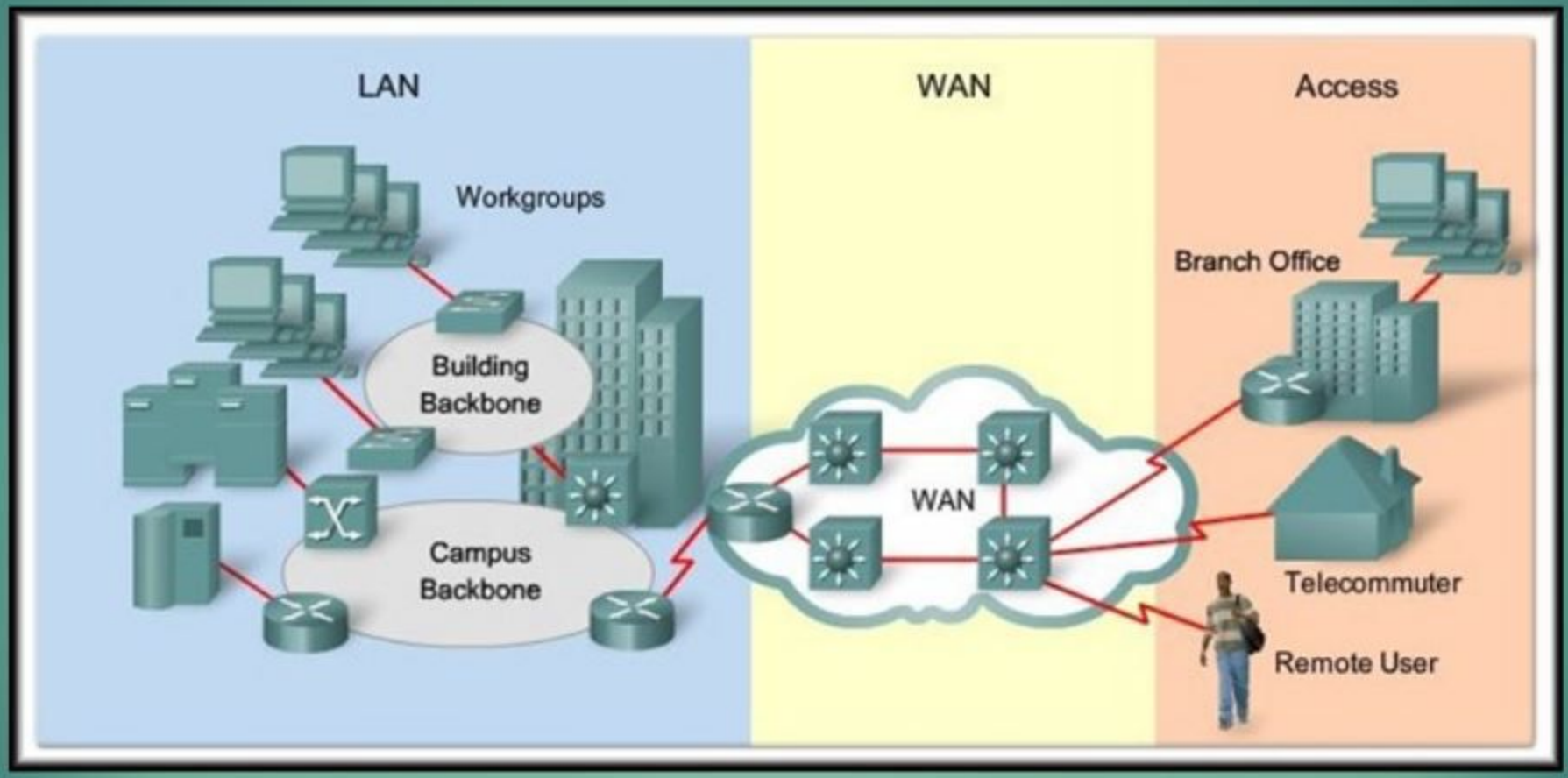
Lecture 1: Introduction to WAN

WAN TECHNOLOGY OVERVIEW

Introduction to WANs

Introducing Wide Area Networks

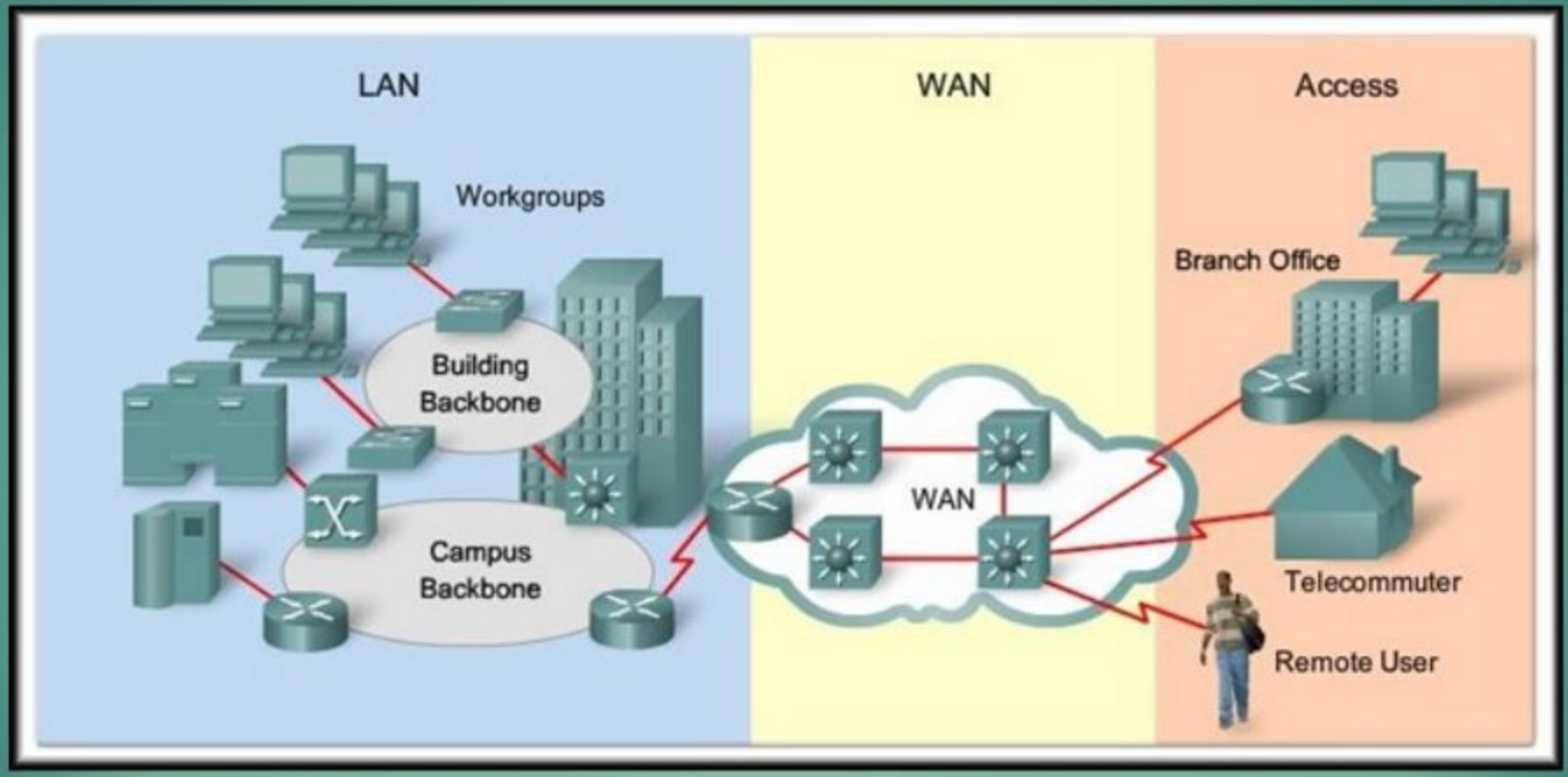


What is a WAN?

- A WAN is a data communications network that operates beyond the geographic scope of a LAN.
  - Connect devices that are separated by a broader geographical area than a LAN.
  - Use carriers (phone companies, cable companies, network providers).
  - Use serial connections of various types.

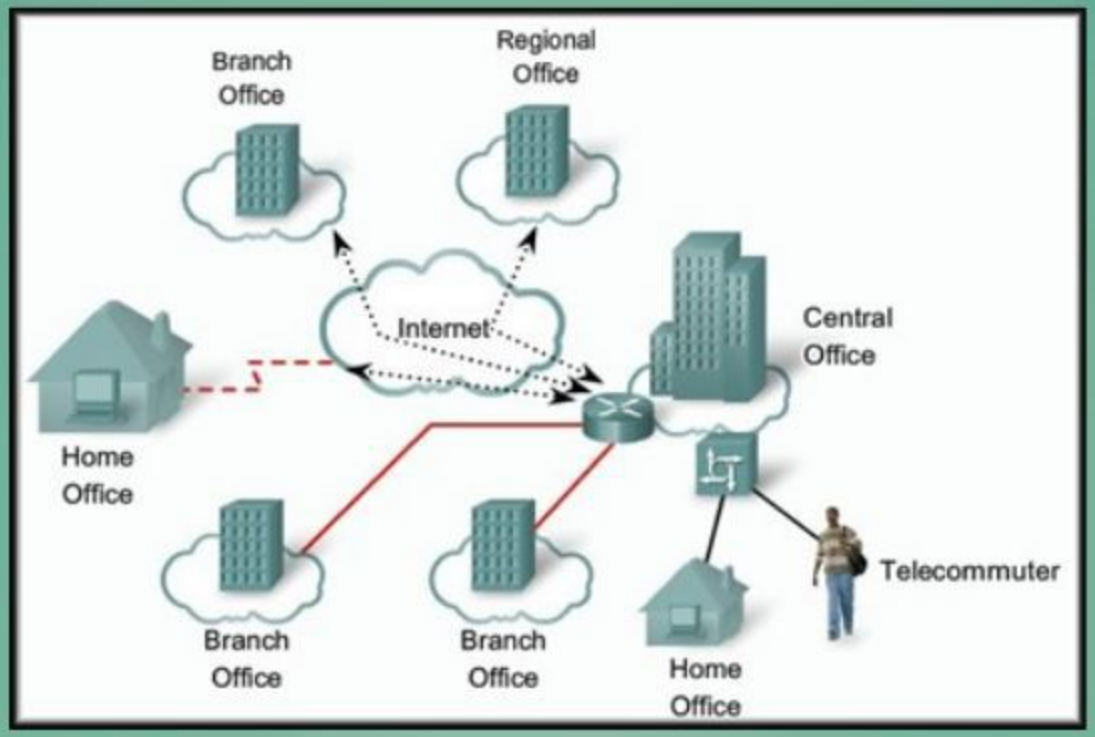
What is a WAN?

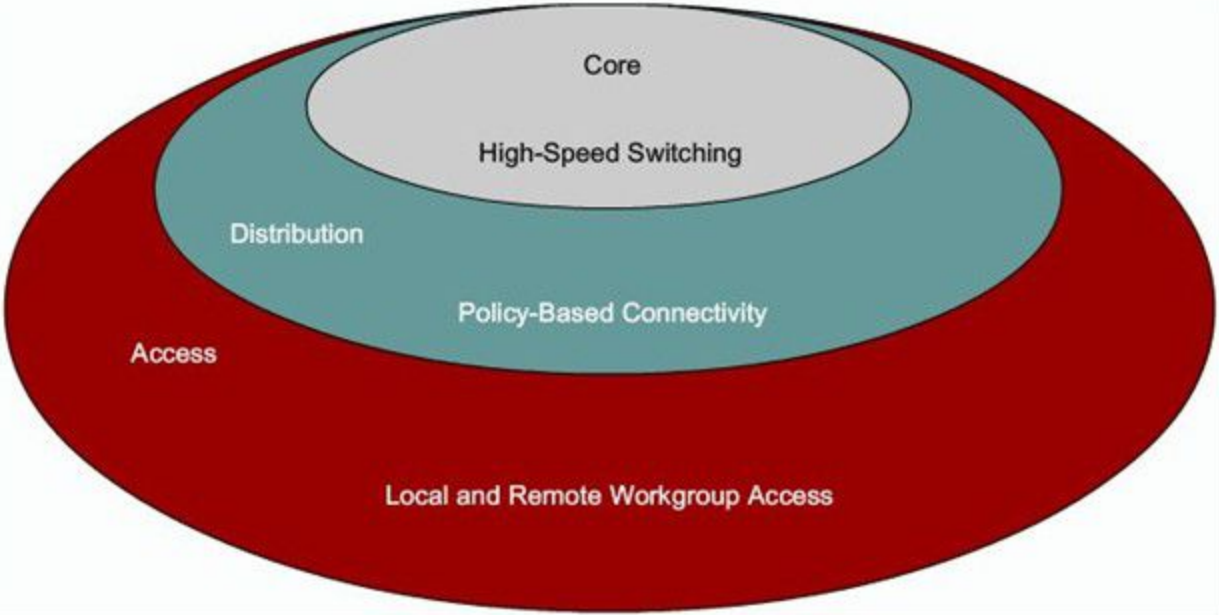
- A WAN is a data communications network that operates beyond the geographic scope of a LAN.

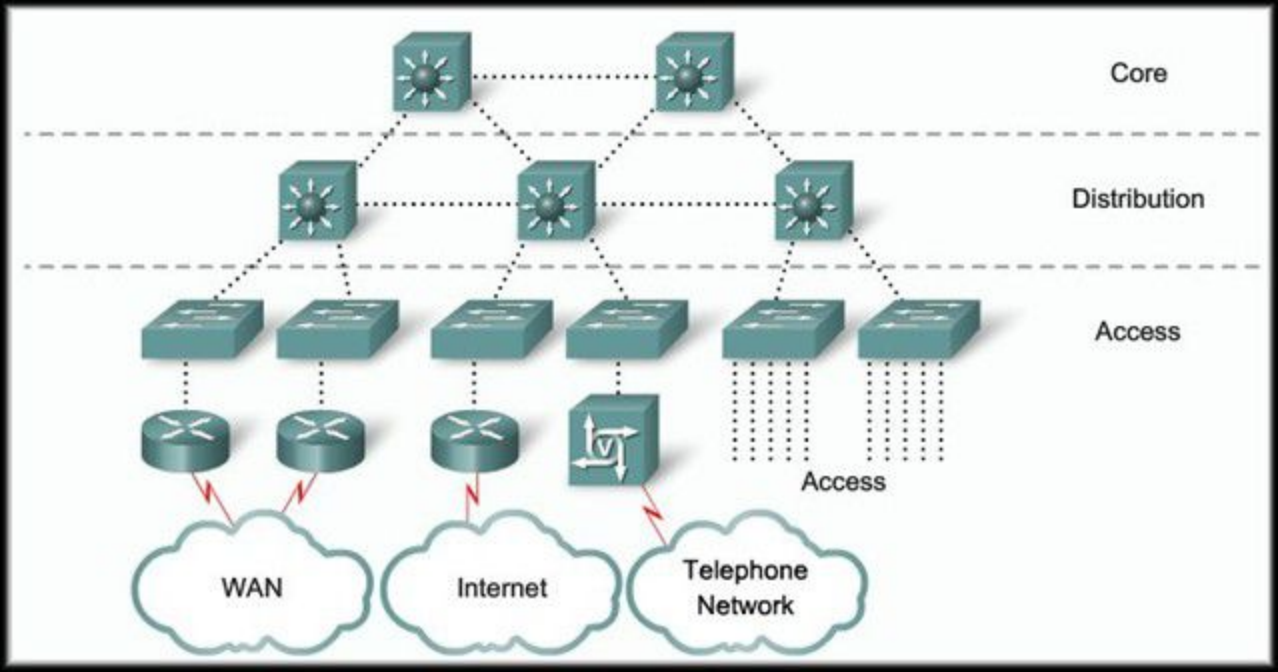


The Evolving Enterprise

- As companies grow, they hire more employees, open branch offices, and expand into global markets.
- These changes also influence their requirements for integrated services and drive their network requirements.



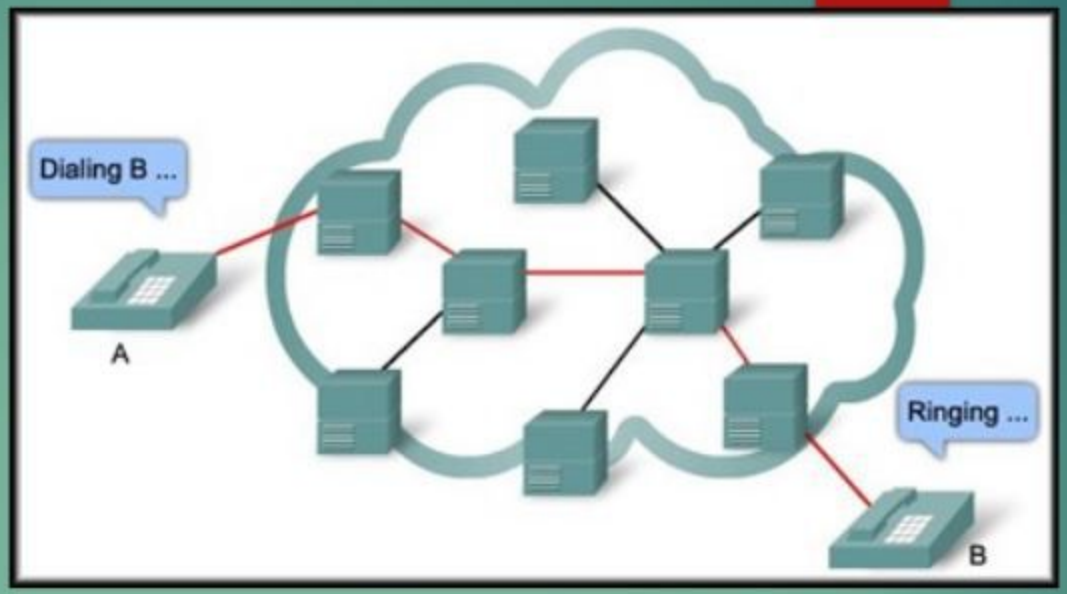

Core
High-Speed Switching
Distribution
Policy-Based Connectivity
Access
Local and Remote Workgroup Access


Core
Distribution
Access
Access
WAN
Internet
Telephone
Network

WAN Switching Concepts

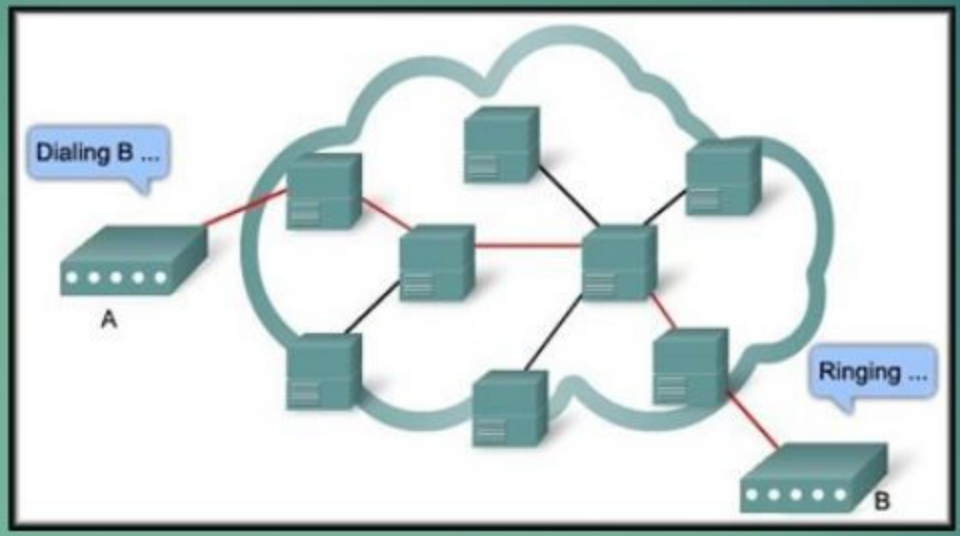
- WAN switched networks fall into two categories:
  - Circuit switched.
    - POTS, ISDN
  - Packet switched.
    - Frame Relay, ATM, X.25

WAN Switching Concepts – Circuit Switched



- When a subscriber makes a telephone call, the dialed number is used to set switches in the exchanges along the route of the call so that there is a circuit from the originating caller to the receiver of the call.
- Because of the switching operation used to establish the circuit, the telephone system is called a circuit-switched network.

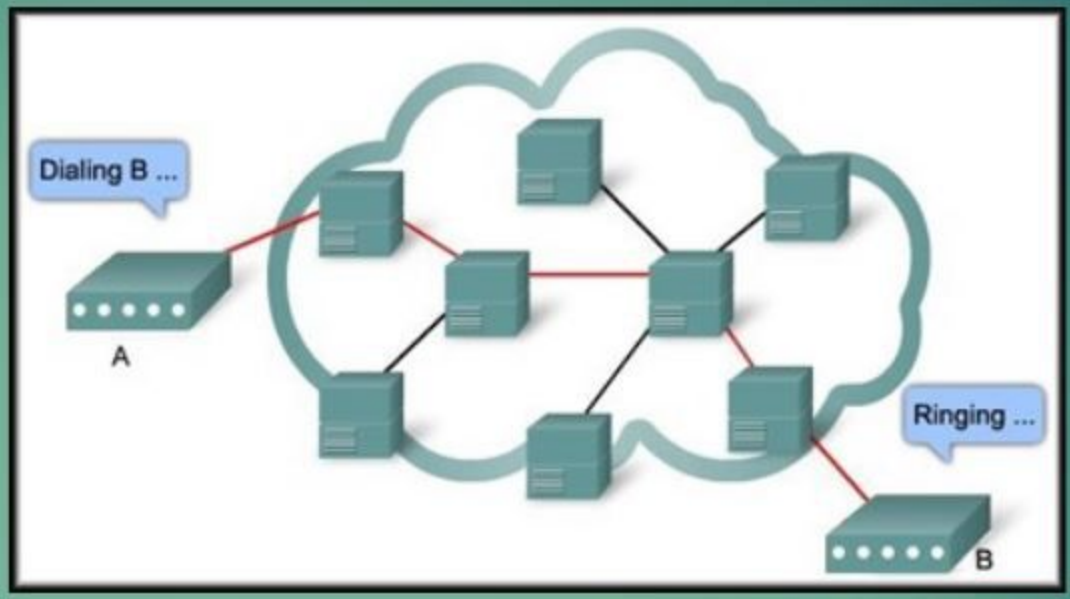
WAN Switching Concepts – Circuit Switched



- If the telephones are replaced with modems, then the switched circuit is able to carry data.
- Suppose it is used to access a web page.
- There will be a burst of activity that uses the entire bandwidth while the page is being downloaded.
- That will be followed by no activity while the user reads the page and followed again by another burst while another page is accessed.

WAN Switching Concepts – Circuit Switched

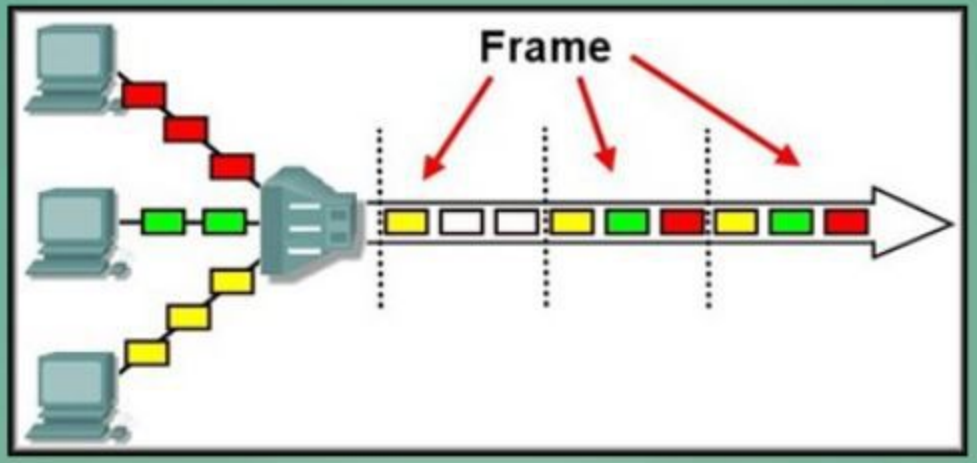
- If the circuit carries data, it may not be very efficient.
- The internal path is shared by several conversations.



- Time Division Multiplexing (TDM) is used to give each conversation a share of the connection in turn.
  - TDM assures that a fixed capacity connection is made available to the subscriber.

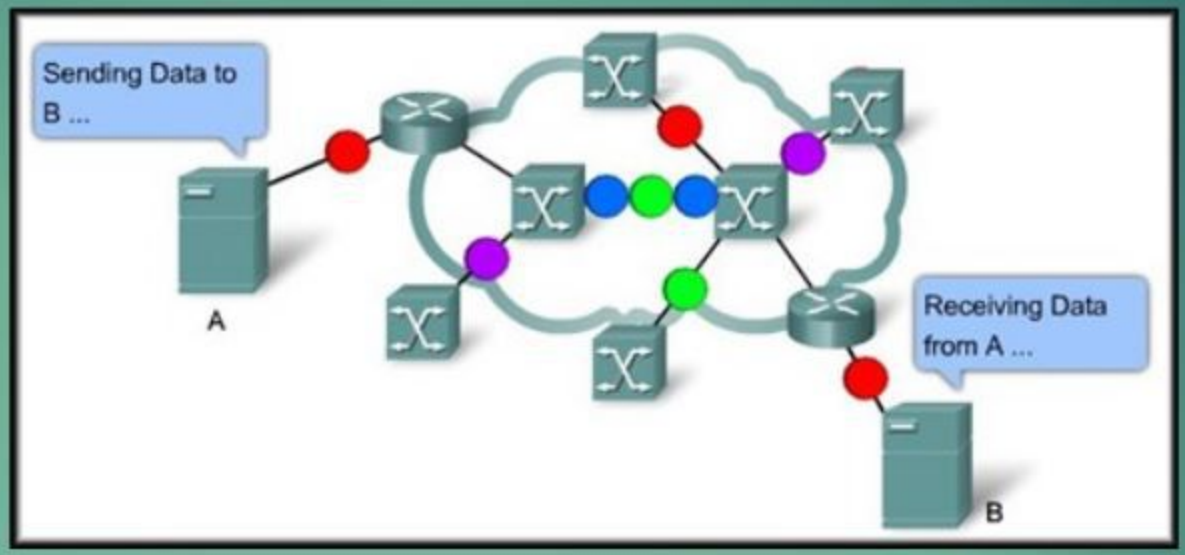
WAN Switching Concepts

- Circuit Switching and TDM:
  - Each device to be multiplexed is assigned a specific *"time slot"* in the frame.
  - At each time slot, 8 bits is read from each device and a fixed length frame is built using that data.
  - If there is nothing to send for that time slot, 8 null bits are placed in the frame for that device.



WAN Switching Concepts – Packet Switched

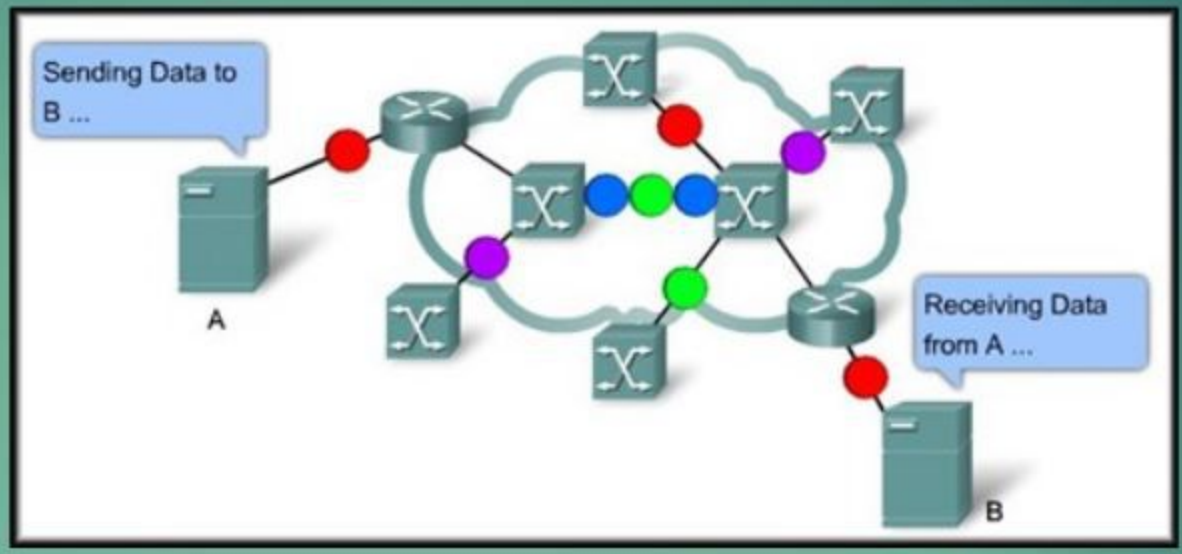
- An alternative is to allocate the capacity to the traffic only when it is needed and share capacity among many users.



- If the circuit is to be shared, there must be some mechanism to label the bits so that the system knows where to deliver them.
- The bits are gathered into groups called cells, frames, or packets.

WAN Switching Concepts – Packet Switched

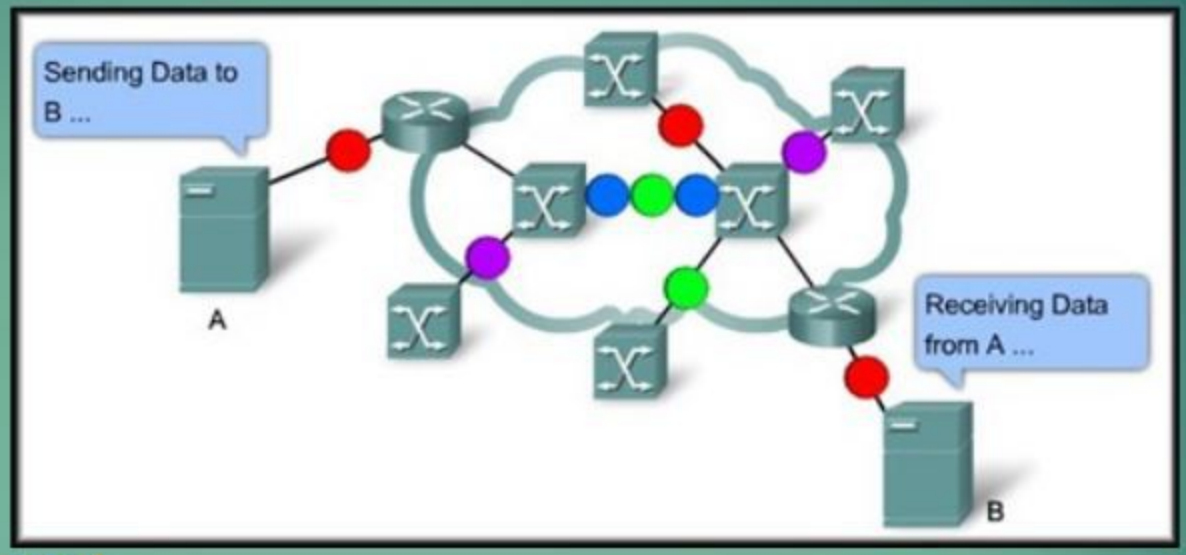
- Each packet must contain the network information in order to be delivered to the correct destination.



- The packet passes from exchange to exchange for delivery through the provider network.
  - *Packet Switched describes the type of network in which relatively small units of data called packets are routed through a network based on the destination address contained within each packet.*

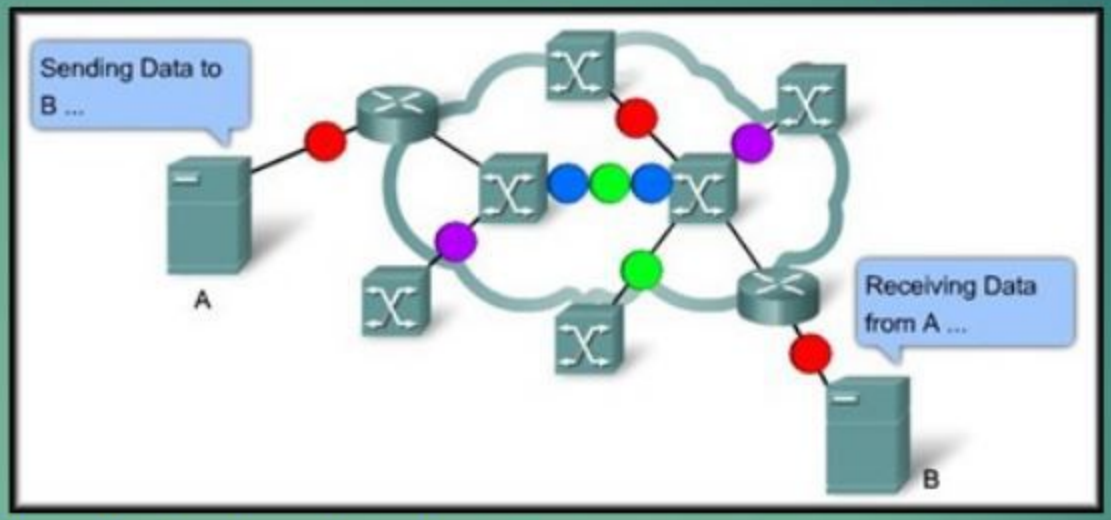
WAN Switching Concepts – Packet Switched

- The circuits only exist while data travels through them.
- They are termed *virtual circuits* and are categorized as switched or permanent.



  - Switched Virtual Circuit (SVC): Is constructed at the time of the connection and disappears when the user is done.
  - Permanent Virtual Circuit (PVC): Is a pre-configured pathway through the provider's network. This path is always available to the user for data transmission.

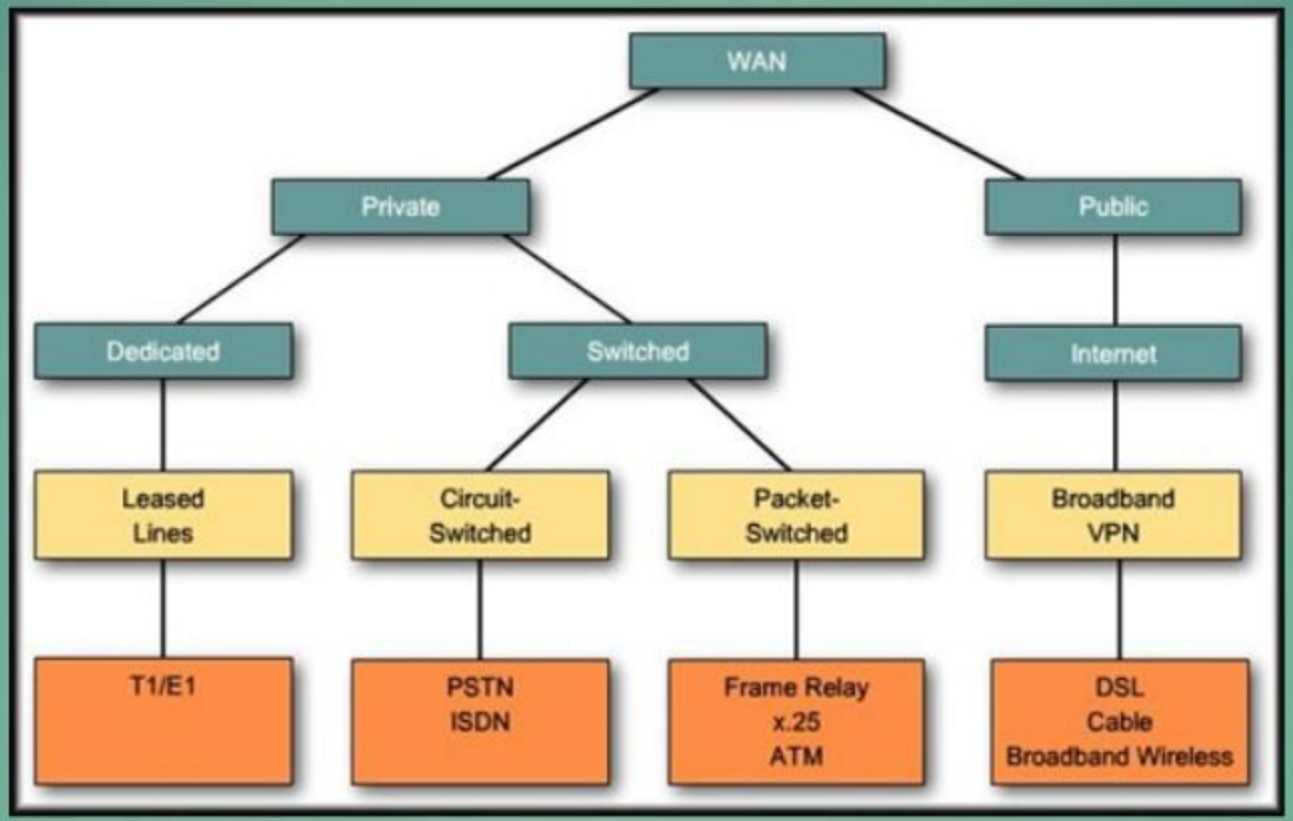
WAN Switching Concepts – Packet Switched



- These networks can also be *connectionless or connection-oriented*.
- The *Internet* is a good example of a connectionless, packet switched network. Each packet contains all of the addressing information required for successful packet delivery.
- *Frame Relay* is an example of a connection-oriented packet switched network. Each packet does not require addressing information and travels a pre-configured path between the source and the destination.

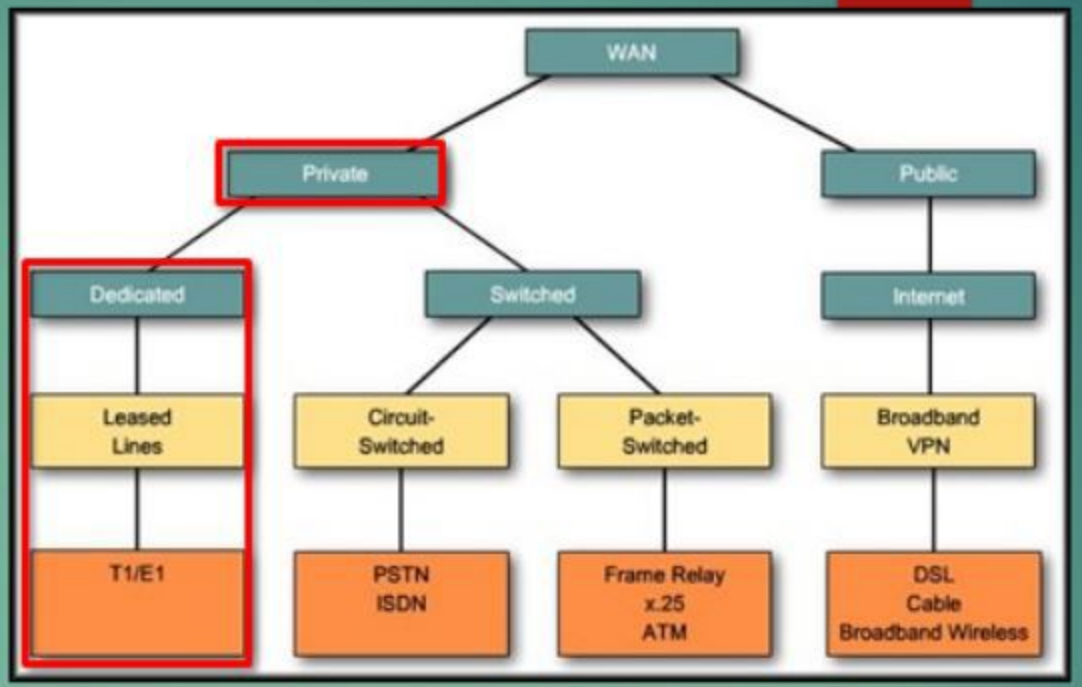
Introduction to WANs

WAN Connection Options



WAN Link Connection Options

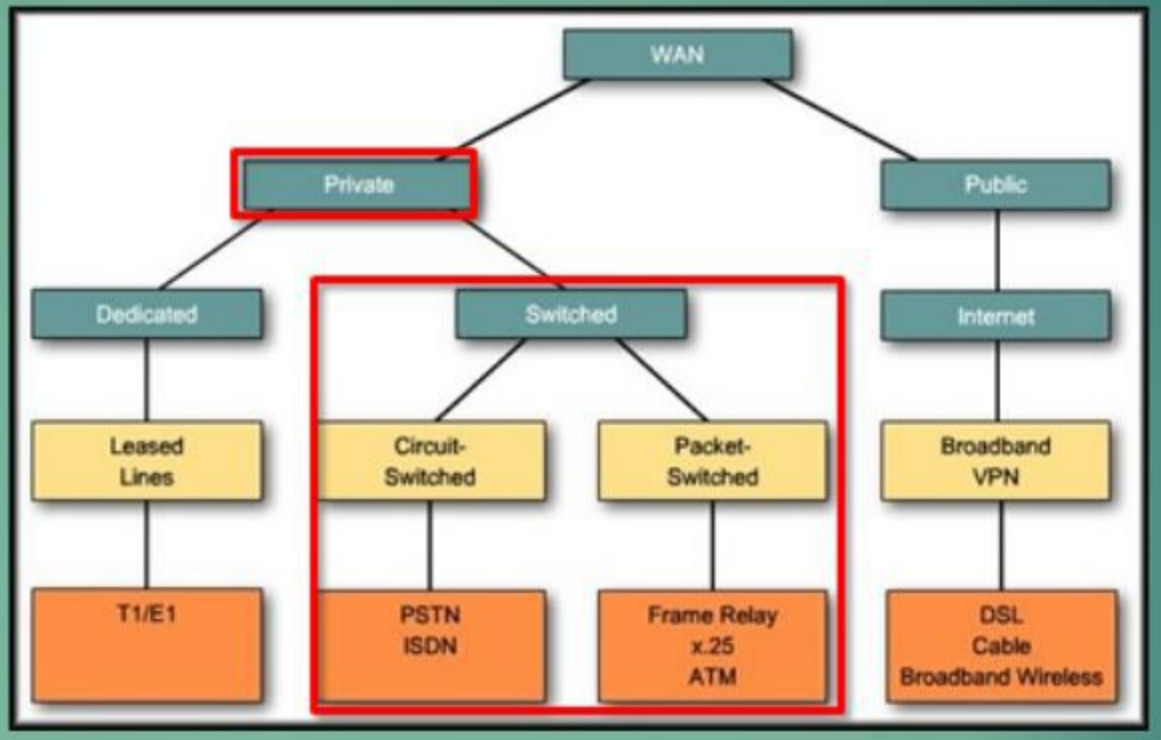
- Dedicated or leased-line networks are the simplest of the implementations.
- A dedicated point-to-point link is provided by the vendor.



- Bandwidth is guaranteed between the end points.
- Leased lines are also used to connect the subscriber to the vendor to make use of other technologies.

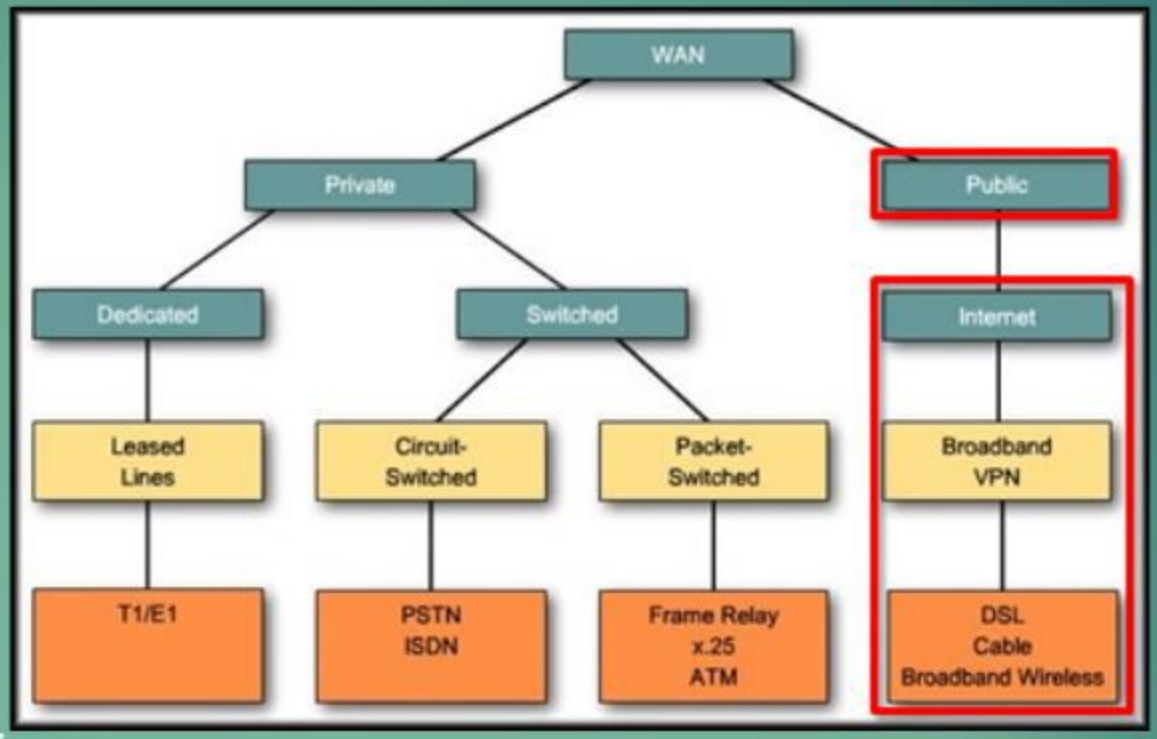
WAN Link Connection Options

- Switched communication links can be either circuit switched or packet switched.
- Circuit Switched:
  - PSTN
  - ISDN
- Packet Switched:
  - Frame Relay
  - X.25
  - ATM



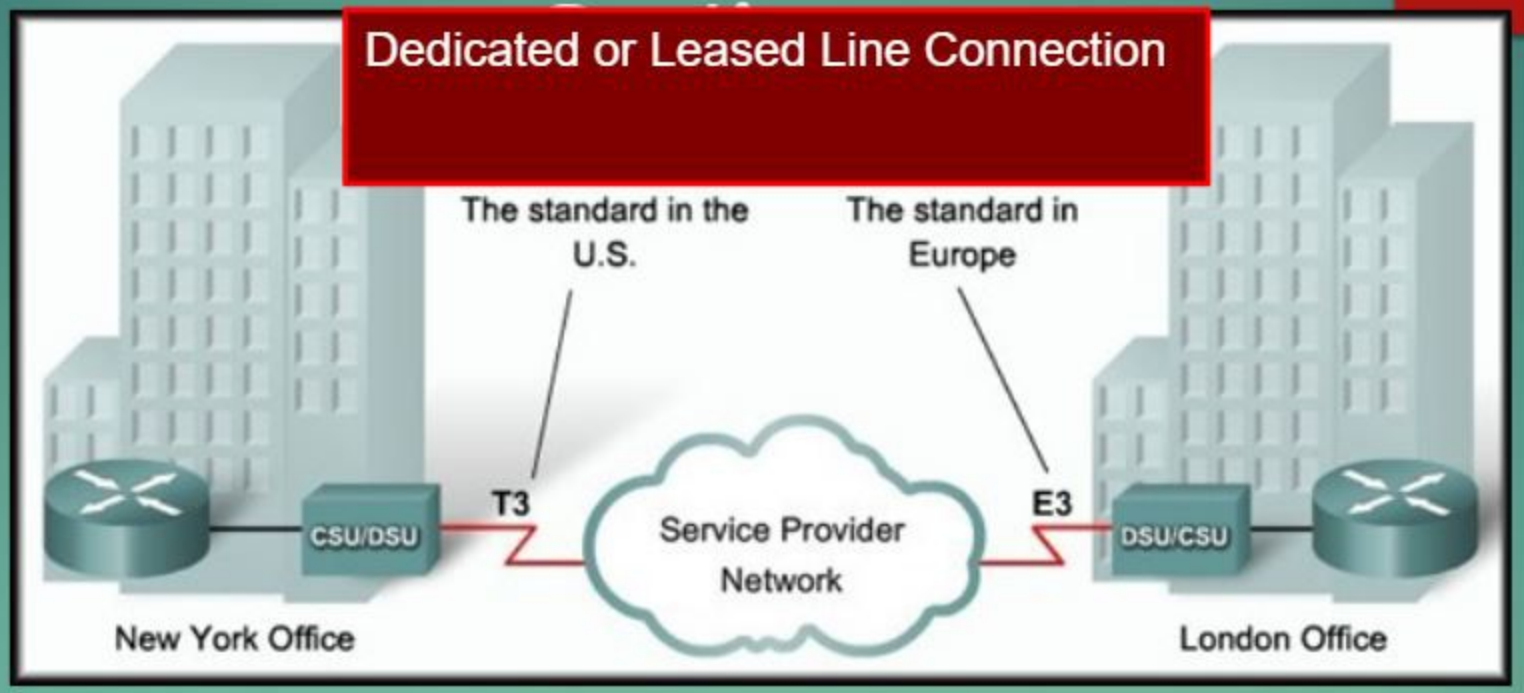
WAN Link Connection Options

- Public:
  Public connections use the global Internet infrastructure.
- Until the development of VPN technology, the Internet was not a viable connection option. Security issues prevented its use.



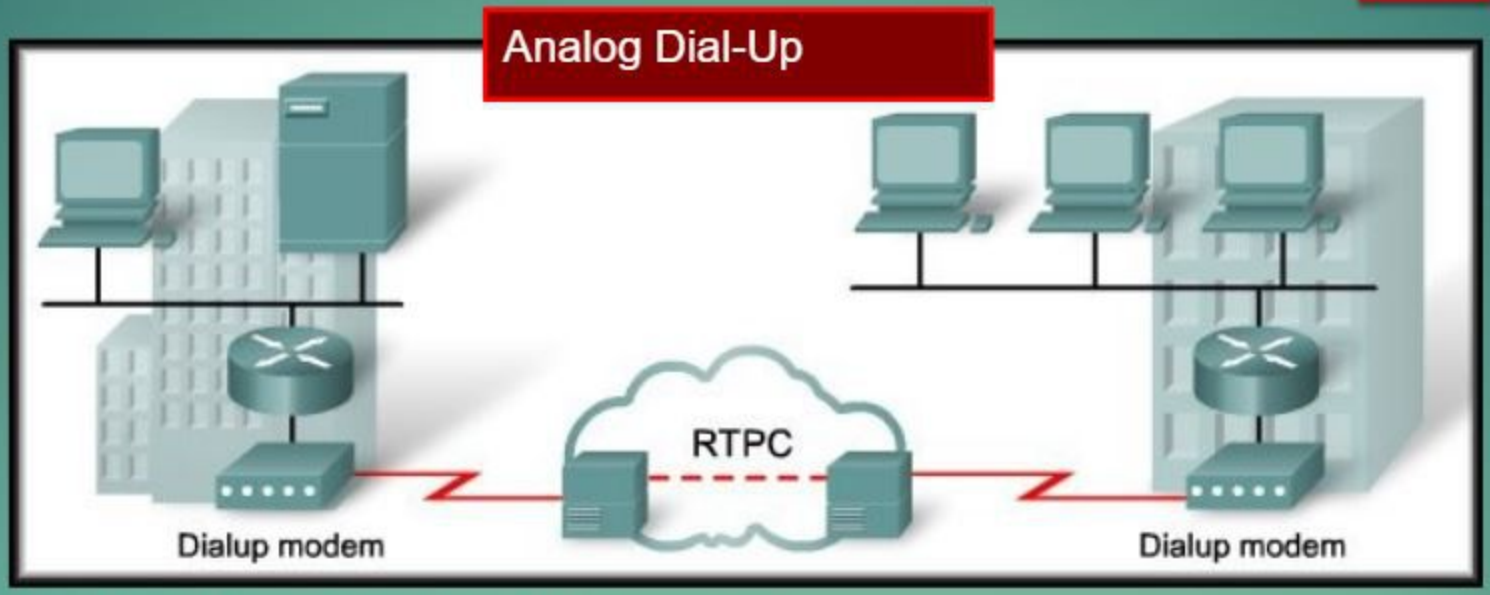
- The Internet is now an inexpensive and secure option for connecting to teleworkers and remote offices where performance guarantees are not critical.
  - DSL, Cable Broadband Wireless

Dedicated Connection Link



- A point-to-point link is used to provide a pre-established WAN communications path from the customer premises through the provider network to a remote destination.
- Point-to-point links are usually more expensive than shared services.

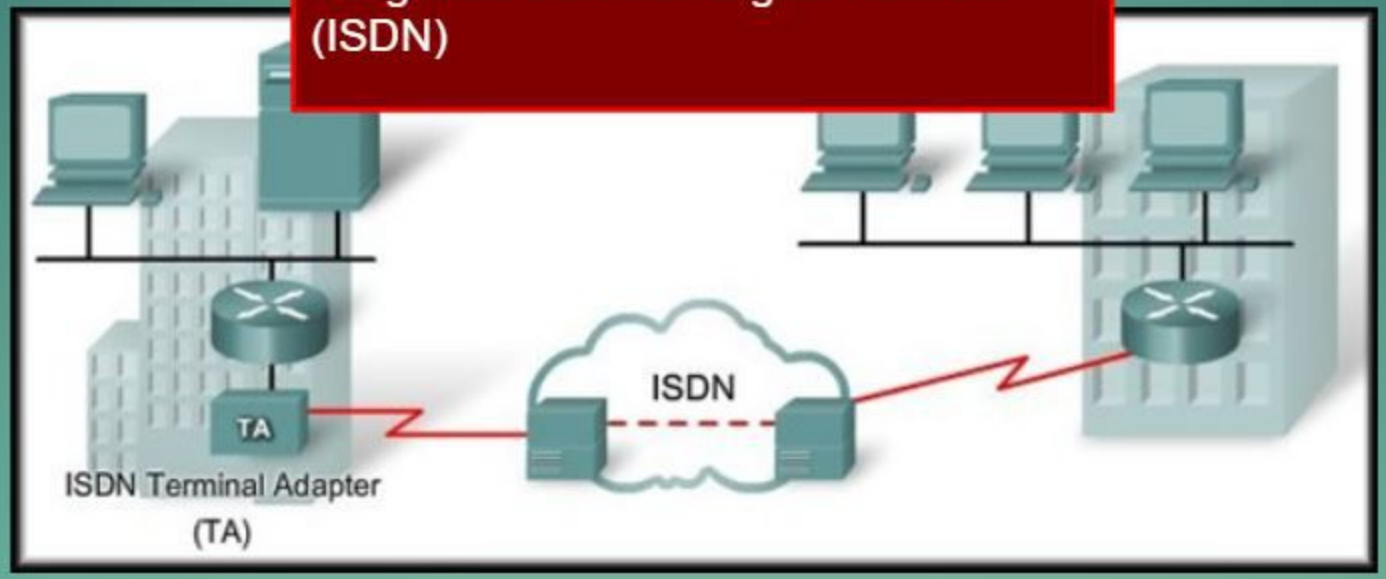
Circuit-Switched Link Options



- Interuptted, low-volume data transfers.
- Limited to less than 56 kb/s.
- Advantages: simplicity, availability, low implementation cost.
- Disadvantages: low data rates, long connection time.

Circuit-Switched Link Options

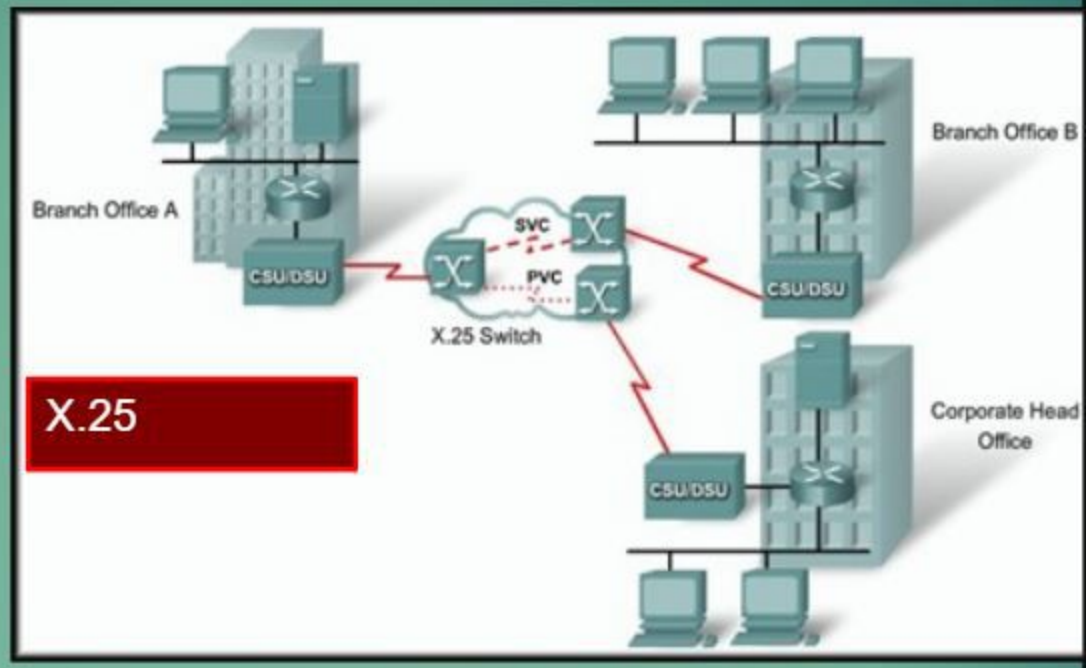
Integrated Services Digital Network (ISDN)



- Enables the local loop to carry end-to-end digital signals.
- Higher capacity connections.
- ISDN changes the internal connections of the PSTN from carrying analog signals to digital signals.

Packet-Switched Connection Options

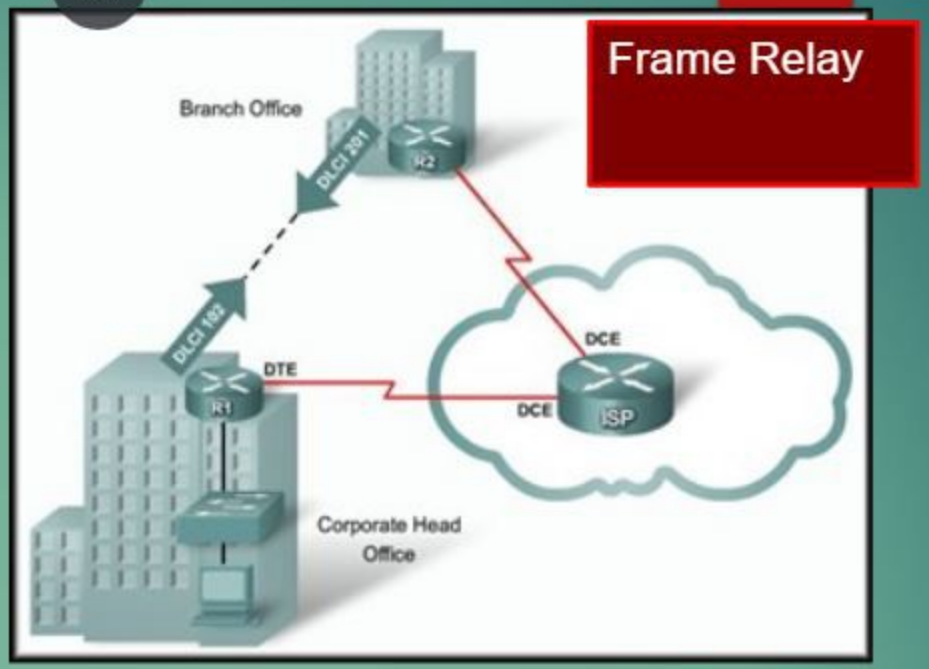
- X.25:
- Legacy network layer protocol.
- Typical applications are point-of-sale card readers.
- Speeds vary from 2400 b/s up to 2 Mb/s.



- Now in dramatic decline.
- They are still in use in many portions of the developing world.

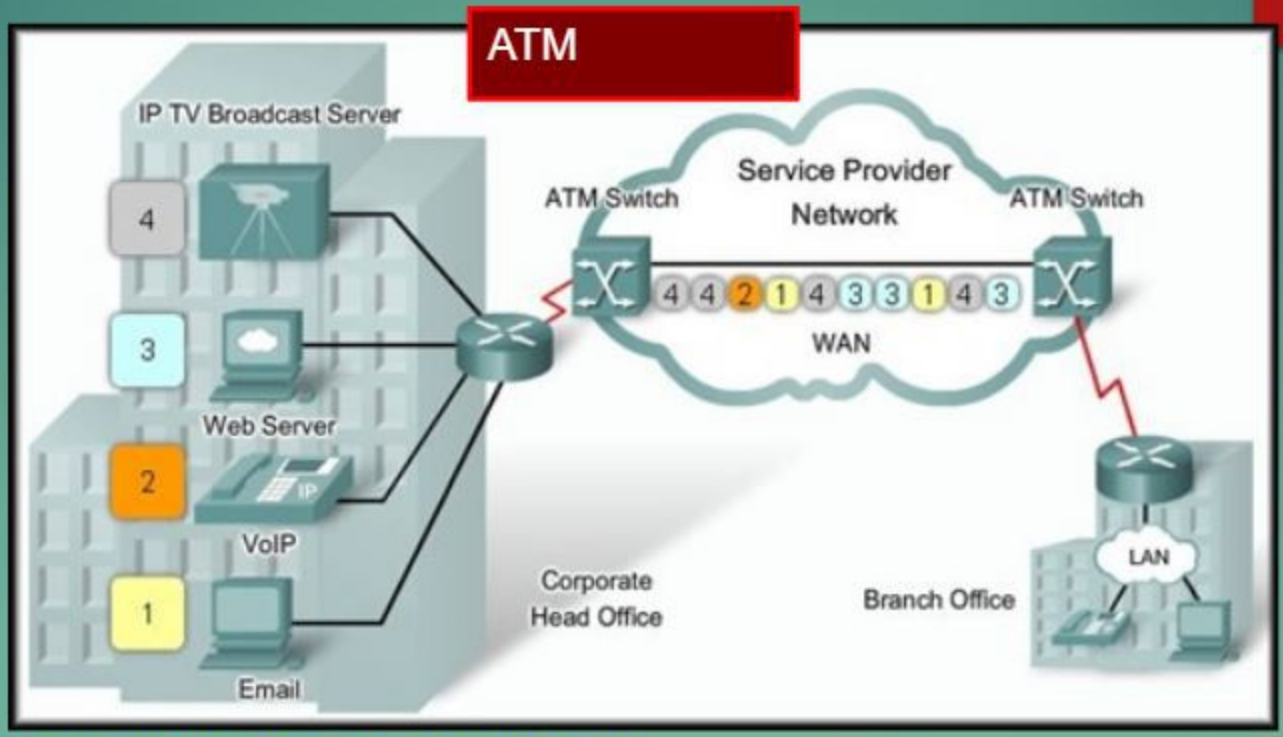
Packet-Switched Connection Options

- Frame Relay:
- Much simpler protocol at the data link layer.
- Implements no error or flow control.
- Data rates up to 4 Mb/s.



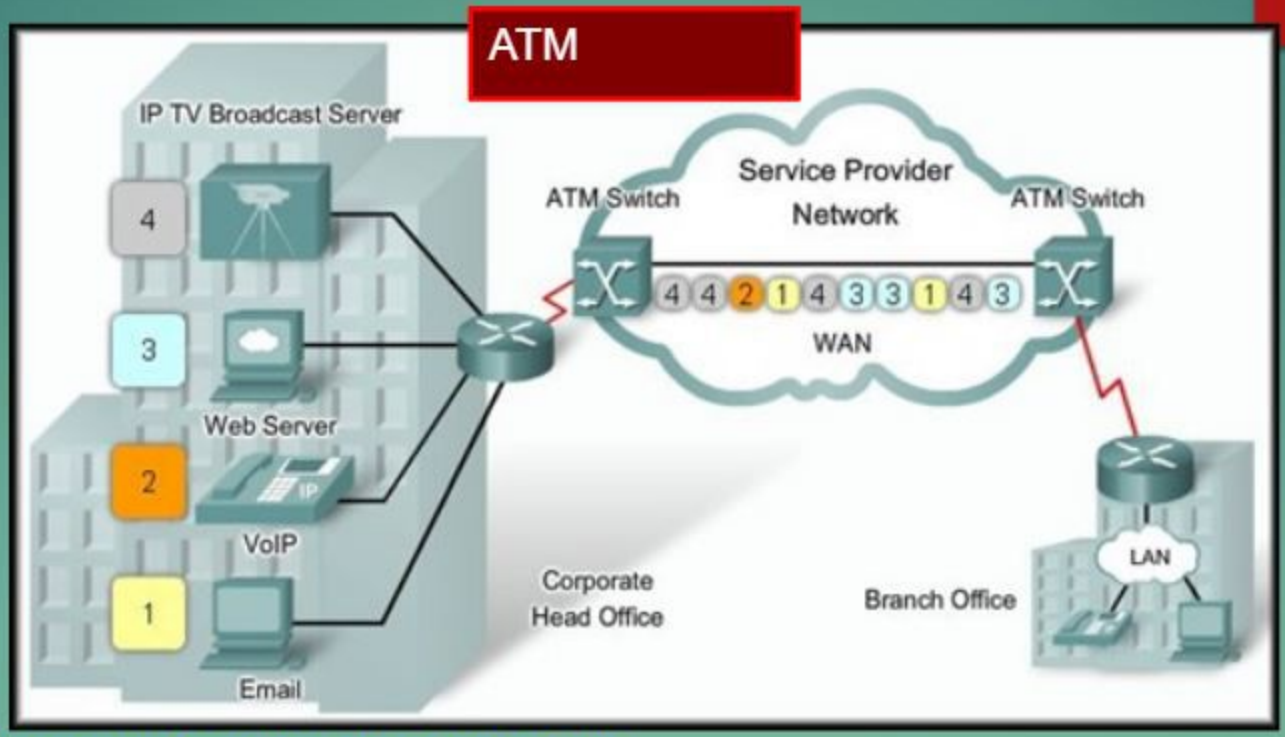
- The router on the LAN needs only a single interface.
- The short-leased line to the Frame Relay network edge allows cost-effective connections between widely scattered LANs.

Packet-Switched Connection



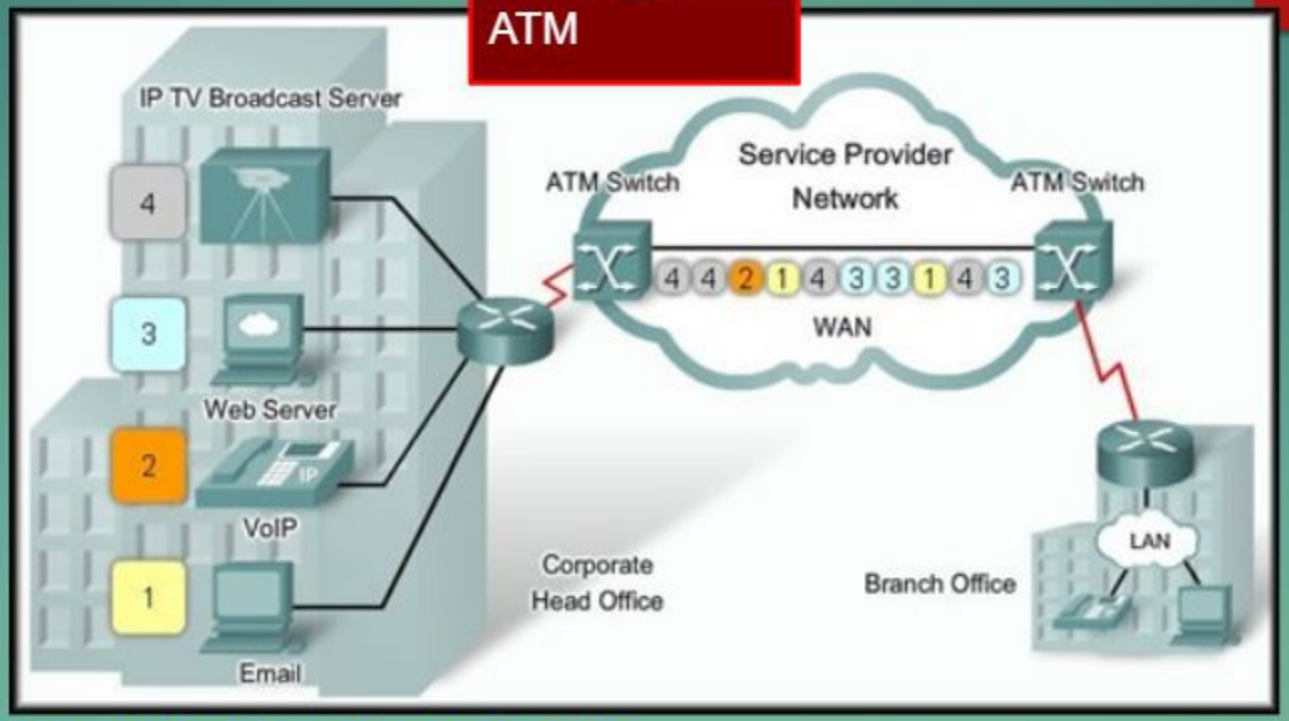
- Asynchronous Transfer Mode (ATM):
  - ATM technology is capable of transferring voice, video, and data simultaneously through private and public networks.
  - It is built on a cell-based architecture.

Packet-Switched Connection



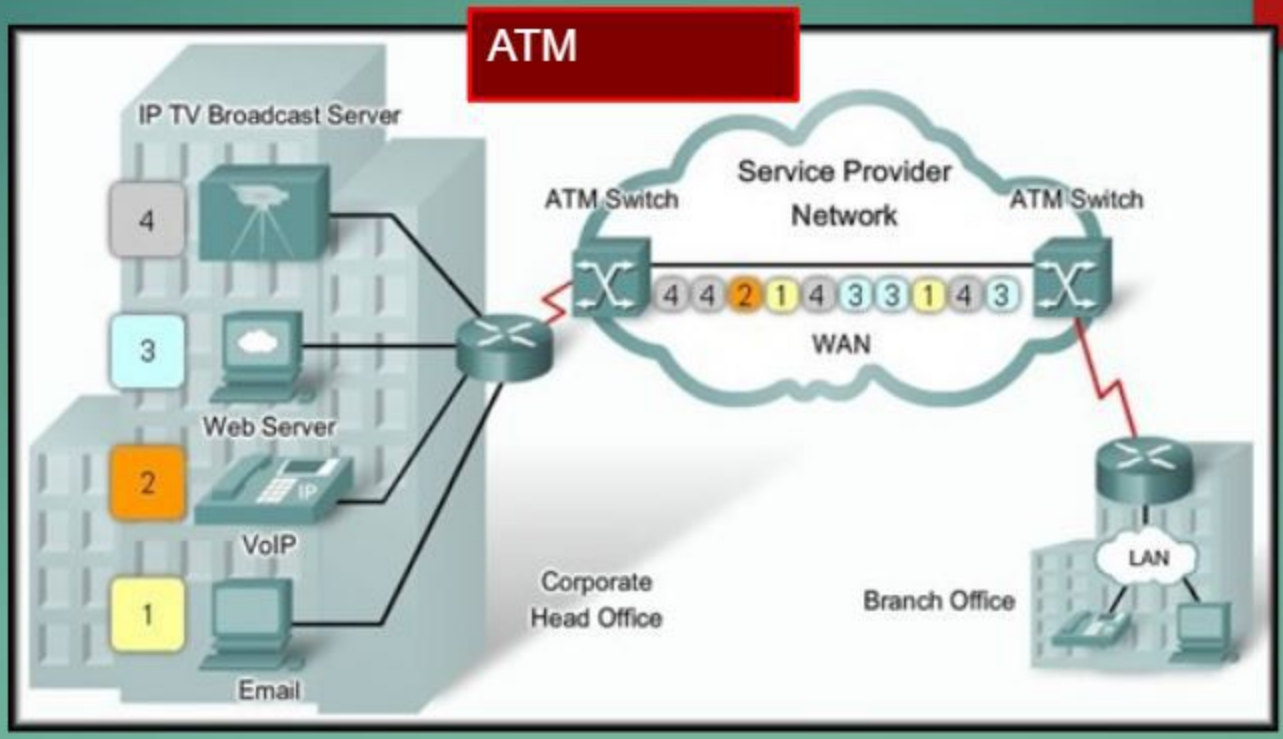
- Asynchronous Transfer Mode (ATM):
  - ATM cells are always a fixed length of 53 bytes.
    - 5 byte ATM header.
    - 48 bytes of ATM payload.

Packet-Switched Connection



- Asynchronous Transfer Mode (ATM):
  - The ATM cell is less efficient than the bigger frames and packets of Frame Relay and X.25.
  - Needs almost 20 percent greater bandwidth than Frame Relay to carry the same amount of data.

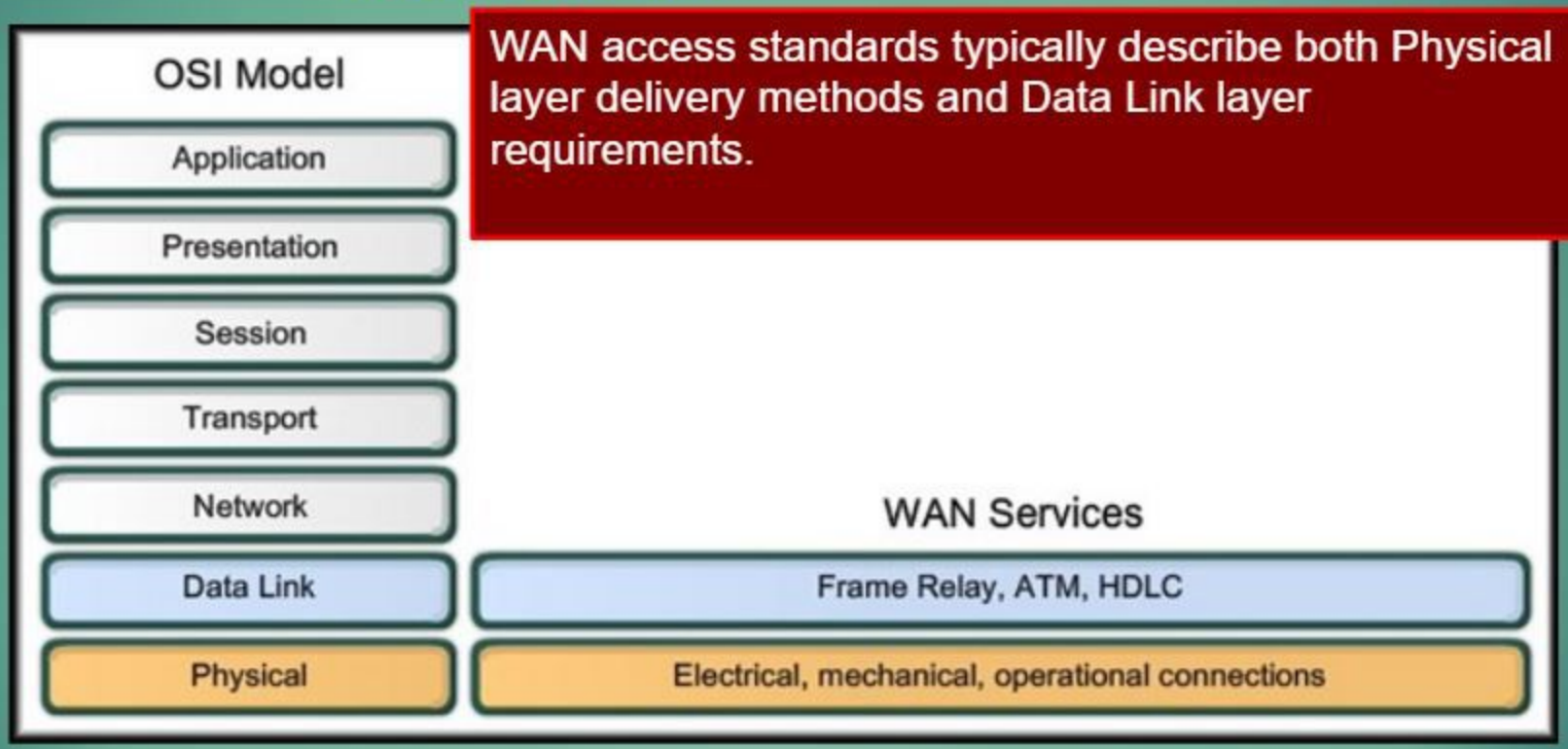
Packet-Switched Connection



- Asynchronous Transfer Mode (ATM):
  - ATM was designed to be extremely scalable and can support link speeds of (622 Mb/s) and higher.

WAN Technology Overview

- WAN and the OSI Model:
  - In relation to the OSI reference model, WAN operations focus on Layer 1 and Layer 2.



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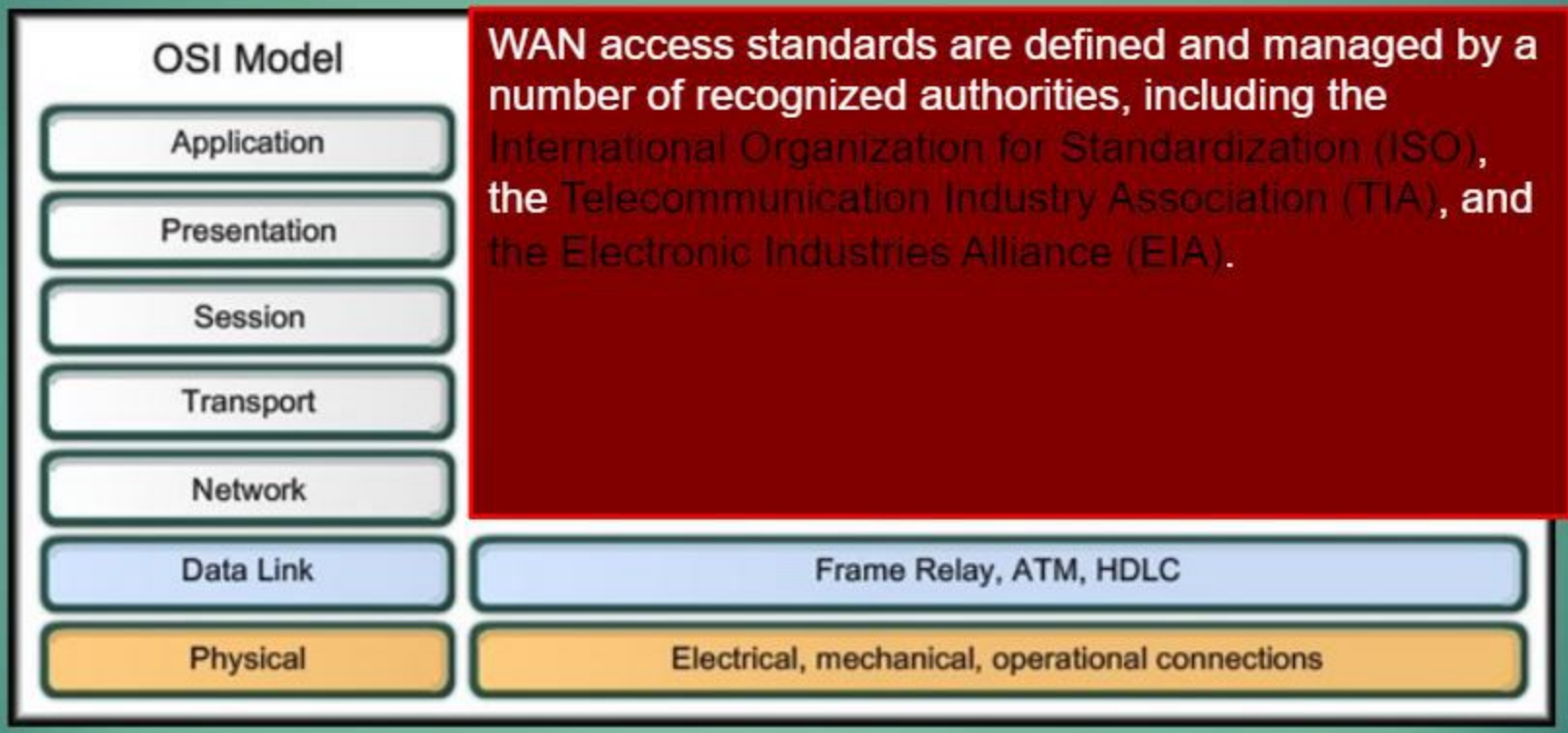

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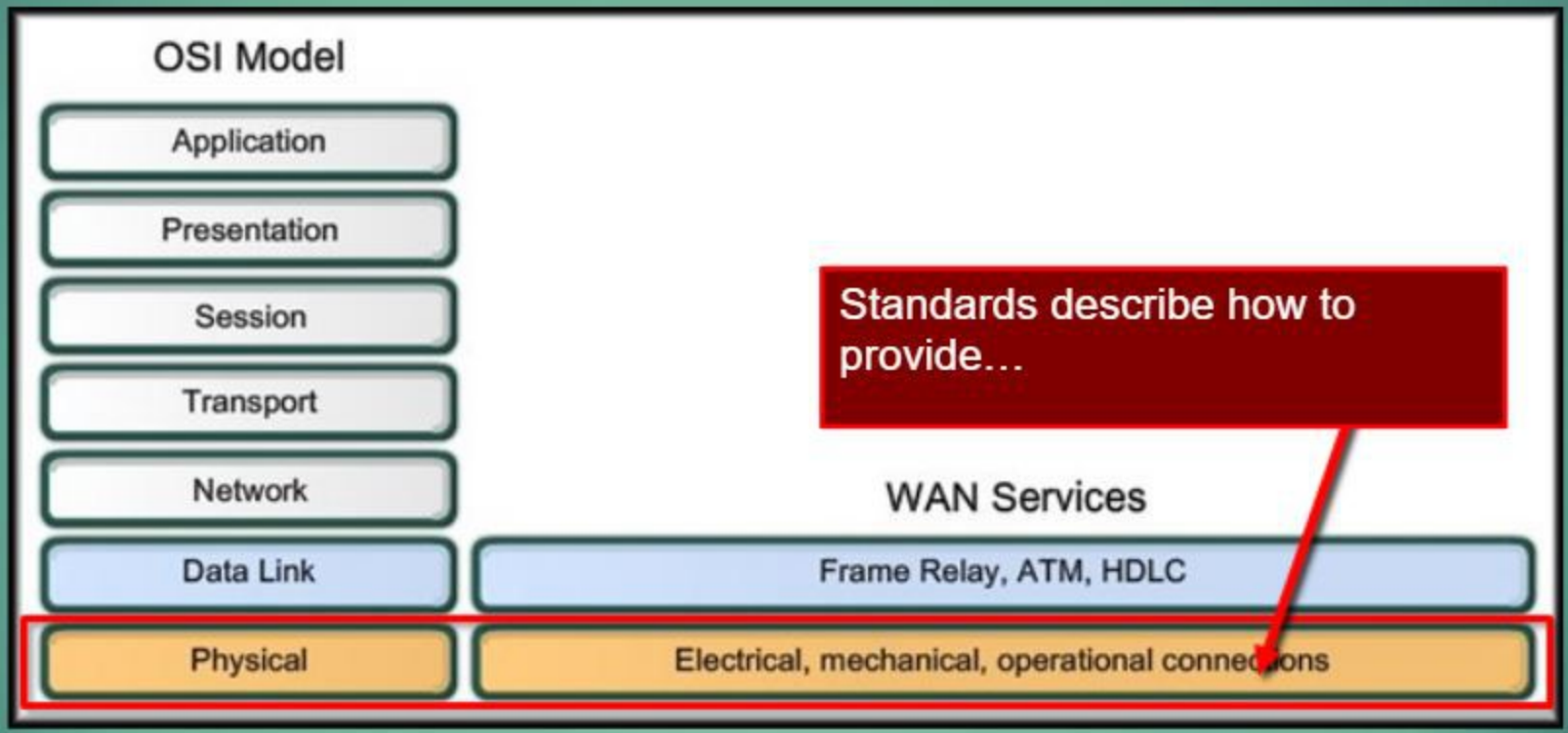

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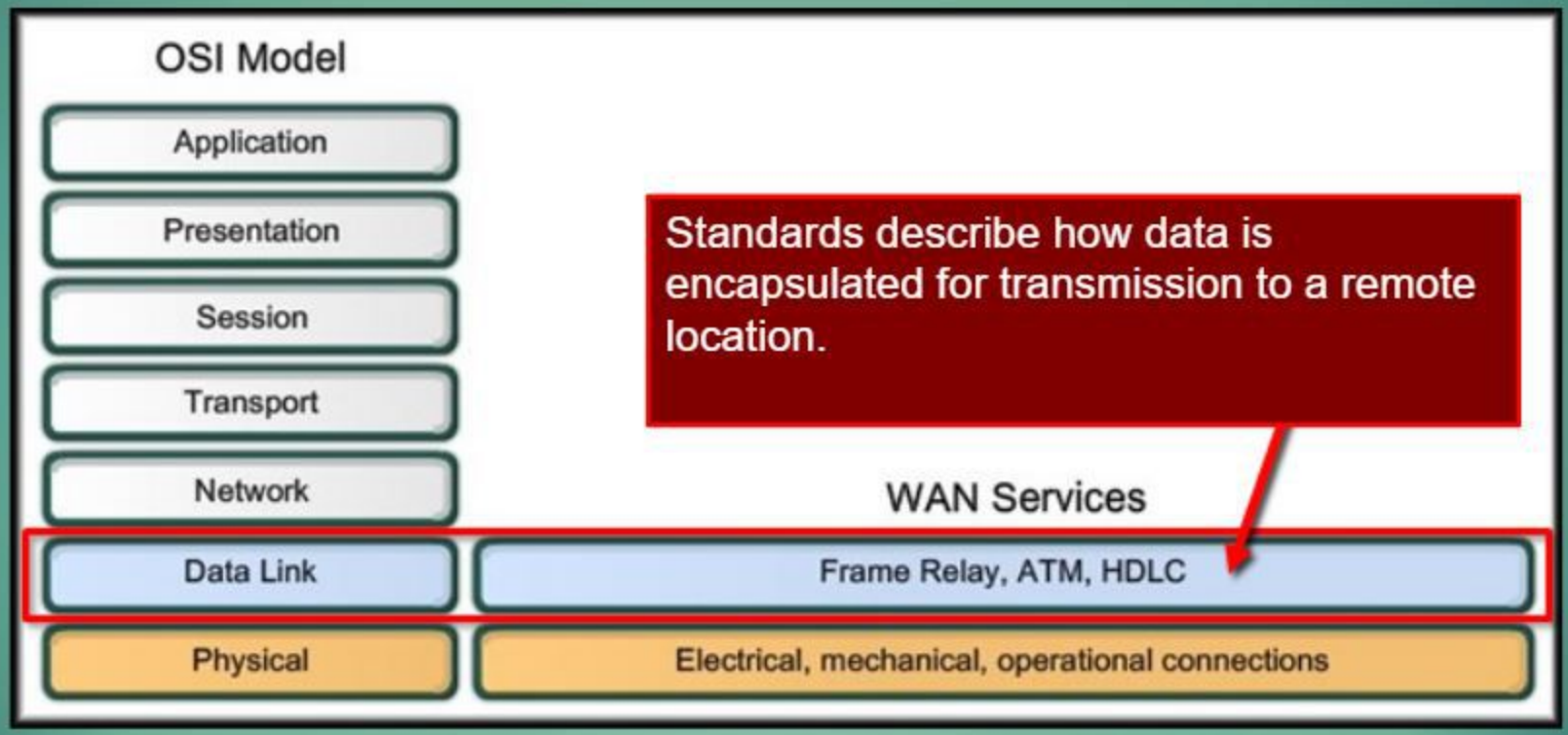
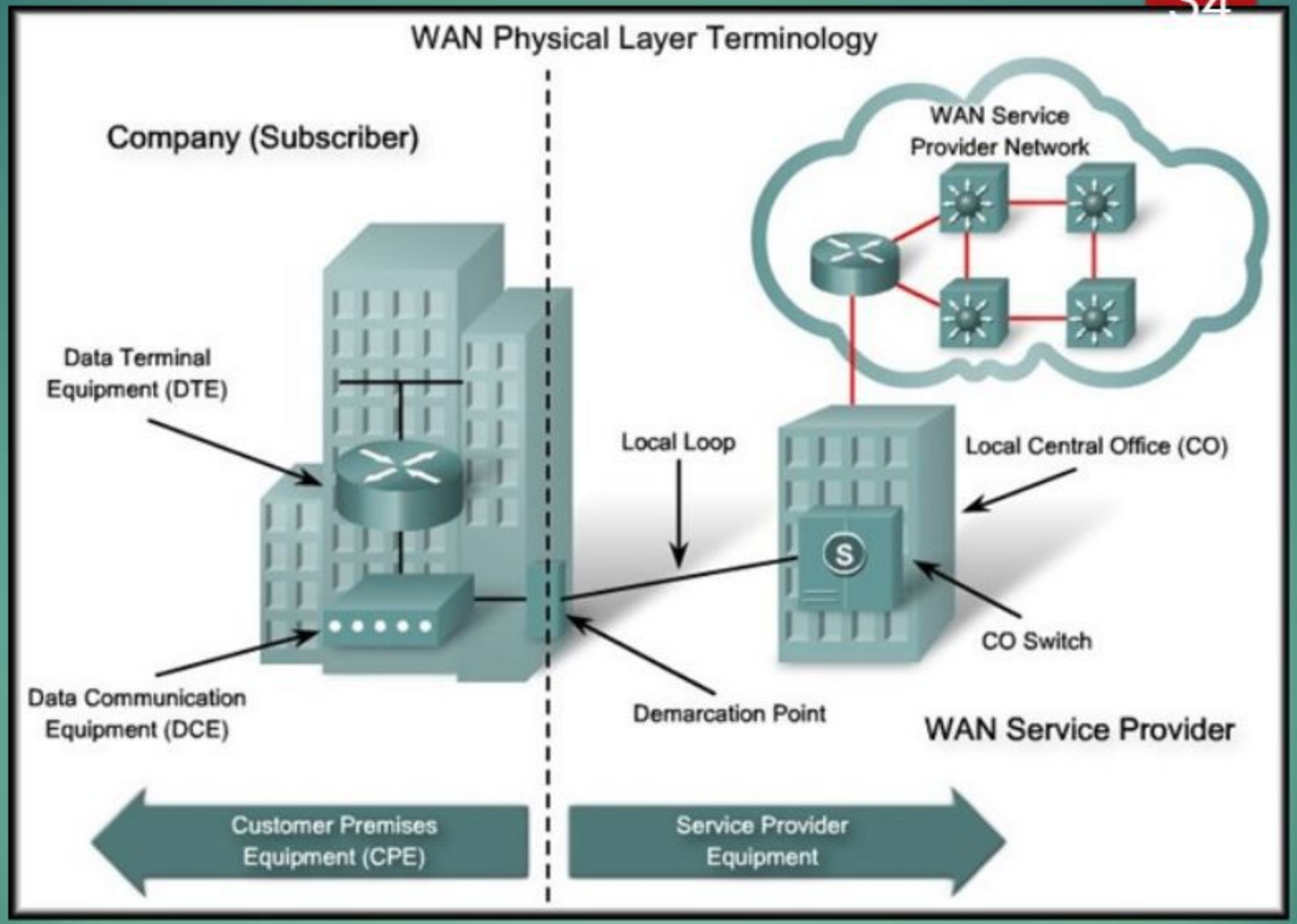
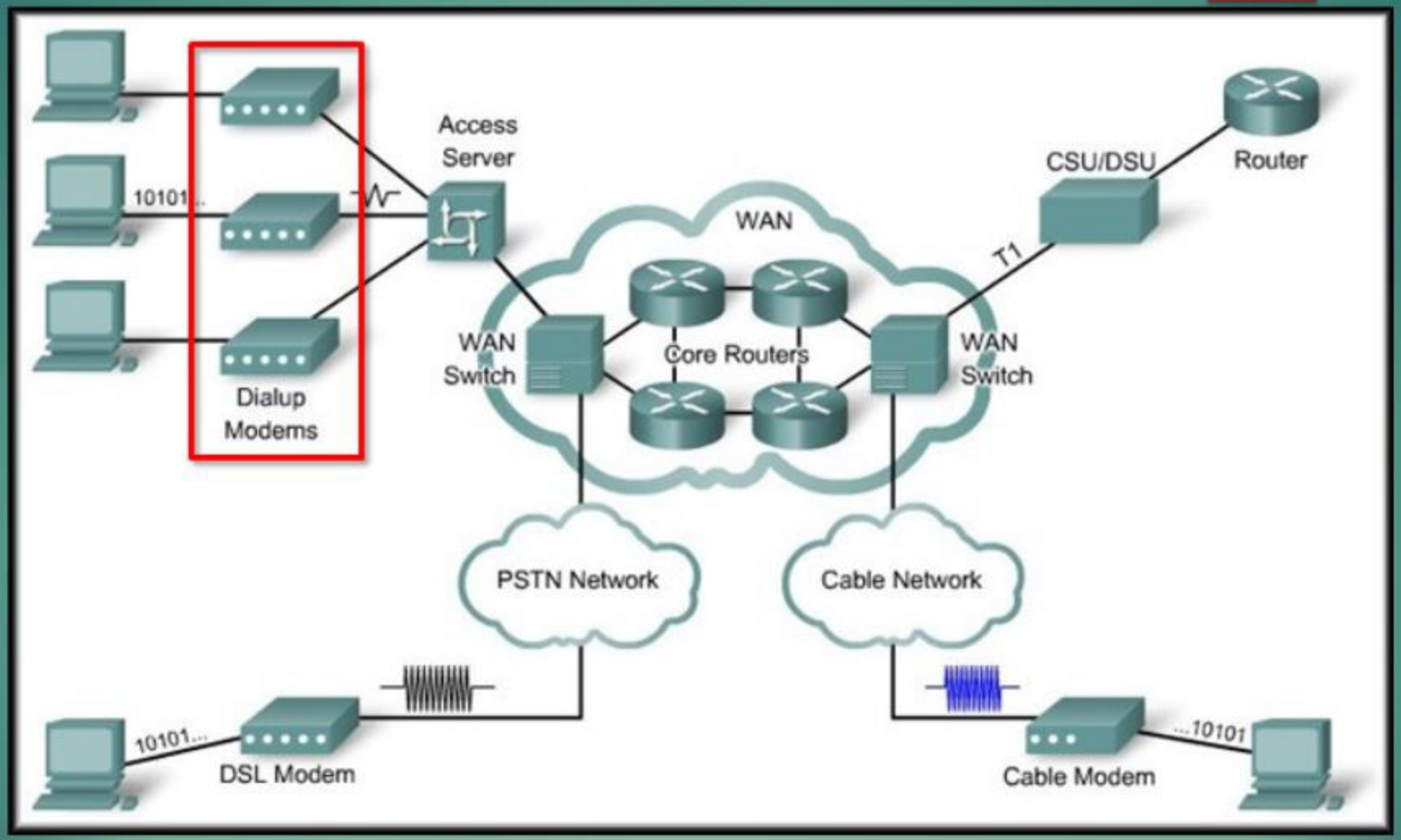


WAN Physical Layer Concepts



WAN Devices


Access
Server
10101...
Dialup
Modems
WAN
WAN
Switch
Core Routers
WAN
Switch
CSU/DSU
Router
T1
PSTN Network
Cable Network
10101...
DSL Modem
Cable Modem
...10101

WAN Data Link Layer Concepts

- Data Link layer protocols define how data is encapsulated for transmission to remote sites and the mechanisms for transferring the resulting frames.
- A variety of different technologies, such as ISDN, Frame Relay, or ATM, are used to move the data across the WAN connection.
- Many of these protocols use the same basic framing mechanism, High-Level Data Link Control (HDLC).

WAN Data Link Layer Concepts

- The most common WAN data-link protocols are:
  - HDLC
  - PPP
  - Frame Relay
  - ATM

- ATM is different from the others, because it uses small fixed-size cells of 53 bytes (48 bytes for data), unlike the other technologies, which use variable-sized packets.

WAN Data Link Layer Concepts

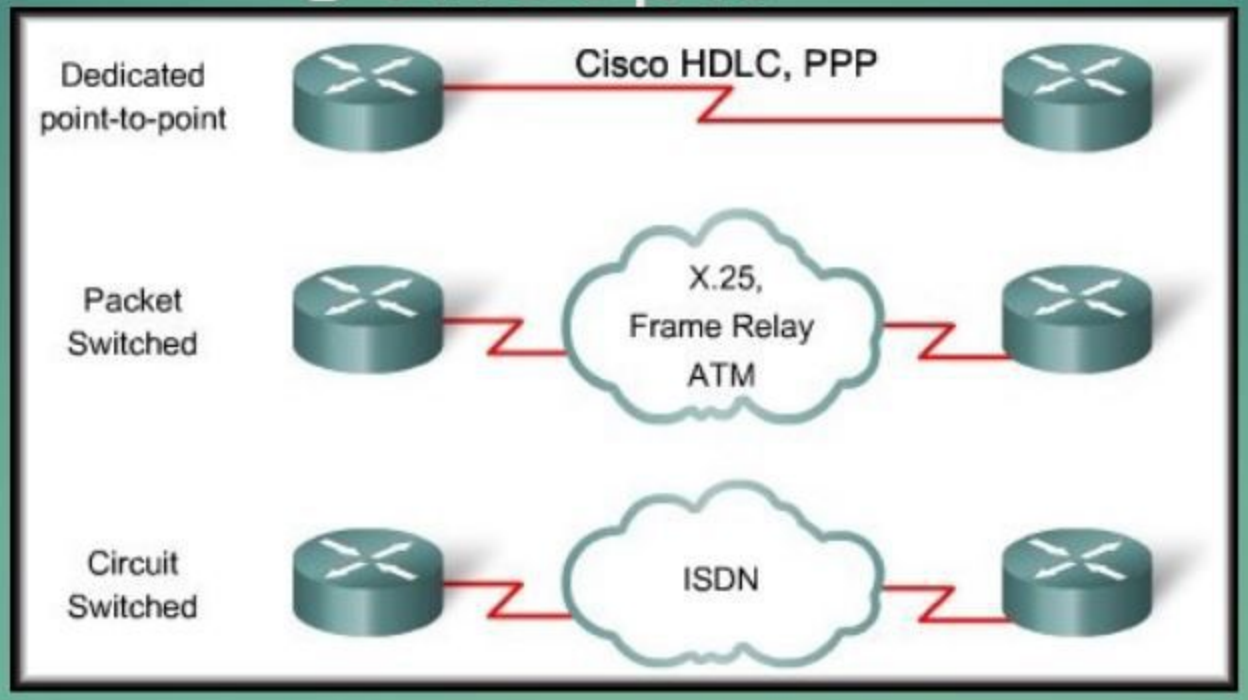
- Another Data Link layer protocol is the Multiprotocol Label Switching (MPLS) protocol.
- MPLS is increasingly being deployed by service providers to provide an economical solution to carry circuit-switched as well as packet-switched network traffic.
- It can operate over any existing infrastructure, such as IP or Ethernet.
- It sits between Layer 2 and Layer 3 and is sometimes referred to as a Layer 2.5 protocol.

WAN Data Link Layer Concepts

Protocol	Usage
Link Access Procedure Balanced (LAPB)	X.25
Link Access Procedure D Channel (LAPD)	ISDN D channel
Link Access Procedure Frame (LAPF)	Frame Relay
High-Level Data Link Control (HDLC)	Cisco default
Point-to-Point Protocol (PPP)	Serial WAN switched connections

Data Link layer protocols define how the data is encapsulated as well as how it is transported between sites.

WAN Data Link Layer Concepts



A number of technologies for the transport of data exist.
While the encapsulation will vary with the technology, most use the ISO HDLC standard or a modification of it.