Universitas Esa Unggul

Smart, Creative and Entrepreneurial

Digital Network

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Prodi Teknik Informatika , Fakultas Imu Komputer

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Integrated Services Digital Network

- Public networks are used for a variety of services
  - Public Switched Telephone Network
  - Private Lines (leased)
  - Packet Switched Data Networks
  - Circuit Switched Data networks

ISDN

- Users have a variety of equipment to connect to public networks
  - Telephones
  - Private Branch Exchanges
  - Computer Terminals or PCs
  - Mainframe Computers
- A variety of physical interfaces and access procedures are required for connection

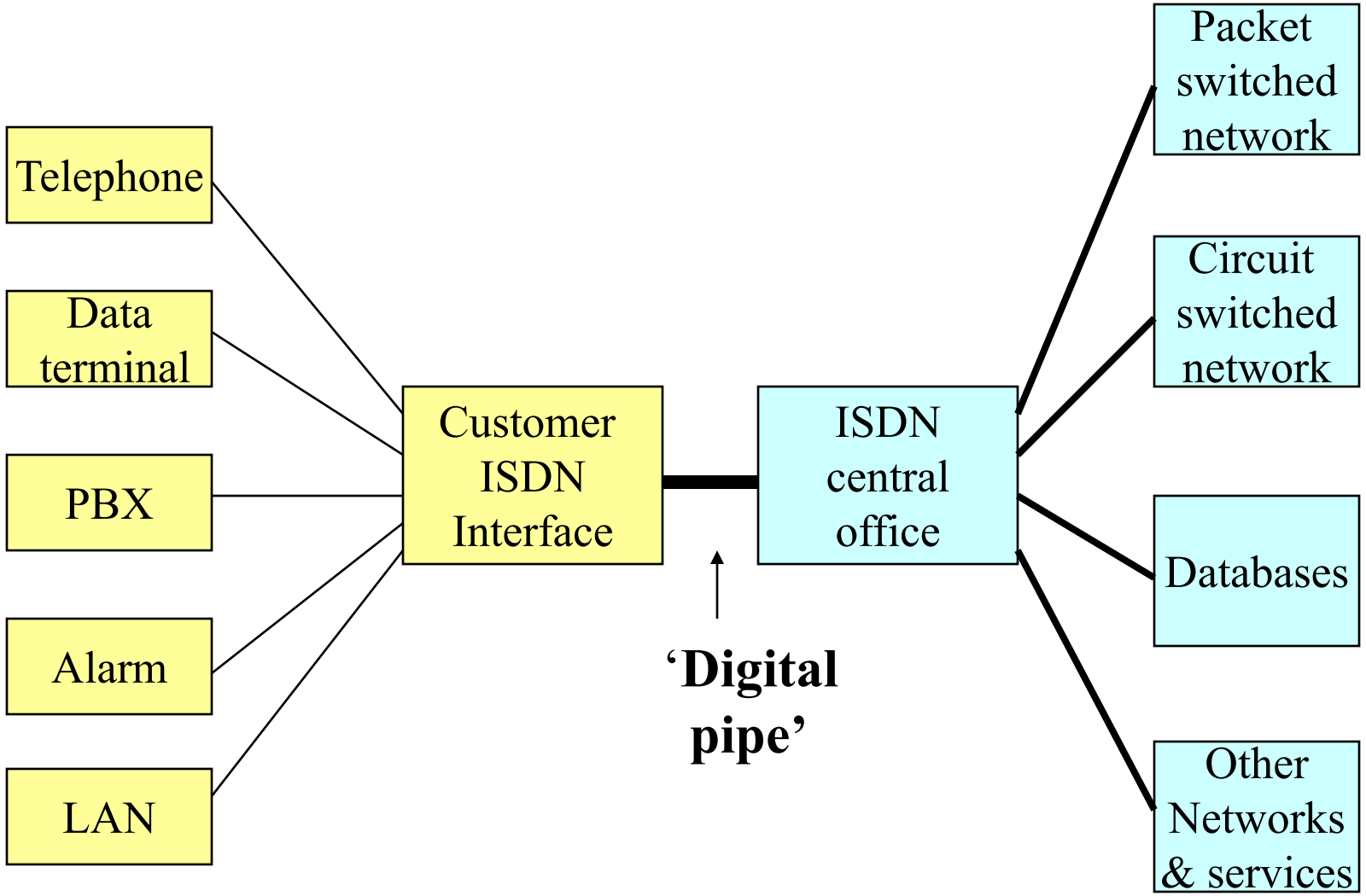
ISDN

- The telephone network has evolved into a digital one with digital exchanges and links
- The signalling system has become a digital message-oriented common channel signalling system (SS#7)
- The term ‘Integrated Digital Network’ is used to describe these developments

ISDN

- The Public Switched Telephone network is still analogue from the subscriber to the local exchange
- The need has arisen to extend the digital network out to subscribers and to provide a single standardised interface to all different users of public networks
- ISDN fulfils that need

Integrated Services Digital Network



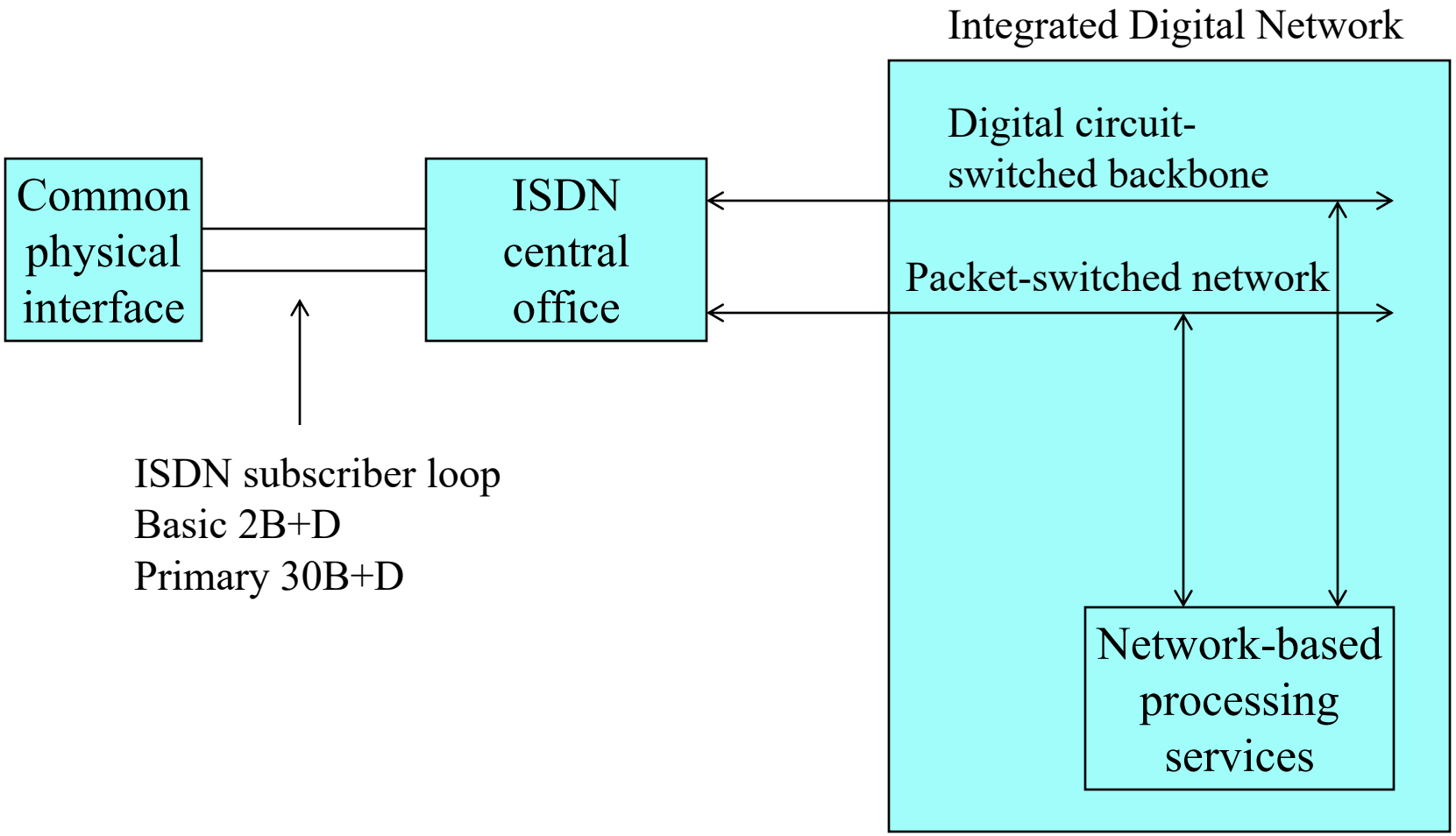
ISDN

- In Practice there are multiple networks providing the service nationally
- The user however, sees a single network

Benefits to Subscribers

- Single access line for all services
- Ability to tailor service purchased to suit needs
- Competition among equipment vendors due to standards
- Availability of competitive service providers

Architecture



ISDN Standards

- Contained in the I-series recommendations
- Issued by CCITT (now ITU-T)
- Six main groupings I.100 to I.600 series
- I.100 series - General Concepts
- I.200 series - Service Capabilities
- I.300 series - Network Aspects
- I.400 series - User-Network Interfaces
- I.500 series - Internetwork Interfaces
- I.600 series - Maintenance Principles

ISDN Channels

- The Digital pipe is made up of channels - one of three types
- B channel, D channel or H channel
- Channels are grouped and offered as a package to users

B Channel

- B channel-64 kbps
- B is basic user channel
  - can carry digital data or PCM-encoded voice
  - or mixture of lower rate traffic.

B Channel

- Four kinds of connection possible
- Circuit-switched
- Packet-switched - X.25
- Frame mode - frame relay (LAPF)
- Semipermanent - equivalent to a leased line

D Channel

- D Channel - 16 or 64 kbps
- Carries signalling information to control circuit-switched calls on B channels
- Can also be used for packet switching or low-speed telemetry

H Channel

- Carry user information at higher bit rates 384kbps or 1536kbps or 1920kbps
- Can be used as a high-speed trunk
- Can also be subdivided as per user's own TDM scheme
- Uses include high speed data, fast facsimile, video, high-quality audio

ISDN Channels and their Applications

B Channel (64 kbps)	**D Channel (16/64 kbps)**	**H Channel (384/1536 kbps)**
Digital voice	Signalling (using SS#7)	High-speed trunk
High-speed data (e.g. packet and circuit switched data)	Low- speed data, (e.g. packet, terminal, videotex)	Very high speed data
Other (e.g. fax, slow video)	Other (e.g. telemetry)	Other (e.g. fast fax. Video)

ISDN Channel Groupings

- Basic Access -
  - → two 64 kbps B channels
  - → plus one 16kbps D channel
- B channels can be used for voice and data
- simultaneous calls to separate destinations supported
- D channel used for signalling and also for data using X.25

ISDN Basic Access

- Intended for small business and residential use
- A single physical interface is provided
- Data rate is 144kbps plus 48kbps overhead bits totalling 192 kbps
- Most existing subscriber loops can support basic access

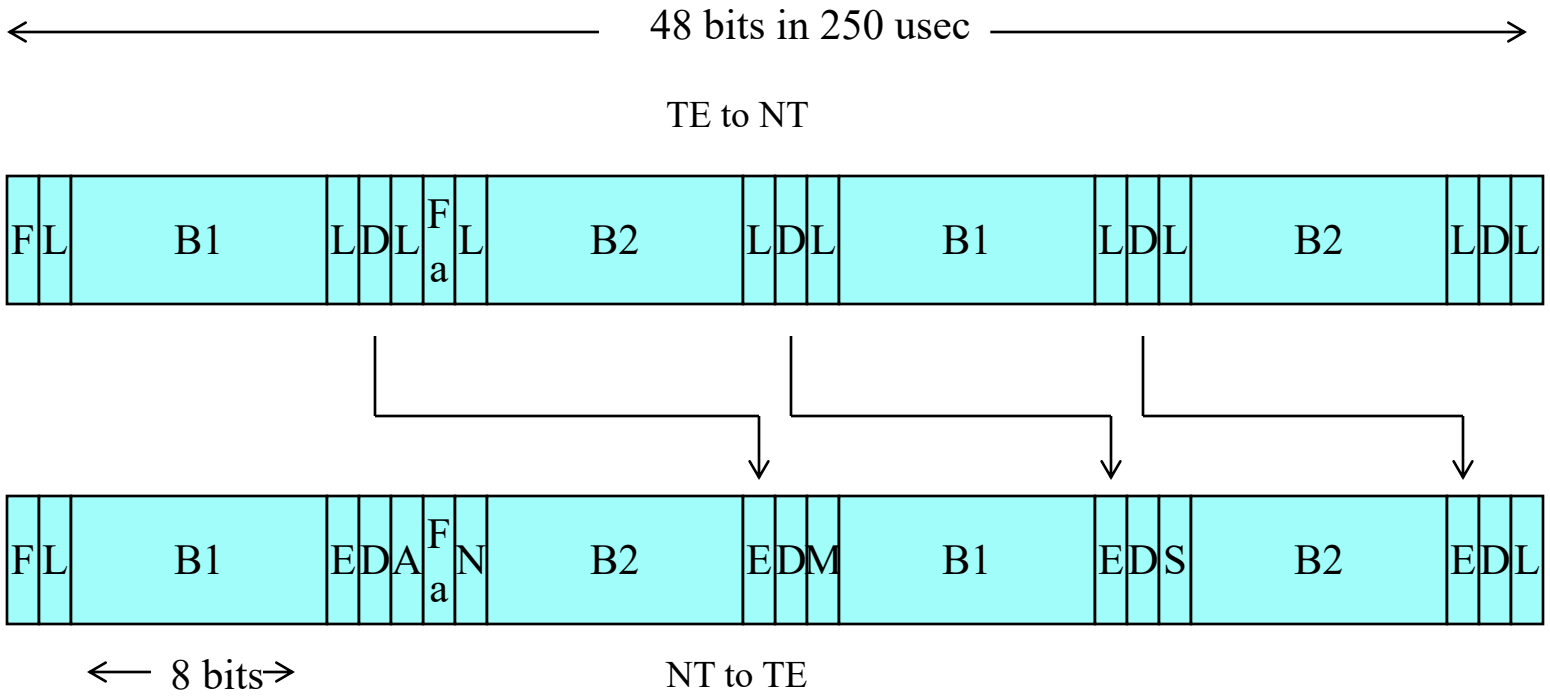
ISDN Primary Access

- Intended for users with greater capacity requirements
- Example would be a digital PBX
- Two standards exist
  - 1.544 Mbps American
  - 2.048 Mbps European

ISDN Primary Access

- Typically it is structured as 30 B channels plus one 64kbps D channel (Europe)
- Can also be structured as H channels
  - 5H0 +D for a 2.048 Mbps interface
  - or 1H12 +D

ISDN Frame Structure Basic Rate Access



F= Framing bit
L = dc balancing bit
E = D-echo channel bit
A = Activation bit

Fa = Auxiliary Framing bit
N = opposite of Fa
M = multiframing bit
B1 = B channel bits

B2 = B channel bits
D = D channel bits
S = Spare bits

ISDN Contention Resolution

- Several TE's can share a single line
- How is contention resolved?
- B-channel Traffic
  - No contention as each channel dedicated to particular TE
- D - Channel used for data and control so requires a contention resolution mechanism

D Channel Contention

- Incoming Traffic
  - LAPD protocol resolves contention
- Outgoing Traffic
  - Multiple devices share D channel
  - Contention resolution algorithm required

D Channel Contention

- Idle TEs sends binary 1s on D channel
- This means no signal (pseudoternery)
- NT echos received binary value back as echo bit
- When NT wishes to send on D channel, it listens to echo bits
- If it hears a string of 1's equal in length to a threshold value Xi, it may transmit
- Otherwise it must wait

D Channel Contention

- If two TE's start transmitting simultaneously a collision occurs
- This is detected by each TE by monitoring E bits
- If E bits are identical to D bits sent then no collision
- If discrepency detected TE stops and listens

D Channel Contention

- Priority mechanisms based on threshold values
  - Control information has priority over user data
  - When TE has sent data its priority is lowered until other terminals transmit

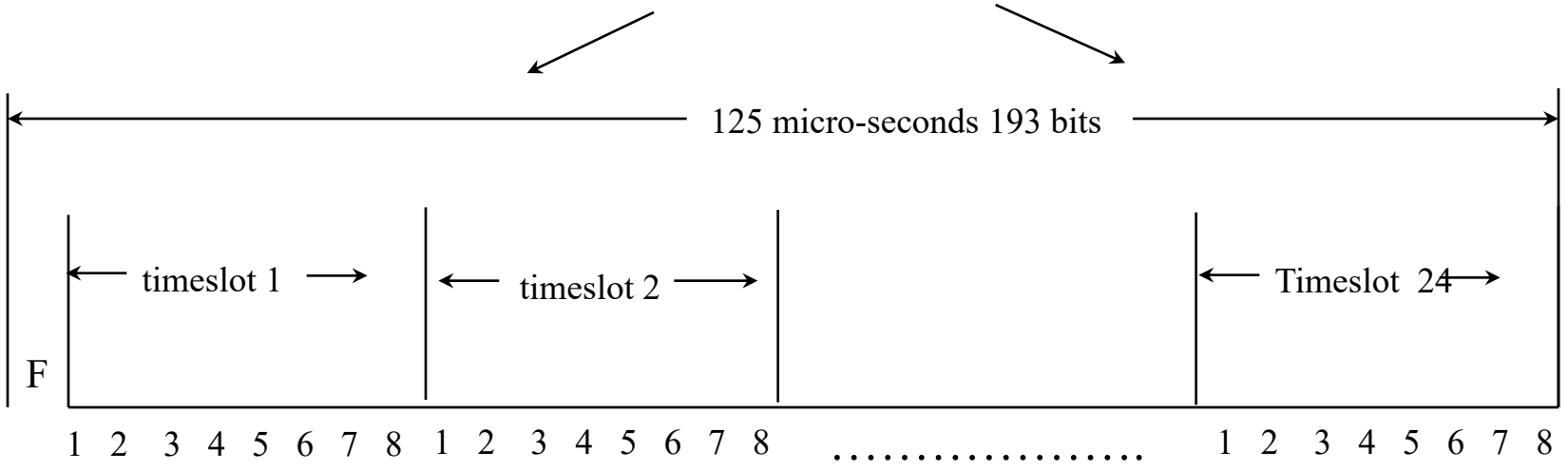
D Channel Priorities

- Control Information
  - Normal Priority X1 =8
  - Lower Priority X1 =9
- User Data
  - Normal Priority X2 =10
  - Lower Priority X2 =11

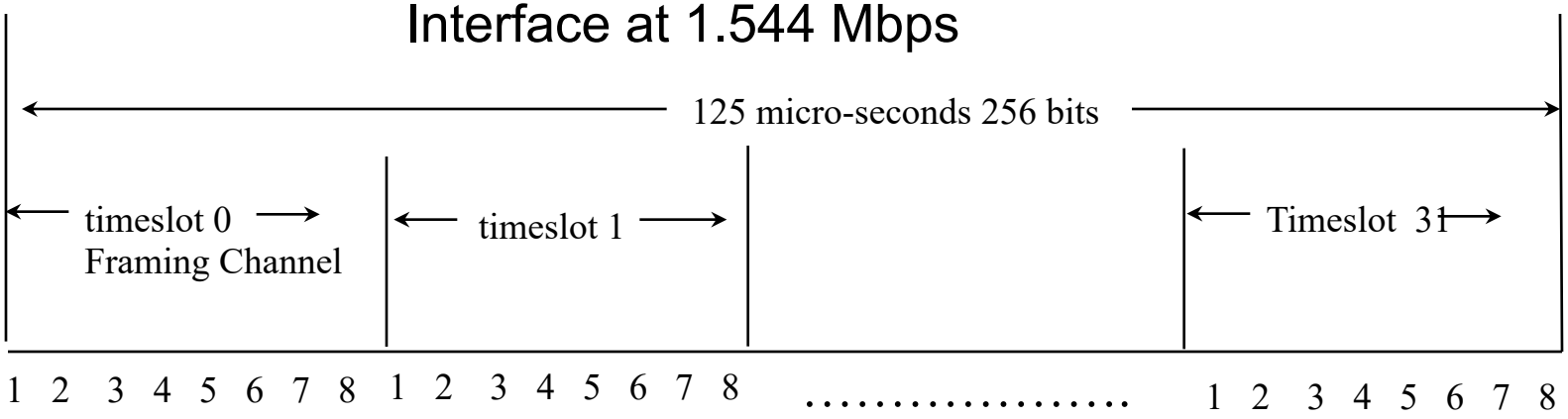
ISDN Primary Interface

- Multiple channels multiplexed on single medium
- Only point to point configuration is allowed
- Typically supports a digital PBX and provides a synchronous TDM facility

ISDN Primary Access Frame Formats



Interface at 1.544 Mbps

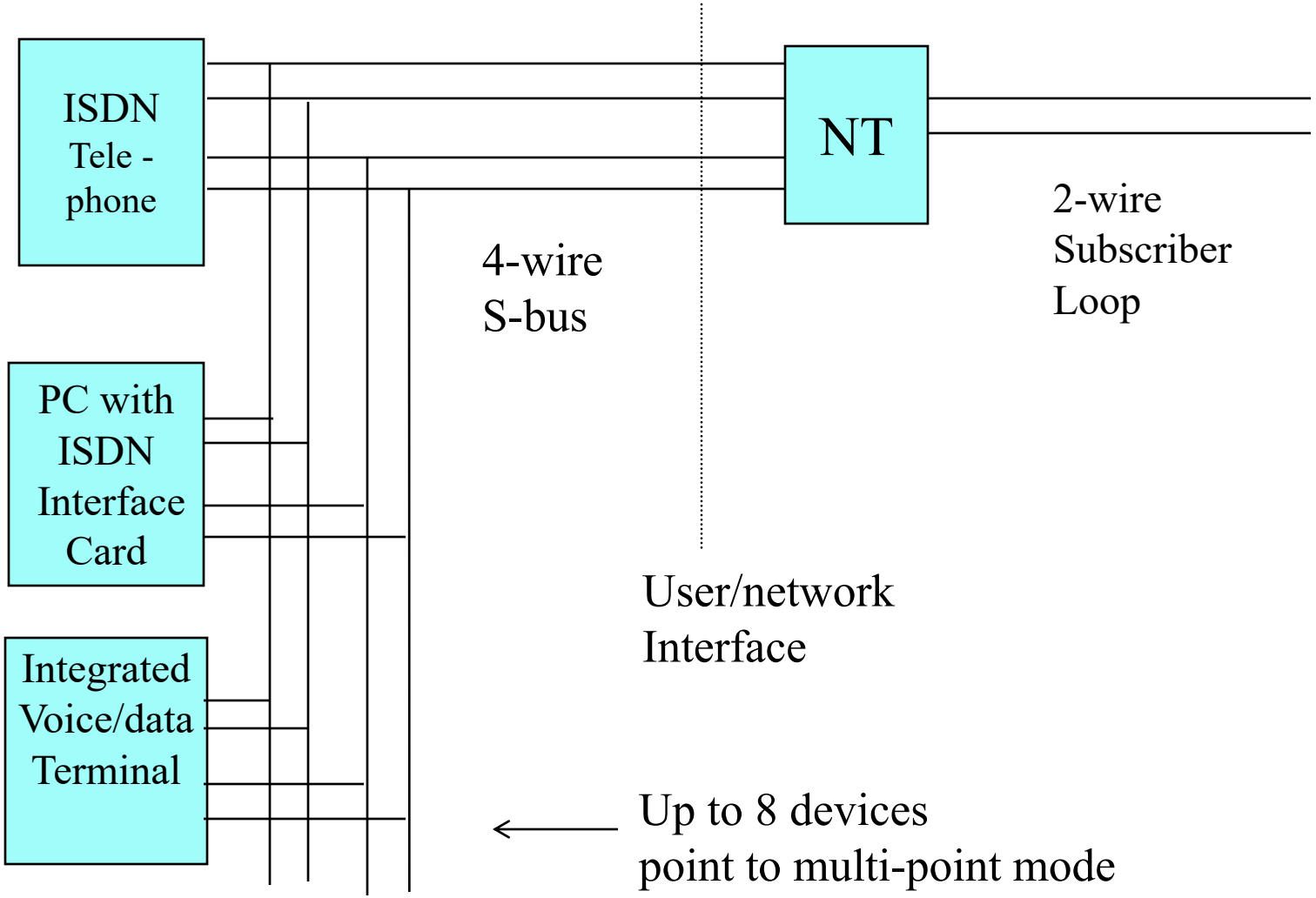


Interface at 2.048Mbps

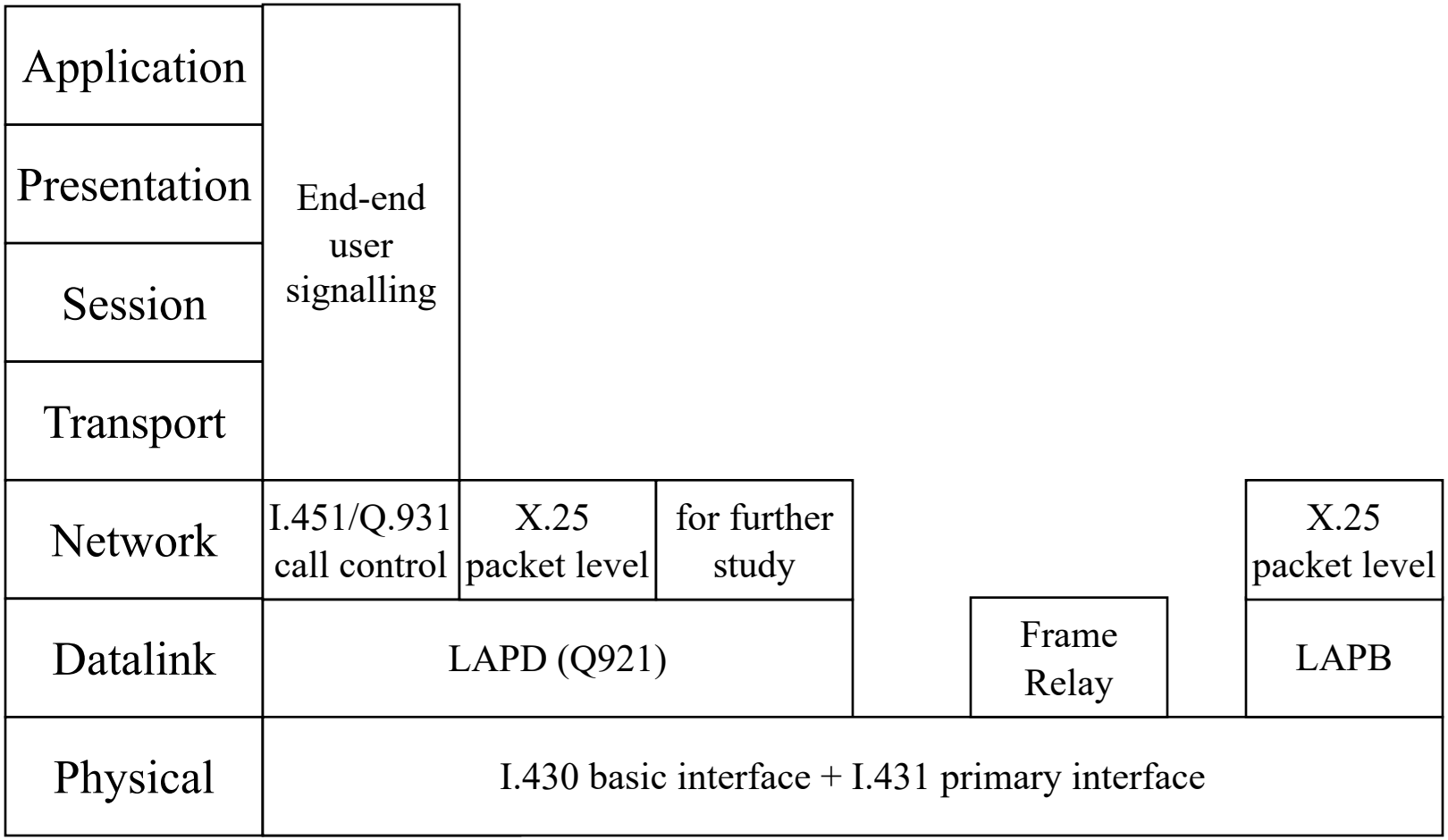
User Access

- Defined using two concepts
  - Functional groupings of equipment
  - Reference points to separate functional groupings

Typical User Access Layout



ISDN Protocol Architecture



ISDN Data Link Layer

- Link Access Protocol for the D channel (LAPD) defined for ISDN
- Three applications are supported
  - Control Signalling
  - Packet Switching
  - Telemetry

Network Layer Above LAPD

- Control Signalling
  - Call Control Protocol (I.451 / Q.931)
    - » Establishes, maintains and terminates connections on B channels
    - » Possibility of user - user control signalling above this layer

B-Channel

- Uses
  - Circuit Switching
  - Semi-permanent circuits
  - Packet switching

B-Channel

- Circuit Switching
  - Circuit is set up on B-channel on demand
  - D-channel call control protocol is used
  - Transparent full-duplex digital data path established between users
  - Layers 2 to 7 are not visible to ISDN or specified

B-Channel

- Semipermanent circuit can be set up by prior agreement between users and network operator
- Can be for indefinite time or at specified times during day or week
- As with circuit switched connection, full duplex digital data path is established
- Layers 2 to 7 are not visible to ISDN or specified

B-Channel Packet Switching

- Circuit-switched connection is established between user and packet-switched node using D-channel call control protocol
- The packet switching node can be integrated into ISDN or be a separate network
- User then employs X.25 layers 2 and 3 to establish virtual circuit to other user
- Frame relay can also be used instead of X.25

D-Channel Packet Switching

- Integrated X.25 service can be accessed by D-Channel in addition to B-Channel
- ISDN provides a semi-permanent connection to a packet switching node within ISDN
- The X.25 level 3 protocol is used for the packet layer
- LAPD is used for the link layer

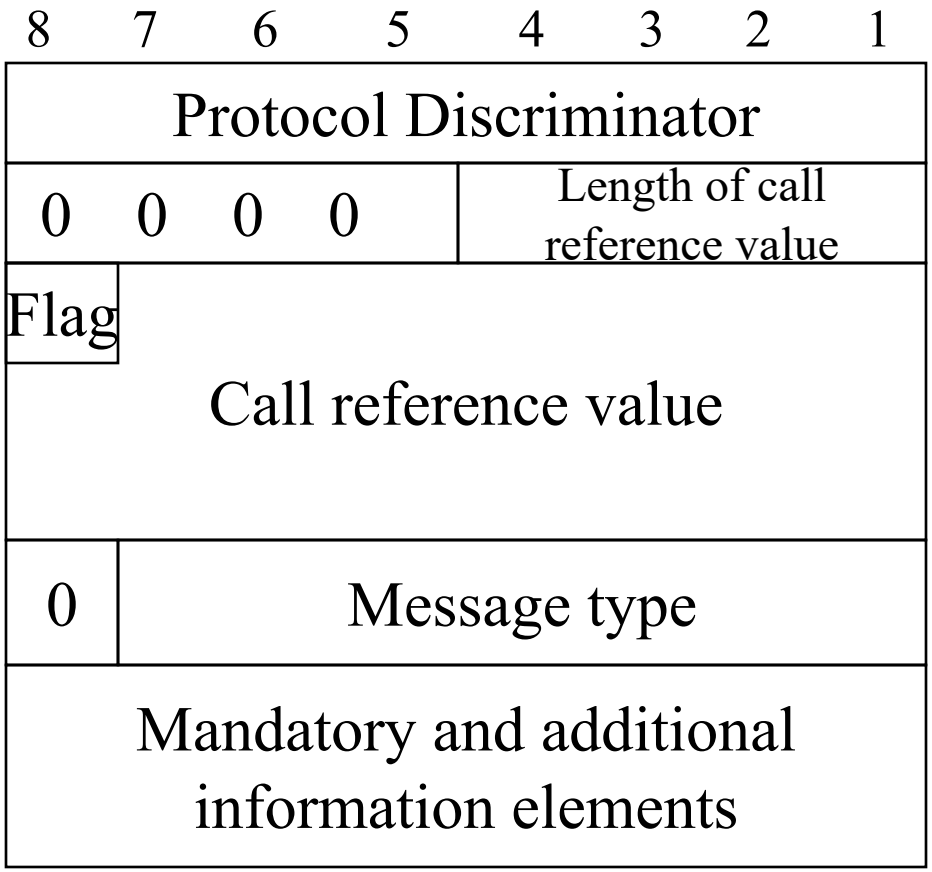
ISDN Call Control Protocol

- Defined in recommendation I.451/Q.931
- Network layer protocol
- Uses services of LAPD link layer
- Specifies procedures for establishing, maintaining clearing connections on B-channels sharing D-channel

ISDN Call Control Protocol

- Message Types
  - Call establishment messages to set up a call
  - Call information messages during a call (e.g. suspend a call and resume a call)
  - Call clearing messages to clear a call
  - Miscellaneous messages (congestion control, requesting supplementary services etc)

I.451 Formats

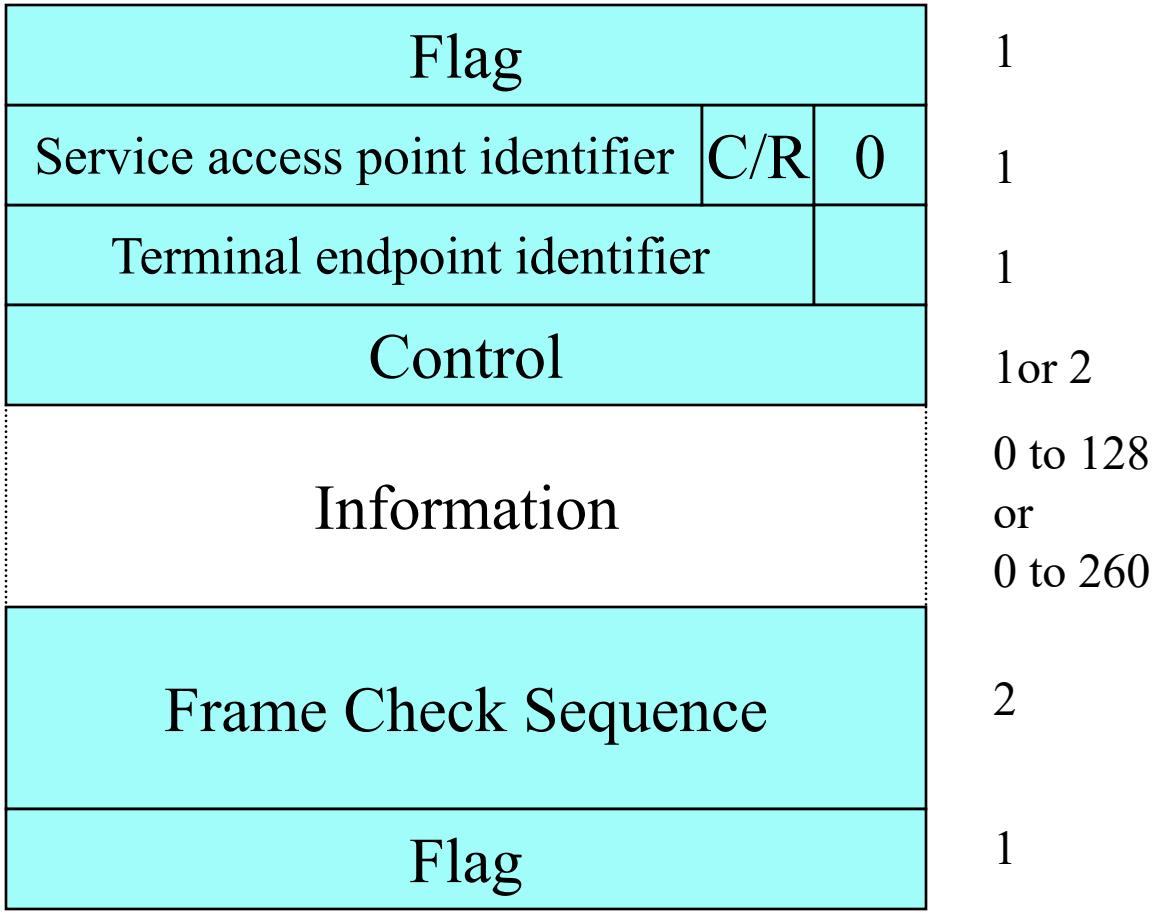


General message format

LAPD

- Provides two types of service
  - Unacknowledged information transfer
    - » No guarantee of delivery
    - » Frames with error are discarded
  - Acknowledged information transfer
    - » Similar to HDLC
    - » Flow and error control
    - » Logical connection established prior to data transfer
    - » Also called multiple-frame operation

LAPD Format


Flag
Service access point identifier
C/R
0
Terminal endpoint identifier
Control
Information
Frame Check Sequence
Flag
1
1
1
1or 2
0 to 128
or
0 to 260
2
1
Length in octets

ISDN Physical Interface

- There are no separate control circuits
- Transmit and receive circuits carry data and control signals
- Pseudoternery coding scheme is used for basic access signals
  - Voltage level is + or - 750 mV
  - Data rate is 192 kbps
- HDB3 code is used for 2.048 Mbps access
- B8ZS code is used for 1.544 Mbps access

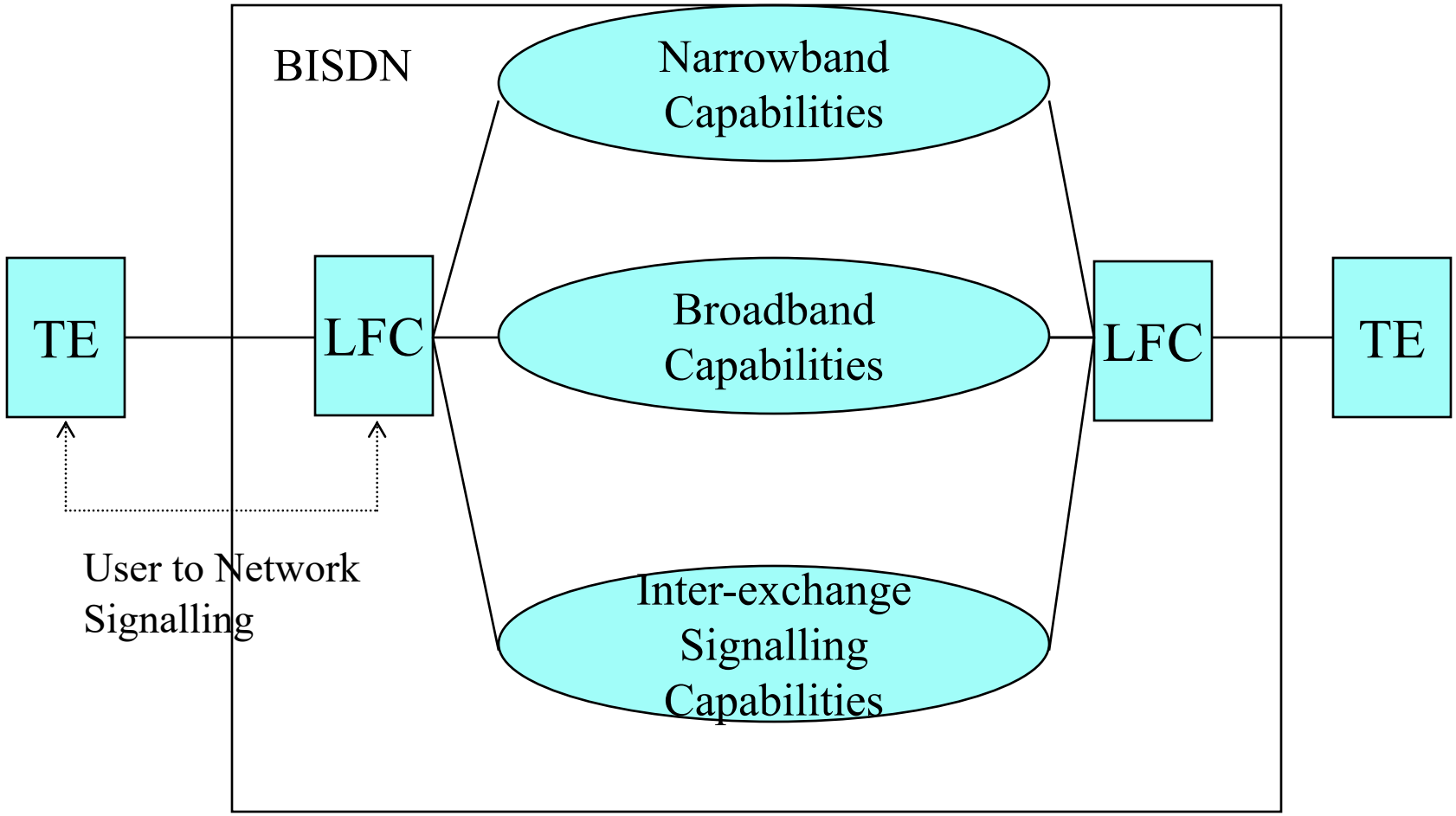
ISDN INTERFACE PLUG PINOUT

PIN	TERMINAL EQUIPMENT	NETWORK TERMINATING EQUIPMENT
1	Power Source 3	Power Sink 3
2	Power Source 3	Power Sink 3
3	Transmit	Receive
4	Receive	Transmit
5	Receive	Transmit
6	Transmit	Receive
7	Power Sink 2	Power Source 2
8	Power Sink 2	Power Source 2

Broadband ISDN

- Recommendations to support video services as well as normal ISDN services
- Provides user with additional data rates
  - 155.52 Mbps full-duplex
  - 155.52 Mbps / 622.08 Mbps
  - 622.08 Mbps full-duplex
- Exploits optical fibre transmission technology
- Very high performance switches

B-ISDN Architecture



TE = Terminal equipment
LFC = Local function capabilities

B-ISDN

- ATM is specified for Information transfer across the user-network interface
- Fixed size 53 octet packet with a 5 octet header
- Implies that internal switching will be packet-based

BISDN Protocol Structure