

# ISDN Network Layer

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- ❑ Q.931 Message types
- ❑ Message formats
- ❑ A sample exchange

Ref: W. Stallings, "ISDN and Broadband ISDN with Frame Relay and ATM," Prentice Hall, 1995, 581 pp., Chapter 8.

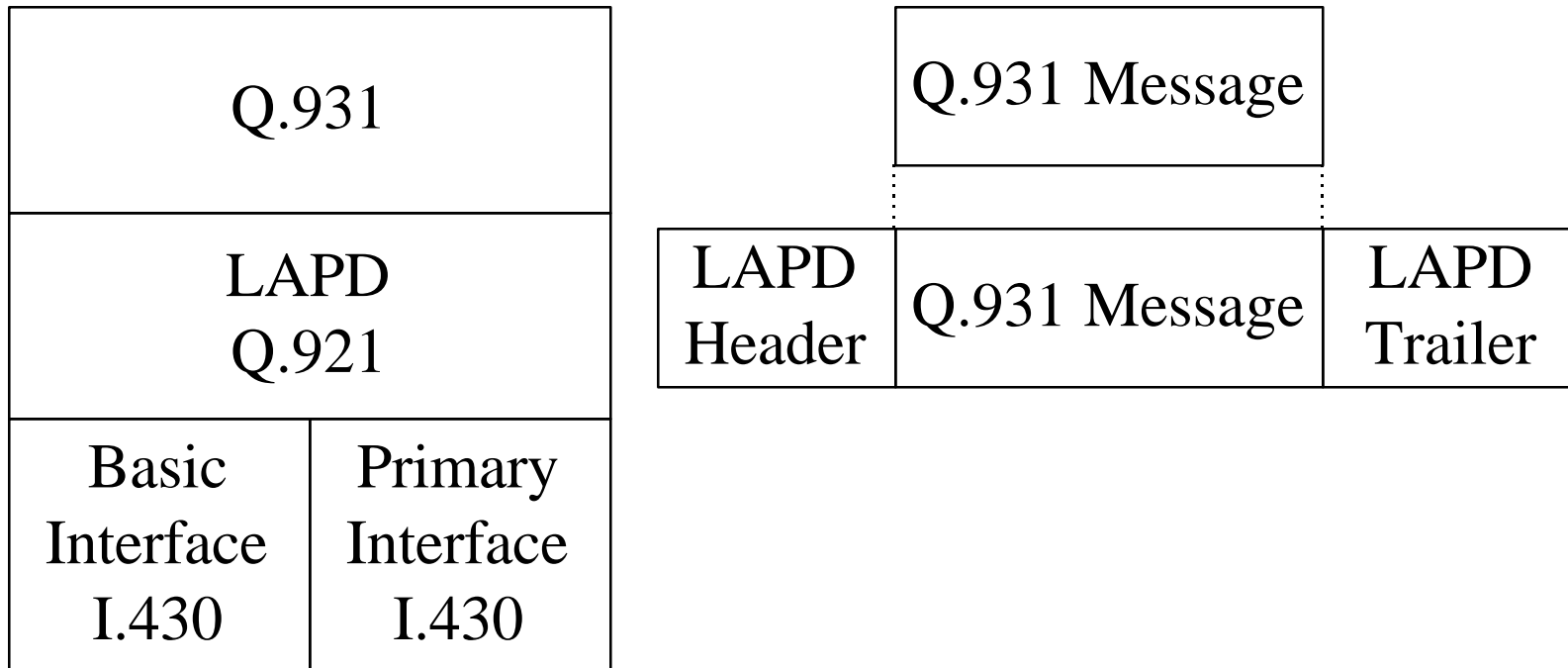
# ISDN Signaling Standards

- ❑ Q.930 ISDN UNI Layer 3 General Aspects
- ❑ Q.931 Specification for Basic Call Control
- ❑ Q.932 Generic Procedures for the Control of ISDN Supplementary Services
- ❑ Q.933 Specification for Frame-mode Basic Call Control
- ❑ Q.939 Typical DSS1 Service Indicator Codings for ISDN Telecommunication Services
- ❑ Q.950 Supplementary Service Protocols - Structure and General Principles

# ISDN Signaling Standards (Cont.)

- ❑ Q.2931 = Q.93B  
= Specification for Basic Call Control for B-ISDN
- ❑ Q.931 specifies procedures for connection establishment and release.
- ❑ Q.932, Q.933 extend/use Q.931 for supplementary services (call forwarding, etc) and frame relay, respectively.
- ❑ Digital Subscriber Signaling System 1 (DSS1)  
= Call control signaling over the D channel  
= Q.931 + Q.932 + lower layers
- ❑ DSS1 deals with outside while SS7 deals with inside the network.

# Protocol Layers



# Basic Call Control

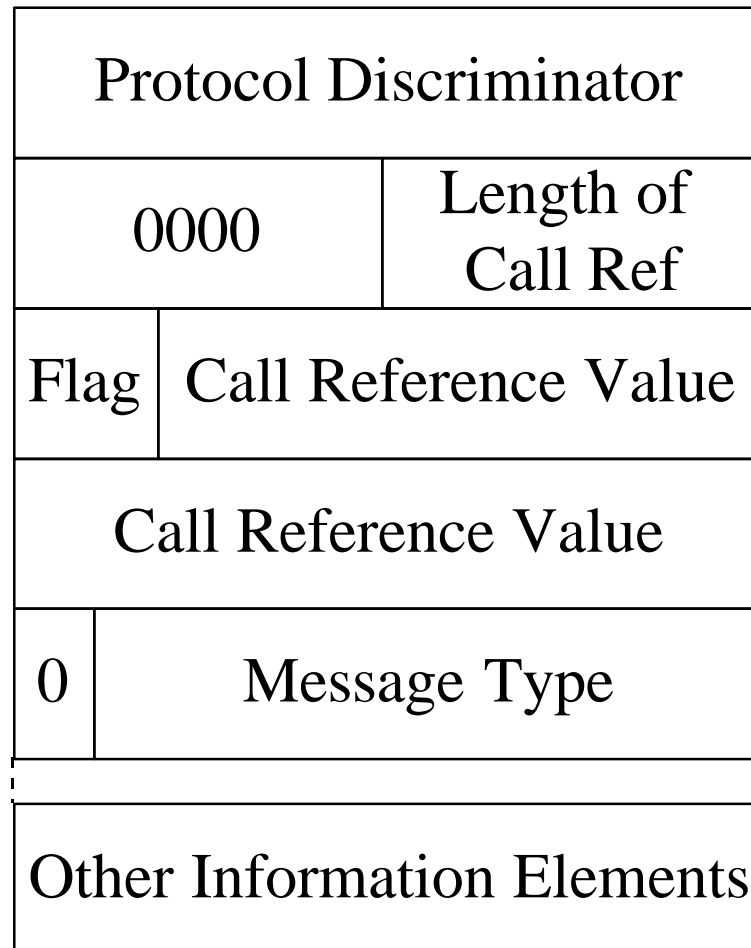
- ❑ Transmit and receive signaling messages using LAPD
- ❑ Network connection multiplexing
- ❑ Segmentation and reassembly of Q.931 messages
- ❑ Error detection and recovery
- ❑ Sequencing
- ❑ Congestion control and flow control of user data
- ❑ Restart

# Terminal Types

- ❑ Functional terminals: Intelligent devices, e.g., switches or ISDN devices
- ❑ Stimulus terminals: Simple devices, e.g., POTs

# Message Format

8 7 6 5 4 3 2 1



# Message Format

- ❑ Protocol Discriminator = 08H  $\Rightarrow$  This is a Q.931 message. Other protocols may share the D channel.
- ❑ Call reference: Identifies call to which this message is related to. One ISDN TE may have many calls simultaneously.
- ❑ Message Type: Many types for four functions for four applications
- ❑ Significance:
  - ❑ Local: Relevant only in the originating or terminating UNI
  - ❑ Access: Relevant in originating and terminating access but not in the network
  - ❑ Global: Relevant in originating and terminating access and in the network

# Applications

- ❑ Circuit-mode connection control:  
Existing Telecom services on B channel.
- ❑ Packet-mode access connection control:  
To connect user to network switch.
- ❑ User-to-user signaling not associated with circuit-switched calls: Temporary signaling over D channel without setting up a connection
- ❑ Messages used with the global call reference:  
Enable user or network to return one or more channels to an idle condition

# Functions

- ❑ Call establishment
- ❑ Call information: During data transmission phase
- ❑ Call clearing
- ❑ Miscellaneous: Used to negotiate network supplementary services

# Circuit-Mode Connection Control

Message	Significance	Direction	Function
Alerting	Global	Both	User alerting begun
Call Proceeding	Local	Both	Call establishment initiated
Connect	Global	Both	Call accepted by TE
Connect Ack	Local	Both	User has been awarded the call
Progress	Global	Both	Reports progress of a call
Setup	Global	Both	Initiates call establishment
Setup Ack	Local	Both	Call establishment initiated but requests more info

□ Call Information Phase Messages

<b>Message</b>	<b>Significance</b>	<b>Direction</b>	<b>Function</b>
Resume	Local	u → n	Resume a suspended call
Resume Ack	Local	n → u	Call has been reestablished
Resume Reject	Local	n → u	Call reestablishment failed
Suspend	Local	u → n	Request suspension
Suspend Ack	Local	n → u	Call suspended
Suspend Reject	Local	n → u	Call suspension failed

## ❑ Call Clearing Messages

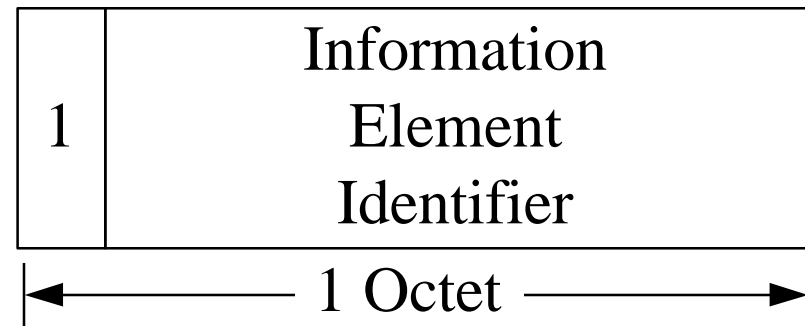
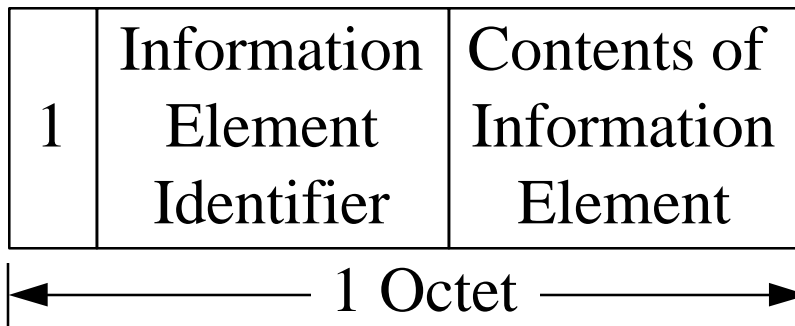
Message	Significance	Direction	Function
Disconnect	Global	Both	User requests clearing Net indicates clearing
Release	Local	Both	Intend to release
Release Complete	Local	Both	Channel released
Information	Local	Both	Additional Info
Notify	Access	Both	Indicates call info
Status	Local	Both	To report error or status
Status Enquiry	Local	Both	Solicit status

# Information Element Formats

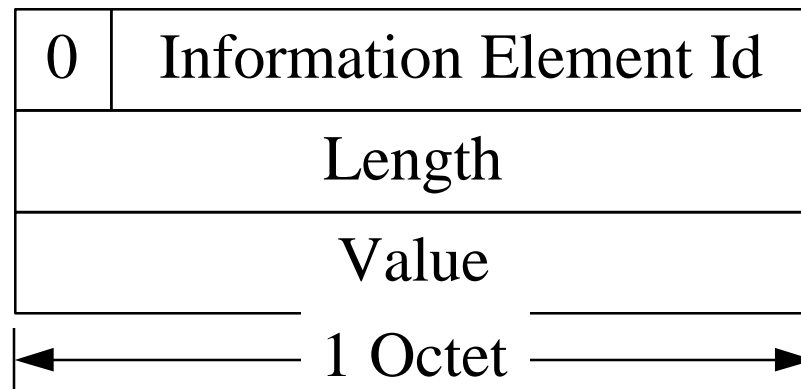
- Single-Octet Information Element

Type 1

Type 2:



- Variable Length Information Element:



# Information Elements

- ❑ Bearer Capability: Protocol options at each layer
- ❑ Call Identity: Identifies a suspended call
- ❑ Call State: Active, Detached, or disconnected
- ❑ Called/calling party number
- ❑ Called/calling party subaddress
- ❑ Cause: Diagnostic information
- ❑ Channel Identification: Which (B) channel is controlled.
- ❑ Date/Time: Time of message generation
- ❑ Display: Show on user terminal
- ❑ Higher-layer Compatibility: Terminal type or application on the user side: X.400, telephony, ...

- ❑ Keypad facility: Terminal input
- ❑ Low-layer compatibility: Protocol Ids for layers 1 to 3
- ❑ Network Specific Facilities: Provider specific
- ❑ Notification Indicator: User suspended, user resumed, and bearer service charge.
- ❑ Progress Indicator: Describes events
- ❑ Repeat Indicator: Select one of n IEs
- ❑ Sending Complete: Completion of called party number
- ❑ Signal: Causes terminal to generate tones and rings
- ❑ Transit Network Selection: Long-distance company to use

# Bearer Capability

8	7	6	5	4	3	2	1	Byte
0	Bearer Capability Information Element ID 0000100							1
Length of the Bearer Capability Contents								2
1	Coding Standard	Information Transfer Capability						3
1	Transfer Mode	Information Transfer Rate						4
1	Rate Multiplier							4a
0/1	Layer 1 Identity	User Information Layer 1 Prot.						5
0/1	Sync/ Async	Nego- tiation	User Rate					5a

# Bearer Capability

8	7	6	5	4	3	2	1	Byte
0/1	Intermediate Rate		NIC on TX	NIC on RX	Flow Control On Tx	Flow Control On Rx	0 Spare	5b
0/1	Hdr/No	Multi Frame	Mode	LLI Neg.	Assignor/ee	In-band neg	0 Spare	5c
0/1	# of Stop Bits		# of Data Bits		Parity			5d
1	Duplex Mode	Modem type						5e
1	Layer 2 Identity		User Information Layer 2 Prot.					6
1	Layer 3 Identity		User Information Layer 3 Prot.					7

# Bearer Capability (Cont)

- ❑ Used in SETUP messages
- ❑ Allows selection among available bearer services
- ❑ Information about destination terminal compatibility
- ❑ Coding standard: ITU-T or not
- ❑ Information transfer capability: Speech, unrestricted digital, 3.1 kHz audio, 7 kHz audio, video
- ❑ Transfer mode: circuit or packet
- ❑ Information transfer rate: 64 kbps,  $2 \times 64$  kbps, 384 kbps, 1.536 Mbps, 1.92 Mbps
- ❑ Rate Multiplier

# Bearer Capability (Cont)

- ❑ Coding Rule:
  - ❑ Layer 1 entity: V.110 or V.120
  - ❑ User information layer 1 protocol:
    - ❑ Synchronous or asynchronous transmission
    - ❑ Negotiation indication (for V.110)
    - ❑ User rate from which rate adaptation occurs
- ❑ For V.110:
  - ❑ Intermediate rate: Not used, 8, 16, 32 kbps
  - ❑ Network independent clock on transmission required
  - ❑ Network independent clock on reception required
  - ❑ Flow control on transmission required
  - ❑ Flow control on reception required

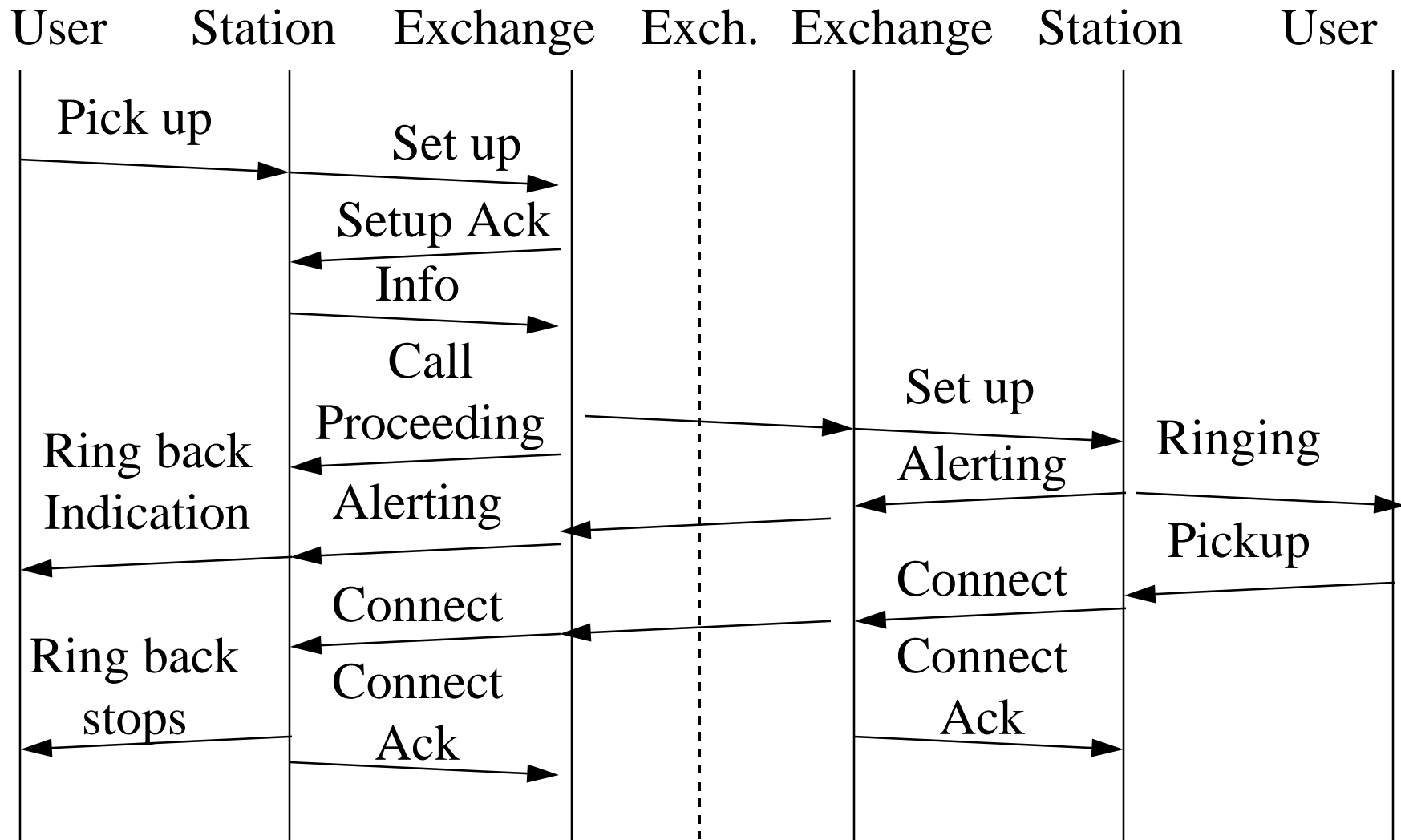
# Bearer Capability (Cont)

- ❑ For V.120:
  - ❑ Header/No header: Rate adaptation header
  - ❑ Multiple-frame establishment support
  - ❑ Mode: Bit transparent or protocol sensitive
  - ❑ Logical Link Identifier Negotiation: Whether default LLI (256) will be used
  - ❑ Assignor/Assignee: Default assignor or assignee only
  - ❑ In-Band negotiation: Negotiation with User information messages on D channel or in-band using LLI = 0

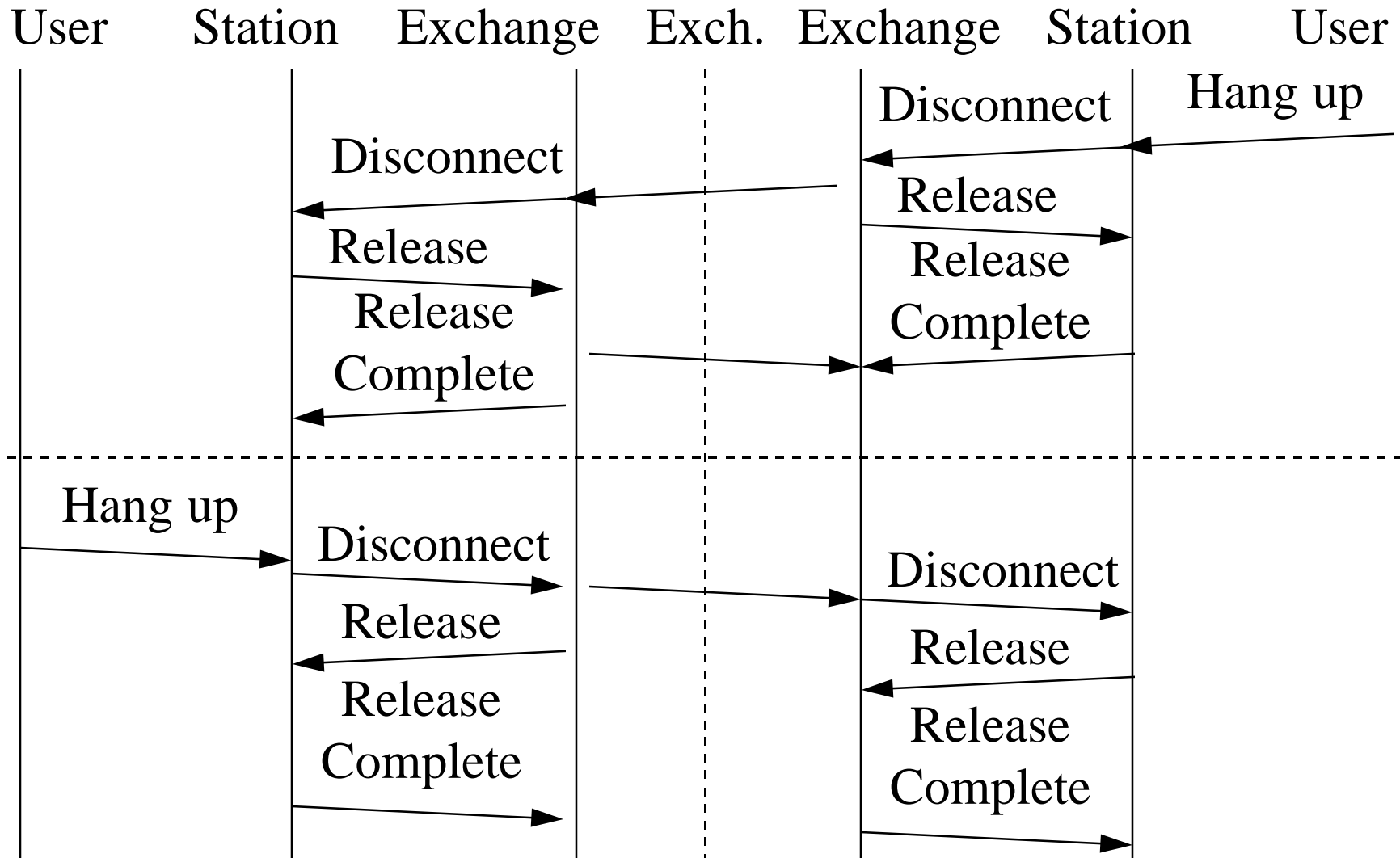
# Bearer Capability (Cont)

- ❑ Physical Layer Characteristics:
  - ❑ Number of Stop bits:
  - ❑ Number of Data bits:
  - ❑ Parity:
  - ❑ Duplex Mode:
  - ❑ Modem Type:
- ❑ Layer 2 Identity: I.441/Q.921 or X.25 layer 2
- ❑ User Information Layer 2 Protocol:
- ❑ Layer 3 Identity: Q.931 or X.25 layer 3
- ❑ User Information Layer 3 Protocol:

# Circuit Mode Example



# Circuit Mode Example (cont)



# Packet-Mode Access Connection

Message	Significance	Direction	Function
Alerting	Local	u - n	User alerting begun
Call Proceeding	Local	Both	Call establishment initiated
Connect	Local	Both	Call accepted by TE
Connect Ack	Local	Both	User has been awarded the call
Progress	Local	u - n	Reports progress of a call
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Message	Significance	Direction	Function
Disconnect	Local	Both	User requests clearing Net indicates clearing
Release	Local	Both	Intend to release
Release Complete	Local	Both	Channel released
Status	Local	Both	To report error or status
Status Enquiry	Local	Both	Solicit status

# Packet-Mode Access (Cont.)

- ❑ Circuit-switched Access to a packet-switched public data network over a B channel.
  - ❑ Set up a circuit mode connection to a packet handler outside the ISDN.
  - ❑ Subset of messages for circuit-mode access.
  - ❑ No setup acknowledge since no additional information is required
  - ❑ No call information phase
    - ⇒ can't suspend/resume circuit-mode connections
  - ❑ No information/notify messages

# Packet-Mode Access (Cont.)

- ❑ Packet-switched access to an ISDN virtual-circuit service over a B channel
  - ❑ Set up connection to a packet handler internal to ISDN
- ❑ Packet-switched access to an ISDN virtual-circuit service over a D channel

# Bearer Services Control Signaling

Message	Significance	Direction	Function
Alerting	Global	Both	User alerting begun
Call Proceeding	Local	Both	Call establishment initiated
Connect	Global	Both	Call accepted by TE
Connect Ack	Local	Both	User has been awarded the call
Setup	Global	Both	Initiates call establishment
Setup Ack	Local	Both	Call establishment initiated but requests more info

Message	Significance	Direction	Function
User Information Release	Access	Both	Transfers info from one user to another
Release	Local	Both	Intend to release channel
Release complete	Local	Both	Channel released
Congestion Control	Local	Both	Sets or releases flow control on messages
Information	Local	Both	Additional Info
Status	Local	Both	Reports status or error
Status Enquiry	Local	Both	Requests status

# Bearer Services Control Signaling

- ❑ Set up and clear a temporary signaling connection over D channel
- ❑ Subset of messages used for circuit-mode connection control
- ❑ No progress messages since call does not leave ISDN environment
- ❑ Only user information messages during call information phase.
- ❑ No DISCONNECT message. Connection closed by RELEASE.
- ❑ RECEIVE NOT READY  $\Rightarrow$  suspend user information messages. Resume on Receive Ready.

# Global Call Reference

- ❑ Used to return a given channel or all channels to a predefined state after a fault condition.
- ❑ Only three messages are used.

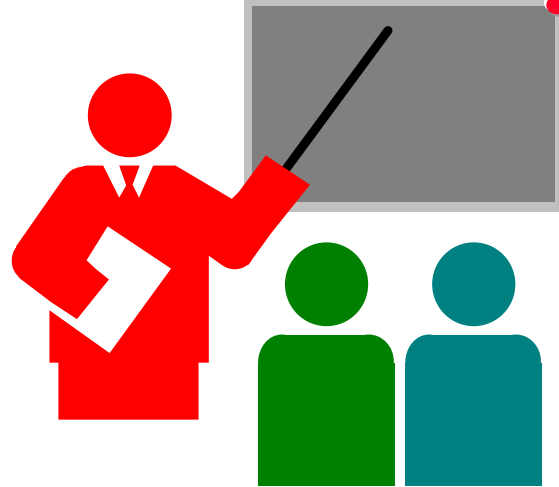
Message	Significance	Direction	Function
Restart	Local	Both	Request to restart
Restart Ack	Local	Both	Restart completed
Status	Local	Both	Reports an error

# Q.932

## Supplementary Services Control

- ❑ Three methods:
  - ❑ Keypad protocol: similar to POTs
  - ❑ Feature key management protocol: Similar to feature phones
  - ❑ Functional protocol: Most general method
- ❑ Two approaches
  - ❑ Separate message approach: Specific message types defined. Currently used only for call holding.
  - ❑ Common Information Element Procedure: Uses information elements in Q.931 messages.

# Summary



- ❑ Q.931 defines messages and procedures for call control signaling
- ❑ Both circuit-switched and packet-switched connections are supported.
- ❑ Also supports user-to-user signaling over D Channel.

# Homework

- ❑ Read Chapter 8 of Stallings' ISDN book
- ❑ Submit answer to Exercise 8.1