

Chapter 1: WAN Concepts



Connecting Networks

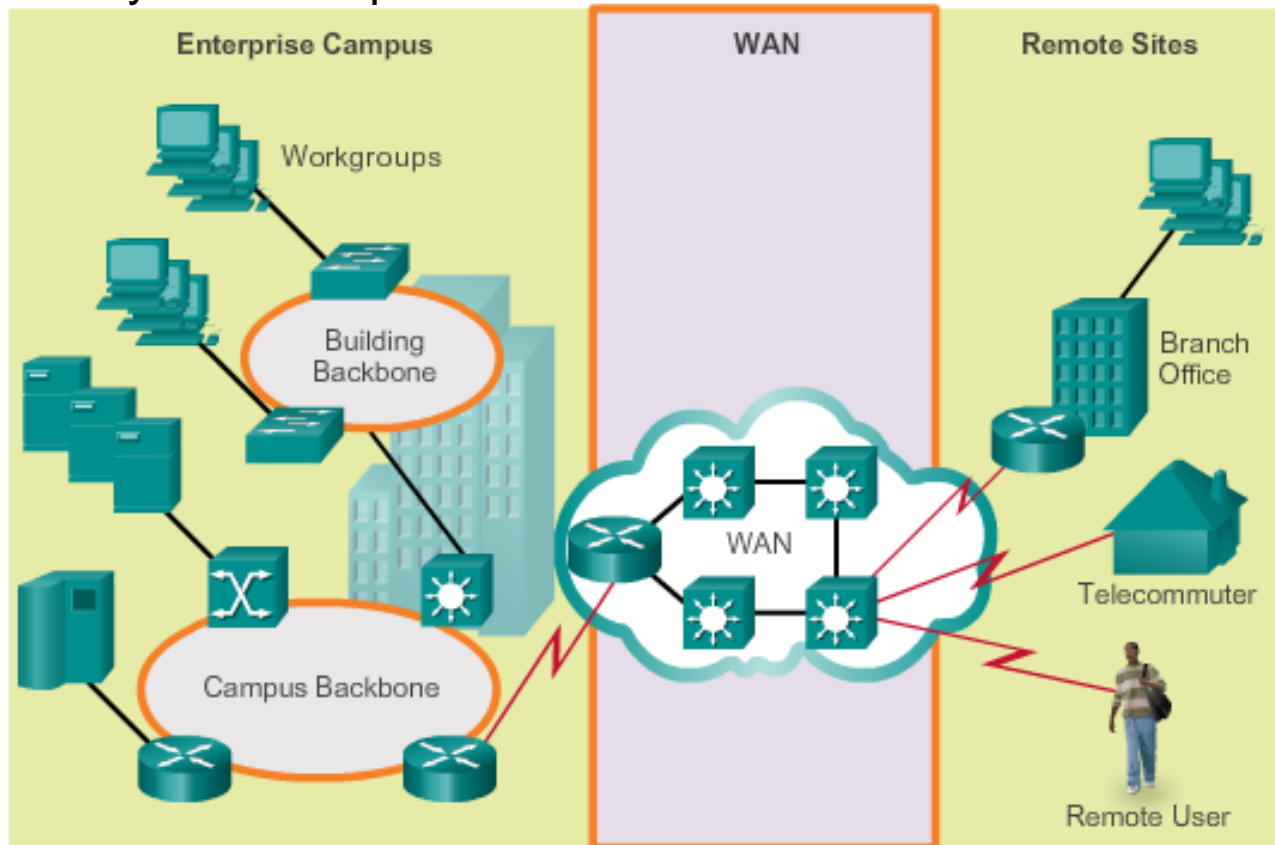
1.1 WAN Technologies Overview





WAN Technology Overview

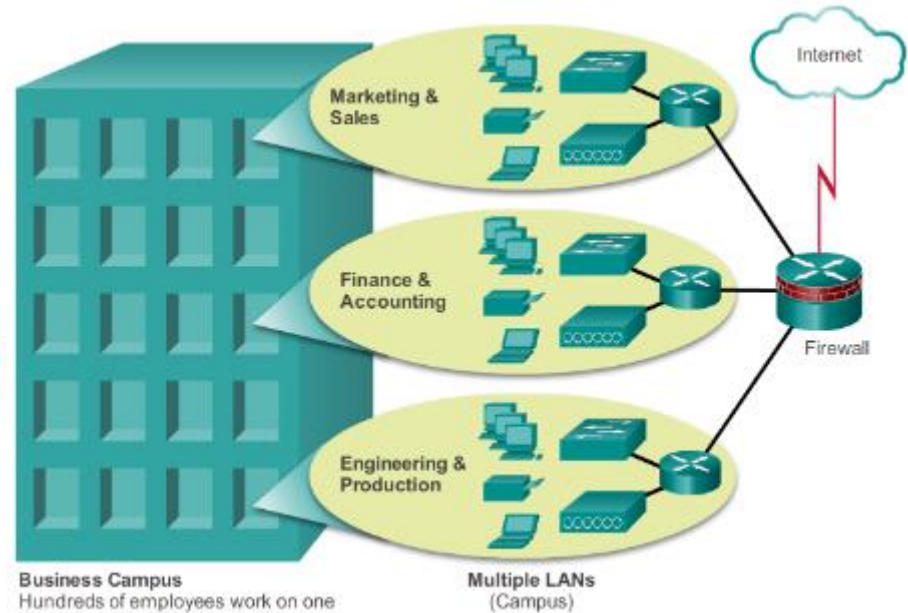
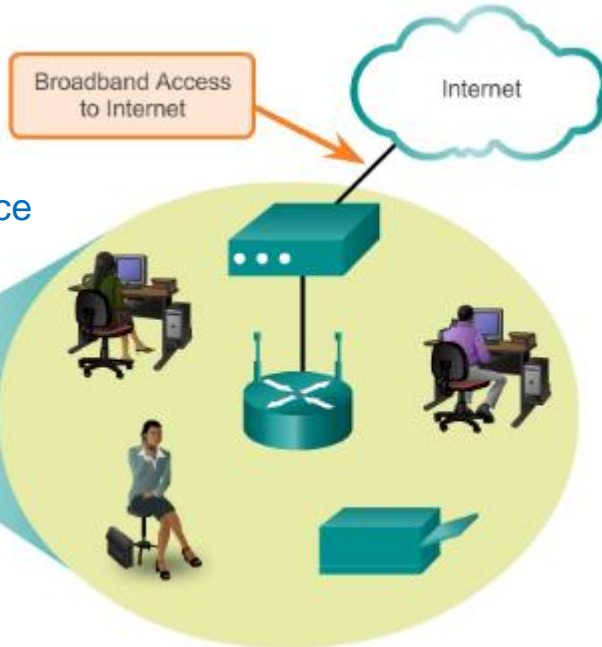
- WANs connect LANs: it operates beyond the geographical scope of a LAN.
 - Connects remote sites to the enterprise network.
 - Connects home users to the Internet.
- WAN is owned by a service provider.



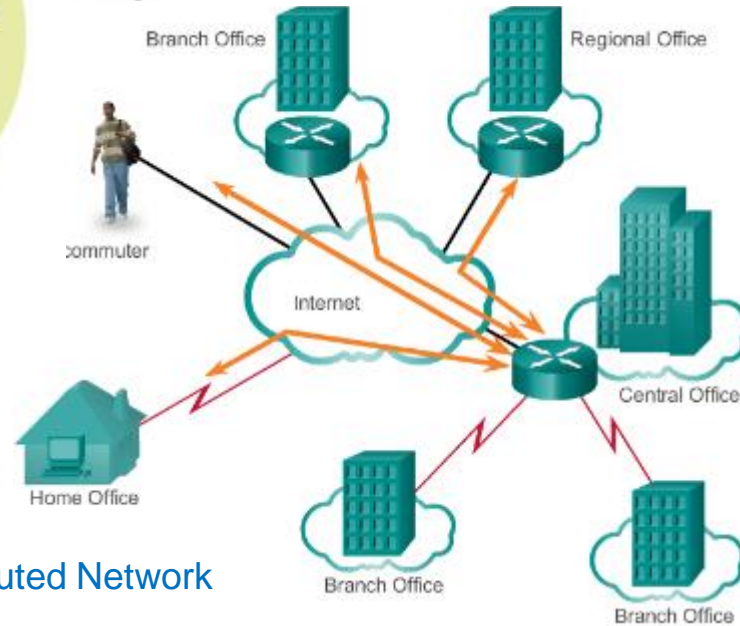


Purpose of WANs

Small Office



Campus Network

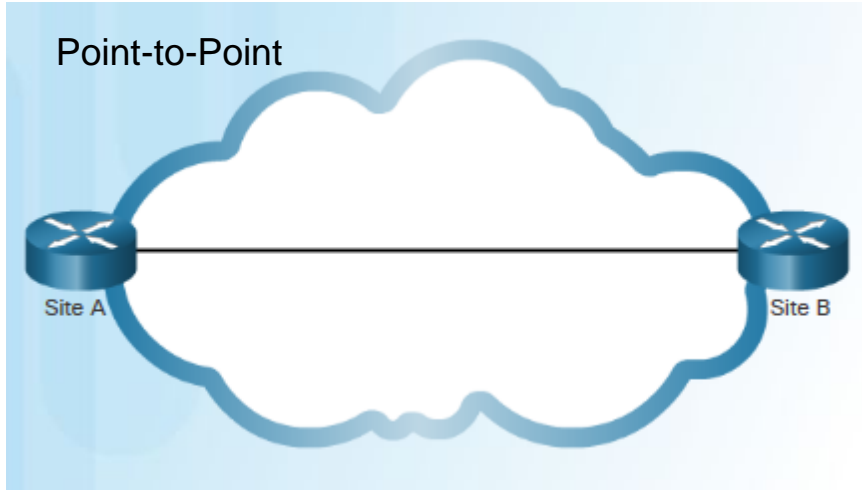


Distributed Network

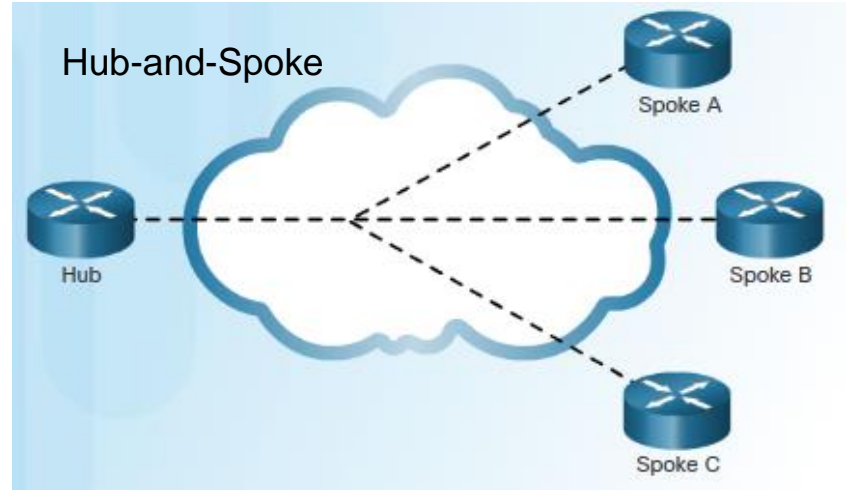


Common WAN Topologies

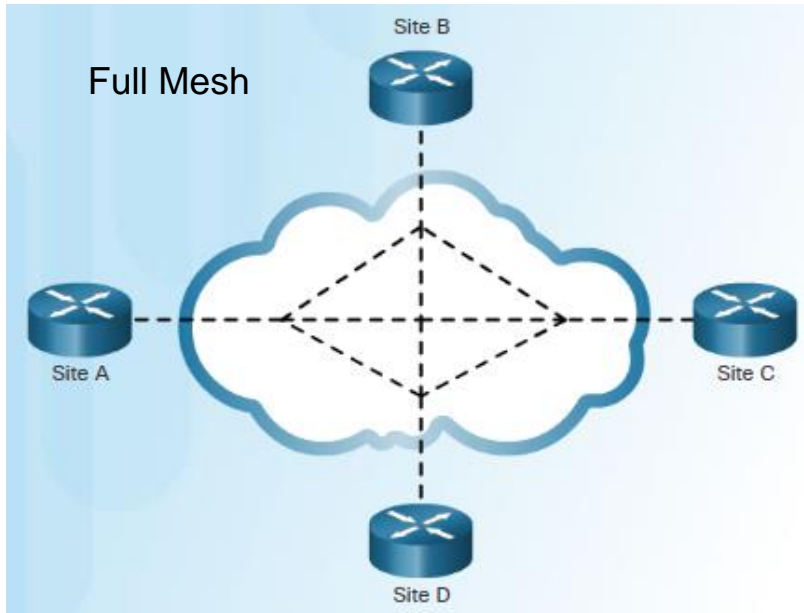
Point-to-Point



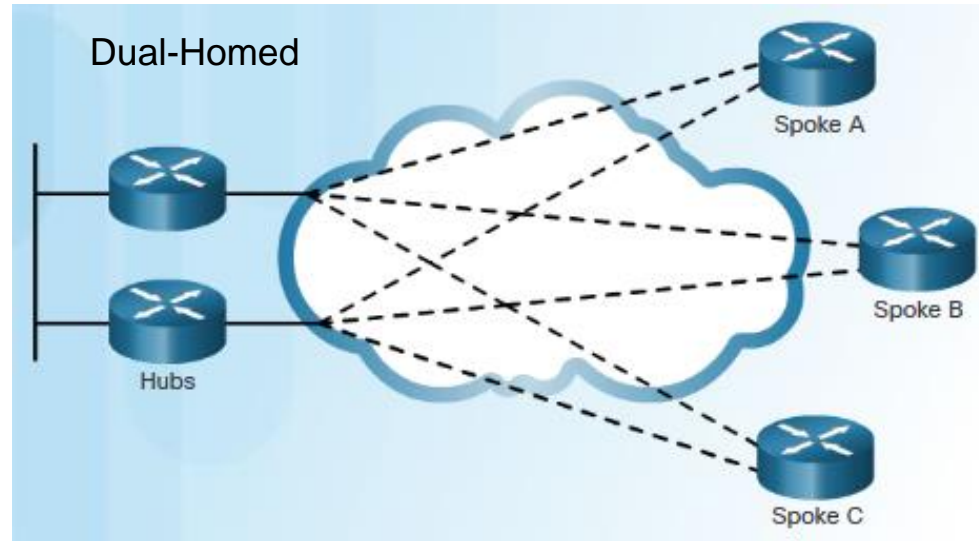
Hub-and-Spoke



Full Mesh



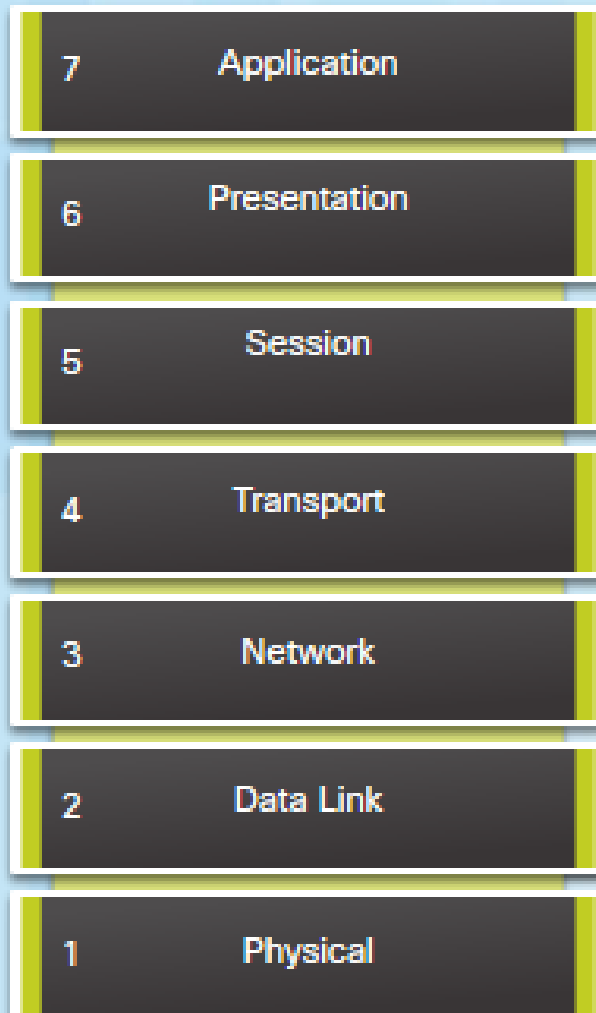
Dual-Homed





WAN and OSI Model

OSI Model



WAN access standards typically describe both physical layer delivery methods and data link layer requirements, including:

- physical addressing
- flow control
- encapsulation.

Standards:

- TIA/EIA (former CCITT)
- ISO
- IEEE

WAN Services

HDLC, PPP, Frame Relay, Ethernet WANs, MPLS, VSAT, Broadband

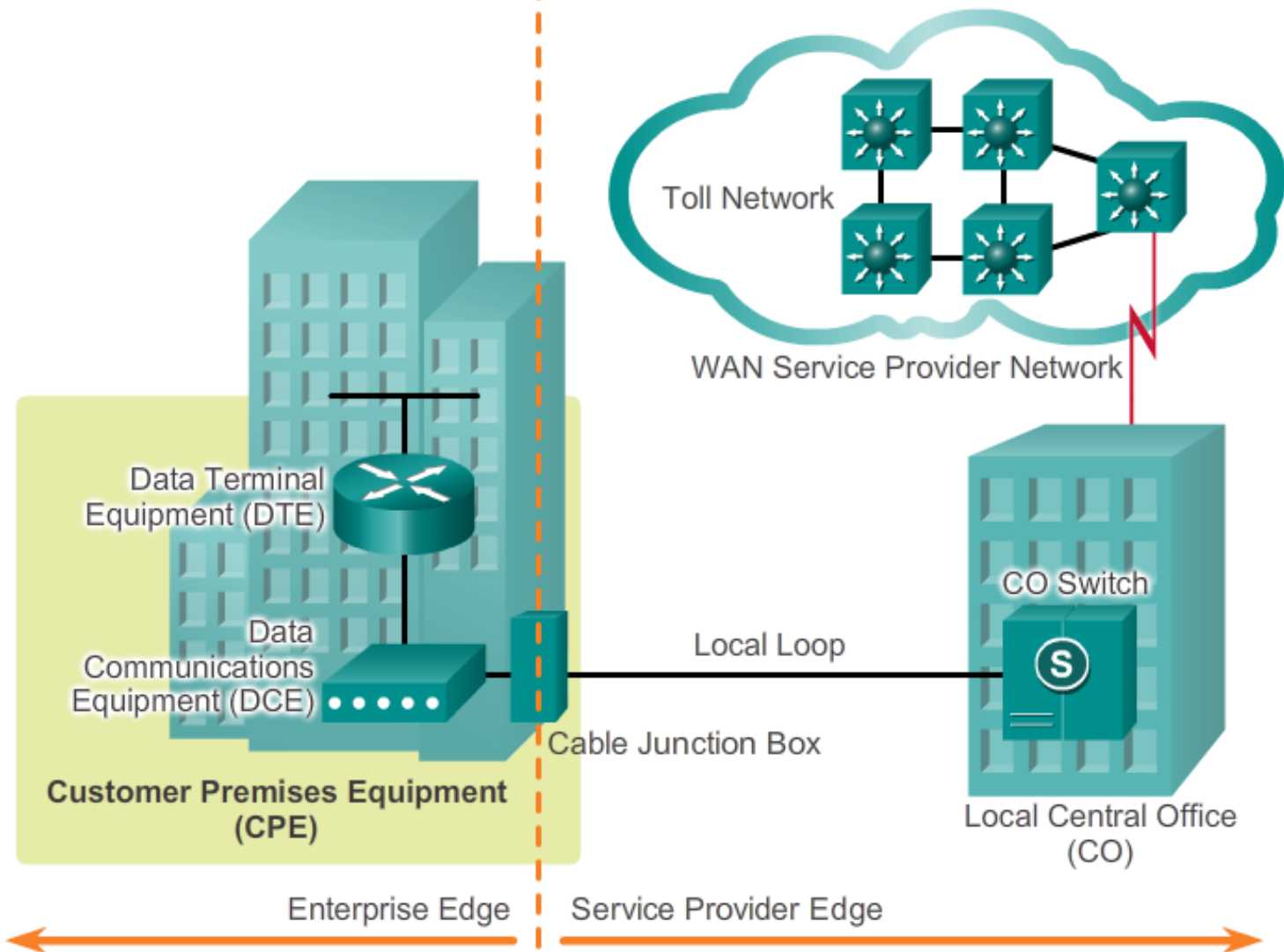
Electrical, Mechanical, and Operational Connections



WAN Terminology

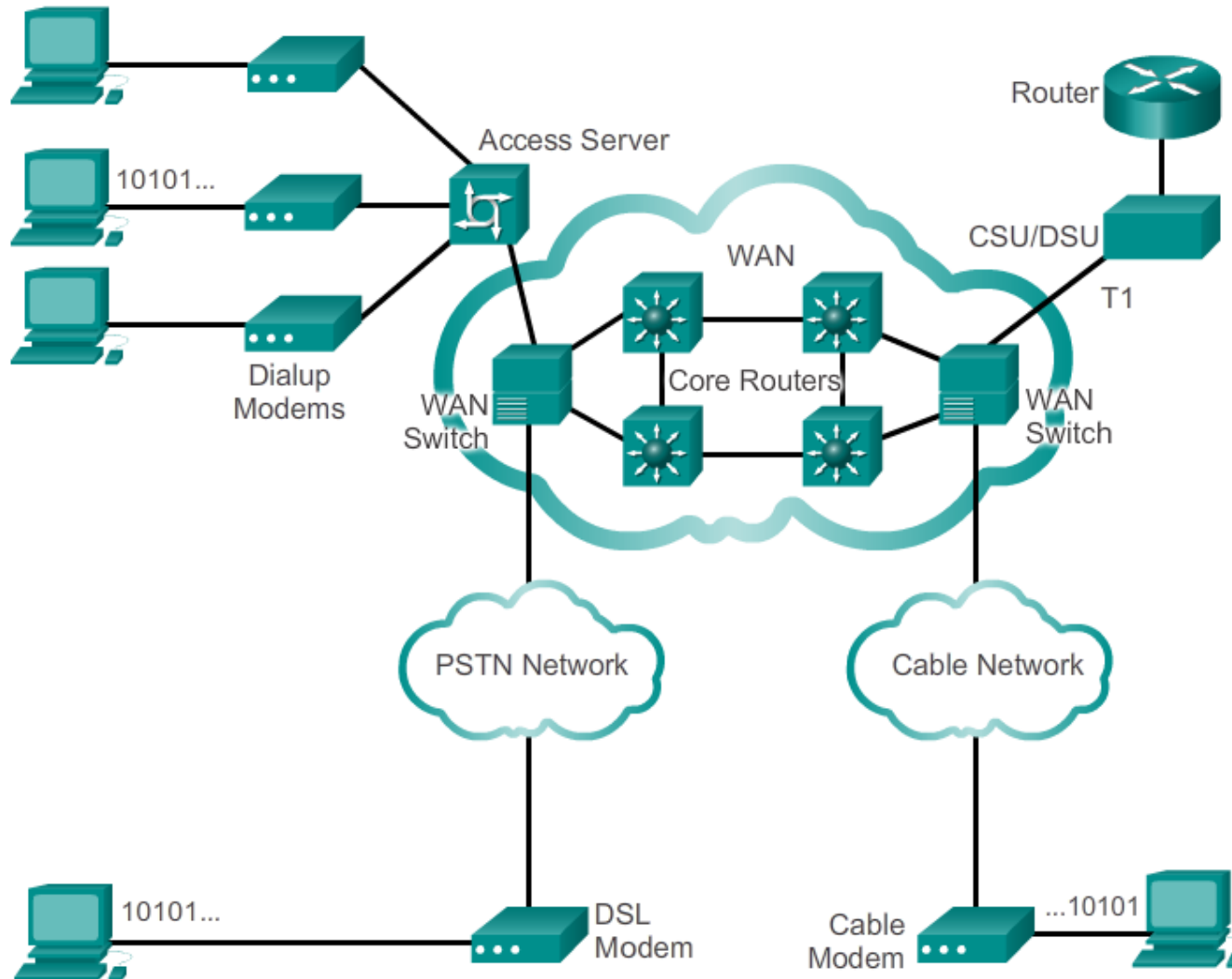
Company (Subscriber)

WAN Service Provider





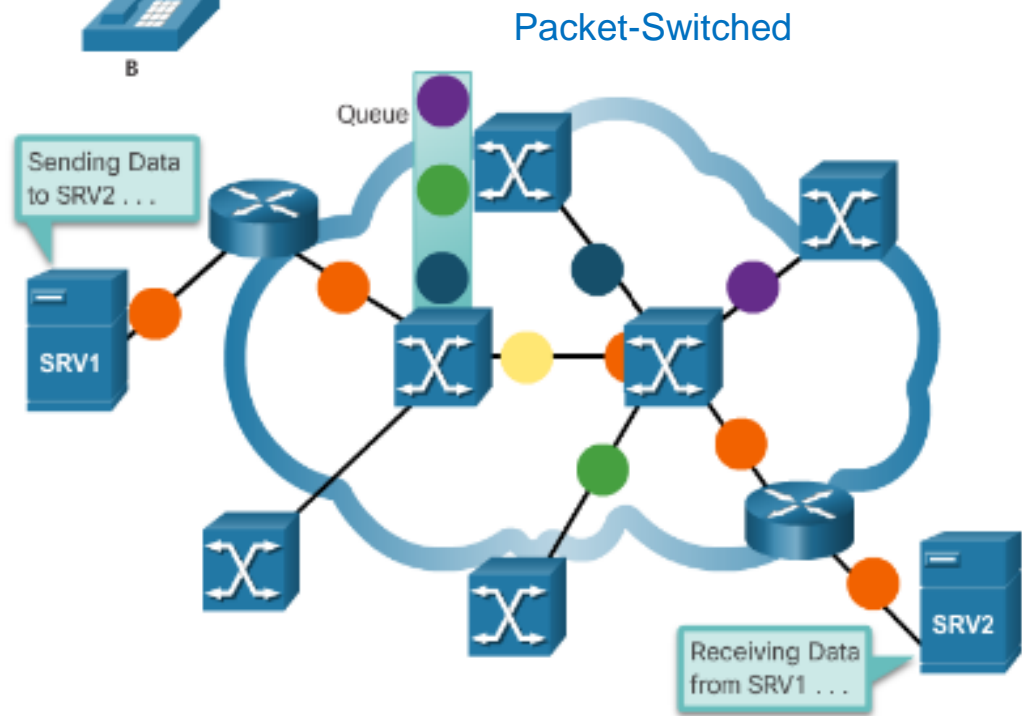
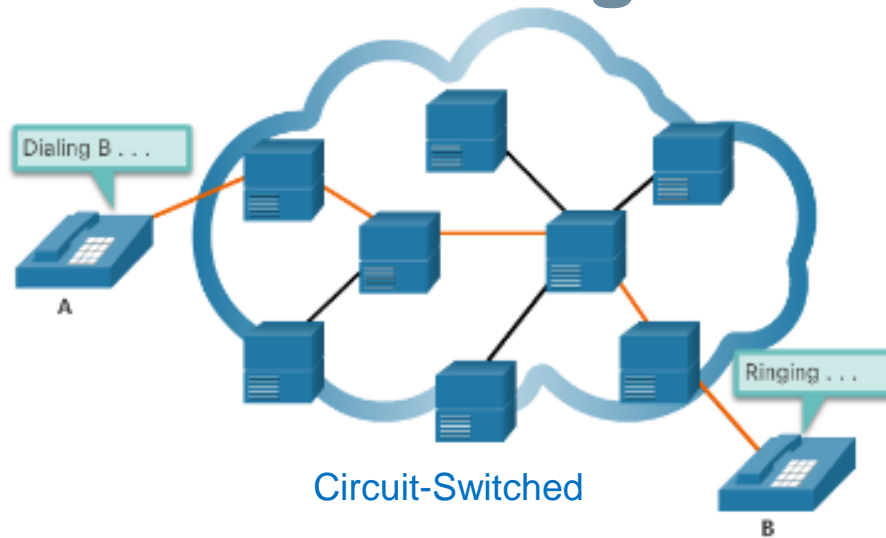
WAN Devices



- Dialup modem
- Access server
- Broadband modem
- CSU/DSU (Channel Service Unit / Data Service Unit)
- WAN switch
- Router
- Core router / Multilayer switch



Circuit Switching and Packet Switching



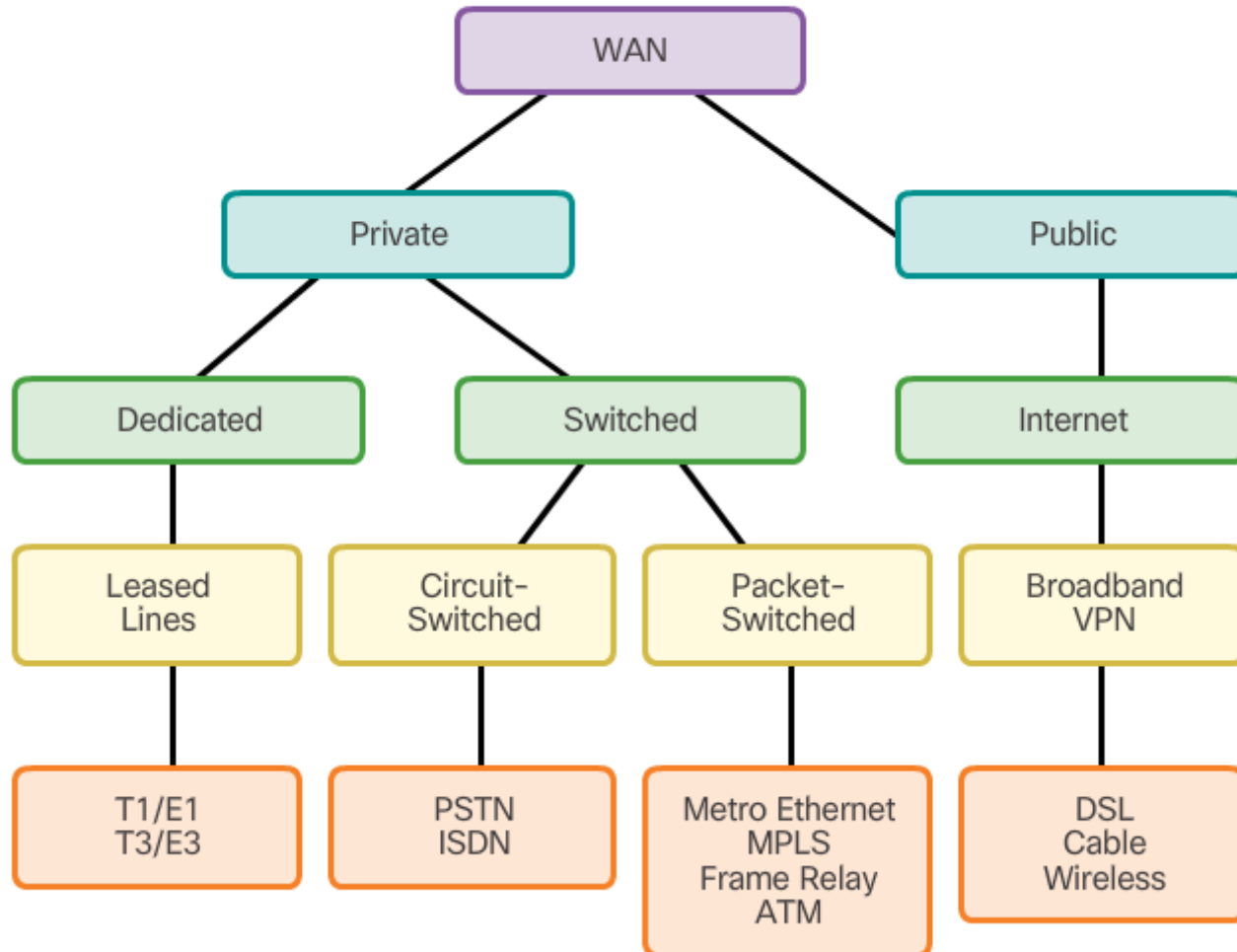
1.2 Selecting a WAN Technology





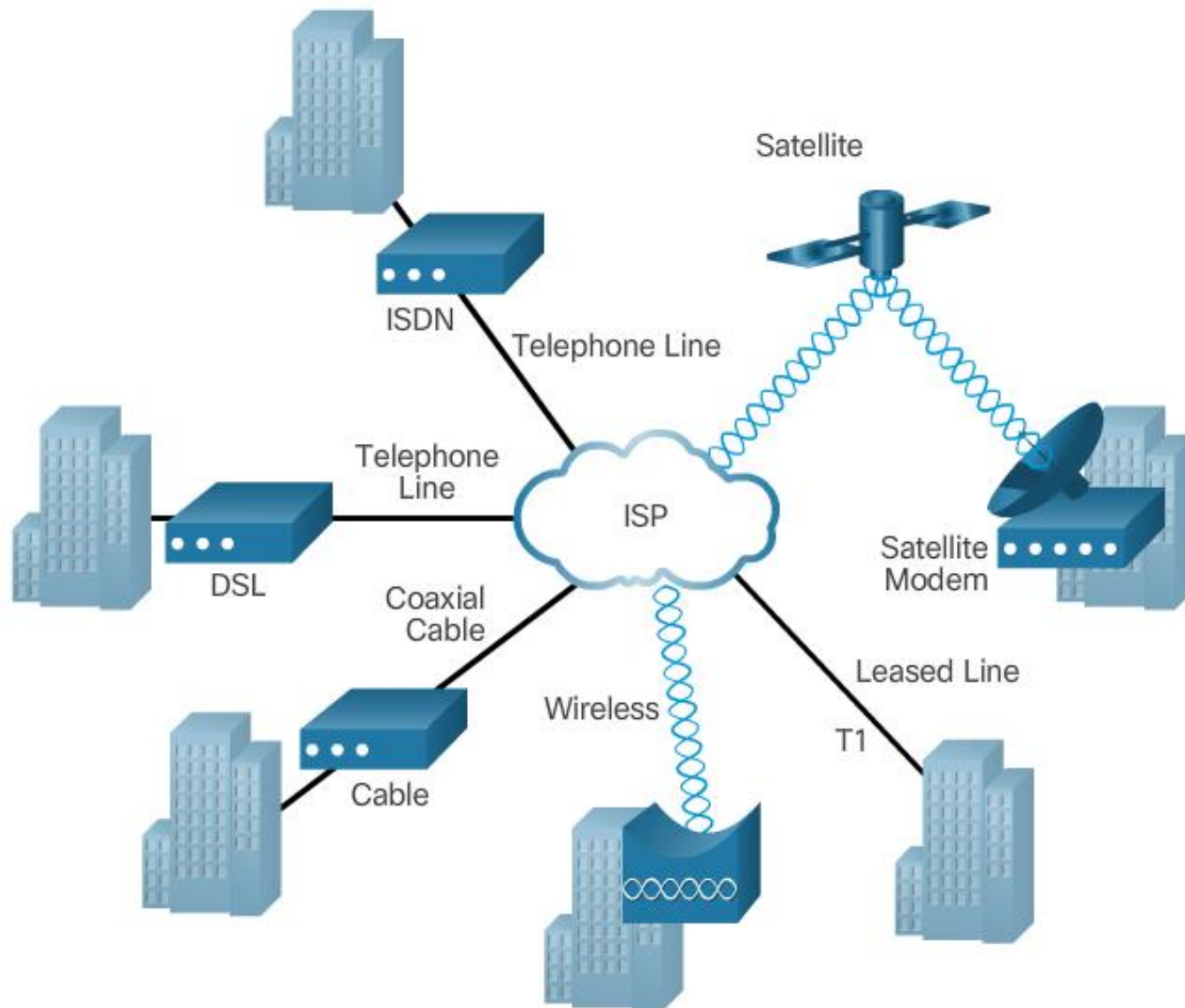
WAN Link Connection Options

WAN Access Options





ISP Network Infrastructure





WAN Infrastructures: Leased Lines

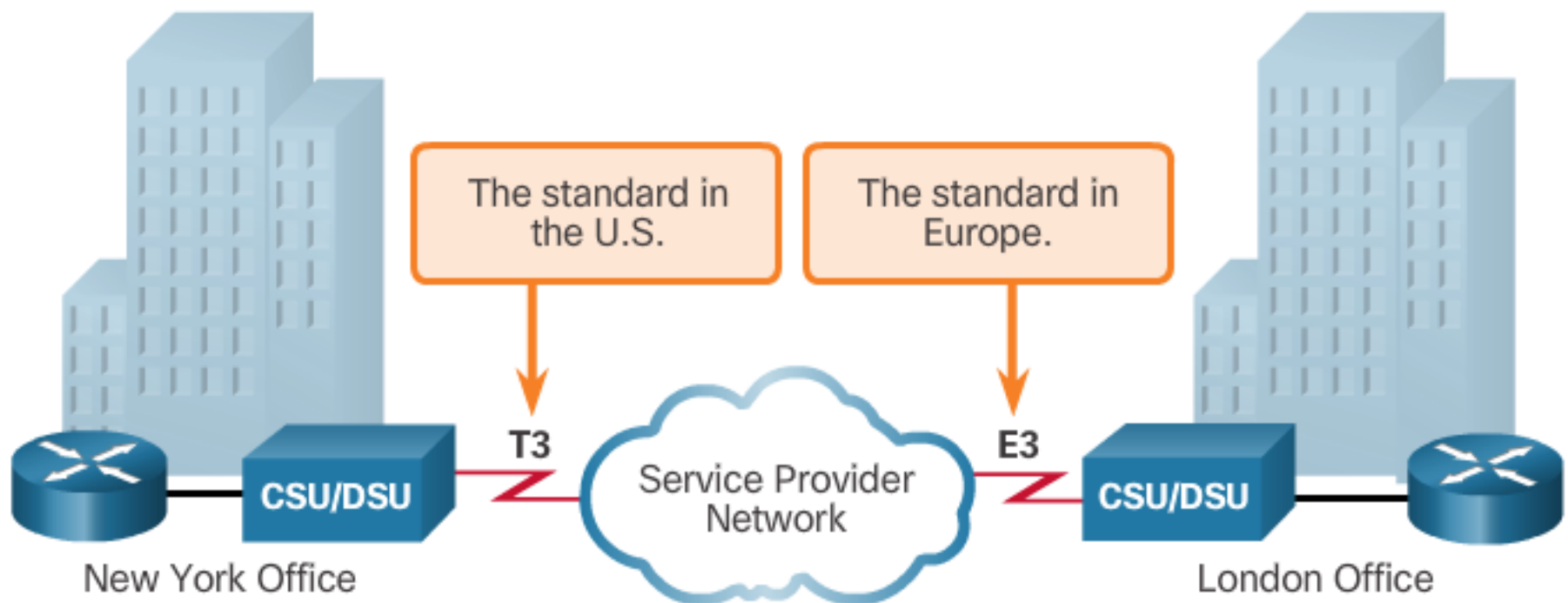
Advantages:

- Simplicity
- Quality
- Availability

Disadvantages:

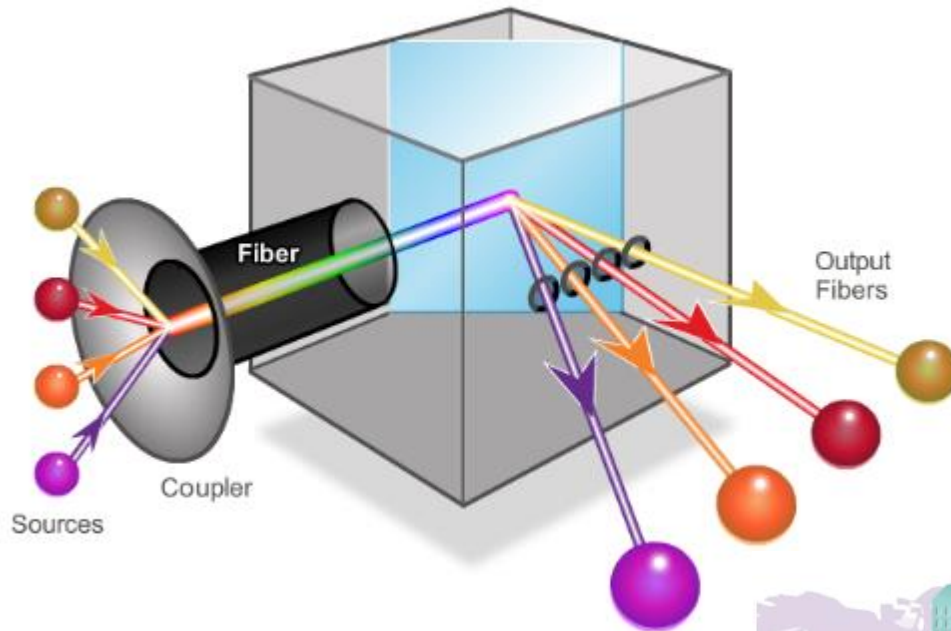
- Cost
- Limited flexibility

T1	1,544 Mb/s
E1	2,048 Mb/s
T3	43,7 Mb/s
E3	34,368 Mb/s

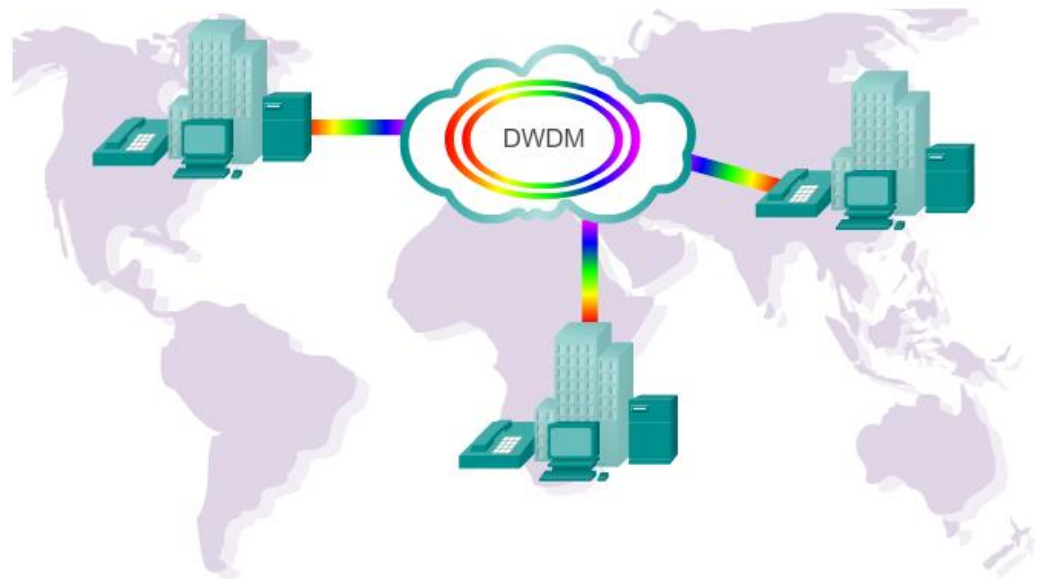




Dense Wavelength-division multiplexing (DWDM)

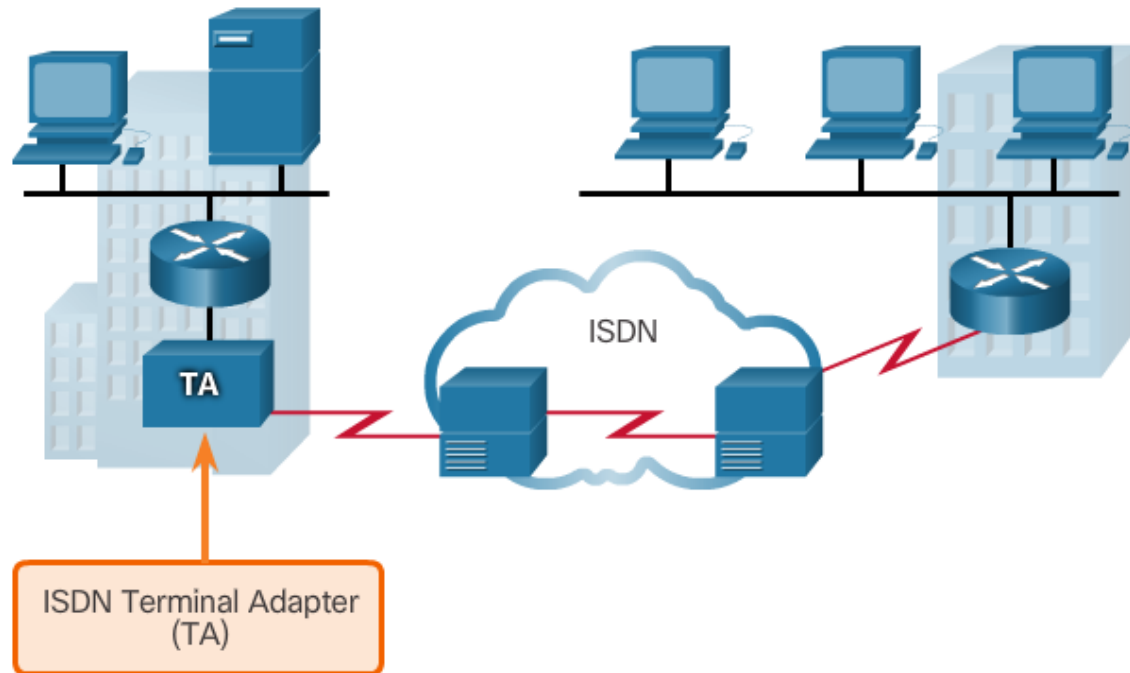


- Bidirectional communication
- Signal transmitted over a specific wavelength (frequency)
- 10 Gbps per channel
- 80 channels per a single fiber
- SONET/SDH standards





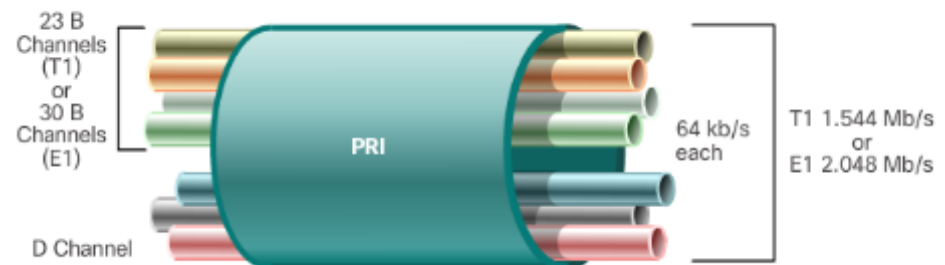
Integrated Services Digital Networks (ISDN)



ISDN BRI

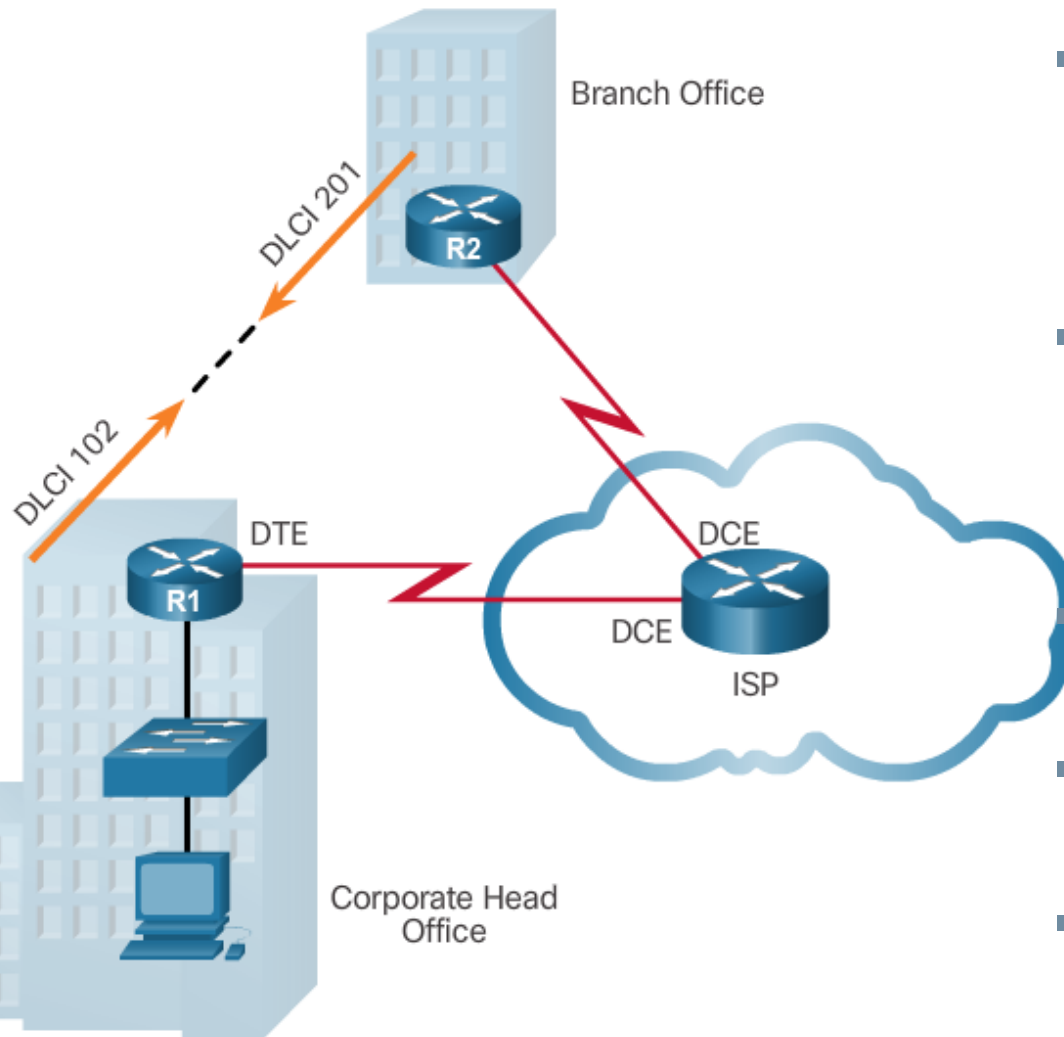


ISDN PRI





Frame Relay

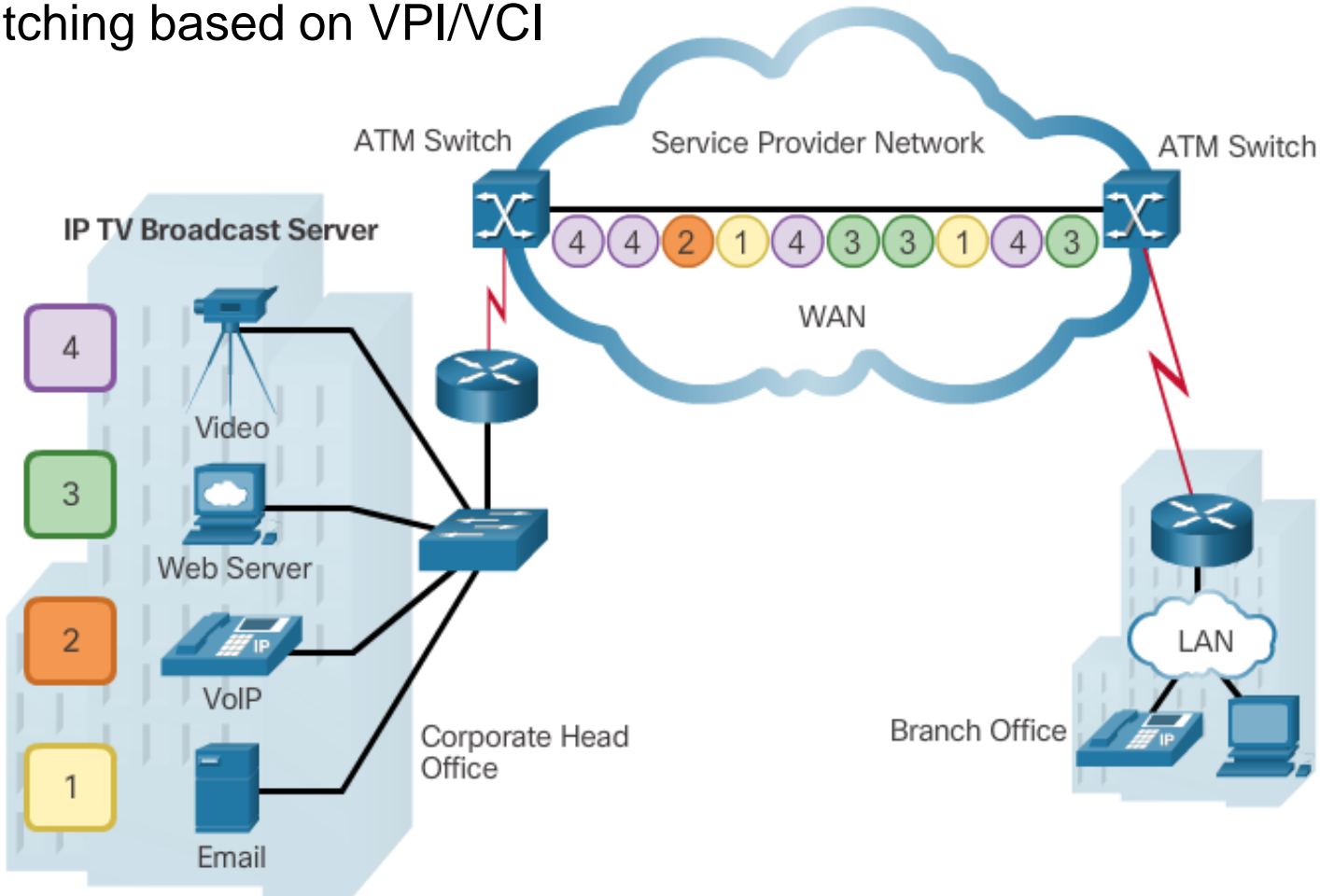


- Packet-switching technology
 - NBMA connection
 - Up to 4 Mb/s
- Architecture
 - Edge routers, Access links
 - FR switches
- Permanent Virtual Channels (PVC)
 - PVCs identified by a data-link connection identifier (DLCI).
 - PVCs and DLCIs ensure bidirectional communication from one DTE device to another.



Asynchronous Transfer Mode (ATM)

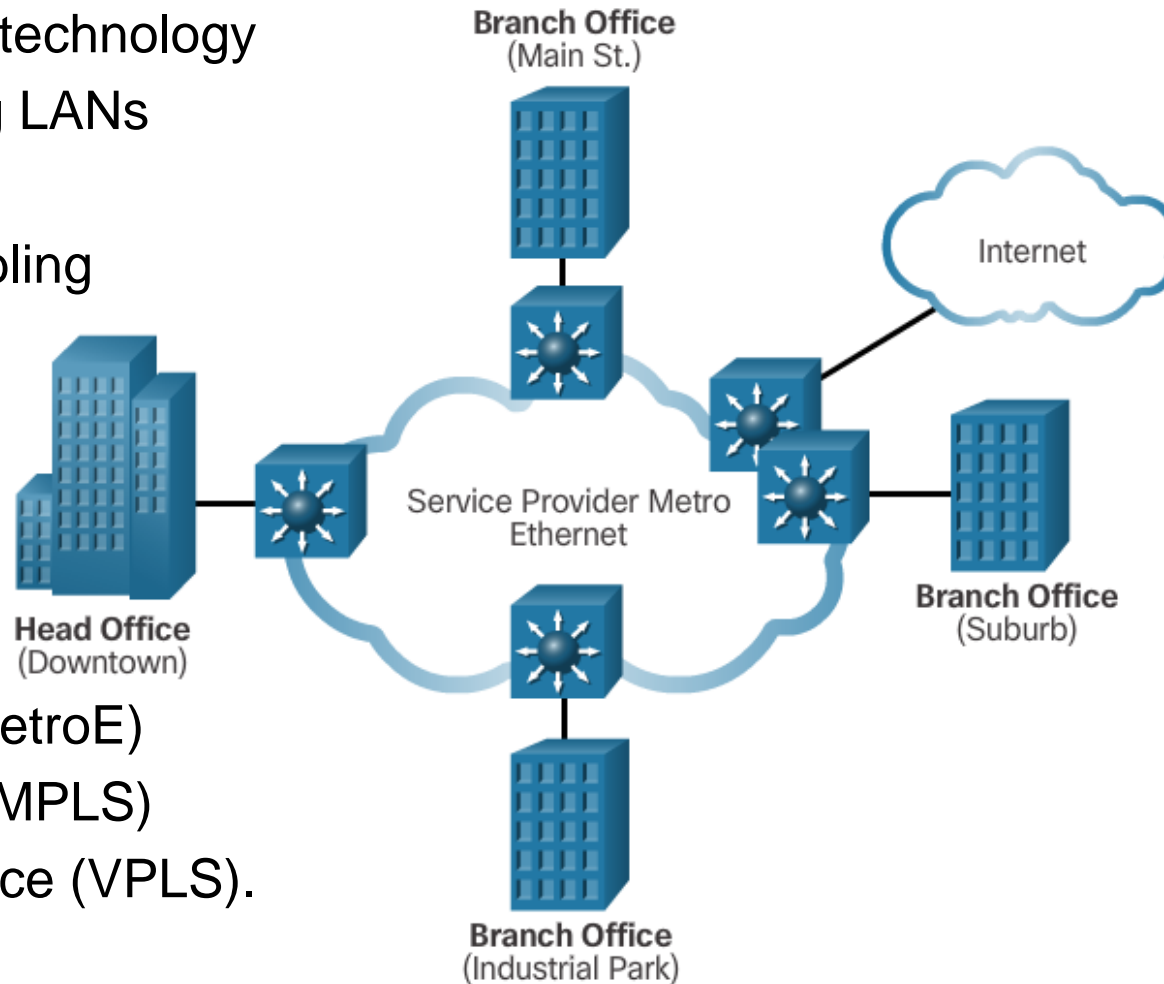
- Cell-based architecture: cells of a fixed length of 53 bytes (5 + 48)
- Up to 622 Mb/s (OC-12)
- Virtual paths (VP) and Virtual channels (VC)
- Switching based on VPI/VCI





Ethernet WAN

- Switched high-bandwidth L2 technology
- Easy integration with existing LANs
- Ethernet using fiber-optic cabling
 - 1000 Base-LX (5 km)
 - 1000 Base-ZX (70 km)
- Ethernet WAN service:
 - Metropolitan Ethernet (MetroE)
 - Ethernet over MPLS (EoMPLS)
 - Virtual Private LAN Service (VPLS).

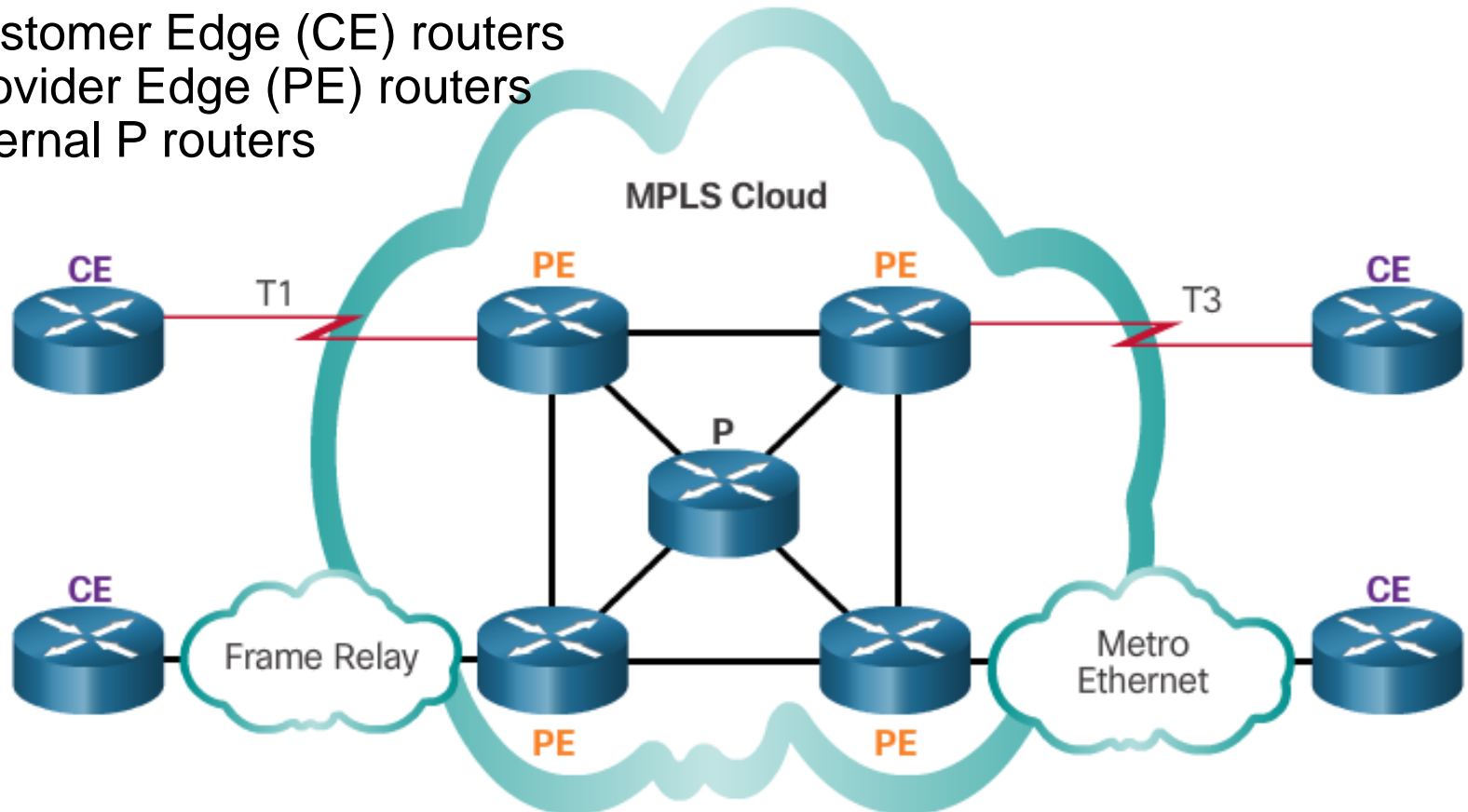


Note: Commonly used to replace the traditional Frame Relay and ATM WAN links.



Multiprotocol Label Switching (MLPS)

- L2 technology that directs packets based on MPLS labels
 - Labels identify paths rather than end-points
- Encapsulates IPv4/IPv6, Ethernet, ATM, DLS, Frame Relay traffic
- Used to build MPLS-VPN networks on a ISP site
- Architecture:
 - Customer Edge (CE) routers
 - Provider Edge (PE) routers
 - Internal P routers



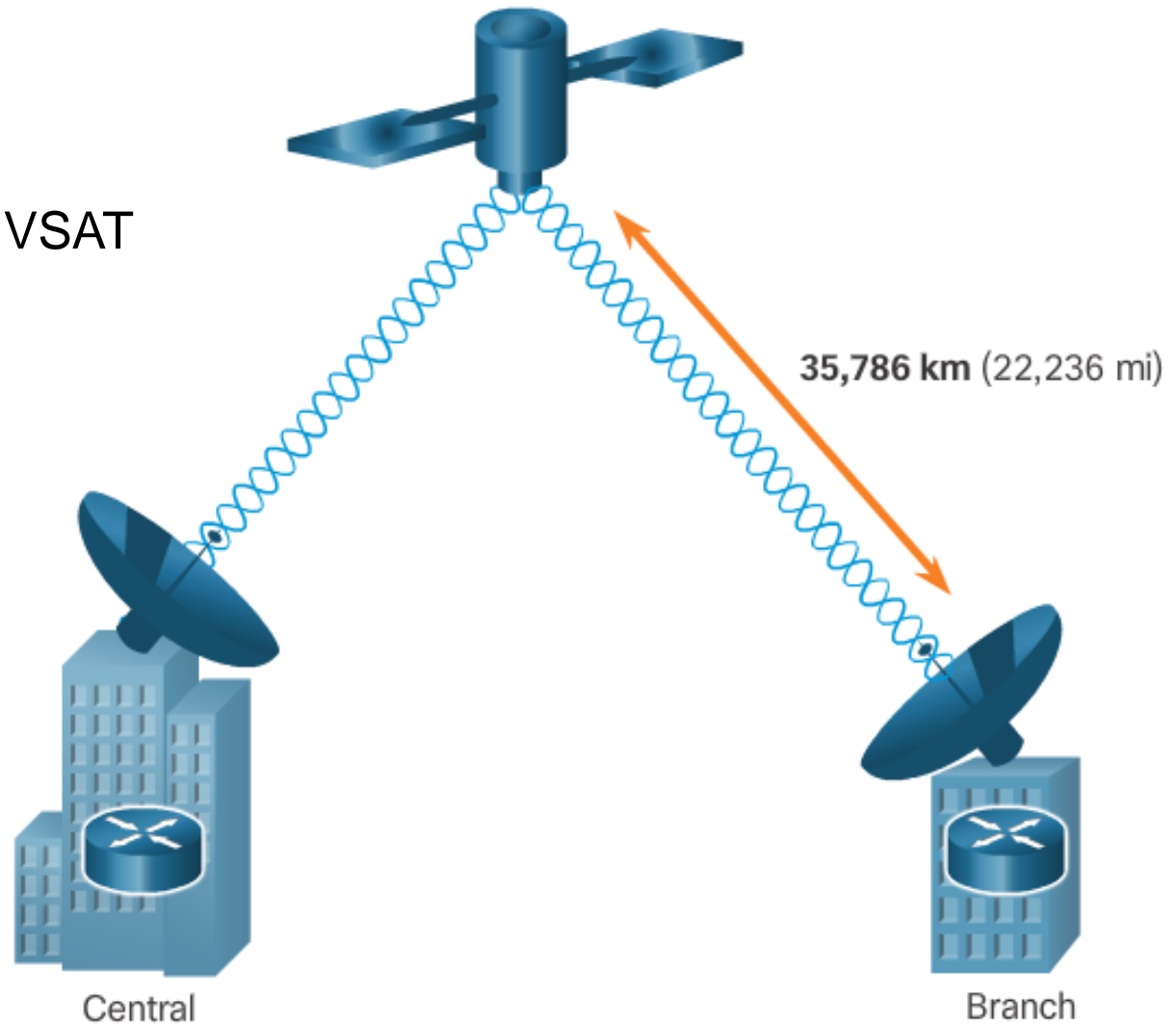


Very Small Aperture Terminal (VSAT)

Private WAN using satellite communications.

Architecture

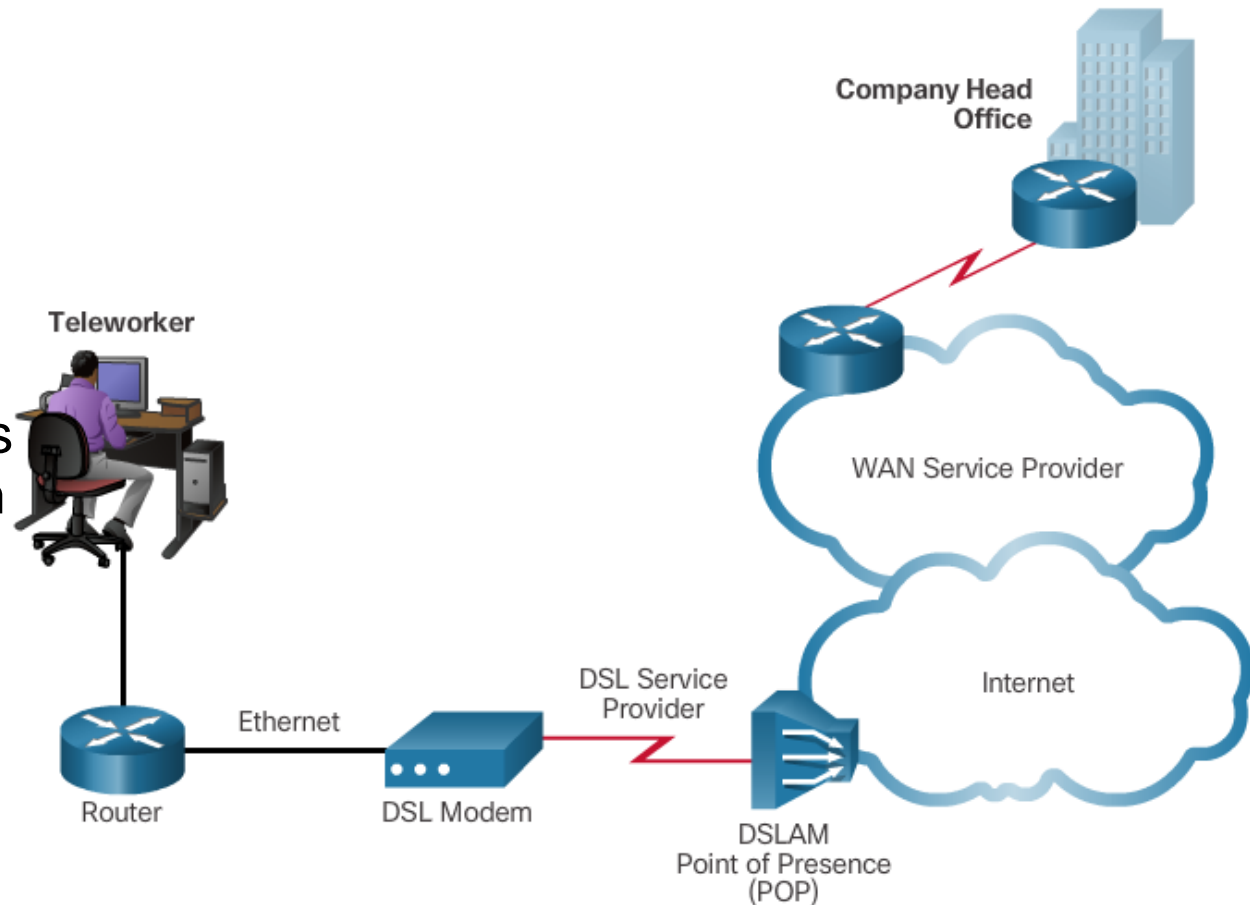
- VSAT satellite dish
- Router connected to a VSAT
- ISP's satellite





Digital Subscriber Line (DSL)

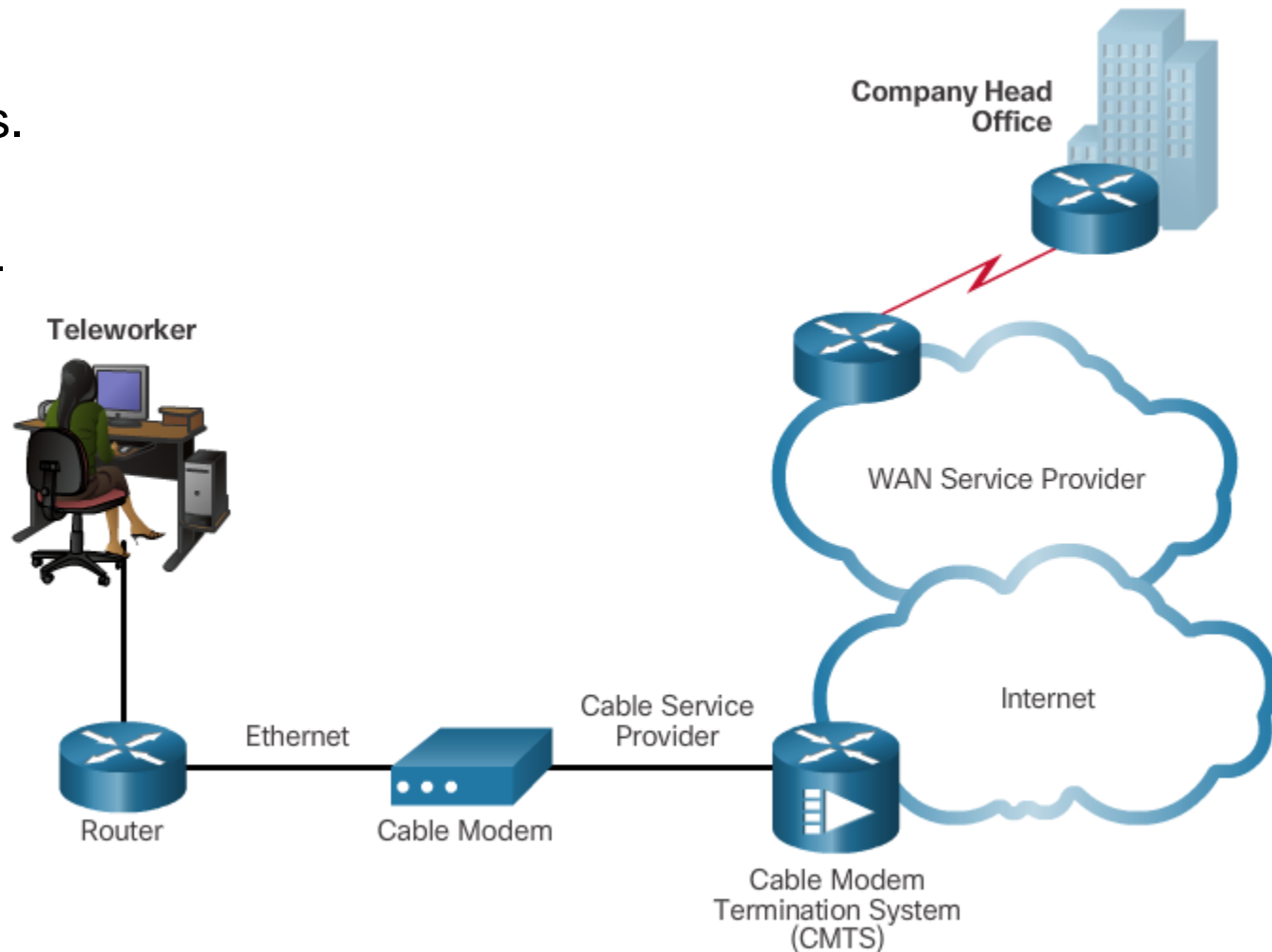
- Always-on connection technology that uses existing twisted-pair telephone lines to transport high-bandwidth data, and provides IP services to subscribers.
- A DSL modem converts an Ethernet signal from the user device to a DSL signal, which is transmitted to the central office.





Cable Modem

- Network access is available from some cable television networks.
- Cable modems provide an always-on connection and a simple installation.



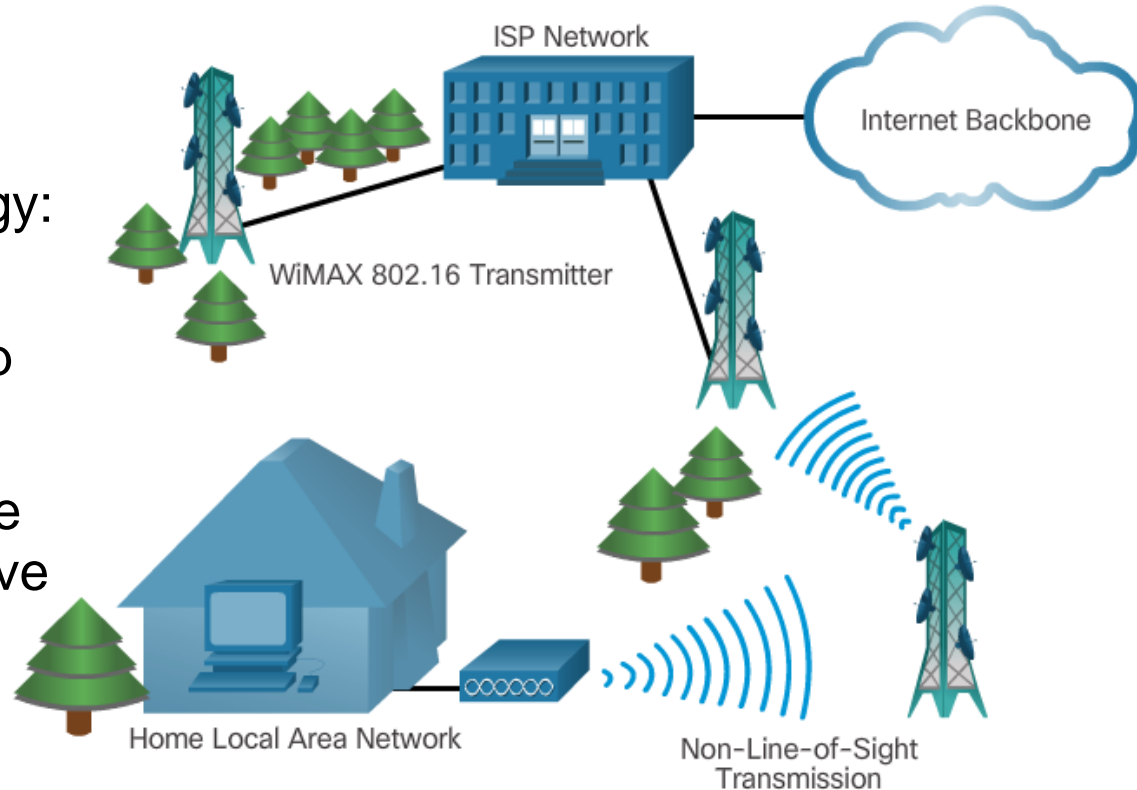


Wireless Connection

Wireless

New developments in broadband wireless technology:

- **Municipal Wi-Fi** – Many cities have begun setting up municipal wireless
- **802.16 WiMAX** – Worldwide Interoperability for Microwave Access (WiMAX) is a new technology that is just beginning to come into use.
- **Satellite Internet** - Typically used by rural users where cable and DSL are not available.

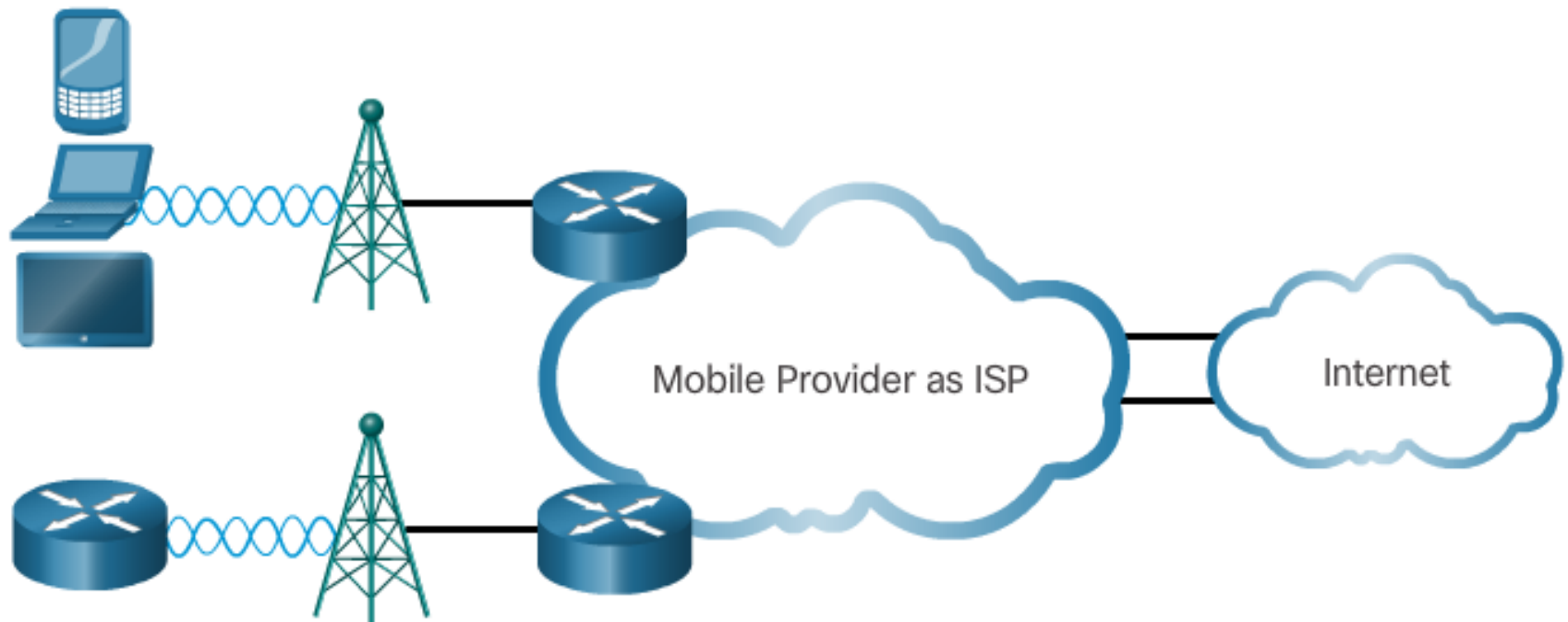




3G/4G Cellular

Common cellular industry terms include:

- **3G/4G Wireless** – Abbreviation for 3rd generation and 4th generation cellular access. These technologies support wireless Internet access.
- **Long-Term Evolution (LTE)** – A newer and faster technology, considered to be part of the 4th generation (4G) technology.





Virtual Private Networks (VPNs)

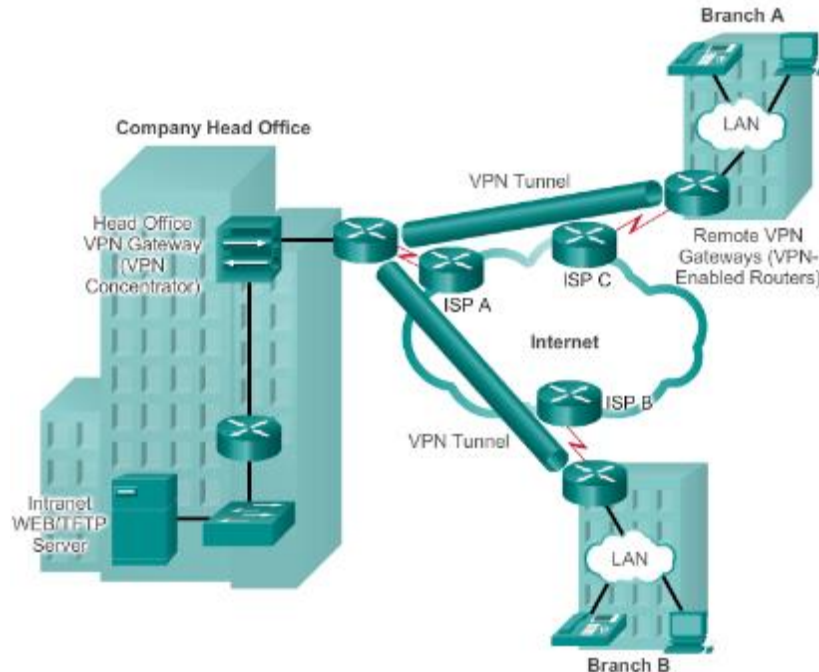
VPN is an encrypted connection btw. private networks over a public network.

- VPN tunnels
- L2,L3,L7 technologies
- Over public infrastructure

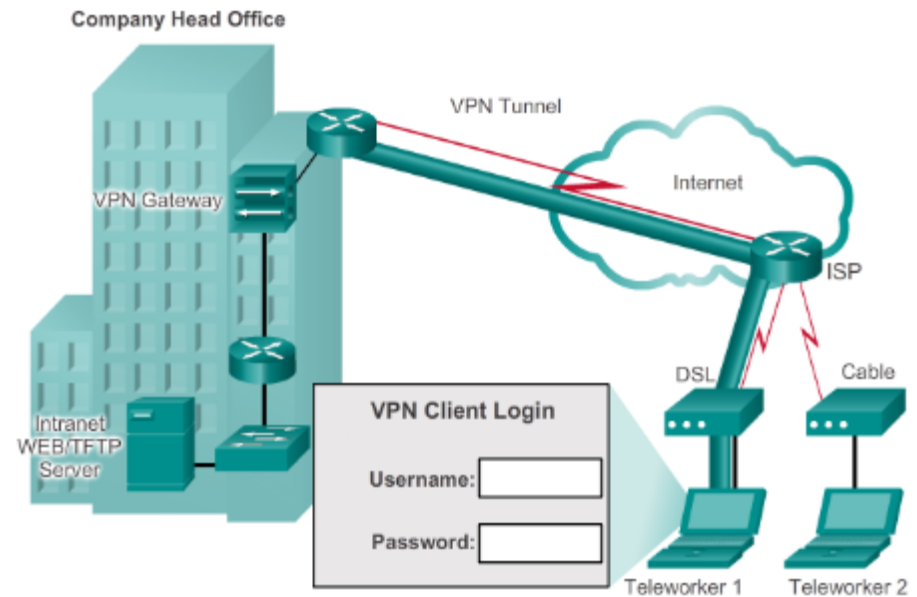
Two types of VPN:

- Site-to-site VPNs
- Remote-access VPNs

Sample Site-to-Site VPN Topology



Sample Remote-Access VPN Topology





Choosing a WAN Link Connection

Answer the following questions when choosing a WAN Connection:

- What is the purpose of the WAN?
- What is the geographic scope?
- What are the traffic requirements?



- Should the WAN use a private or public infrastructure?
- For a private WAN, should it be dedicated or switched?
- For a public WAN, what type of VPN access is required?
- Which connection options are available locally?
- What is the cost of the available connection options?

