CS25110

# ISDN - Integrated Services Digital Network

"An ISDN is a network, in general evolving from a Telephony IDN that provides end-to-end digital connectivity to support a wide range of services, to which users have access by a limited set of standard multipurpose user-network interfaces"

CCITT I-Series recommendations on ISDN



# Principles of ISDN

CCITT Recommendation 1.120 (1988)

- To support a wide range of voice and non-voice services.
- To support of a wide variety of applications including both switched and non switched connections.
- As far as practicable new services to be compatible with 64kbit/s switched digital connections.
- An ISDN will contain intelligence for providing service features, maintenance and network management functions.
- A layered protocol structure should be used for the specification of access to the ISDN.
- May be implemented in a variety of configurations...

## An all digital network

- IDN “pushed” by
  - need for better quality voice
  - fast digital switching
  - high bandwidth fibre trunk system
- “pulled” by
  - desire to provide framework for ISDN
  - greater need for data communications
- Existing infrastructure expensive -subscriber loop



## ISDN Services

- Bearer service
  - Provides connectivity.
  - No interpretation of the data or protocols.
- Tele services
  - Value adding.
  - Interprets protocols.
  - Provides extra services.
- Supplementary services

## Types of Access

- Basic rate access
  - 2 B channels at 64kbit/s each
  - 1 D channel at 16 kbit/s each
- Primary rate access

  UK/Europe (2.048Mbps):
  - 30 B channels at 64kbit/s each
  - 1 D channel at 64kbit/s

  US, Canada, Japan (1.544Mbps):
  - 23B channels at 64kbit/s each
  - 1D channel at 64kbit/s
- B channel - voice, FAX, slow video, data
- D channel - signalling, telemetry, low speed data



## Types of service

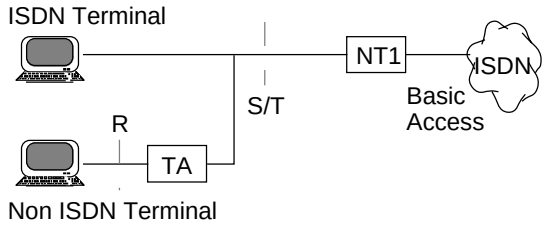
- Circuit switched over B channel.
- Semi permanent connections over B channel.
- Packet switched calls over B channel.
- Packet switched calls over D channel.

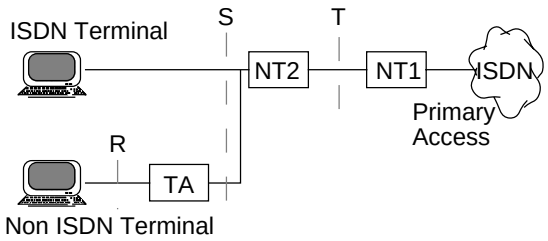
# Types of User Interface

- NT1 - Network termination 1
  - physical and electrical termination (OSI 1)
  - supports multidrop line
- NT2 - Network Termination 2
  - intelligent device
  - perform switching and concentration functions
- TE1 - Terminal Equipment 1
  - equipment supporting the standard interface
- TE2 - Terminal Equipment 2
  - existing non ISDN equipment
- TA - Terminal Adapter



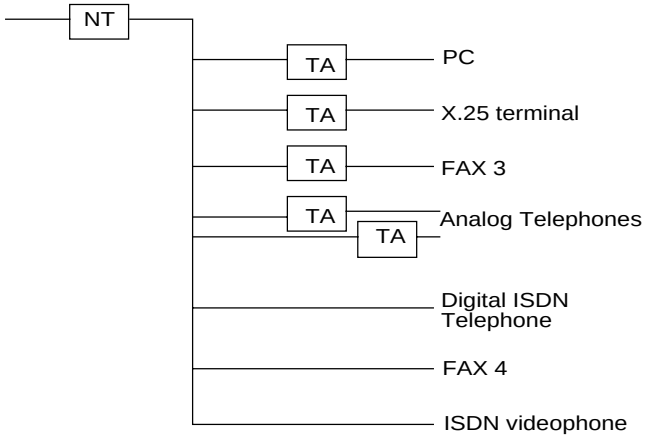
# Reference Points



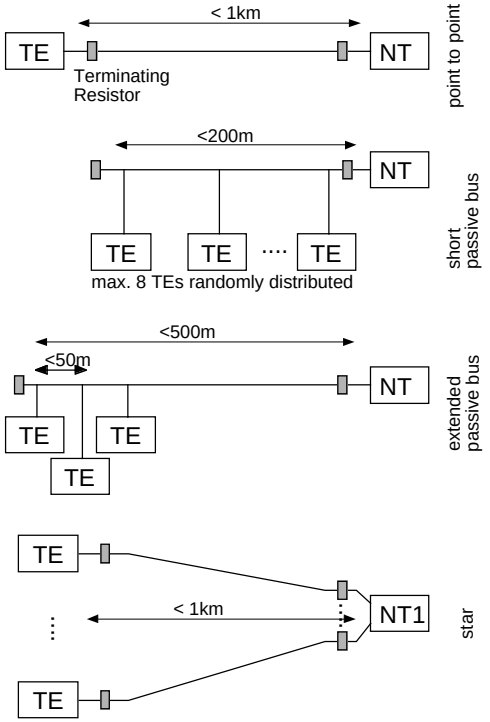
# Basic Access Configurations

- A ‘multidrop’ configuration can be used, with up to 8 TEs.
- Two devices can simultaneously transmit on two B channels.
- A contention resolution protocol detects collisions on the D channel.






# Basic Access Configurations



# The Subscriber Loop

**The requirements were:**

- utilise existing twisted pair wire
- digital data
- required to support 2B+D (144kbit/s)
- full duplex

**Possible solutions were:**

- MODEMS...
- Time Compression Multiplexing (TCM)
- echo cancellation

*Digital signal transmission using echo cancellation was chosen for the subscriber loop since it can support a range 4km rather than the 2km of TCM.*

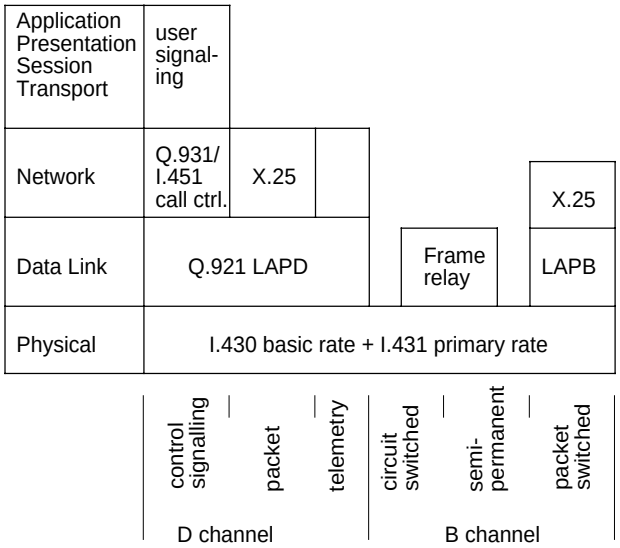


# The basic rate signal structure

**See Diagram at this point**

- multiplexing of both the B channels and the D channel (TDM)
- frames are 48 bits
- two 16 bit B channels
- one 4 bit D channel
- alternating 8 bit chunks from B channels with one D channel bit between each chunk.
- other bits used for framing and synchronisation

# ISDN protocols






# Protocols

**Link level protocols**

- LAP-D based on LAP-B
- LAP-B subset of HDLC (ISO 33009,4335)
- LAP-F Frame relay

**Network level protocols**

- I.451 / Q.931 B channel control signalling over D channel
- X.25 packet level used for user packet data over B or D channels

# LAP-D

**Aims:**

- multiple terminals at the user network interface (S/T)
- multiple "layer 3" entities in each device

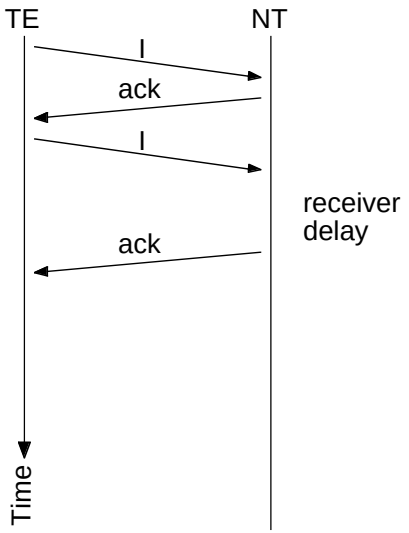
**Two types of service:**

- Unacknowledged operation:
  - error detection but no error control
  - no flow control
- Acknowledged operation:
  - error control
  - flow control



# Flow and Error Control

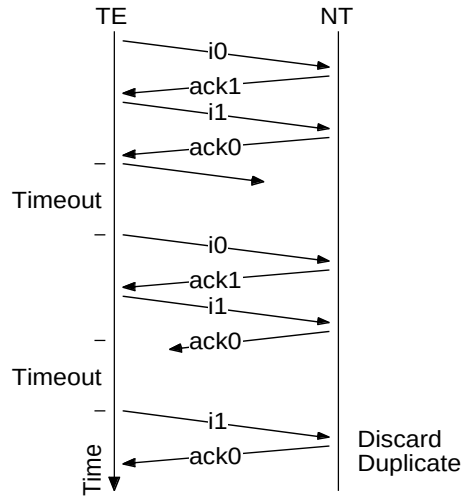
- Stop and wait - simple




- what about errors ?
- what about duplex channels ?

## Flow and error control (cont)

- Stop and wait Automatic Repeat Request (ARQ).
- Frames numbered 0 and 1 to correctly deal with lost acknowledgement.




*Inefficient - for long transmission delays*



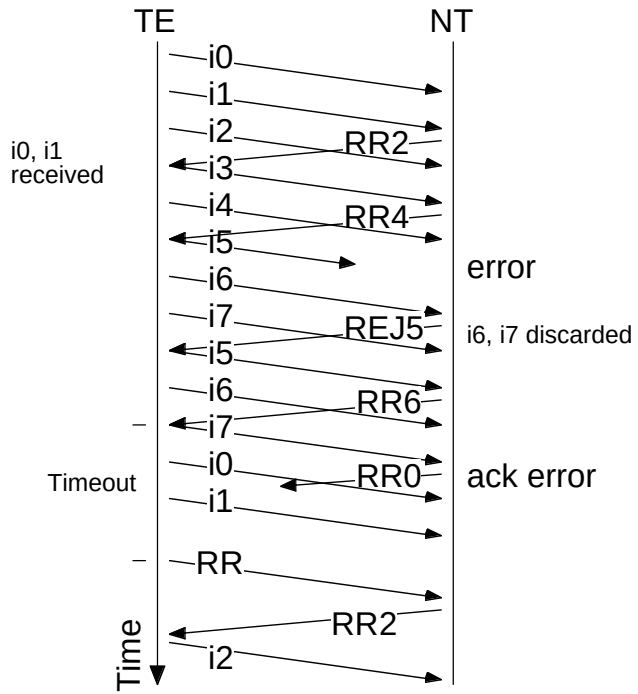
## Flow and Error control (cont)

- Go-back-N ARQ
- allow several frames to be in transit
- need to number frames and acknowledgements
- use control messages
  - Receiver Ready (RR)
  - Receiver Not Ready (RNR)
  - Reject (REJ)

Example:

- 3 bit sequence numbers
- 2 frames already sent beyond the one being acknowledged

## Flow and Error Control (cont)



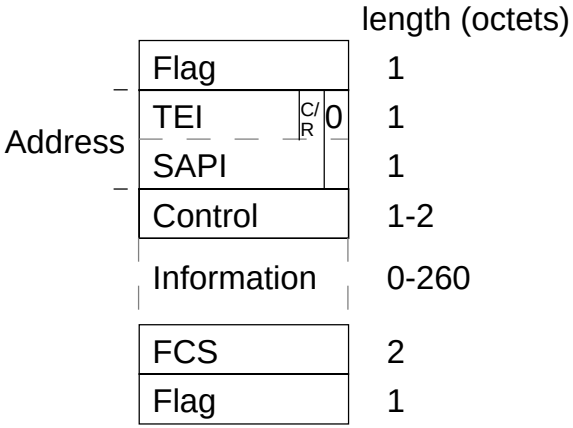



## Flow and Error Control (cont)

For full duplex operation

- "piggyback" acknowledgements onto information frames
- send acknowledge for TE->NT with information for NT->TE
- send acknowledge for NT->TE with information for TE->NT
- what if no data to be sent from one side ?
  - wait for a time less than timeout and send acknowledgement frame.

# LAPD Frame Format



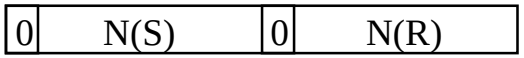

Control field specifies:

- Information frame
- Supervisory frame
- Unnumbered frame
- 7 bit frame numbers

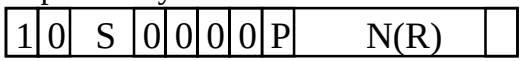


# LAPD control field

- Information

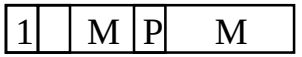



- Supervisory




  - Receive Ready
  - Receive Not Ready
  - REJect

- Unnumbered




  - SABME Set Asynchronous Balanced Mode
  - DM disconnected mode
  - UI Unnumbered Information
  - DISC Disconnect
  - UA Unnumbered Acknowledgement
  - FRMR Frame reject

N(S), N(R) send / receive sequence nos,
M and S function specifier bits

## LAPD in operation

- See diagram at this point



## Packet mode service

- see diagram at this point

## Teleservices

CCITT defined teleservices:

- Telephony
- Teletex
- Telefax
- Mixed mode
- Videotex
- Telex
- Message Handling Service (MHS)
  X.400 E-mail

List does not include computer-computer applications such as file transfer. These are mostly defined by ISO.



## Supplementary Services

Each supplementary service adds value to an underlying Bearer service or Teleservice

- Call Forwarding
- Closed User Group
- Calling Line Identification Presentation (CLIP)
- Calling Line Identification Restriction (CLIR)
- Advice of Charge at End of Call (AOC-E)
- plus many others...

## Costs

- More than ordinary phone line to install & line rental- but price dropping.
- Call charges the same.
- Cost per bit less for data.
- Cost effective against leased line when used of the order of 3 hours or less per day.



## Euro - ISDN

- 1989 Memorandum of Understanding
  - 26 operators
  - 20 countries
- in place end 1992
- implementation 1993
- provides a minimum set of standardised services

## MoU - Minimum Set of Services and Facilities

- International Interface
- Basic Rate Access
- Primary Rate Access

- Circuit mode 64Kbit/s unrestricted
- Circuit Mode 3.1Khz audio

- CLIP and CLIR
- Direct Dialling In
- Multiple Subscriber Number
- Terminal Portability



## Lower Priority Items

- Packet Mode - X.31 B channel
- Packet Mode - X.31 D channel
- Advice of Charge
- Call waiting
- conference
- call completion - busy
- call foreward
- call deflection
- free phone
- malicious call identification
- sub addressing
- three party
- user -user signalling

## Items Not Covered

- Channel aggregation N*64kbit/s
- Video Conference

- Programming Interfaces
- Data Encapsulation