Networking technologies and applications

Common Channel Signaling System 7 (SS7) Part 1

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Channel Associated Signaling - CAS

- Signaling: set-up and release of connections between two subscribers
- Signals were carried by the same circuit (subscriber line, trunk) that carried the speech during the call
  - Subscriber Signaling – between subscriber and his local exchange
- Not possible to send signaling messages in the absence of a call
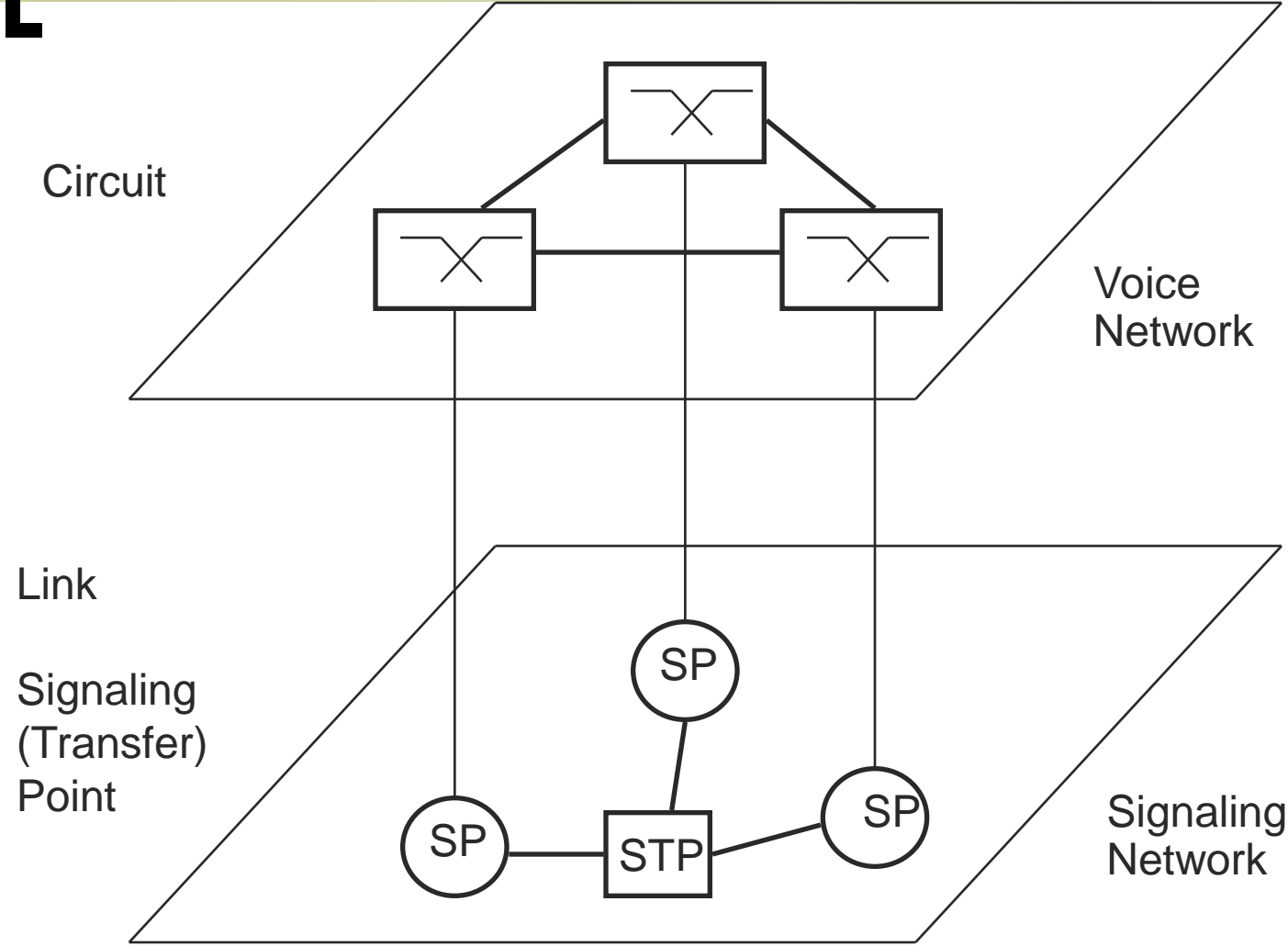
Common Channel Signaling - CCS

- **CCS**
  - Signaling does not have to go along the same path as speech
  - Abbreviated as CCS7, CCS#7, SS7 or simply C7
  - Modular in design protocol architecture
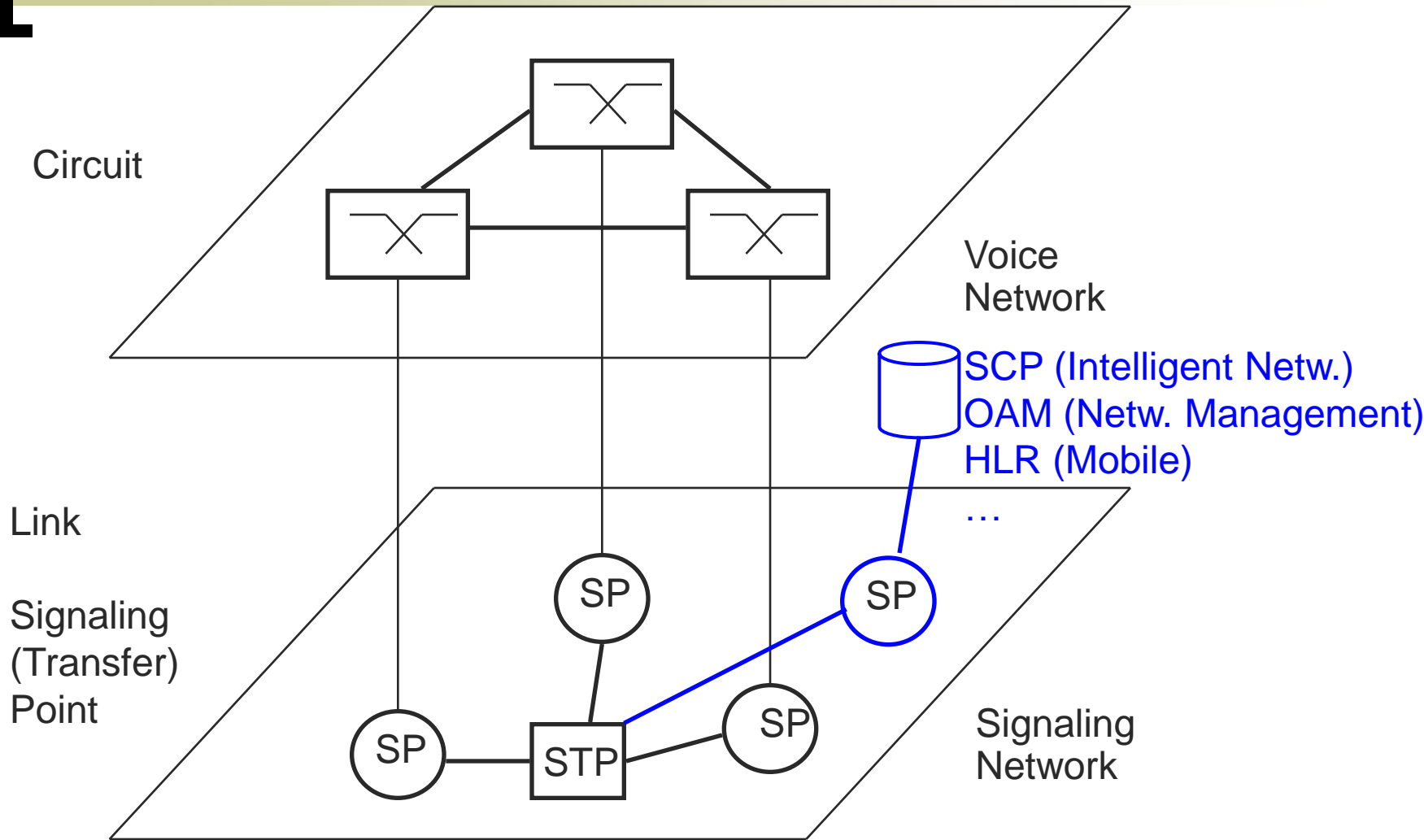 - Non call related signaling possible

Common Channel Signaling Systems

- Digital signals on a voice circuit independent network

- One signaling link serves the need of several voice circuits

- Disadvantages:
  - additional subnetwork $\rightarrow$ plus cost
  - more complicated switches
  - explicit continuity check needed

- Advantages:
  - better voice circuit utilisation
  - complex messages: several services/features can be controlled by one system
  - stronger protection than for voice transmission
  - call-independent messages possible
    - data base query
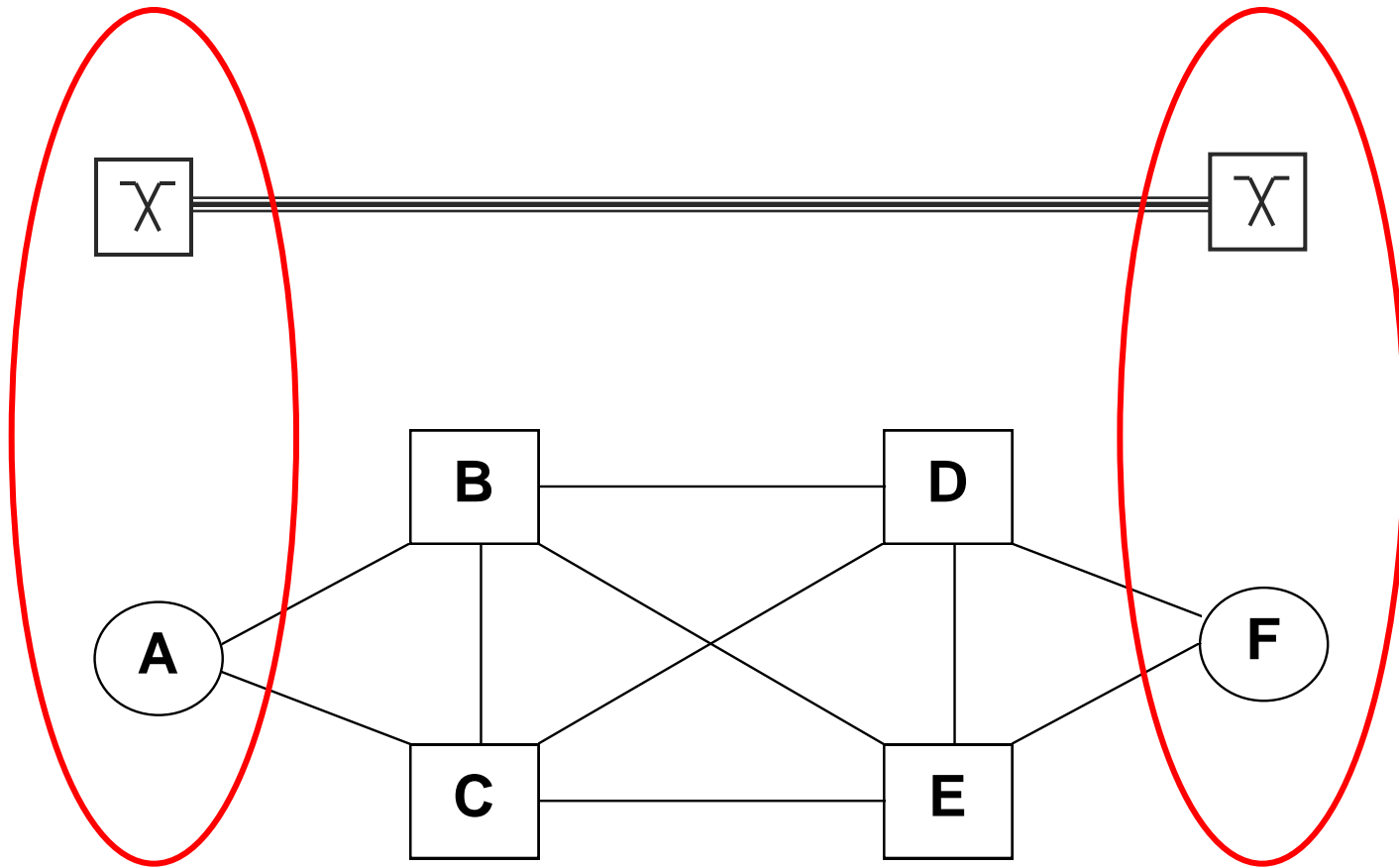   - SMS
    - operation and mainteneance messages

4

CCSS

Circuit

Voice
Network

Link

Signaling
(Transfer)
Point

SP

SP

STP

SP

Signaling
Network

5

CCSS

Circuit

Voice
Network

SCP (Intelligent Netw.)
OAM (Netw. Management)
HLR (Mobile)

...

Link

Signaling
(Transfer)
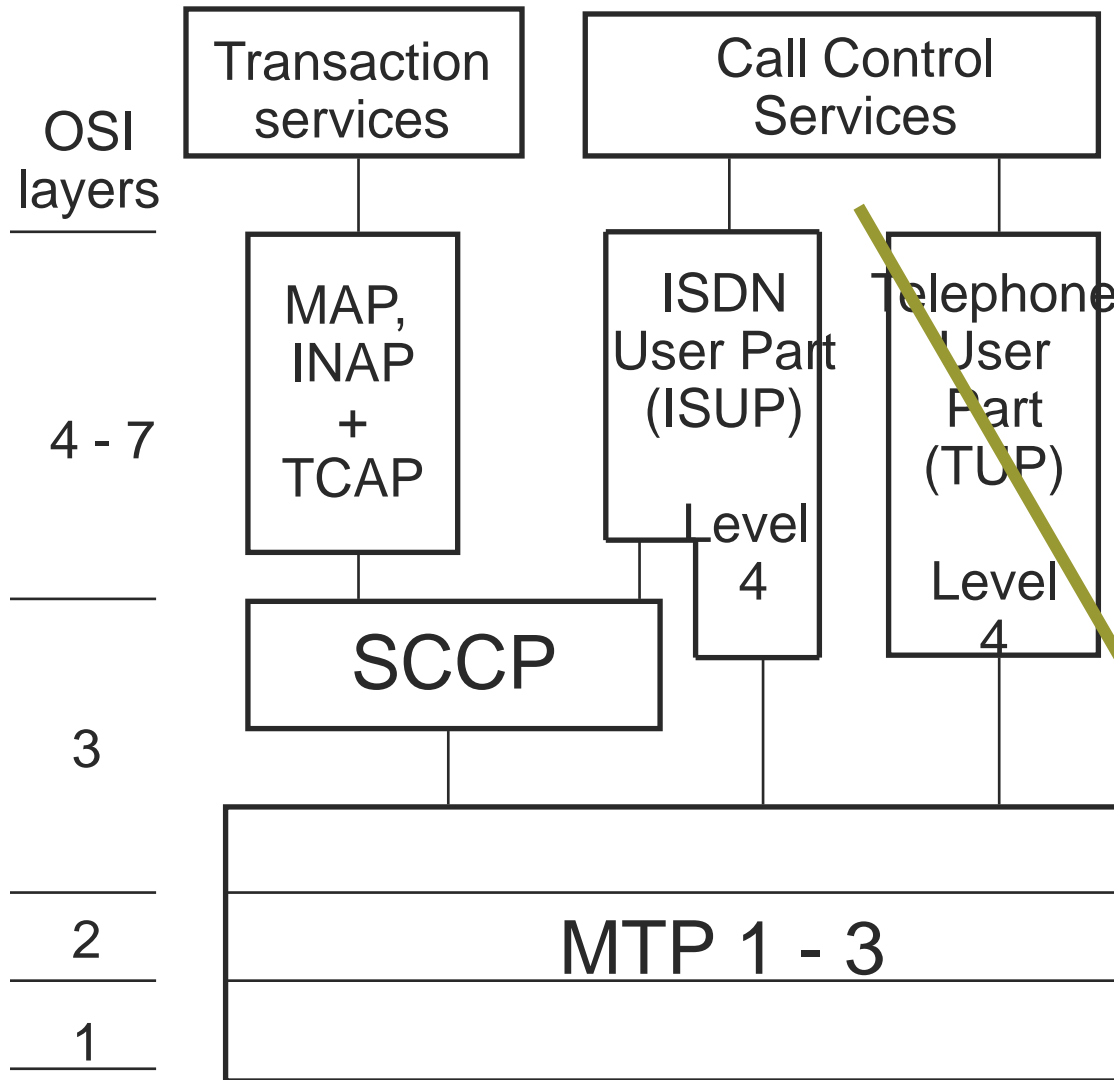Point

SP

SP

SP

STP

SP

Signaling
Network

6

Connection Types

- Associated connection
  - Same path for link and circuit
    - different, dedicated time slots
    - different, dedicated cables
- Quasi-associated connection
  - Different paths

CCSS7 Subnetwork

CCSS7 Protocol Architecture

	Transaction services		Call Control Services	
OSI layers				

4 - 7	MAP, INAP + TCAP	ISDN User Part (ISUP) / Telephone User Part (TUP) / Level 4

SCCP

3

MTP 1 - 3

2

1

SS7 Protocol Layers

Signaling System 7 was introduced by AT&T in 1975 and approved by worldwide standard bodies in 1980.

SS7 basic functions are as follows

MTP (Message Transfer Part) - Provides a reliable transfer and delivery of signaling information in a signaling network.

TUP (Telephone User Part) - Provides the transport of call set-up information between two signaling points only for voice services.

ISUP (ISDN User Part) - Provides the transport of call set-up information between two signaling points.

SCCP (Signaling Connection Control Point) - Provides additional routing capabilities via SubSystem Numbers (SSNs). It also offers the capability of routing based on dialed digits or global title translation.

TCAP (Transaction Capability Application Part) - Provides the capability of transferring non-circuit-related information between signaling points.

SS7 Protocol Layers over IP

SCTP (Streams Control Transmission Protocol) - Provides generic transport for SCN signaling .
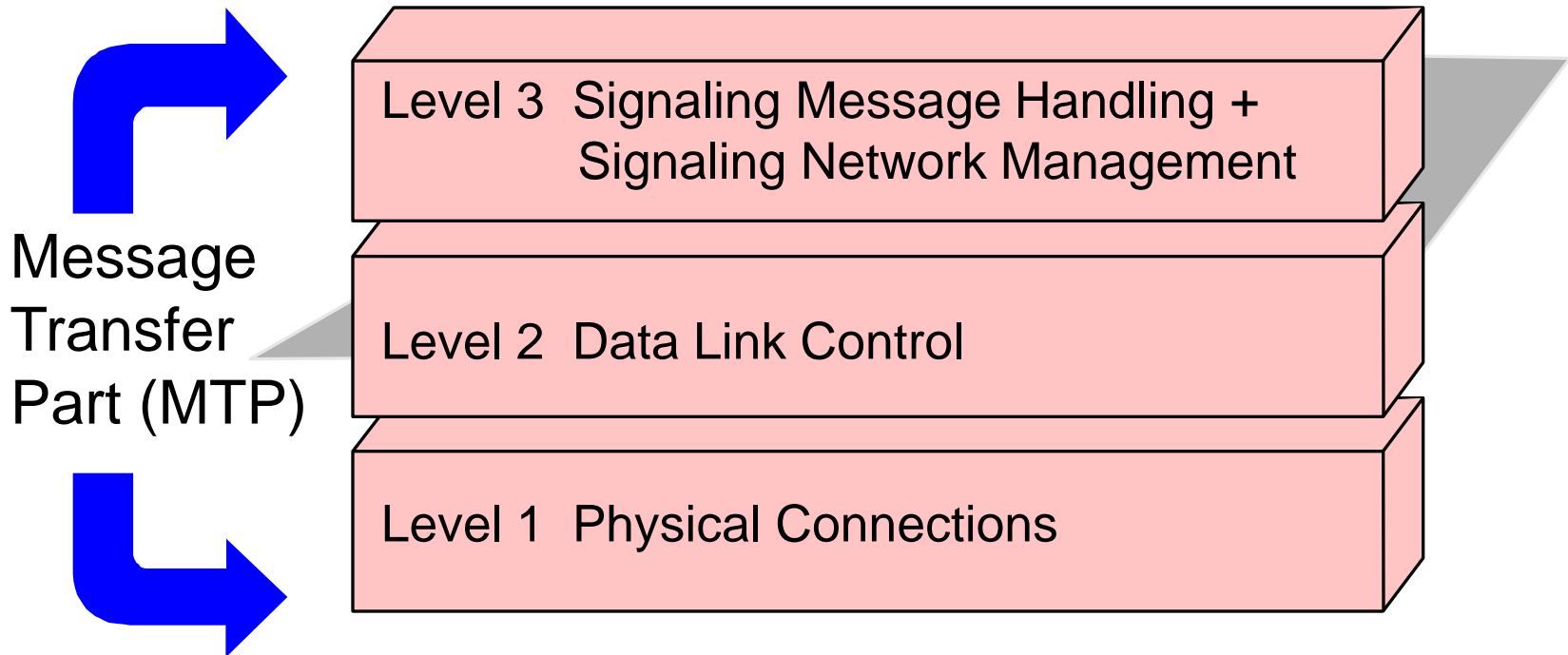
M2PA (MTP 2 Peer-to-peer Adaptation Layer) - Enables SS7 links replacement over IP.

M2UA (MTP 2 User Adaptation Layer) - Enables SS7 back-hauling from remote end-points over IP.

M3UA (MTP 3 User Adaptation Layer) - Enables SS7 User Parts (e.g. ISUP and SCCP) to run over IP.

SUA (SCCP User Adaptation Layer) - Enables SS7 Application Parts (e.g. TCAP) to run over IP.
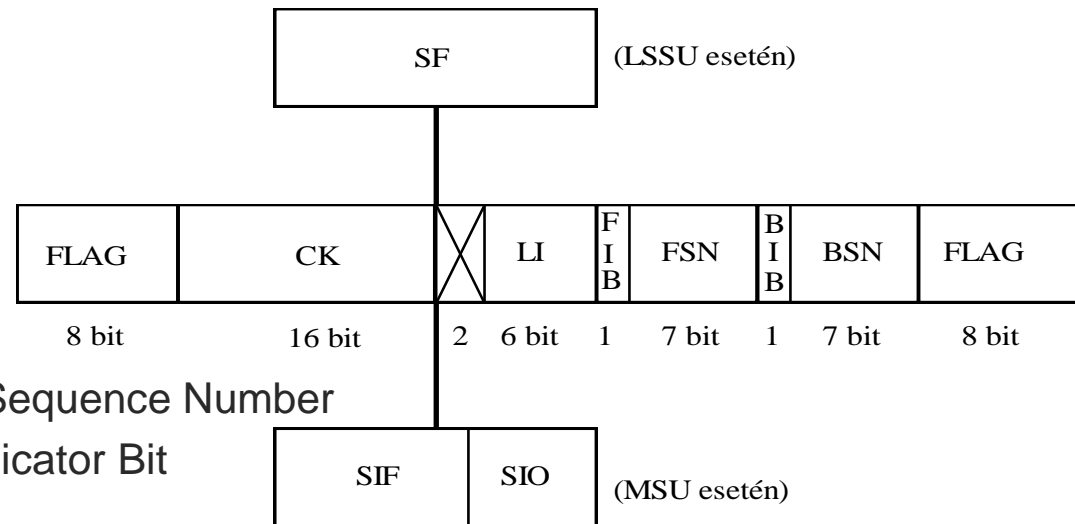
MTP levels of CCSS7

Message Transfer Part (MTP)

Level 3 Signaling Message Handling + Signaling Network Management

Level 2 Data Link Control

Level 1 Physical Connections
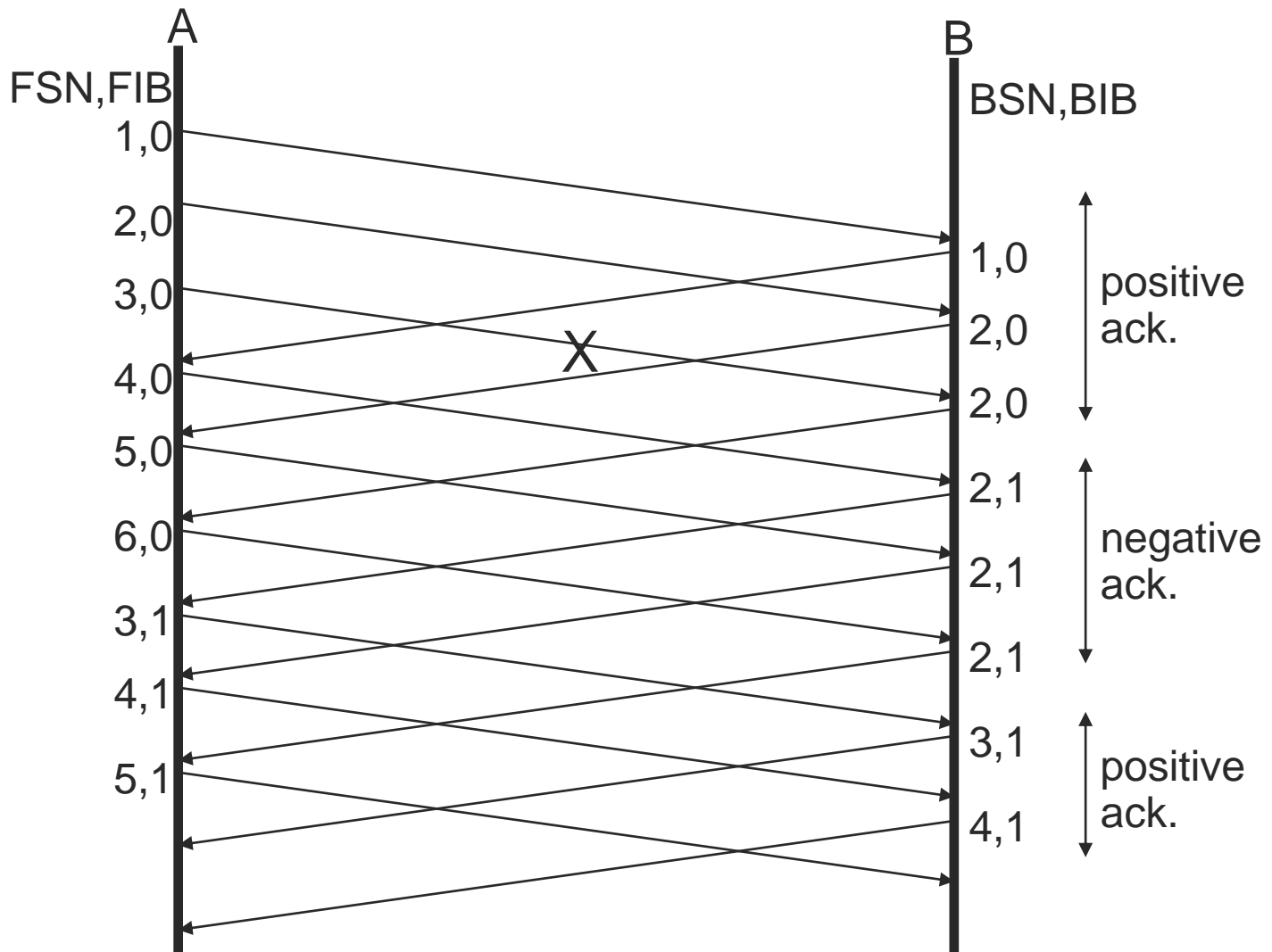
Message Transfer Part (MTP)

- **Level 1 Physical Connections** : Defines the physical, electrical, and functional characteristics of the digital signaling link. Defined physical interfaces include, DS1 (1.544 Mbps), **E1 (2.048 Mbps),** V.35 (64 kbps),DS0 (64 kbps), and DS0A (56 kbps).

- **Level 2 Data Link Control** : Defines the functions and procedures to ensure that messages are reliably transmitted across a signaling link. They implement flow control, message sequence validation, and error checking. When an error occurs on a signaling link, the messages are retransmitted.
  - Framing
  - Error detection and correction
  - Different message types

MTP-2 Message Structure

SF		(LSSU esetén)

FLAG	CK	⊠	LI	FIB	FSN	BIB	BSN	FLAG
8 bit	16 bit	2	6 bit	1	7 bit	1	7 bit	8 bit

SIF	SIO	(MSU esetén)

- Flag: 01111110 + bit stuffing
- FSN/BSN: Forward/Backward Sequence Number
- FIB/BIB: Forward/Backward Indicator Bit
- LI: Length Indicator
- CK: Checksum
- FISU: Fill-In Signal Unit
- LSSU: Link Status Signal Unit
- MSU: Message Signal Unit
- SIF: Service Information Field („Address" + Message)
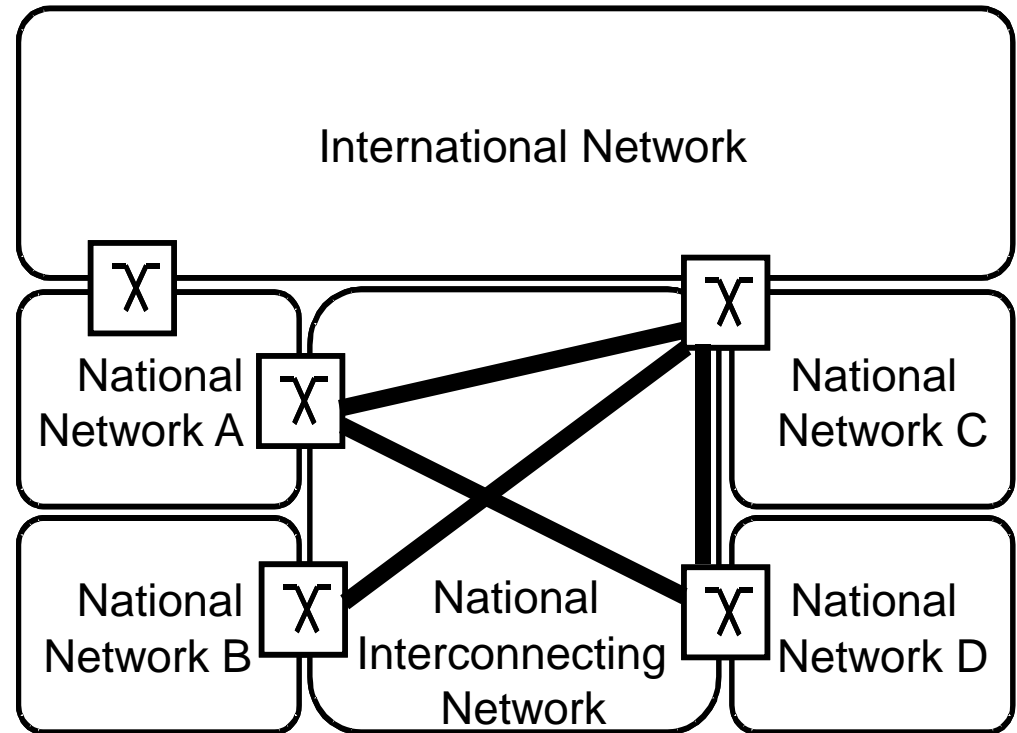- SIO: Service Information Octet

MTP-2 – Basic Error Correction

Message Transfer Part (MTP)

- **Level 3**
  - **Signaling Message Handling**: Provides message routing between signaling points in a SS7 network.
  - **Signaling Network Management:** Monitors state of the signaling network + performs reconfiguration when necessary

Signaling Networks, Signaling Point Codes

International Network

National Network A

National Network C

National Network B

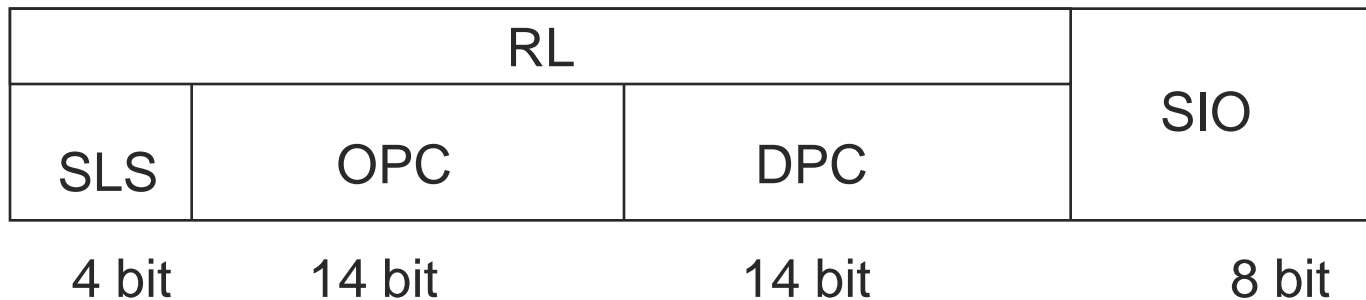National Interconnecting Network

National Network D

Signaling Point Code – 14 bit

ISPC = Zone Code + Area/Network Code + Signaling Point Identifier
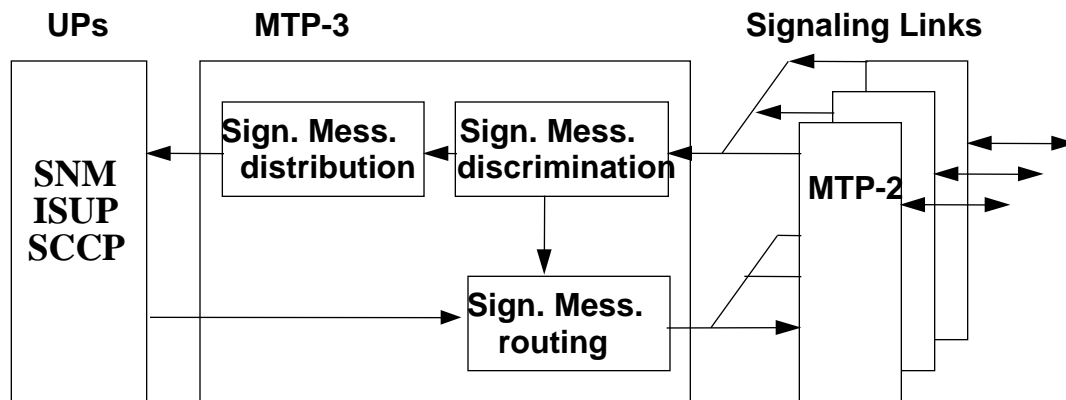NISPC = Operator Code + Signaling Point Identifier
NSPC

MTP-3 Addressing

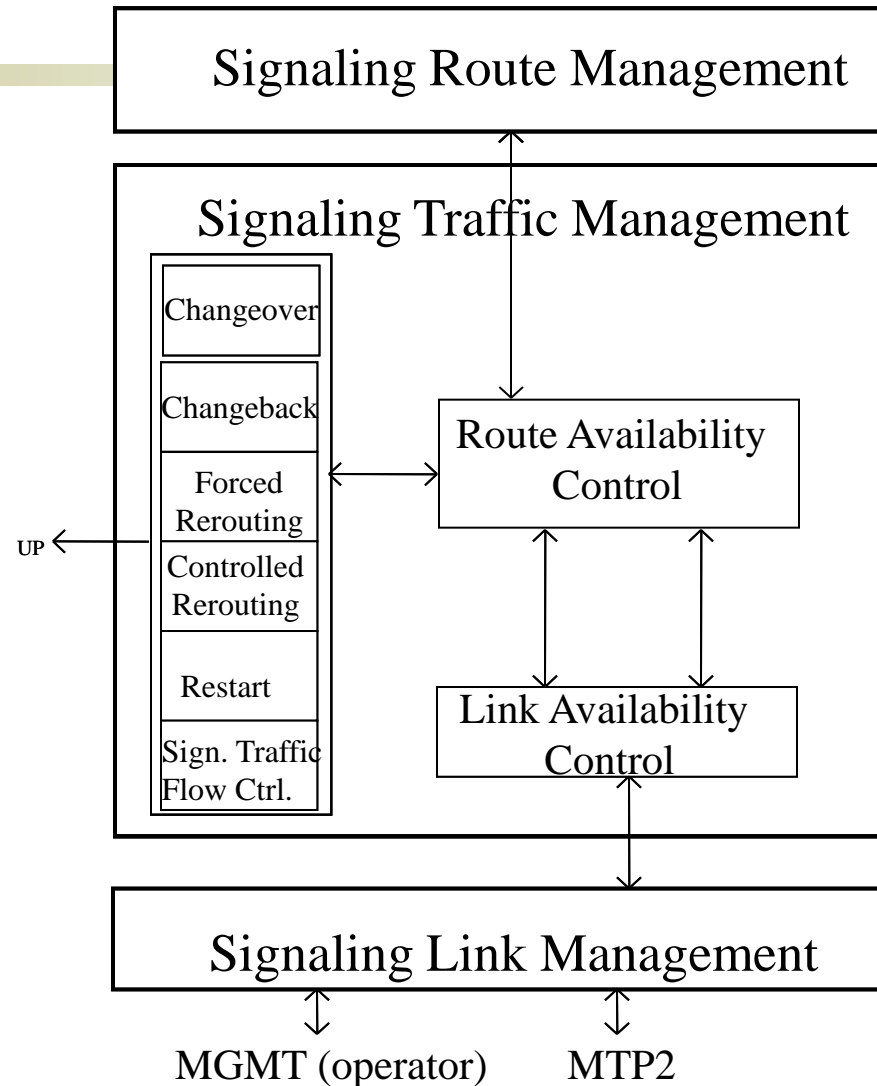| RL			SIO
SLS	OPC	DPC	

| 4 bit | 14 bit | 14 bit | 8 bit |

- RL – Routing Label
  - OPC, DPC – Originating Point Code, Destination Point Code –
  - SLS – Signaling Link Selection
- SIO – Service Indicator Octet = Network Indicator (NI) + Service Indicator (SI)

MTP-3 Signaling Message Handling

MTP-3 Signaling Network Management

Signaling Route Management

Signaling Traffic Management

Changeover

Changeback

Forced Rerouting

Controlled Rerouting

Restart

Sign. Traffic Flow Ctrl.

UP

Route Availability Control

Link Availability Control

Signaling Link Management

MGMT (operator)   MTP2

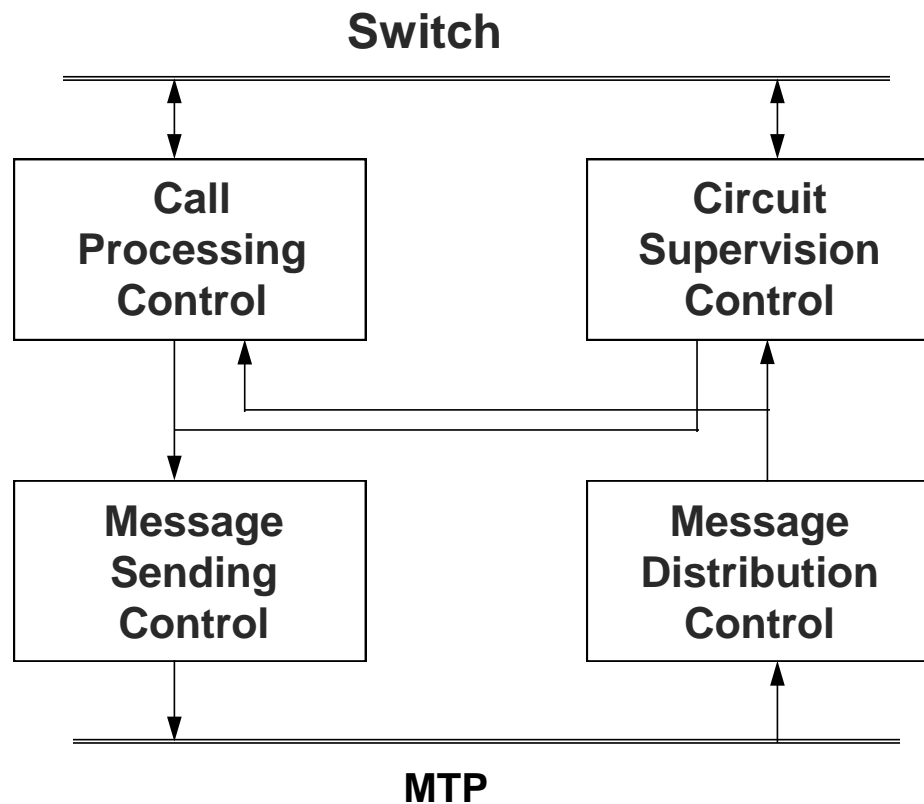# Protocol stack for fixed networks in CCSS7
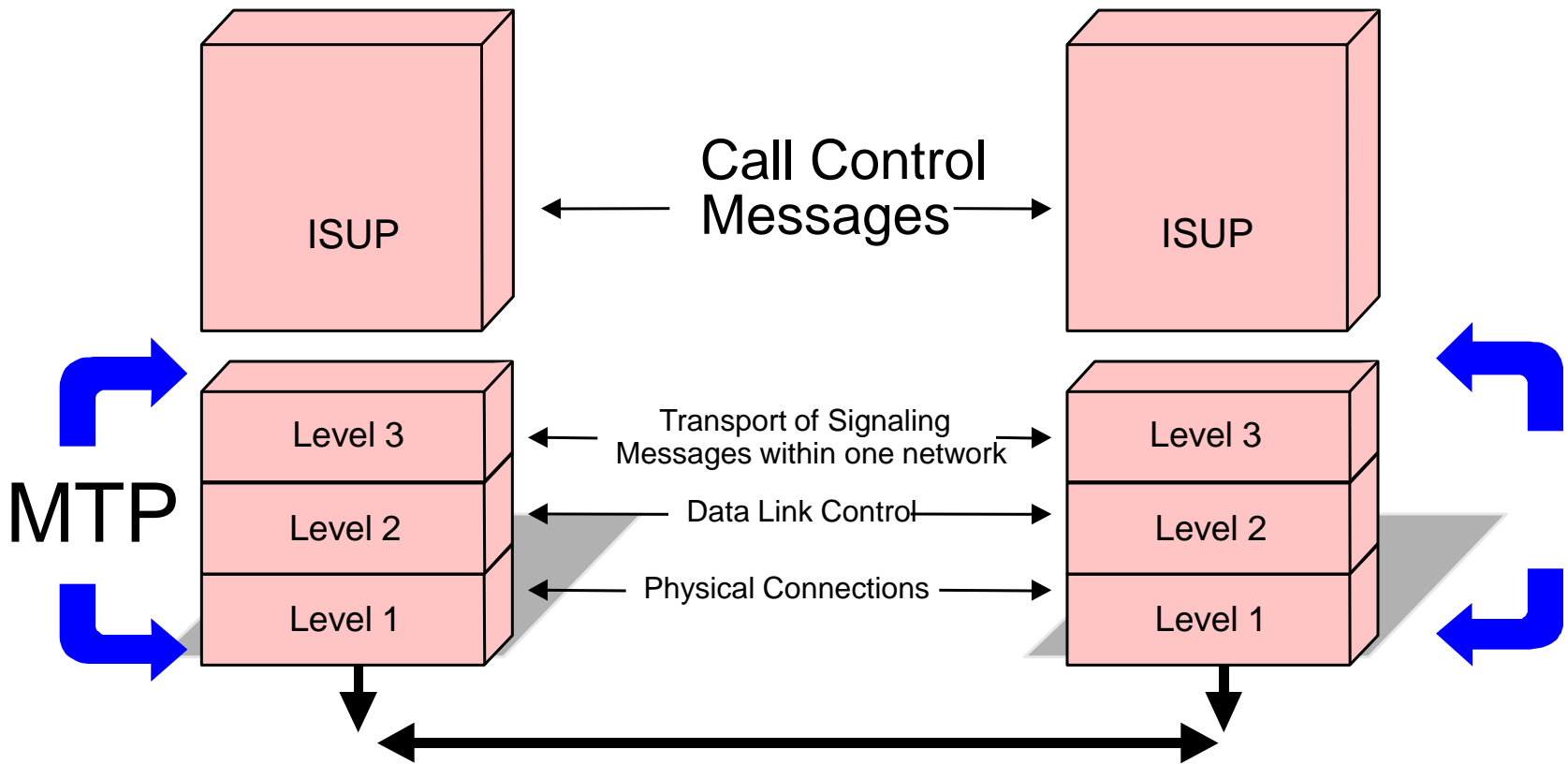
MTP – Message Transfer Part

User Parts

- **Telephone User Part (TUP)**
  - Defines the international telephone call control signaling functions for basic call setup and release. Withdrawn.

- **Data User Part (DUP)**
  - Defines data transfer control. Obsolete.

- **ISDN User Part (ISUP)**
  - Defines the protocol used to setup, manage, and release trunk circuits that carry voice and data + ISDN Supplementary Services
    - Call Control
    - Circuit Supervision

ISUP Functional Blocks

Switch

```
        Call                    Circuit
     Processing               Supervision
      Control                   Control


      Message                   Message
      Sending                 Distribution
      Control                   Control
```

MTP

ISUP Message Structure

CIC
Circuit Identification Code (12 bit + 4 spare)

Message type code
Type

Mandatory fixed part
Parameter A
Parameter ...
Parameter F

Mandatory variable part
Pointer to parameter M
Pointer to parameter ...
Pointer to parameter P
Pointer to start of optional part

Length indicator of parameter M

Parameter M

...
Length indicator of parameter P

Parameter P

Optional part
Parameter name=X
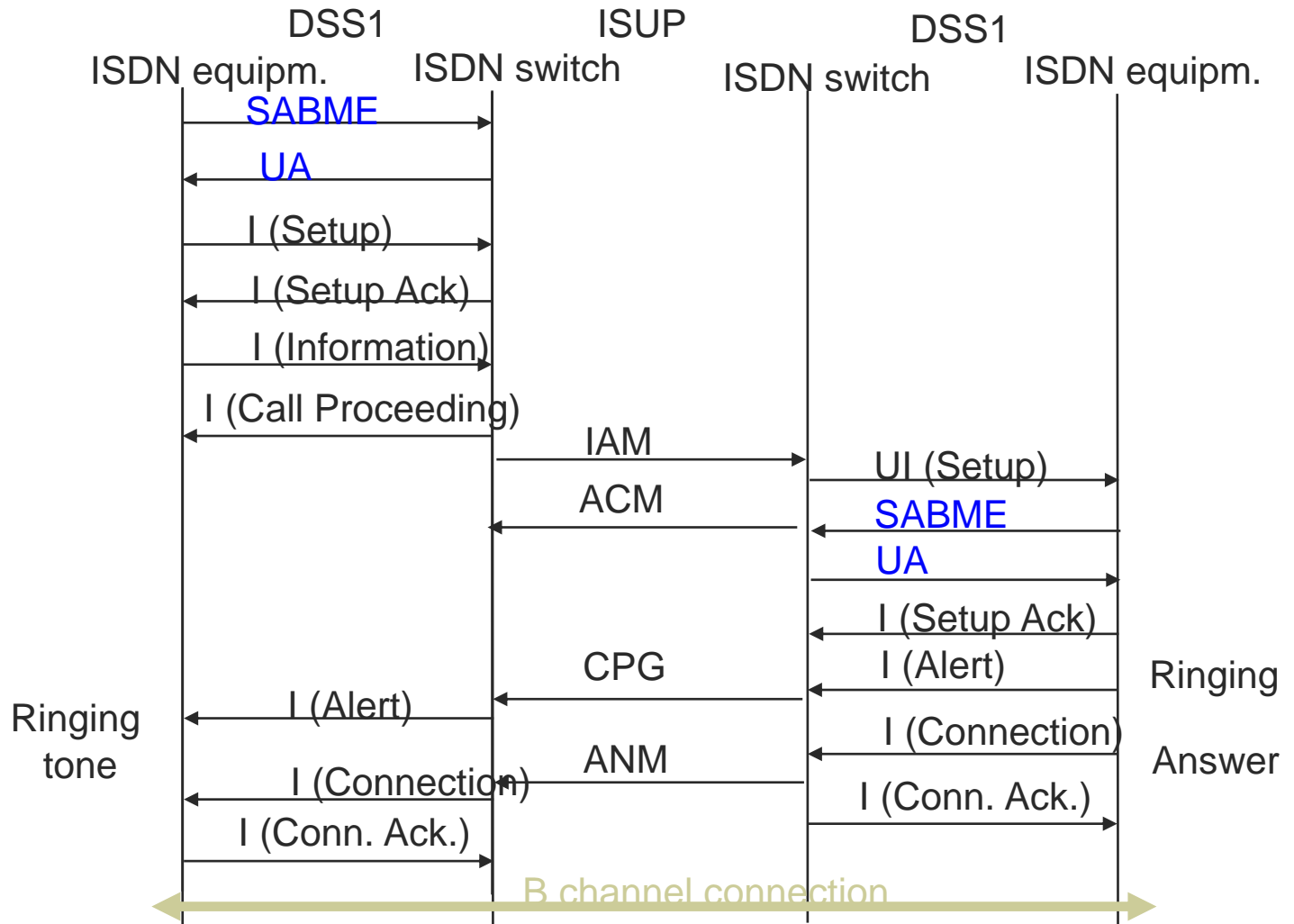Length indicator of parameter X

Parameter X
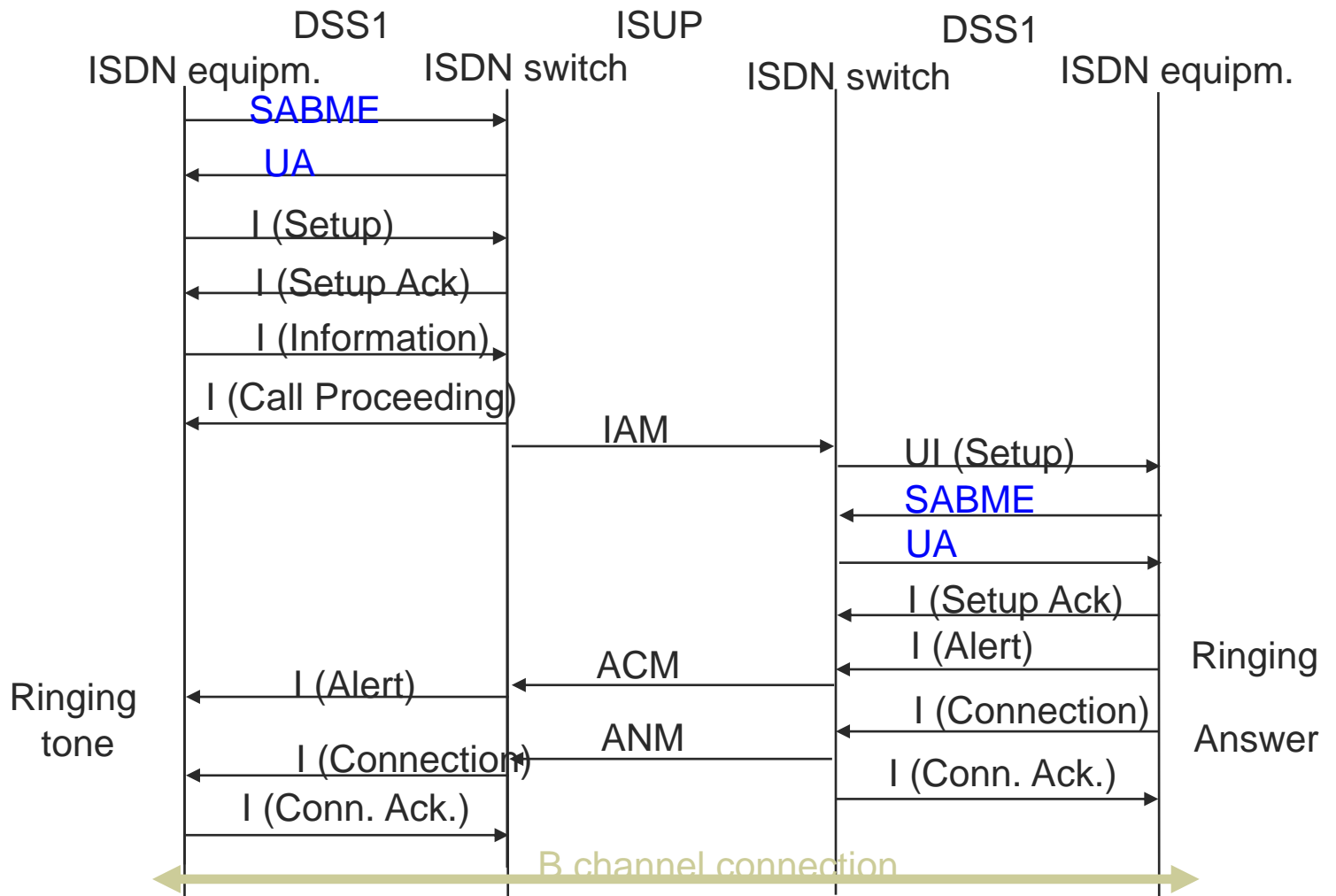
...
Parameter name=Z
Length indicator of parameter Z

Parameter Z
End of optional parameters

ISDN call establishment – early ACM

DSS1
ISDN equipm. — ISDN switch
ISUP
ISDN switch
DSS1
ISDN switch — ISDN equipm.

SABME →
← UA
I (Setup) →
← I (Setup Ack)
I (Information) →
← I (Call Proceeding)
IAM →
UI (Setup) →
← ACM
← SABME
UA →
← I (Setup Ack)
CPG →
← I (Alert)
Ringing
← I (Alert)
I (Connection) →
ANM →
← I (Connection)
Answer
I (Conn. Ack.) →
Ringing tone
← I (Connection)
I (Conn. Ack.) →

B channel connection

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ISDN call establishment – late ACM

ISDN call release

ISDN equipm. ISDN switch ISDN switch ISDN equipm.

DSS1 ISUP DSS1

B channel connection

Dis-
connect

I (Disconnect) REL I (Disconnect)

RLC I (Release)

I (Release)

I (Rel. Complete) I (Rel. Complete)

DISC DISC

UA UA
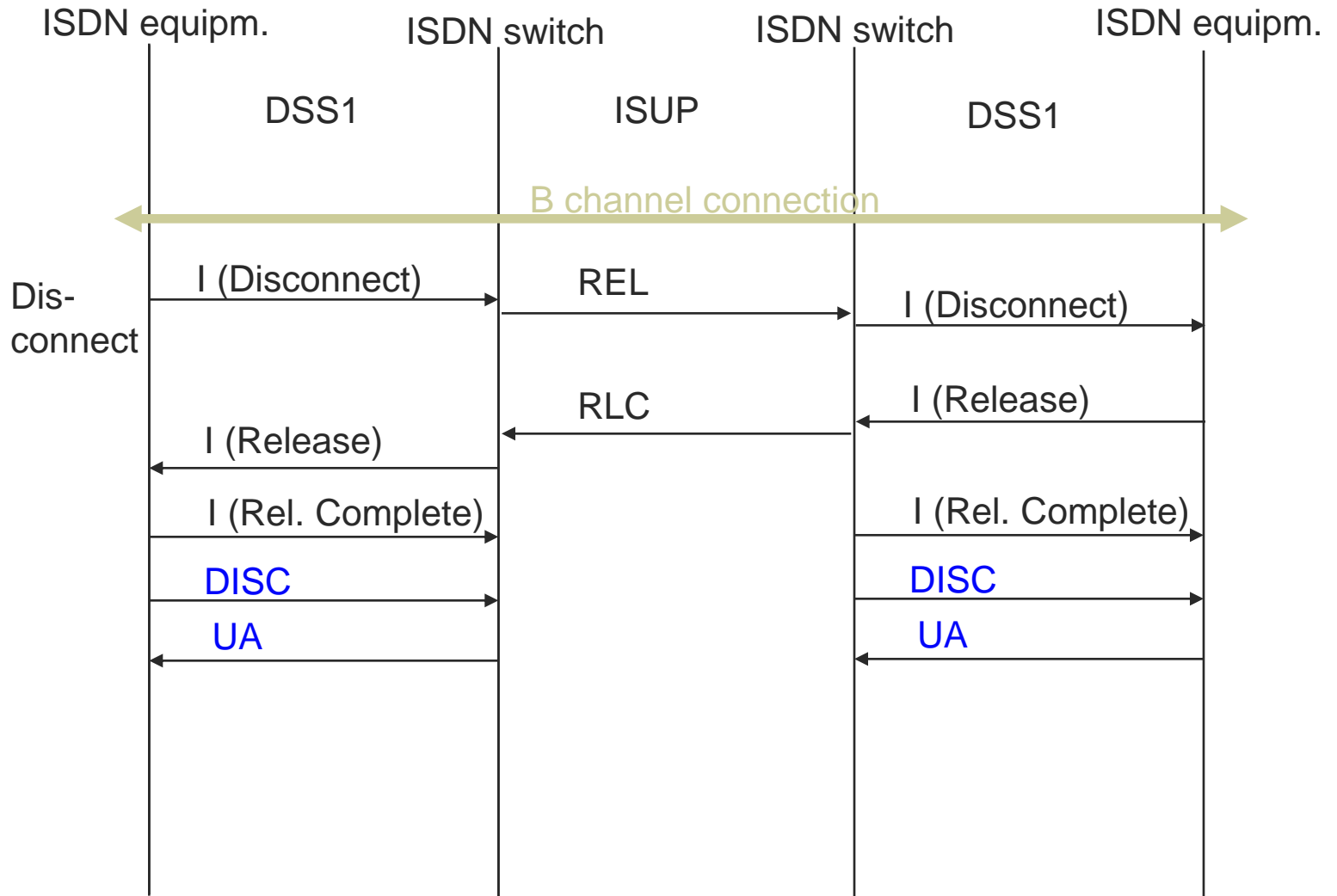
ISUP messages

- Initial address message (IAM): contains all necessary information for a switch to establish a connection

- Subsequent Address Message (SAM)

- Address complete message (ACM): acknowledge to IAM; the required circuit is reserved and the "phone is ringing" (ringback tone)

- Call Progress (CPG)

- Answer message (ANM): occurs when the called party picks up the phone

- Release (REL): sent by the switch sensing that the phone hung up

- Release complete (RLC): each exchange that receives REL, sends an RLC message back (this acknowledges receipt of REL)

IAM parameters

Message Type (IAM)

Nature of Connection Indicators
  • *Satellite Ind.*
  • *Continuity Ind.*
  • *Echo Control Device Ind.*

Forward Call Indicators
  • *Nat/Intl Call Ind.*
  • *End-to-End Method Ind.*
  • *Interworking Ind.*
  • *End-to-End Information Ind.*
  • *ISDN User Part Ind.*
  • *ISDN User Part Preference Ind.*
  • *ISDN Access Ind.*
  • *SCCP Method Ind.*
  • *Ported Number Translation Ind.*
  • *Query On Release Attempt Ind.*

Calling Party's Category
Transmission Medium Requirement *(ITU Networks)*
User Service Info *(ANSI Networks)*
Called Party Number
Optional Parms

General info

Signaling requirements

Type of caller

Voice line (B channel) requirements