Communication Networks 2

Signaling

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Signaling

- 6. Signaling
  - **6.1 Overview**
  - 6.2 Subscriber signaling
  - 6.3 Inter-switch signaling (SS7)
  - 6.4 GSM signaling

Overview of signaling systems

- Why do we need signaling systems?
  - Communication of terminals and network nodes
- Signaling systems may be (according their place in the network)
  - subscriber signaling systems: between a terminal and a switch (User-network interface, UNI)
  - network signaling systems: between switches and/or other network elements (Network-to-Network Interface, NNI)
- Encoding of signals may be
  - analogue (e.g. voice frequency signal – e.g. DTMF)
  - digital message (similar to the protocols of computer networks)
- Connection with voice path
  - Channel Associated Signaling
  - Common Channel Signaling, CCS (independent from voice path)

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Analogue terminal

- Classification on frequency used:
  - DC: closing of local loop: ringing tone request
  - almost DC: periodical cutting of local loop: dialled number transmission („PULSE mode”, 66ms+33ms)
  - under voice band: ringing 25 Hz (15-68 Hz, USA 20 Hz, Eu. typically 25 Hz, 40-150V (!) AC)
  - in voice band *(in-band signaling)*
    - subscriber → switch: DTMF (Dual Tone MultiFrequency)
      - sum of two sinusoid signals

F (Hz)	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

    - switch → subscriber: dial tone, ringing tone, engage signal, etc. (mainly for humans, not for machines)

Analogue terminal

- Classification on frequency used (cont.):
  - in voice band:
    - Calling number presentation during ringing
      - in the gaps between ringing transfer of digits by FSK (Frequency Shift Keying) modulation
      - Modulating signal:

      - Modulated signal:

    - SMS in fixed network:
      - FSK, the terminal acts as a simple modem (digital signal even in analogue equipments)
  - over vioce band: tariff pulses (12-16 kHz)
    - payphones

Digital Subscriber System No. 1 (DSS1)

- DSS1: Digital Subscriber System No. 1.

3rd layer
LAPD
physical layer

- 1. Physical layer: ISDN D channel
- 2. LAPD: Link Access Procedure on D channel
  - framing
  - error-free signal transfer between a terminal equipment (TE) and a switch (NT – Network Termination)
    - connection-oriented
- 3. DSS1 3rd layer: call control

LAPD – Link Access Procedure on D channel

- Classic 2nd layer (Data Link layer) protocol
- Services:
  - Framing
  - Error free transmission
    - Error Detection
    - Error Correction
- LAPD is a member of the HDLC – High Level Data Link Control protocol family
  - HDLC: Original version – 1960s
  - Connecting a Terminal to a Host Computer

LAPD framing

- Special bit pattern (Flag) to indicate the beginning/end of a frame
  - 01111110 – 7EH
- Transparent transmission
  - prevent the occurence of this pattern inside of a frame
  - Transmitter: inserts a bit0 after 5 consecutive bit1(bit stuffing)
    - Flag-pattern cannot occur for sure – flag contains 6 consecutive bit1s
  - Receiver: after receiving 5 consecutive bit1s – analyzes the next bit
    - If 1: Flag
    - If 0: „inserted” bit – throw, not part of the message

Bit stuffing - example

- Original message:
  - (end) 01111101111110110 (beginning)
- Transmitted message:
  - 011111100011111011011111011001111110
- Length of the message depends on its value

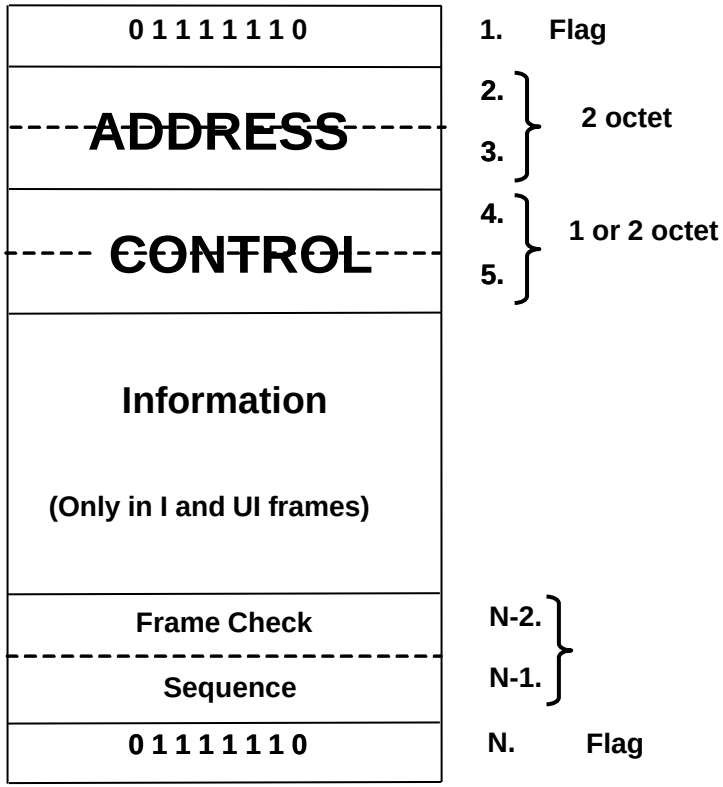
Error detection and Correction

- Detecting transmissional errors
  - Transmitter: Generates a 2 octet long checksum
    - CRC – Cyclic Redundancy Code
  - Receiver: Generates according to the same rules from the received message
    - If the same as in the message – considered to be received correctly
    - If different – thrown away, WITHOUT ANY FURTHER PROCESSING
- Detecting a lost frame
  - Sequence numbers (only in I frame types!)
  - Receiving a message with a „wrong” sequence number
    - Request to repeat

LAPD

- 3 different LAPD frame types:
  - U (Unnumbered): 2nd layer (LAPD) connection control (establishment, release)
  - I (Information): 3rd layer (call control) message transfer
  - S (Supervisory): control the sending of I frames

General format of a LAPD frame



Address:

- SAPI – Service Access Point Identifier
  - 0 – signaling, 63 – LAPD (TEI) management
- TEI – Terminal Endpoint Identifier

  0 – 63 fixed, 64 – 126 automatic, 127 - broadcast

LAPD U frames

- Unnumbered – U frame
- Mainly for controlling a LAPD connection (establishment – release)
- Additionally: Unnumbered Information (UI)
  - LAPD: TEI management
  - DSS1 Layer 3: NT ➔ TE Setup (see later)

Acronim	Name	Meaning
SABME	Set Asynchronous Balanced Mode Extended	LAPD connection establishment request
UA	Unnumbered Acknowledgement	ack. for SABME and DISC
DISC	Disconnect	LAPD disconnection request
DM	Disconnected Mode	Indication of inability of LAPD connection establishment
UI	Unnumbered Information	Unnumbered info transfer (TEI management, network→terminal Setup)

I frame

- Information – I frame
- Transmission of DSS1 Layer 3 info (Call control)

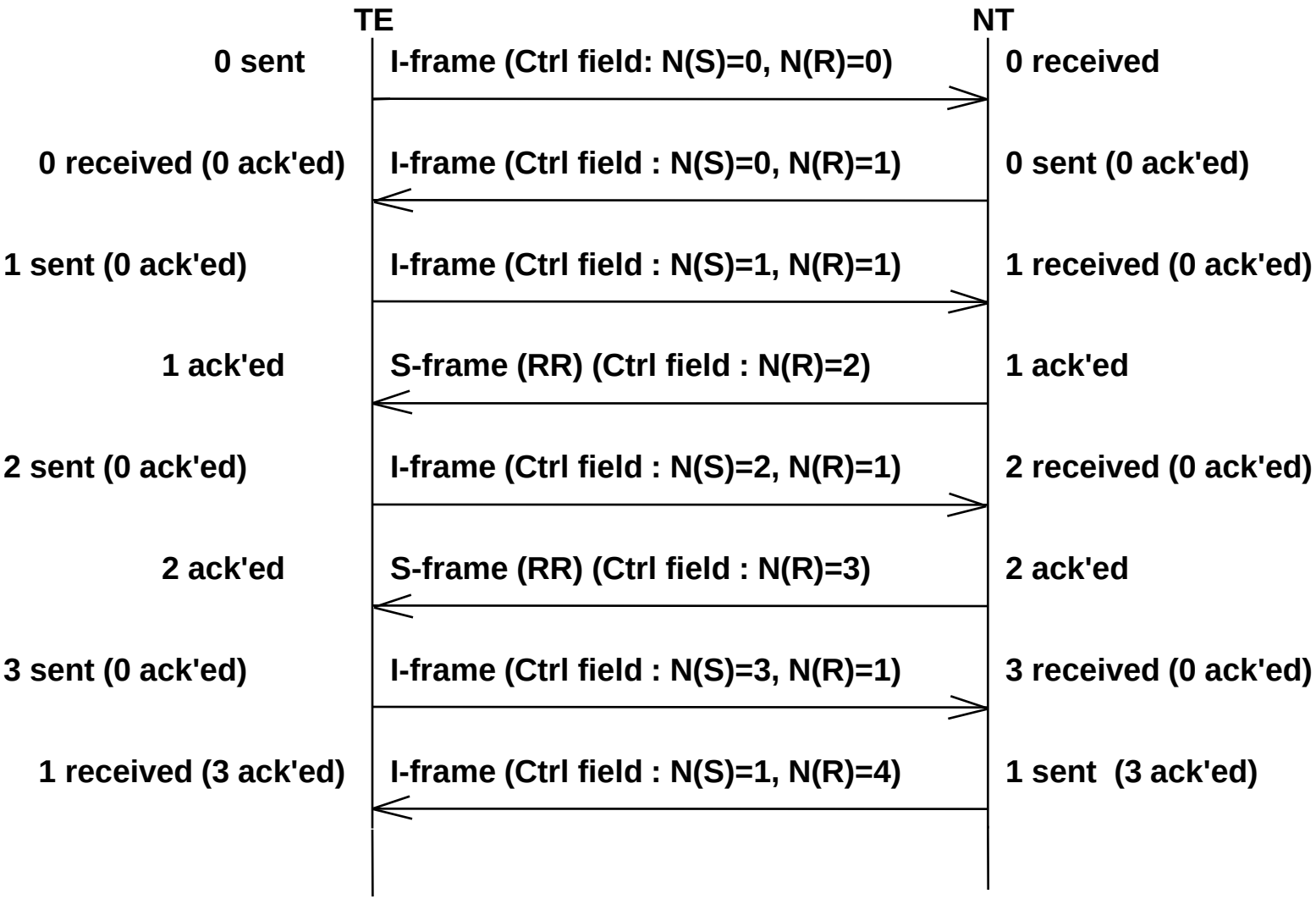
- N(S) – sent number
- N(R) – receive number
  - sequence number of the frame waited for from the opposite side
  - acknowledgement for all the previous frames

S frame types

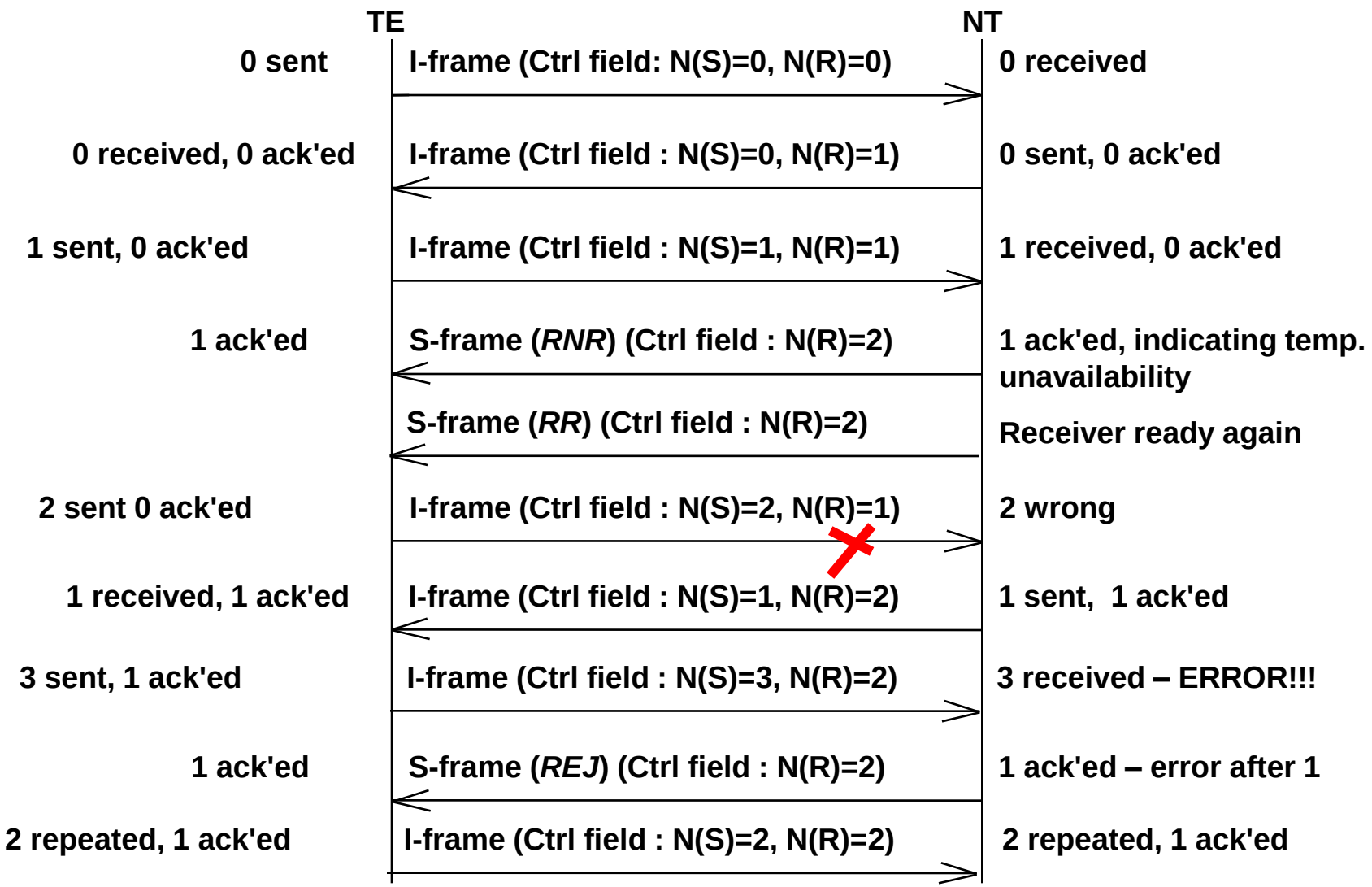
- Supervisory – S frame
- Flow control for I frames

SS	Acronym	Name	Meaning
00	RR	Receive Ready	Positive ack. for an I frame OR Indicating the end of temporary unavailability (after RNR)
01	RNR	Receive Not Ready	Temporary unabitily of receiving I frames (e.g. procession takes a long time, buffer full, etc.)
10	REJ	Reject	Request to repeat I frames

Example of using sequence numbers



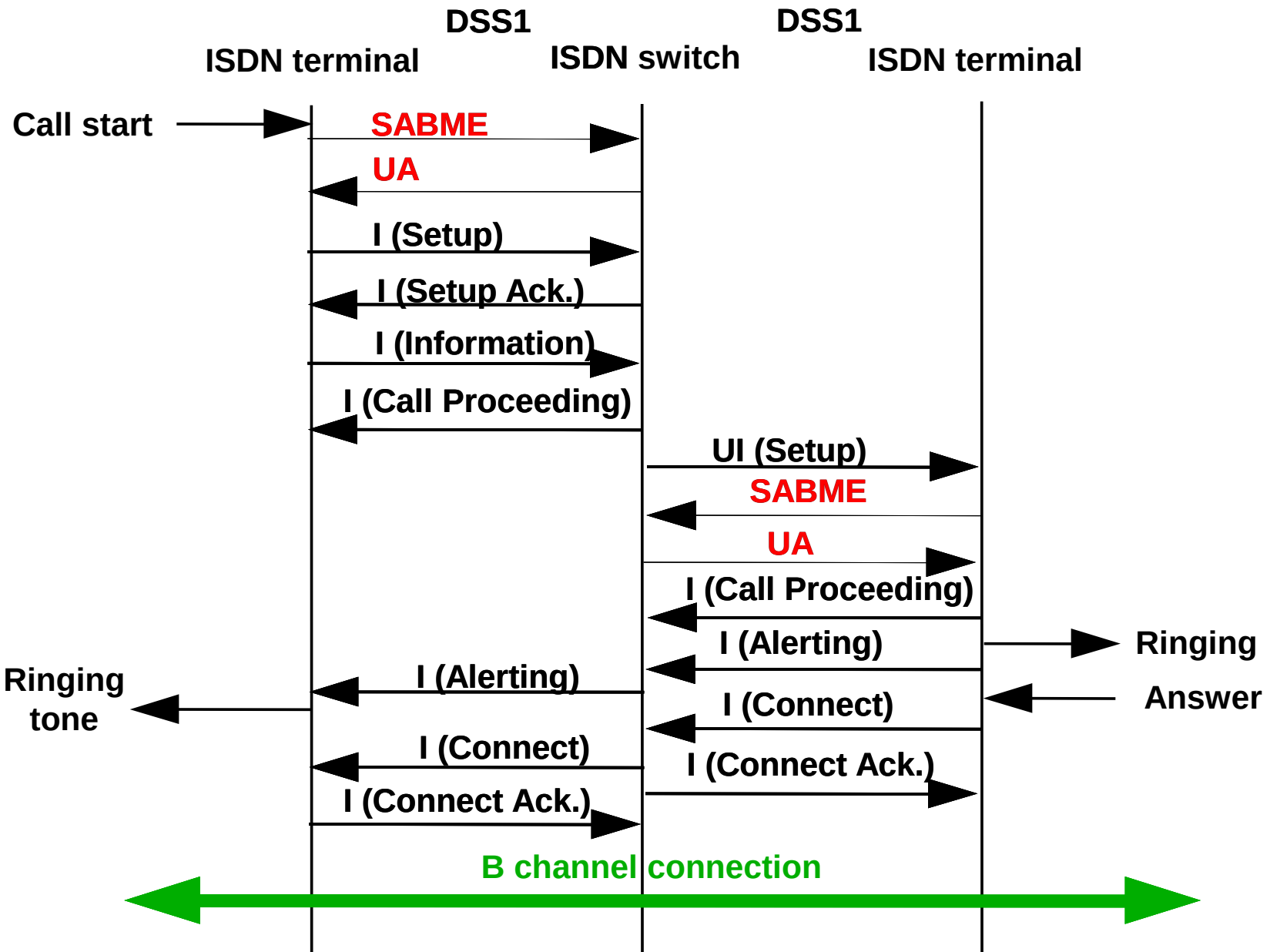
Example of using S frames



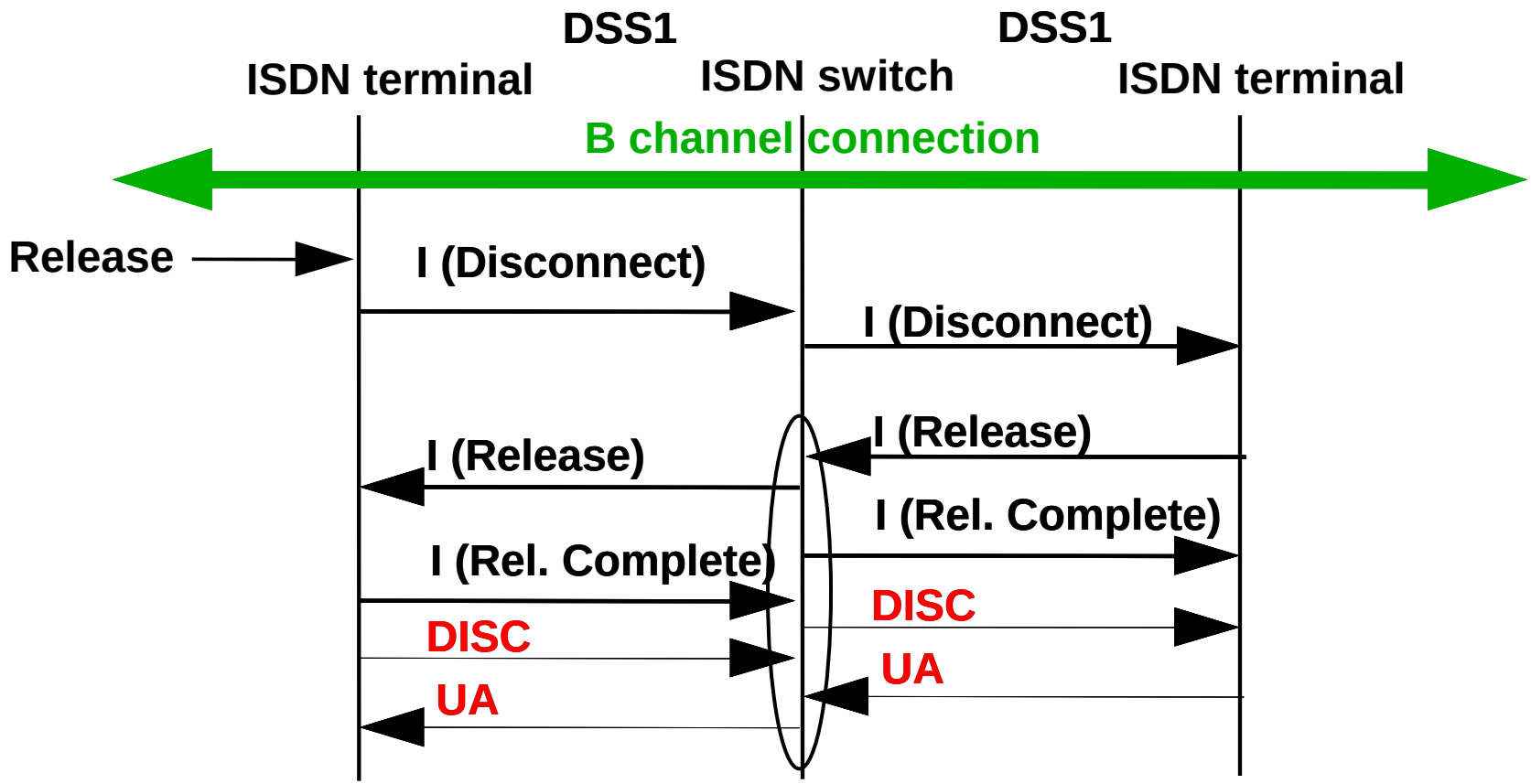
DSS1 3rd layer

- 3rd layer: sometimes we call as DSS1 for short
  - call establishment/release with signaling messages
  - an example on next slide
    - with LAPD messages!

DSS1 example: call establishment



DSS1 example: call release



- Release processes: in parallel at the two sides
- Release process can be started by any of the parties

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Channel Associated Signaling

- Originally: analogue systems
  - or in the voice channel itself – in-band signaling
  - or in a signaling channel associated to the voice line – out-of-band signaling
- Later: digital
  - Signaling bits in a signaling channel associated to the voice line (PCM signaling channel) – out-of-band signaling

Channel Associated Signaling

- Advantages:
  - simple
  - relation between signal and voice channel is obvious
- Disadvantages:
  - limited signaling transfer capability
  - signal transfer is not protected
  - different signaling for different services

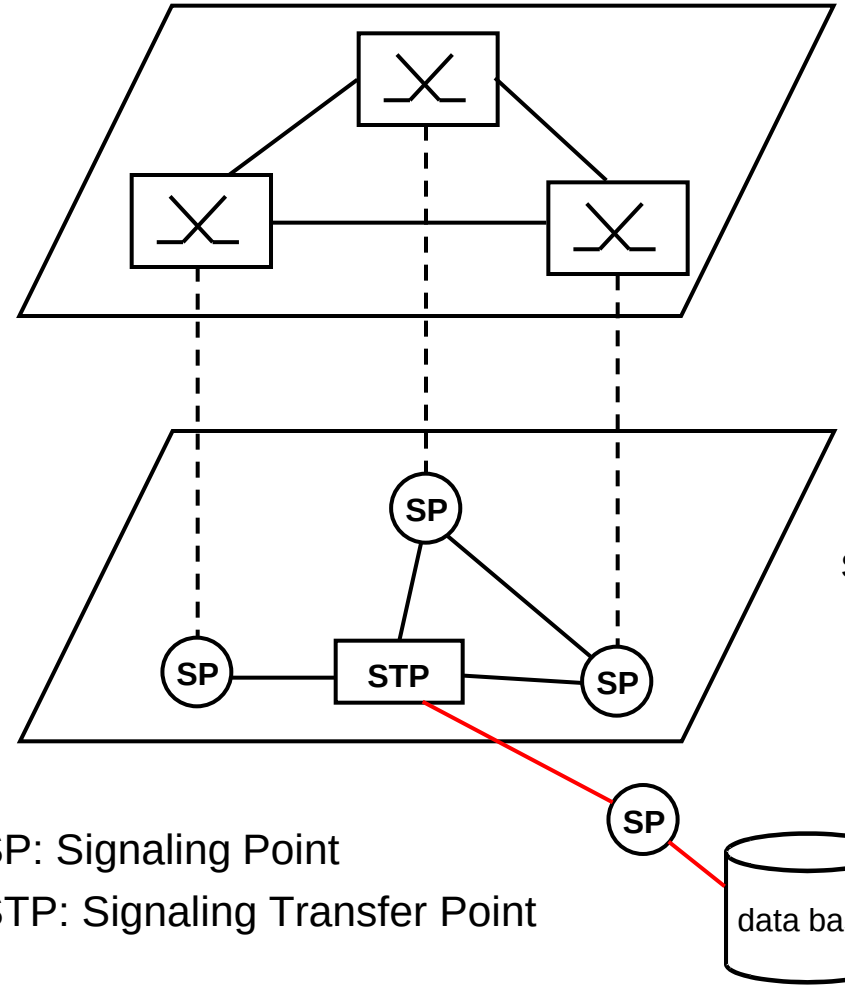
- No non-call-related signal

Common Channel Signaling Systems

- Digital signals on a dedicated signaling channel that is independent from the voice channel
- Idea: not to occupy a voice channel for several, short (~100 byte) signals
- Advantages:
  - better utilisation of voice circuits
  - more complicated signals: lot of services can be controlled
  - signal transfer can be protected more than voice transfer
  - internal (e.g. management) messages possible
  - non-voice-related (e.g. data base query) signals possible (!!!!)
- Disadvantages:
  - separated signaling network → plus cost
  - more complicated functioning of switches, etc.
  - voice path to be established separately – may be checked (call continuity control)
- More advantages…

Common Channel Signaling Systems

- Separate signaling network



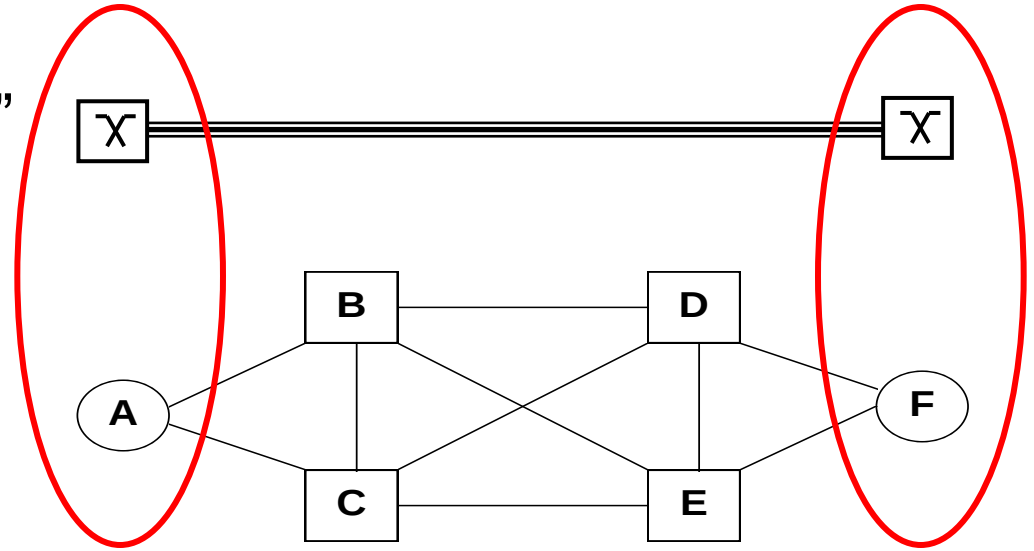
SP: Signaling Point

STP: Signaling Transfer Point

e.g.: HLR, SMSC,
IN – number translation,
number portability

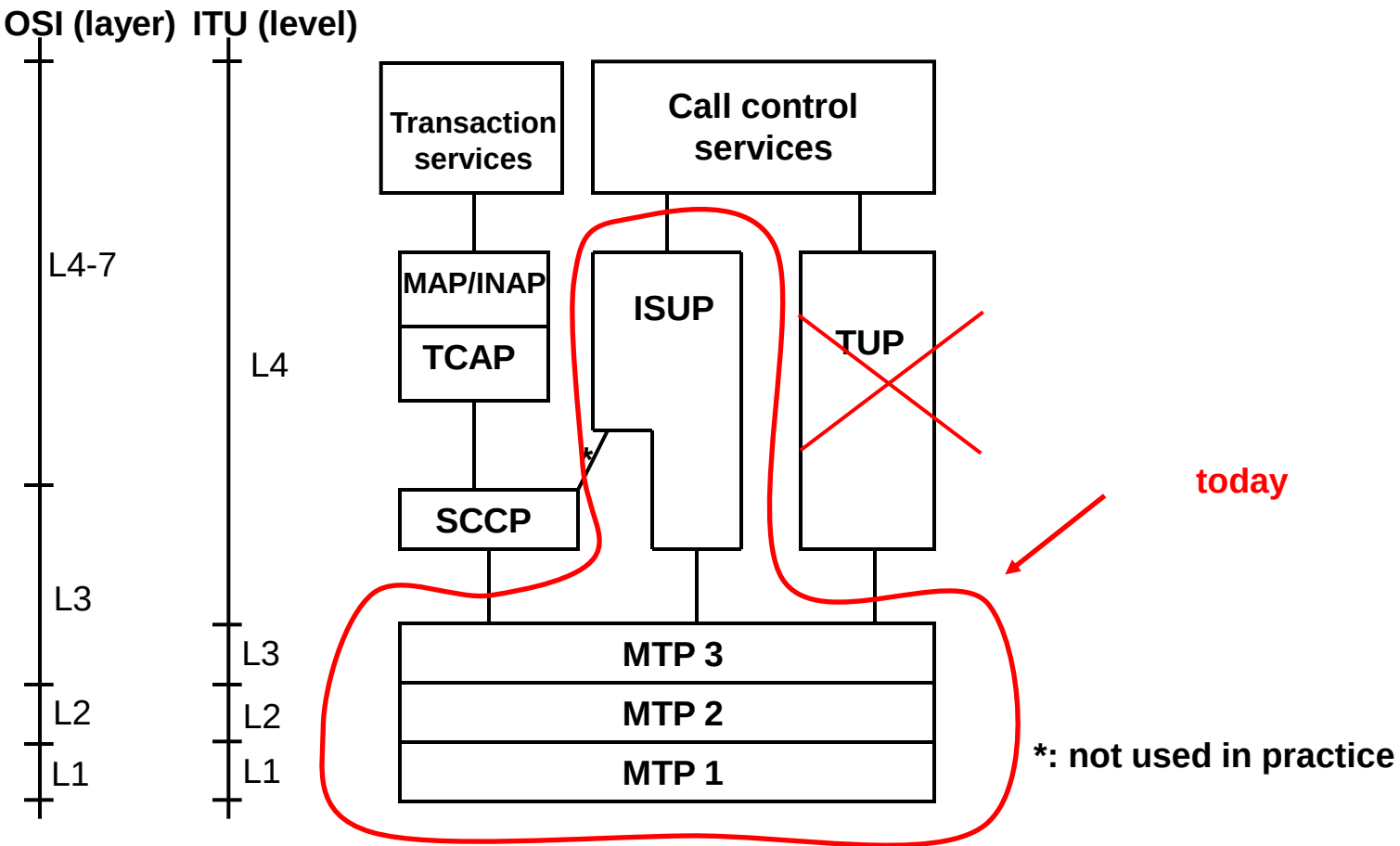
Connection Types

- Associated connection
  - Same path for link and circuit
    - different, dedicated time slots
    - different, dedicated cables
- Quasi-associated connection
  - Different paths
  - “6 sub-network”



(CC)SS7

- „The” Common Channel Signaling System: SS7
- (CC)SS7 = (Common Channel) Signaling System No. 7,
- OSI-like architecture:



SS7

- MTP: Message Transfer Part
- MTP-1: physical level -- 64 kbps digital channel
- MTP-2: framing, error free transmission between neighbouring points
  - 3 types of signaling messages:
    - MSU, Message Signal Unit – carries signals from UPs (e.g. call control)
    - FISU, Fill-In Signal Unit
      when no „useful” signal to be sent – empty signal to maintain synchronisation + acknowledgement
    - LSSU, Link Status Signal Unit – used to indicate the status of the link – processed by SNM

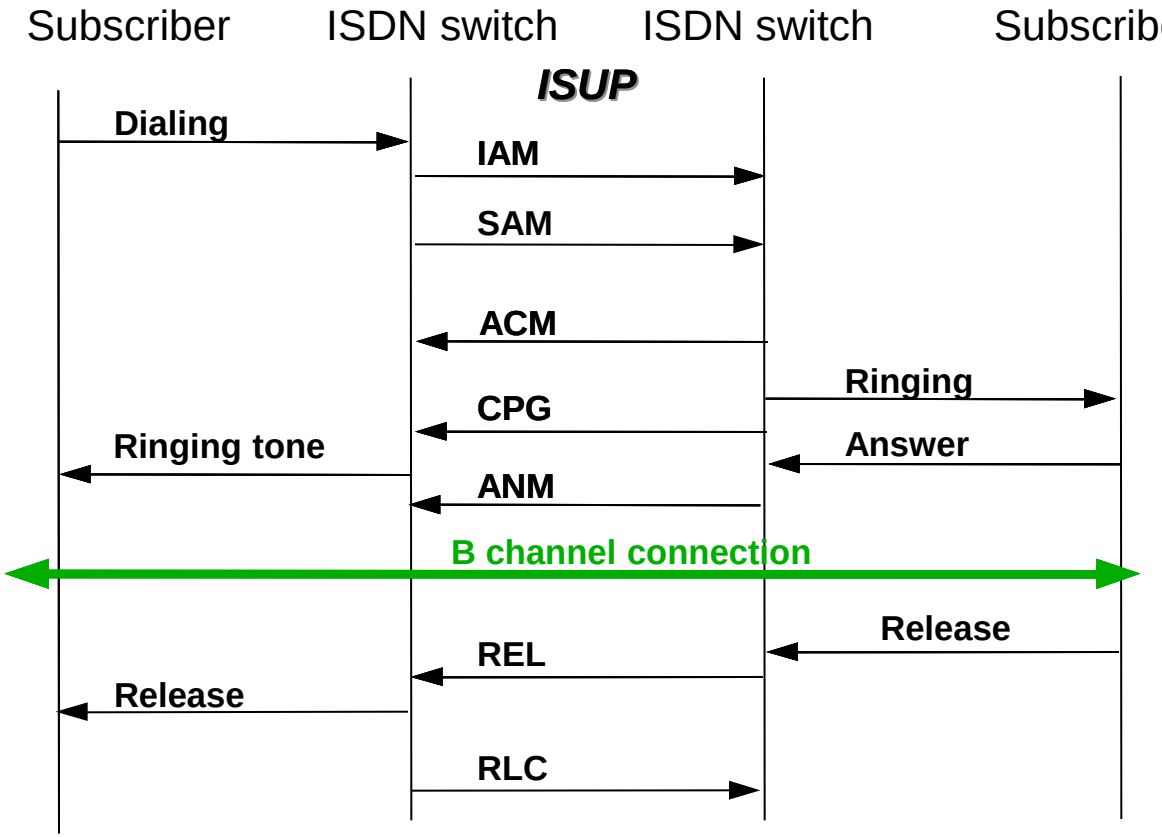
SS7

- MTP-3: message transfer between any two signaling points within a signaling network (remember: national, national interconnecting, international networks)
  - two ends of every voice circuit are always in the same network
  - problem in GSM control: SCCP will be the solution
  - + Signaling Network Management

SS7

- TUP: Telephony User Part, DUP: Data User Part
  - withdrawn → ISUP
- ISUP: ISDN User Part
  - call control/release messages with a lot of parameters
  - circuit supervision
- SCCP: Signaling Connection Control Part
  - inter-network signaling
  - used in mobile systems
  - Global Titles (typically tel. numbers)
- TCAP: Transaction Capabilities Application Part
  - data base transactions (e.g. in GSM)
- MAP: Mobile Application Part
- INAP: Intelligent Network Application Part

ISUP call establishment/release

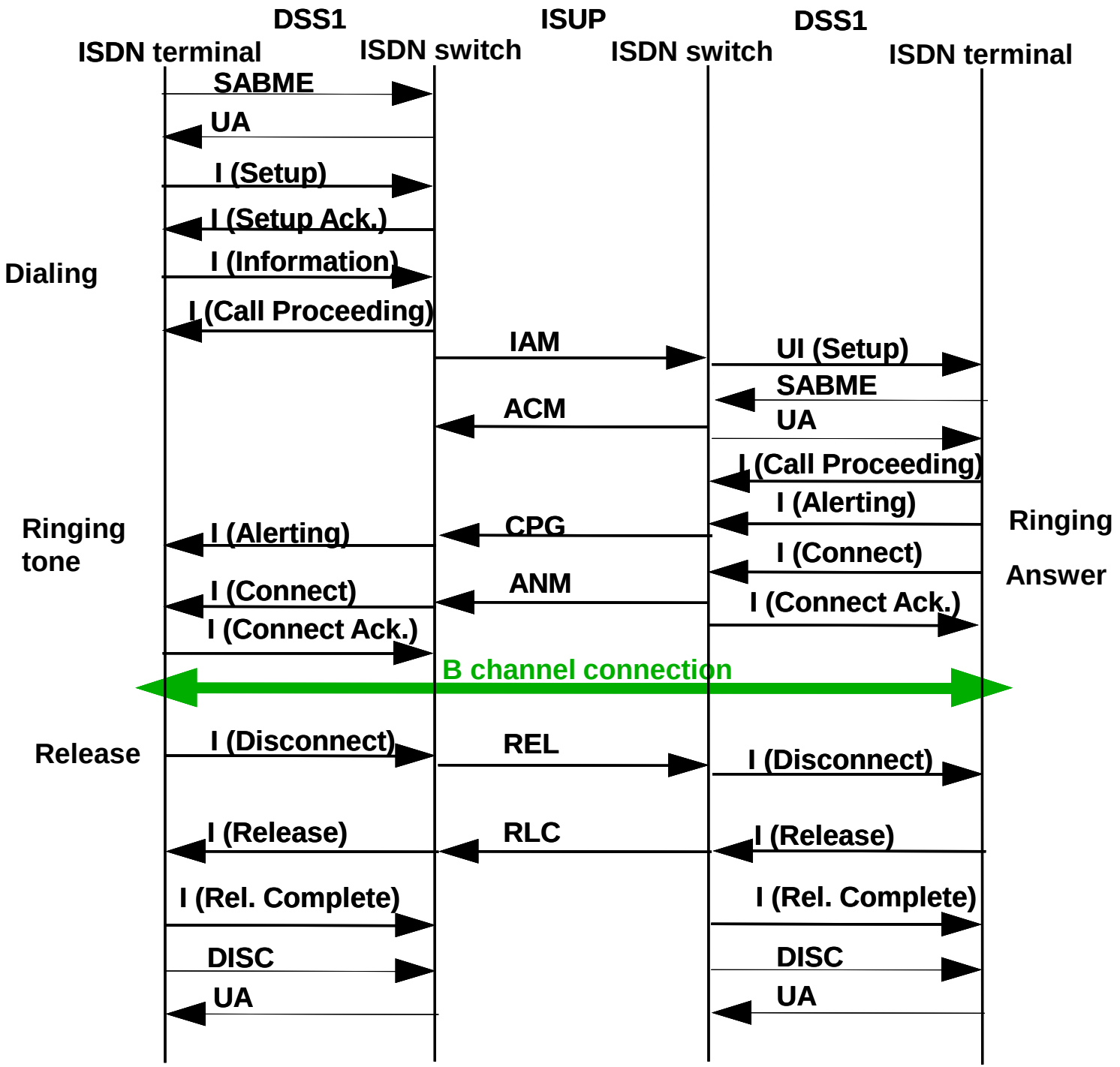


IAM: Initial Address Message,
SAM: Subsequent Address Message,

ACM: Address Complete

CPG: Call (in) Progress,
ANM: Answer Message
REL: Release
RLC: Release Complete

DSS1 + ISUP


DSS1
ISUP
DSS1
ISDN terminal
ISDN switch
ISDN switch
ISDN terminal
SABME
UA
I (Setup)
I (Setup Ack.)
Dialing
I (Information)
I (Call Proceeding)
IAM
UI (Setup)
SABME
ACM
UA
I (Call Proceeding)
I (Alerting)
Ringing
CPG
Ringing tone
I (Alerting)
I (Connect)
Answer
ANM
I (Connect)
I (Connect Ack.)
I (Connect Ack.)
B channel connection
Release
I (Disconnect)
REL
I (Disconnect)
I (Release)
RLC
I (Release)
I (Rel. Complete)
I (Rel. Complete)
DISC
DISC
UA
UA