

# Introduction to SS7 Signaling

*This tutorial provides an overview of Signaling System No. 7 (SS7) network architecture and protocols*

SS7 is a set of telephony signaling protocols that are used to set up most of the world's public switched telephone network (PSTN) telephone calls. SS7 primarily sets up and tears down telephone calls, but other uses include number translation, prepaid billing mechanisms, local number portability, short message service (SMS), and a variety of mass-market services.

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## SS7: Common Channel Signaling System No. 7 (SS7 or C7)

A worldwide standard for telecommunications defined by the International Telecommunication Union (ITU) Telecommunication Standardization Sector (ITU-T).

The SS7 standard defines the procedures and protocol by which network elements in the public switched telephone network (PSTN) exchange information over a digital signaling network to enable wireless (cellular) and wireline call setup, routing, and control.

### Variants of SS7

American National Standards Institute (ANSI) and Bell Communications Research (Telcordia Technologies) standards used in North America and the European Telecommunications Standards Institute (ETSI) standard used in Europe.

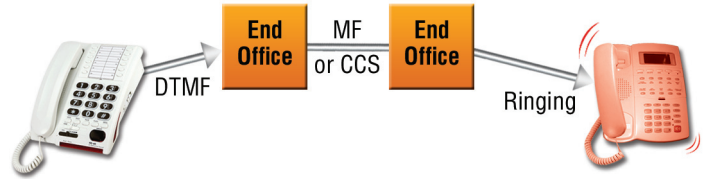
The SS7 network and protocol are used for:

- Basic call setup, management, and tear down
- Wireless services such as personal communications services (PCS), wireless roaming, and mobile subscriber authentication
- Local number portability (LNP)
- Toll-free (800/888) and toll (900) wireline services
- Enhanced call features such as call forwarding, calling party name/number display, and three-way calling
- Efficient and secure worldwide telecommunications
- SMS (Short Message Service)

### Signaling

Everything in the telecommunications network is based on signaling—call setup, connection, teardown,

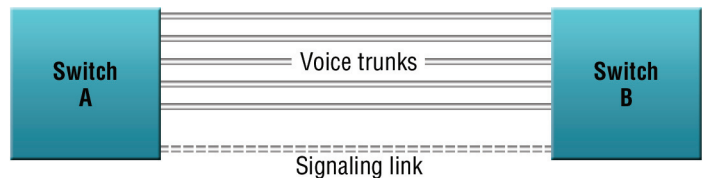
Figure 1. CAS: ESF, SF, RBS, MFR2



and billing. The two forms of signaling that you are most familiar with used by Patton products are:

- Channel Associated Signaling (CAS) RBS or MFR2 are examples of CAS signaling (see Figure 1).
- Common Channel Signaling (CCS) ISDN-PRI (see Figure 2).

Figure 2. CCS: PRI-ISDN



### You already know ISDN

Integrated Services Digital Network—Primary Rate Interface (ISDN-PRI) divides digital transport services into bearer channels (B-channels) for voice and data transmission and data channels (D-channels) for signaling data.

In North America T1-PRI employs 24 channels (23B+1D at 64 Kbps per PCM channel) with an aggregate bandwidth of 1.536 Mbps. In Europe E1-PRI employs 32 channels (30B+2D at 64 Kbps per PCM channel) with an aggregate bandwidth of 2.048 Mbps.

However the principal disadvantage of ISDN-PRI is its use of Associated Signaling mode, which only works with directly trunked switches.

## SS7 like ISDN uses a form of CCS

While similar to ISDN-PRI, Signaling System Number Seven (SS7) uses different messaging for call setup and teardown. SS7 lets any SS7-enabled node to talk to any other, regardless of whether they have direct trunk connections between them.

The preferred mode of signaling for SS7 networks is Quasi-Associated, whereas ISDN-PRI uses the Associated Signaling mode.

### Signaling Links (Common channel signaling)

SS7 messages are 56 or 64 kbps bidirectional channels called (signaling links) exchanged between network elements. Signaling occurs **out-of-band** on dedicated channels rather than **in-band** on voice channels.

SS7 is a form of common channel signaling, that provides intelligence to the network, and allows quicker call setup and teardown—saving time and money.

Compared to in-band signaling, out-of-band signaling provides:

- Faster call setup times (compared to in-band signaling using multi-frequency (MF) signaling tones)
- More efficient use of voice circuits
- Support for Intelligent Network (IN) services which require signaling to network elements without voice trunks (e.g., database systems)
- Improved control over fraudulent network usage
- Lowering network operating costs by reducing SS7 links.

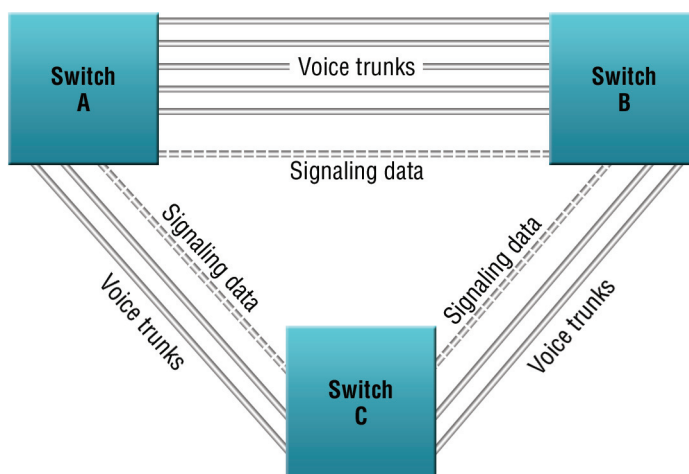
## Signaling Modes

- **Associated Signaling**—Uses one dedicated path between switches as the signaling link. Examples: ISDN-PRI and E1-CAS.
- **Non-Associated Signaling**—Uses separate logical paths and multiple nodes.
- **Quasi-Associated Signaling**—Uses a minimal number of nodes (preferred for SS7, causes less delay).

### Associated Signaling

With this type of signaling, the signaling link directly parallels associated voice trunks. Thus, dedicated links must be provisioned between every interconnected switch. (See Figure 1-3.)

Figure 1-3. Associated Signaling

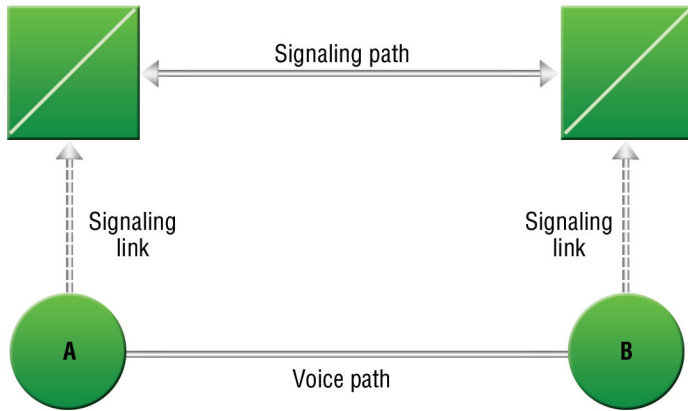


### Non-Associated Signaling

With this type of signaling, voice/data and signaling are carried on separate, logical paths. Multiple nodes in the signaling path to the final destination can cause

delays. Although used in the SS7 network, it is not preferred. (See Figure 1-4.)

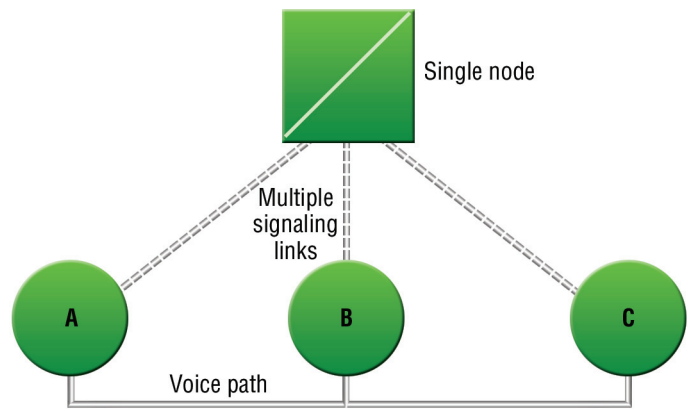
**Figure 1-4. Non-Associated Signaling**



**Quasi-Associated Signaling**

This type of signaling employs a minimal number of nodes, thus minimizing delays. Quasi-associated signaling is the preferred signaling mode for SS7. (See Figure 1-5.)

**Figure 1-5. Quasi-Associated Signaling**



**Signaling Points**

All nodes in the SS7 network are called Signaling Points (SPs). Each SP is identified by a unique address called a Point Code (PC). SPs have the ability

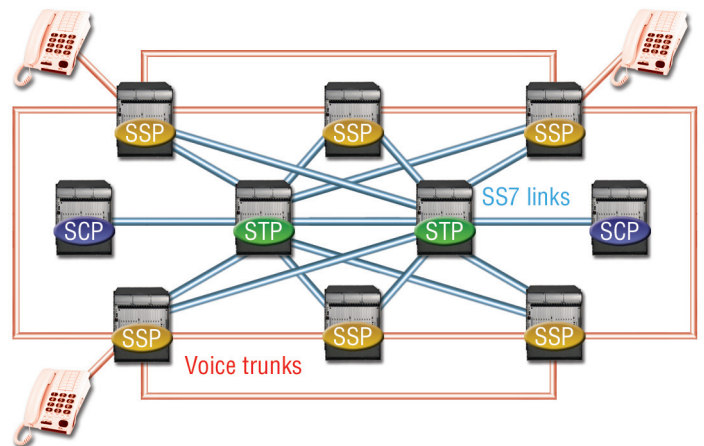
to read a Point Code and determine if the message is for that node and the ability to route SS7 messages to another SP.

Each signaling point in the SS7 network is uniquely identified by a numeric point code. Point codes are carried in signaling messages exchanged between signaling points to identify the source and destination of each message. Each signaling point uses a routing table to select the appropriate signaling path for each message.

There are three kinds of signaling points in the SS7 network (see Figure 6):

- SSP (Service Switching Point or Signal Switching Point)
- STP (Signal Transfer Point)
- SCP (Service Control Point)

**Figure 1-6. SS7 Signaling Points**



**Service Switching Point (SSP)**

SSPs are switches, for example, Class 5 (local) and Class 4 (tandem) with SS7 interfaces.

SSPs convert global title digits (i.e. a dialed number) from a subscriber line to SS7 signaling messages.

SSPs setup, manage and release voice circuits required to make a call.

SSPs send messages using the ISDN User Part (ISUP) and Transaction Capabilities Application Part (TCAP) protocols

To summarize, an SSP's function is to use a global title to determine how to connect a call using its routing table.

**Signal Transfer Point (STP):**

An STP is a router and/or a gateway in the SS7 network.

Messages are not originated by an STP.

STPs switch SS7 messages between signaling points.

If an originating SSP does not know the address of a destination SSP, the STP must provide it using Global Title Translation.

Gateway STPs serve as the interface into another network and they can provide protocol conversion .

STPs also provide traffic and usage measurements.

**Service Control Point (SCP)**

An SCP provides application access. It is an interface to applications such as databases.

An SCP communicates with applications using primitives. A primitive is an interface that provides access from one level of a protocol to another level.

The protocol used to access and interface a database application is TCAP.

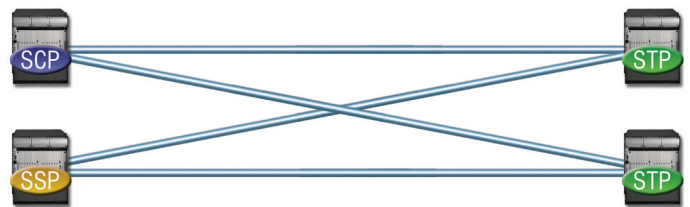
**SS7 Signaling Links:**

All SPs (signaling points) are connected using (typically) pairs of Links. Each Link type is identified with a letter as defined below:



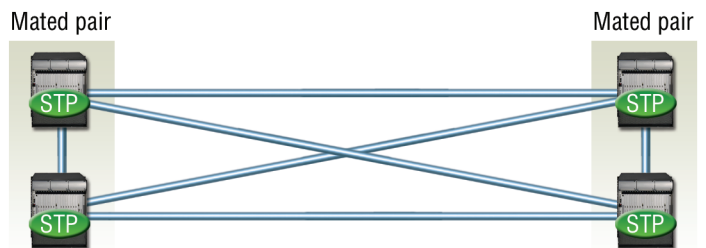
**Type A—Access Links (used to connect SSPs to STPs or STPs to SCPs)**

An “A” (access) link connects a signaling end point (for example, an SCP or SSP) to an STP. Only messages originating from or destined to the signaling end point are transmitted on an A link.



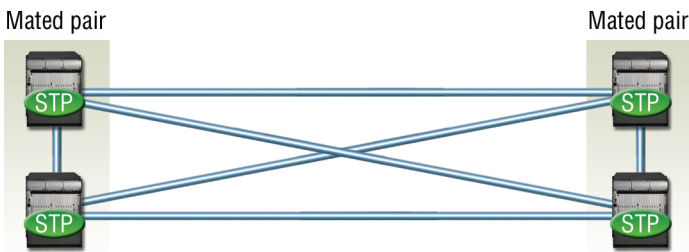
**Type B—Bridge Links (used to connect paired STPs to other paired STPs).**

A “B” (bridge) link connects an STP to another STP. Typically, a quad of “B” links interconnect peer (or primary) STPs (for example, the STPs from one network to the STPs of another network). The distinction between a B link and a D link is rather arbitrary. For this reason, such links may be referred to as B/D links.



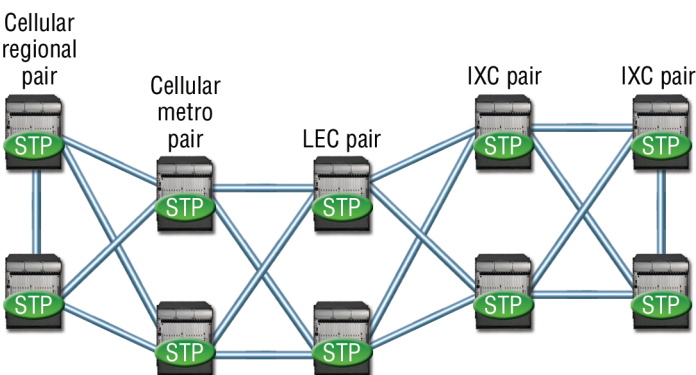
**Type C—Cross Links (used to connect paired STPs)**

A “C” (cross) link connects STPs performing identical functions into a mated pair. A C link is used only when an STP has no other route available to a destination signaling point due to link failure(s). Note that SCPs may also be deployed in pairs to improve reliability; unlike STPs, however, mated SCPs are not interconnected by signaling links.



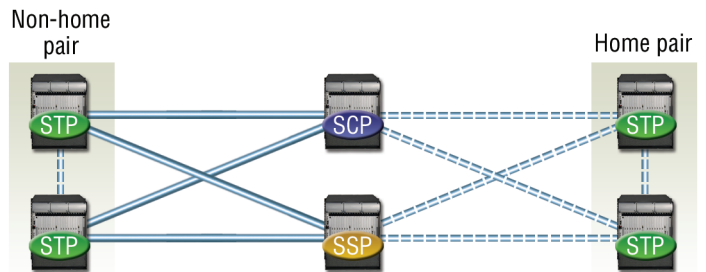
**Type D—Diagonal Links (used to connect paired STPs at one in the hierarchy to paired STPs at another level in the hierarchy)**

A “D” (diagonal) link connects a secondary (local or regional) STP pair to a primary (for example, inter-network gateway) STP pair in a quad-link configuration. Secondary STPs within the same network are connected via a quad of D links. The distinction between a B link and a D link is rather arbitrary. For this reason, such links may be referred to as B/D links.



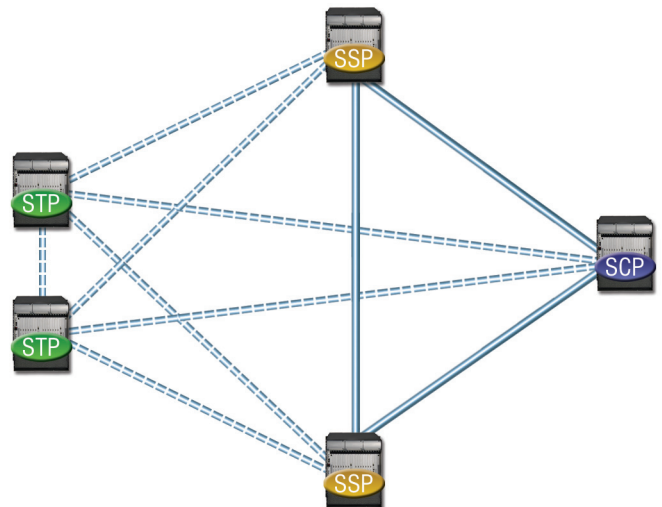
**Type E—Extended Links (connects SSPs to alternate or remote STPs for increased resilience and load sharing)**

An “E” (extended) link connects an SSP to an alternate STP. E links provide an alternate signaling path if an SSP’s home STP cannot be reached via an A link. E links are not usually provisioned unless the benefit of a marginally higher degree of reliability justifies the added expense.



**Type F—Fully Associated Links (used to connect SSPs when significant traffic flows between them)**

An “F” (fully associated) link connects two signaling end points (i.e., SSPs and SCPs). F links are not usually used in networks with STPs. In networks without STPs, F links directly connect signaling points.



All links use the same physical connections, typically DS0A—56 kbps or DS1 (T1). The letter designation allows differing congestion and recovery treatment.

## SS7 Protocol Layers

The SS7 protocol is designed to both facilitate these functions and to maintain the network over which they are provided. Like most modern protocols, the SS7 protocol is layered.

### Physical Layer MTP Layer 1

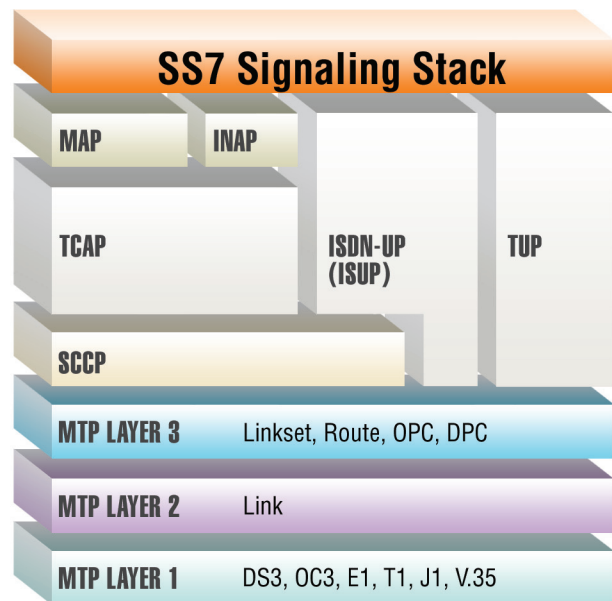
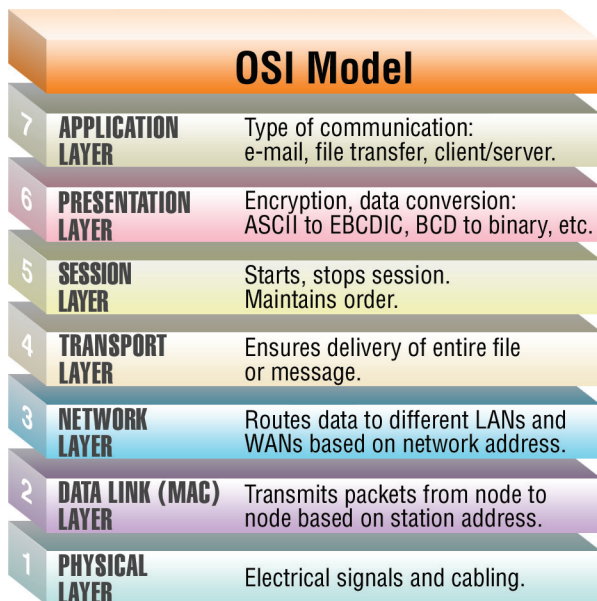
This defines the physical and electrical characteristics of the signaling links of the SS7 network. Signaling links utilize DS-0 channels and carry raw signaling data at a rate of 56 kbps or 64 kbps (56 kbps is the more common implementation).

### Data Link Layer MTP

The layer 2 portion provides link-layer functionality. It ensures that the two end points of a signaling link can reliably exchange signaling messages. It incorporates such capabilities as error checking, flow control, and sequence checking.

### Network Layer MTP

The layer 3 portion extends the functionality provided by MTP level 2 to provide network layer functionality. It ensures that messages can be delivered between signaling points across the SS7 network regardless of whether they are directly connected. It includes such capabilities as node addressing, routing, alternate routing, and congestion control





## **Signaling Connection Control Part (SCCP)**

The signaling connection control part (SCCP) provides two major functions that are lacking in the MTP. The first of these is the capability to address applications within a signaling point. The MTP can only receive and deliver messages from a node as a whole; it does not deal with software applications within a node.

While MTP network-management messages and basic call-setup messages are addressed to a node as a whole, other messages are used by separate applications (referred to as subsystems) within a node. Examples of subsystems are 800 call processing, calling-card processing, advanced intelligent network (AIN), and custom local-area signaling services (CLASS) services (e.g., repeat dialing and call return). The SCCP allows these subsystems to be addressed explicitly.

Enhanced routing is called global title (GT) routing. It keeps SPs from having overly large routing tables that would be difficult to provision and maintain. A GT is a directory number that serves as an alias for a physical network address. A physical address consists of a point code and an application reference called a subsystem number (SSN). GT routing allows SPs to use alias addressing to save them from having to maintain overly large physical address tables. Centralized STPs are then used to convert the GT address into a physical address; this process is called Global Title Translation (GTT). This provides the mapping of traditional telephony addresses (phone numbers) to SS7 addresses (PC and/or SSN) for enhanced services. GTT is typically performed at STPs.

## **ISDN User Part (ISUP)**

ISUP user part defines the messages and protocol used in the establishment and tear down of voice and data calls over the public switched network (PSN), and to manage the trunk network on which they rely. Despite its name, ISUP is used for both ISDN and non-ISDN calls. In the North American version of SS7, ISUP messages rely exclusively on MTP to transport messages between concerned nodes

## **Definitions**

**AIN**—Advanced Intelligent Network

**ANSI**—American National Standards Institute

**CAS**—Channel Associated Signaling

**CCS**—Common Channel Signaling

**CLASS**—Custom Local-Area Signaling Services

**DPC**—Destination Point Code is used to identify the message destination (this is key for the routing of the message on the SS7 network)

**ETSI**—European Telecommunications Standards Institute

**GT**—Global Title used as a directory number used as an alias for a physical network.

**GTT**—Global Title Translation is the conversion of the GT address into a physical address

**ISDN**—Integrated Services Digital Network

**ISDN-PRI**—Integrated Services Digital Network-Primary Rate Interface

**ISUP**—ISDN User Part

**ITU**—International Telecommunication Union

**ITU-T**—Telecommunication Standardization Sector

**Linkset**—Links between two SPs are logically grouped for administrative and load-sharing reasons. A logical group of links between two SP is called a linkset

**MFR2**—Multi-frequency R2

**MTP**—Message Transfer Part

**OPC**—Originating Point Code is used to identify which node originated the message

**PC**—Point Code

**PCS**—Personal Communications Services

**PSTN**—Public Switched Telephone Network

**RBS**—Robbed-bit-signaling refers to CAS signaling on a T1

**Linkset**—Links between two SPs are logically grouped for administrative and load-sharing reasons. A logical group of links between two SP is called a linkset.

**SCP**—Service Control Point

**SMS**—Short Message Service

**SP**—Signaling Point

**SS7**—Signaling System No. 7

**SSN**—Subsystem Number

**SSP**—Service Switching Point or Signal Switching Point

**STP**—Signal Transfer Point

**TCAP**—Transaction Capabilities Application Part

**T1-PRI**—T-carrier 1-Primary Rate Interface

**SCCP**—Signaling Connection Control Part