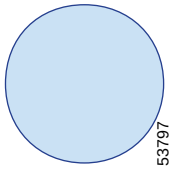
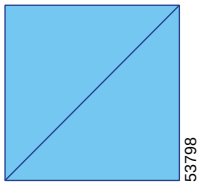
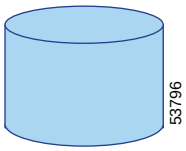
CHAPTER 2

SS7 Signaling Architecture

The SS7 signaling architecture consists of three essential components, interconnected via signaling links. Table 2-1 lists these components and their associated symbols.

Table 2-1 SS7 Network Signaling Components

Abbreviation	Name	Symbol
SSP	Signal Switching Point *- or -* Service Switching Point	
STP	Signal Transfer Point	
SCP	Signal Control Point *- or -* Service Control Point	

Signal Switching Point

SSPs are switches that have SS7 software and terminating signaling links. An SSP can be a combined voice/SS7 switch or an adjunct computer system (front end) connected to a voice (Class 5 or tandem) switch.

SSPs create packets (signal units) and send those messages to other SSPs, as well as queries to remote shared databases to find out how to route calls. They can originate, terminate, or switch calls.

SSPs communicate with the voice switch via the use of primitives and have the ability to send messages using ISUP (call setup and teardown) and TCAP (database lookup) protocols.

The SSP uses the calling party information (dialed digits) to determine how to route the call. It looks up the dialed digits in the SSP routing table to find the corresponding trunk circuit and terminating exchange. The SSP then sends an SS7 message out to the adjacent exchange requesting a circuit connection on the trunk which was specified in the routing table.

The adjacent exchange sends an acknowledgement back, giving permission to use that trunk. Using the calling party information contained in the setup info, the adjacent exchange determines how to connect to the final destination. This might require several trunks to be set up between several different exchanges.

SSP manages all of these connections until the destination is reached.

Signal Transfer Point

STPs are packet switches, and act like routers in the SS7 network. Messages are not usually originated by an STP. An STP can act like a firewall, screening messages with other networks.

STPs route SS7 messages (based on information contained in the message format) to outgoing signaling links over the SS7 network. They are the most versatile of all the SS7 entities, and are a major component in the network.

There are three levels of STPs. (See Figure 2-1.)

- National Signal Transfer Point
- International Signal Transfer Point
- Gateway Signal Transfer Point

National STP

A National STP exists within the national network (will vary with the country). It can transfer messages that use the same national standard of protocol.

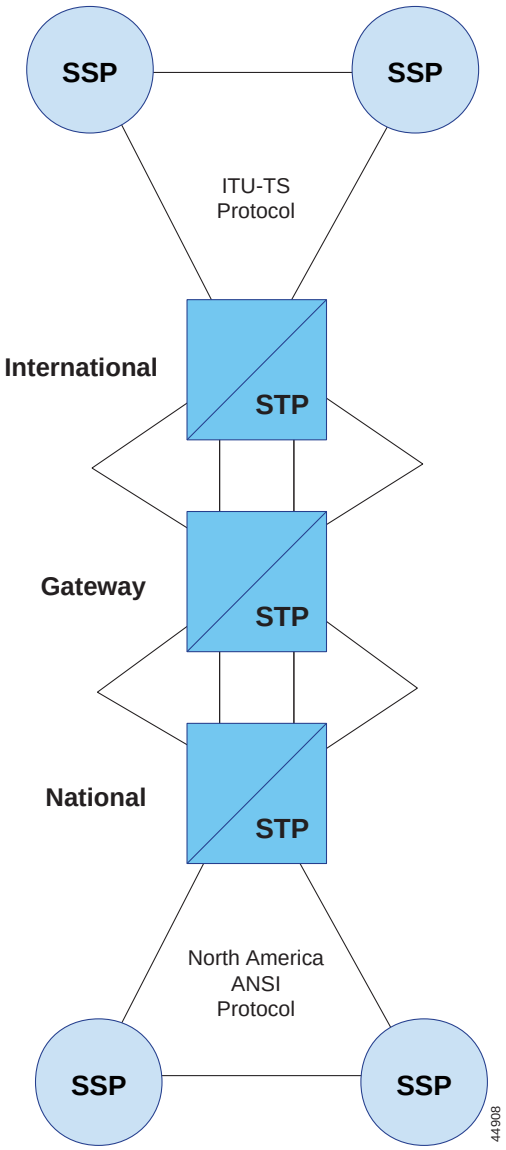
Messages can be passed to an International STP, but can not be converted by the National STP. Protocol converters often interconnect a National and an International STP by converting from ANSI to ITU-TS.

International STP

An International STP functions within an international network. It provides for SS7 interconnection of all countries, using the ITU-TS standard protocol.

All nodes connecting to an International STP must use the ITU-TS protocol standard.

Figure 2-1 STP Levels



Gateway STP

A Gateway STP converts signaling data from one protocol to another. Gateway STPs are often used as an access point to the international network. National protocols are converted to the ITU-TS protocol standard. Depending on its location, the Gateway STP must be able to use both the International and National protocol standards.

A Gateway STP also serves as an interface into another network's databases, such as from an interexchange carrier (IXC) to an end office. The Gateway STP can also be configured to screen for authorized users of the network.

Gateway STPs also provide measurements of traffic and usage via the following means:

- **Traffic**—Measures the peg counts of the type of messages entering or leaving the network.
- **Network events**—Track events such as link out-of-service or local processor outage, for maintenance purposes.
- **Usage**—Provides peg counts of the record number of messages by message type. Usage counts are sent to the Regional Accounting Office (RAO) for processing in Bell Networks. RAOs invoice customers such as IXCs and independent telcos, charging for access into the SS7 network, to help offset the cost of deploying the network.

Signal Control Point

An SCP is usually a computer used as a front end to a database system. It is an interface to telco databases, not usually to other, application-specific databases. (Refer to Table 2-2.)

Telco databases are usually linked to SCPs by X.25 links. The SCP can provide protocol conversion from X.25 to SS7, or can provide direct access to the database through the use of *primitives* which support access from one level of protocol to another.

Note Some new SCP applications are being implemented in STPs.

The address of an SCP is a *point code*, and the address of the database it interfaces with is a *subsystem number*. The database is an application entity which is accessed via the TCAP protocol.

Table 2-2 Telco Databases Accessible via SCP

Abbreviation	Name	Description
BSDB	Business Services Database	Allows companies to create and store proprietary databases, as well as create private networks.
CMSDB	Call Management Services Database	Provides information relating to call processing, network management (prevent congestion), call sampling (create reports for traffic studies), and the routing, billing and third-party billing for 800, 976 and 900 numbers.
HLR	Home Location Register	Used in cellular networks to store subscriber information.
LIDB	Line Information Database	Provides billing instructions.

Table 2-2 Telco Databases Accessible via SCP (continued)

Abbreviation	Name	Description
LNP	Local Number Portability	Allows people to change telco service providers but keep their same telephone number.
OSS	Operations Support Systems	Associated with remote maintenance centers for monitoring and managing SS7 and voice networks.
VLR	Visitor Location Register	Used when a cell phone is not recognized by the mobile switching center (MSC).

SS7 Links

An SS7 link is the physical transmission line (serial 56/64 Kbps or DS0 channel) that connects the individual nodes in an SS7 network.

SS7 networks are built to be highly reliable and redundant. Link diversity is built into the network design, providing multiple signaling paths, so that there is no single point of failure. This practice ensures that redundant links have the capacity to handle all rerouted network traffic.

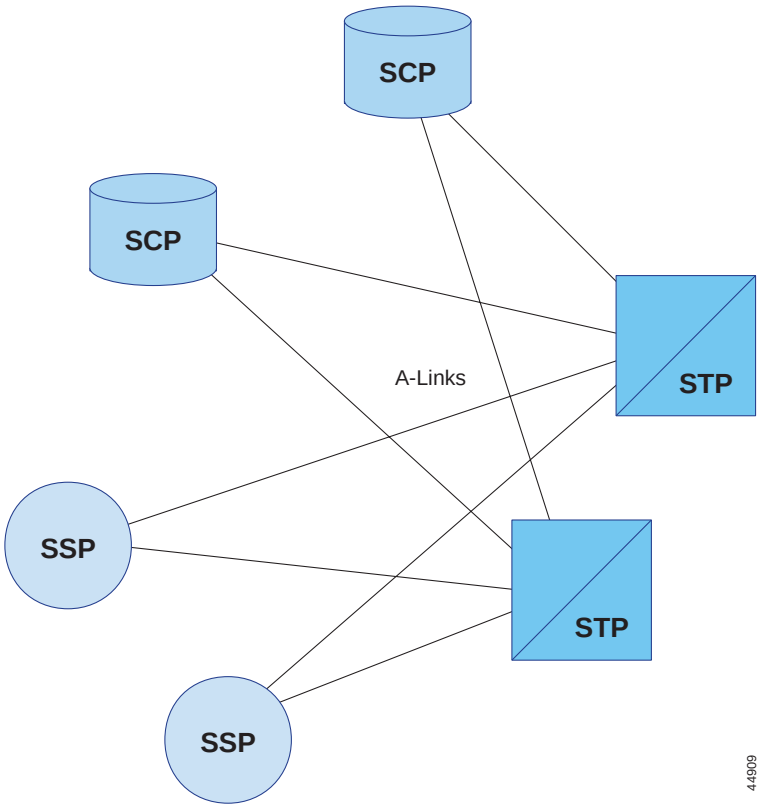
Link Types

A-Links

Access links (A-links) interconnect an STP and either an SSP or an SCP (signaling end points). Their sole purpose is to deliver signaling to and from signaling end points. End points always have at least two A-links (also called signaling beginning points).

Any signaling that an SSP or SCP needs to send to any other node in the SS7 network is sent on one of its A-links to its “home” STP, which processes and routes the message along its way. Messages addressed to an SSP or SCP are routed to its “home” STP, which forwards them to the addressed node over its A-links. (See Figure 2-2.)

Figure 2-2 A-Links

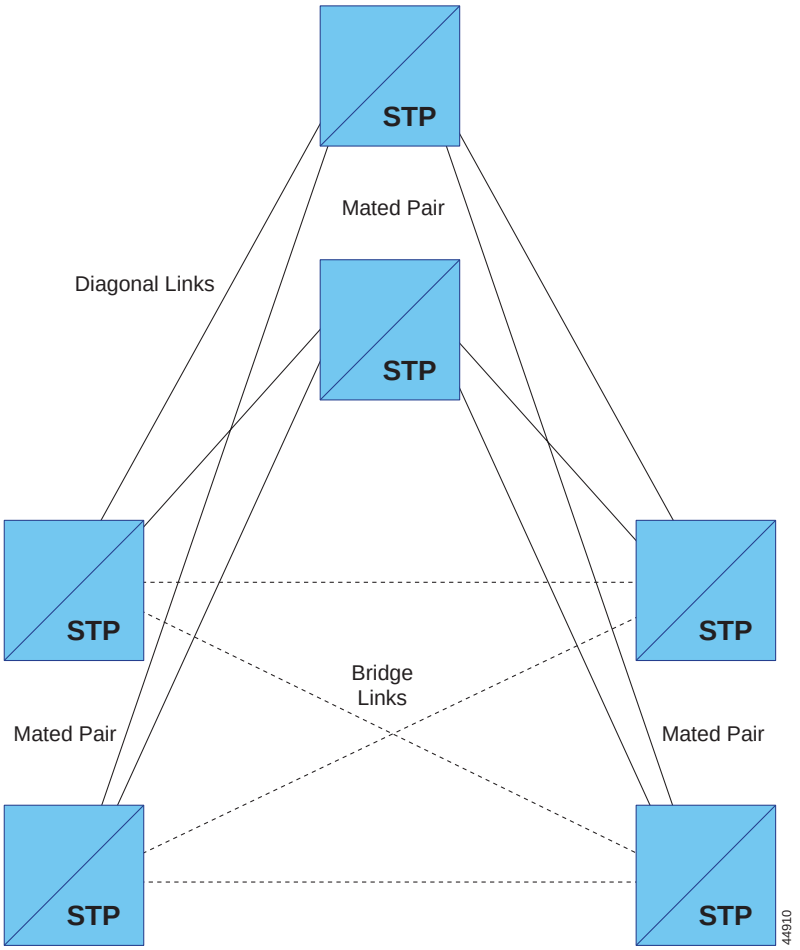


B- and D-Links

Bridge links (B-links) are the quad of links interconnecting peer pairs of STPs. Diagonal links (D-links) are the quad of links interconnecting mated pairs of STPs at different hierarchical levels. (See Figure 2-3.)

Since the SS7 network has no clear hierarchy, these links are referred to as B-links, D-links, or B/D-links.

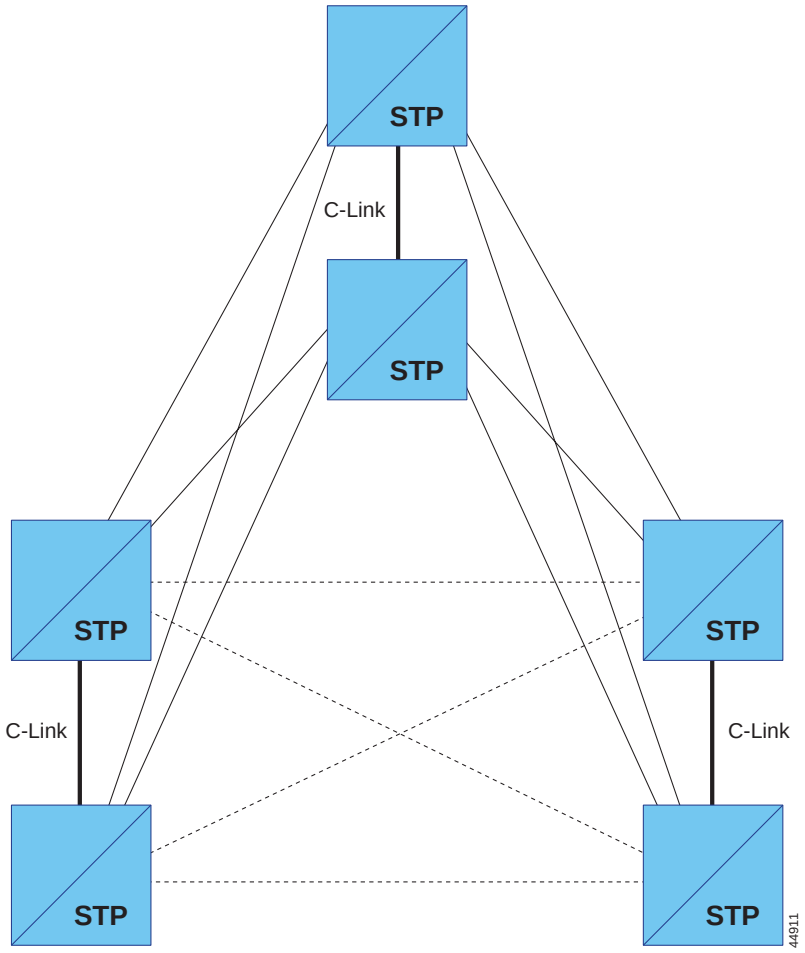
Figure 2-3 B/D-Links



C-Links

Cross links (C-links) interconnect mated STPs and are used to enhance the reliability of the signaling network not regularly used by SS7 traffic. (See Figure 2-4.) They are used only when there has been a link failure which causes an STP to have no other route.

Figure 2-4 C-Links



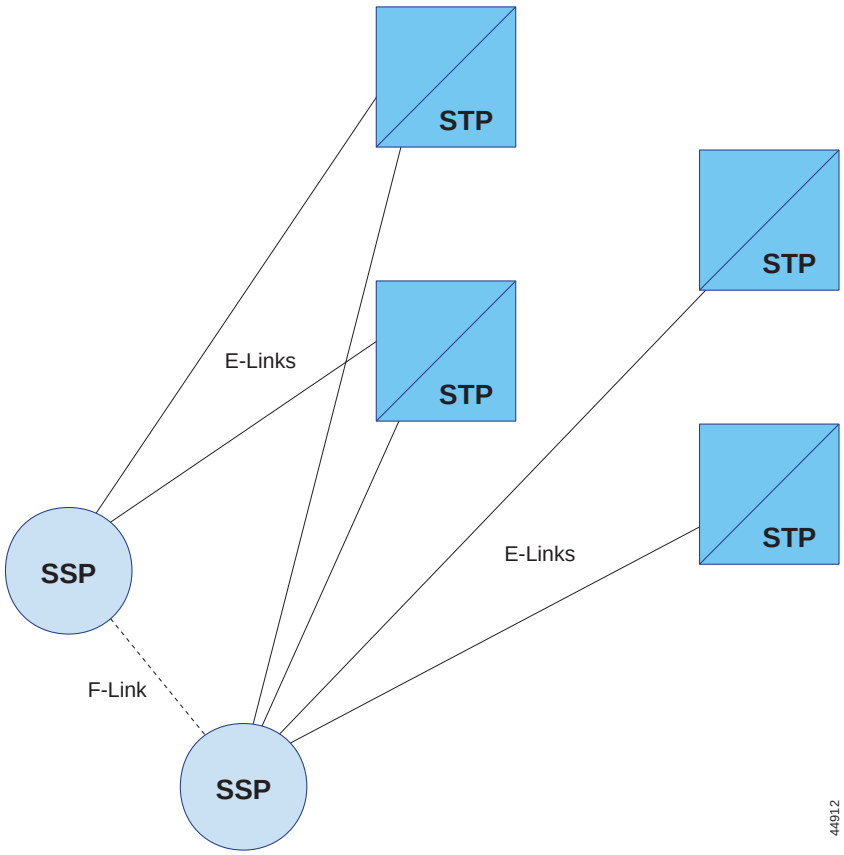
E- and F-Links

Extended links (E-links) connect an SSP to an alternate STP to provide backup connectivity to the network if the SSP's "home" STP cannot be reached on its A-link.

Note E-links are not usually provisioned, unless cost/reliability trade-offs justify the expense.

Fully associated links (F-links) directly connect two signaling end points (SSPs and/or SCPs). They are not usually used in networks with STPs because they allow associated signaling only, thus bypassing the security features provided with an STP. (See Figure 2-5.)

Figure 2-5 E- and F-Links

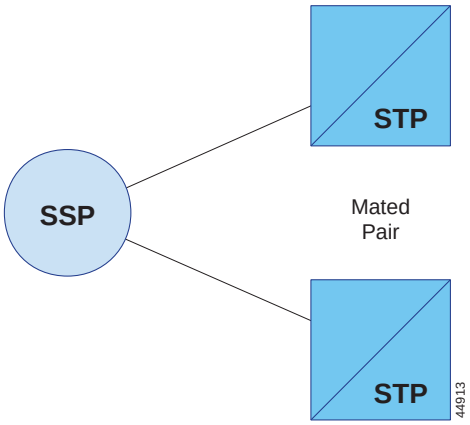


Linksets

Links are put into groups called linksets. Up to 16 links can be assigned to one linkset. All links in a linkset must have the same adjacent node. (See Figure 2-6.)

Switches will alternate traffic across all links in a linkset to ensure equal usage of all facilities in the network.

Figure 2-6 Linksets



Linkset Characteristics

If possible, links should be terrestrial. Satellite links can be used but are not preferred because of the inherent delay.

Alternate linksets are set up to provide backup paths when congestion occurs in the network. When a link fails, all other links within the linkset must take over. (See Figure 2-7.)

Note A maximum of 10 minutes downtime per year is allowed for any one linkset, to protect network integrity.

If an SS7 entity such as an STP fails, its mate assumes the full traffic load. For this reason, SS7 entities are designed to send less than 40 percent of the traffic on any given link. If an entity fails at 40-percent capacity, there is still enough room on its mate for it to carry the entire traffic load of the mated pair.

Physical Link Interfaces

The signaling link interface type will depend on the type of equipment used with the links. The V.35 interface is used to connect from the data service unit (DSU) to the signaling point. V.35 can also be used from a digital system cross-connect frame (DSX).

Note V.35 needs a clock source. Data links are 56 or 64 Kbps.

The most commonly used interface is a DS0A, one 56/64 Kbps channel of a DS1. A channel service unit (CSU) or DSU terminates the DS1 and separates DS0s from the T1 or E1 span circuit.

Routes

The signal point must define linksets and routes in SS7 messaging. The following entities are used in SS7 messaging:

- **Route**—A collection of linksets to reach a particular destination. A linkset can belong to more than one route.
- **Routeset**—A collection of routes that are assigned to destinations and also provide alternate routes.
- **Destination**—An address entered into the routing table of a remote signaling point. A destination need not be adjacent to the signaling point, but must be a point code that can be reached by the signaling point.

Point Codes

In SS7, addresses are assigned using a three-level hierarchy.

- **Member**—A signaling point within a cluster.
- **Cluster**—A collection of signaling points (members).
- **Network**—Each cluster is defined as being part of a network.

Any node in the SS7 network can be addressed by the three-level number defined by its network, cluster, and member numbers. Each of these numbers is an 8-bit number assigned a value from 0 to 255. This three-level address is called the *point code* of the signaling point.

Network Numbers

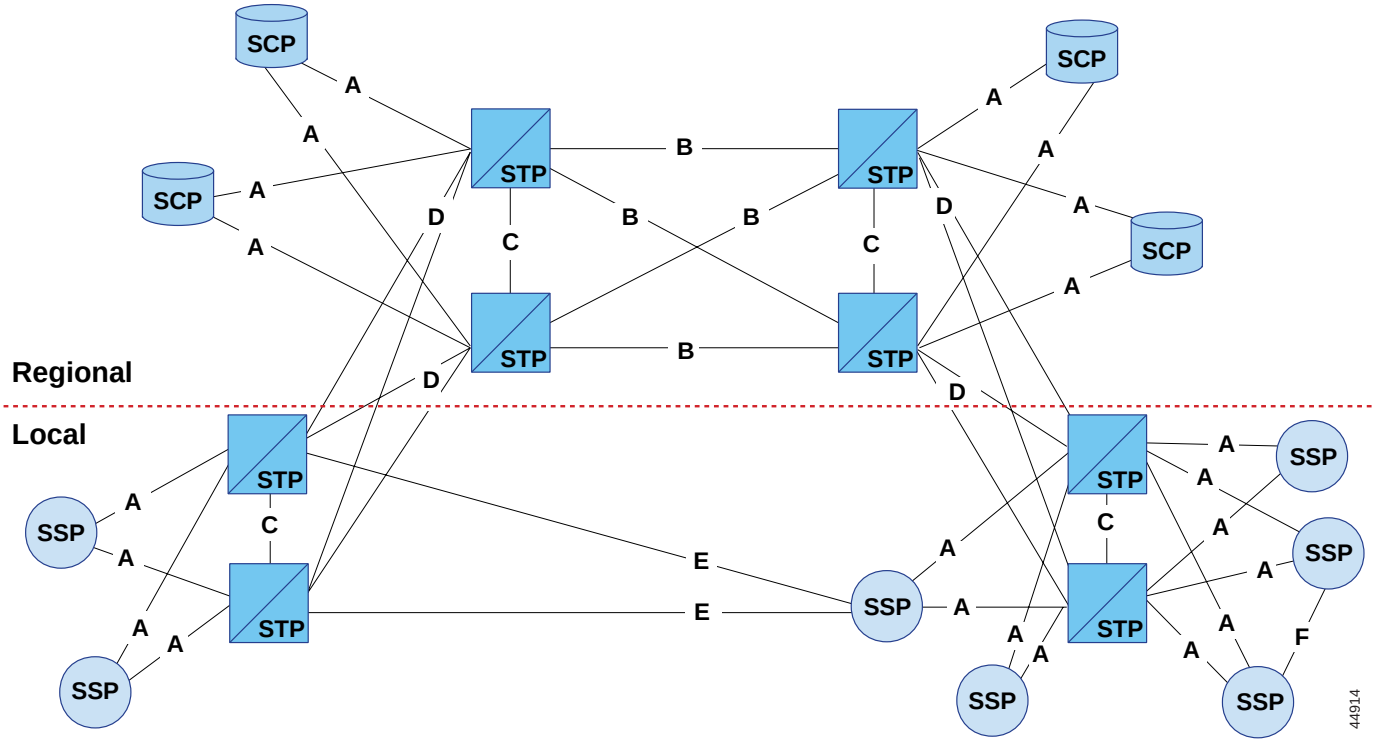
Network numbers are assigned on a nationwide basis. In North America, RBOCs, IXCs and telcos already have network numbers assigned to them.

Network numbers are relatively scarce. Companies are expected to meet size requirements in order to be assigned a network number.

Note Network number 0 is not available and 255 is reserved.

Smaller networks can be assigned one or more clusters within network numbers 1, 2, 3 and 4. The smallest networks are assigned point codes within network number 5. The cluster to which they are assigned determines the state or province they are in.

Figure 2-7 SS7 Network



Review: Signaling Architecture

1. Name the three essential SS7 components.
2. Which SS7 component functions like an SS7 network router?
3. Which SS7 component originates, terminates and switches calls?
4. Identify the three levels of STPs.
5. What interconnects a national and international STP?
6. Which protocol does an interjectional STP use?
7. Which SS7 component provides traffic measurements?
8. Which SS7 components provides interfaces to telco databases?
9. Name three types of telco databases in the SS7 network.
10. Which two databases are used in cellular networks?
11. What is meant by link diversity?
12. What does an A-link interconnect.
13. What are B- and D-links used for?
14. Are C-links used all of the time?
15. Define linkset.
16. Name two types of link interfaces. Which is the most common?
17. What is a route?
18. Define the three components of a point code.