Networking technologies and applications

Digital Subscriber System No. 1 (DSS1)

Gusztáv Adamis

BME TMIT

2015

Overview – DSS1

- Introduction
  - Terminology, protocol stack
- LAPD
  - Tasks
  - Frame formats
  - Automatic TEI management
- DSS1 Layer 3 – Call Control
  - Message formats
  - Call establishment and release
  - Additional messages

BRA - refreshment

- 2B+D16: BRA/BRI: Basic Rate Access/Interface,
  - 144 kb/s
  - on single wire pair
  - typically for private/small company subscribers
  - possible combinations:
    - 2 independent voice calls
    - 1 voice call + 1 fax
    - 1 voice call + 64 kb/s data transfer (e.g. Internet access)
    - 128 kb/s data transfer
    - dynamically adjustable
  - 16kb/s D (signaling) channel
    - Originally for low speed data transfer
      - D – Data channel
    - Nowdays for call control only
      - DSS1

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
- HDLC – High Level Data Link Control family member
  - Original version – 1960s
  - Connecting a Terminal to a Host

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

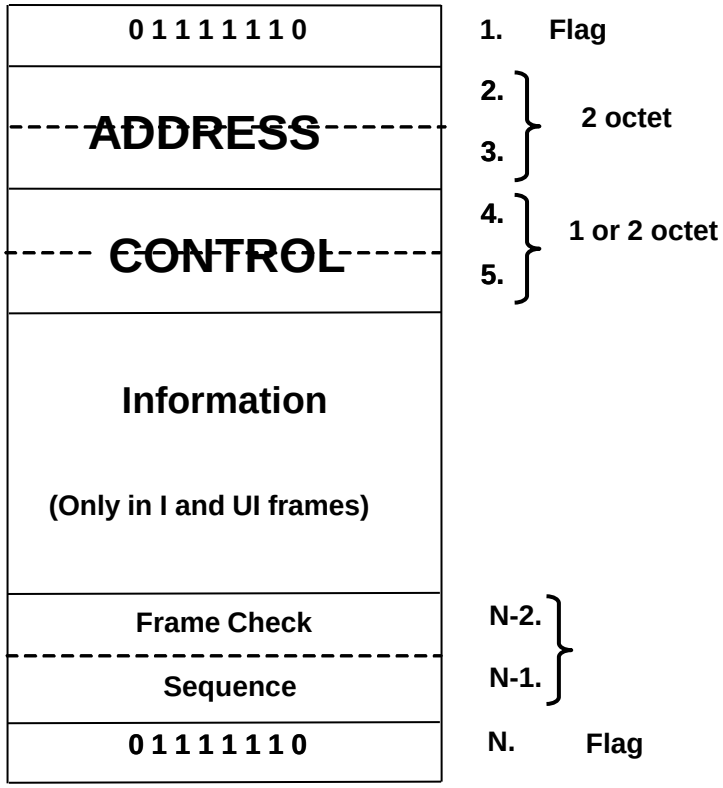
Bit stuffing - example

- Original message:
  - (end) 01111101111111 0110 (beginning)
- Transmitted message:
  - 01111110001111101101111101100111110
- Length of the message depends on its value
  - Later slides: field lengths given BEFORE bit stuffing

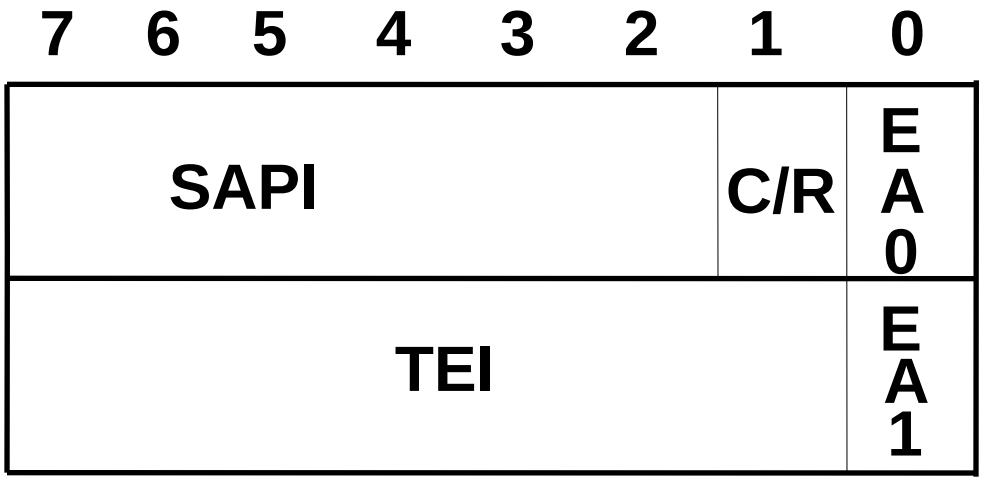
Error detection and Correction

- 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 (not in all frame types!)
  - Receiving a message with a „wrong” sequence number
    - Request to repeat

General format of a LAPD frame



Address



Command/Response	NT → TE	TE → NT
Command (C)	1	0
Response (R)	0	1

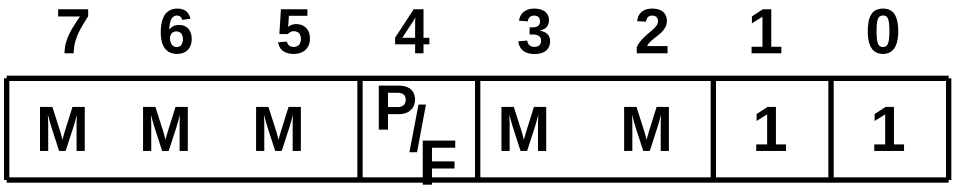
- SAPI – Service Access Point Identifier
  - 0 – signaling, 63 – LAPD management
- TEI – Terminal Endpoint Identifier
  - 0 – 63 fix, 64 – 126 automatic, 127 - broadcast

LAPD frame types

- 3 frame types:
  - U (Unnumbered): Signaling connection establishment, release and control
  - I (Information): transmit DSS1 Layer 3 (Call control) messages
  - S (Supervisory): Flow control of the I frames

Control – U frame

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



- P/F: Poll / Final bit

U frame types

MMMMM	Acronym	Name	Meaning
01111	SABME	Set Asynchronous Balanced Mode Extended	Request for a LAPD connection
01100	UA	Unnumbered Acknowledgement	Positive acknowledgement for SABME and DISC
01000	DISC	Disconnect	Reuest to release a LAPD connection
00011	DM	Disconnected Mode	LAPD connection cannot be established (Negative ack. for SABME)
000000	UI	Unnumbered Information	Information transfer in an unacknowledged way

Control – I frame

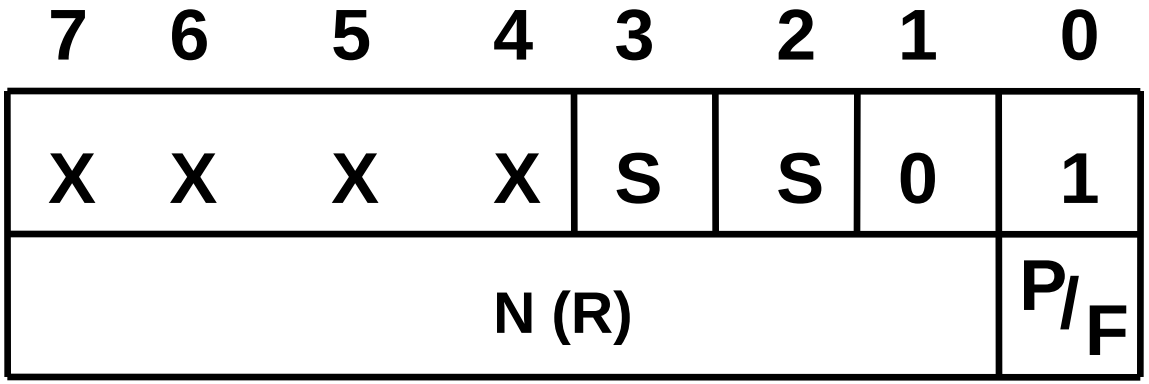
- Information – I frame
- Transmission of DSS1 Layer 3 info (Call control)

7	6	5	4	3	2	1	0
N (S)							0
N (R)							P/F

- N(S) – sent number
- N(R) – receive number
  - sequence number of the frame waited for
  - acknovledgement for all the previous frames

Control – S frame

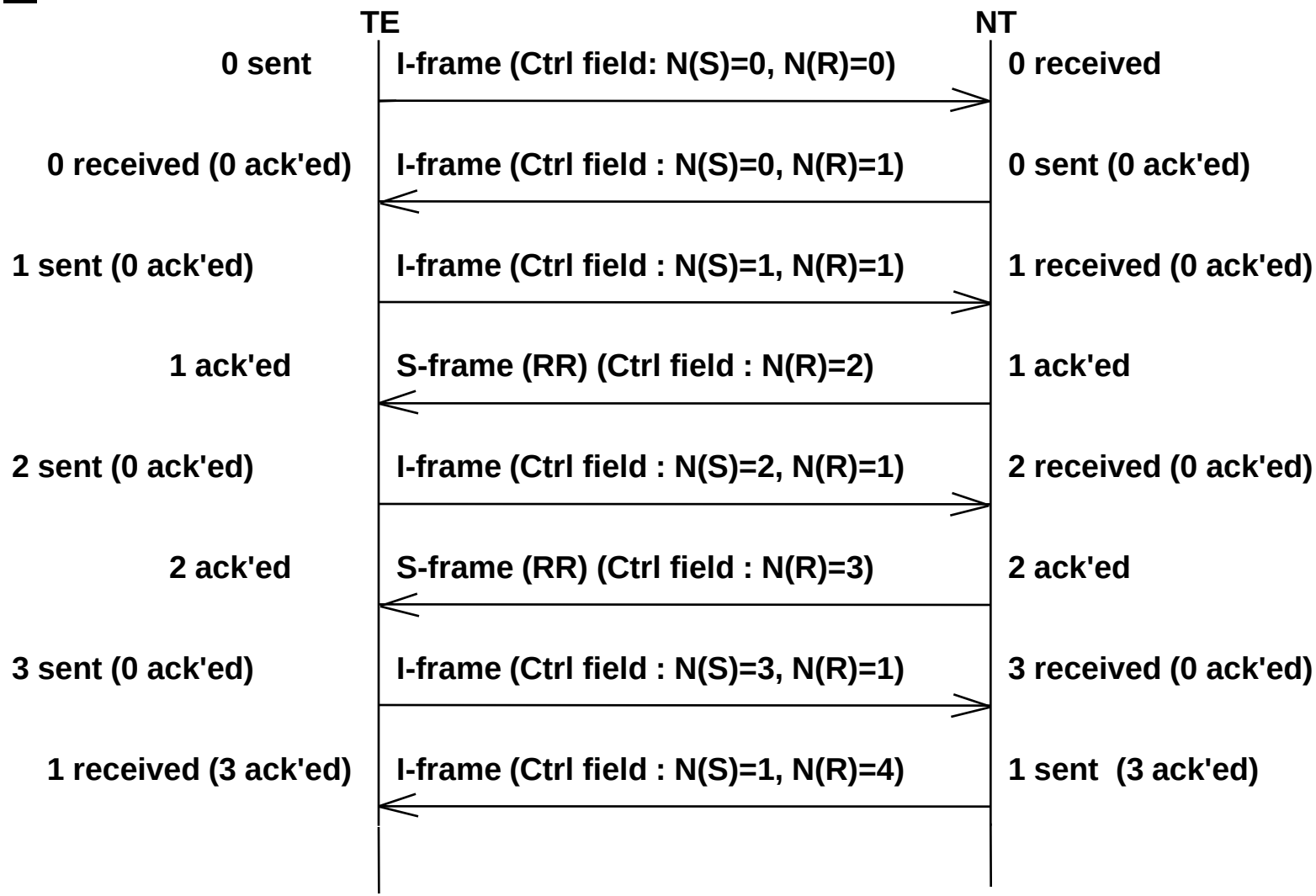
- Supervisory – S frame
- Flow control for I frames



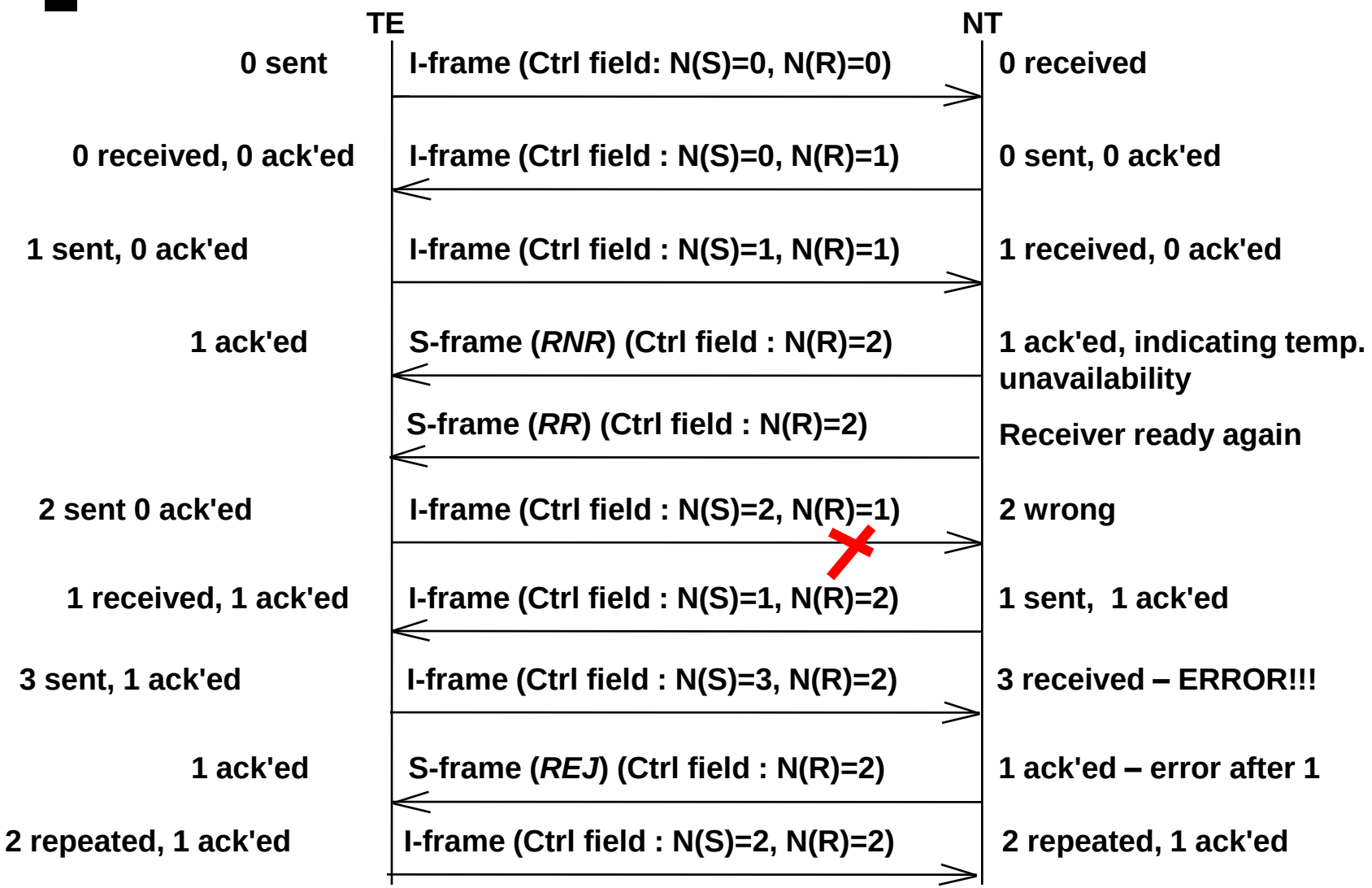
S frame types

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



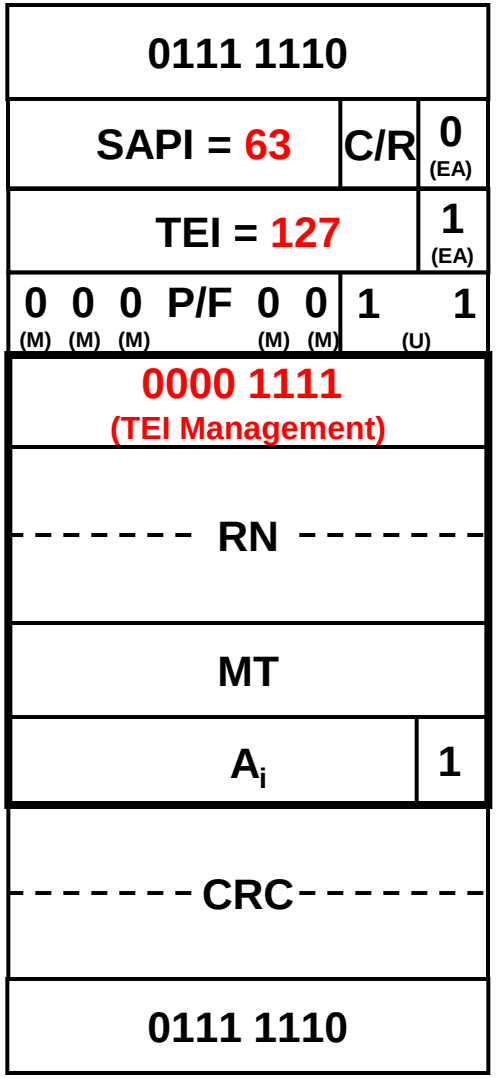
Example of using S frames



Automatc TEI management

- Processes
  - TEI assignment
  - TEI check
  - TEI removal
- Messages
  - Broadcast UI (TEI = 127)
  - LAPD management (SAPI = 63)

Automatic TEI management message structure

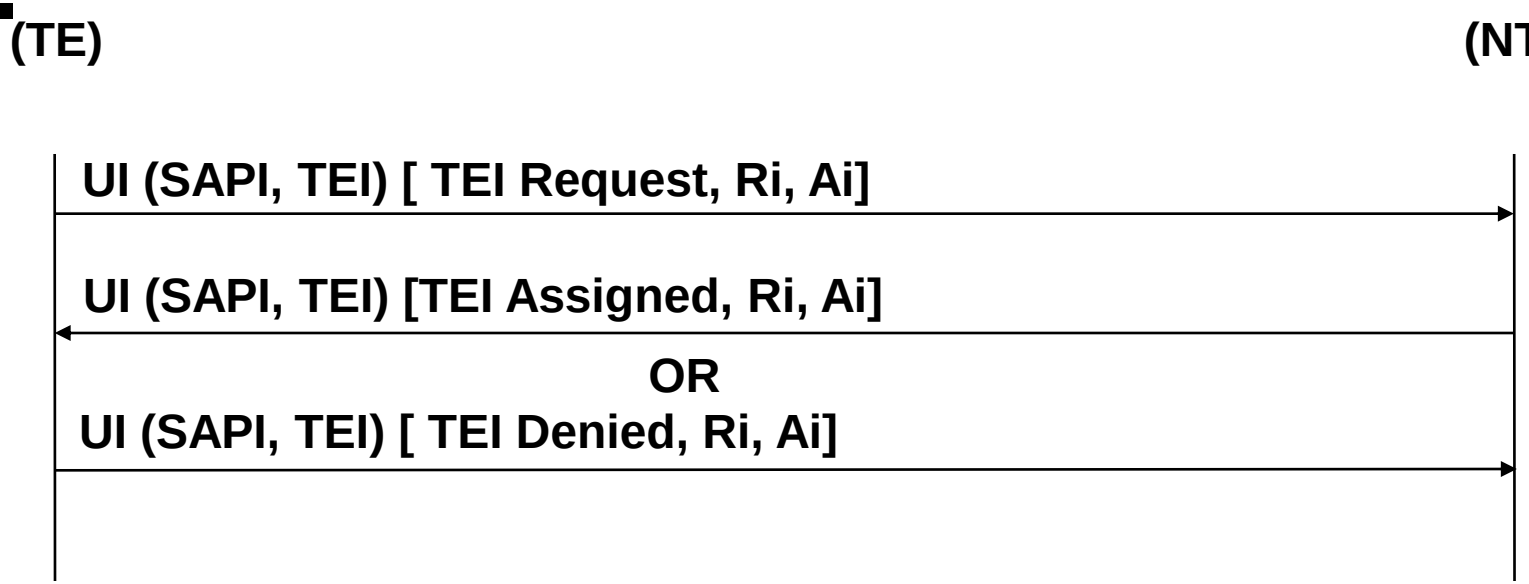


- RN: Random Number (Transaction ID)
- MT: Message Type code
- Ai: Action indicator (Managed TEI, or if 127: all TEI)

TEI management message types

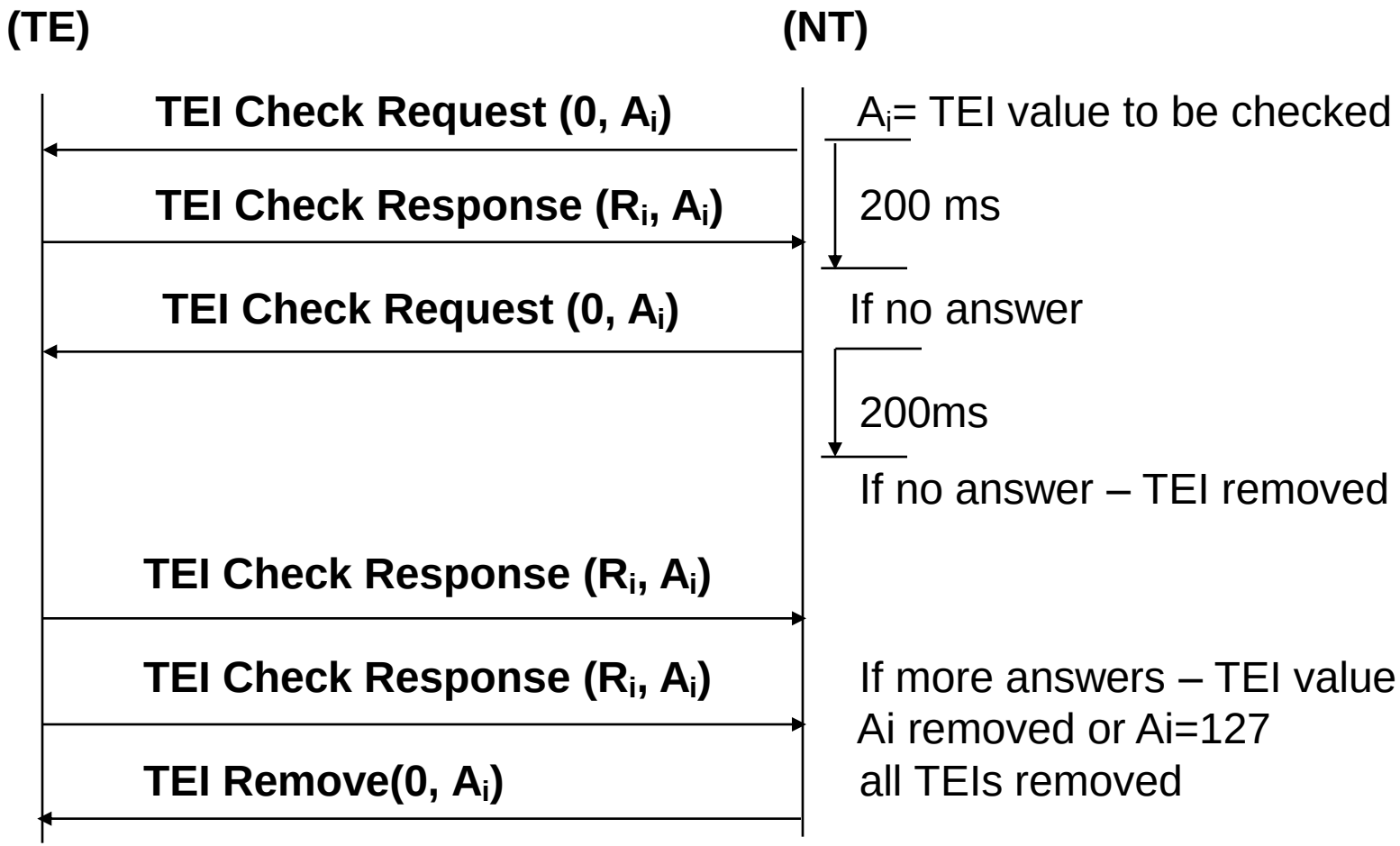
MT	Name	Meaning
1	Request	TEI assignment request
2	Assigned	TEI assigned
3	Denied	TEI assignment denied
4	Check Request	TEI check request
5	Check Response	TEI check response
6	Remove	TEI withdrawal
7	Verify	Request for a TEI check by a TE

TEI request / denial



- Ri : 16 bit random number for identifying the request,
  in response the same value used to be able to match request/response
- Ai : in request: the requested TEI or if 127: any TEI accepted,
  in response: the assigned/denied TEI

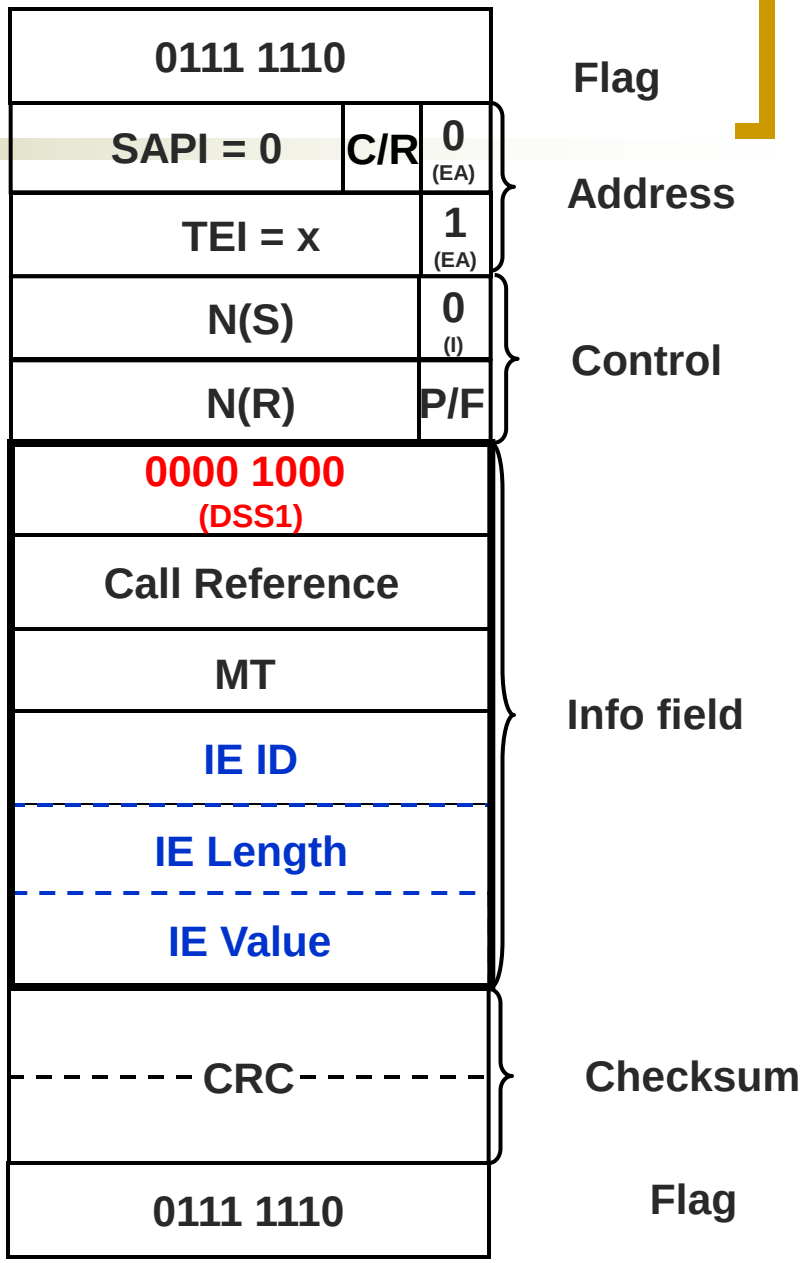
TEI check and removal



DSS1 Layer 3

- DSS1 Layer3: this is referred as DSS1 shortly
  - Call establishment and release
  - Formats, parameters

DSS1 Layer 3 message format



Call Reference

- Identification of a call
- Assigned by the side that generates the call
- Valid only for one NT-TE connection
- Makes it possible to have multiple calls on the same TE

Call Reference

- 2 or 3 octet long
  - 1. octet: length (1 or 2 more octets)
  - 2. octet MSB - indicator:
    - 0: message sent by the assignee of the call ref.
    - 1: message sent to the assignee of the call ref.

Message Type

- Determines the type of the message
- Determines the set of the possible IEs – Information Elements

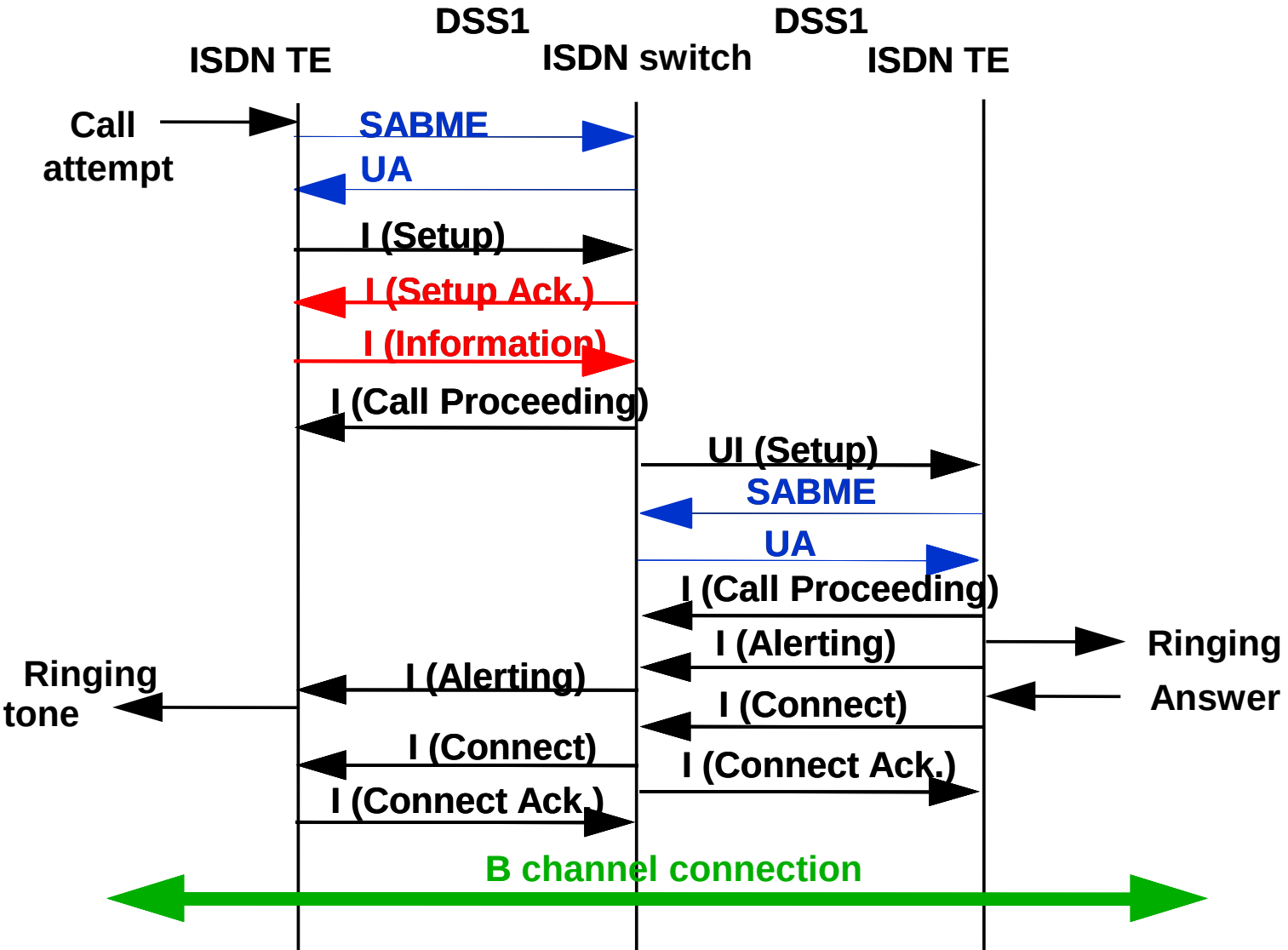
Information Elements

- Mandatory or optional
- 2 main versions:
  - One octet long: MSB = 1,
    - 3 bit: type, 4 bit: value
  - More octet long MSB = 0
    - Variable length:
      - 1st octet: type,
      - 2nd octet: length
      - 3..255th octet: value (as many value octets as indicated by length)

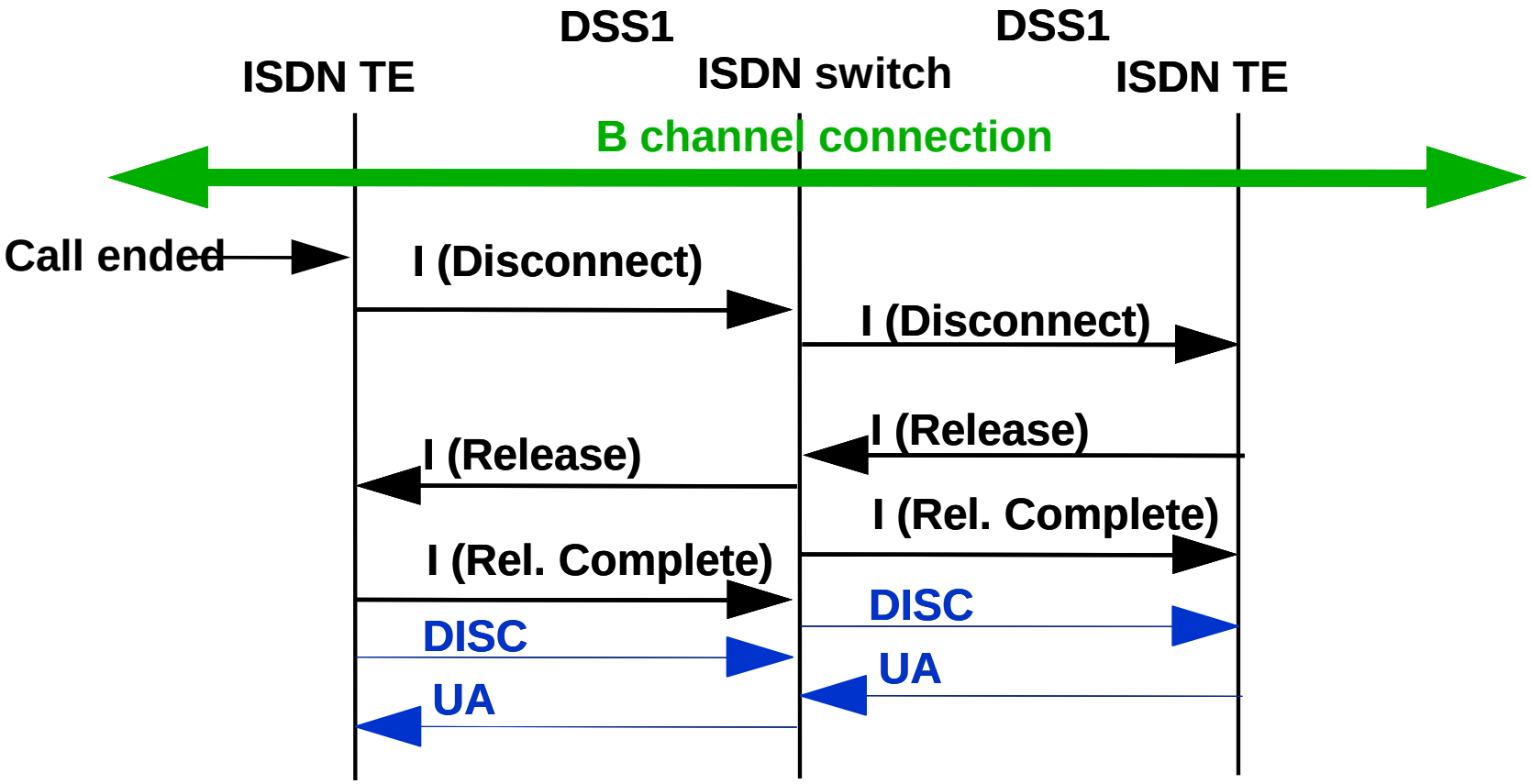
DSS1 Layer 3

- Call establishment and release
  - next slides
  - blue: LAPD U frames
  - red: optional

DSS1 call establishment



DSS1 call release



- Release can be initiated either by caller or called party

Setup (important) parameters

- Sending complete – if dialled number presented
- Bearer capability (important parts):
  - Information transfer – speech, (un)restricted digital, audio, stb.
  - Transfer mode – circuit/packet + transfer rate (e.g. 64kb/s)
  - Modem type
  - Layer 1 protocol (A/μ)
  - Layer 2 protocol (Q.921 – LAPD, X.25)
  - Layer 3 protocol (Q.931 – DSS1, X.25)
- Calling/Called party number

Disconnect – Cause parameter

- Indicates the reason of disconnection (7 bits)
  - Class (000, 001): normal event
    - 16 – normal call clearing
    - 17 – busy
    - 19 – no answer
  - Class (010): resource unavailable
  - Class (011): service or option not available
  - Class (100): service or option not implemented
  - Class (101): invalid message (e.g. parameter out of range)
  - Class (110): protocol error (e.g. unknown message)
  - Class (111): interworking

Other DSS1 messages

- Q.931 call info
  - SUSPEND
  - SUSPEND ACKNOWLEDGE
  - SUSPEND REJECT
  - RESUME
  - RESUME ACKNOWLEDGE
  - RESUME REJECT
  - USER INFORMATION

Other DSS1 messages

- Q.932 supplementary services:
  - HOLD
  - HOLD ACKNOWLEDGE
  - HOLD REJECT
  - RETRIEVE
  - RETRIEVE ACKNOWLEDGE
  - RETRIEVE REJECT

Other DSS1 messages

- RESTART
- RESTART ACKNOWLEDGE