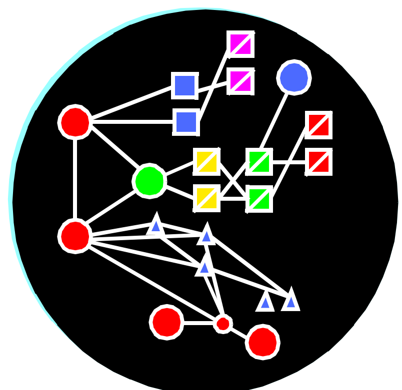
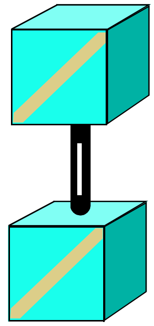
SS7 Tutorial



Network Architecture



SS7 Network Architecture

The Signalling Transfer Point (STP)

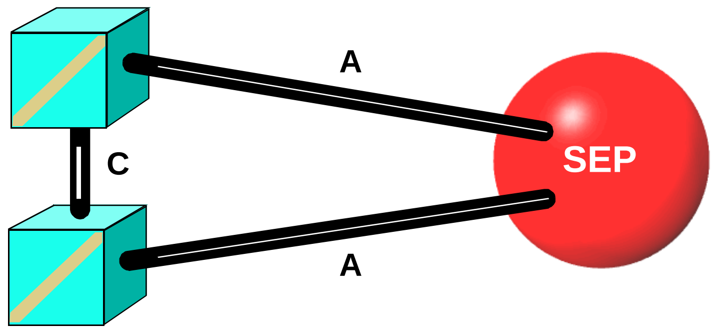
What would you say is the key element in the PSTN (**Public Switched Telephone Network**)? While there are a number of key elements, it really is the switching location that makes it a network. Switches are the "glue" that holds the PSTN together.

The SS7 is held together by a digital sister of the switch known as a Signalling Transfer Point (STP). The requirements of voice switching and digital transfer are different, but they resemble each other in some ways. The PSTN requires circuit connections of voice lines. The SS7 requires the use of continuously available transmission lines. The infrastructure of the network provides that capability in whatever "flavor" happens to be standard in the network. Thus the permanent connections called **links** may be individual channels in a T1 or E1 or any other transmission type that is readily available.

The job of the STP is to examine the destination of messages it receives, consult a routing table, and send the messages on their way using the links that are selected from the routing tables. The routing becomes necessary because, like the switch, the STP may have numerous links to end users of the network. And, like the switch, it may have links to other STPs to perform the routing to locations with no direct connections to the STP which performs the first routing.

Telecommunications reliability requires redundancy. For this reason STPs are always paired. Links connect the pair and allow messages to "cross over" from one to the other. Because of this, the links are referred to as **Cross Links**, or simply **C** links.

As you will see, link names are defined by what they connect and, sometimes, by the function they perform. They are named using the letters of the alphabet (A-F). Knowing the types of links that make up the linkset brings an immediate knowledge of the type of network nodes (without the specifics of the applications working there) that are linked.



SS7 Network Architecture

The Signalling End Point (SEP)

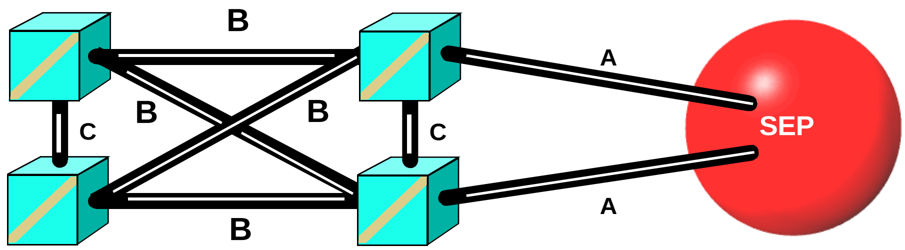
The SEP is an end point in the SS7 in the same way that a telephone is an end point in the PSTN. The telephone has an address that is in a form recognizable to the PSTN. That address is a telephone number which is addressable by the switch because phone numbers have been laid out geographically in the North American Numbering Plan (NANP).

End Points in the SS7 use an address known as a Signalling Point Code. Just as the NANP breaks phone numbers down into Area Code, Exchange Code and Line Number, the SS7 breaks Signalling Point Codes into Network, Cluster and Member portions.

Unlike the NANP, the SS7 addressing bears little relationship to geographical areas. Instead the numbering relates to the ways in which STPs are tied together and the way in which endpoints are connected to STPs. For SS7 the Network portion of the code literally refers to networks within the larger network.

The term used here to describe these working locations within the networks (SEPs) does nothing to illuminate what these locations do, nor it intended to do so. Here it is intended simply as an aid to describing SS7 architecture. In a later section we'll give other names to these locations as we begin to describe the applications they host.

The links shown in the drawing above connect an SEP to an STP, thereby providing network access for the SEP. Because of this, the links are referred to as **Access Links**, or simply **A** links. Typically, the choice of STP pairs for connection varies from SEP to SEP. It may be dictated by politico-economic considerations. For example, if the company planning an SEP also owns and operates its own STP, the choice is usually a foregone conclusion. Otherwise the choice may be geographic (choose the closest STP) or economic (choose the STP offering the lowest rates). In any case, the STP chosen for the first (and perhaps only) link connections is generally referred to as the “local” STP.



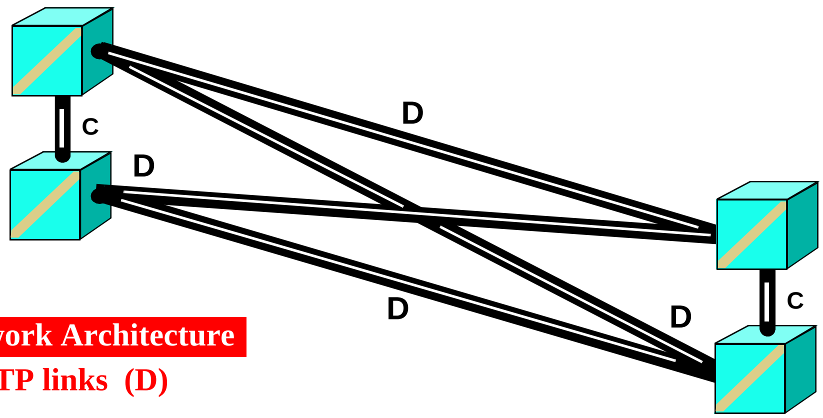
SS7 Network Architecture

STP to STP links (B & D)

An STP which has no links into the broader network can do no routing except for messages coming from and going to its own connected SEPs. The next step for an STP to broaden its routing horizons might well be to find another “local” STP pair serving its own SEPs. For the sake of real redundancy each of the STPs in the pair connects links to each of the STPs in the other pair. The result is a quad-linking arrangement which creates a “bridge” from one local network to another. Because of this, the links are referred to as **Bridge Links**, or simply **B** links.

In the PSTN there is a switch hierarchy. Some switches exist at the lowest end of the hierarchy, existing only to connect trunks to lines. At the next level, tandems appear for the purpose of connecting switches to switches. Then there are IXC (**I**ntere**X**change **Carrier** or long distance) switches, etc. The same may be said of the SS7 network. Local STP pairs connect SEPs to the network. But if the STP connects only to other local pairs, its routing capabilities are limited and the number of link connections required grows rapidly. Some locations need only to communicate with their own local network or with their local network and one other. In such cases the links already described may be adequate.

Their are other instances, however, in which the SEP needs to communicate with locations which are numerous and which exist far beyond the confines of a local network or two. To satisfy such needs an STP pair will sometimes connect to an STP pair at a different level of the hierarchy. This may be an STP whose main job is to route messages from one local network to another. To accomplish that connection a quad-linking arrangement is used that is identical to Bridge links. However, bear in mind that the link nomenclature tells us what is connected. When a drawing is made to show STP pairs at a different level of hierarchy, the convention calls for drawing the pairs at “higher” or “lower” positions on the pages. Then, when the links are drawn they don’t look like Bridge links because they have to be drawn diagonally.



SS7 Network Architecture

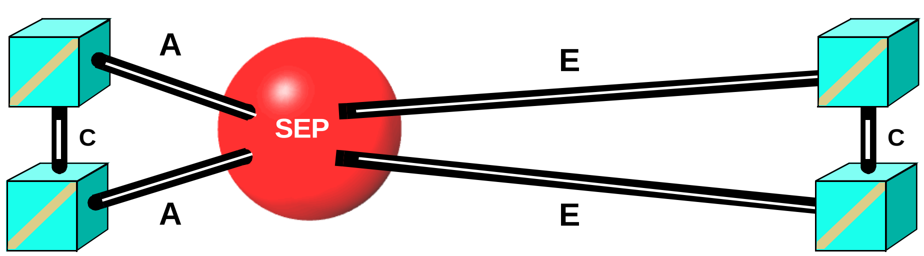
STP to STP links (D)

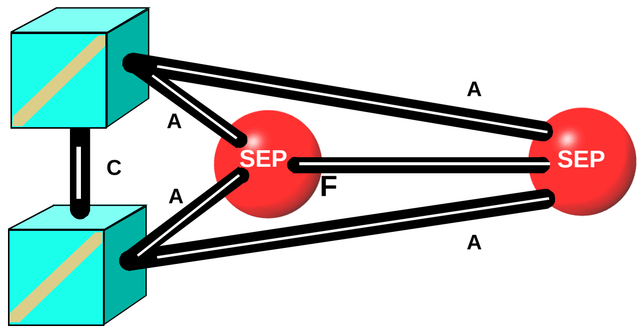
The resulting links are therefore called **Diagonal** or **D** links. In the drawing above the local STP pair is shown on the right at the “lower” level of the hierarchy. The **D** nomenclature makes it unnecessary to add that the STPs connected are not at the same level of hierarchy.

SEP to STP links (E)

We have already mentioned one type of SEP to STP linking arrangement, but there is another. From time to time an SEP would like to “hedge its bets” on network access. The SEP might have redundant sets of links to a redundant STP pair. But there’s always Murphy.

To increase the likelihood of remaining in service and to increase the flexibility of its own outbound routing, the SEP might choose a second STP pair to which it connects. In so doing, the SEP gains greater access into the network. But, as before, calling these links Access links doesn’t give us the whole picture. Since the A link connections were made to the local pair, these new connections will be made to a local pair which is not quite so “local”. That is, this new pair is further away, so to reach them we’ll have to extend our links. Of course such links also extend network access for the SEP. The resulting links are therefore called **Extended** or **E** links.





SS7 Network Architecture

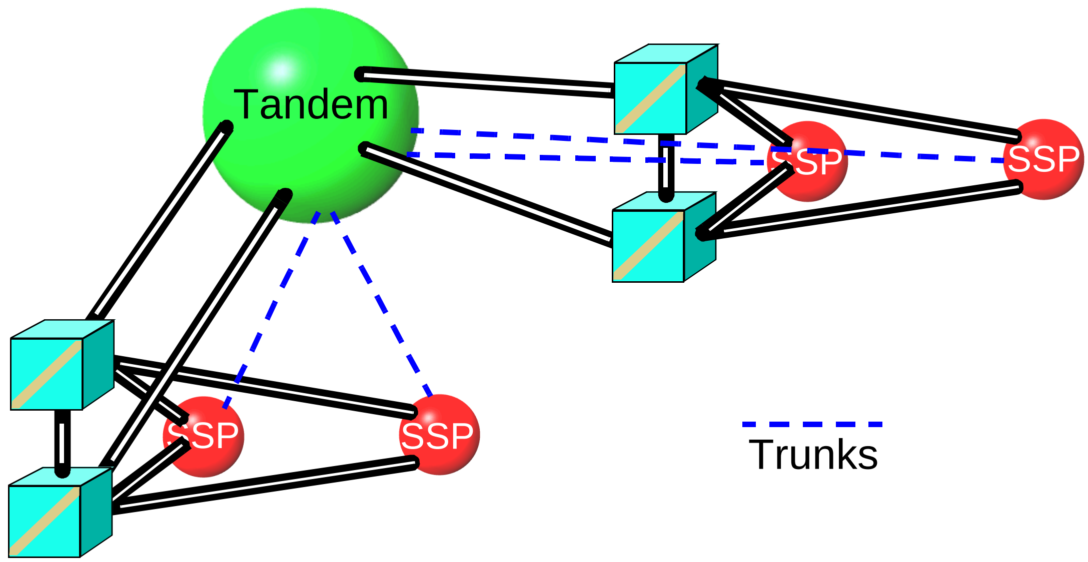
SEP to SEP links (F)

In many networks a node (SEP) exists solely for the purpose of providing data, special processing, data concentration, etc. to one or more other nodes in the network. When this is the case, the standards provide for link connections from network nodes to this node with which the connecting nodes are fully associated (owned by the same company, part of the same network, etc.).

The node being connected may or may not have its own access connections into the network. In the drawing above, both SEPs have Access connections (A links) into the network at large. Since this is the case, they could certainly communicate with each other using the routing services of the STP. However, they also have a direct link connection called **F** Links (for **F**ully Associated).

The messages being sent over the F links are obviously intended only for each of the two connected nodes. Since this is the case, while they must abide by the rules of the protocol in sending messages, they need not abide with the details of the data of the messages sent. That is, they can really send their own messages as long as both sides understand the format and intent of such messages.

Hopefully you now have an understanding of the **A**ccess, **B**ridge, **C**ross, **D**iagonal, **E**xtended, and **F**ully Associated link types and we can continue our examination of the network by looking at some of the applications we'll find at the nodes.



SS7 Network Architecture

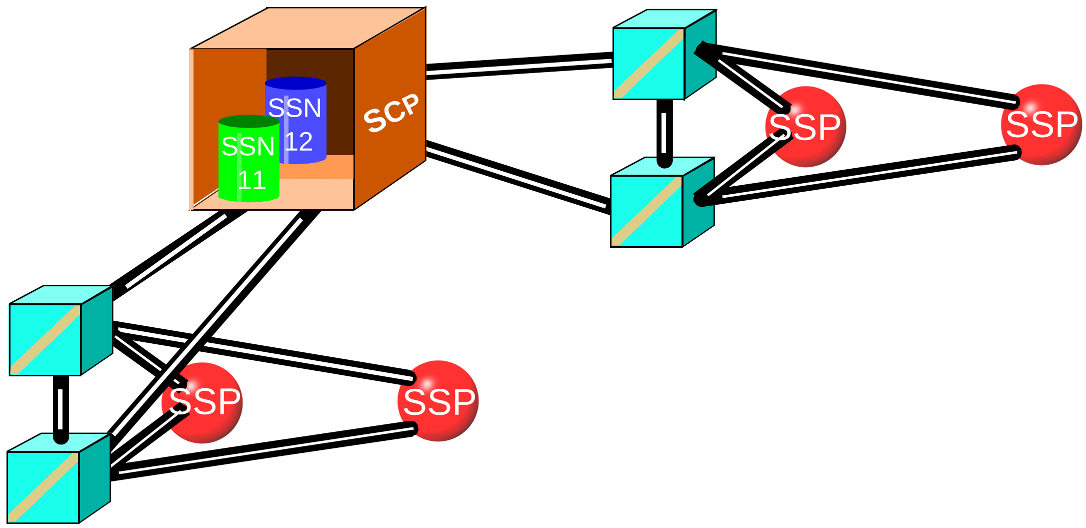
Network Nodes

In our discussions so far we have used the generic "SEP" to describe Signalling Points. With the architecture of the network in mind, it's time to take a look at some specific signalling point types. Since the SS7 Network developed originally with the idea of improving the efficiency of the PSTN (Public Switched Telephone Network), we'll start where the PSTN meets the SS7.

The SSP (Service Switching Point)

There are actually two types of Signalling nodes that are switch associated. The first type is called a **CCSSO** (Common Channel Signalling Switching Office). These are end or tandem offices which have the capability to use the SS7 in what is referred to as a trunk signalling mode for call set-up.

The second type (and the name you'll hear most often) is the Service Switching Point (**SSP**). Like the CCSSO this switch can handle call set-up. Unlike the CCSSO, the **SSP** also has the ability to stop call processing, make queries of even unknown databases, and perform actions appropriate to the response. The greatest difference between the two lies with the fact that the **SSP** is equipped with whatever software is required to handle numerous feature capabilities. In a way the **CCSSO** is a more limited version of the **SSP**.



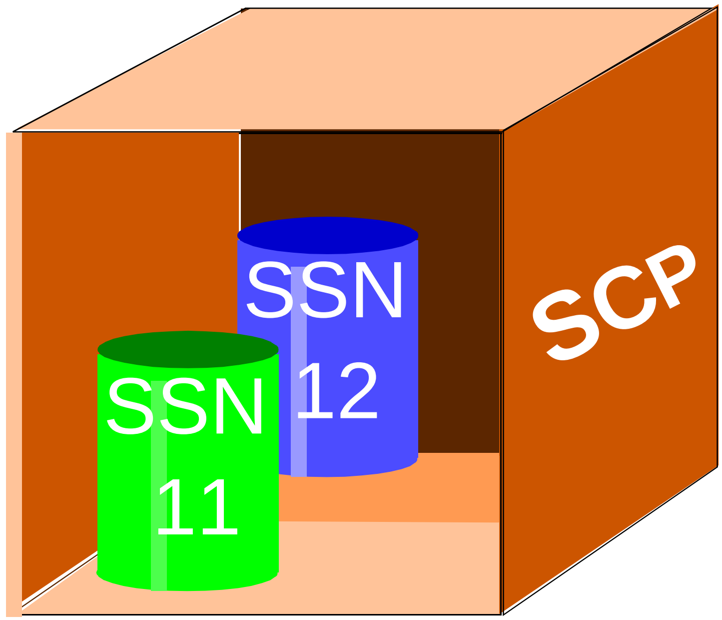
SS7 Network Architecture

Network Nodes

The SCP (Service Control Point)

When a number like 800 or 888 or 900 is dialed there is no way for the switch to determine how to route the call because such prefixes have no reference to the NANP (North American Numbering Plan). In fact, an 800 number dialed in New York may be connected to a number in Connecticut, while the same number dialed in California may result in a connection to Arizona. This is accomplished through the process of the switch sending the dialed number to a location where a database can be queried to provide a translation into a standard NANP number. When that translation is returned to the switch, the number can be connected exactly as it would have been if it had been dialed in the first place.

The database is located at an SS7 address (Signalling Point Code). A location which provides data from database or other digital services is called a Service Control Point. They come in a large number of flavors (such as Calling Card verification and tracking). Such locations free the switch from trying to maintain ever larger routing tables, and enable the use of a broad range of services which depend on translations or digital data services of a variety of types.

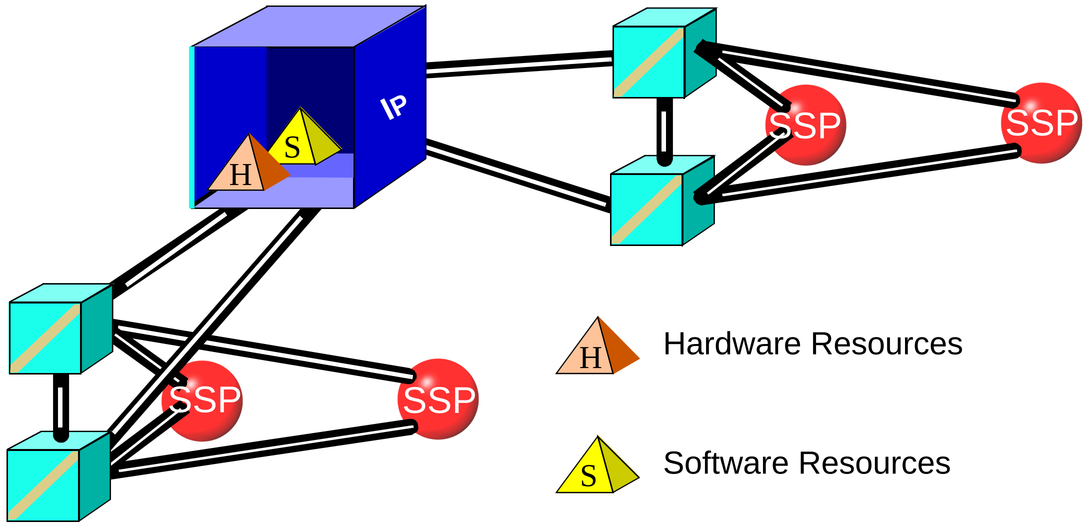


The SCP (Service Control Point)

The SCP provides the access required for digital services. Those digital services may reside in the same location as the SCP or the SCP may serve as a “front end” for services located elsewhere. In either case the SCP may control several different services.

As you have learned, nodes in the SS7 network are addressed by their **Signalling Point Code** (SPC). When locations like an SCP are addressed, Signalling Point Code is not enough. Another value must be used to identify the service application that is sought. For this purpose, the SS7 simply uses a value (represented in the message packet by a byte, and therefore, in the range of 0 to 255) which is called a **Sub-system Number** (SSN).

Subsystem numbers typically identify databases. However, they may also identify other services. For example, a switch may offer several features. Because several features are offered, simply sending the request to the SPC of the switch is not enough. A subsystem number will be used as well in order to specifically address the exact service that is required.



The IP (Intelligent Peripheral)

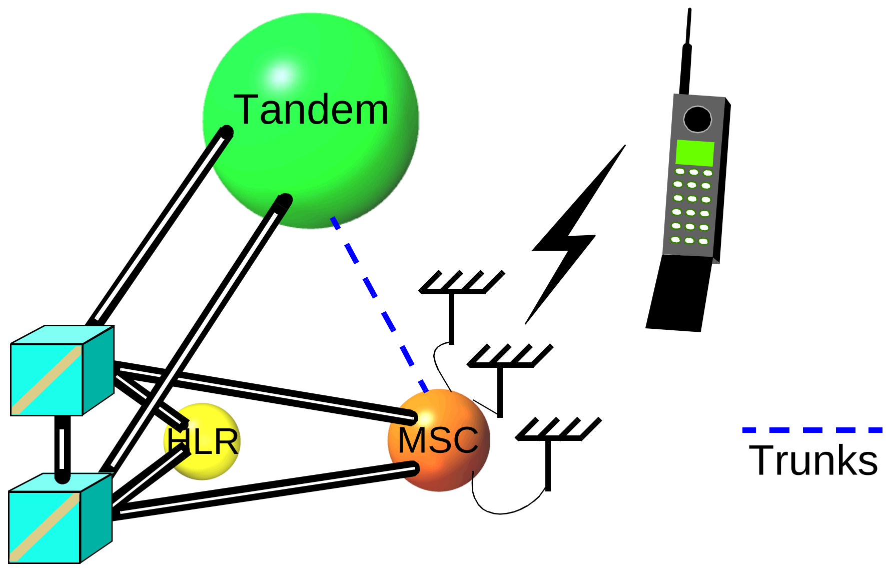
The same second level addressing capability allows the SCP to access and make available services located at other signalling points in the network. Sometimes this entails invoking features for which the switch is not equipped. At other times it entails utilizing an Intelligent Peripheral.

In general, the **Intelligent Peripheral** (IP) is home to a Process which can deal with the requests made of it through the SCP by providing the services of a variety of devices. If you are unfamiliar with the term “devices,” think of it simply as equipment.

In a fast changing Telecom world, many things become obsolescent very quickly. In recent times digital signalling has replaced a number of signalling techniques. Multifrequency signalling, for example is far less used today than formerly. Still, the new technologies require new equipment, and deploying new technologies can take time. That means that the switch may need to deal with both new and older technologies for some time to come. But no one wants to buy a new switch which is more costly simply because it contains the devices to handle old technologies. Likewise, when something new comes along that requires specialized equipment to implement, it becomes costly and time consuming to provide that new technology to every switch location.

One answer to both problems is to house both new and old technologies at a limited number of locations in the network and allow switches access to these technologies whenever they are required. Such a location is the Intelligent Peripheral. Also, new processes can be housed here that offer the types of new services which can only occur through programming.

We’ll mention one more node here. It is called the Services Node (SN). What is the difference between an IP and an SN? The answer is that, in some networks, there is no difference. However, it is generally agreed that what makes the node an SN is the programmable services it offers rather than the physical devices. Still, what one network calls an IP might be called a Services Node in another network.



The MSC (Mobile Switching Center)

Mobile Networks normally end up with numerous nodes in SS7 networks. The Mobile Switching Center communicates with and controls the radio transceivers which form the cells of a cellular network. Usually, once the transceiver has received and sent calls to the cell phone, the wireless part of a wireless network has done all it can do. The next step is for the MSC to make a circuit connection into the PSTN for an outgoing call or to accept a connection from the PSTN for an incoming call.

To provide the customer information required for other networks to validate a call, and to keep subscriber data necessary for the local network to provide numerous services, another node called the Home Location Register (**HLR**) is deployed. This node is essentially a database providing subscriber information.

Mobile networks employ other SS7 nodes as well. **Authentication Centers** (AUC) provide security processes to verify and validate cell phones seeking services. **Short Message Centers (**SMC) communicate with HLRs and MSCs to coordinate delivery of the text messages they store. All of these make use of the SS7 to send the messages they need to send to each other.

It is not the intention here to describe every node that can exist in SS7 networks. They generally fall into only a few categories.

1. Switches (**SSP**, **MSC**, etc.) which control voice circuits and need to send circuit related SS7 data to other switches.
2. Databases (**SCP**s, **HLR**s) which provide dialed digit translations, subscriber information, credit card and calling card validation, and any other required information not available at the switch.
3. Locations offering other resources such as special switch features, hardware technologies, etc.

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