



# Connection Services

**Hakim S. ADICHE, MSc**

adiche@ccse.kfupm.edu.sa

Department of Computer Engineering  
King Fahd University of Petroleum and Minerals  
Dhahran, Saudi Arabia

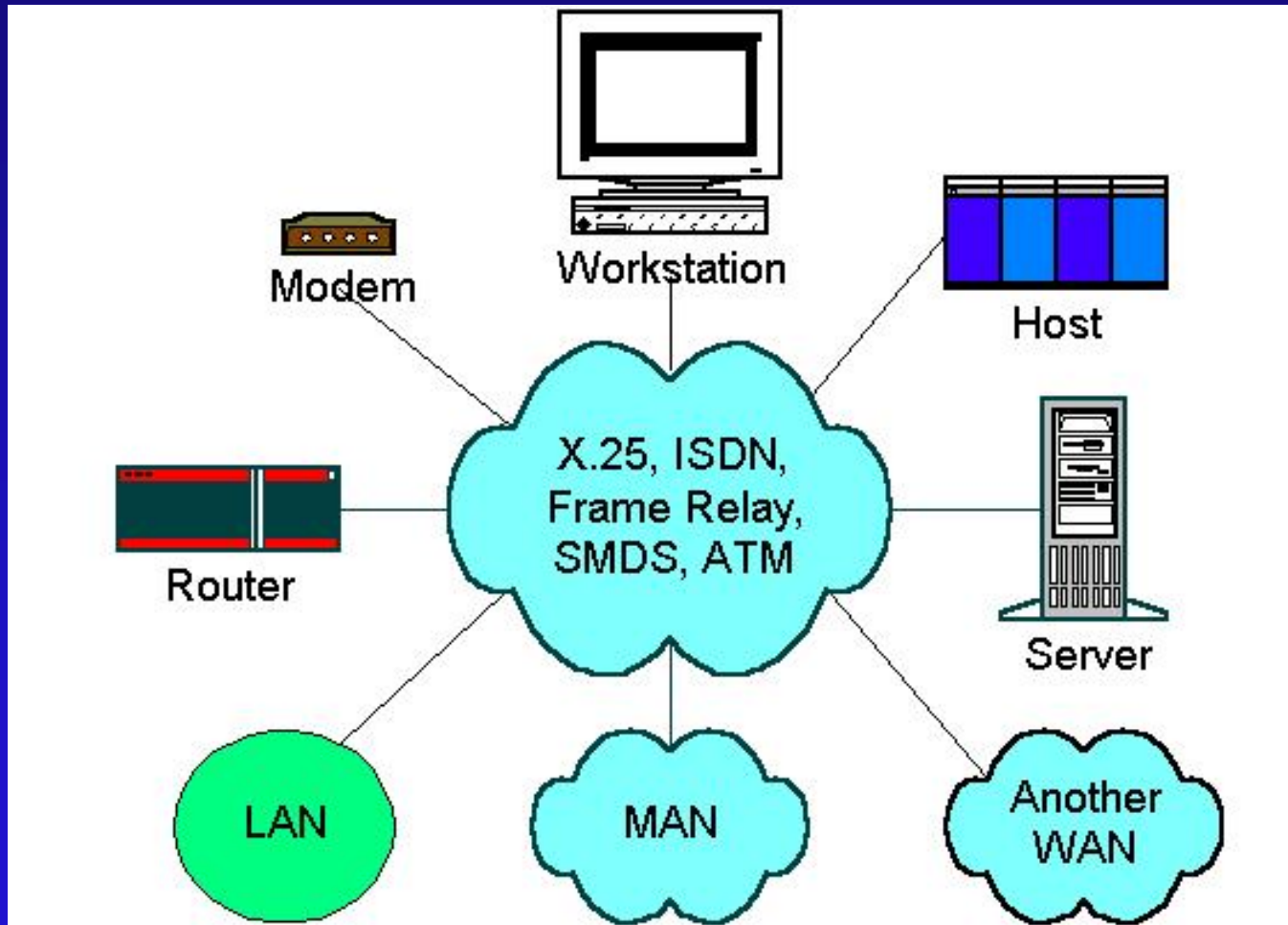
# Connection Services

- Different connectivity services are used in Wide Area Networks WANs.
- WANs are complex groups of equipment and services that seamlessly integrate LANs, MANs, and other WANs. They support all platforms from PCs to Supercomputers.
- Several characteristics to consider when determining the appropriate WAN technology needed:
  - distance between users
  - traffic & performance requirements
  - types of user needs & platforms
  - costs

# Speed Communication Technologies

- WANs are deployed over the existing telecommunication infrastructure using technologies such as:
  - » Leased lines services.
  - » Switched services.
  - » Packet services.
  - » Cell-based services.
  - » Shared-media services.

# Wide Area Network



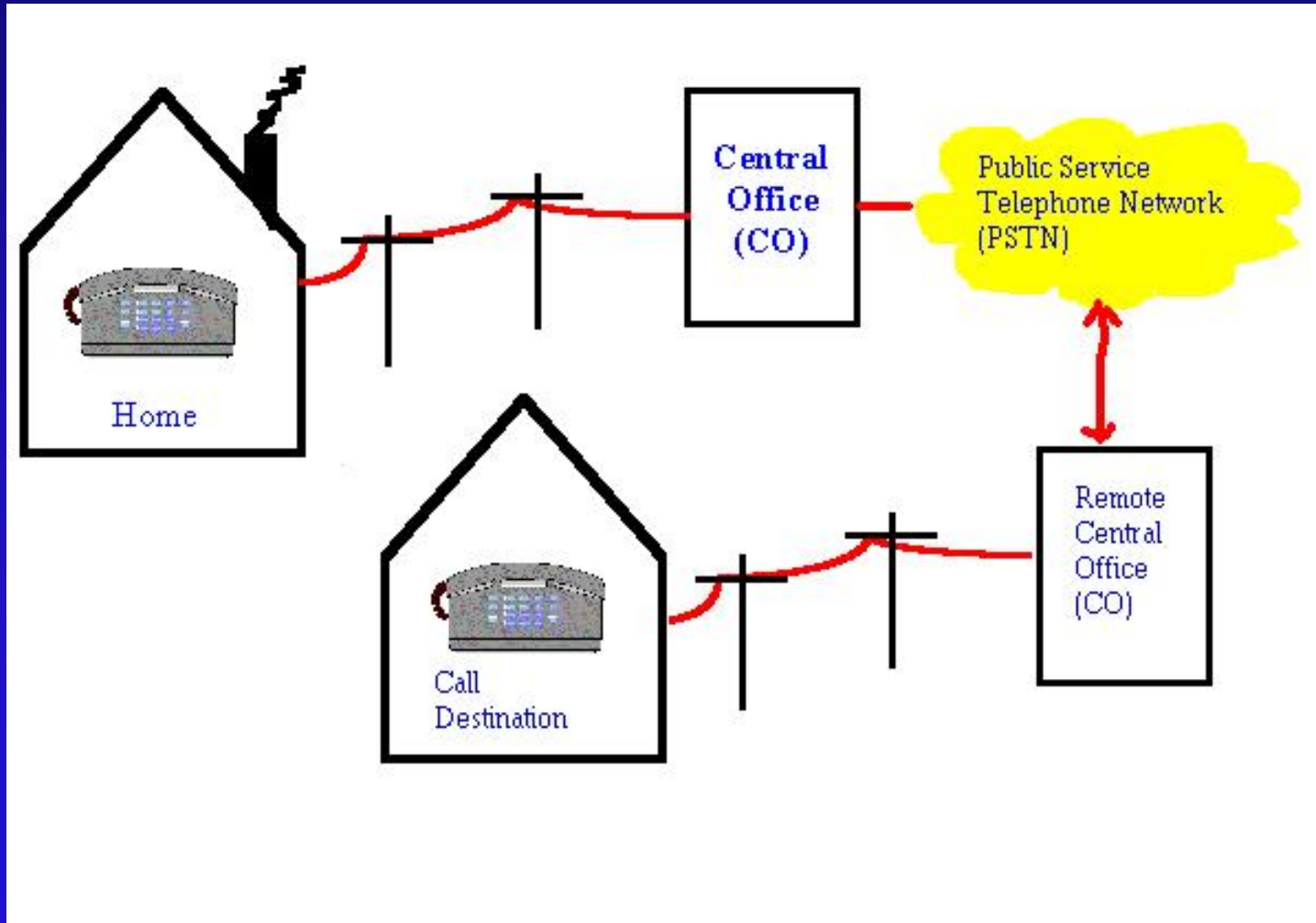
# Leased-line services

- Leased lines are digital or analog telephone lines dedicated exclusively to the use of the lessee.
- Examples:
  - » T1: 24 multiplexed channels at 64 Kbps each.
  - » E1: 30 multiplexed channels at 64 Kbps each.
  - » T2: multiplexes 4 T1 data streams.
  - » T3: carries 672 multiplexed channels.
  - » Fractional T1 services

# Switched Services

- Switched services are dial-up point-to-point communication lines through the PSTN.
- End station should communicate at the same speed.
- Example:
  - » Modems.
  - » Switched 56 Kbps services.
  - » Switched ISDN.
  - » Digital Subscriber Line DSL.

# Modems



# Switched 56

- Digitally switched or dial-up technology.
- Provides single channel for dependable data connectivity.
- Channel clock speed is 56 Kbps.
- Low cost with respect to digital leased lines.
- Fast data transmission capabilities and low error rates with respect to analog dial-up.



# Integrated Service Digital Network

- ISDN is an all-digital, circuit switched telephone system that was designed to replace the analog telephone system.
- Connection-oriented service.
- Two kinds of connections offered:
  - » Permanent virtual circuits.
  - » Switched virtual circuits.
- Integrated Services Digital Network (ISDN) is the lowest cost digital communication available and uses traditional phone lines to produce a maximum bandwidth of 1.544 Mbps.
- There are two types of ISDN interfaces.
  - » The Basic Rate Interface (BRI) provides two B channels at 64 Kbps and one D channel at 16 Kbps.
  - » The primary Rate Interface (PRI) provides 23 B channels at 64 Kbps and one D channel at 64 Kbps for a total bandwidth throughput of 1.544 Mbps.

# ISDN benefits

- Some of the other benefits of ISDN include:
  1. Multiple voice and data communications over one phone line.
  2. Additional phone services available.
  3. Video Conferencing.
  4. Widely available.
  5. Relatively cheap cost.

# Digital Subscriber Line

- DSL is a new technology that uses the existing POTS (Plain Old Telephone Service) lines you have in your home.
- POTS lines carry analog signals—voice, fax, and dial-up modem.
- DSL shares the line with the analog signal by using a different frequency range.
- The benefit is you can talk on the phone and surf the Web at the same time, using the same telephone line.
- There are several different "flavors" of DSL: ADSL, HDSL, IDSL, SDSL, and others. They are often referred to as "xDSL".

# DSL (Cont'd)

- The most common DSL service for home use is Asymmetric Digital Subscriber Line (ADSL).
- The asymmetric part of ADSL refers to the different bandwidths for sending and receiving data.
- Data is sent "upstream" to the Internet and "downstream" from the Internet.
- There are essentially three asymmetrical pipes, or streams, of data on a DSL line:
  - » A POTS pipe for analog signals (like voice and fax)
  - » A medium-sized upstream pipe
  - » A large downstream pipe

# DSL Technology Characteristics

Technology	Bandwidth	Mode	Max Distance
ADSL	640 Kbps up 6 Mbps down	Asymmetric	18,000 ft
ADSL Lite	384 Kbps up 1.5 Mbps down	Asymmetric	18,000 ft
CDSL	128 Kbps up 1 Mbps down	Asymmetric	18,000 ft
HDSL	1.5 or 2.048 Mbps	Symmetric	12,000 ft
VDSL	2.3 Mbps up 51.84 Mbps	Asymmetric	5,000 ft (13-Mbit) 3,000 ft (26-Mbit) 1,000 ft (500-Mbit)
SDSL	2.048 Mbps	Symmetric	10,000 ft
RADSL	640 Kbps up 2.048 Mbps down	Asymmetric	Up to 21,000 ft

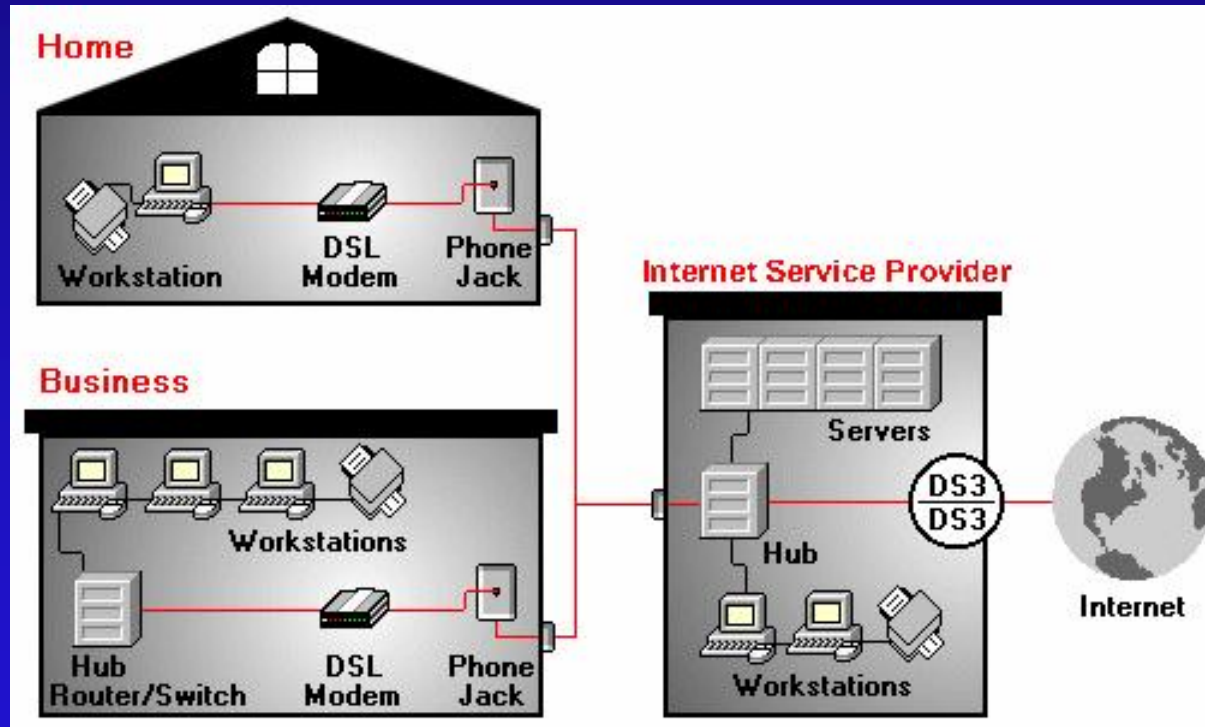
# Use of DSL

- Special equipment has to be installed in the telephone company's central office near your home.
- For DSL to be available, you must not be more than the maximum distance to the central office, which is usually about 13,000 to 18,500 feet.
- the quality and availability of the telephone wire outside and inside your home.

# DSL Benefits

- Always-On Service
- Phone/Internet Simultaneously
- Up to 25x Times Faster Than Dial-up Modem
- Cost Effective
- No More Busy Signals
- No More Dropped Connections
- Faster Downloads
- Faster Games
- Multiple Computers on Single DSL Line
- Dedicated Connection & Speed

# DSL Connection





# Packet Service

- Public Data Networks (PDN) uses packet-switching protocols for worldwide data transfer between computers.
- The two end stations can communicate at different data rates.
- Examples:
  - » X.25
  - » Frame Relay
  - » ISDN

# X.25

- X.25 was the original-packet scheme that grew from the old ARPANET internetwork protocol.
- X.25 is a connection-oriented service with:
  - » Switched virtual circuit, or
  - » Permanent virtual circuit.
- Driving forces that made X.25:
  - » Lack of sophistication of computers and the concept of GIGO.
  - » Quality of telephone lines and connections.
- X.25 capabilities:
  - » Ensuring error-free delivery of data by performing error-checking at many levels.
- Packet up to 128 Bytes.
- Speed of up to 64 Kbps.

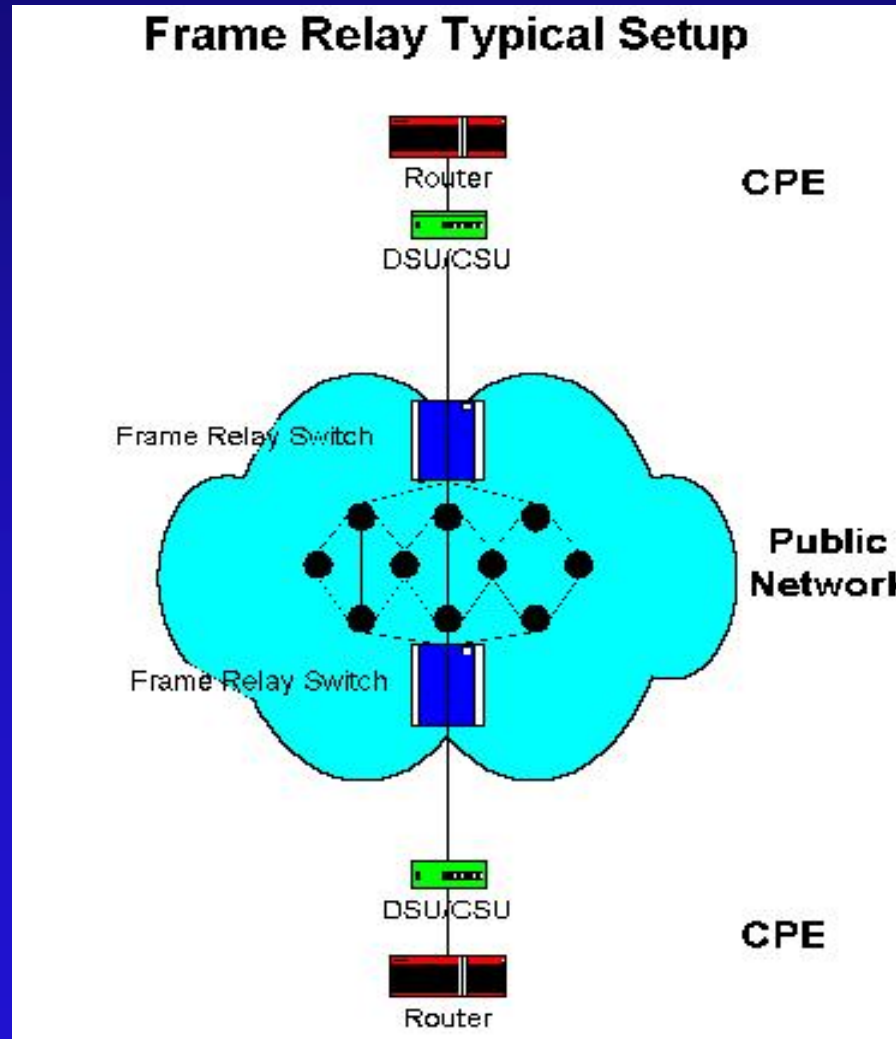
# Frame Relay

- Frame Relay technology is a simplified packet switching interface standard optimized for protocol oriented data.
- Connection-oriented service.
- Frame Relay is a type of virtual network that shares a public infrastructure.
- Frame Relay defines a connection between a DCE (connection point to the PDN) and DTE (CPE) equipment.
- Frame size up to 1600 bytes.
- It provides high speed digital bandwidth of 56Kbps to 1.544Mbps and can operate at T3 speed.

# Frame Relay (Cont'd)

- Frame relay assumptions:
  - » Computer systems being connected together by Frame Relay networks are by their nature intelligent devices.
  - » The telephone circuits carrying the data within a Frame Relay network are of above average.
- Why use Frame Relay
  - » Speed
  - » Cost

# Frame Relay Typical Setup



# Frame Relay Network Components

- Frame Relay networks consist of two components:
  - » CPE equipment includes Routers, DSU/CSUs, FRADS, Bridges, and Packet devices.
  - » The public network provides multiple logical connections to a physical destination.
    - Resources are shared with other Frame Relay customers.
    - access lines and committed information rate need to be purchased to access Frame Relay public networks.
    - Access lines are typical leased lines.
    - Committed information rate (CIR) and a burst rate, of up to 200% of the CIR should be specified.

# Frame Relay Benefits

- Reduced internetworking costs
- Increased performance and reliability
- Increased interoperability

# Cell-Based Services

- Cell-based services are the most recent development in the switched and packet-based family of services.
- Examples:
  - » SMDS
  - » ATM which is a broadband WAN service.
  - » ATM supports rates at T1 speed.
  - » ATM's most common use is 155 Mbps operation over copper or fiber-optic cables.



# ed Multi-Megabit Data Service

- (SMDS) is a connectionless high speed digital network service based on cell relay for end-to-end application usage.
- SMDS allows transport of mixed data, voice, and video on the same network.
- SMDS provides higher speeds (56kbps - 34Mbps up to 45 Mbps).
- It uses 53 byte cell transmission technology.

# SMDS Benefits

- SMDS provides some of the same benefits as Frame Relay including:
  1. protocol transparency
  2. inexpensive meshed redundancy
  3. reliability
  4. high speeds

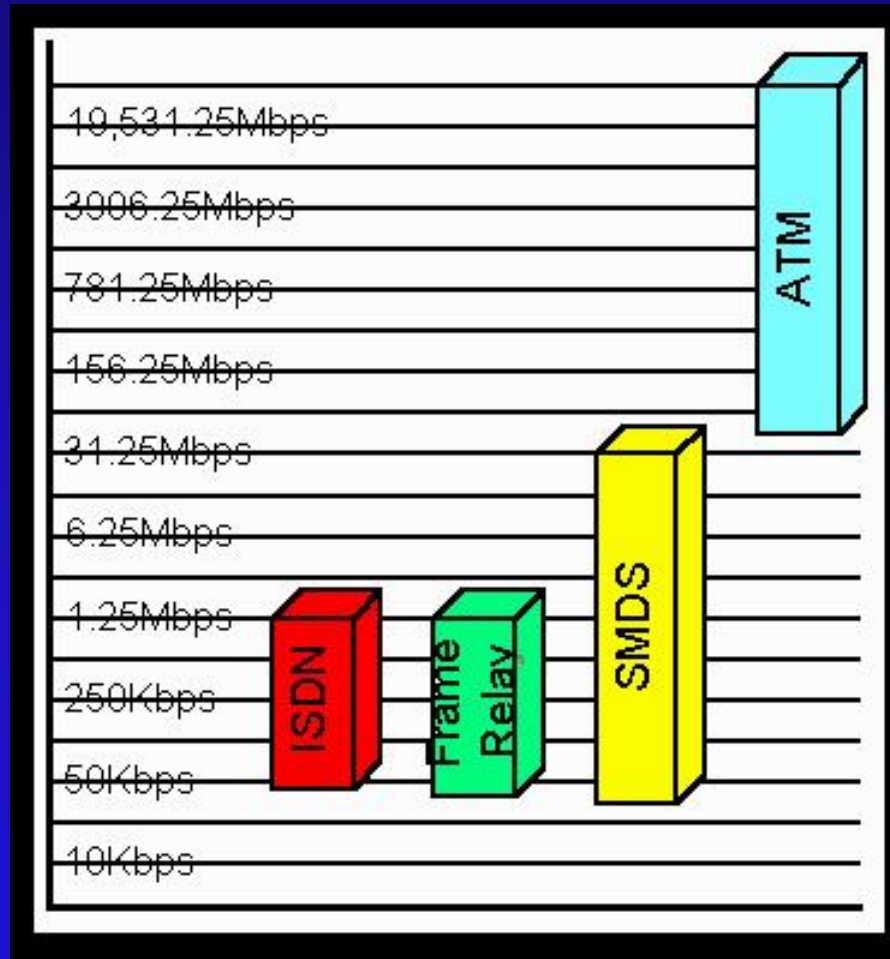
# Asynchronous Transfer Mode

- ATM is a proposed telecommunications standard for Broadband ISDN (B-ISDN).
- Connection-oriented service.
- It is a high speed digital technology with bandwidth rates between 50Mbps - 10,000Mbps.
- It is designed for transporting short fixed length packets at the gigabit/sec rate over large distances.
- ATM uses Cell Relay technology, that is, it uses fixed sized packets called cells. These cells are 53 bytes long.
- ATM does provide the technology to insure cells are delivered in order.
- ATM can be installed for both LANs and WANs.

# ATM Current speeds

- Intended speeds:
  - » 155 Mbps: transmit HD TV pictures.
  - » 622 Mbps: 4 155-Mbps channels could be sent over it.

# Comparison





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# Shared Media

- É Cable modem
- É Satellite links

# Cable Modem

- Use the existing infrastructure of the cable TV companies.
- Possibility to access internet at rates of more than 500 times than that of a standard 28.8 Kbps analog modem.
- Asynchronous type of operations:
  - » Theoretically, downstream speeds can go up to 36 Mbps
  - » Most are limited to 2Mbps-10Mbps.

# Satellite

- Bypass the telephone company.
- Access the Internet at higher data rates, typically 400 Kbps.