The University of Sydney

AUSTRALIA

School of Electrical and Information Engineering

Advanced Communication Networks

Chapter 7

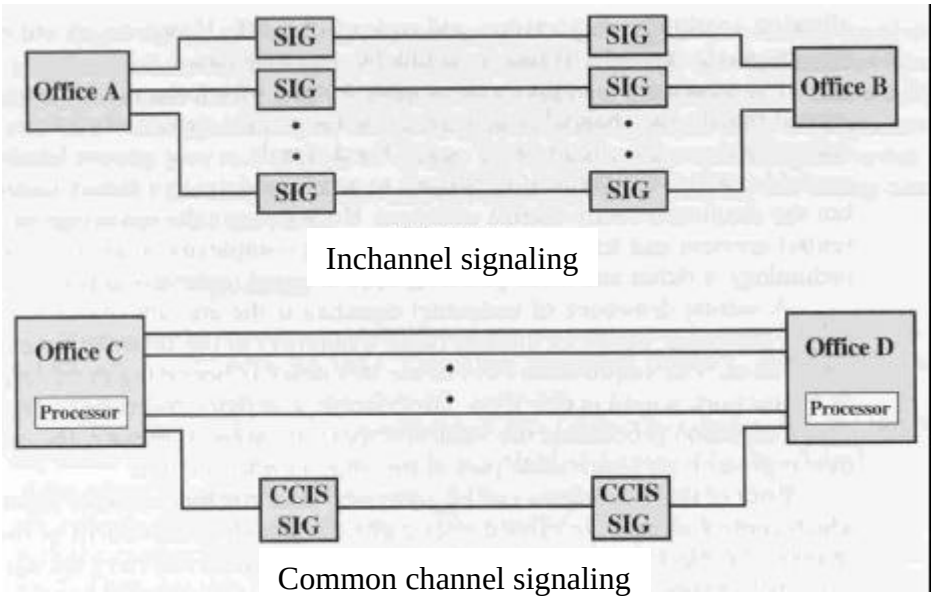
Common Channel Signaling System Number 7 (SS7)

Based on chapter 11 of Stallings ISDN-4e book

Abbas Jamalipour

7.1 Introduction

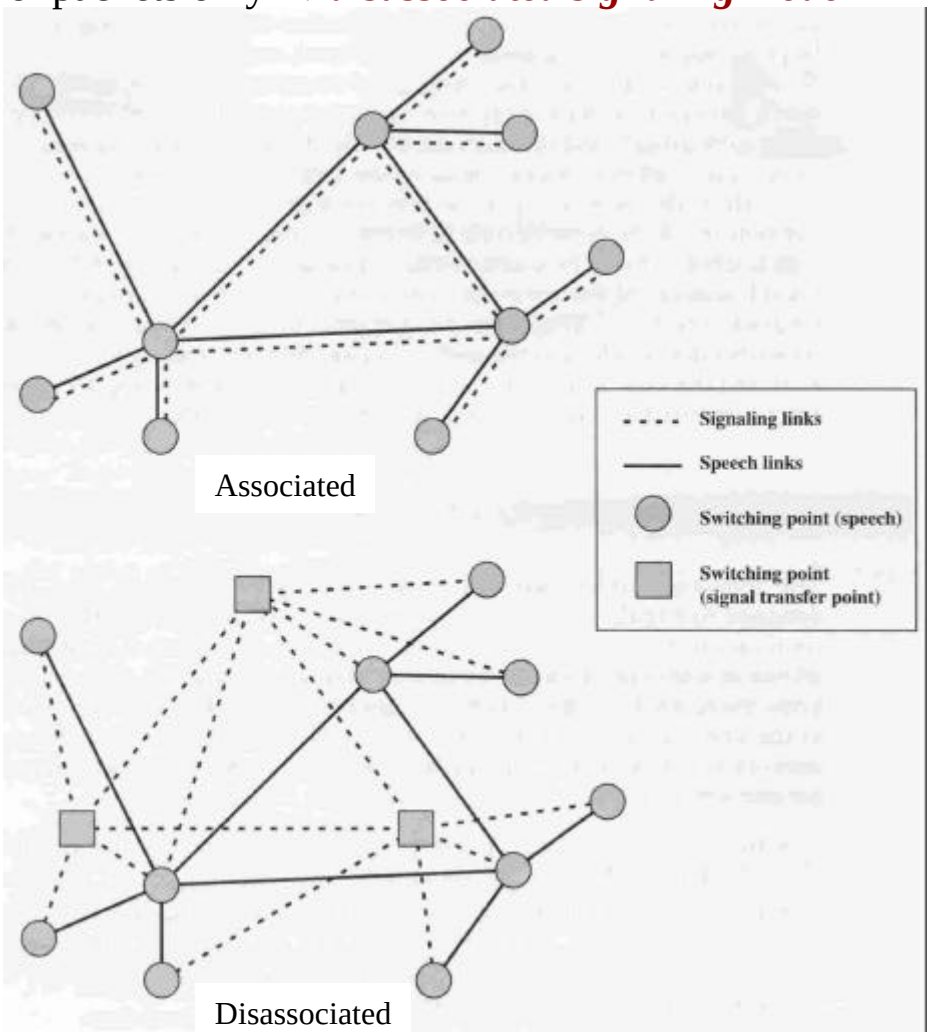
- Network control signaling
  - transition from inchannel to a common channel approach
- Signaling System Number 7 (SS7) was first issued by CCITT in 1980 and revised in 1984, 1988, and 1992.
- Designed to be an open-ended common-channel signaling standard for a variety of digital circuit-switched networks.
- Specifically designed to be used in ISDN: provides internal control and network intelligence essential to an ISDN.
- Primary characteristics of SS7
  - optimized for use in digital telecommunication networks in conjunction with digital stored program-control exchanges, utilizing 64-kbps digital channels
  - designed to meet present and future information transfer requirements for call control, remote control, management, and maintenance
  - designed to be a reliable means for the transfer of information in the correct sequence without loss or duplication
  - suitable for operation over analog channels and at speeds below 64 kbps
  - suitable for use on point-to-point terrestrial and satellite links
- The scope of SS7 is immense, because it must cover all aspects of control signaling for complex digital networks, including the reliable routing and delivery of control messages and application-oriented content of those messages.



7.2 SS7 Architecture

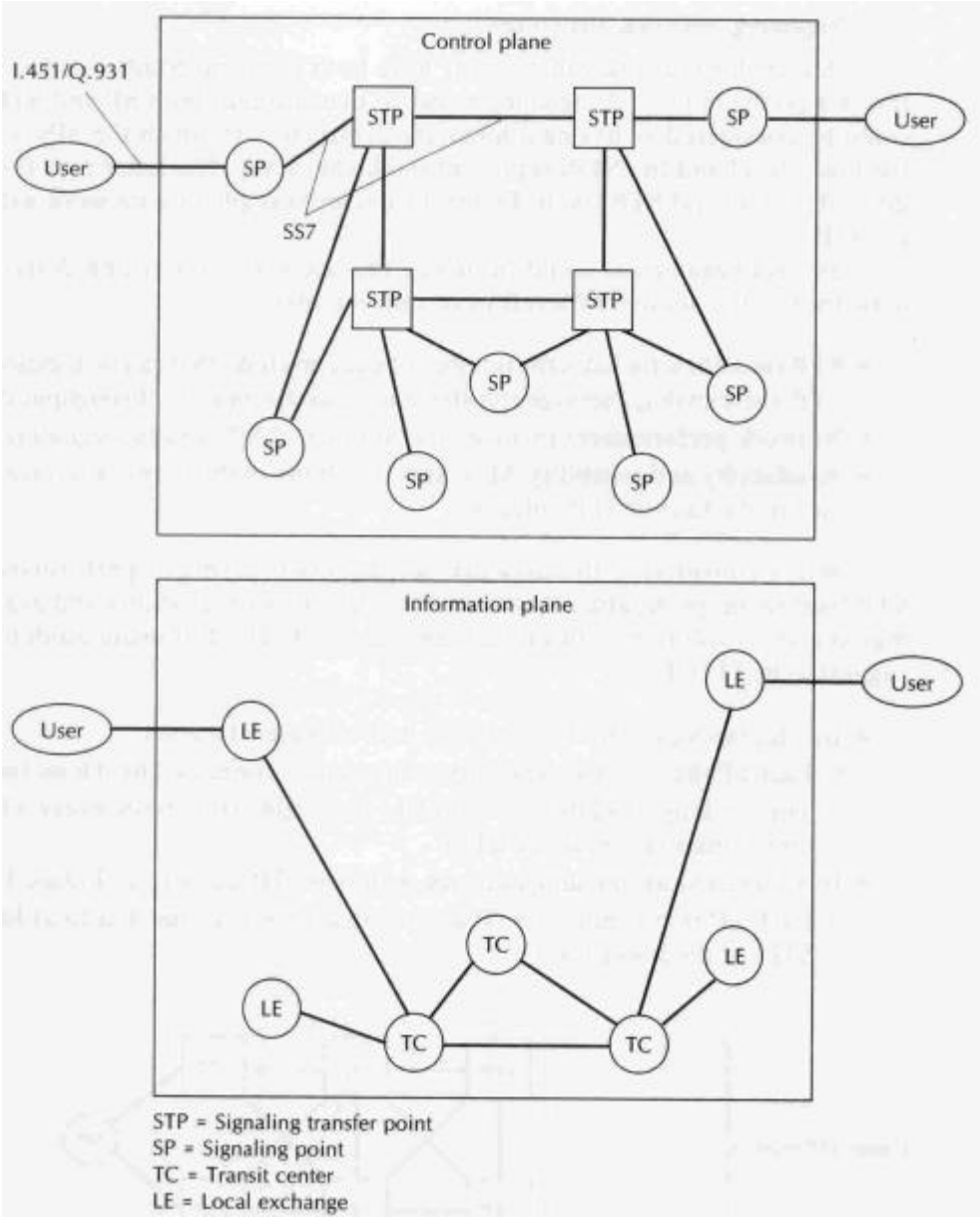
Functional Architecture

- Control messages in a common channel signaling system are short packets routed through the network.
- Although the network is a circuit-switched network, the control signaling is implemented using packet switching technology.
- SS7 functions could be implemented as additional functions in circuit-switching nodes → ***associated signaling mode***
- Or, the network can have separate switching points for carrying control packets only → ***disassociated signaling mode***



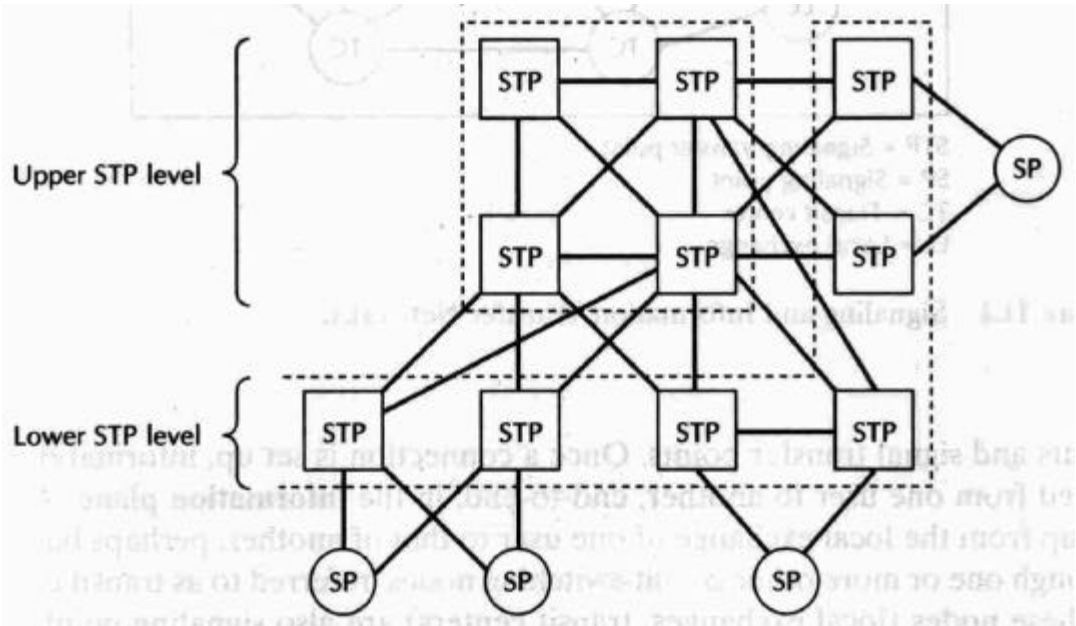
Signaling Network Elements

- Three functional entities in SS7
  - **signaling points (SP)**: any point in signaling network capable of handling SS7 control messages, e.g. an endpoint (such as a circuit switching node)
  - **signal transfer points (STP)**: a signaling point capable of routing control messages, e.g. a pure routing node
  - **signaling links**: a data link that connects signaling points
- Two planes of operation: **control plane** and **information plane**

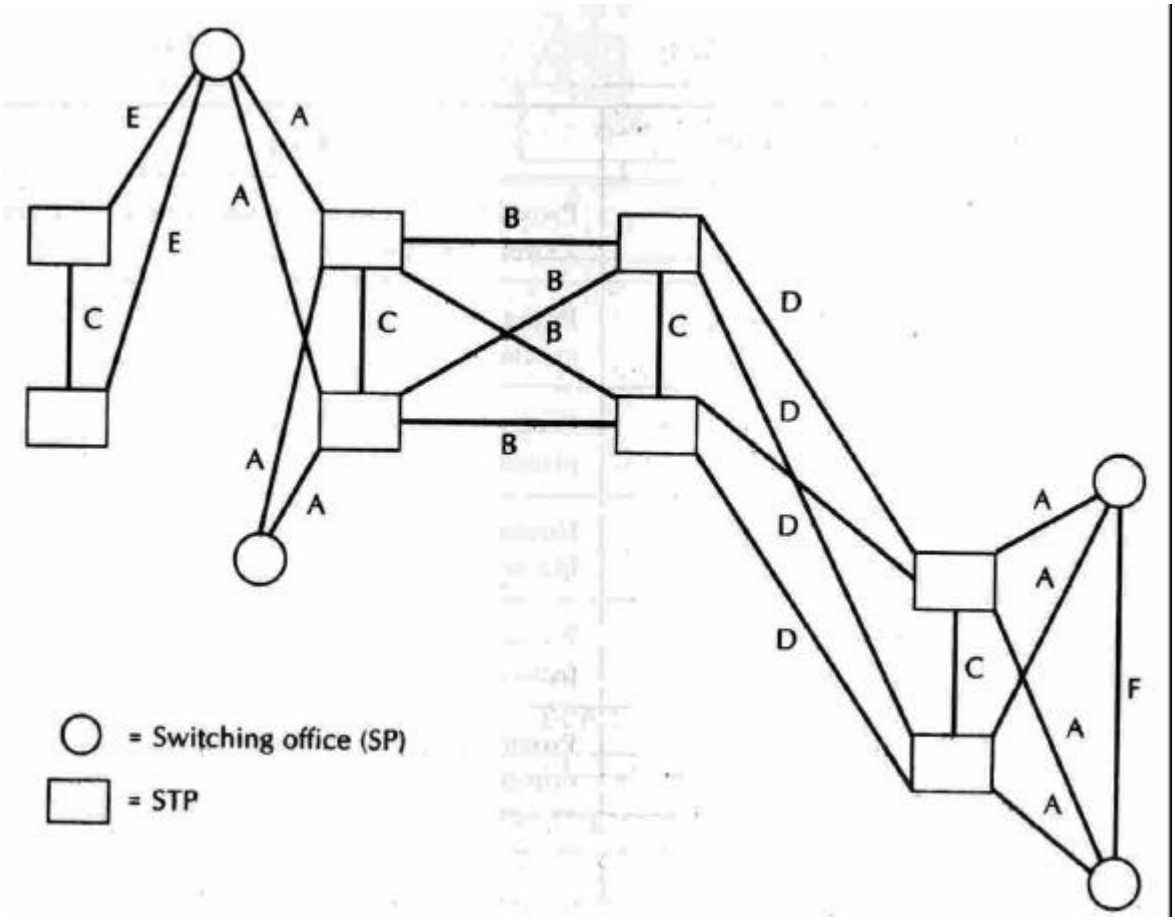


Signaling Network Structures

- A complex network may have both SPs and STPs in a hierarchical structure, SPs at lower level and STPs at one or more higher levels.
- Parameters related to network design and number of levels
  - **STP capacities**
    - number of signaling links that can be handled, signaling message transfer time, and the message throughput capacity
  - **Network performance**
    - number of SPs and the signaling delays
  - **Availability and reliability**
    - ability of the network to provide service when STP failures
- ITU-T suggestions for better reliability
  - In a signaling network with a single STP level
    - each SP that is not an STP at the same time connected to at least 2 STPs
    - the meshing of STPs is as complete as possible (full mesh)
  - In a signaling network with two STP levels
    - each SP that is not an STP at the same time is connected to at least two STPs of the lower level
    - each STP in the lower level is connected to at least two STPs of the upper level
    - the STPs in the upper level are fully meshed



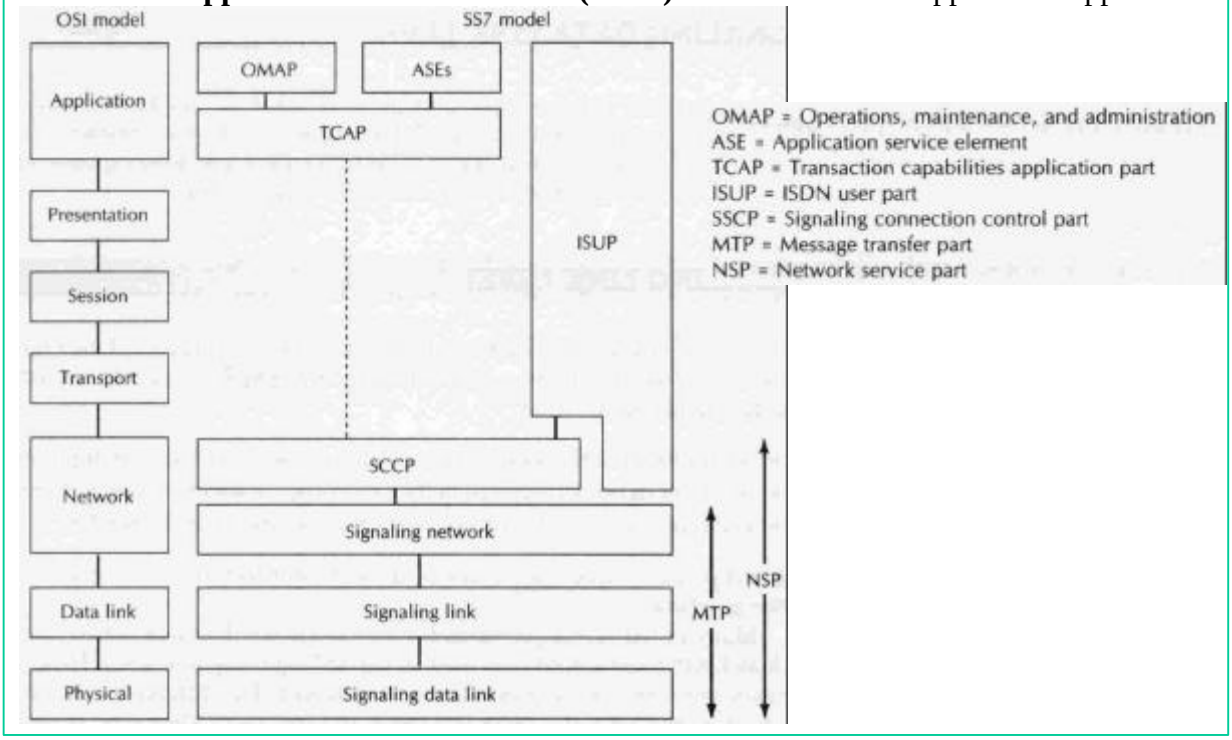
Example of Links Used in an SS7 Network



Designation	Connection	Use
A	SP TO STP	Provides access to the signaling network from a switching office.
B	STP to STP at same level of a hierarchy	Primary routing of messages from one SP to another via multiple STPs.
C	STP to mated STP	Communication between paired STPs; also provides alternate route around failed B links.
D	STP to STP at different levels of a hierarchy	Routing of messages up or down in a hierarchy.
E	SP to STP	Provides direct connection to nonhome STP from a switching office.
F	SP to SP	Provides direct access between switching offices with a high community of interest.

Protocol Architecture

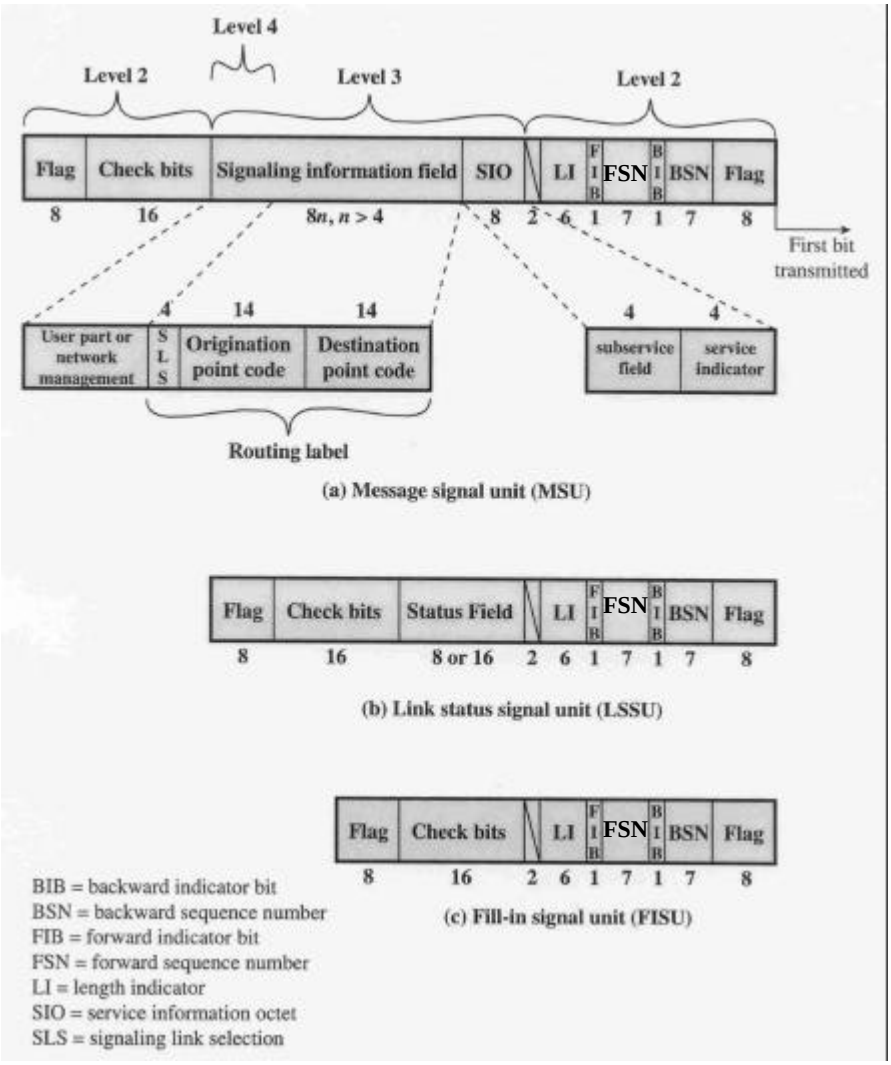
- SS7 has a layered protocol architecture similar to that of OSI model.
  - **Message transfer part (MTP):** the lowest three levels providing a reliable but connectionless (a datagram style) service for routing messages
    - signaling data link: a full-duplex physical link dedicated to SS7 (OSI L1)
      - includes control links between STPs, between an STP and an SP, between SPs
    - signaling link: a data link control protocol, corresponds to OSI layer 2
      - provides reliable sequenced delivery of data across signaling data link
    - signaling network: provides routing data across multiple STPs from control source to control destination
  - **Signaling connection control part (SCCP):** added in 1984 version of SS7
    - SCCP + MTP = NSP (Network Service Part)
    - contains different network-layer services to meet needs of NSP users
    - NSP is a message delivery system
  - **ISDN user part (ISUP):** controls signaling needed in an ISDN to deal with ISDN subscriber calls and related functions
  - **Transaction capabilities application part (TCAP):** provides the mechanisms for transaction-oriented (not connection-oriented) applications and functions
  - **Operation, maintenance, and administration part (O&MAP):** specifies network management functions and message related to operation&maintenace
  - **Application service elements (ASEs):** add. modules to support new applicat's



7.3 Signaling Link Level

- corresponds to the data link control layer of OSI model
- to turn an unreliable physical link into a reliable data link
- reliability implies that
  - transmitted blocks of data are delivered with no loss or duplication
  - same order delivery of data blocks as they were transmitted
  - receiver is capable of exercising flow control over the sender
- use of well-known data link control protocol (LAPD and LAPB)

Signal Unit Formats **1. MSU 2. LSSU 3. FISU**



- **Message signal unit (MSU)**
  - carries user data from level 4
- **Level status signal unit (LSSU)**
  - carries control information needed at the signaling link level
- **Fill-in signal unit (FISU)**
  - transmitted when no other signal units are available

Definition of different fields in signal units

- **flag:** delimits the signal unit at both ends (01111111)
  - bit stuffing may be used as with LAPB and LAPD

Four fields for flow- (sliding-window) and error-control (go-back-N ARQ)

- **backward sequence number (BSN)**
  - contains the number of last MSU successfully received at the other side; for piggyback acknowledgement
- **backward indicator bit (BIB)**
  - negative ack of BSN is indicated by inverting this bit
- **forward sequence number (FSN)**
  - for numbering MSUs uniquely in modulo 128
- **forward indicator bit (FIB)**
  - indications of MSU is new or retransmitted (e.g. after negative ack)

- **length indicator (LI)**
  - specifies the length in octets of the following upper-level fields
  - cross-check on closing flag, also a signal unit type indicator
    - FISU has no user data field → *LI = 0*
    - LSSU has a single user data field of one octet → *LI = 1 or 2*
    - MSU has a data portion that is longer than two octets → LI = *3 to 63*
- **service information octet (SIO)**
  - indicates the nature of the MSU, consists of two subfields:
    - service indicator: specifies the type of message being carried
    - subservice field: indicates whether the message is national or internation.

- **Signaling information field (SIF)**
  - contains information for signaling network level and SS7 level 4
  - consists of two subfields:
    - routing label: a 32-bit (14 bits source and destination address each + 4 bits signaling link selection filed, used in traffic distribution)
    - data: user data from some SS7 application or network management data
- **check bits (CK)**
  - contains an error-detecting code (CRC-16 from all except flags)
- **status field (SF)** (only in LSSU)
  - used to indicate the sender's view of the actual status of the link

(a) Service Information Octet

Service Indicator	
Code	**Indication**
0000	Signaling network management messages
0001	Signaling network testing and maintenance messages
0010	Spare
0011	Signaling connection control part (SCCP)
0100	Telephone user part
0101	ISDN user part
0110	Data user part (call- and circuit-related messages)
0111	Data user part (facility registration and cancellation)
1000	MTP testing user part
1001	Broadband ISDN user part
1010	Satellite ISDN user part
1011 to 1111	Spare

Subservice Field	
Code	**Meaning**
00XX	International network
01XX	Spare
10XX	National network
11XX	Reserved for national use

(b) Status Field

Code	Indication
000	Out of alignment
001	Normal alignment
010	Emergency alignment
011	Out of service
100	Processor outage
101	Busy

Operation

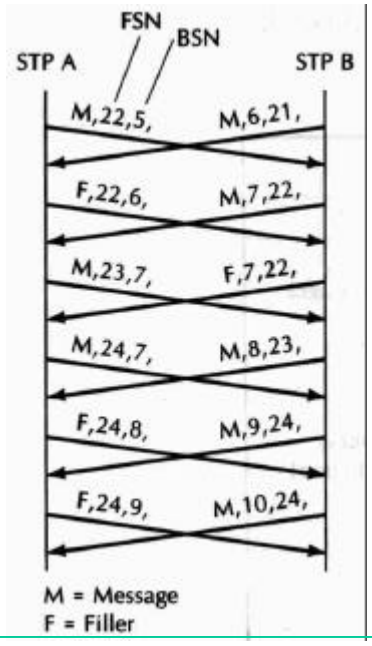
- Basic functions of the signaling link protocol

1. flow control ***2. error control*** ***3. error monitoring***

flow control

- Employs a sliding-window technique
- Each MSU is given a new FSN, in modulo 128
- LSSUs and FISUs not numbered, but carry the last MSU's FSN
- All three types of signal unit can have negative acknowledgements and piggybacked acknowledgements.
- In the case of LSSU flow control, if one side is unable to keep up with the flow of data from the other side, busy indication is performed by the status field.
- For long congestion, timer control is used. Rules are:
  - If a receiver becomes overloaded, it must send a busy signal to stop transmission from the other side. The receiver withholds ack of the MSUs. If the overload condition persists, the node must repeatedly send a busy indication at intervals of T5 time units (80-120 ms). Other side suspends tx of MSUs.
  - When congestion abates at the receiver, the receiver signals the end of busy condition by resuming positive ack of incoming MSUs.
  - Even if repeated busy indications are received every T5 time units, a node will report the network level that the link is out of service every T6 (3-6 sec).

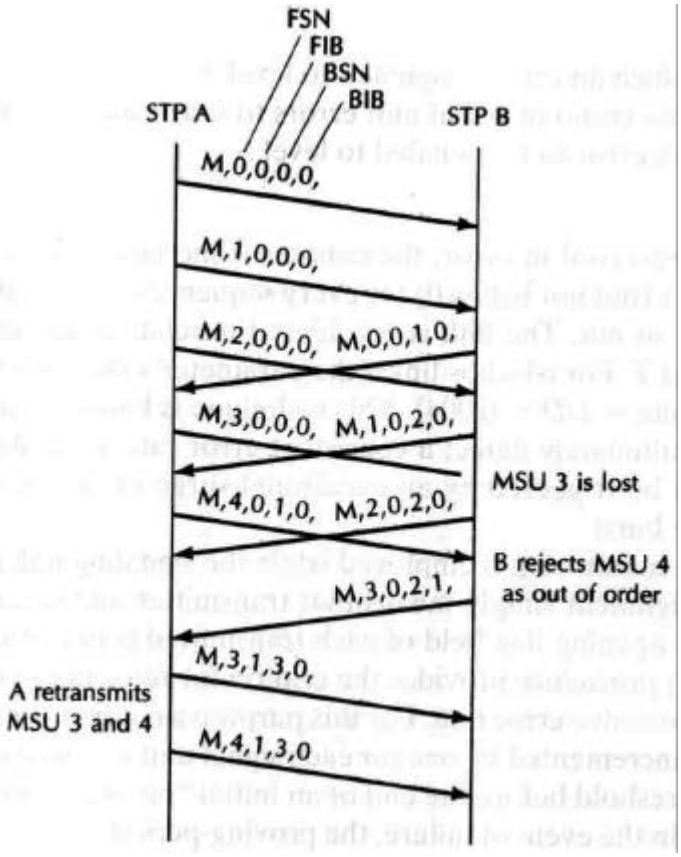
Error-free signal unit exchange



error control

- two forms of error control:
  - **Basic method:** applies for signaling links where one-way PD is < 15 ms.
  - **Preventive cyclic retransmission method:** applies for signaling links where one-way PD is ≥ 15 ms (include signaling links established via satellite).
- Basic method is simply a go-back-N ARQ (figure below)
- When the PD is long, the message unit is relatively short and the link is idle for the most of the time → low efficiency
- In this case, it is better not to wait and retransmit all unacknowledged MSUs whenever a node has no MSUs to send. Only positive acks are sent by the other side.
- *Forced retransmission procedure:* because of only positive acks, there may be undetected error for a considerable period of time. When a predetermined number of outstanding unacknowledged signal units exists, the transmission of new units is interrupted and the retained signal units are retransmitted cyclically until the number of unacknowledged signal units is reduced.

Transmission of MSUs
with error correction



error monitoring

- two types of signaling link error-rate monitoring
  - signaling unit error-rate monitor
  - alignment error-rate monitor
- **signaling unit error-rate monitor**
  - is employed while the signaling link is in service
  - a means to decide a link be taken out of service due to errors

leaky bucket algorithm

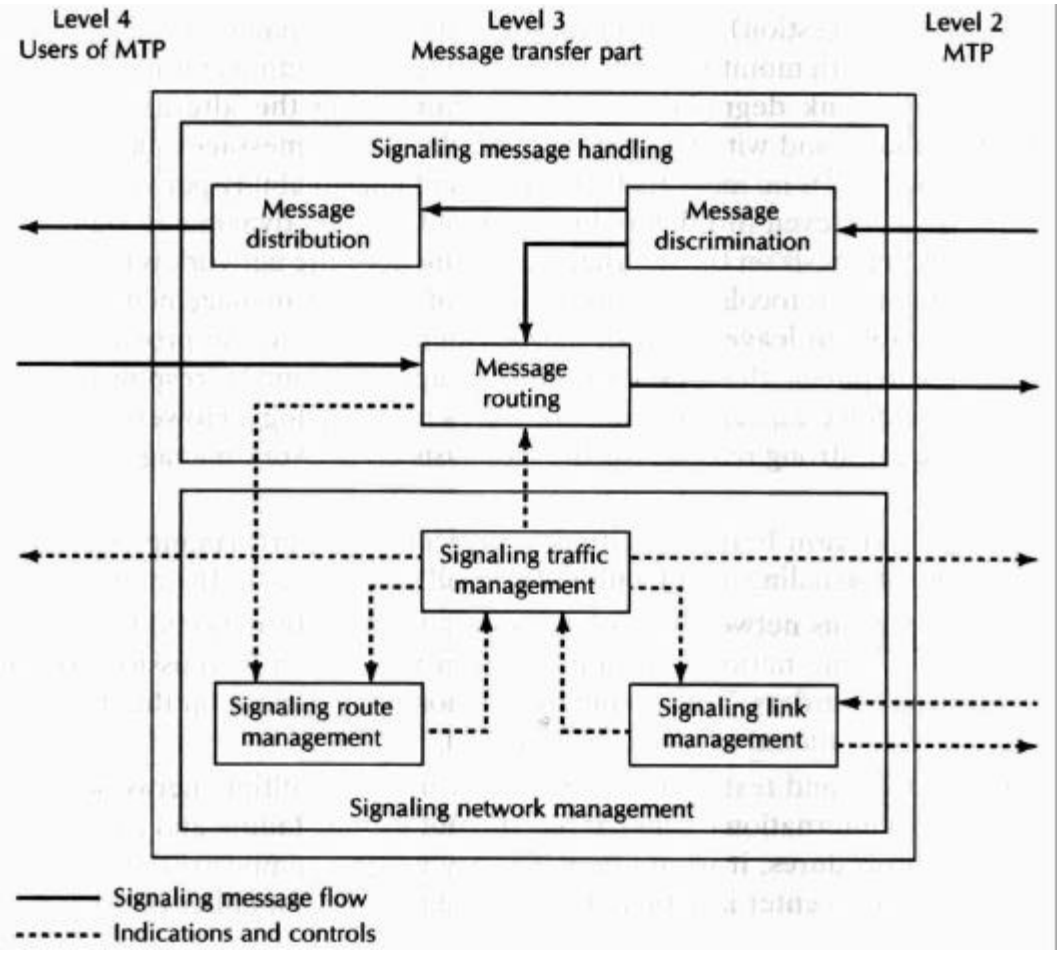
  - using a counter initially set to zero and manipulated based on:
    - *T:* threshold above which an error is signaled to level 3
    - 1/*D:* the lowest error rate(ratio of signal unit errors to signal units) that will eventually cause an error to be signaled to level 3
  - counter increments one for each signal unit received in error
  - counter decrements one for every sequence of *D* received signal units, whether in error or not
  - an unreliable link is that when the counter reaches threshold *T*
  - for 64-kbps links: $T = 64$ and $D = 256$ ($1/D = 0.004$)
  - detects a consistent error rate not occasional surge of errors
- **alignment error-rate monitor**
  - is employed while the signaling link is being initialized and aligned
  - *alignment:* transmitter and receiver are aligned with respect to the opening flag field of each transmitted frame
  - provides the criteria for rejecting a signaling link for service due an excessive error rate
  - using a counter initially set to zero and
    - increments by one for each signal unit received in error
  - If the counter exceeds a threshold before the end of an initial proving period, the proving period is aborted.
  - Five successive failures result in the link being declared unreliable.

7.4 Signaling Network Level

- Signaling network level provide functions and procedures for the transfer of SS7 messages between signaling points.
  - includes message handling and network management functions

Signaling message handling functions

- performed at every SP and STP, falls into three categories:
  - Discrimination: based on analysis of destination code in the routing label of the message, a message is relayed to another node or kept as it is in destination.
    - Thus delivered to routing function or to distribution function
    - only needed in signal transfer points (STPs)
  - Routing: determines the signaling link to be used in forwarding a message.
  - Distribution:determines the user part to which a message should be delivered.



- Routing decision is based on value of signaling link selection (SLS) field.
- With a 4-bit SLS field, 16 different routes for each source/dest is possible.
- Different routes have different internal virtual circuits, but, in general, control signals for a single call follow the same route to be in sequence.
- To have uniformly distributed traffic, the user part varies the route selection from one call to the next.

Signaling network management functions

- *Main objective:* to overcome link degradations (failures or congestion)
- by monitoring status of each link and dictating alternate routes to affected nodes, and recovering from the loss of messages due to link failure.
- SS7 is aimed to have no more than 10 minutes of unavailability per year for any route, achieved by redundancy of links and dynamic rerouting.
- SS7 has strong reasons for emphasis on network management (rare case)
  - Specified functions are critical. Performance of a network's control signaling architecture affects all subscribers to the network.
  - Various networks involved must support international traffic. National signaling system has effects on international network.
  - Recovery and restoration actions may involve multiple networks and therefore SS7 should include failure and congestion recovery procedures .

- Signaling network management (SNM) functions include:

  - **signaling traffic management**
  - **signaling link management**
  - **signaling route management**

- These functions are performed by exchange of level 3 messages between signaling points, carried in signaling information field (SIF) of an MSU. Each message consists of 8-bit identification + message value (0,8,16,24)
- All procedures in SNM require monitoring and control of status of various entities (signaling links, signaling routes, signaling points, and signaling route sets).

Signaling traffic management

- Signaling traffic management is used to divert signaling traffic, without causing message loss or duplication, from unavailable signaling links or routes to one or more alternative signaling links or routes, or to reduce traffic in the case of congestion.

Signaling network management procedures

Signaling Traffic Management

Changeover
Divert traffic to one or more alternative links in the event of a link unavailability.

Changeback
Reestablish traffic on a signaling link that becomes available.

Forced rerouting
Divert traffic to an alternate route when a route becomes unavailable.

Controlled rerouting
Divert traffic to a route that has been made available.

Signaling point restart
When a signaling point becomes available and when signaling traffic is diverted to or through this point, update the network routing status and control.

Management inhibiting
Link is made unavailable to user-part-generated traffic for maintenance or testing purposes.

Signaling traffic flow control
Limit signaling traffic at its source when the signaling network is not capable of transferring all signaling traffic offered by the user because of network failures or congestion.

Signaling Link Management

Signaling link activation, restoration, and deactivation
Restore failed links, activate new links, and deactivate links.

Link set activation
Activate a link set not having any links in service.

Automatic allocation of signaling terminals and signaling data links
Allocate terminals to links.

Signaling Route Management

Transfer-controlled procedure
Performed at an STP in the case of link congestion. Message sources are told to stop sending messages having a congestion priority less than the congestion level of the link.

Transfer-prohibited procedure
Performed at an STP to inform adjacent signaling points that they must no longer route to a particular destination via this STP.

Transfer-allowed procedure
Informs adjacent signaling points that routing to a given destination is now normal.

Transfer-restricted procedure
If possible, adjacent signaling points should no longer route to a particular destination via this STP.

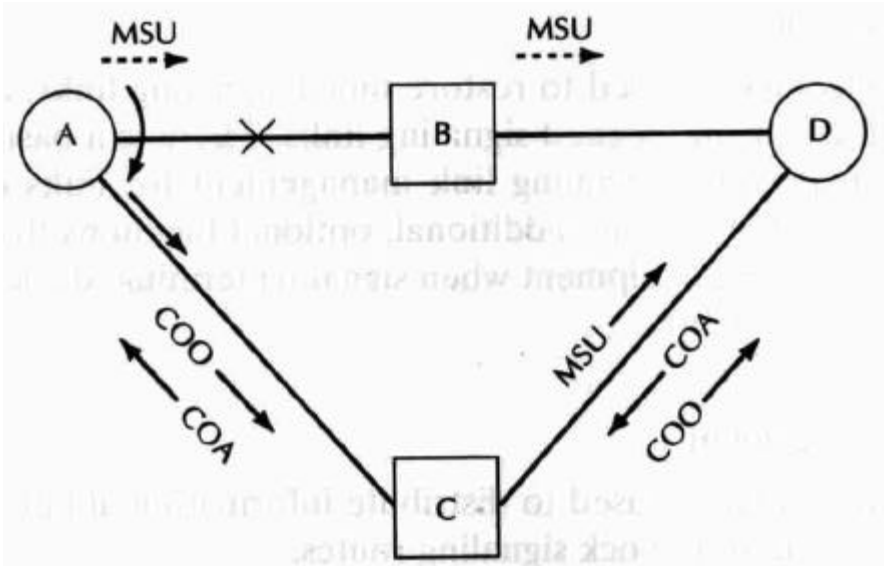
Signaling-route-set test procedure
Used by signaling points receiving transfer-prohibited and transfer-restricted messages to recover the signaling route information that may not have been received due to some failure.

Signaling-route-set congestion test procedure
Used to update the congestion status associated with a route toward a particular destination.

An example of signaling traffic management functions

Changeover Procedure

- *objective:* diverting signaling traffic carried by a link that becomes unavailable to an alternative signaling link as quickly as possible
- If a signaling link is recognized as unavailable, changeover is initiated:
  - termination of transmission and acceptance of MSUs on the failed link
  - determination of alternative links and construction an alternative route
  - identification of undelivered messages or in retransmission buffer of failed link
  - transferring the identified messages to transmission buffer of the new link
- Procedures to accomplishing the last two steps:
  - A signaling point that recognizes the unavailability of a link sends a changeover order (COO) message to the remote signaling point via some available route.
  - The message value field contains the forward sequence number of the last message accepted from the unavailable signaling link.
  - When the other side receives the COO, it responds with a changeover ack. (COA) message with forward seq. no. of its last accepted MSU.
  - The two sides are now able to resume the exchange of MSUs containing user-part information over an alternate route.
- In the figure below, traffic between signaling points A and D is initially carried via signaling point B. When link A-B become unavailable, A sends a COO message to D via C. C responds along the same route with COA. After that, all MSUs follow the route through C.



Signaling link management

- Signaling link management is used to restore failed signaling, activate new signaling links, and deactivate aligned signaling links.

Signaling route management

- Signaling route management is used to distribute information about the signaling network status to block or unblock signaling routes.
- One example of functions is the signaling-route-set congestion procedure, used by STPs to control congestion. (If congestion occurs between signaling points, it will be handled by flow control at level 2, but if it occurs on a link emanating from an STP, the source SPs that send messages through that link must be controlled.)

Status values for the signaling network level

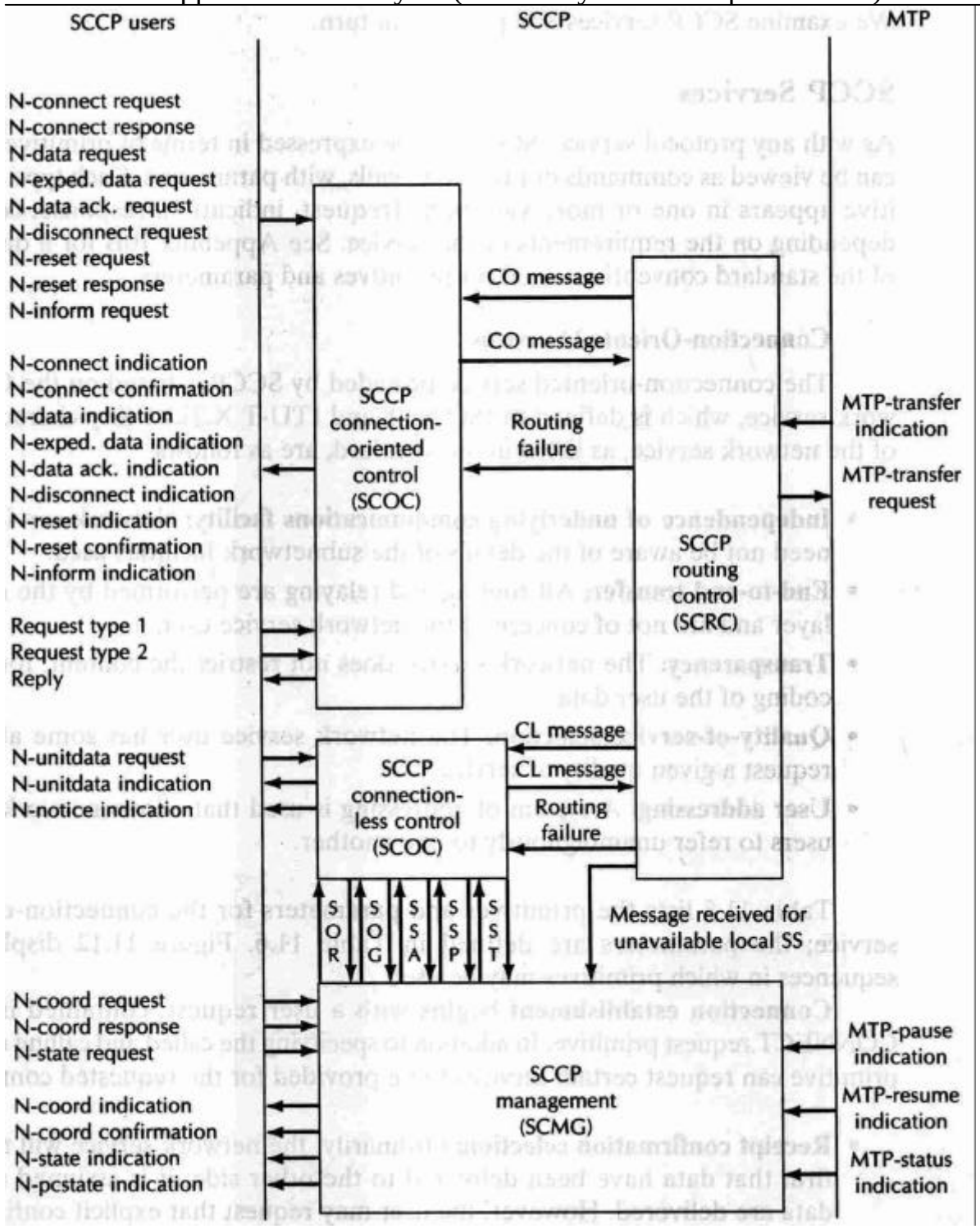
Signaling Link Status	
Available	Messages may be transmitted over this link.
Unavailable	
Failed	Unable to perform transmission function within acceptable performance parameters.
Deactivated	Removed from service by signaling link management or external management function.
Blocked	Processor outage exists at one end of the link.
Inhibited	Link unavailable to user-part-generated traffic.
Signaling Route Status	
Available	Signaling traffic toward a particular destination can be transferred via this signaling transfer point.
Restricted	Signaling traffic toward a particular destination is being transferred with some difficulty via this signaling transfer point.
Unavailable	Signaling traffic toward a particular destination cannot be transferred via this signaling transfer point.
Signaling Point Status	
Available	Signaling traffic may be transferred to this signaling point.
Unavailable	Signaling traffic may not be transferred to this signaling point.
Signaling Route Set Status	
Congested	Indicates that the buffer occupancy rate of a link exceeds a given threshold.
Uncongested	The buffer occupancy rate of a link is within predetermined limits.

7.5 Signaling Connection Control Part

- ***Signaling Connection Control Part (SCCP)*** was developed to enable SS7 supports of more than signaling such as explicit addressing and sophisticated services between remote signaling points.
- The signaling network level does not provide all the routing and addressing capabilities that the OSI model dictates for the network layer.
  - Example:
    - The message distribution function provides only a limited addressing capabilities.
    - More complex specification of the user of a message at a node is necessary.
    - This can be provided by the signaling connection control part.
    - SCCP overhead can be avoided for those user parts for which MTF suffices and for classic circuit-switched telephone-call-related signaling which doesn't use SCCP.
  - The enhancement provided by SCCP is in areas of addressing and message-transfer services.
- The **addressing capabilities** of SCCP extends those of MTP (delivering a message to a specified node using a 4-bit indicator) to distribute messages within a node.
  - SCCP provides this addressing by using destination point codes (DPCs) plus subsystem numbers (SSNs).
  - SSN: a local addressing information identifies each of SCCP users at a node.
  - Another addressing enhancement of SCCP: ability to address messages with global titles not in a form usable by MTP for routing.
    - Mapping facility for translating global titles into an DPC + SSN address
- The **message transfer services** of SCCP in four classes:
  - 0–Basic connectionless
    - a user provides a block of data (network service data unit-*NSDU*) to SCCP for a pure connectionless (datagram type) to a user at another node.
  - 1–Sequenced (MTP) connectionless
    - enhancement of class 0 with the ability to specify delivery of a particular stream of NSDUs in sequence, by using a sequence number to each member NSDU and giving all messages in the stream the same signaling link code.
  - 2–Basic connection oriented
    - operates over logical connections (*signaling connections*) equivalent to virtual circuits through the signaling network, each having a unique signaling link code.
  - 3–Flow-control connection oriented
    - enhancement of class 2 with the ability to perform flow control over a logical connection, and with detection of message loss and missequencing.

SCCP Structure (an OSI model approach)

Internal structure of SCCP (as a set of protocol elements) and interfaces to upper and lower layers (defined by a service specification)



Functional blocks of the SCCP structure

- **Connection-oriented control**
  - controls the establishment and release of signaling connections and provides for data transfer on signaling connections
- **Connectionless control**
  - provides for connectionless transfer of data units
- **Management**
  - provides capabilities beyond those of MTP to handle the congestion or failure of either the SCCP user or the signaling route to the SCCP user
- **Routing control**
  - provides necessary routing functions of a received message from MTP etc. to forward the message to MTP for transfer. The called party address shows whether the message is local or for a remote user.

SCCP Services

Connection-oriented services (ISO 8348, ITU-T X.213.1)

Key characteristics of the network service are:

- Independence of underlying communications facility
  - network service users need not be aware of the details of the subnetwork facilities used
- End-to-end transfer
  - all routing and relaying are performed by the network layer and are not of concern to the network service user
- Transparency
  - the network service does not restrict the content, format, or coding of the user data
- Quality-of-service selection
  - the network service user has some ability to request a given QoS
- User addressing
  - a system of addressing is used that allows network service users to refer unambiguously to one another

- Two phases in connection-oriented services
  - **Connection establishment**
  - **Data transfer**
- **Connection establishment** begins with a user request contains in CONNECT.request primitive, specifying called and calling user & maybe
  - receipt confirmation selection
    - user may request explicit confirmation on delivery of data to the network
  - expedited data selection
    - user may request an expedited data service be available
  - quality of service
    - user may specify two QoS parameters: proposes one of the four classes to be used for connection and also proposes a flow-control window size
- A connection may be denied and called user responds with an N-DISCONNECT.request. An N_DISCONNECT.indications being passed to the calling user.

Network service primitives for connection-oriented services

Primitive	Parameters
N-CONNECT.request N-CONNECT.indication N-CONNECT.response N-CONNECT.confirmation	Called address, Calling address, Responding address, Receipt confirmation selection, Expedited data selection, Quality of Service parameter selection, User data, Connection identification
N-DATA.request N-DATA.indication	Confirmation request, User data, Connection identification
N-EXPEDITED-DATA.request N-EXPEDITED-DATA.indication	User data, Connection identification
N-DATA-ACKNOWLEDGE.request N-DATA-ACKNOWLEDGE.indication	Connection identification
N-DISCONNECT.request N-DISCONNECT.indication	Originator, Reason, User data, Responding address, Connection identification
N-RESET.request N-RESET.indication N-RESET.response N-RESET.confirmation	Originator, Reason, Connection identification

(see also Figure 11.12 [page 283] of your textbook)

- **Data transfer** phase is started after completion of a logical connection between two SCCP users.
  - User data are conveyed in an N-DATA primitive.
  - Expedited data service may be provided for expediting the delivery of occasional urgent data such as an interrupt, an alarm, or an abrupt connection termination at a higher level.
  - N-RESET primitive can occur with class 3 transfer, causes SCCP to start a re-initialization procedure for sequence numbering.

Connectionless services (ISO 8348, ITU-T X.213)

- It is based on the OSI connectionless network service.
- It provides the SCCP user with the ability to transfer signaling messages via the signaling network without the setup of a signaling connection.
- Basic enhancement over MTP: the ability to map the called address to the signaling point code of the MTP service.
- User can choose to have notification of the undelivered message by setting the return option in N-UNITDATA.request.
- Sequence control parameter can be used to select data transfer mode:
  - with sequence control
    - MTP guarantees an in-sequence delivery of messages that contain the same signaling link code (SLC). SCCP put same SLC into the primitive to MTP for all primitives from the SCCP user with same seq. cont. value.
  - without sequence control
    - SCCP inserts randomly, or with respect to the load sharing within the signaling network.
- SCCP uses N-NOTICE primitive to notify the originating user of a failure to deliver a message.

Primitives of the connectionless services

Primitive	Parameters
N-UNITDATA.request N-UNITDATA.indication	Called address, Calling address, Sequence control, Return option, User data
N-NOTICE.indication	Called address, Calling address, Reason for return, User data

SCCP management

- SCCP management is used to maintain network performances by rerouting or throttling traffic in the event of failure or congestion in the network.
- Applies to both connection-oriented and connectionless services of SCCP
- N-COORD primitive is used to coordinate the withdrawal of one of the SCCP users when multiple replications of a user at a node are employing SCCP. This informs SCCP that a particular user is no longer available.
- N-STATE primitives allow a user and SCCP to exchange status information.
- N-PCSTATE primitive is used to inform a user about the status of a signaling point.

SCCP Protocols

four protocol classes of SCCP protocol (one for each SCCP service class)

- 0–Basic connectionless
- 1–Sequenced (MTP) connectionless
- 2–Basic connection oriented
- 3–Flow-control connection oriented

- SCCP consists of four distinct services, each with its own protocol.

[***Student homework:*** self-study of SCCP protocol on pp. 286-292 of the text]

Primitives of the SCCP management

Primitive	Parameters
N-COORD.request **N-COORD.indication** **N-COORD.response** **N-COORD.confirmation**	Affected subsystem, Subsystem multiplicity indicator
N-STATE.request N-STATE.indication	Affected subsystem, User status, Subsystem multiplicity indicator
N-PCSTATE.indication	Affected DPC, Signaling point status

7.6 ISDN User Part

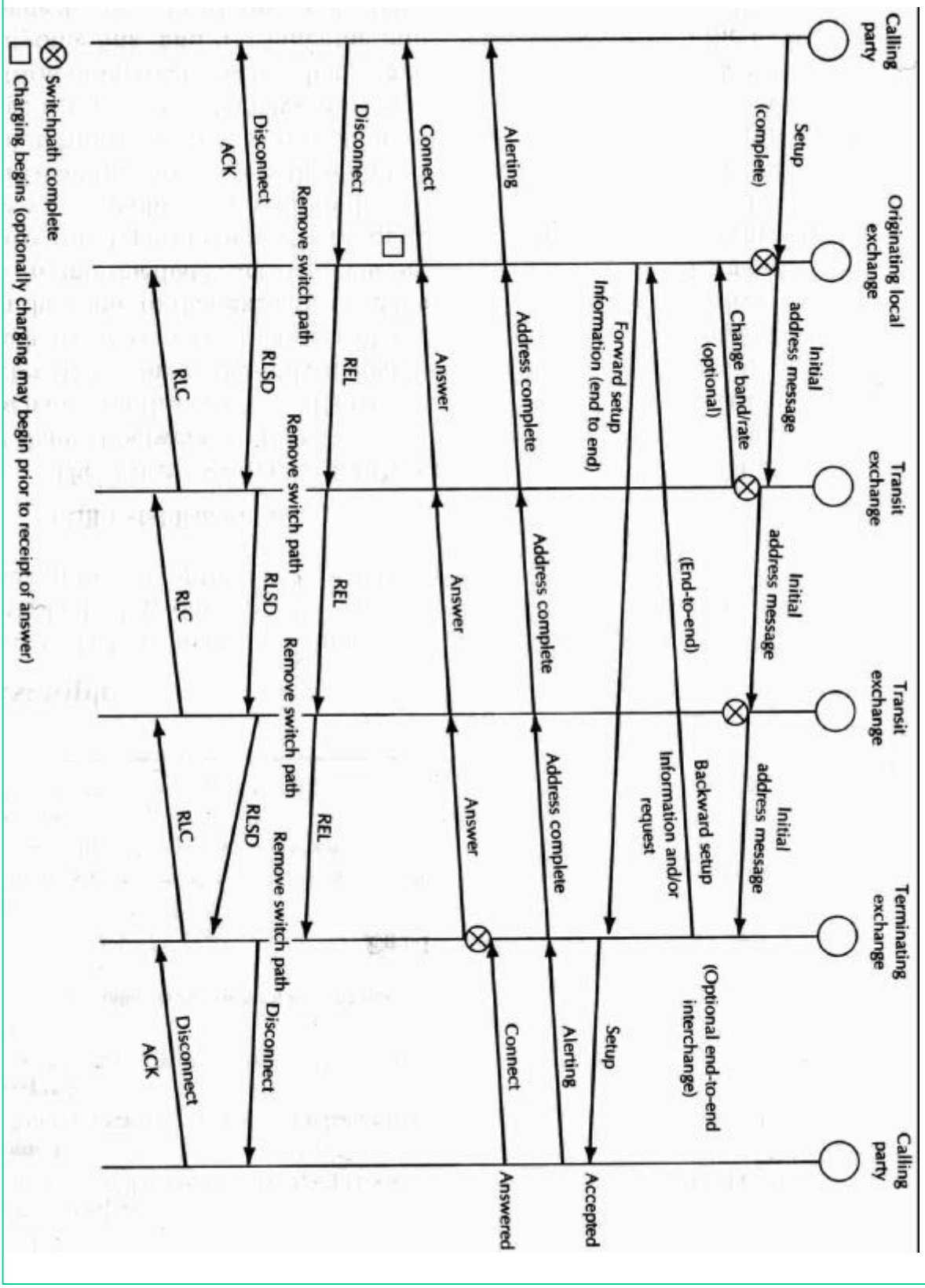
- ISDN user part (ISUP) of SS7 defines functions, procedures, and inter-exchange signaling information flows required to provide circuit-switched services and associated user facilities for ISDN voice and nonvoice calls.
- Three requirements for ISUP:
  - rely on message-transfer part or network service part of SS7 for Tx of messages
  - flexible design to accommodate future enhancements of ISDN capabilities
  - interworkable with the user-network Q.931 call control protocol (CCP)
    - CCP refers to CCS facilities open to use by the ISDN subscriber
    - used by subscriber to set up calls to other subscribers with associated user facilities
    - ISUP refers to sig. facilities employed by network provider on behalf of ISDN user
    - *user part* doesn't refer to ISDN user; it refers to ISUP as a user of lower layers of SS7

ISUP Messages

- exchanged between exchanges and signal transfer points within network
- for establishing, controlling, and terminating a call in the network
- common format of ISUP messages has the following fields (Fig. 11.15):
  - **Routing label:** actually part of MTP header; indicates source and destination points of message; also includes a signaling link code field,used in load sharing across multiple physical links; for each individual circuit connection the same routing label must be used in all messages associated with the connection
  - **Circuit identification code:** specifies the circuit to which this message relates
  - **Message type:** identifies which ISUP message is being sent; reminder of the message depends on the message type.
  - **Mandatory fixed part:** contains those parameters that are mandatory for a particular message type and of fixed length.
  - **Mandatory variable part:** contains those parameters that are mandatory for a particular message type and of variable length; requires a pointer and a length indicator as well as a parameter value.
  - **Optional part:** contains those parameters that may or may not occur for a particular message type; each parameter requires a name and length indicator as well as parameter value.

Note: Check Table 11.11 (pp. 295-297) of your text for ISUP messages.

Example of protocol use to set up a B channel circuit-switched call-**Call Establishment and Call Release Procedures**



End-to-End Signaling

- The capability to transfer signaling information directly between the endpoints of a circuit-switched connection or between signaling points that are not interconnected by a circuit-switched connection.
- used between ISUPs located in call originating and terminating exchanges
- can be used to request or respond to requests for additional call-related information or transfer user-to-user info. transparently through network
- If the end-to-end signaling relates to an existing connection, it may be achieved by the *pass-along method*.
  - signaling information is sent along previously established path
  - simply message passes along the transit exchanges
  - ISUP makes direct use of the message-transfer part of SS7
- When a call is placed, two connections are established across ISDN:
  - a circuit that supports the user's B channel traffic
  - an SS7 end-to-end connection
  - both connections follow same network route but separate dedicated connections
- An alternate method for end-to-end signaling
  - signaling connection control part (SCCP) method
    - makes use of the SCCP protocol of SS7
    - can be used whether or not there is a circuit established bet. exchanges
    - the route may not relate to any user circuit and determined by SCCP

Services

- Services provided by the ISDN user part
  - **basic services**
    - setup a simple circuit-switched call
    - release a simple circuit-switched call
  - **supplementary services**
    - calling line identification
    - call forwarding
    - closed user groups
    - direct dialing in
    - user-to-user signaling

- **Calling line identification**-supplementary services:
  - **presentation:** a service that enables a subscriber to be informed on incoming calls of the address of the calling party
  - **restriction:** when the calling party restricts access to information
  - information may be contained in the initial address message or the terminating exchange requests it.
- **Call forwarding**: redirects incoming calls addressed to a particular number to an alternate number, with three types:
  - *call forwarding busy*
  - *call forwarding no reply*
  - *call forwarding unconditional*
- **Closed user group**: enables a subscriber to belong to one or more closed user groups, permits group users to communicate with each other but precludes communications with all others. In addition to basic service, there are some extensions such as:
  - *closed user group with outgoing access*
  - *closed user group with incoming access*
  - *incoming calls barred within a closed user group*
  - *outgoing calls barred within a closed user group*
- **Direct dialing-in**: enables a user to call another user on a digital PBX or other private system w/o attendant intervention.
- **User-to-user signaling**: provides a means of communication between two end users through the signaling network for the purpose of exchanging information of end-to-end significance.
  - **Service 1**: allows transfer of user-to-user information (UUI) during setup and clearing phases of a call, with UUI embedded within ISUP call control messages.
  - **Service 2**: allows transfer of UUI during setup phase of a call, transferred independently of call-control message.
  - **Service 3**: allows transfer of UUI during the active phase of a call.