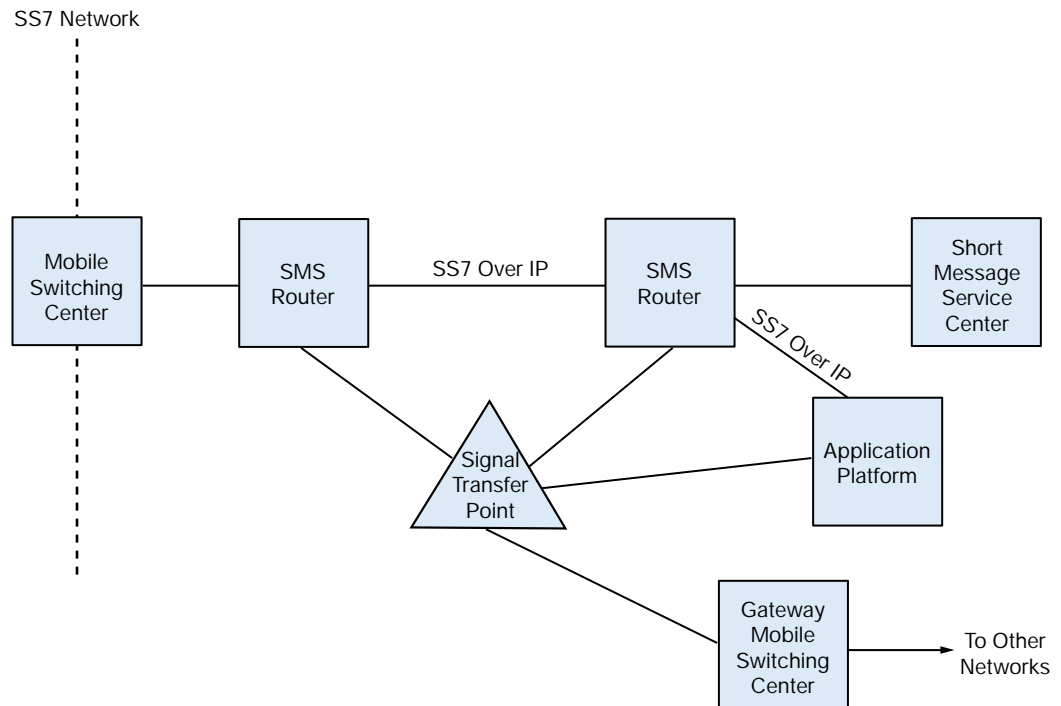


Figure 4. Adding IP to SMS-Enable an SS7 System

For additional details about the modular components discussed in this section, see Appendix A. More information about the network nodes referenced in this paper can be found in Appendix B.

Extending an SS7 Network for SMS – and the Future

Traditional telecom infrastructure has been deployed as monolithic entities – each platform using different hardware and software, and different proprietary interfaces. Even though SS7 protocols are standardized, the largest TEMs have extended these protocols to provide extra features and subsequently blocked compatibility with other vendors. This worked adequately when only a few vendors, who deployed their equipment end-to-end within a network, existed in the market segment, but it is not thought to be a prudent solution today.

As the telecom marketplace matures, service providers and TEMs can no longer afford to extend expensive SS7 infrastructure. Instead, they must devise a strategy that lets them

respond to demands for new services and applications without scraping their existing infrastructure or extending it with expensive proprietary components.

Providing SMS services to mobile customers is an ideal way to increase profits. Fortunately, provisioning an SS7 network for additional SMS traffic and new SMS applications need not be prohibitive. A modular approach can provide fast time-to-market, low development costs, and reduced overall TCO since the modular approach allows easy enhancement and scalability as new, standards-based building blocks become available.

Adopting a modular strategy also has the benefit of preparing equipment manufacturers and service providers to face a future in which communications technology continues to advance rapidly, leaving behind old technology and usage models.

The outlook for the worldwide SMS and communications marketplace is a positive one, and modularity is the key to prospering in that world.

For more information on Intel telecom products, go to www.intel.com/go/telecom.

To get details about Intel's SS7 modular components, see www.intel.com/go/ss7.

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Appendix A. SS7 Building Blocks for SMS

Over the last 25 years, the SS7 network has evolved from basic call set-up and tear-down to the technology platform for premium value-added services inside the network. Since SS7 is the transport mechanism for SMS services, understanding the underlying SS7 protocols and architectures is important. These basic building blocks for an SMS solution directly interface with the SS7 network, and are described in detail here.

SS7 Software Protocols

The standard protocol building blocks that support SMS and associated operations are MTP1-3, SCCP, TCAP, and GSM-MAP or IS41-MAP. All of these software components must exist within the system. The specific operations supported within the MAP modules vary, depending on the node function, but these are fairly simple for SMS operations.

Application
MAP
TACP
SCCP
MTP3
MTP2
MTP1

Message Transfer Part (MTP1, MTP2 and MTP3) — MTP protocol layers reliably transport messages inside the SS7 network. MTP1 and MTP2 handle the physical link and link management. MTP3 handles routing, route management, and node availability up and down the protocol stack.

Signaling Connection Control Part (SCCP) — SCCP provides connection service between two nodes within the SS7 network. It uses the MTP services to route messages between nodes.

Transaction Capabilities Application Part (TCAP) — TCAP is the protocol that uses the services of SCCP and provides a standard schema for transactions between nodes in the SS7 network. TCAP messages include, for

example, a transaction ID field that identifies the message to both nodes for a particular session. It also provides the platform for the SMS service.

Mobile Application Part (MAP) — The MAP layer uses the TCAP layer and provides the specific functions for the operation of the mobile network. Mobile-specific queries between nodes for routing and status use this protocol. The SMS service is defined in the core network by this protocol, and this is what provides the send/receive capability to an SMS application.

MTP, SCCP, TCAP, and MAP provide services to each other and ultimately the applications that are the basis of operation for the SS7 network. Intel provides protocol “stacks” such as the one described here to speed SMS deployment in SS7 networks.

SS7 Boards

SS7 interface boards from Intel support E-1/T-1 or V.35 interfaces to network STPs or other network nodes. When a network already supports SIGTRAN standard interfaces (M3UA or M2PA being the most likely), physical interfaces are not required. In most networks, however, actual SS7 interfaces will be needed.

The key requirement for SS7 interface boards is the ability to operate at very high utilization. For a high-density application, SS7 boards should be able to run at or near 1 Erlang at message sizes of 128 octets or above. This will prevent a system failure at the node level because of excessive traffic. Handling congestion in a graceful manner is a necessity.

Signaling Gateway

The Intel NetStructure SG430 SS7 Signaling Gateway is a key building block in the new generation of networks and service platforms. It supports standards-based protocols and architectures, and includes a set of features for increasing system reliability, maintainability, and efficiency.

The SG430 interfaces to both SS7 and IP networks, carrying SS7 information to and from IP-based applications such as softswitches and mobile network elements.

It lets these applications be distributed over multiple platforms, creating scalable and resilient networks. Routing algorithms do not simply re-create SS7 links and linksets in the IP domain, but form the foundation of advanced distributed service platforms. The gateway uses Internet Engineering Task Force (IETF) SIGTRAN protocols, ensuring interoperability with other equipment using the SIGTRAN standard.

The SG430 uses SIGTRAN's Stream Control Transmission Protocol (SCTP) and adaptation layers to transparently carry SS7 traffic through IP networks to remote applications or between gateways. The SG430 handles management, such as the monitoring and reporting of route availability between the IP and SS7 domains.

Appendix B. SS7 Nodes Important for SMS

Appendix B provides more information about the SS7 nodes discussed in this paper.

Mobile Switching Center (MSC) — The MSC is the equivalent of the local switch inside the mobile network. It provides very similar services to a switch, but uses virtual circuits over radio channels instead of physical voice circuits. One variation on the MSC is the Gateway Mobile Switching Center (GMSC) which routes calls into and out of the network and will not have phones locally registered.

Visitor Location Register (VLR) — The VLR is the database attached to an MSC that keeps track of all the phones currently “registered” to it, informing other nodes of status changes, and checking authentication information.

Short Message Service Center (SMSC) — The SMSC is the clearinghouse for SMS messages on an SS7 network and provides store-and-forward services.

Home Location Register (HLR) — HLR is a core database that keeps track of subscribers. It contains information on the current account status and provides authorization information for billing. When a call or SMS is trying to reach a subscriber, this is the node that is queried to find out where in the network that subscriber actually is.

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