

N-ISDN

"It still does nothing"

Why ISDN?



- **During the century, Telcos**
 - ◆ Created telephony networks
 - ◆ Created **separate** digital data networks
- **Today: Demand for various different services**
 - ◆ Voice, fast signaling, data applications, realtime applications, videostreaming and videoconferences, music, Fax, ...



- **Integrated Services Digital Network**
- **ISDN is the digital unification of the telecommunication networks for different services**
- **ISDN ensures world wide interoperability**
- **All-digital interfaces at subscriber outlet**
- **This module describes N-ISDN (!)**
 - ◆ **Narrowband ISDN (the "normal" ISDN)**

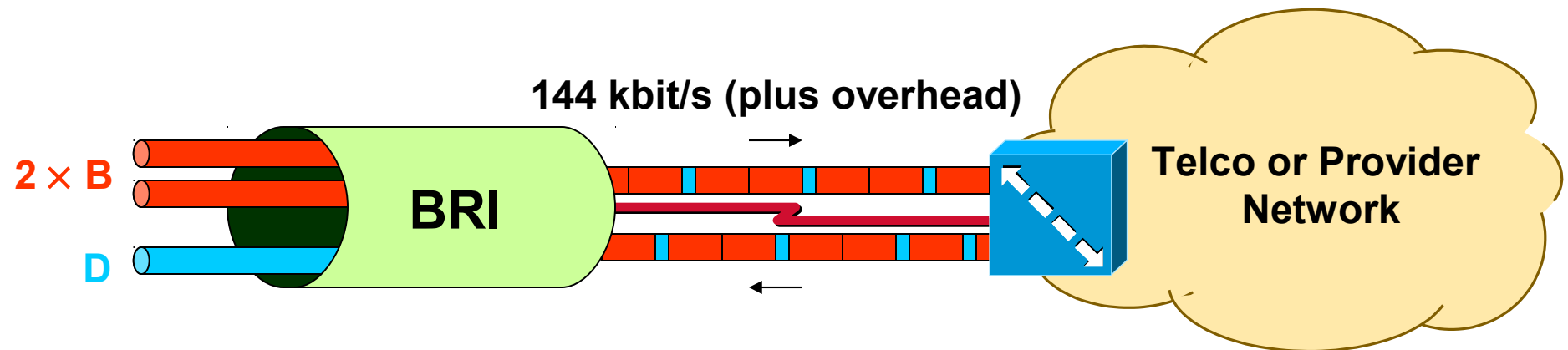


- **ISDN provides standardized UNI**
 - ◆ Basic Rate Interface (BRI)
 - ◆ Primary Rate Interface (PRI)
- **Synchronous and deterministic multiplexing**
 - ◆ Constant delays
 - ◆ Constant bandwidth
- **Dynamic connection establishment**
 - ◆ User initiated
 - ◆ Temporarily

Basic Rate Interface (BRI)



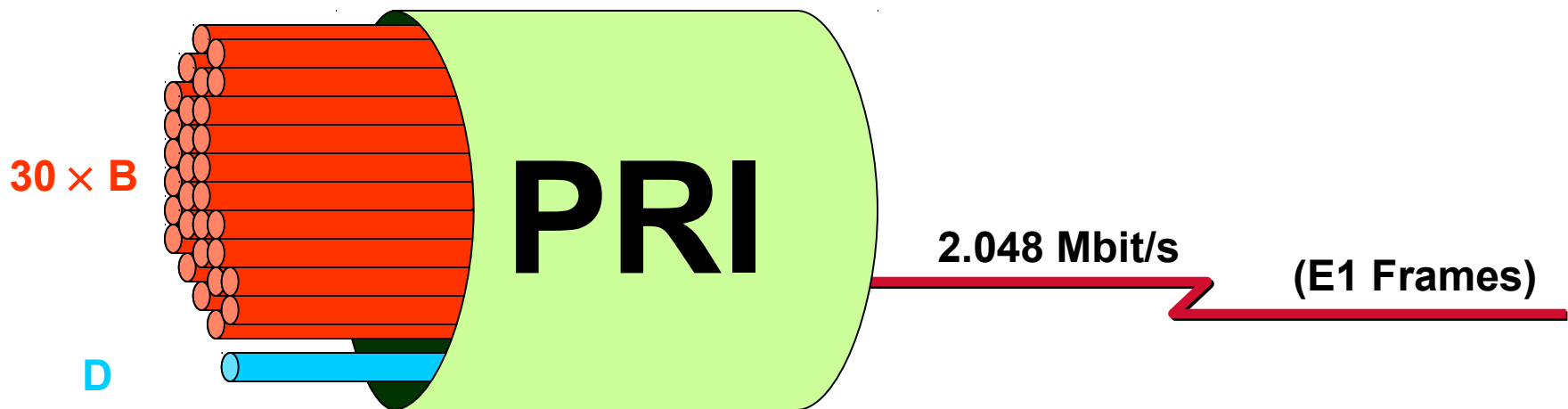
- 2 Bearer (B) channels with **64 kbit/s** each
- 1 Data (D) channel with **16 kbit/s**
 - ◆ For **outband** signaling purposes (mainly)



Primary Rate Interface (PRI)



- 30 Bearer (B) channels with **64 kbit/s** each (USA: 23 B)
- 1 Data (D) channel with **64 kbit/s**
 - ◆ For **outband** signaling purposes (mainly)





- **CCITT defined three services**
 - ◆ **Bearer services** (Circuit or Packet)
 - ◆ **Teleservices** (Telephony, Telefax, ...)
 - ◆ **Supplementary services**
 - Reverse charging
 - Hunt groups
 - etc...

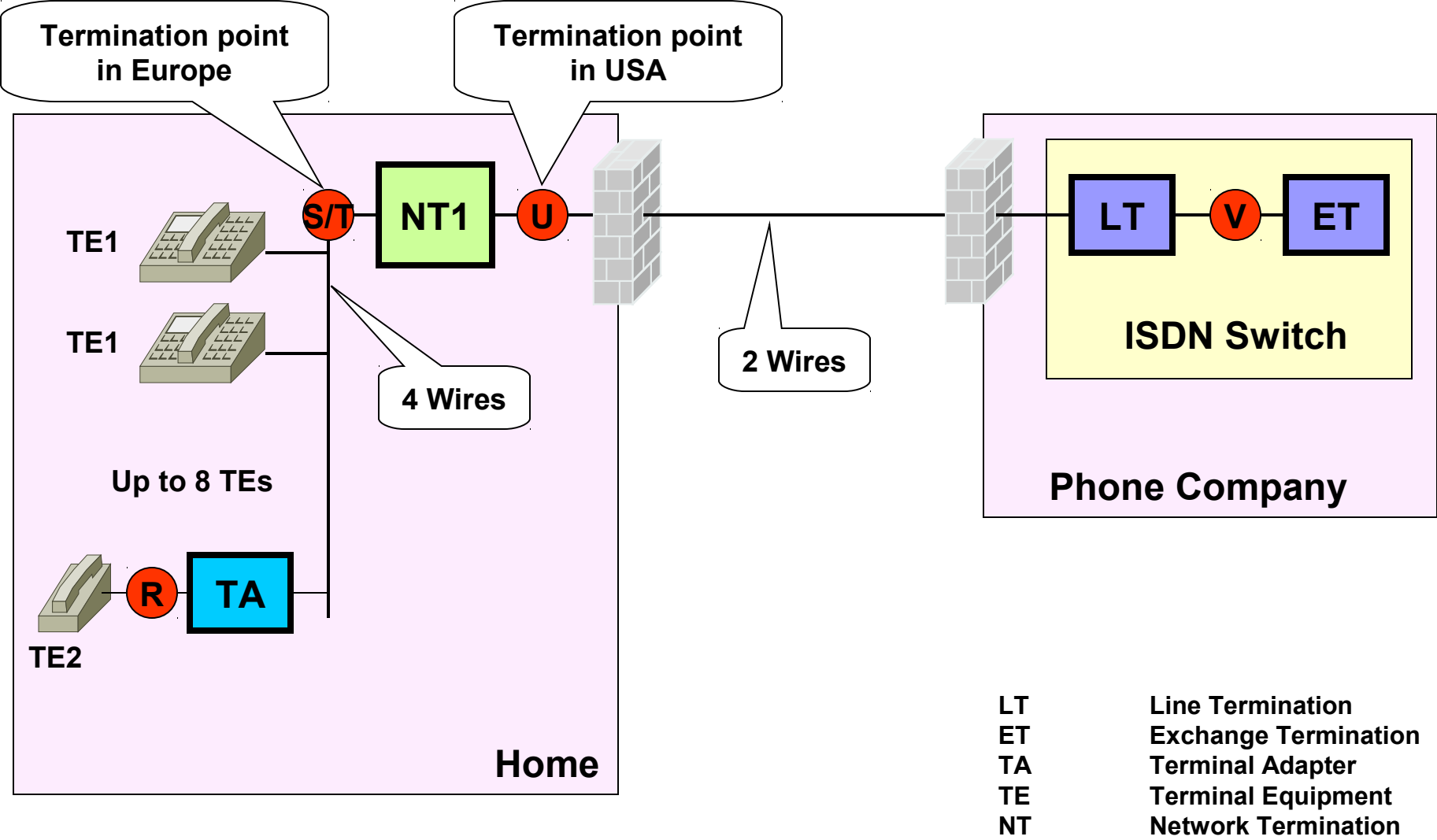


- **Terminal Equipment (TE)**
 - ◆ **TE1** is the native ISDN user device (phone, PC-card, ...)
 - ◆ **TE2** is a non-ISDN user device (Analog telephone, modem, ...)
- **Network Termination (NT)**
 - ◆ **NT1** connects TEs with ISDN
 - ◆ **NT2** provides concentration and supplemental services (PBX)
- **Terminal Adapter (TA)**
 - ◆ **TA** connects TE2 with NT1 or NT2



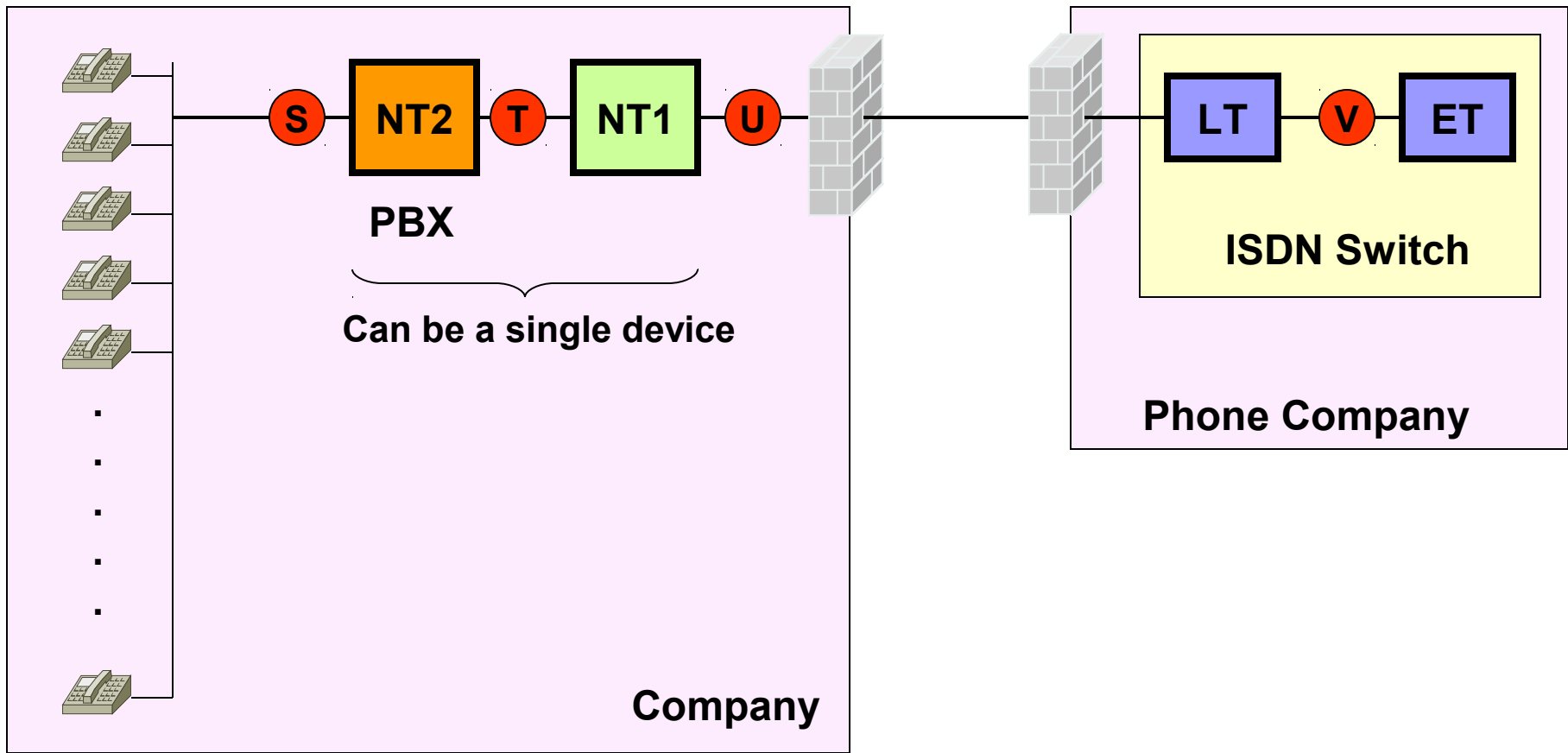
- **Logical interfaces between functional groups**
 - ◆ **R** connects PSTN equipment with TA
 - ◆ **S** connects TEs with NT2
 - ◆ **T** connects NT2 with NT1
 - ◆ **U** connects NT1 with Exchange Termination (ET)

Reference Diagram (BRI)



- LT Line Termination
- ET Exchange Termination
- TA Terminal Adapter
- TE Terminal Equipment
- NT Network Termination

Reference Diagram (PRI)



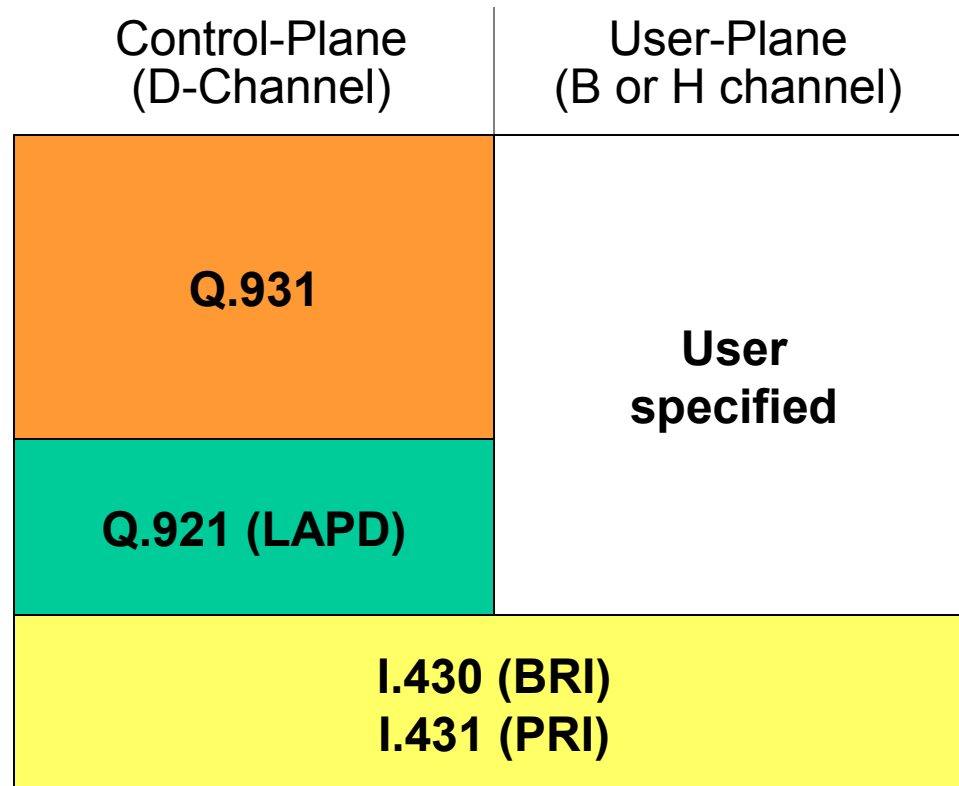


- **Recommendation G.961**
 - ◆ 160 kbit/s (remaining capacity used for framing and synchronization)
- **Either echo cancellation or time compression (ping-pong)**
- **2B1Q (ANSI T1.601)**
 - ◆ -2.5 V, -0.833 V, +0.833 V, +2.5 V
 - ◆ Requires half the BW of NRZ
 - ◆ Plus scrambling for synchronization and uniform PSD distribution



- TEs just require one D and 1 or 2 B channels
- High-speed PRI applications can be connected with so-called **H-channels**
 - ◆ H0 (6B = 384 kbit/s)
 - ◆ H11 (24B = 1536 kbit/s)
 - ◆ H12 (30B = 1920 kbit/s)

Layers





- **Q.920 (I.440)**
 - ◆ **Layer 2 UNI general aspects**
- **Q.921 (I.441)**
 - ◆ **Layer 2 UNI specification and LAPD**
- **Q.930 (I.450)**
 - ◆ **Layer 3 UNI general aspects**
- **Q.931 (I.451)**
 - ◆ **Layer 3 UNI specification and call control procedures**



- **S/T interface is implemented as bus**
 - ◆ **Point-to-point**
 - Maximum distance between TE and NT is 1km (!)
 - Requires a PBX
 - ◆ **Multipoint**
 - Up to 8 TEs can share the bus
 - Maximum distance between TE and NT is 200 meters (short bus) or 500 meters (extended bus)

Multipoint Configuration



- **D** channel is **shared** by all TEs
 - ◆ To request usage of B channels
 - ◆ Contention mode
- **B** channels are **dynamically assigned** to TEs
 - ◆ Exclusive usage only (!)

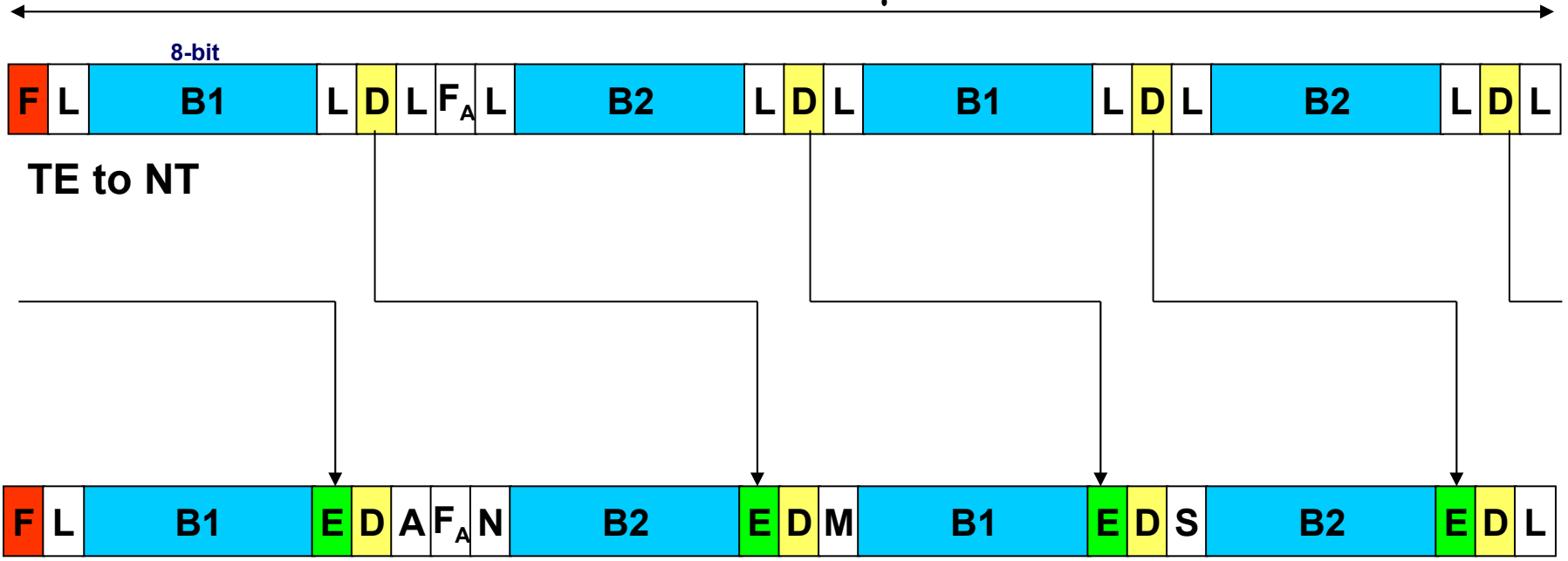


- **192 kbit/s=**
144 kbit/s (2B+D) + 48 kbit/s
for Framing, D-echoing, and DC
balancing
- **48 bit frames every 250 μ s**
 - ◆ **Modified AMI code (zero-modulation)**
 - ◆ **Bit-stuffing**
 - ◆ **Synchronization through code violation**

S/T-Bus



48 bits in 250 μ s



- F... Framing bit
- L... DC balancing bit
- E... D-echo channel bit
- A... Activation bit
- F_A... Auxiliary framing bit
- N... Set to opposite of F_A
- M... Multiframing bit
- S... Spare bits



- **Before TE may use D channel:**
Carrier Sense
 - ◆ At least eight ones (no signal activity) in sequence must be received
- **Then TE may transmit on D channel:**
Collision Detection
 - ◆ If E bits unequal D bits TE will stop transmission and wait for next eight ones in sequences

D – Channel Access Control (2)



- **When using D channel**
 - ◆ **Bit stuffing prevents sequence of eight ones for the rest of the message**
- **Fairness**
 - ◆ **TE must release D channel after message was sent**
 - ◆ **Next time, this TE must wait for a sequence of **nine** ones**

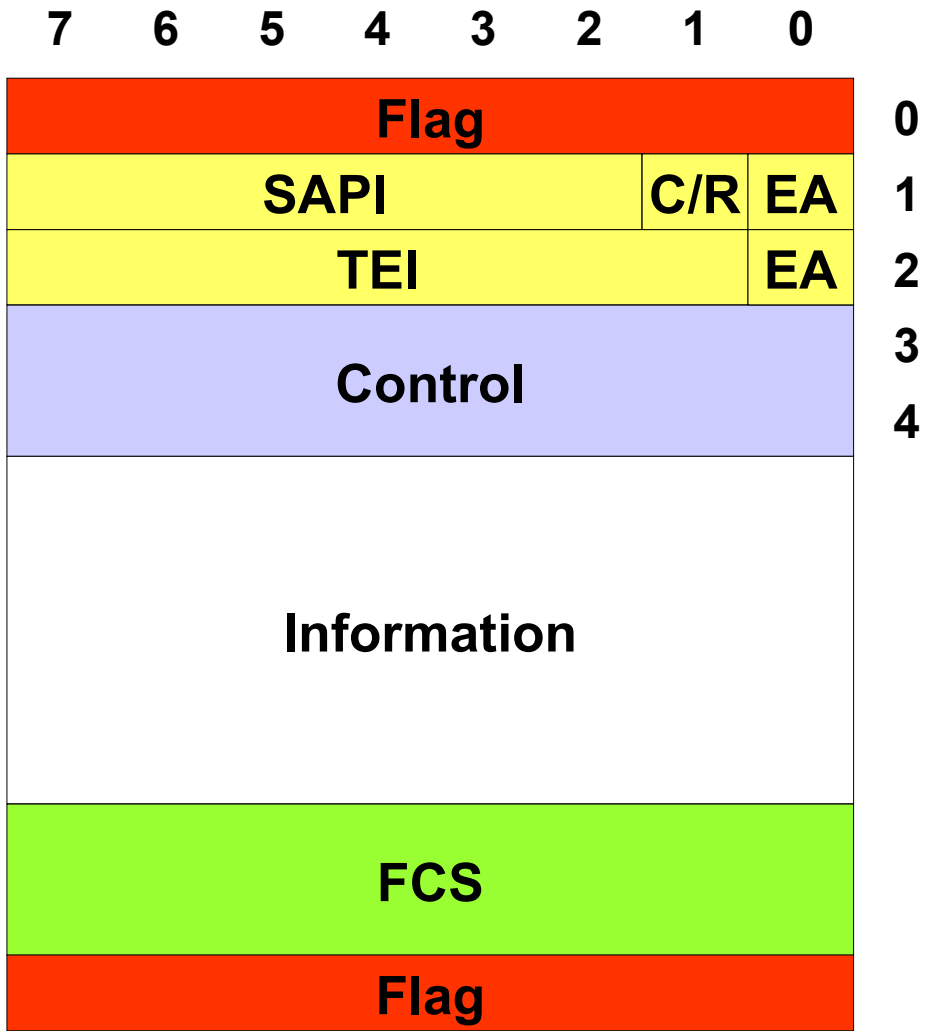


- **Point-to-point configuration only**
- **Europe: E1**
 - ◆ 30 B channels
 - ◆ 1 D channel (also 64 kbit/s)
 - ◆ 1 Framing Channel
- **USA: T1**
 - ◆ 23 B channels
 - ◆ 1 D channel



- **Link Access Procedure D-Channel**
 - ◆ **Based on HDLC ABM mode**
 - ◆ **2 byte address field (SAPI + TEI)**
 - ◆ **Optionally extended sequence numbering (0-127)**
- **Carries Q.931 packets**
- **May also be used to carry user traffic**
 - ◆ **For example X.25 packets**

LAPD Frame Format



} **Address Information**

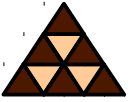
- SAPI ... Service Access Point Identifier
- TEI Terminal Endpoint Identifier
- EA Address Field Extension Bit
- C/R Command/Response Bit



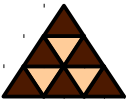
- When TE occupies D channel, the ET (switch) assigns a **Terminal Endpoint Identifier (TEI)** to it
- LAPD frames carry TEI
 - ◆ To identify source (TE → ET)
 - ◆ To identify destination (ET → TE)
- Possible values: 0-127



- **TEIs are either assigned automatically**
 - ◆ By switch (ET)
 - ◆ TEI value range **64-126**
- **Or preconfigured**
 - ◆ Checking for duplicates necessary
 - ◆ TEI value range **0-63**
- **TEI = 127 reserved for broadcasting**



- **Service Access Point Identifier (SAPI)**
 - ◆ **OSI interface to layer 3**
 - ◆ **“Identifies payload”**
 - **0 signaling information (s-type)**
 - **16 packet data (p-type)**
 - **63 management information**



- **UI frames with SAPI = 63 and TEI 127**
- **Information field contains**
 - ◆ **Reference indicator (RI) to correlate request and responses**
 - ◆ **Action indicator (AI) to specify TEI in question**
 - ◆ **Message type**



- **Carries signaling information**
 - ◆ Call control
 - ◆ E. g. dial number and ring information
 - ◆ Terminated by ET
- **ET is real 7-layer gateway**
 - ◆ Translates Q.931 into Signaling System 7 (SS#7)
- **Country-dependent versions (!)**

ISDN Switch Types



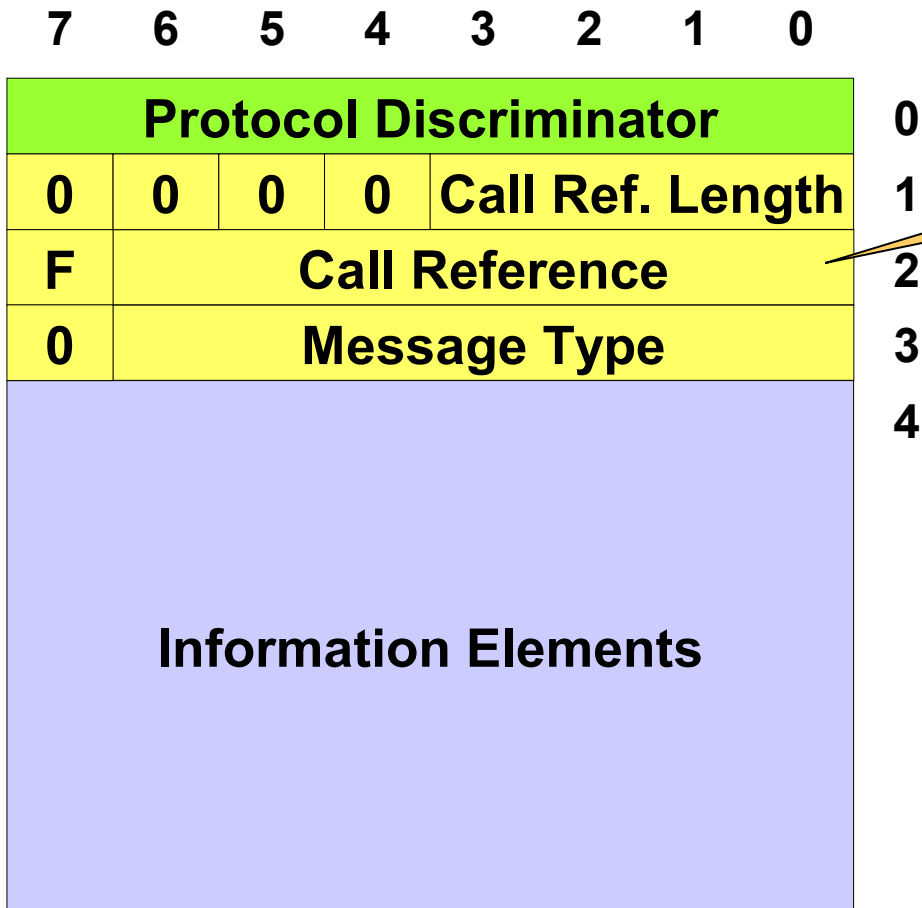
■ BRI

- **Basic-net3 (Euro ISDN)**
- **5ESS, DMS-100, NT1 (USA)**
- **NTT (Japan)**
- **Basic 1TR6 (Germany, old)**
- **VN2, VN3 (France)**
- **TS013 (Australia)**

■ PRI

- **primary-net5 (Euro ISDN)**
- **4ESS, 5ESS, DMS-100 (USA)**
- **NTT (Japan)**
- **TS014**

Q.931 Packet Format



Random Number

Message Types:

Call Clearing
DETach
DETach ACKnowledge
DISConnect
RELease
RELease COMPLETE
REStart
REStart ACKnowledge

Call Information Phase
RESume
RESume ACKnowledge
RESume REJect
SUSPend
SUSPend ACKnowledge
SUSPend REJect
USER INFORMATION

Call Establishment
ALERTing
CALL PROCEEDing
CONNect
CONNect ACKnowledge
SETUP
SETUP ACKnowledge

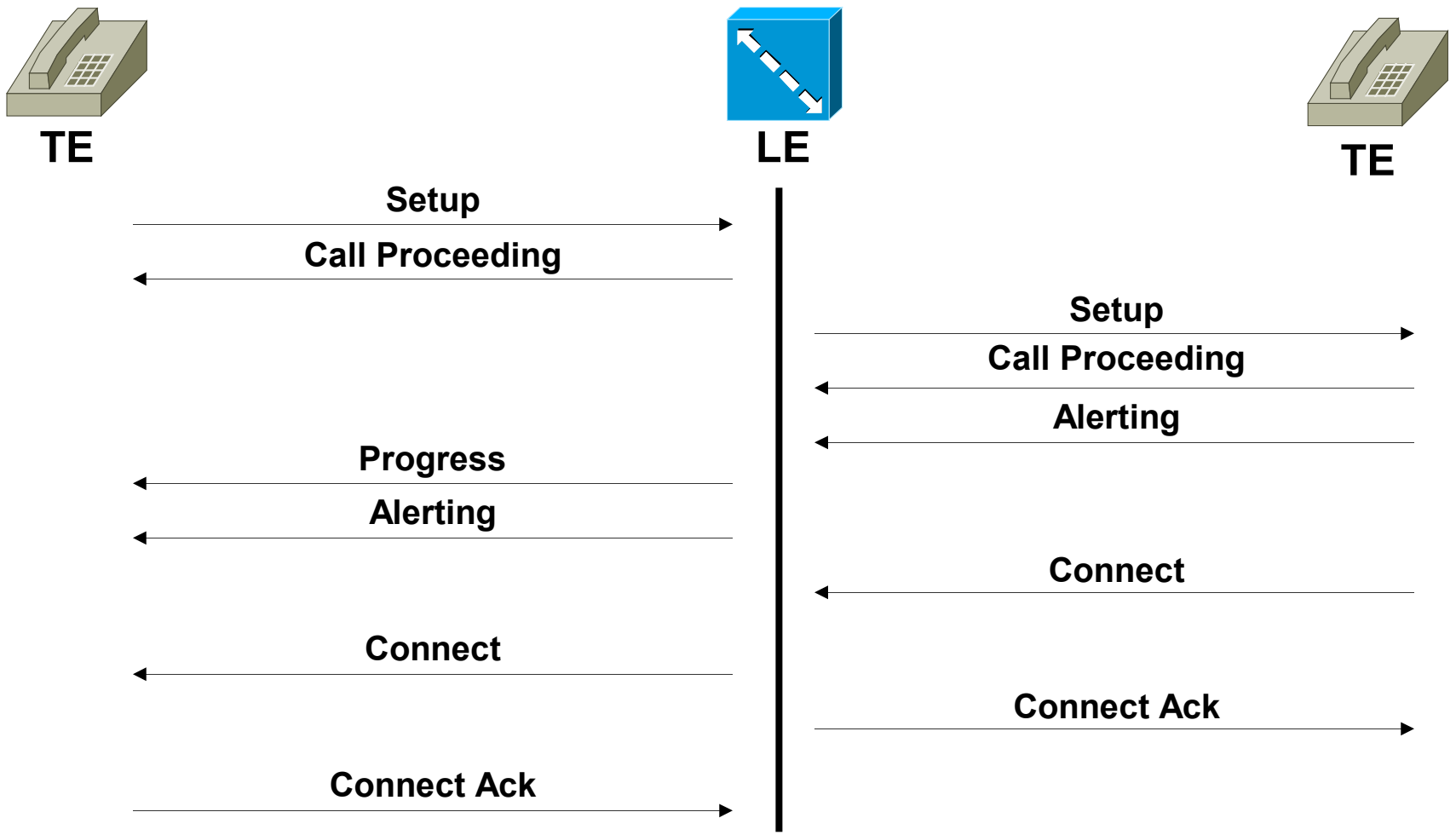
Miscellaneous
CANCel
CONgestion CONTROL
FACility (Ack, Rej)
INFORMATION
REGister (Ack, Rej)
STATUS

Information Elements Examples

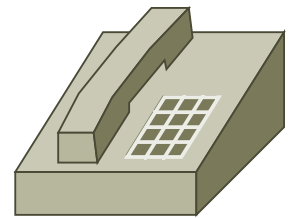


0x04	Bearer Capability (eg. 0x8890 .. dig. 64kb/s Circuit)
0x08	Cause (reason codes for call disconnect)
0x18	Channel Identification
0x1E	Progress Indicator (check for 56kb/s connection)
0x2C	Keypad
0x6C	Calling Party Number
0x6D	Calling Party Sub address
0x70	Called Party Number
0x71	Called Party Subaddress
0x7C	Low-Layer Compatibility
0x7D	High-Layer Compatibility

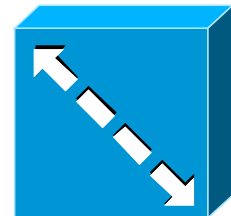
Call Establishment



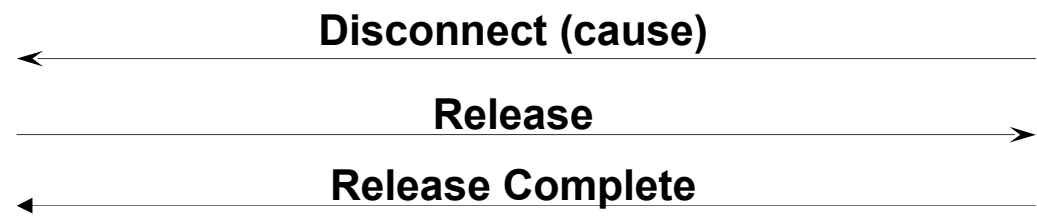
Call Release



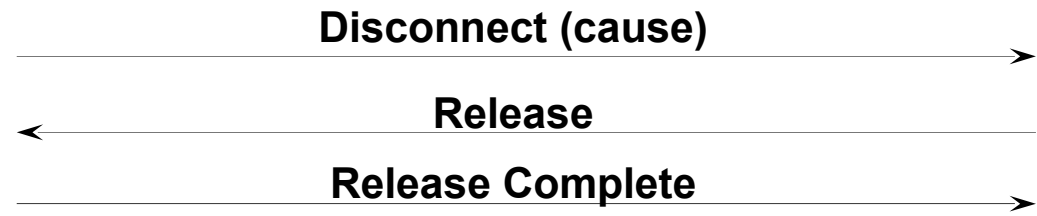
TE

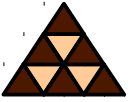


LE

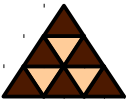


OR





- **Dynamical circuit switching**
- **BRI (2B+D) and PRI (30B+D)**
 - ◆ Bearer channels (B)
 - ◆ Signaling channel (D)
- **Q.921 (LAPD) and Q.931 on D channel**
- **Reference points (R, S, T, U)**
- **Function Groups**
 - ◆ TE1, TE2, TA, NT1, NT2, ET



- **What voltage might be supplied for power supply?**
- **The U interface is full-duplex but there are only two wires...? How does it work?**