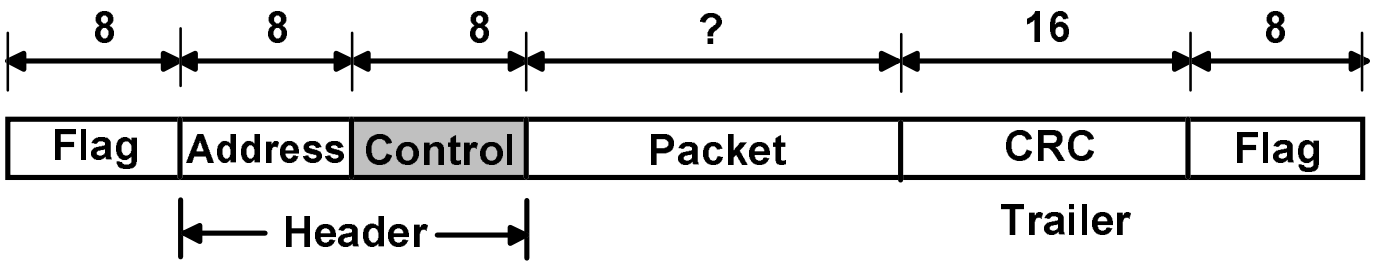
# Standard DLC

HDLC (ISO), ADCCP (ANSI), LAPB (CCITT), SDLC (IBM).

Frame structure:




## Address: for multipoint links.

HDLC = High-level Data Link Control

ISO = International Standards Organization

ADCCP = Advanced Data Communications Control Procedure

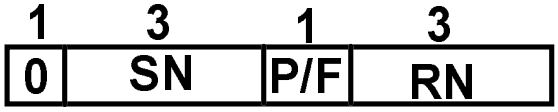
ANSI = American National Standards Institute

LAPB = Link Access Procedure, Balanced

CCITT = Consultative Committee for International Telephony and Telegraphy

SDLC = Synchronous Data Link Control

## Control Byte Format:




← Information frames use go back n (mod B)

← Supervisory frames send ACKs (RN) without data.

← Unnumbered frames (for initiation, termination and other special commands)

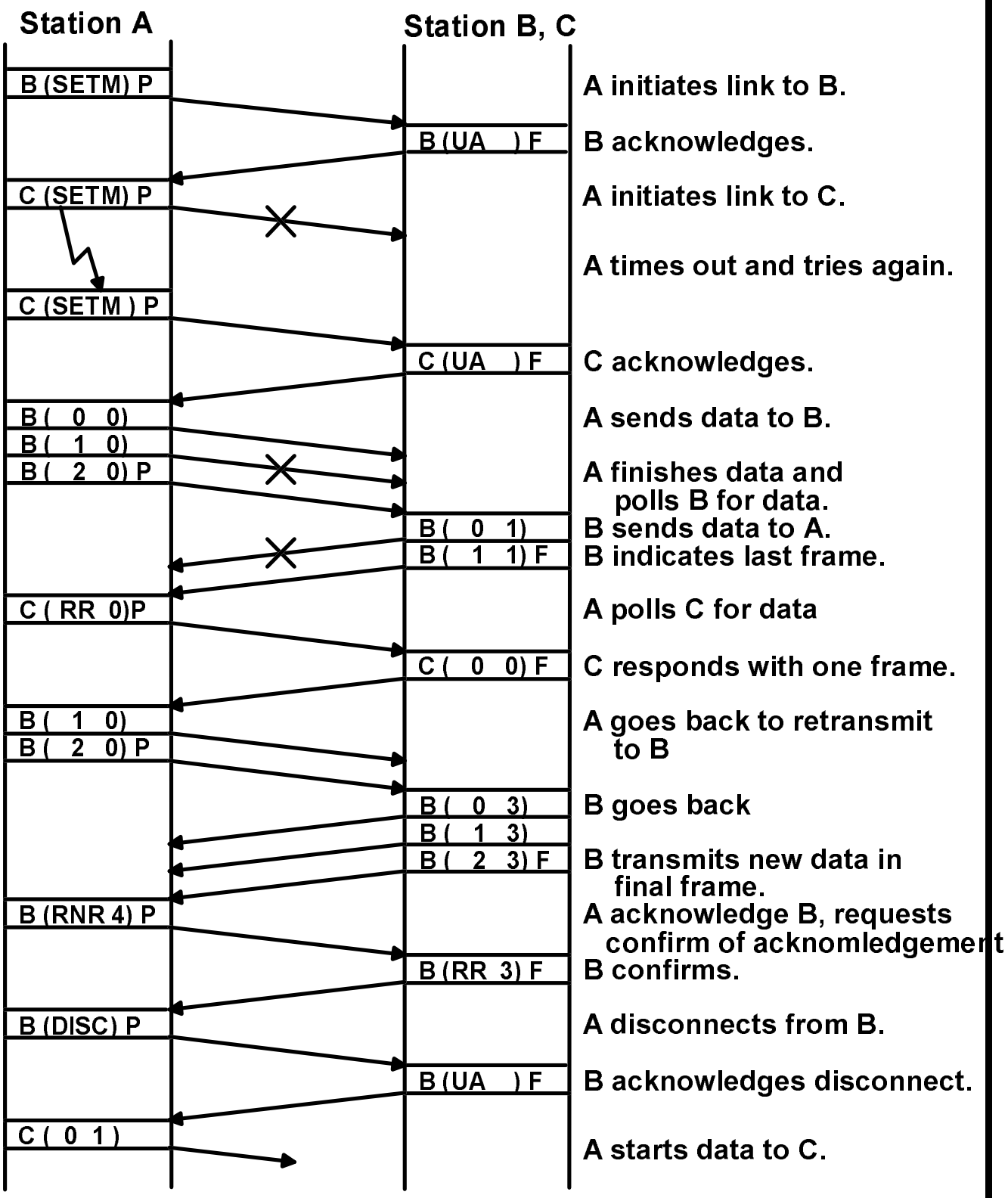
Types of supervisory frames:

- RR : Receive ready (normal ACK).
- RNR : Receive not ready (ACKs but requests no further data).
- REJ : Reject (to explicitly send a NAK).
- Selective reject (for primitive selective repeat).

P/F (poll/final) bit

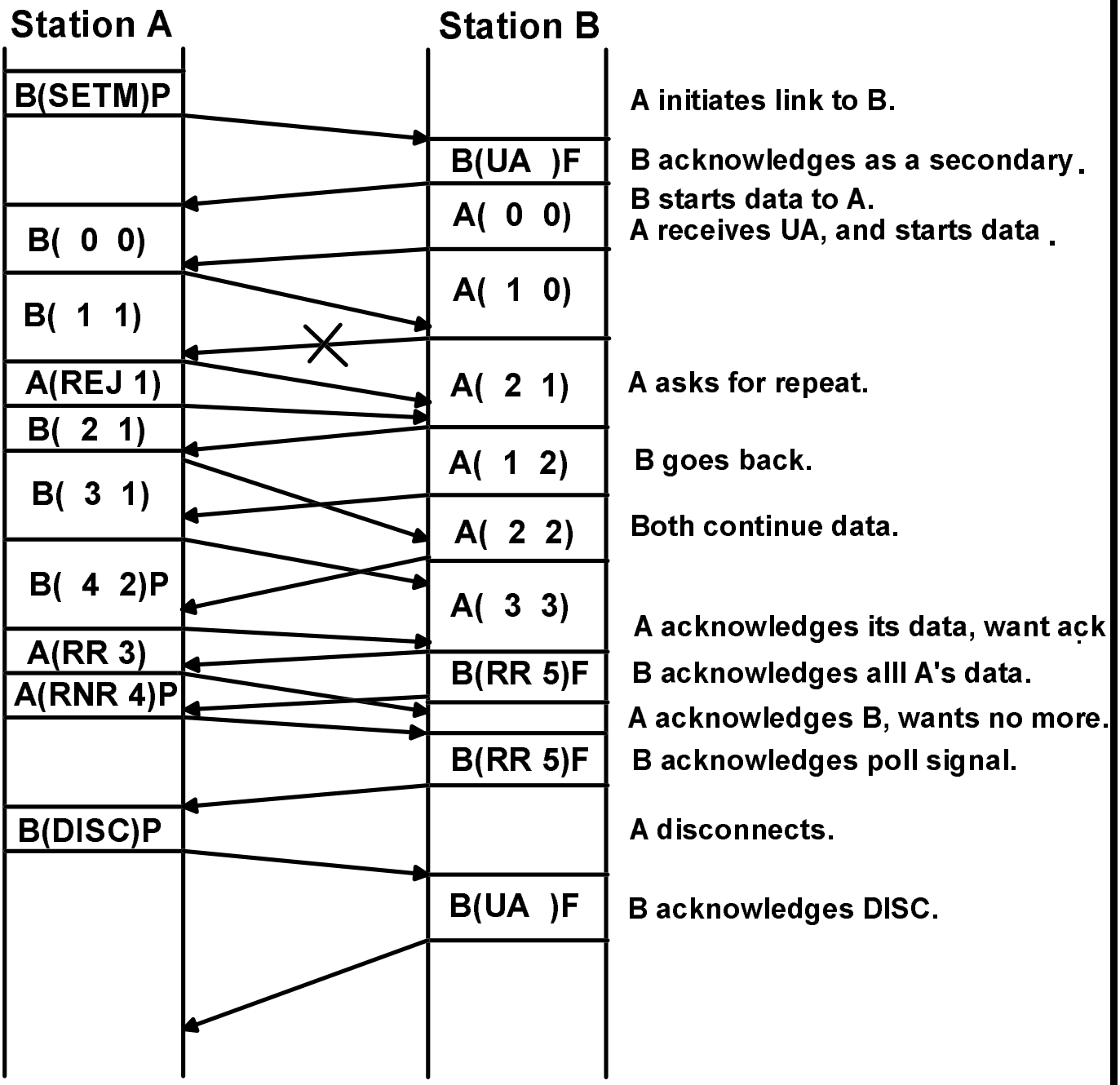
- P=1 (requires response).
- F=1 (provides response).

# Normal Response Mode (NRM)



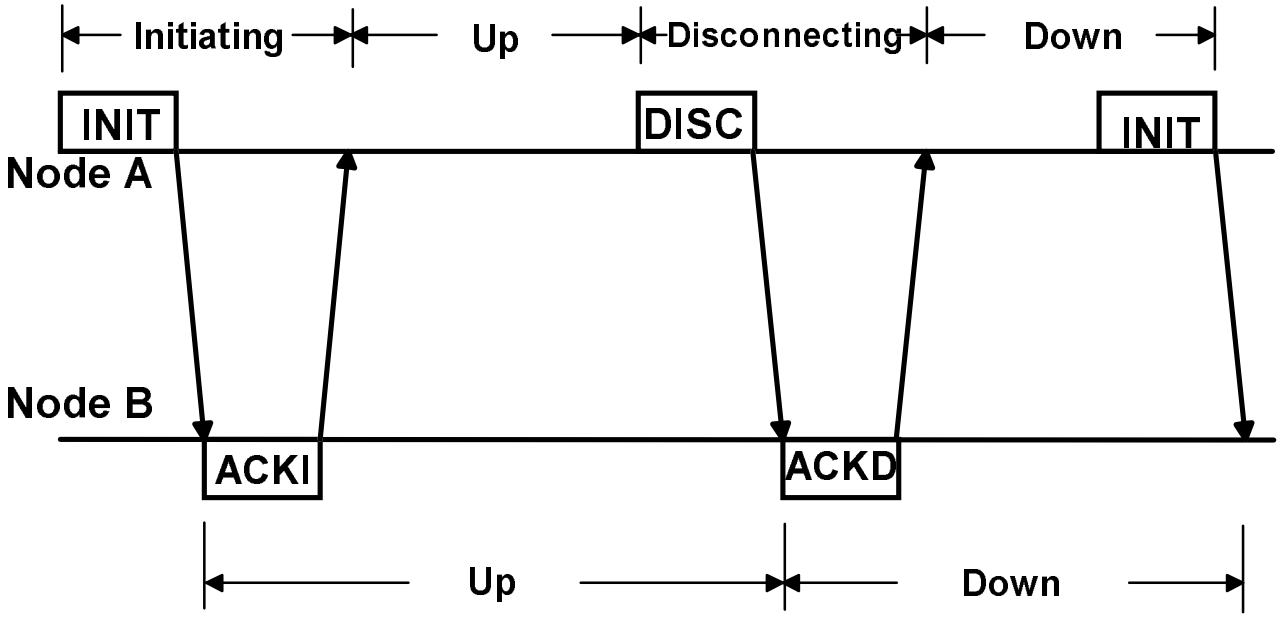

SETM = Set mode (NRM)
UA = Unnumbered acknowledgement

# Asynchronous Balanced Mode (ABM)

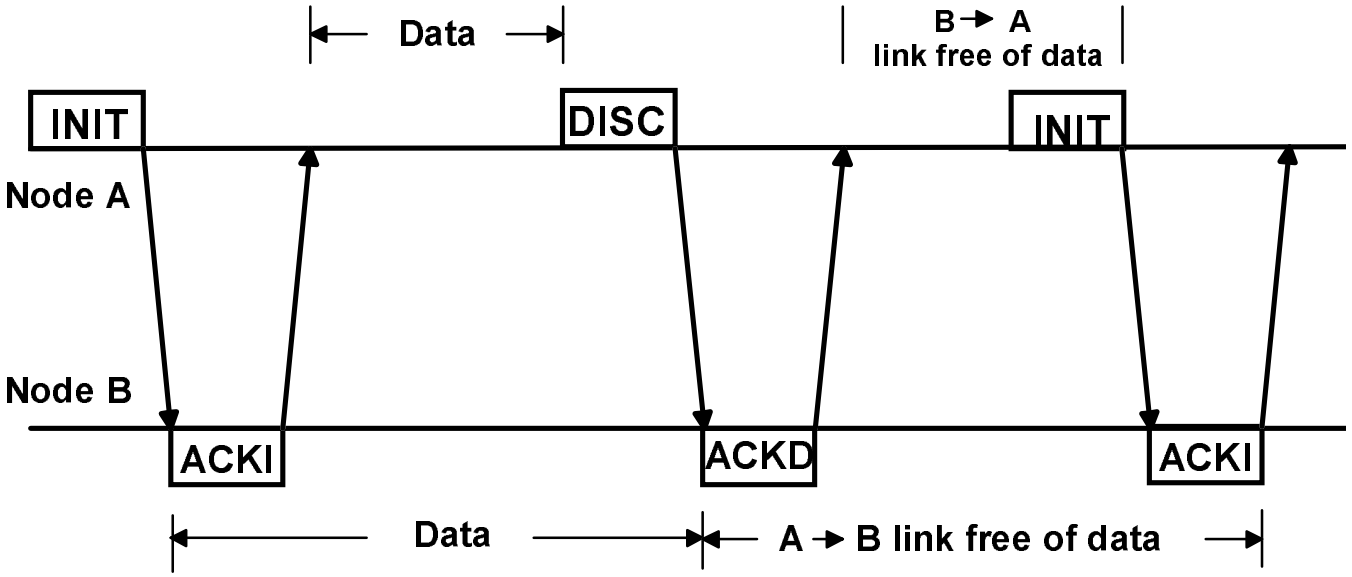



SETM = Set mode (ABM)

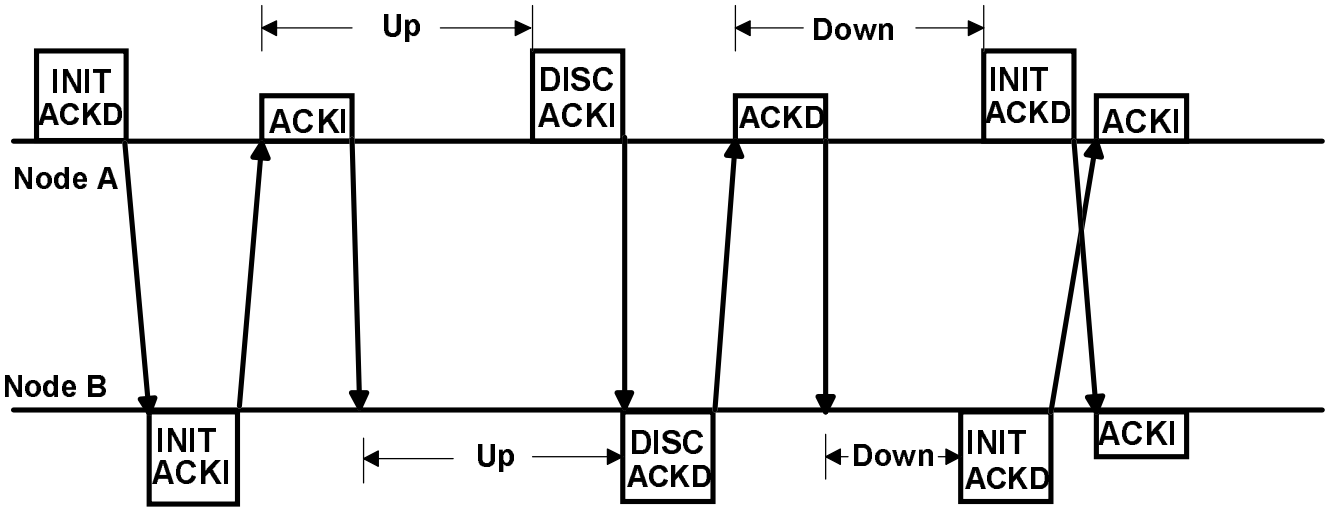
# Initialization and disconnection protocol



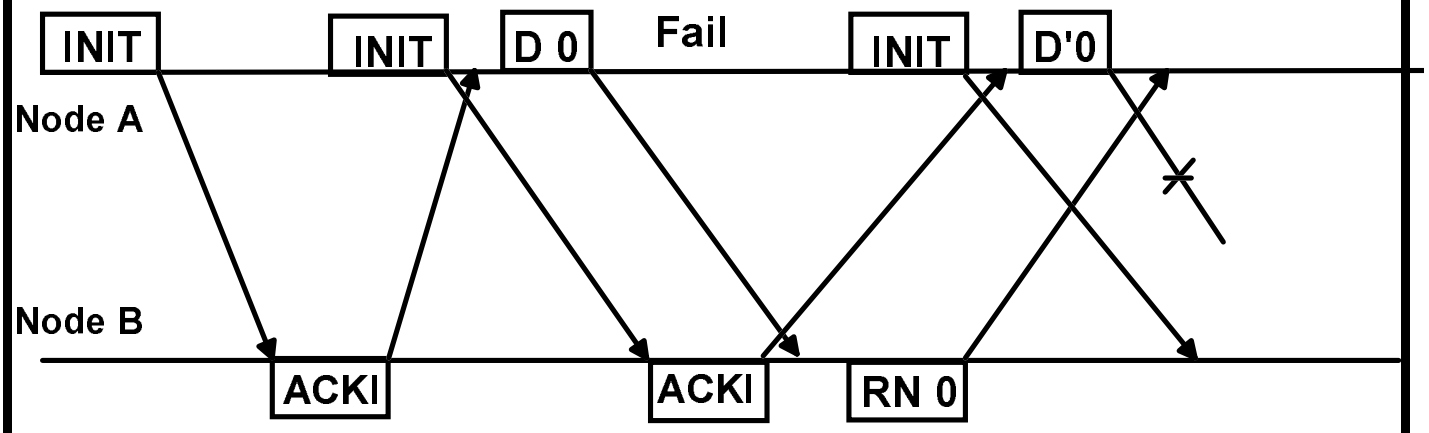

# Data are transmitted only in up period



# Balanced initialization and disconnect protocol

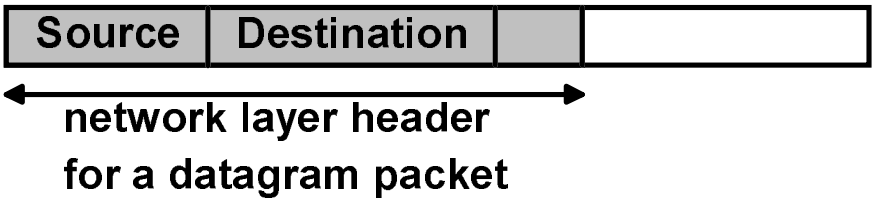



- **The initialization part is called *three-way handshake*.**



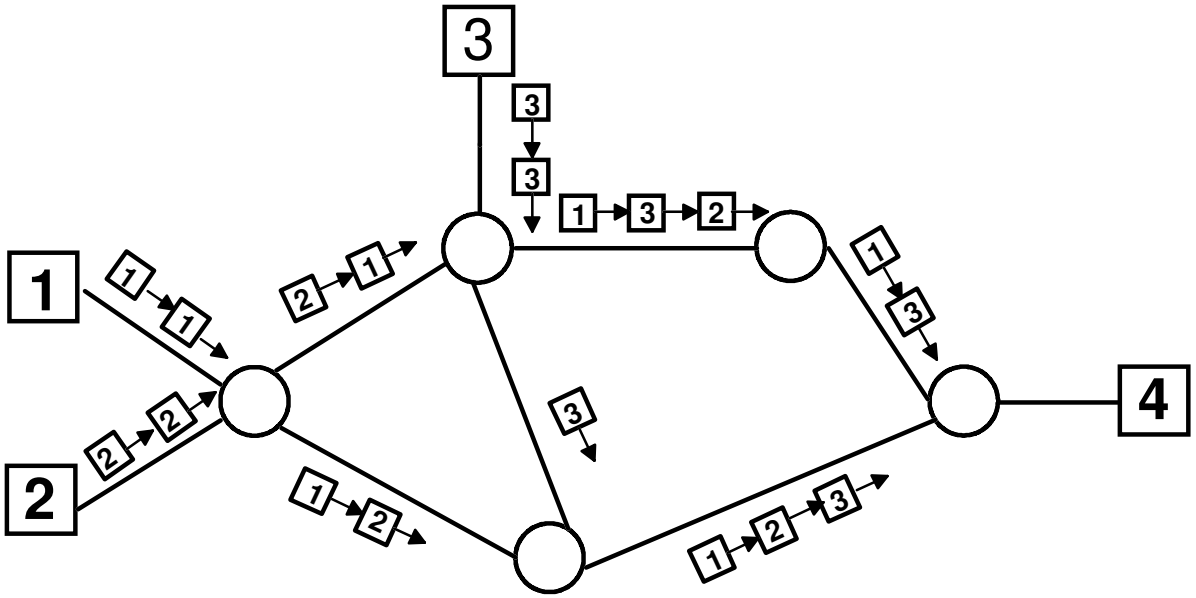
# Addressing Issues at Network Layer

**Addressing not used in DLC (except for multipoint).**

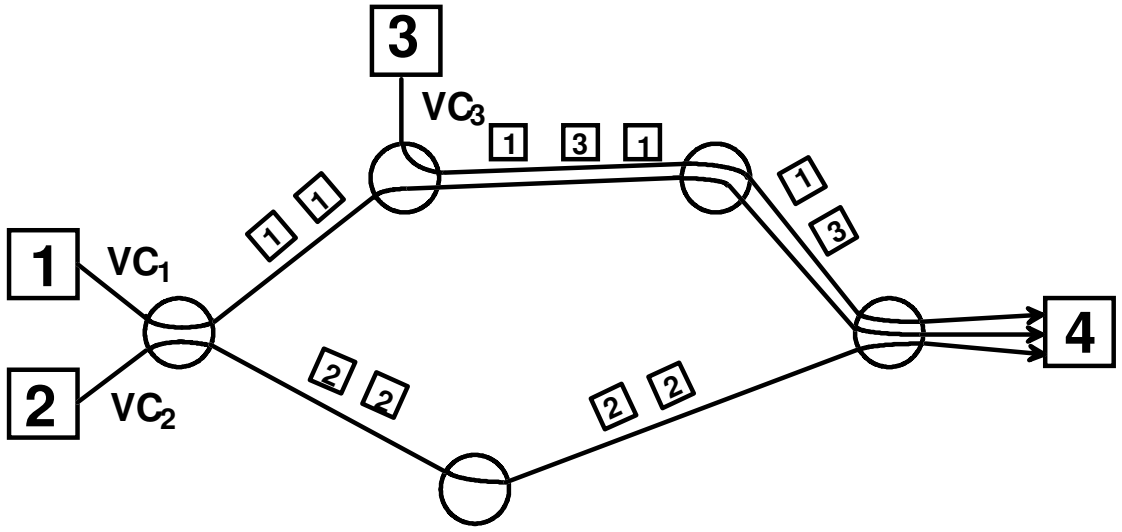



**For datagrams each packet carry information about the source and the destination.**

**Advantage: flexibility in routing.**
**Disadvantage: reordering needed at higher layers.**

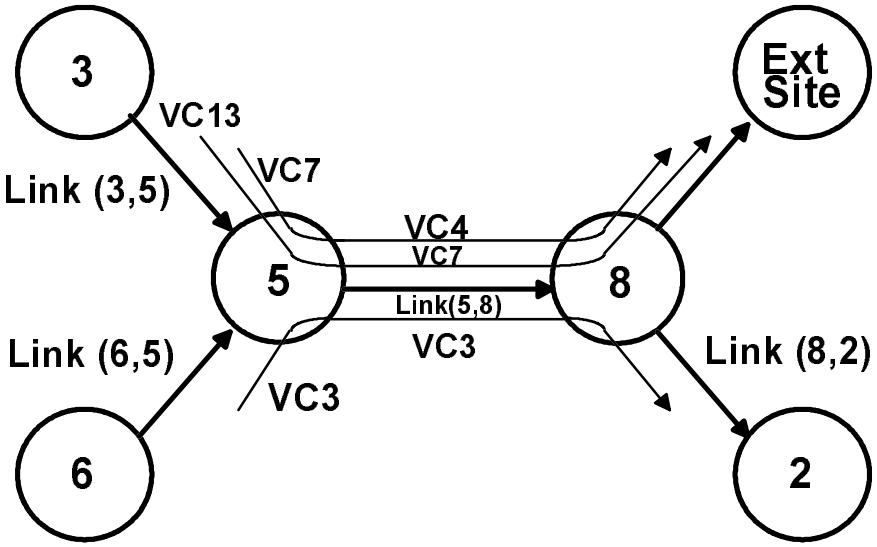



**Routing in a datagram network.**



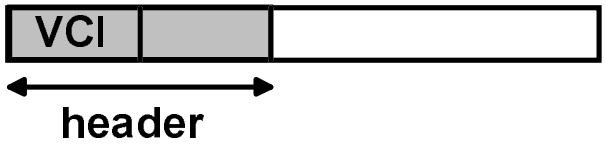

**Routing in a virtual-circuit network.**

**For virtual circuits, only the circuits on a link need to be distinguished by addressing.**



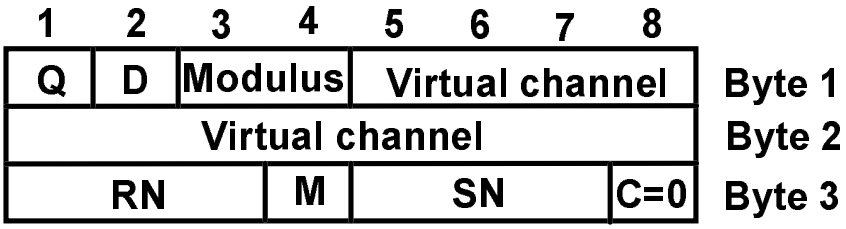

| Node 5 table | |
|---|---|
| (3,5) VC13 | (5,8) VC7 |
| (3,5) VC7 | (5,8) VC4 |
| (6,5) VC3 | (5,8) VC3 |
| incoming link | outgoing link |

**Subsequent packets contain only a virtual circuit identifier(VCI)**



# X.25 network layer standard (CCITT)

**data packet header**




**SN and RN can be extended to 7 bits (modulus 128).**

**C: 0 for data packets; 1 for control packets.**

**M: 0 for final packet of message; 1 otherwise.**

**Modulus: 01 for mod 8; 10 for mod 128.**

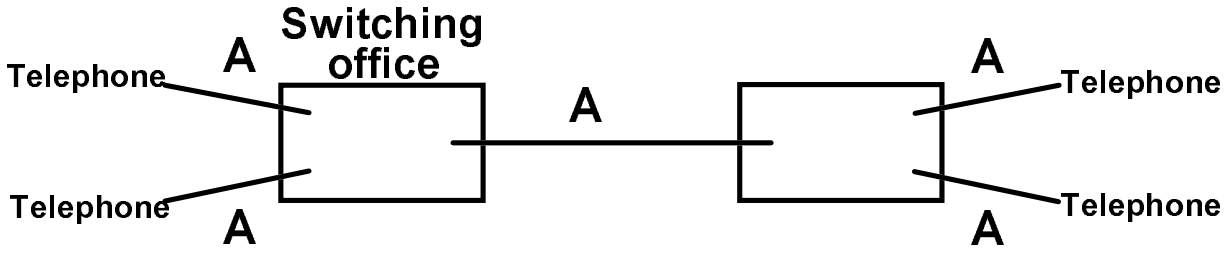
**D: 0 means end to end ACK; 1 means local ACK.**

**Q: 1 for higher layer control.**

- **SN and RN number packets within a given session.**
- **SN and RN used for flow control here rather than error control (since DLC is supposed to provide error free service).**

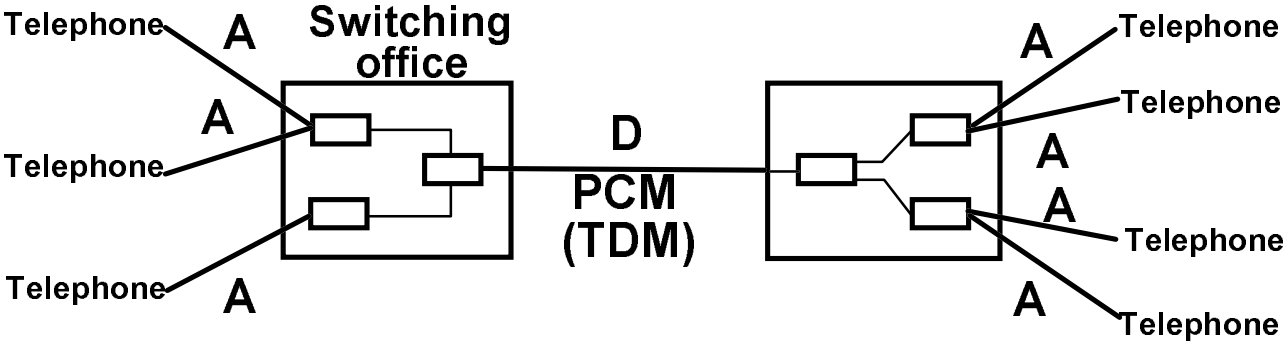
# Telephone Network

**1920's**




**A : analog communication links.**
**Switching was done manually.**

**1988: The voice network is now a digital network accessed by analog local loops.**




**A: analog communication links.**
**D: digital communication links.**
**Switching done electronically**

# ISDN

**Telephone companies want to make the entire voice network digital (i.e. digitize the local loops).**

**Such a network is called an INTEGRATED SERVICES DIGITAL NETWORK (ISDN)**

**It is called integrated because of the obvious ability to integrate voice and data (and possibly other applications).**

**Voice-64 Kbps**

**Interactive- less than $10^4$ bits per message (login, bank ATM).**

**Image- about $10^7$ to $10^9$ bits per message.**

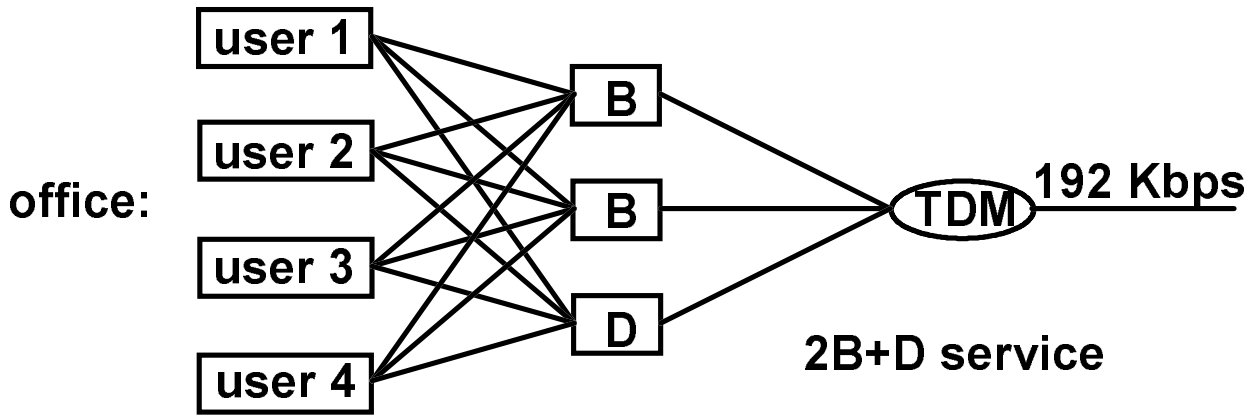
**Video- $10^5$ to $10^8$ bps flow.**

**File transfer > $10^5$ bits per message.**

# Local Access to ISDN

**Access loops are primarily twisted pair, and they constitute about ½ the total investment of the telephone network.**

- **The twisted pair will remain, but will be used for digital transmission up to 192Kbps**
- **This allows for two 64Kbps( called B channels ), one 16Kbps channel ( called a D channel), plus overhead.**




**All users access the D channel on a contention basis.**

**Each B channel is connected to at most one user at a time**

**D channel (16Kbps): used to set-up calls for B channels, and as a packet switched network for low rate interactive applications**

**B channel (64 Kbps): circuit switched channel for voice or data.**

**Primary service (big users): 24× 64Kbps=1.5Mbps**

# Interactive

**Interactive terminal-computer traffic is probably decreasing due to PCs and workstations.**
**Thus most conventional interactive traffic will be human generated transactions such as cash machine, order entry, etc..**

**Ex: Suppose each individual in a city generates data transaction at 5 transaction per hour. Each transaction generates a 1000bit packet and there are $10^6$ inhabitants in the city.**

**We thus have a total traffic of $5 \cdot 10^9$ bits per hour which is less than 1.5Mbps.**

**The conclusion is that conventional interactive traffic will be a negligible fraction of the traffic in future network.**

## Voice

- Total volume of voice traffic currently dwarfs that of data.
- Data traffic is growing more rapidly.
- Voice traffic will be dominant in ISDN for the near future, but video might be dominant in B-ISDN.

## File and image transfer

- One 1.5Mbps link will carry about 75 pages of single spaced typed data per second. Britannia would take 20 minutes.
- One 1.5Mbps link will carry a $10^9$ bit high resolution graphics image in about 11 minutes
- As transmission gets faster and cheaper, the tendency will be to send much more than is needed (i.e. send text as image rather than worry about word processing incompatibility).

## Video

- 0.1-100Mbps would benefit from higher transmission rates.

## Limitations of ISDN

**Advantage of ISDN over current packet nets is better file transfer (plus a competitive advantage to phone companies)**

**Large file and image transfer is still inconveniently slow($10^9$ bit high resolution image takes over 4 hours at 64 Kbps, 11 min at 1.5Mbps)**

## Broadband ISDN (B-ISDN)

**Broadband ISDN systems are planned with standard 155 Mbps optical fiber local access.**

- **True high rate file transfer.**
- **Video conferencing.**
- **On demand HDTV**
- **Interface with high speed LANS.**
- **Many potential image & video applications**

**Major argument is that optical fiber capacity ($10^{14}$ bps) makes BISDN a natural goal.**

# ATM

**Asynchronous transfer mode (ATM) is a packet switching protocol for B-ISDN networks.**

**ATM packets are called cells; cells are fixed length (53 bytes = 5 bytes of header + 48 bytes of data)**

**Reasons this standard was selected:**

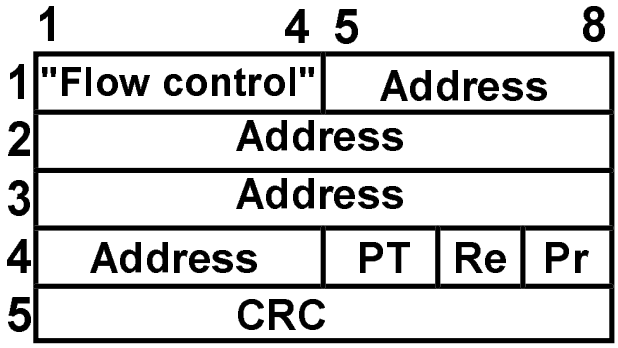
**1) Can deal well with bursty traffic.**

**2) Can provide variable rates.**

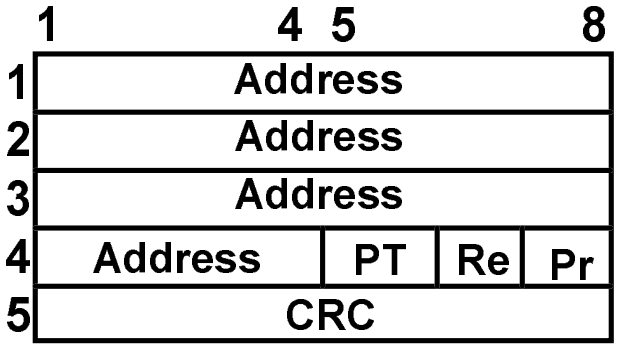
**3) Voice packets must be short (<1000 bits) because of delay in packet generation.**

**4) Very high speed switches are easier to build for fixed size packets.**

# ATM header format




user/subnet




internet subnet

**The "Flow control" field is to help the user multiplex different application. It does not help with network congestion.**

**The address is essentially the same as the Virtual Circuit Number.**
**It changes from link and identifies the session among the set of sessions using a given link.**

**The address is broken into a VCI and a VPI subfield. Session following the same path for several nodes can be assigned the same VPI. Some switches only look at VPI, simplifying switch complexity.**

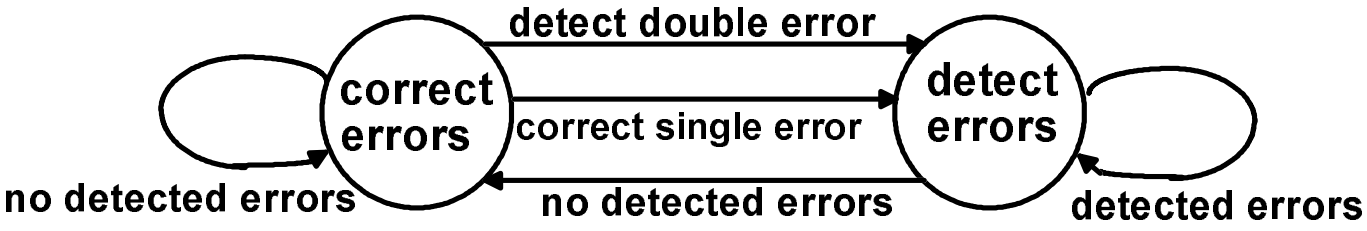
**Generator polynomial:**

$$g(x) = x^8 + x^2 + x +$$

The CRC is unusual here.

It has the conventional structure of a primitive polynomial times x+1, and thus has a minimum distance 4.

It checks only on the header of the cell, and alternates between two modes.




There is only one bit in the header, the priority bit, to help in flow control.

This can be set by the user to indicate low priority cells that can be dropped by the network under congestion.

This bit could also be set by the network to indicate a user who is violating his rate agreement; again the cell could be dropped under congestion.

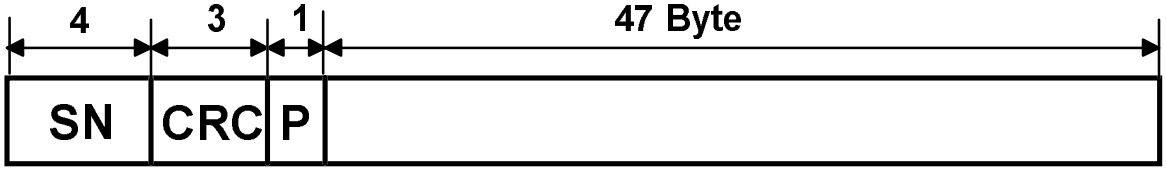
The priority bit is probably inadequate to solve the congestion problem.

# The ATM Adaptation Layer (AAL)

| | Class 1 | Class 2 | Class 3 | Class 4 |
|---|---|---|---|---|
| Timing relation between Source and destination | Required | | Not required | |
| Bit rate | Constant | Variable | | |
| Connection mode | Connection-oriented | | | Connectionless |

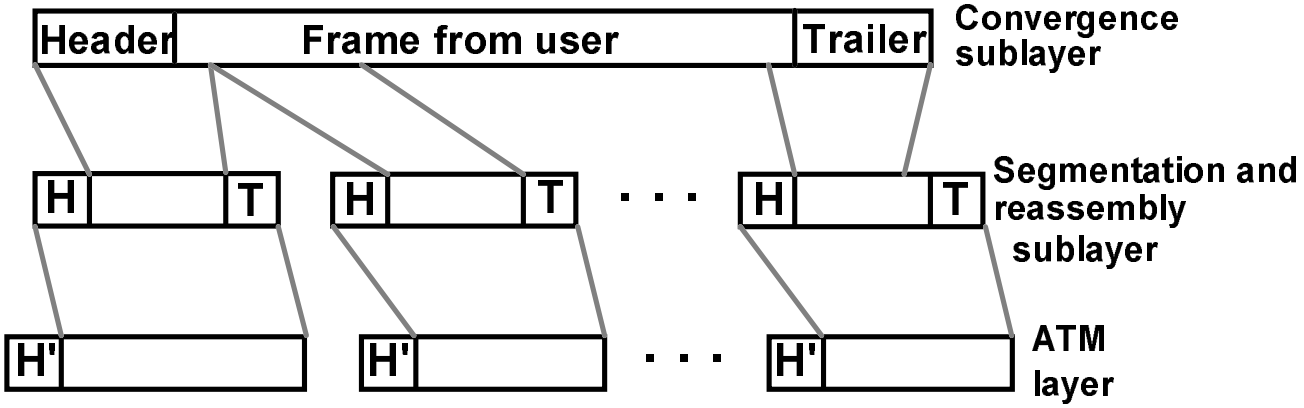
Service classification for AAL

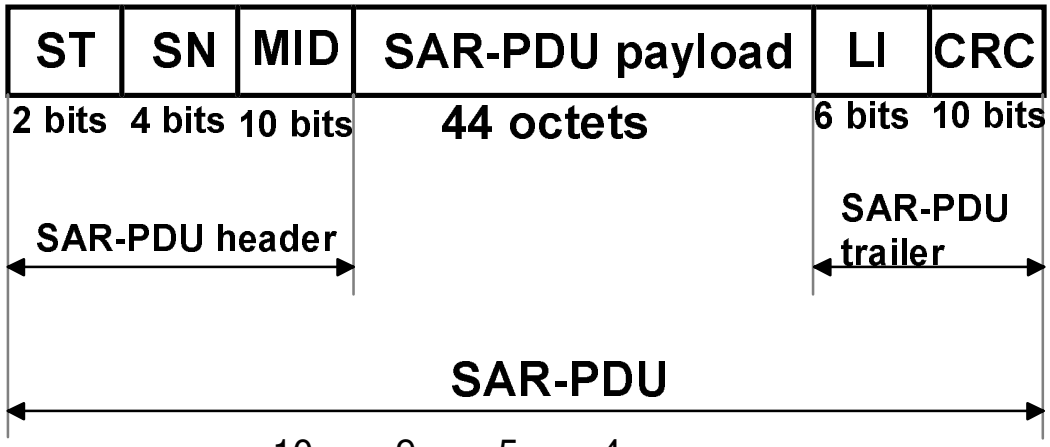
## AAL type 1




$g(x) = x^3 + x + 1$

# AAL type 3/4




$$g(x) = x^{10} + x^9 + x^5 + x^4 + x +$$

**LI = Length indicator**

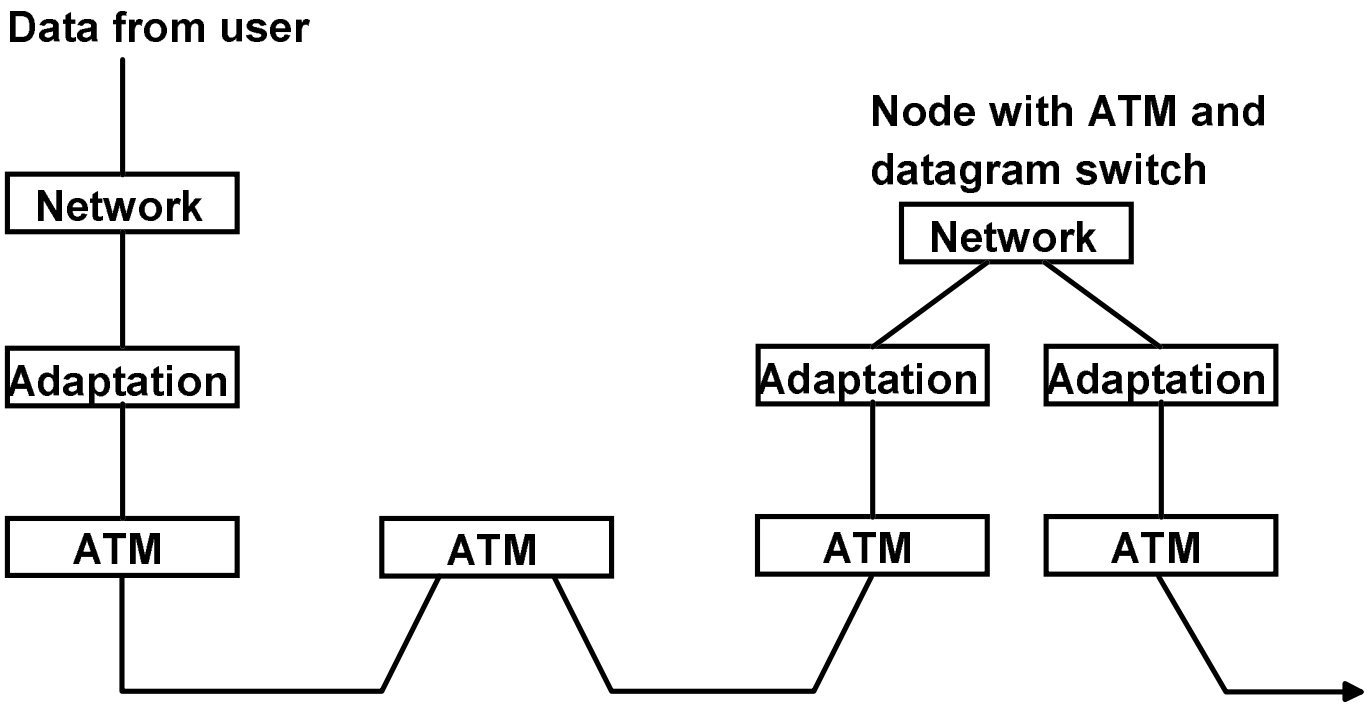
**MID = Multiplexing identifier**

**PDU = Protocol data unit**

**SAR = Segmentation and reassembly**

**ST = Segment type**

# Datagram traffic using an ATM network




- **Datagram traffic is routed using permanent virtual circuits between datagram switches.**