

# SS7

- ITU-T Common Channel Signalling System No. 7 (CCSS7, CCS7, CCS, CCS#7, C7, SS7 ...)
- At present the dominant inter-exchange signalling system in digital networks (PSTN, ISDN, PLMN)
- SS7 is in effect a **robust, high-performance** packet switched network, intended for secure transmission of signalling messages
- ITU-T Q.700-series Recommendations

# Channel-associated vs. common channel signalling

Channel-associated signalling (CAS):

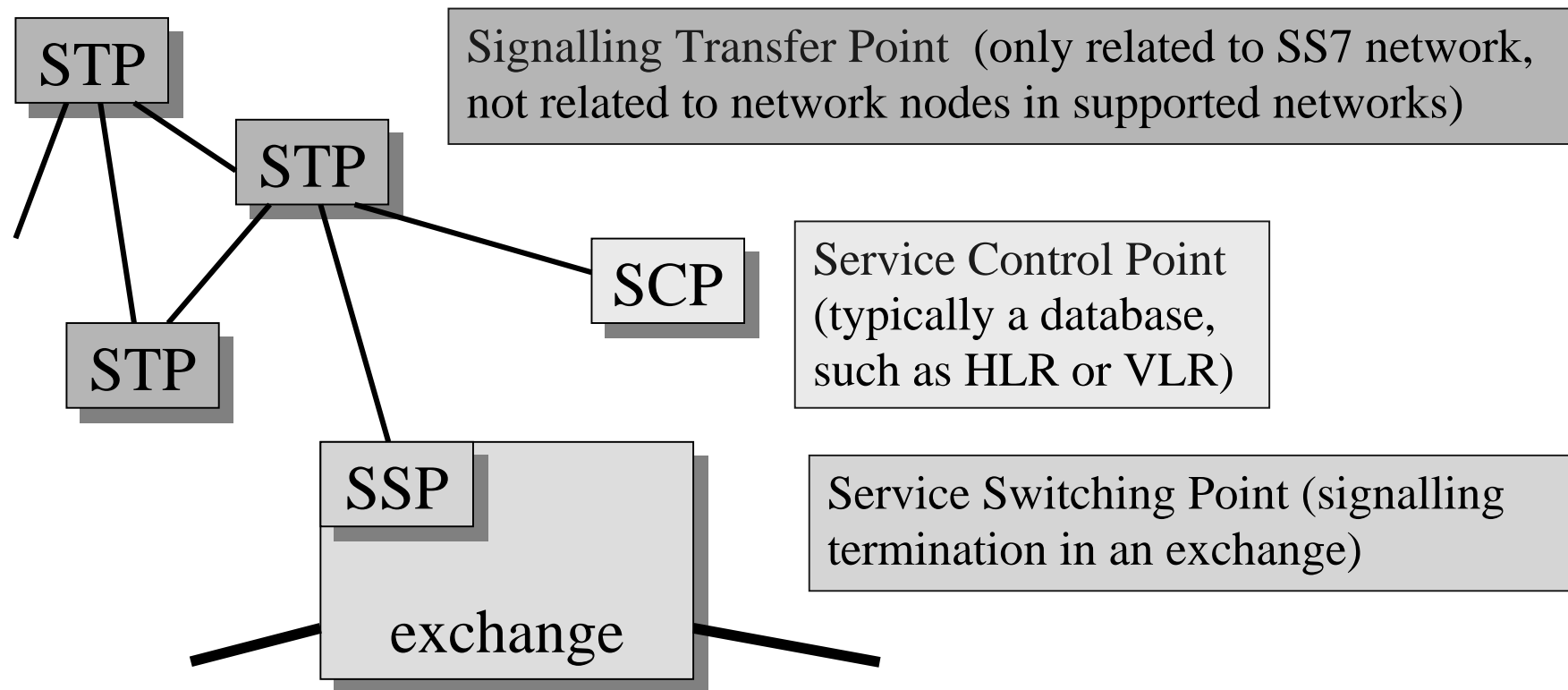
Dependent on circuit switched connection: if connection is cut, no connection-related signalling is possible.

Common channel signalling (CCS):

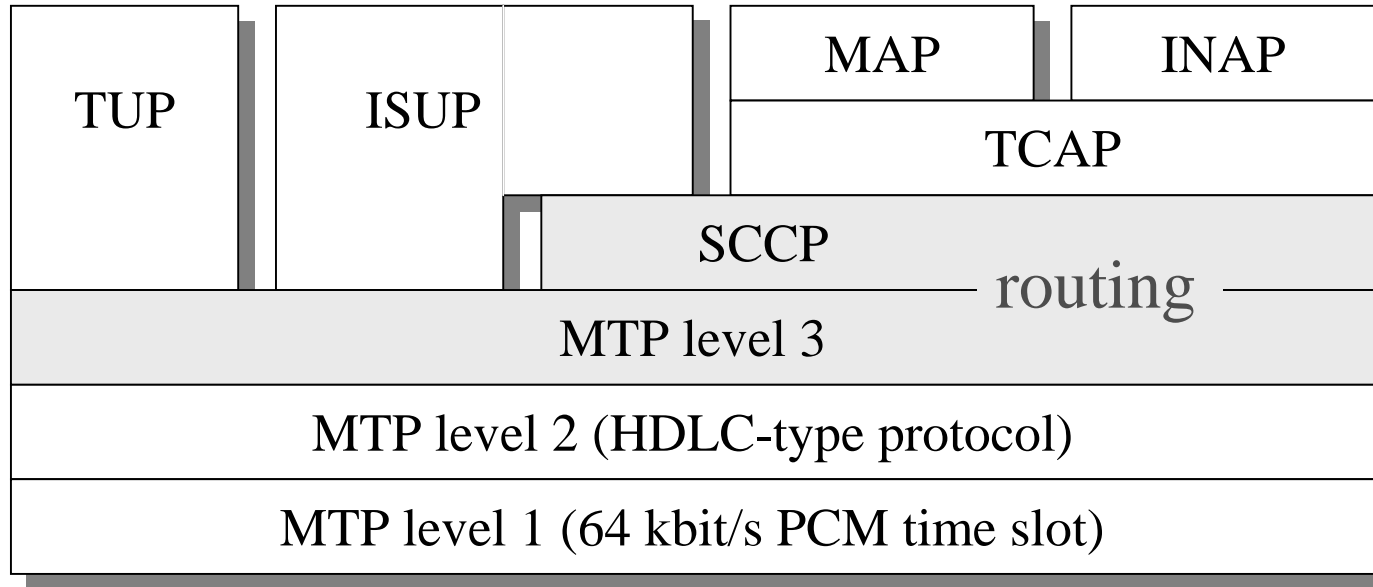
”Separate” packet-switched signalling network which is independent of circuit switched connections. If part of the switching network is out of operation, CCS can search for a different route between originating and terminating exchanges and restore the lost circuit connection.

# Signalling points (SP) in SS7

Every SP is identified by a signalling point code (SPC)



# Protocol layers ("levels") of SS7



MTP - Message Transfer Part

SCCP - Signalling Connection Control Part

UP - User Part

AP - Application Part

# MTP functions

MTP level 1 (signalling data link level):

Physical transmission in a 64 kbit/s PCM time slot.

MTP level 2 (signalling link level):

HDLC-type frame-based protocol for flow control, error control (using ARQ), and signalling network supervision and maintenance functions.

MTP level 3 (signalling network level):

Used for routing in the signalling network (OPC  $\leftrightarrow$  DPC) between SPs with level 4 users (see SIO at level 2).

# MTP level 2 frame formats

## MSU (Message Signal Unit)



## LSSU (Link Status Signal Unit)



## FISU (Fill-In Signal Unit)



*Network:*  
National network(s)  
International network

*User part:*  
TUP  
ISUP  
SCCP  
Network management

# MTP level 2 frames

*MSU (Message Signal Unit):*

- Contains signalling messages (User Part ?  $\Leftrightarrow$  SIO)
- The received frame is MSU if  $LI > 2$  (number of octets)

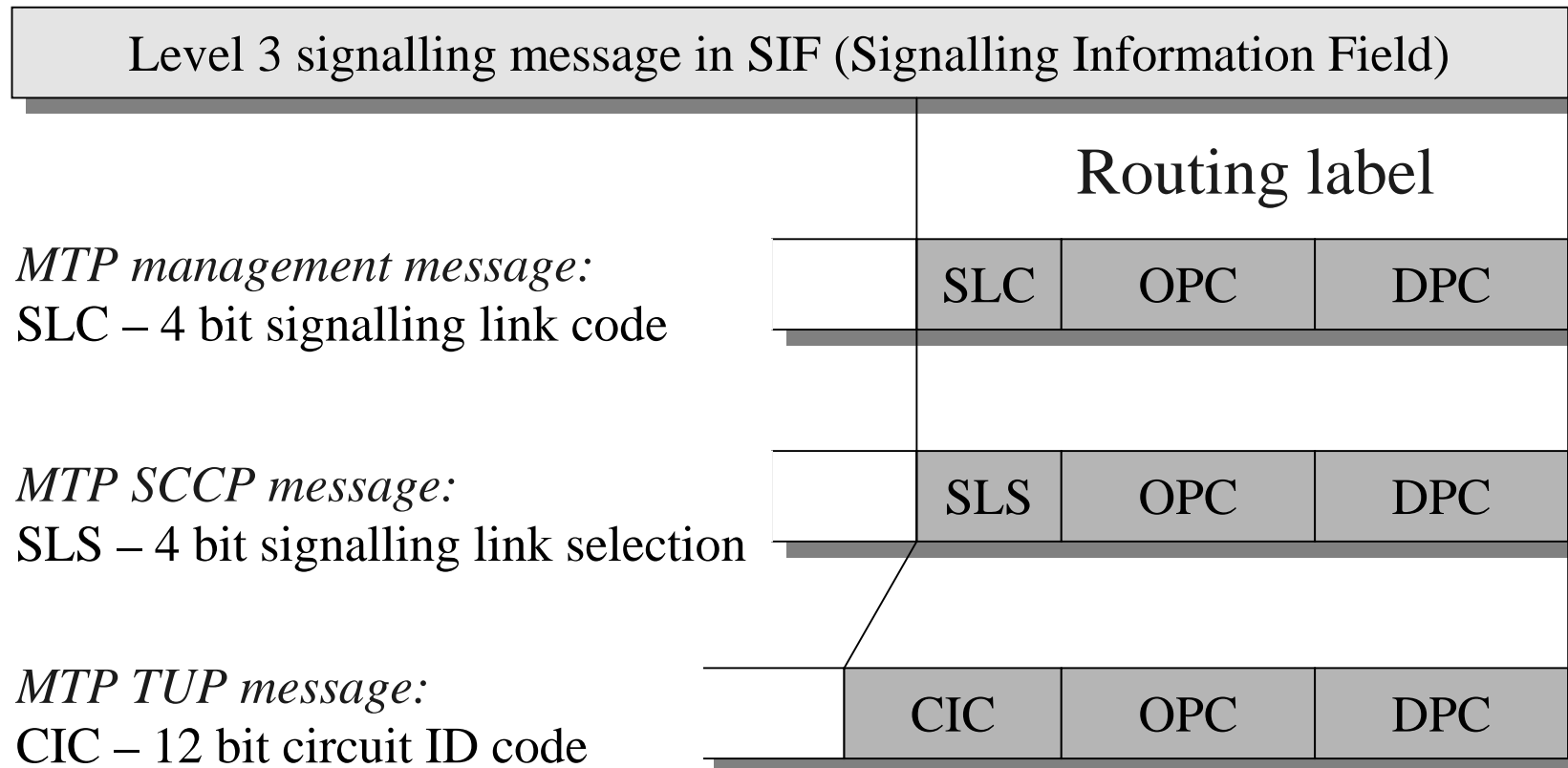
*LSSU (Link Status Signal Unit):*

- Contains signalling messages for link supervision
- The received frame is LSSU if  $LI = 1$  or  $2$

*FISU (Fill-In Signal Unit):*

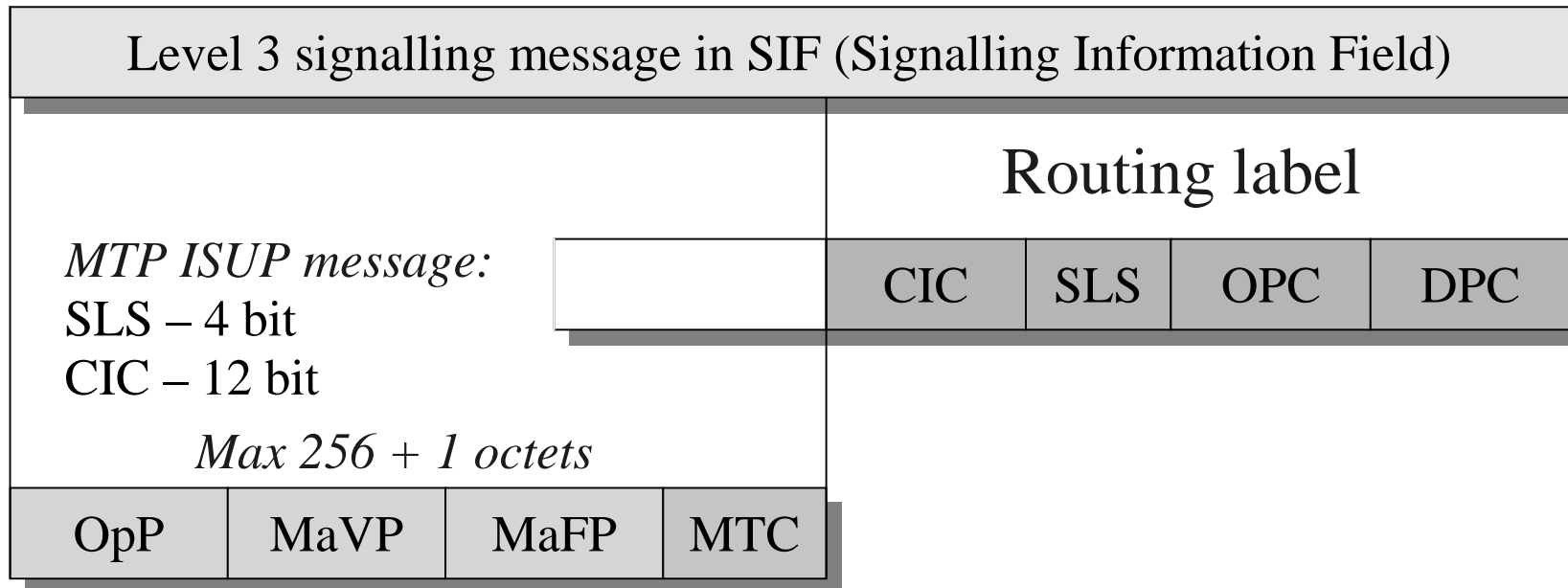
- Can also be used to monitor quality of signalling link
- The received frame is FISU if  $LI = 0$

# Routing through SS7 network





# Routing through SS7 network



MTC – Message Type Code (name of ISUP message)

MaFP – Mandatory Fixed Part (no LI, no parameter names required)

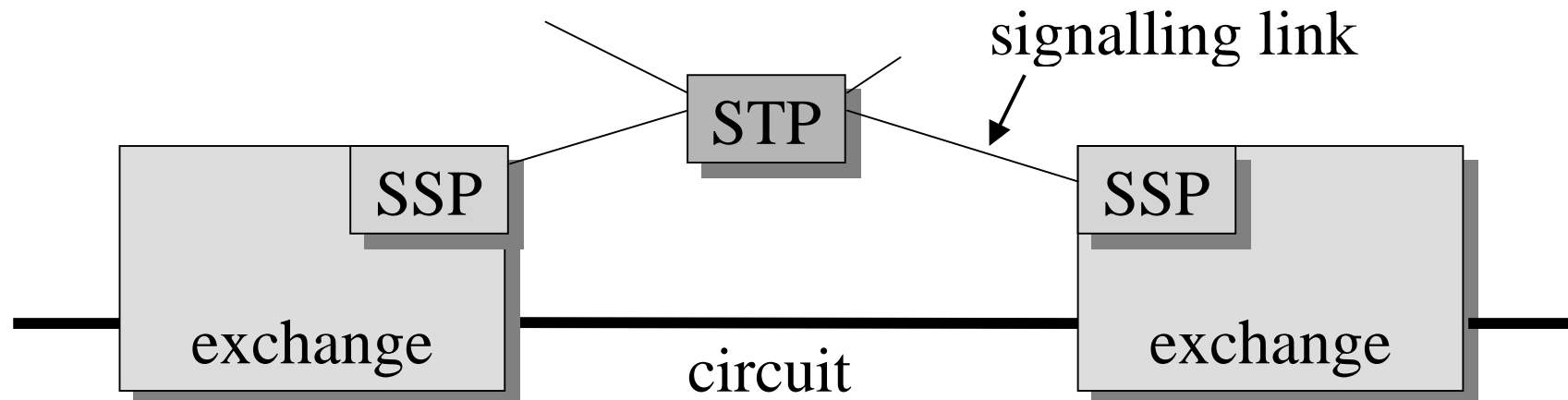
MaVP – Mandatory Variable Part (LI, no parameter names required)

OpP – Optional Part (LI and parameter names required)

# Difference between SLS and CIC

SLS defines the signalling link used for transfer of signalling information.

CIC defines the circuit (used for a certain circuit switched connection) with which the ISUP message is associated.



# Role of DPC and OPC in SS7

*DPC – Destination Point Code* (14 bit  $\Leftrightarrow$  16384 SPs)

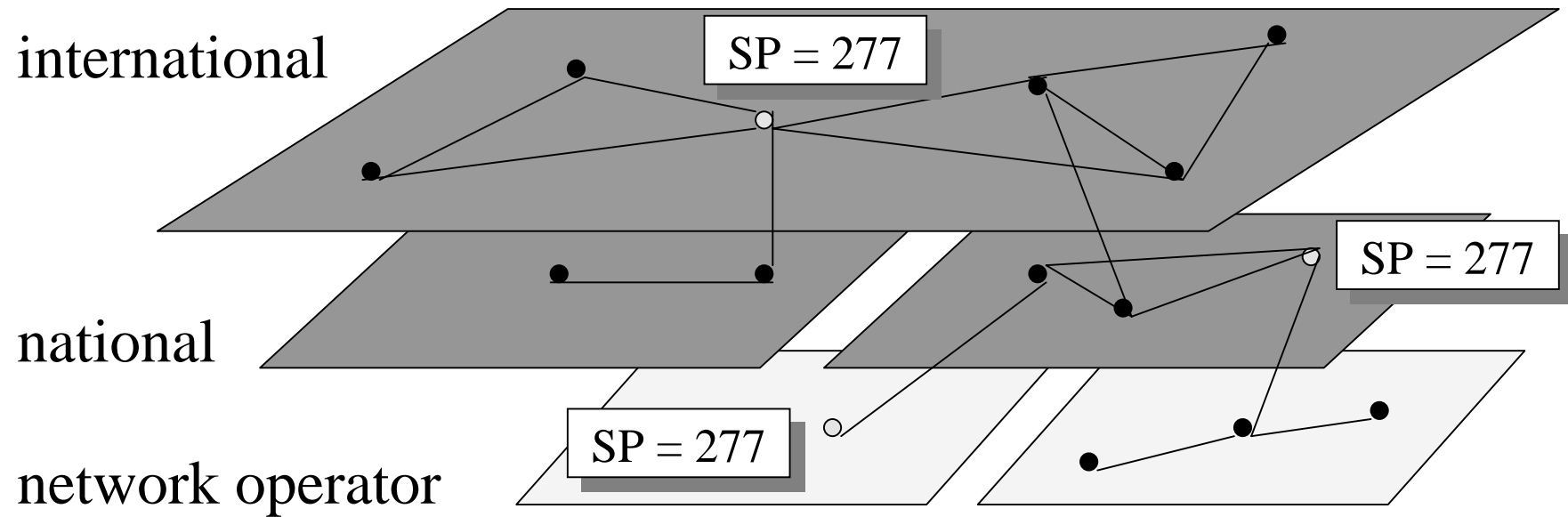
- Global termination point of user part transaction
- Key information for routing within SS7 network
- The DPC is inserted by the originating MTP "user".

*OPC – Originating Point Code* (14 bit)

- Global originating point of user part transaction

The "network indicator" in the SIO octet determines whether the DPC or OPC is an international, national, or network dependent SP identifier.

# Same signalling point codes can be reused at different network levels





# ISUP

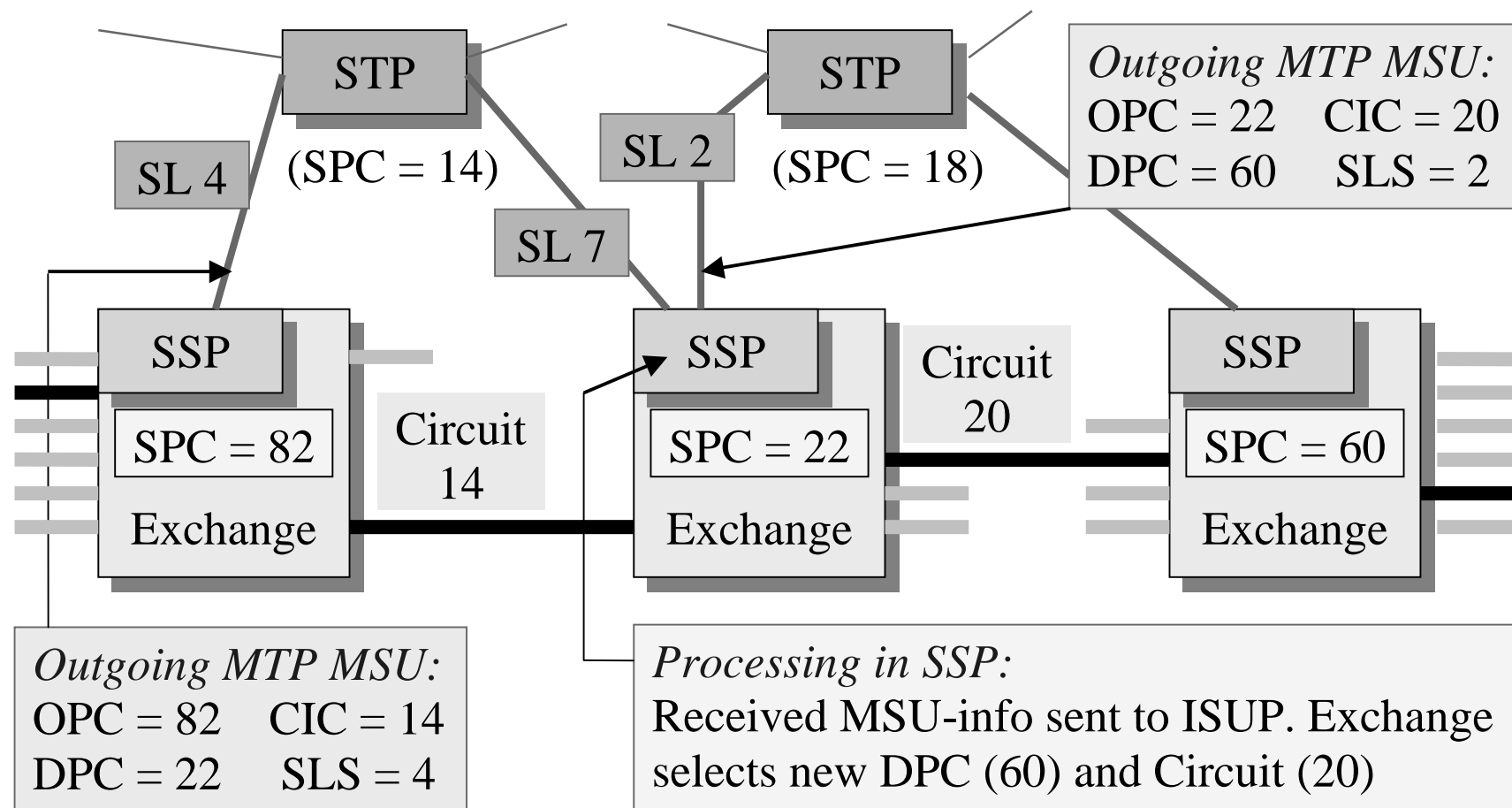
## Integrated Services User Part

Essential for circuit-switching related signalling

### *Features:*

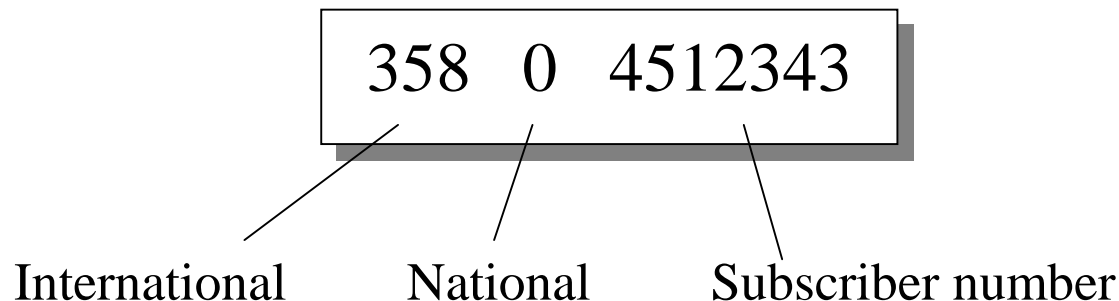
- 1) Establishment / release of circuit switched connections
- 2) End-to-end signalling between two exchanges (for this purpose SCCP + ISUP is required)
- 3) General (non-user-related) circuit management

# Example: ISUP for link-by-link signalling



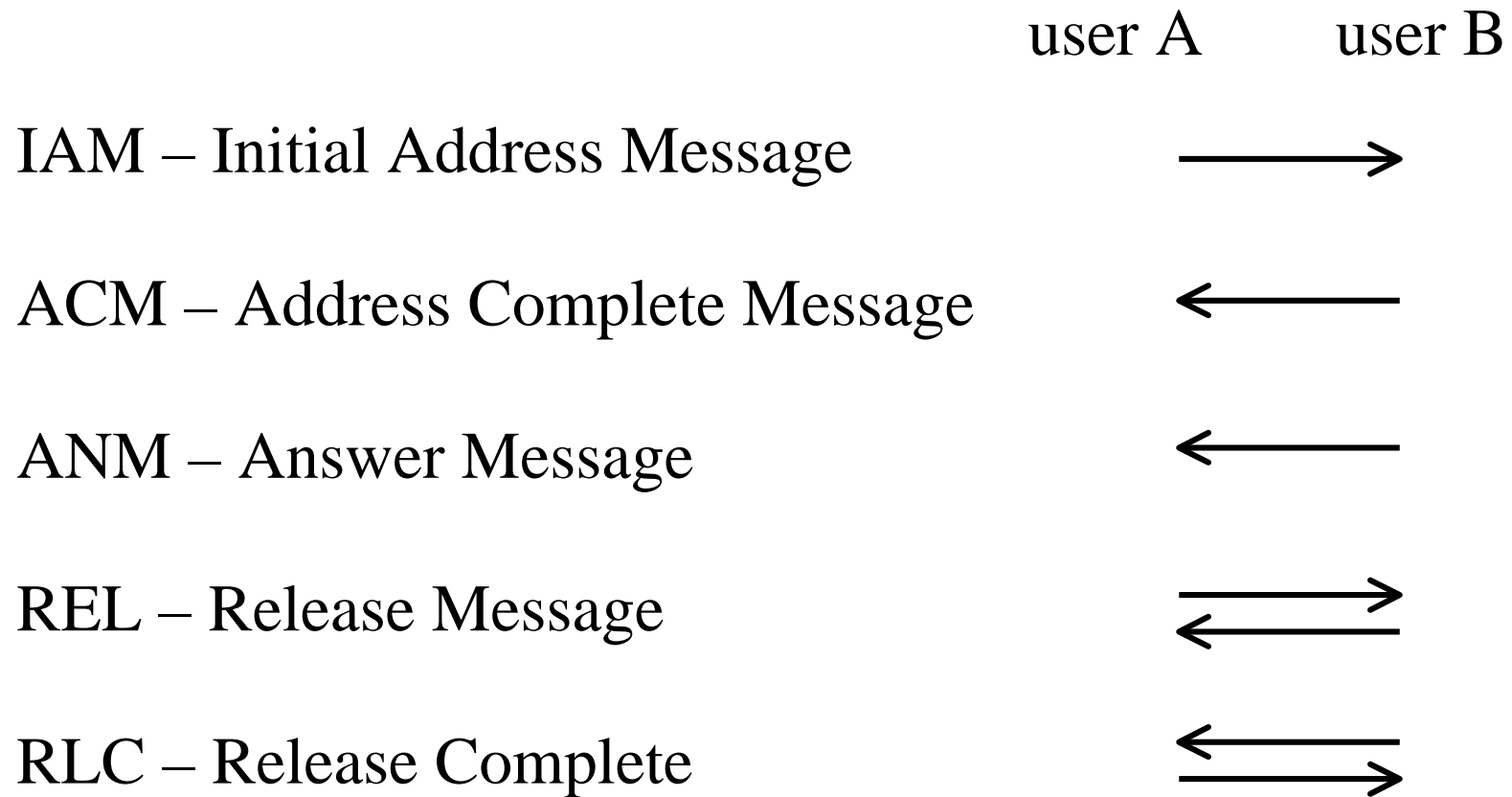
# MTP + ISUP in SS7

- The routing capability of MTP is very limited (routing between adjacent exchanges only).
- Exchanges perform the routing through the network(s) during the establishment of circuit switched connections on an exchange-to-exchange basis, using the dialed digits (and generating routing tables for further use).

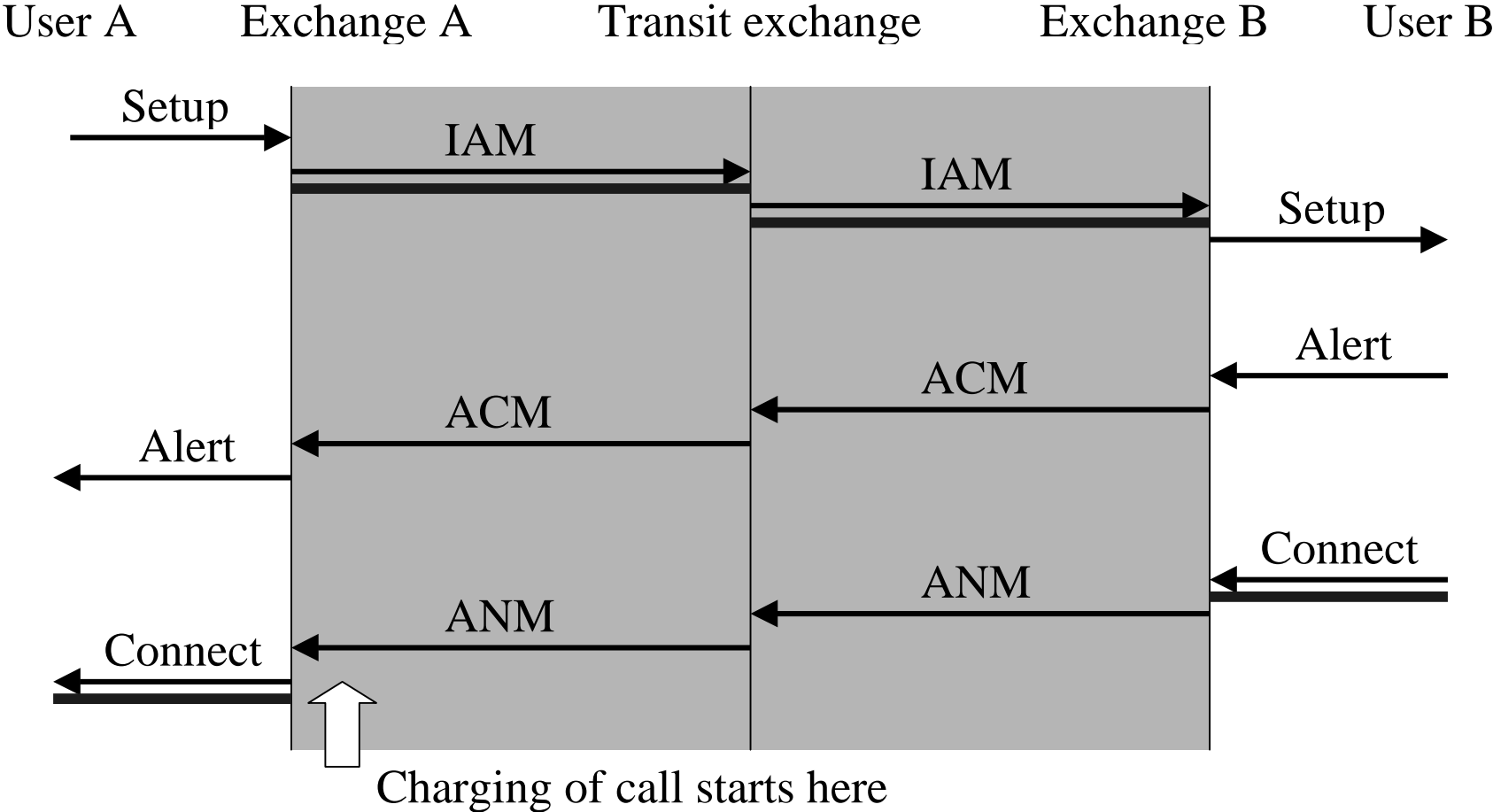




# Some basic ISUP messages



# Setup of a "call" using ISUP



# SCCP

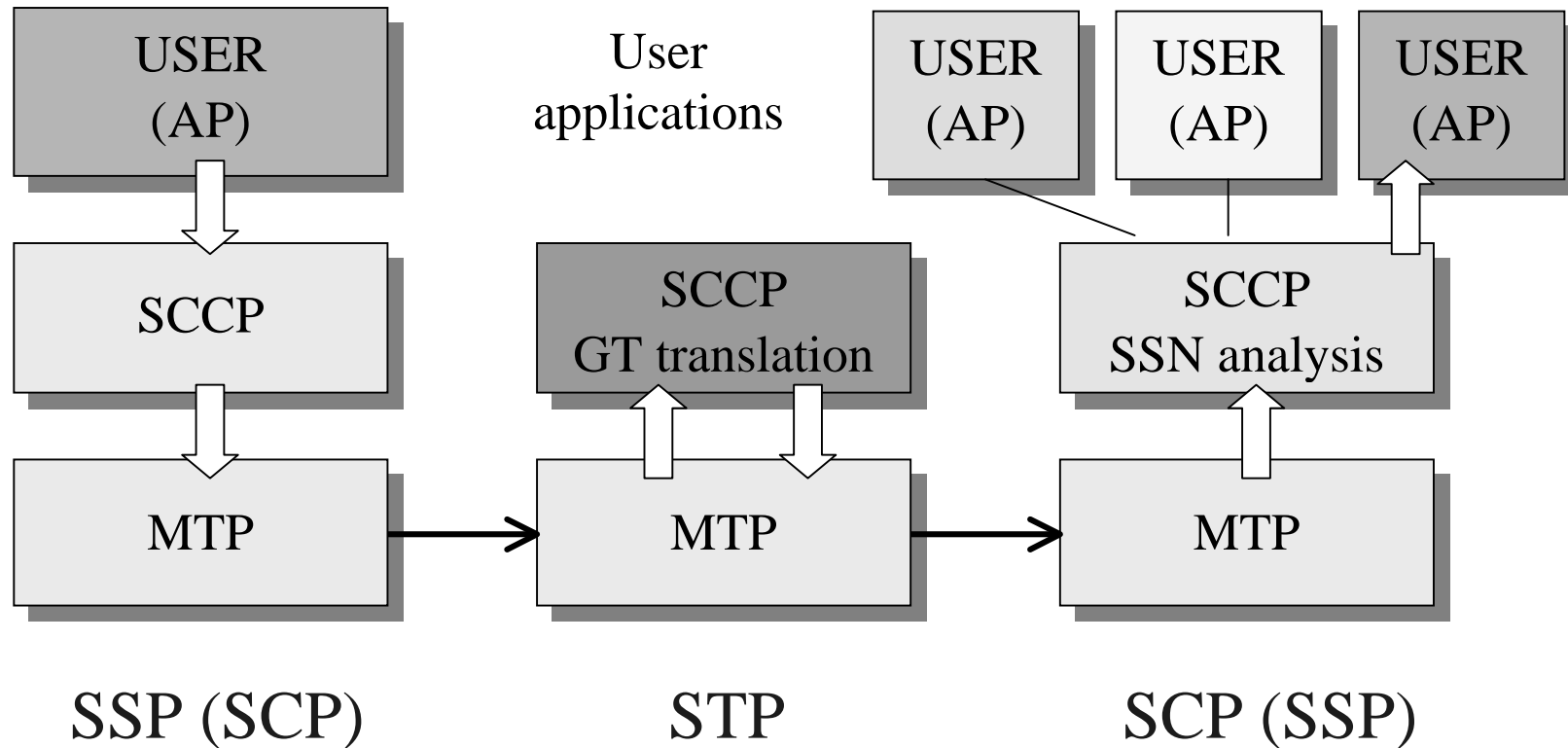
## Signalling Connection Control Part

Essential for non-circuit-switching related signalling

### *Features:*

- 1) Global Title Translation (GTT) for enhanced routing
- 2) SubSystem Number (SSN) analysis at destination
- 3) 4 Transport Service Classes

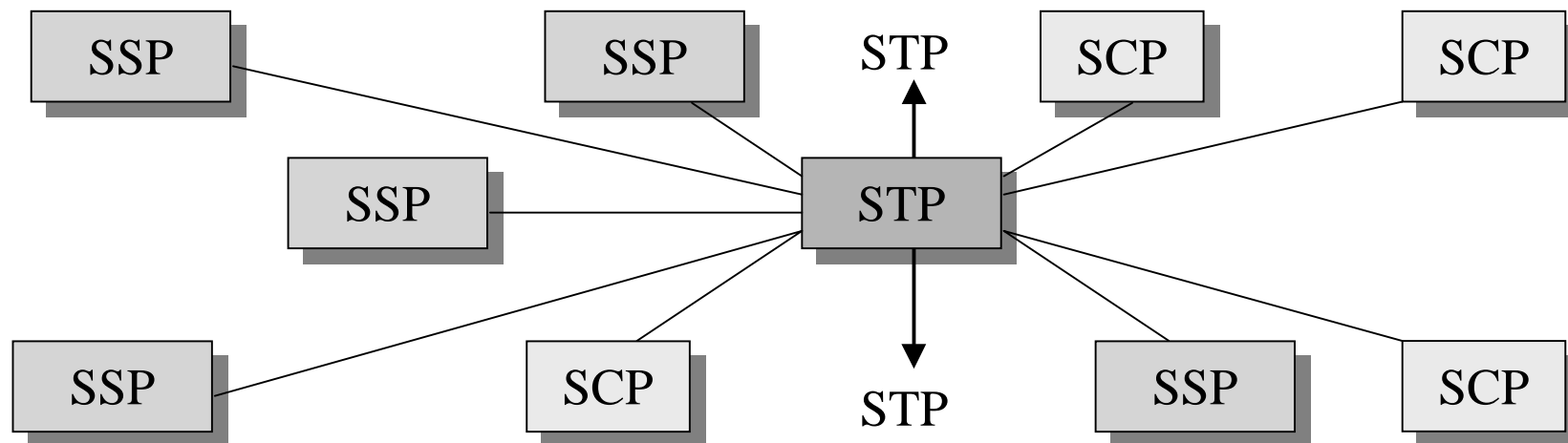
# SS7 connection setup using SCCP



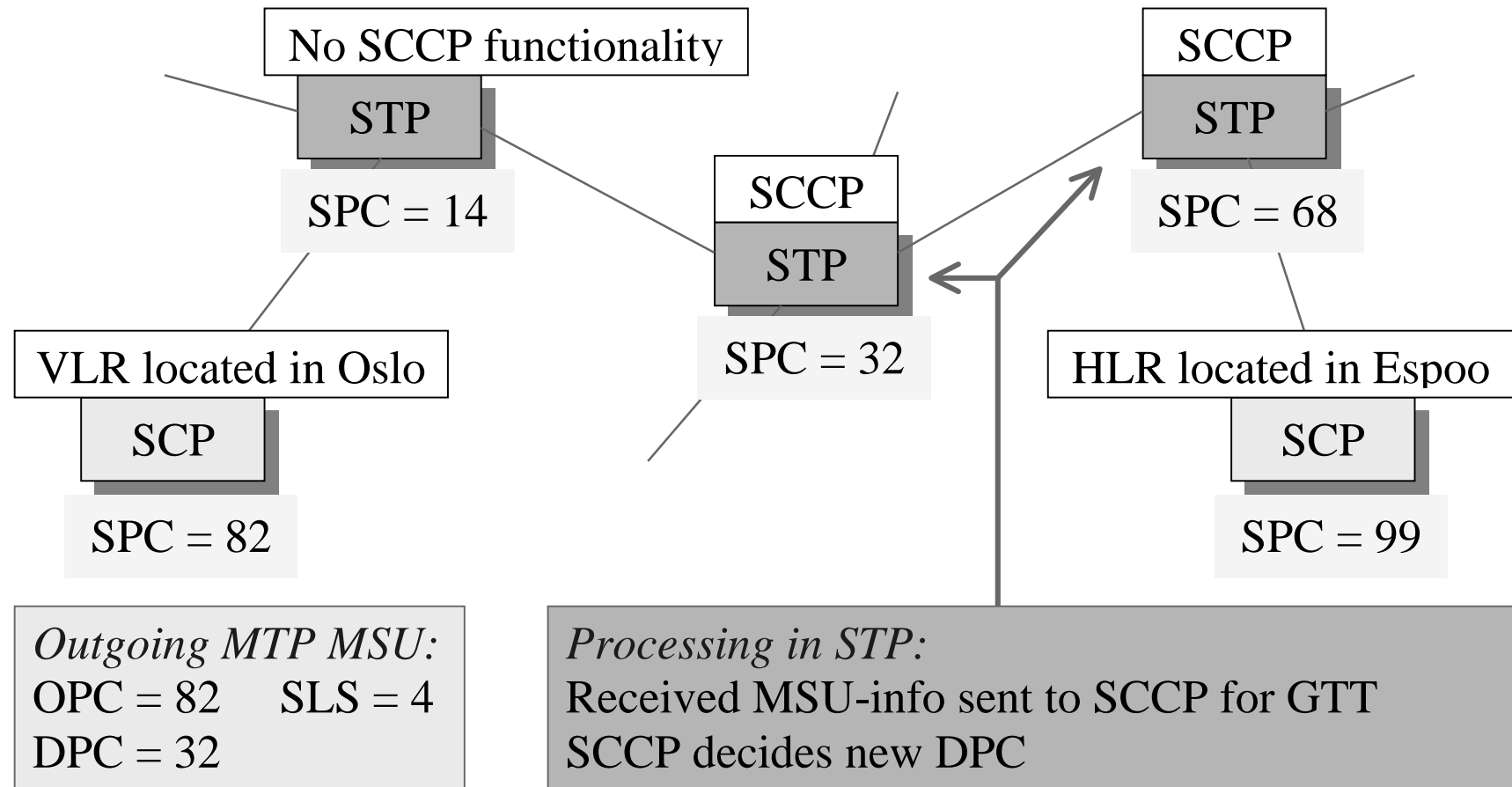
# SS7 connection setup using SCCP

Global title translation (GTT) is usually done in an STP.

*Advantage:* GTT functionality needed only in a few STPs with large packet handling capacity, instead of many SSPs (exchanges) and SCPs (databases) in the network.



# Example: SCCP connection



# MTP + SCCP

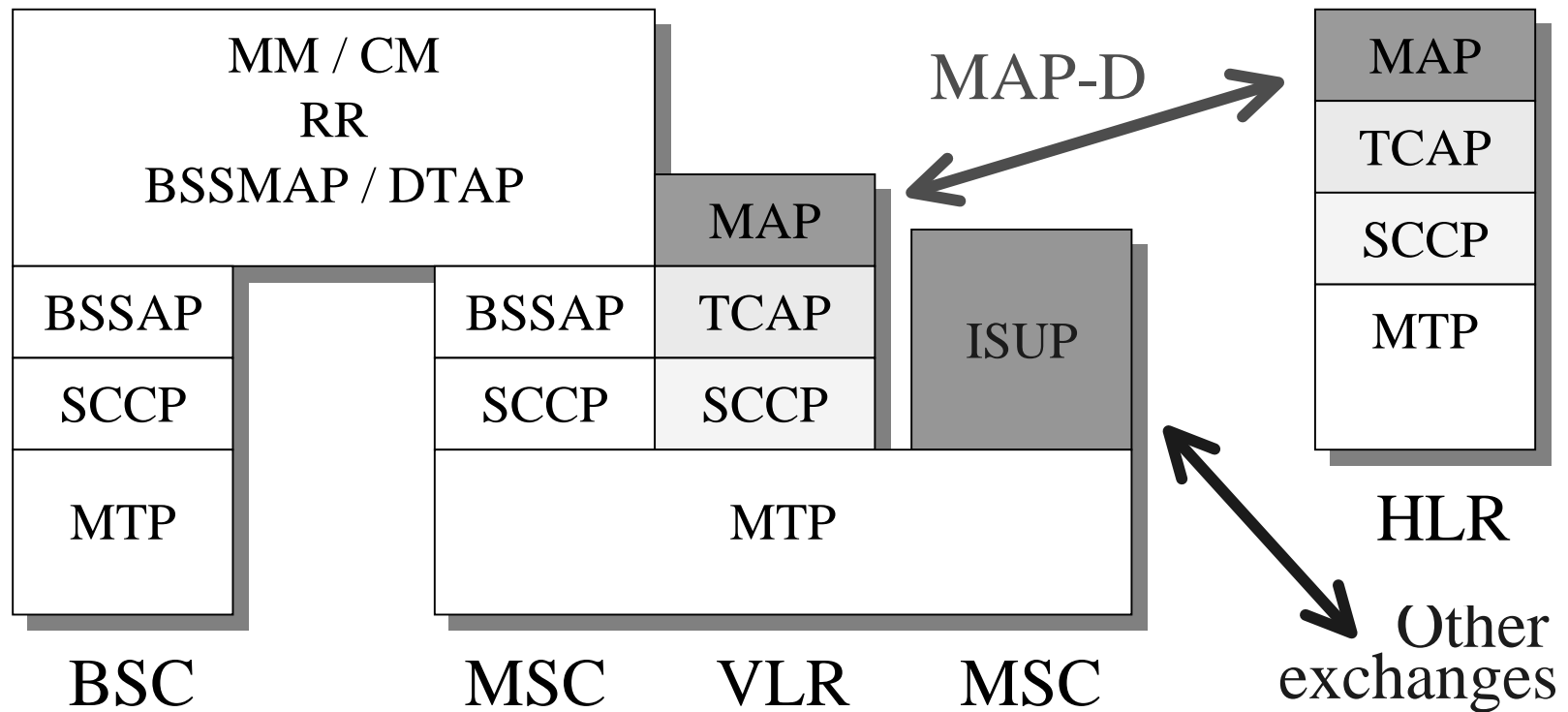
- SCCP  $\Leftrightarrow$  can handle routing over large distances since routing is not associated with exchanges/SSPs
- GT (Global Title) translation in intermediate STP node(s) with SCCP functionality
- SSN (SubSystem Number) for distribution to the correct user (application part)  $\Leftrightarrow$  SAP in OSI
- Routing capability of SCCP is much better than that of MTP and is needed for SCP (database) access

## Four classes of service in SCCP

- Class 0: Basic connectionless class. Each information block (SCCP message) is transmitted from one SCCP user to another SCCP user independently.
- Class 1: Sequenced (MTP) connectionless class. All messages use the same SLS code.
- Class 2: Basic connection-oriented class. Virtual connections are set-up and released + same SLS code + segmentation & reassembly (SAR)
- Class 3: Flow-control connection-oriented class. VC control + same SLS codes + SAR + flow control



# Signalling in GSM core network (and over A interface)



# GSM /UMTS core network interfaces (1)

(UMTS: Circuit switched domain of core network)

## **MAP-B: Between MSC and its associated VLR.**

The interface is "internal" and message transfer does not involve the signalling network. This interface is not standardised by ETSI or 3GPP.

## **MAP-C: Between Gateway MSC (GMSC) and HLR.**

This interface is required for the establishment of mobile terminated calls. Through this interface the GMSC enquires the current user location from the HLR, and the HLR provides the MSC with a Mobile Subscriber Roaming Number (MSRN) necessary for setting up the circuit switched connection from the GMSC to the serving MSC (see case study 2 in GSM slides).

# GSM /UMTS core network interfaces (2)

## **MAP-D: Between VLR and HLR.**

This interface is involved both in CM (Connection Management) and MM (Mobility Management) applications.

CM: Through this interface the HLR asks the VLR to assign and return a roaming number (MSRN) which is used for the establishment of a mobile terminated call (see case study 2 in GSM slides).

MM: This interface may also be used during a Location Update between VLRs when the VLRs update the HLR (in other words the VLRs inform the HLR about changes in user location), or when the HLR deletes information in “old” VLR (see case study 1 in GSM slides).

# GSM /UMTS core network interfaces (3)

## **MAP-E: Between MSCs in a PLMN.**

This interface is used during inter-MSC handover operations. (Note: in addition, the E interface involves ISUP)

## **MAP-F: Between MSC and EIR.**

This interface carries information for MS identity checking.

## **MAP-G: Between two VLRs.**

For instance, in case of an inter-VLR Location Update the “new” VLR may request the “old” VLR to provide relevant user information (see case study 1 in GSM slides).

# GPRS /UMTS core network interfaces

(UMTS: Packet switched domain of core network)

**Gc:**     **Between GGSN and HLR.**

Similar to MAP-C interface (see above).

**Gf:**     **Between SGSN and EIR.**

Similar to MAP-F interface (see above).

**Gn:**     **Between SGSN and GGSN.**

**Gr:**     **Between SGSN and HLR.**

**Gs:**     **Between SGSN and MSC/VLR.**

This interface is required when the user location information cannot be stored at the SGSN.

# Further information on SS7

## Tutorials:

Modarressi, Skoog: "SS7: a tutorial", *IEEE Comm. Magazine*, July 1990

Laitinen, Rantala: "Integration of IN services into GSM", *IEEE Comm. Magazine*, June 1995

Jabbari: "CCSS7 for ISDN and IN", *Proc. IEEE*, Feb. 1991

## Books:

Bhatnagar: *Engineering networks for synchronization, CCS7, and ISDN*, IEEE Press, 1997

Van Bosse: *Signaling in telecommunication networks*, Wiley, 1998