SS7 and Intelligent Networking Applications

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1. Abstract

Signaling System 7 (SS7) is the data communications protocol which provides the underlying network to support Intelligent Networking (IN). The increasingly widescale adoption and deployment of SS7 and IN presents excellent opportunities for Natural MicroSystems' partners.

The deployment of SS7 and IN technology across the globe has been driven by the desire of telephone companies to offer new services, many of which will generate significant revenues. Examples of applications made possible by IN and SS7 include 800# portability, wireless roaming, caller ID and other CLASS (Custom Local Area Signaling Services) services. Opportunities abound for Natural MicroSystems' customers to leverage NMS' SS7 and IN enabling technology by developing systems to support the IN and SS7 infrastructure, provide connectivity to the SS7 infrastructure, and enhance performance of traditional IVR and Call Center applications.

This applications note provides an overview of SS7 and IN standards and applications, and discusses how Natural MicroSystems' products can be used to address a broad range of IN applications.

2. SS7 Overview

SS7 (Signaling System #7), also referred to as out-of-band signaling, is the common channel signaling protocol used for call handling within the telephone network and as the basis of IN (Intelligent Network). SS7 is the underlying data communications protocol used by telephone networks to control call set-up and call routing, and to provide services such as caller ID and CLASS features. SS7 offers telephone network management functions which are faster, more reliable, and more advanced than earlier technology by managing voice circuit functions on a separate, fully redundant data network.

SS7 was originally designed in the mid 1970's for exchanging call control information between the various network switches and databases of the PSTNs (Public Switched Telephone Network). SS7 was increasingly used for more sophisticated purposes including enabling the deployment of new technologies such as ISDN (Integrated Services Digital Network). SS7 replaced the first Common Channel Interoffice Signaling system which was based on SS6, and offered several important advantages including greater speed. SS7 is also referred to as CCS7 by AT&T, C7 in Europe, and SS#7 by ANSI. Note that while many of the elements of SS7 are common, there can be some significant regional variations in its deployment.

3. Intelligent Network (IN) Overview

The Intelligent Network (IN) refers to an architecture for implementing intelligence and advanced functionality within the telephone network. Also referred to as Advanced Intelligent Network (AIN) in the U.S., the IN architecture uses SS7 as the underlying data communications protocol.

The need for IN architecture has become increasingly important in recent years as customers have demanded more sophisticated services and as regulators, such as those in the U.S., have forced competition. IN enables PSTN operators to implement a more uniform set of services (e.g., Caller ID) across a diverse installed base of central office switches and to provide new enhanced services such as 800# rerouting and one number follow me.

A key reason for using SS7 as the underlying network for implementing IN/AIN networks is that SS7 provides communications networks with the reliability and speed necessary for passing all call control information. For example, consider the relatively simple example of an IN implementation of an 800# translation service. In this example, the Local CO switches, each referred to as a Service Switching Point (SSP), are programmed to detect all calls which require special handling and to initiate a trigger function. When a trigger is activated, the local SSP sends a message over the SS7 network to a remotely located database system, referred to as a Service Control Point (SCP). This message is used by the SCP to request information on how to handle the call. Based on the trigger presented and the call characteristics, an SLP (Service Logic Program) running on the SCP determines the appropriate action and sends this information back to the SSP. The SSP then handles the call in the determined manner.

Even from this brief description, it is clear that the entire process must be very fast and highly reliable. If the process is too slow, there will be a noticeable delay; if the process is unreliable, the call will either be lost or handled in some incorrect manner. This example also demonstrates how IN, in using a centralized database(s) (the SCP), eliminates the need to update tables or programs in each of the local CO switches whenever a service or number changes.

Key elements of the Intelligent Network (shown in Figure 2†) include:

- **Service Switching Points (SSP)** — These signaling points are the originators and terminators of signaling messages such as local Central Offices (CO) or exchanges.
- **Service Control Points (SCP)** — These signaling points are typically databases, such as the Line Information Database (LIDB) in a wireline network or the HLR (Home Location Register)/VLR (Visitor Location Register) in a wireless network. The program running on the SCP which determines how the call should be handled is referred to as the Service Logic Program (SLP).
- **Signal Transfer Points (STP)** — These signaling points are the SS7 packet switches, or routers, which route traffic through the SS7 network.
- **Intelligent Peripheral (IP)** — These IN network elements provide services which facilitate customer interaction such as voice prompting, voice storage, and fax storage.
- **Adjunct** — These IN network elements provide customer service functions through the CO Switch. (Note: IN Adjuncts are not currently available commercially.)

Several AIN standards, such as AIN 0.1 and AIN 0.2, have been developed by Bellcore and are being implemented in the U.S. In addition, IN standards are currently being developed by the IN Forum, of which NMS is a Principal Member.

4. SS7 Protocol Overview

The SS7 protocol is a highly structured and layered protocol stack as shown in Figure 3†. The protocol defines all key layers, from the physical layer represented by Message Transfer Part Level 1, to application layers of which there are several. Each application layer is designed to support specific applications such as ISDN, GSM wireless mobility, and IN.

The Natural MicroSystems (NMS) SS7 product family provides broad support for the SS7 protocol, with the protocol stack typically running on an ISA-based (or PCI-based) communications card, and the Application Programming Interface (API) running on the host computer. This approach significantly improves efficiency by off-loading the host computer from processing the SS7 protocol stack, effectively freeing the host computer to process the application.

The NMS SS7 product family provides complete lower level functionality at the Physical, Data Link and Network Level, including MTP (Message Transfer Part) 1 through 3. Key higher level functionality is also provided, including SCCP (Signaling Control Connection Part), ISUP (Integrated Services Digital Network User Part), and TCAP (Transaction Capabilities Application Part), and TUP (Telephony User Part). Support for TUP and other application specific layers are planned for the future.

Refer to the NMS SS7 and TX Series product data sheets for additional information.

5. SS7 Software Layers

MTP (Message Transfer Part) Layers 1 through 3 — These layers provide complete lower level functionality at the Physical, Data Link and Network Level. They serve as a signaling transfer point, and support multiple congestion priority, message discrimination, distribution and routing.

ISUP (Integrated Services Digital Network User Part) — This layer provides the network side protocol for the signaling functions required to support voice, data, text and video services in an Integrated Services Digital Network (ISDN). Specifically, ISUP supports the call control function for the control of analog or digital circuit switched network connections carrying voice or data traffic.

SCCP (Signaling Control Connection Part) — This layer supports higher protocol layers (such as TCAP and IS-634) with an array of data transfer services including connection-less and connection oriented services. SCCP supports global title translation (routing based on directory number or application title rather than point codes), and ensures reliable data transfer independent of the underlying hardware.

TCAP (Transaction Capabilities Application Part) — This layer provides the signaling function for communication with network databases. TCAP is an SS7 (and ISDN) application protocol which provides non-circuit transaction based information exchange between network entities. For example, TCAP enables transaction based service applications such as enhanced dial-800 which must exchange information between a pair of signaling nodes in an SS7 network to access remote databases, referred to as Service Control Points (SCPs). Important applications which use TCAP include:

- 800 number routing
- Automated credit card calling which queries the Line Information Database (LIDB) for calling card validation
- Advanced Intelligent Network call processing (referred to as AIN call “triggers”)

TUP (Telephony User Part) — This layer provides the telephone signaling function for national and international telephone call control. TUP is primarily used outside of the U.S. in Europe, China, parts of Asia and Latin America, and can control all the various types of national and international connections used worldwide.

Higher Level Application Parts — These layers are highly application specific, with each designed to serve a particular application type. Examples include:

- **GSM MAP (Mobile Application Part) —** This layer provides inter-system connectivity between wireless systems, and was specifically developed as part of the GSM standard.
- **IS-41 —** This layer provides similar functionality to GSM MAP. It provides inter-system connectivity between wireless systems and is typically deployed in North American wireless networks. For, example it is widely used to provide interconnection between the analog AMPS (Advanced Mobile Phone System) cellular systems in the U.S.
- **IS-634 —** This layer provides the interface for Mobile Switching Center (MSC) to base station communications for public 800 MHz cellular networks (i.e., for AMPS).
- **INAP (Intelligent Network Application Part) —** This layer runs on top of TCAP and provides similar functionality to MAP but for a fixed network. Note that INAP is primarily a European standard, developed by ETSI. INAP is part of the CS1, CS2 IN Capability Set, the European equivalent to the AIN specification. While the AIN and CS specifications are similar and can be deployed using SS7 for functions such as call routing, there are some differences which the standards organizations are working to converge.
- **1129/1129+/1129A —** These protocols provide a direct connection between the SCP and IP and are variants of the Bellcore 1129 and AIN 0.2 standards. In some cases, SS7 may not be required to implement the direct SCP-IP connection; in other instances, SS7 is used. Using SS7 as the underlying protocol allows any SCP to communicate directly with any IP in the SS7 network. When SS7 is used, the 1129 application layer typically runs on top of TCAP.

6. SS7 Network Overview

SS7 networks provide the transport of messages required to perform critical functions including call set up, making reliability a top priority. To this end, SS7 networks are designed to achieve extremely high levels of reliability, including link diversity as well as redundancy. Figure 6† illustrates a standard example of a simplified SS7 network which highlights some of the built-in reliability features such as the mesh configuration which provides redundant links between each point in the network.

Two-way and three-way link diversity is built into the network design. Two-way link diversity is defined as an Access Link (A-Link) pair in which each link in the pair is provisioned over diverse routes to the interconnecting network interface(s). Additionally, the links should not use a common building, carrier system, cable, or supporting structure.

Three-way link diversity, from the STP, is provided by a Diagonal Link (D-Link) quad of which at least three links are provisioned over diverse routes to the interconnecting network interface(s). As with the A-Links, these links should not be served by common physical or communications infrastructure.

The SS7 network is designed to incorporate significant excess capacity. For example, in the U.S., SS7 networks are typically designed so that no link exceeds 40% capacity. Thus, in the event of a link failure, even when all the traffic is switched to the remaining link, the remaining link will not reach full capacity.

In the U.S., connectivity to the SS7 network is typically provided by 56 kbps links, while in Europe, a single timeslot on an E1 trunk is typically used to carry SS7 (referred to as C7 or CCS7 in Europe) traffic. The importance of reliability in the SS7 network is clearly demonstrated in the European example, as in some European countries the remaining 29 E1 time slots are left unused and do not carry any traffic, thus avoiding any risk of disturbing the SS7 traffic.

Access to the SS7 network is typically restricted to maintain the network's integrity. Initially, only telephone companies were able to gain access to the SS7 network. This is beginning to change, however, particularly in the U.S., due to the increasing numbers and types of service providers — from the major

LECs (Local Exchange Carriers) and IXC's (Inter Exchange Carriers), to the wireless operators and smaller carriers that require access to the SS7 network. In addition, corporate users operating large call centers are gaining access to SS7 networks serving the IXCs to improve their operating efficiency and implementation of new services. In the future, accessibility to SS7 networks is expected to increase across the globe.

One of the challenges of incorporating redundancy in the network design is the cost of providing the additional links and ports to support these links. This can be a costly undertaking, particularly if the operator needs to connect several relatively small (low traffic) central offices (SSP) or other entities onto the SS7 network. Natural MicroSystems' SS7 products are specifically designed to offer solutions with lower port costs. Application examples in the latter sections of this paper show how NMS SS7 products can be configured to reduce the number of ports required into the SS7 network.

7. SS7 Applications

There are a wide variety of potential applications for SS7 technology. The following table provides a sampling of applications for which SS7 is used.

This section describes some key SS7 applications and demonstrates how NMS products, such as the TX Series cards, can be incorporated to implement these applications.

8. Wireless Network Applications

Supporting the mobility of wireless subscribers is a key challenge in designing wireless systems. The wireless systems' signaling requirements are significantly more demanding than those needed to perform similar functions for land line systems. As a result, wireless networks must incorporate more advanced and comprehensive signaling and control systems. Even when the mobile unit is within its home network, tracking a mobile's location is required for terminating calls, authentication, and hand-off functions. The trend is for system operators to offer customers increasingly sophisticated levels of mobility, which in turn requires sophisticated signaling between systems to support roaming, registration and routing functions. SS7 is often the signaling system of choice.

SS7 is also widely used for signaling between wireless networks and the PSTN, and increasingly between the wireless network subsystems. In GSM networks, SS7 is also used for signaling between Base Station Controllers (BSC) and the Mobile Switching Center (MSC).

Figure 8-1† illustrates how SS7 is used to support roaming in a wireless network.

As shown in Figure 8-1, each system maintains its own HLR (Home Location Register) and VLR (Visitor Location Register) database. A subscriber's full record is maintained at a single HLR by the subscriber's home system. Records for subscribers who are only visiting the system are maintained in the VLR. When a subscriber travels to another service area and wishes to make a call, the visited system recognizes upon registration (when the mobile unit is first turned on) that the user is from another area and has a dialog with the subscriber's home system, using SS7 to temporarily register the visiting mobile unit in its VLR. In addition, the home system marks its HLR record for the subscriber so that calls to the subscriber are automatically routed to the visited location.

Figure 8-2† illustrates how TX Series cards supporting T1/E1 are used in the BSC and MSC to support SS7.

Note: IS-634 is the MSC to base station interface for public 800 MHz radio. NMS provides the underlying protocols to enable compliance with IS-634.

Please note that Natural MicroSystems' Wireless Infrastructure Applications note provides additional background information on wireless mobility and wireless applications.

9. Interactive Voice Response (IVR) Applications

SS7 can be used with IVR systems to improve efficiency, provide new functionality, and reduce telecommunications costs. Specifically, the key benefits of using SS7 in an IVR application include:

- Faster call set-up and call tear down
- Increased information associated with a call (ANI/DNIS)
  Intelligent routing
- Ability to implement large distributed IVR systems
- Ability to reduce telecommunications costs (e.g., 800# service) by purchasing high capacity trunks
- Ease of upgrade to new services

One of the challenges in implementing an IVR system is to ensure that either the call is routed to the location where the associated data resides, or that the data is passed to where the call is handled. This challenge is particularly important in large and/or distributed IVR systems which handle multiple applications. It is in these types of systems where SS7 is likely to be most applicable.

Figure 9† illustrates an example of a large distributed IVR application which uses SS7 signaling to route the call to the appropriate application. Note that an SS7 Gateway is used to concentrate traffic from two of the locations to reduce the number of SS7 links required. In determining whether to upgrade an IVR system with an SS7 capability, it is important to weigh the cost savings gained through increased efficiency and lower per call costs versus the additional cost of the SS7 links.

In other situations, such as with some European PTTs, access to the SS7 network may not currently be available. In these cases, the TX Series hardware can be used with other Natural MicroSystems data communications protocol stacks including X.25 and TCP/IP to provide a data network path between the varidards organizations are working to converge.

- **1129/1129+/1129A —** These protocols provide a direct connection between the SCP and IP and are variants of the Bellcore 1129 and AIN 0.2 standards. In some cases, SS7 may not be required to implement the direct SCP-IP connection; in other instances, SS7 is used. Using SS7 as the underlying protocol allows any SCP to communicate directly with any IP in the SS7 network. When SS7 is used, the 1129 application layer typically runs on top of TCAP.

10. Call Center Applications

SS7 can also be used with call centers to improve efficiency, provide new functionality, and to reduce telecommunications costs. An outbound call center will typically use a predictive dialer, only routing answered calls to an agent. Several outgoing lines for each agent are provided to optimize agent utilization. A key challenge in developing and operating these systems, however, is determining when a call is answered. Traditional telephone systems do not provide any specific signaling to indicate answer or hang-up. SS7 does, however, provide answer and hang-up indication to the call center, resulting in more efficient operation and lower operating costs.

Thus, key potential benefits of using SS7 in an outbound call center application include:

- Faster call set-up, answer detection and call tear down
- Increased information associated with the call (ANI/DNIS)
- Ability to reduce telecommunications costs by purchasing high capacity trunks
- Ease of upgrade to new services

SS7 has many applications in call centers, particularly large call centers. For example, SS7 can be used to improve the efficiency of an inbound call center with intelligent routing and with faster ANI (Automatic Number Identification), or to implement a distributed call center by using SS7 to link in remote agent stations. SS7 can be used to reduce telecommunications costs for a large inbound call center/IVR application where calls are routed to the call center from a distributed IVR system. In this example, the remotely located IVR would transfer a call to the call center only when a live agent is available to take it, rather than immediately transferring all calls to the call center and incurring additional long distance telephone charges while the calls are queued.

As with the IVR application, the system designer must consider the cost savings gained through increased efficiency and lower per call costs versus the additional cost of the SS7 links when determining whether to upgrade a call center with SS7 capability.

11. SS7 Switching and Gateway Applications

The Natural MicroSystems SS7 and data communications product family offers high performance capabilities at an intrinsically low cost, providing an ideal platform for developing sophisticated LAN systems for concentrator and gateway applications. The application examples outlined in this section includes: SS7 Micro STP, SS7/MF Converter, and SS7/IP Gateway.

Note that in the following application examples, Natural MicroSystems' products provide the underlying data communications protocols; however, in each case, an application would either need to be developed or purchased from a third party.

11.1. Application Example: SS7 Micro-STP

Figure 11-1† illustrates a Micro STP, combining traffic from a group of SS7 A-links onto a single pair of SS7 A-Links. The goal of this application is to reduce the number of links required for accessing a common carrier's SS7 network. Adding links into the common carrier's SS7 network can be a relatively costly undertaking, sometimes prohibitively so. This approach is particularly cost-effective for smaller switches which may only generate a small amount of SS7 traffic.

The Micro STP terminates multiple links from SSPs and concentrates them into a link set connected to an STP, supporting two links for the STP link set. The Micro STP port presents the same appearance to the SSPs as an STP port. The Micro STPs are deployed in mated pairs to provide the availability and reliability that diversity offers. Each Micro STP is connected to its mate via a Cross-Link (C-Link). In addition, each port on the Micro STP may be assigned a unique point code, allowing SS7 links to be moved without affecting the endpoint SSPs.

Micro STPs offer significant cost savings to telcos which operate smaller CO (Central Office) switches. For example, the price per port of a Micro STP using the NMS SS7 products is easily less than half the cost of a port on a typical STP.

11.2. Application Example: SS7/MF Gateway

Figure11-2† illustrates how an SS7/MF (Multi-Frequency) Tone converter can be deployed next to an existing switch to provide that switch with SS7 signaling capabilities, without the need for any upgrades. Using a combined SS7 and Tone based call set-up environment (such as the one shown in Figure 9) provides cost-effective access to the SS7 network for cellular carriers, local exchange carriers, inter-exchange carriers, and operators using older CO switches.

Applications for the SS7/MF Tone Gateway include:

- Providing enhanced services
- Extending the life of and protecting investment in existing switching equipment (typically used to front-end older switches to avoid significant upgrading cost)
- Improving utilization of facilities through enhanced performance of SS7 signaling
- Offering network management

Figure 11-3† shows a detailed schematic of the internal configuration of the SS7/MF host gateway that was depicted in Figure 9.

11.3. Application Example: SS7/IP Gateway

An SS7/IP Gateway (depicted in Figure 11-4†) uses an existing TCP/IP network as the backbone for carrying SS7 traffic to provide cost-effective access to the SS7 network for carriers and enhanced service providers. Key advantages of this approach include:

- Reduces the need for dedicated 56 kbps links by utilizing IP backbone for transport.
- Improves STP performance by concentrating SSP A-links into fewer STP ports, off-loading expensive transmission/reception of FISUs (Fill In Signal Unit) onto gateways.
- Provides centralized or distributed management of all gateways via IP backbone network.

For example, a cellular carrier with several widely distributed sites can avoid leasing large numbers of SS7 links by instead using the IP network to provide transport.

The SS7/IP Gateway can also be used to provide access to the SS7 network for host computers and LAN-based workstations via TCP/IP for:

- Access to Line Information Databases (calling card validation)
- Enhanced telecommunications services
- Network management

As with the prior application examples, while NMS technology and products are used to provide the underlying data communications capabilities, in each case the specific application would need to be developed by the customer.

12. Other Application Examples

The NMS SS7 family of products offers advantages for many other types of applications such as protocol testing, equipment simulation, and call monitoring and logging. For example, the TX2000 and SS7 protocol stack have been used by a major telephone equipment manufacturer to test their central office switch SS7 implementation, as depicted in Figure 12†.

While the configuration shown in Figure 12 is relatively simple, the application itself shows the strength of the NMS SS7 product as it is used to test and validate a third party SS7 implementation running on the CO Switch.

Note, while the NMS SS7 and TX Series products provide a very powerful “off the shelf” SS7 capability, in some instances such as for passive monitoring or logging applications the customer may need to use the TX Series hardware and software development facilities to develop application specific capabilities which reside on the TX Series board.

13. Natural MicroSystems SS7 Product Overview

The Natural MicroSystems SS7 product family includes TX Series communications processor cards which are used in conjunction with appropriate SS7 software protocol stacks. NMS currently offers protocol stacks up through and including ISUP and SCCP running in conjunction with a range of operating systems including UNIX, Windows NT, and OS/2 with TCAP and TUP protocols available soon. The protocol stacks adhere to domestic (ANSI) and international (ITU-T) standards. The combination of this SS7 technology and NMS Open Telecommunications technology provides a broad offering that enables our customers to offer solutions in a wide range of markets.

The TX Series cards are fully MVIP-compliant and are easily incorporated into applications which use other MVIP products from Natural MicroSystems or other companies. Alternatively, certain TX Series cards can be used in a standalone mode, eliminating the need for a host computer. TX Series cards can also support other data communications protocols including X.25, TCP/IP and SNA, and can be configured to support multiple protocols on a single board.

13.1. SS7 Software Module Overview

The NMS SS7 software offering includes support for the following layers:

- Message Transfer Part (MTP) Layers 1 through 3
- Integrated Services Digital Network User Part (ISUP) with API
- Signaling Control Connection Part (SCCP) with API
- Transaction Capabilities Application Part (TCAP)* with API
- Telephony User Part (TUP)* with API

Each of the modules provides both the call processing application which runs on the TX Series communications processor card, and a C-language Application Program Interface (API) which runs on the host. This approach is highly advantageous as it off-loads SS7 protocol processing from the host while providing ease of access to the API by the host application.

** — Please refer to your sales representative for specific product availability and OS support.*

13.2. TX Series Communications Processor Cards

TX Series communications processor cards are high performance communications boards for ISA bus and PCI bus compatible computers. Specific configurations vary but each TX Series card has one or more on-board Motorola 68000 series communication processors, supported by the necessary RAM. Each TX Series board also supports a variety of ports, including wide area ports (V24/RS232C or V.35), LAN ports (10BASE2, 10BASE5, 10BASE-T, and 100Mhz Ethernet), and T1 or E1. Each TX Series card is factory configured using interchangeable daughter boards to support specific network interfaces.

The TX Series includes the TX1000, TX2000 and TX3000 products. For the purposes of this application note, only the TX2000 is described in detail. For more information on any of the TX Series cards, please refer to the appropriate TX Series data sheets from Natural MicroSystems.

TX2000
The TX2000 board is similar to the TX1000, but provides 2-2.5 times the throughput performance. The TX2000 uses the Motorola 68360 processor, supports an optional second Motorola 68360 processor and up to 64 MB of RAM. The port configuration is particularly flexible. For example, the TX2000 supports up to four wide area ports, three wide area ports and a LAN port, or a dual T1 or E1 and one LAN port (as shown in the TX2000 configuration options table below).

In the SS7 configuration, the TX2000 provides functionality for SCCP, ISUP, and MTP Level 3 (Network), MTP Level 2 (Data Link) and MTP Level 1 (Physical Link), with only the API part running on the host.

A single TX2000 board can support the interfaces listed figure 13† on the following page. Any one of the listed options may be selected (at time of ordering) from each row for each TX2000 card.

Note for the dual T1/E1 interface: All channels from the digital trunk interfaces can either be terminated locally on the card or switched onto the MVIP bus for processing by other MVIP compliant boards. For example, the TX2000 can terminate a T1, processing two of the DS0s supporting SS7 links and switching the remaining 22 DS0s onto the MVIP bus for handling by other MVIP resources.

Please refer to the TX Series hardware and SS7 data sheets for specific product information.

14. NMS Support for Developing SS7 and IN Applications

Natural MicroSystems works with and supports developers of SS7 and IN applications from system/subsystem concept and specification through the development, test and deployment cycles.

Specifically, NMS works with system developers to assist in the development of both overall system architecture and internal architecture to determine the best approach for taking advantage of the NMS products. Important considerations in developing the internal system architecture include an understanding of the overall application, interfaces to other parts of the system, number and type of interfaces, number of ports, and overall performance requirements.

Another key decision is to determine which operating system to use. NMS products are typically used with one of several operating systems, including Windows NT, OS/2, or UNIX. All of these operating systems are supported by excellent operating system, vendor-supplied or third party tools and development environments. For most developers of SS7 and IN applications, either C or C++ is typically the language of choice. Microsoft's Visual C++ for NT and IBM's C Set and Visual Age C++ compilers for OS/2 are popular choices for implementing systems.

Other important considerations in selecting the underlying operating system are the availability and performance of third party applications. Again, because all Natural MicroSystems products are based on widely accepted open standards, developers typically have a broad array of choices. Natural MicroSystems' System Engineers and the NMS Developer Support Group can offer highly practical recommendations based on their many years of hands-on experience.

In some cases, customers may want to add software to the TX Series communications processor board. While this is not a common requirement for SS7 customers, a software development kit (SDK) and other tools are available from NMS for those customers which have the technical capabilities and need to develop application specific functions on the TX Series board.

Most importantly, NMS is committed throughout the entire organization to working with our customers from design to roll-out, system sale, deployment and beyond. In particular, the NMS Developer Support Group is ready to assist our customers before, during, and after implementation of systems using NMS products.

15. SS7 Standards

SS7 standards are defined in the ITU-TS documents as noted below:

Q.700-Q.709	Messaging Transfer Part (MTP)
Q.710	PBX Application
Q.711-Q.716	Signaling Connection Control Part (SCCP)
Q.721-Q.725	Telephone User Part (TUP)
Q.730	ISDN Supplementary Services
Q.741	Data User Part (DUP)
Q.761-Q.766	ISDN User Part (ISUP)
Q.771-Q.775	Transaction Capabilities Application Part (TCAP)
Q.791-Q.795	Monitoring, Operations, and Maintenance
Q.780-Q.783	Test Specifications

Note that in addition to these standards, many countries and/or PSTNs also define their own variants which, while based on the ITU specifications, may have important differences. NMS is highly experienced in dealing with international variants and is working to support an increasing number of international SS7 variants.

Glossary

A-Link	Access Link – SS7 link which connects an SCP or SP to each STP of a mated pair
ACD	Automatic Call Distributor – a PBX-like device used in call centers to assign calls to agents
AIN	Advanced Intelligent Network – Bellcore developed architecture /specifications for using a separate data network to provide the telephone network with advanced call control and enhanced services features
AMPS	Advanced Mobile Phone System – the standard for the original cellular system deployed by AT&T in the U.S.
ANI	Automatic Number Identification – provides the called party with the calling parties number
API	Application Programming Interface — a tightly defined way for an application program to interact and control lower level software such as parts of the SS7 protocol stack
B-Link	Bridge Link – SS7 link which interconnects STPs in different regions
CCS7	Common Channel Signaling 7 — European name for SS7 (may also be referred to as C7)
CLASS	Custom Local Area Signaling Services – a Bellcore definition of local calling services including call forwarding, caller ID, and call waiting
C-Link	Cross Link – SS7 link between a mated pair of STPs
CO	Central Office – a local telephone exchange. Referred to as a SSP in the IN architecture
D-Link	Diagonal Link – SS7 link which interconnects a local STP with a regional STP
DNIS	Dialed Number Identification Service – a feature of 800# lines which provides the number dialed to the called party
FISU	Fill In Signal Unit — a null message exchanged over the SS7 link as a filler to indicate to the receiver that the sender is alive
HLR	Home Location Register – a wireless database which holds key information on all locally based subscribers of the wireless operator

H-MVIP	High Capacity-MVIP — a higher capacity version of MVIP which allows switching between several thousand timeslots in a single chassis
IN	Intelligent Network - using a separate data network to provide the telephone network with advanced call control and enhanced services features
INAP	Intelligent Network Application Part – an IN application layer or capability set for wireline applications
ISDN	Integrated Services Digital Network – standards for digital telephone service available to subscribers
ISUP	ISDN User Part – an SS7 layer which supports implementation of ISDN
ITN	Independent Telephone Network – a telephone network operated by a carrier independently of a PTT, PSTN or RBOC
IVR	Interactive Voice Response – an automated system for providing a spoken response to some user entry
IXC	Inter-Exchange Carrier – a long distance phone company
LEC	Local Exchange Carrier – the local phone company
MF	Multi-frequency (signaling) - an in-band signaling scheme which uses tones to transfer call data
MSC	Mobile Switching Center – the wireless equivalent of a CO
MTP	Message Transfer Part – lower layers of the SS7 protocol stack (e.g. physical, link and network)
MVIP	Multi-Vendor Integration Protocol – an open standard for interconnecting telecommunications cards using host PC computers
PC	Point Code - an SS7 term which defines the address of an SS7 element
PIN	Personal Identification Number – a unique identification number which must be entered by a subscriber to authenticate a transaction
PPSN	Public Packet-Switched Network – refers to a packet-switched network available to the public or large corporations. This is not used to refer to the Internet but is more likely to refer to a public X.25, Frame Relay or similar data network

PSTN	Public Switched Telephone Network – typically refers to the state telephone operator. In the past, this was always a monopoly but now could refer to one of the primary telephone companies which offers local and long distance services in a given country
PTT	Public Telephone and Telegraph – similar to PSTN
RBOC	Regional Bell Operating Company – originally one of the seven local U.S. phone companies divested from AT&T, but several have recently merged and are seeking to offer a broad range of telecommunications services, including long distance.
SCP	Service Control Point – an IN definition of a control element, typically a database which is used to determine how to handle the call
SCCP	Signaling Control Connection Part – an SS7 protocol layer which provides data services used to support TCAP and other higher level layers
SLK	Signaling Link – the physical transmission line connecting the individual nodes in an SS7 network
SP	Signaling Point - an SS7 signaling point
SS7	Signaling System 7 – the international data communications protocol standard which supports advanced telephone services and IN
SSP	Service Switching Point – an IN definition for an originator or terminator of calls and SS7 messages, typically a central office (CO)
STP	Signal Transfer Point – an IN definition for a network node in an SS7 network
TCAP	Transaction Capabilities Application Part – a higher level SS7 protocol layer which supports transaction based applications
VLR	Visitor Location Register – a wireless database which holds key information on all subscribers which are visiting (i.e., roaming) in the wireless operator's service area