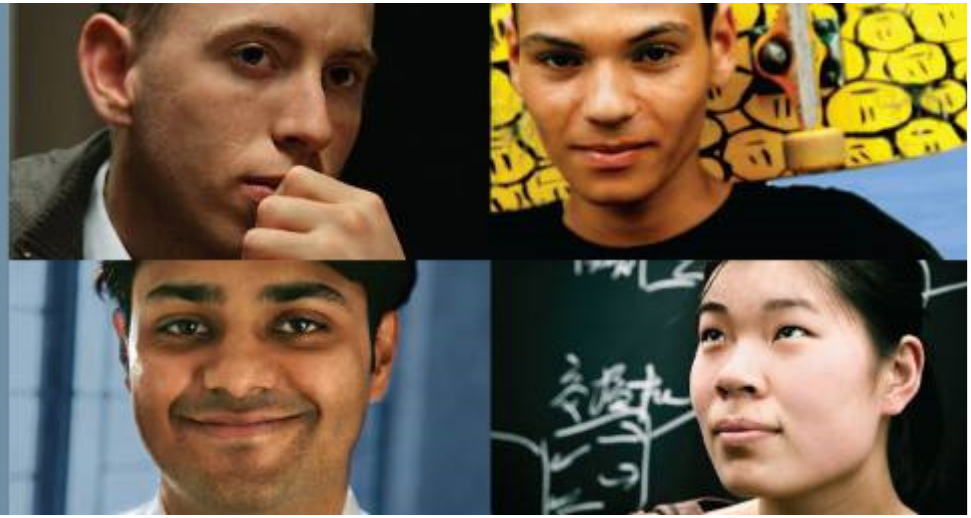
Chapter 2: Connecting to the WAN



Connecting Networks

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Chapter 2

2.0 Introduction

2.1 WAN Technologies Overview

2.2 Selecting a WAN Technology

2.3 Summary

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Chapter 2: Objectives

- Describe the purpose of a WAN.
- Describe WAN operations.
- Describe WAN services available.
- Compare various private WAN technologies.
- Compare various public WAN technologies.
- Select the appropriate WAN protocol and service for a specific network requirement.

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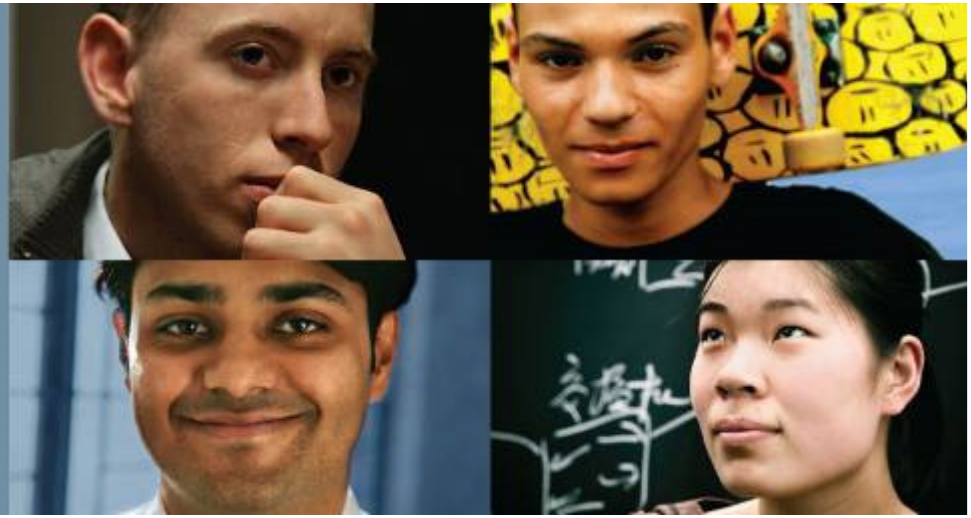
2.1 WAN Technologies Overview



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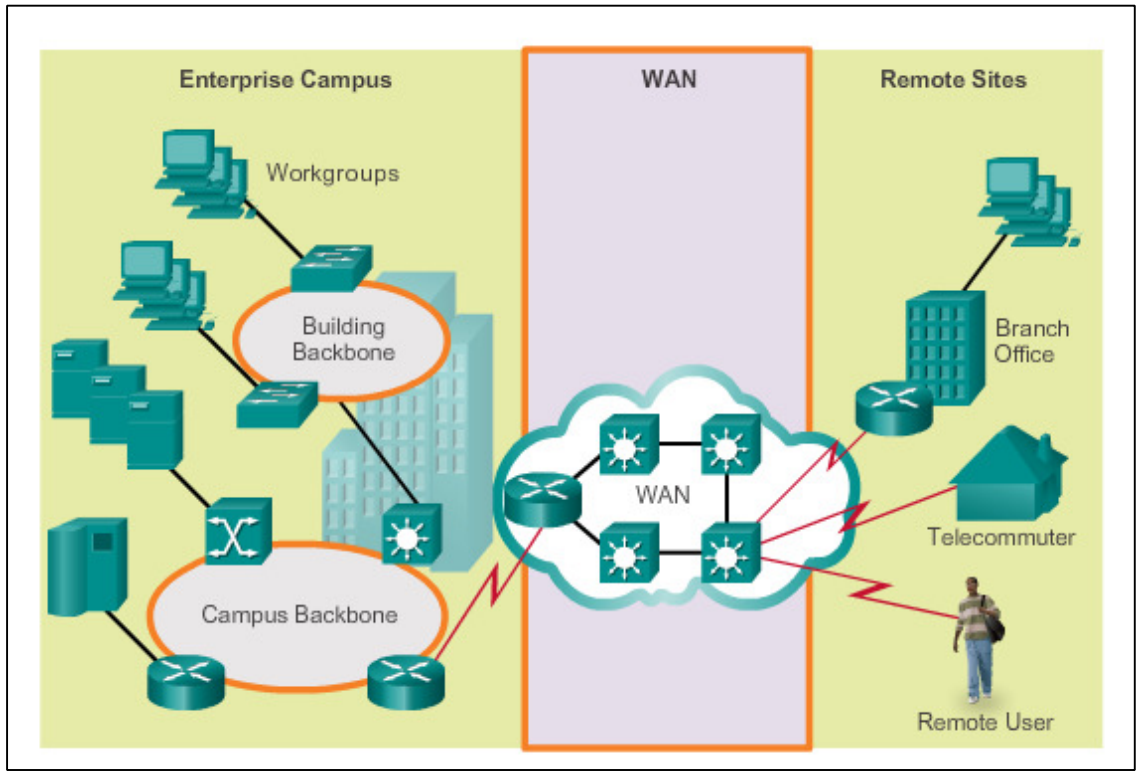
Why Choose a WAN?

- Operates beyond the geographic scope of a LAN
- Used to interconnect the enterprise LAN to remote LANs in branch sites and telecommuter sites
- Owned by a service provider
- Organization must pay a fee to use the provider's services to connect sites



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Are WANs Necessary?

Businesses require communication among geographically separated sites. Examples include:

- Regional or branch offices must be able to communicate and share data.
- Organizations must share information with other customer organizations.
- Mobile workers must access information that resides on corporate networks.

Home computer users must send and receive data across increasingly larger distances. Examples include:

- Consumers communicate over the Internet with banks, stores, and a variety of providers of goods and services.
- Students do research by accessing library indexes and publications located in other parts of the country and in other parts of the world.

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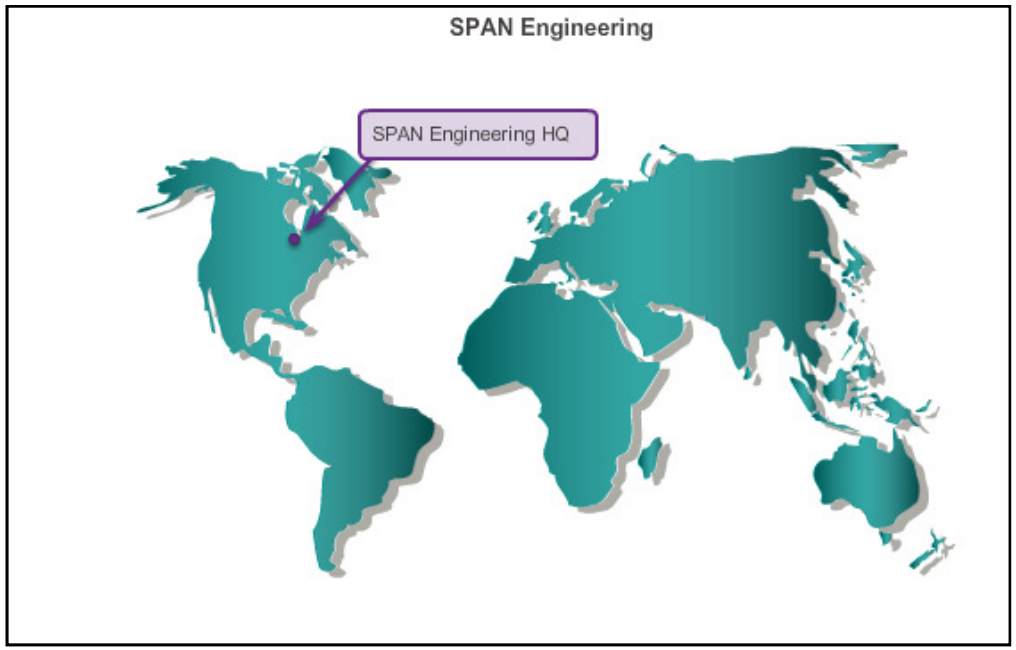
Evolving Networks

- Companies expect their networks to perform optimally and to be able to deliver an ever increasing array of services and applications to support productivity and profitability.
- SPAN Engineering – example used in the curriculum



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Small Office

SPAN Engineering – Environmental Consulting Firm

- Been in business for four years, has grown to include 15 employees: six engineers, four computer-aided drawing (CAD) designers, a receptionist, two senior partners, and two office assistants
- Uses a single LAN to share information between computers, and to share peripherals, such as a printer, a large-scale plotter, and fax equipment
- Upgraded LAN to provide inexpensive VoIP service to save on the costs of separate phone lines for their employees
- Connection to the Internet is through a common broadband service called DSL
- Uses support services purchased from the DSL provider
- Uses a hosting service rather than purchasing and operating its own FTP and email servers

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Campus Network

SPAN Engineering – Environmental Consulting Firm

- Five years later has grown rapidly.
- Contracted to design and implement a full-sized waste conversion facility.
- Won other projects in neighboring municipalities and in other parts of the country.
- Hired more staff and leased more office space with several hundred employees, organized itself into functional departments.
- Network now consists of several subnetworks, each devoted to a different department.
- Multiple LANs are joined to create a company-wide network or campus, which spans several floors of the building.

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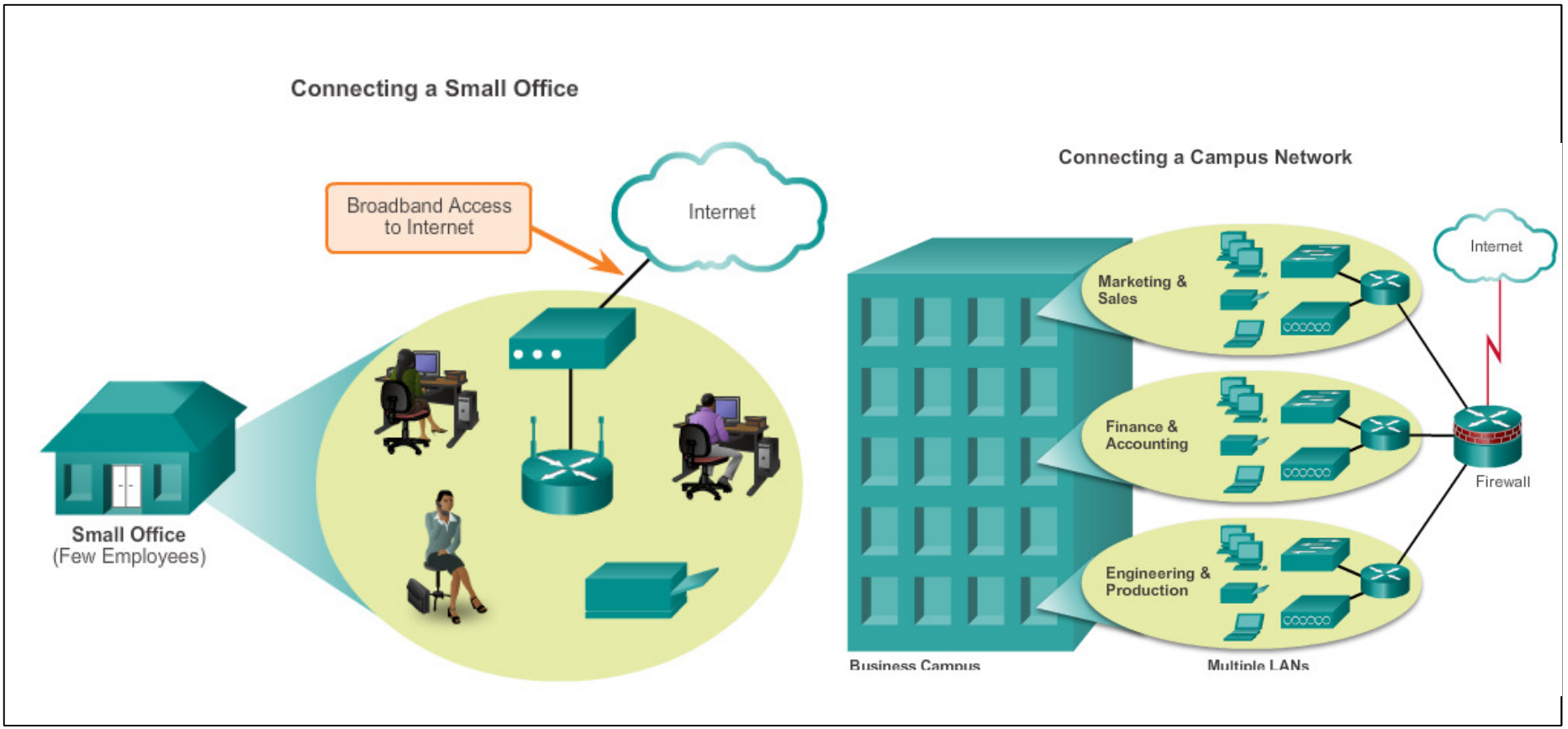
Small Office – Campus Network



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Branch Networks

- Another six years later, SPAN Engineering demand for its services has skyrocketed.
- To manage those projects, the company has opened small branch offices closer to the project sites.
- SPAN Engineering now has a data center, which houses the various databases and servers of the company. They must now implement a WAN.
- For its branch offices that are in nearby cities, the company decides to use private dedicated lines through their local service provider.
- For those offices that are located in other countries, the Internet is an attractive WAN connection option.
- Although connecting offices through the Internet is economical, it introduces security and privacy issues that the IT team must address.

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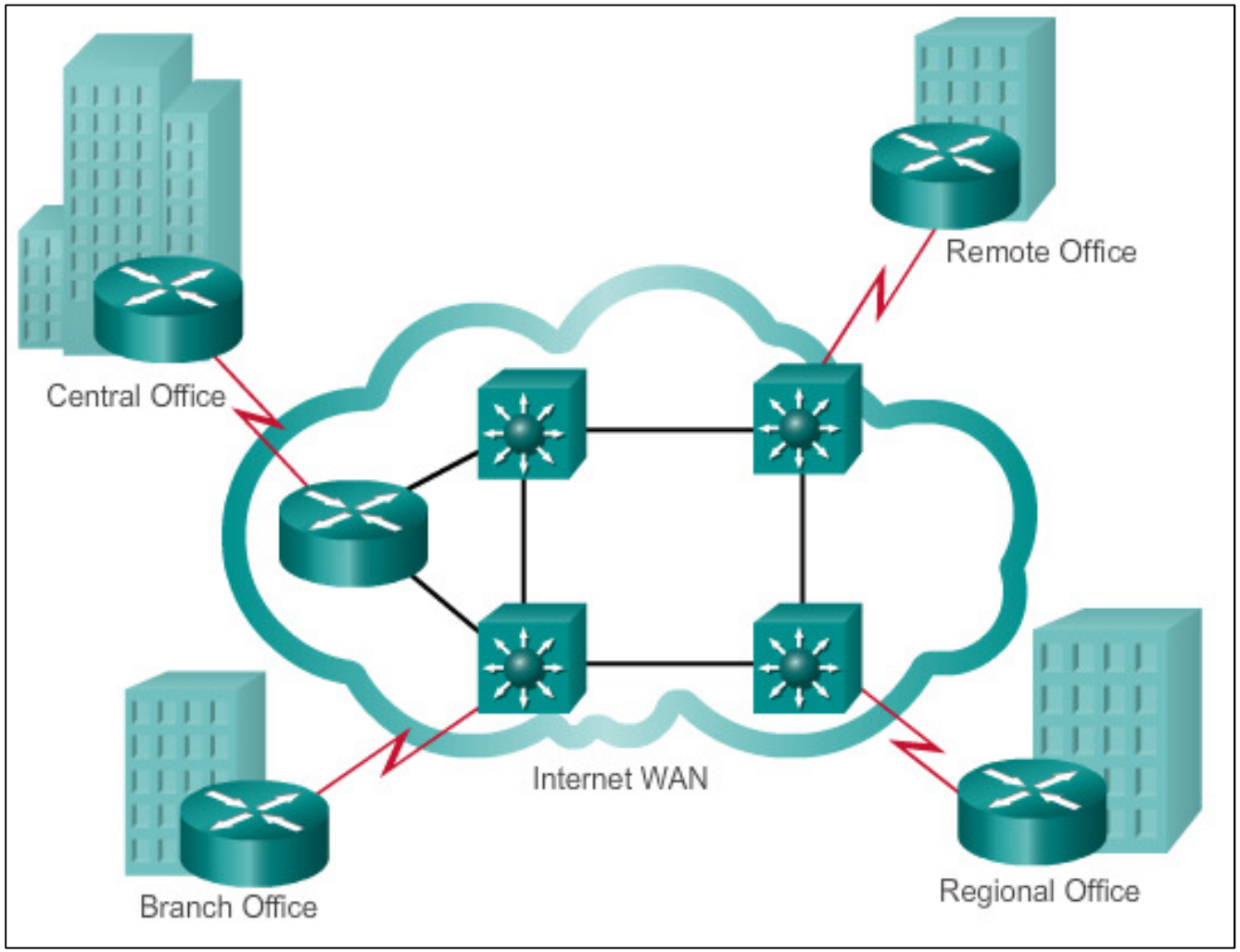
Branch Networks (cont.)



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Distributed Networks

- SPAN Engineering has now been in business for 20 years and has grown to thousands of employees distributed in offices worldwide.
- Cost of the network and its related services is a big expense.
- Looking to provide the best network services at the lowest cost.
- Encouraging teleworking and virtual teams, web-based applications are being used to increase productivity and reduce costs.
- Site-to-site and remote access Virtual Private Networks (VPNs) enable the company to use the Internet to connect easily and securely with employees and facilities around the world.

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Distributed Networks (cont.)

- Network requirements can change dramatically as the company grows.
- Distributing employees saves costs in many ways, but it puts increased demands on the network.
- Network must be able to adapt and grow as the company changes.
- Network designers and administrators meet these challenges by carefully choosing network technologies, protocols, and service providers, and by optimizing their networks.

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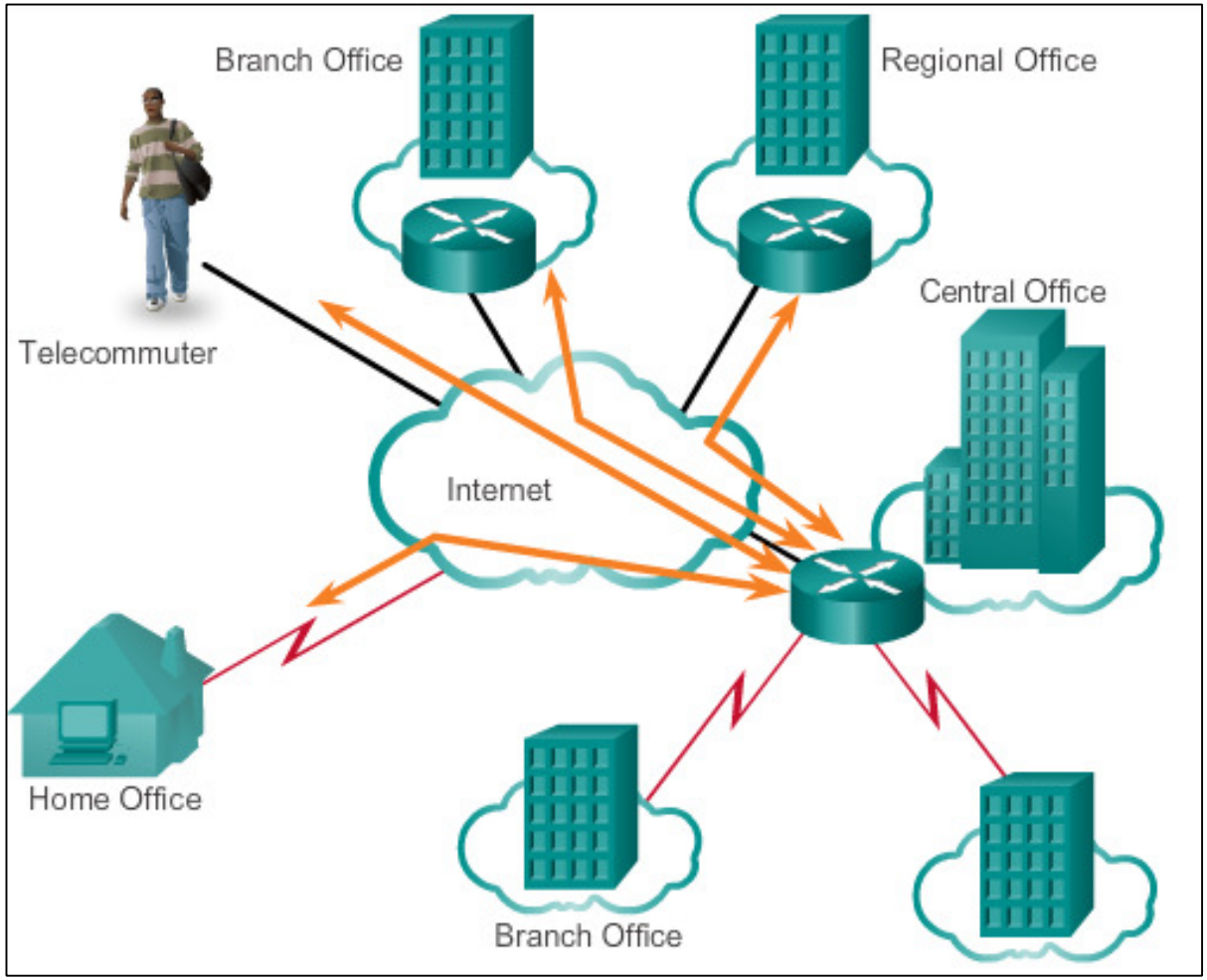
Distributed Networks (cont.)



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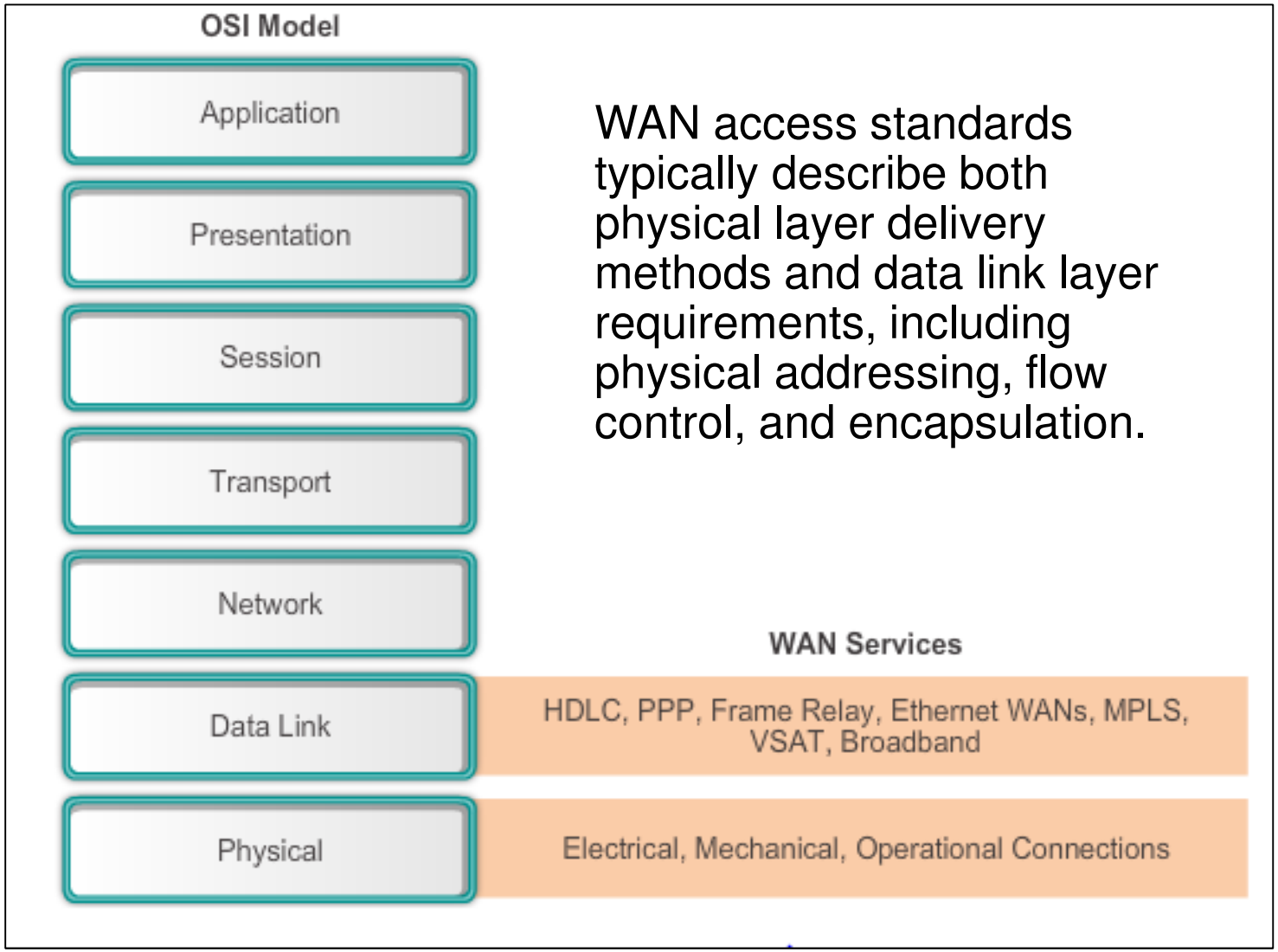
WANs in the OSI Model



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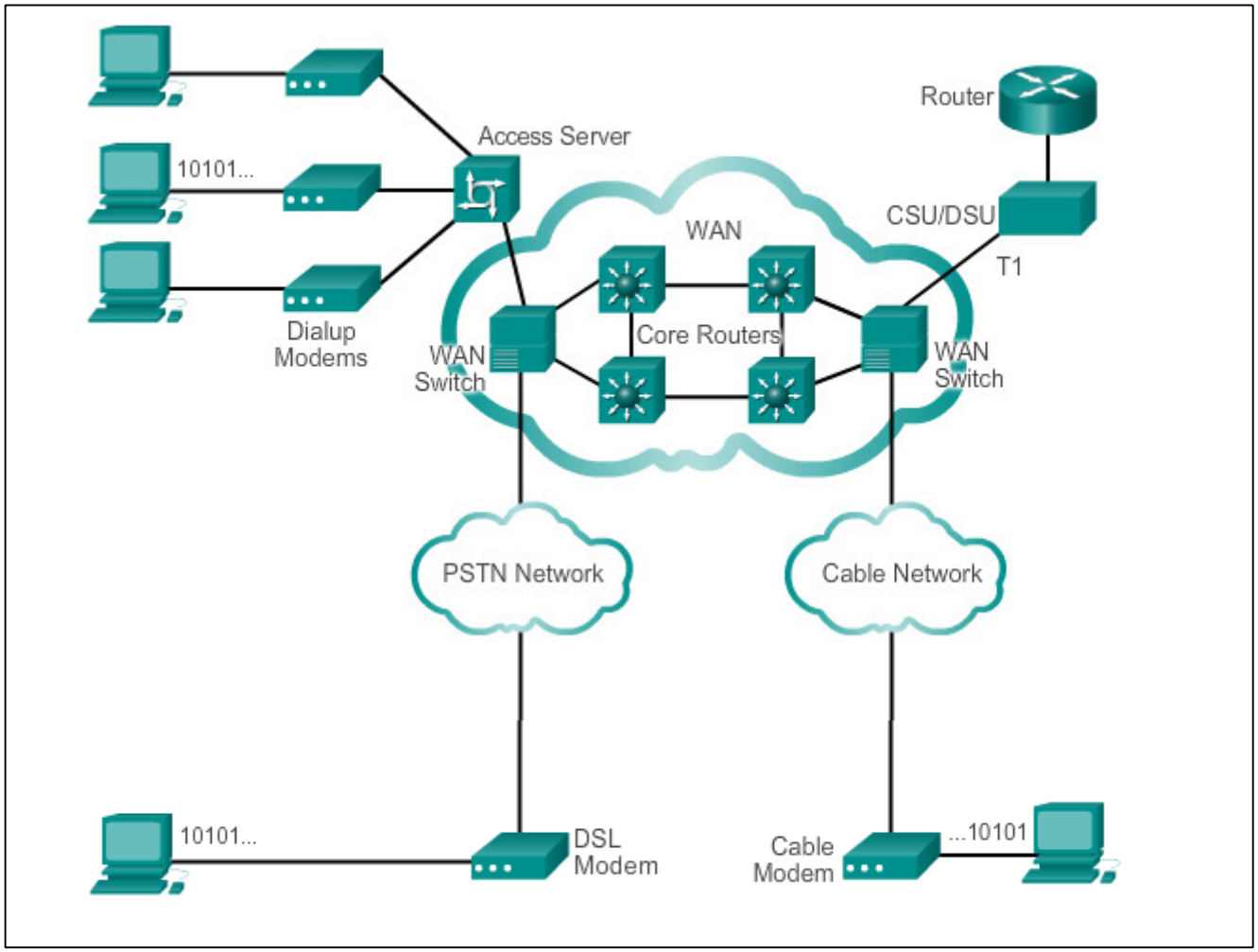
WAN Devices



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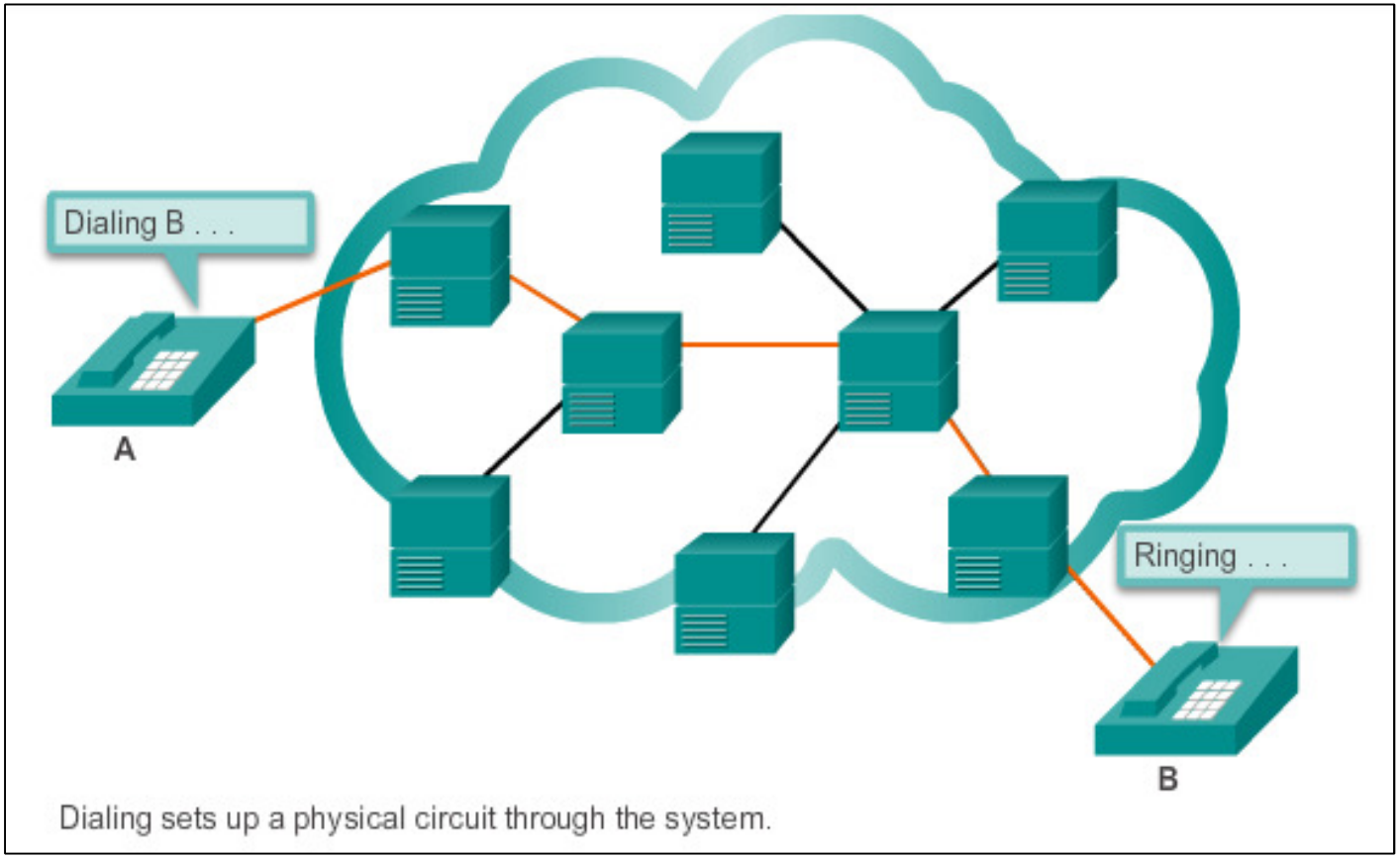
Circuit Switching

The two most common types of circuit-switched WAN technologies are the public switched telephone network (PSTN) and the Integrated Services Digital Network (ISDN).



Dialing sets up a physical circuit through the system.

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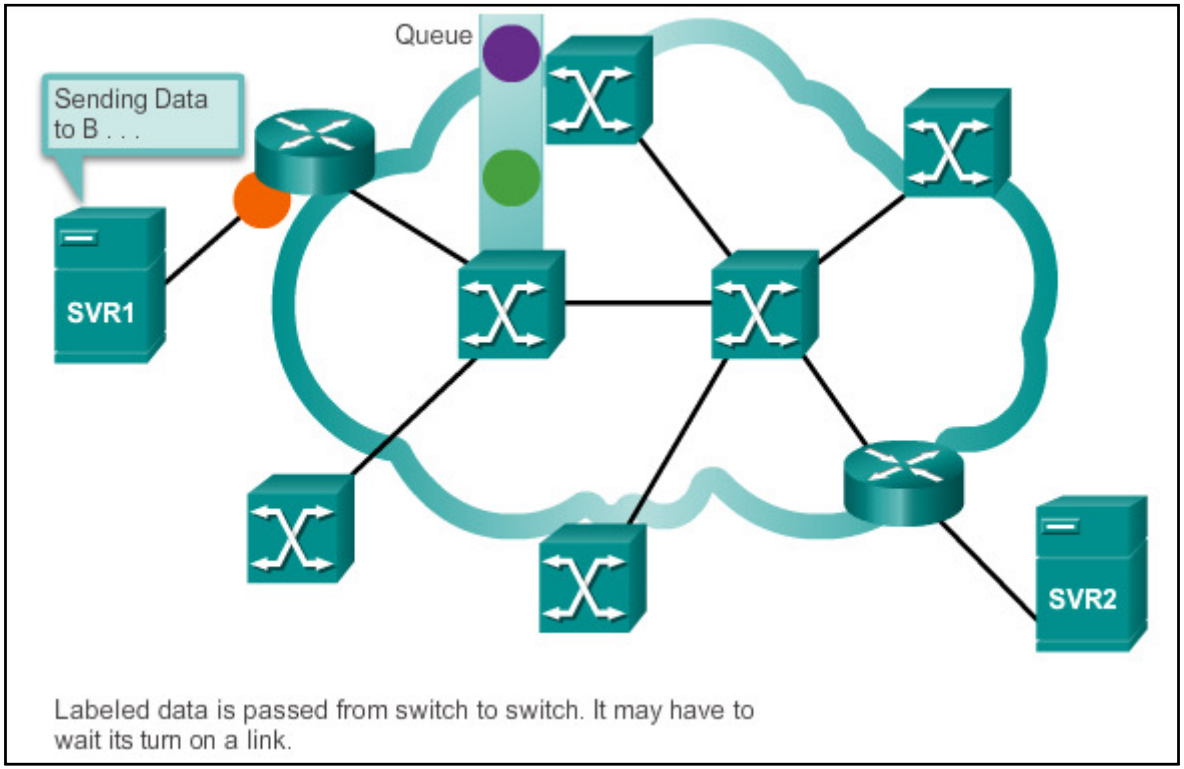
Packet Switching

Splits traffic data into packets that are routed over a shared network. Packet-switching allow many pairs of nodes to communicate over the same channel.



Labeled data is passed from switch to switch. It may have to wait its turn on a link.

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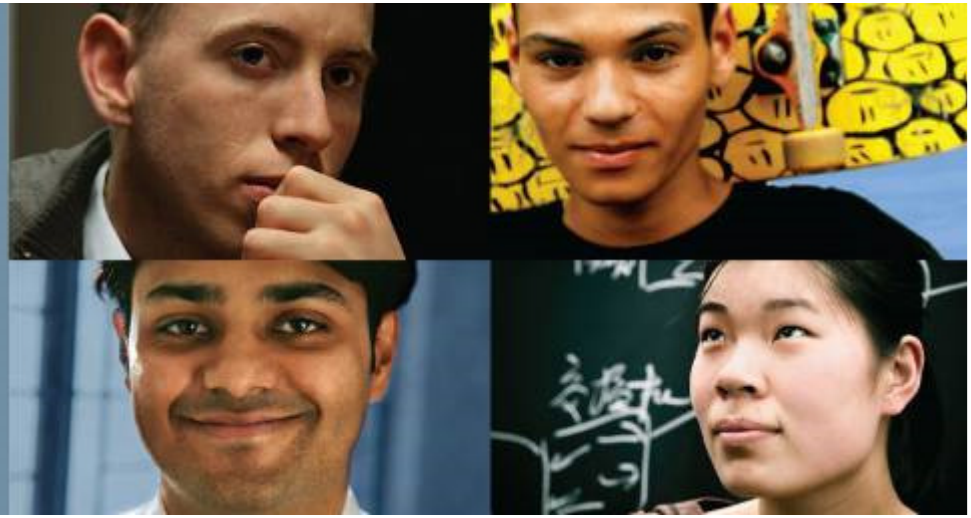
2.2 Selecting a WAN Technology



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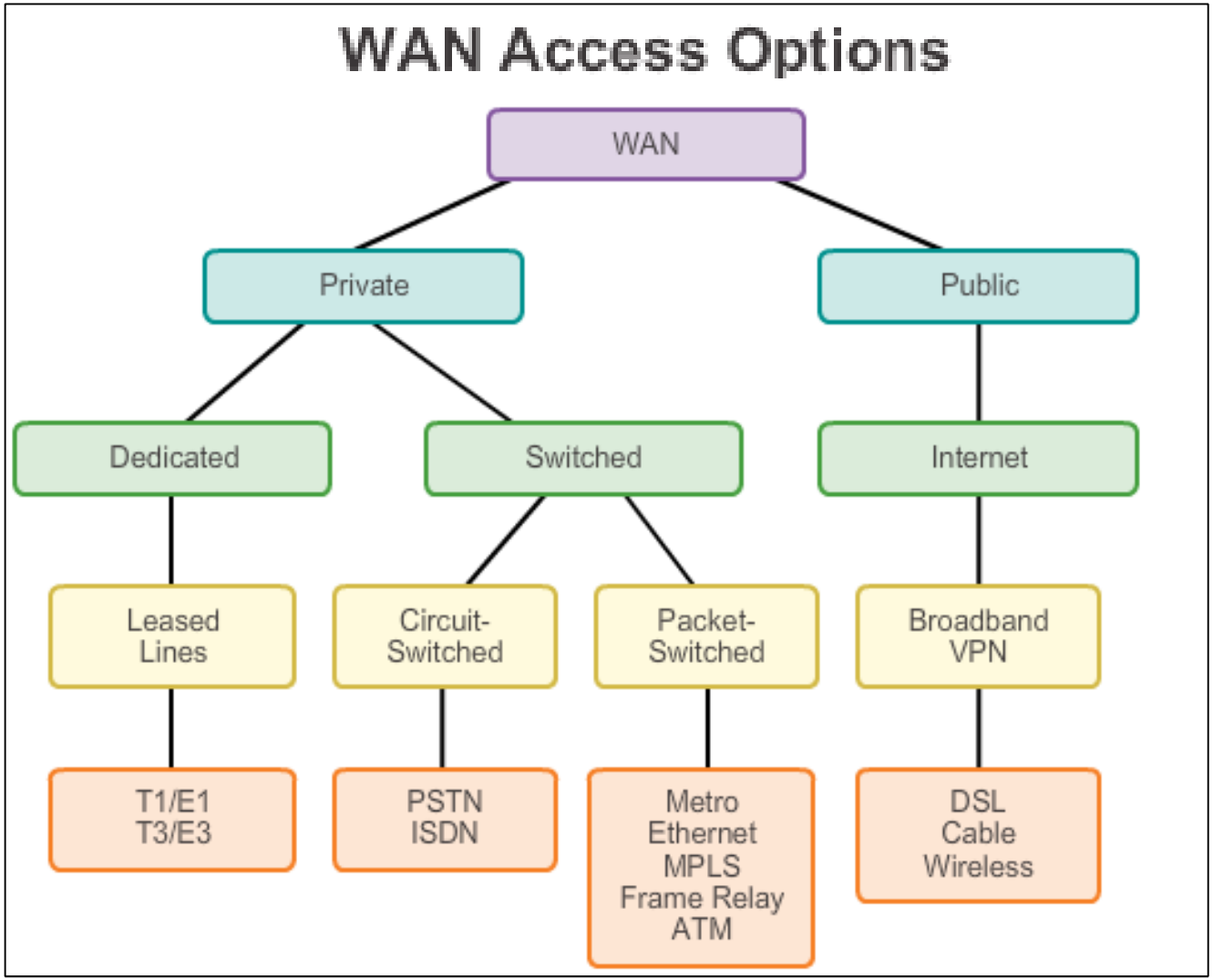
WAN Link Connection Options



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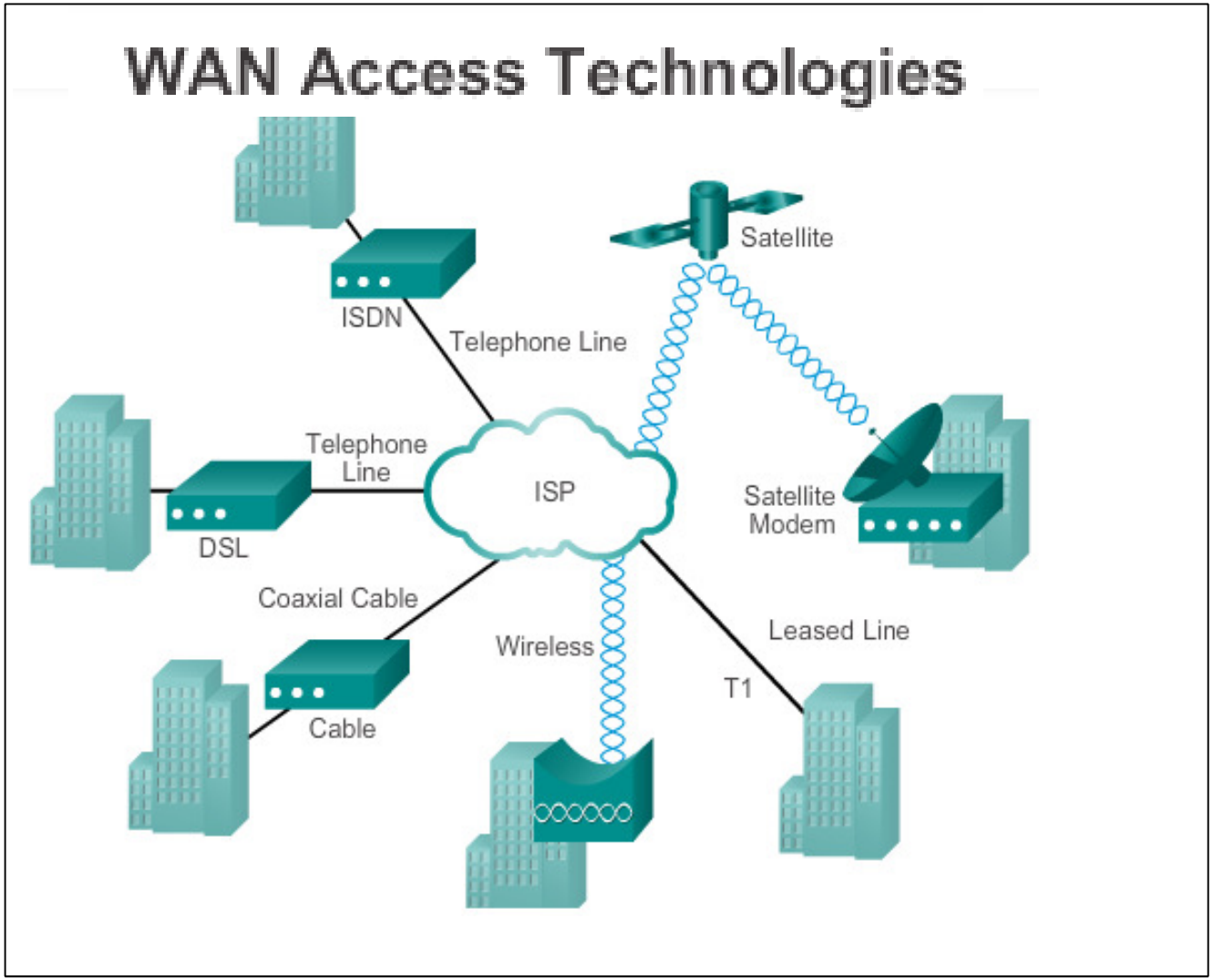
Service-Provided Network Infrastructure



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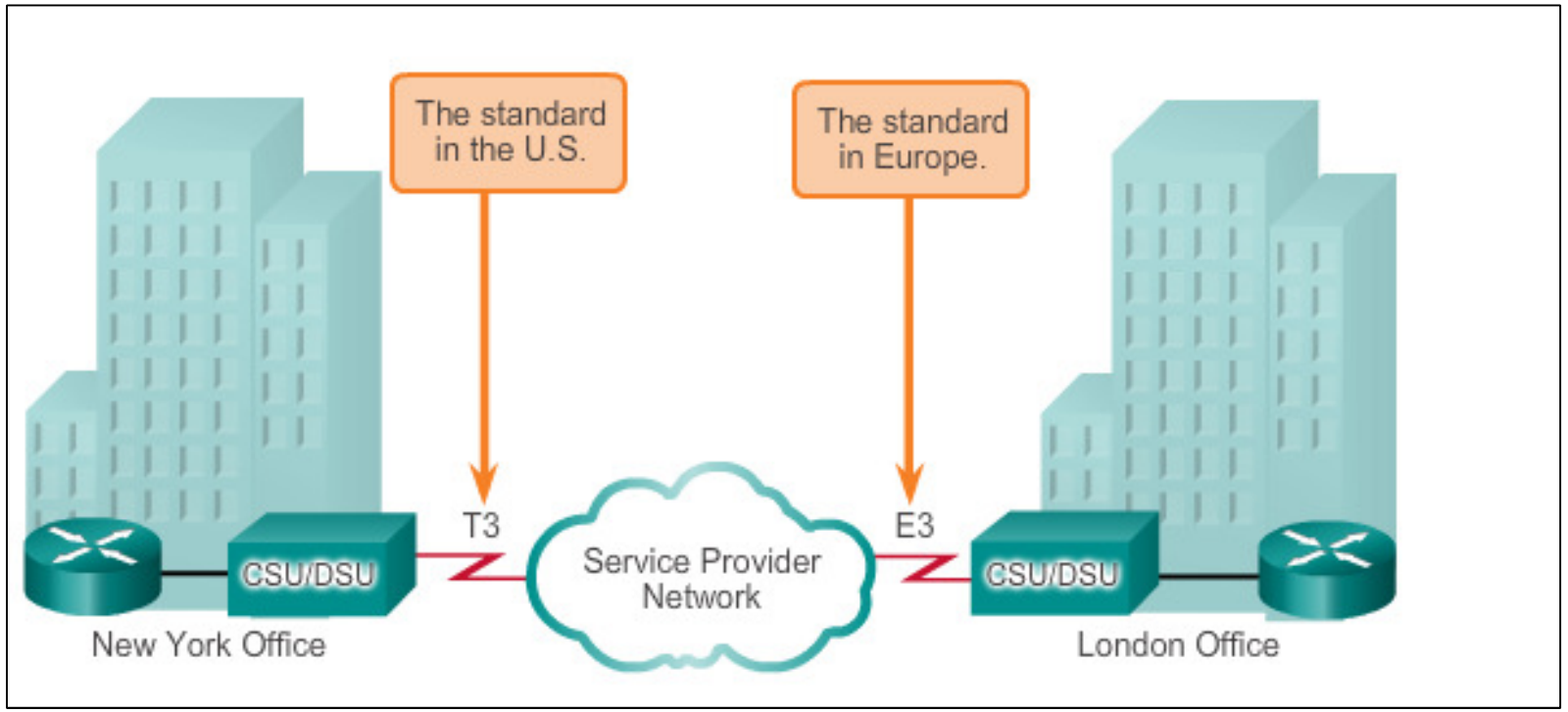
Leased Lines

Advantages:

- Simplicity
- Quality
- Availability

Disadvantages:

- Cost
- Limited flexibility



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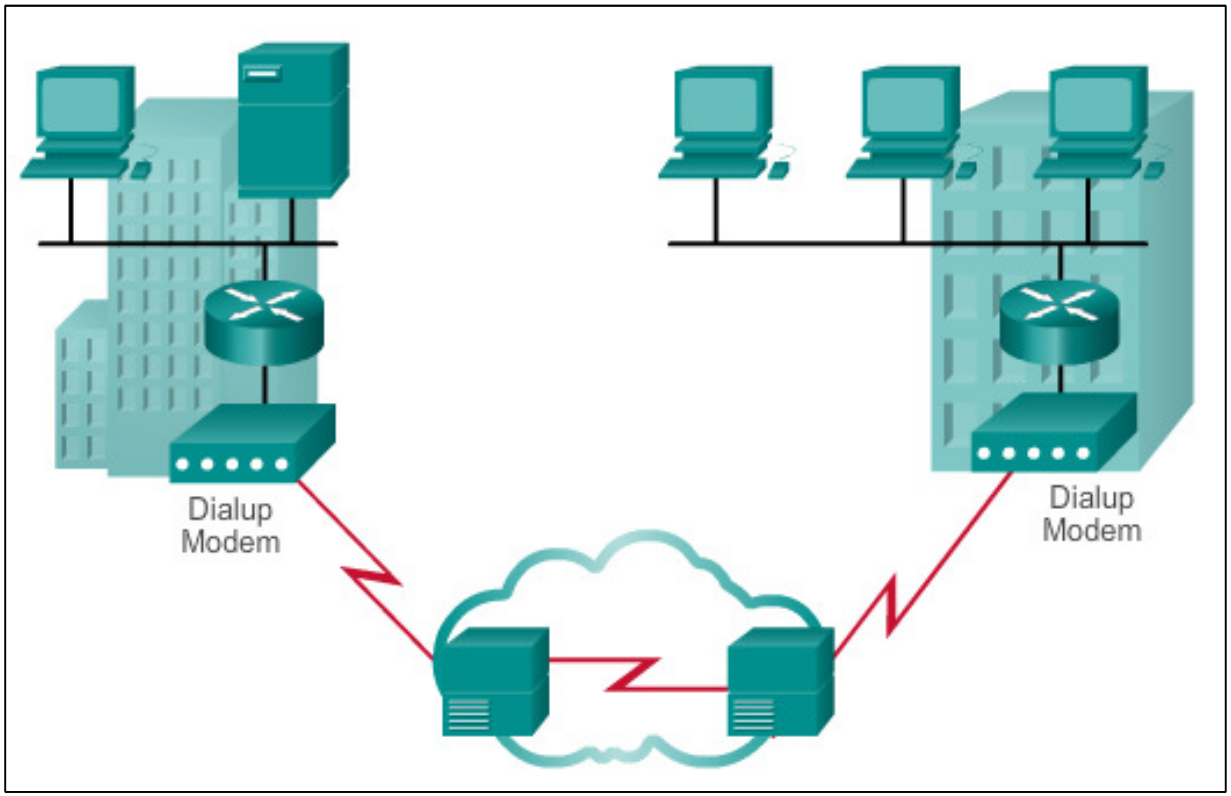
Dialup

Advantages:

- Simplicity
- Availability
- Low implementation cost

Disadvantages:

- Low data rates
- Relatively long connection time



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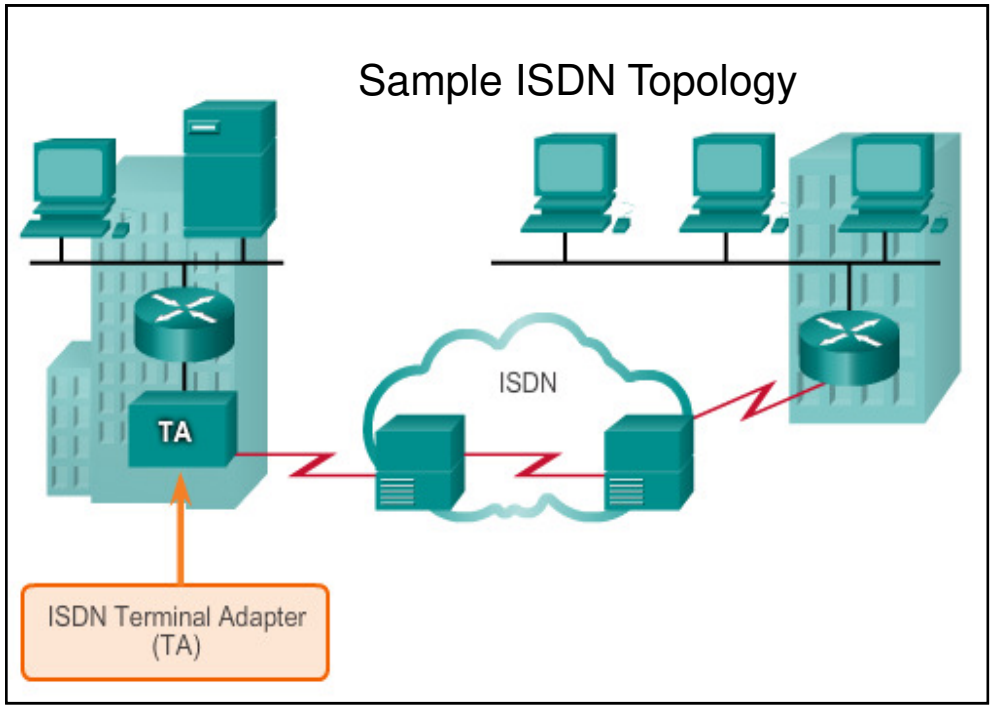
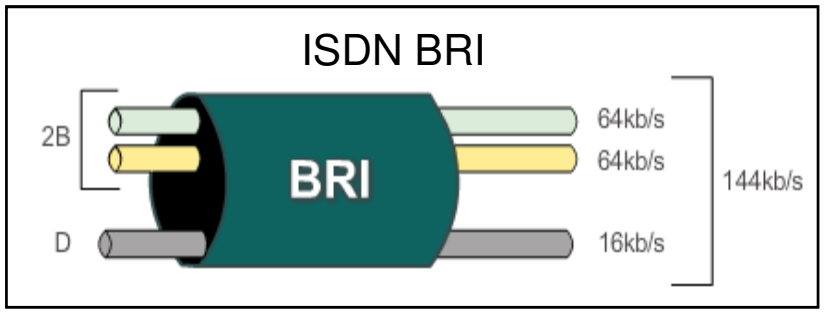
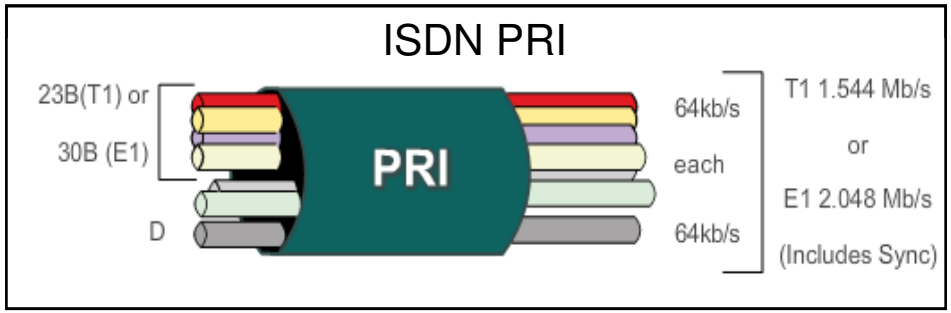
ISDN







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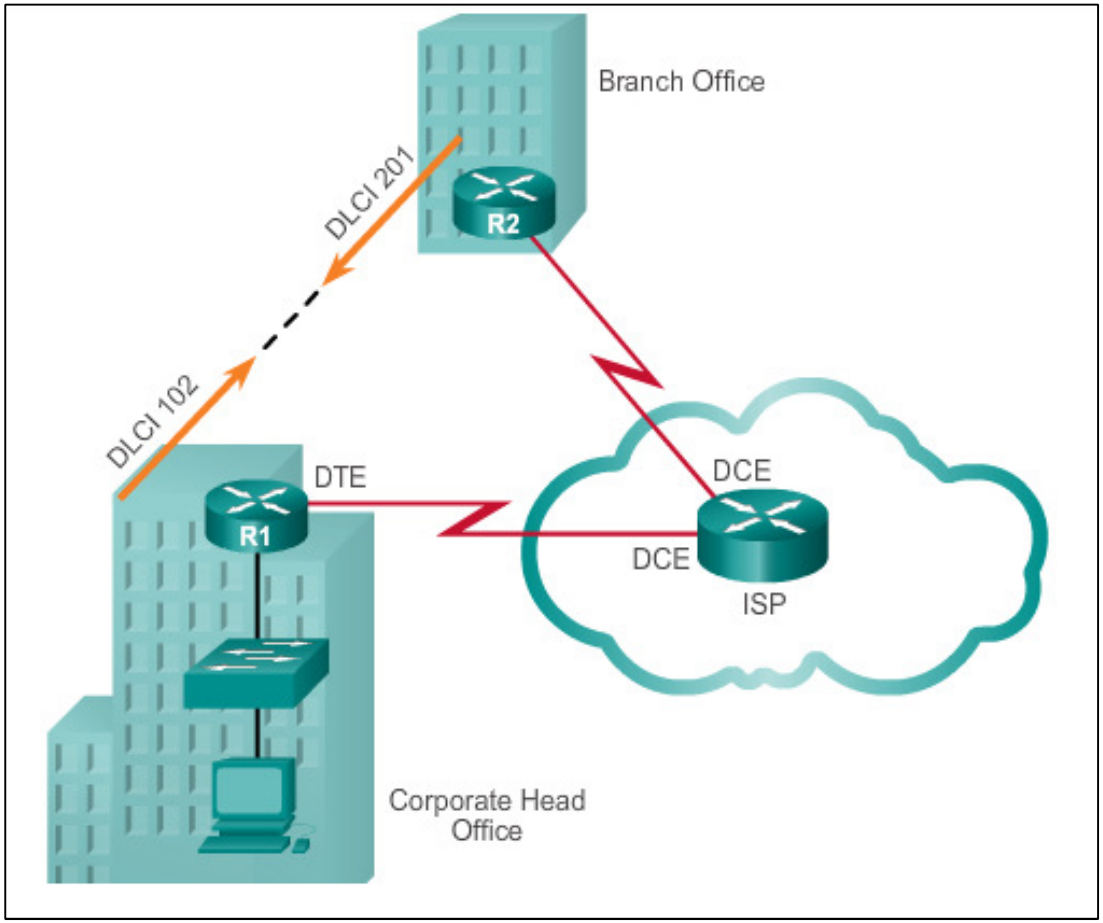
Frame Relay



- PVCs carry both voice and data traffic.
- PVCs are uniquely identified by a data-link connection identifier (DLCI).
- PVCs and DLCIs ensure bidirectional communication from one DTE device to another.
- R1 uses DLCI 102 to reach R2 while R2 uses DLCI 201 to reach R1.

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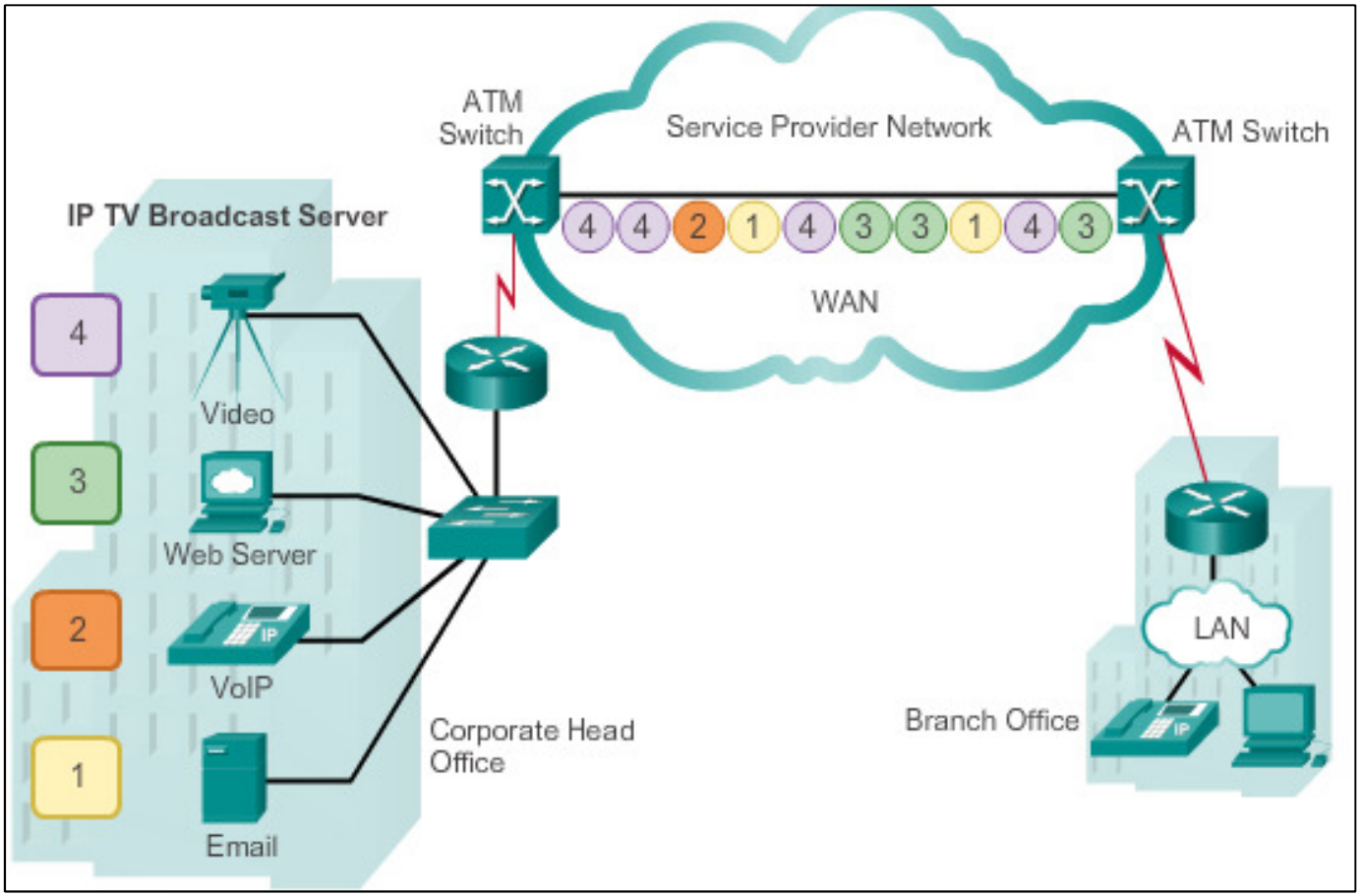
ATM

Built on a cell-based architecture, rather than on a frame-based architecture. ATM cells are always a fixed length of 53 bytes.



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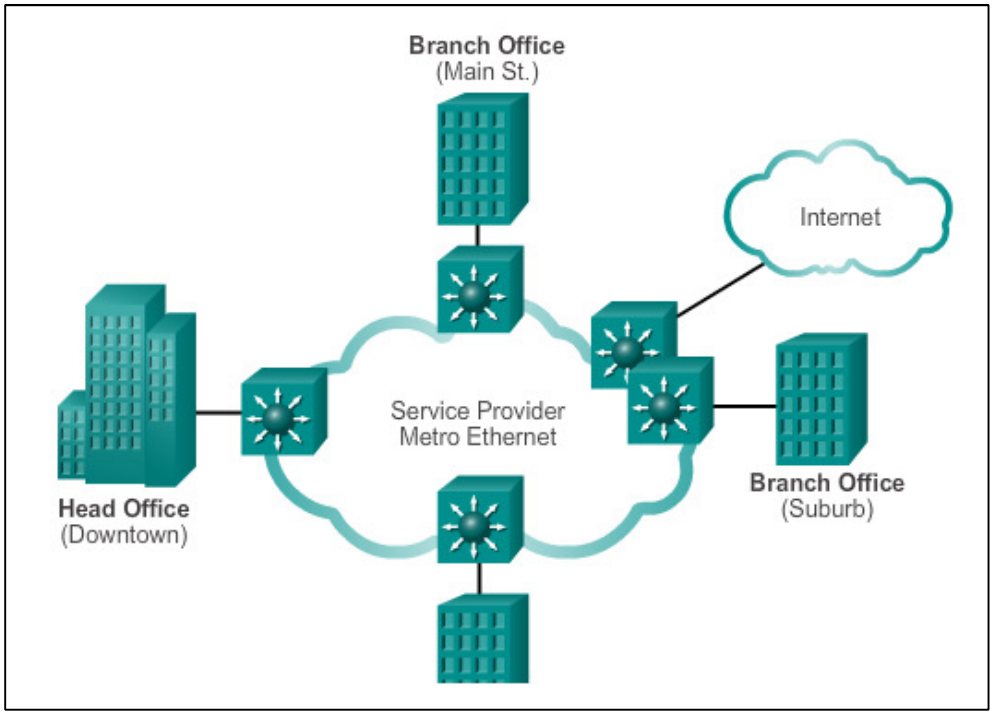
Ethernet WAN

Features and Benefits of Ethernet WAN include:

- Reduced expenses and administration
- Easy integration with existing networks
- Enhanced business productivity
- Service providers now offer Ethernet WAN service using fiber-optic cabling.
- Known as Metropolitan Ethernet (MetroE), Ethernet over MPLS (EoMPLS), and Virtual Private LAN Service (VPLS).



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

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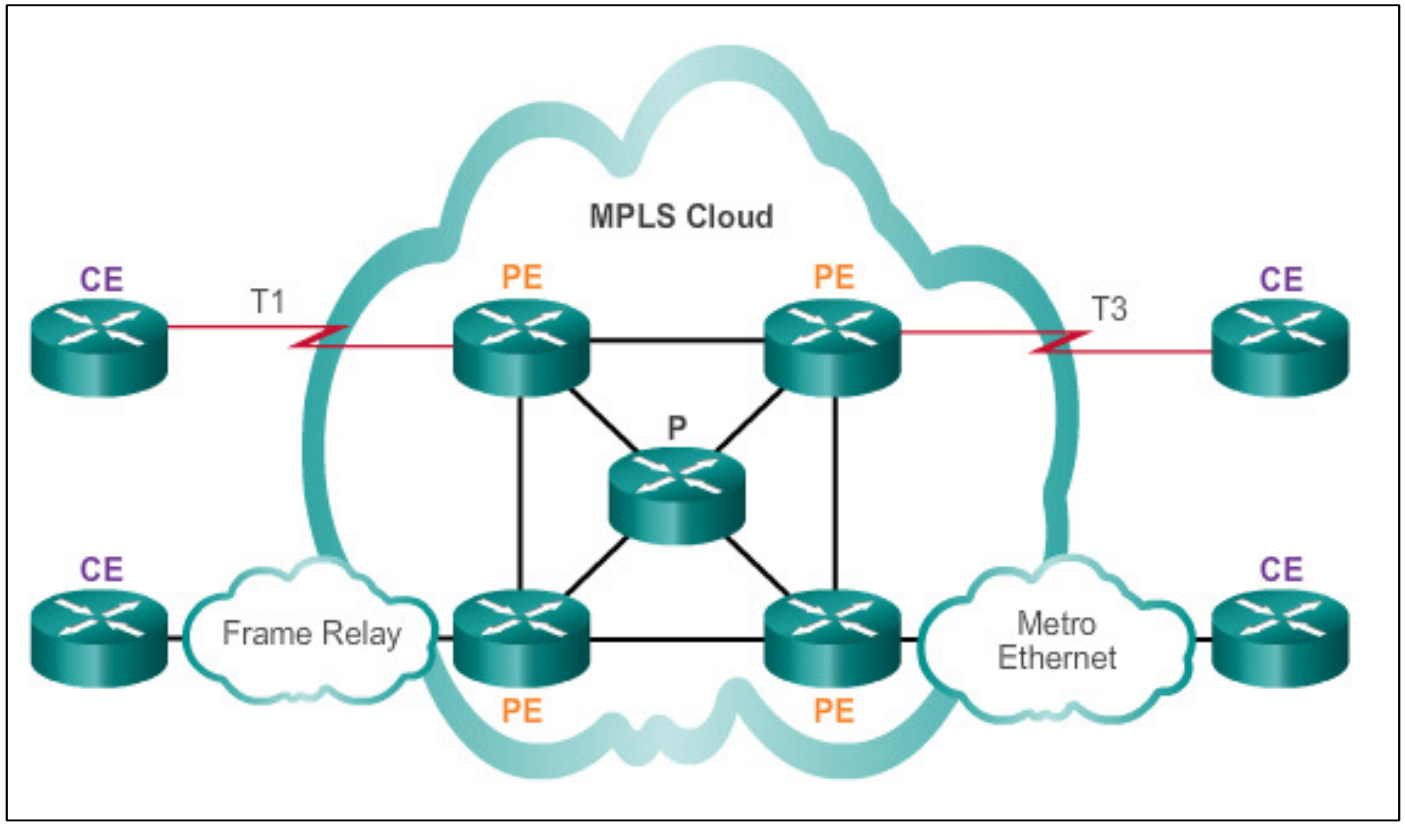
MPLS

Multiprotocol Label Switching (MPLS) is a multiprotocol high-performance WAN technology that directs data from one router to the next, based on short path labels rather than IP network addresses.



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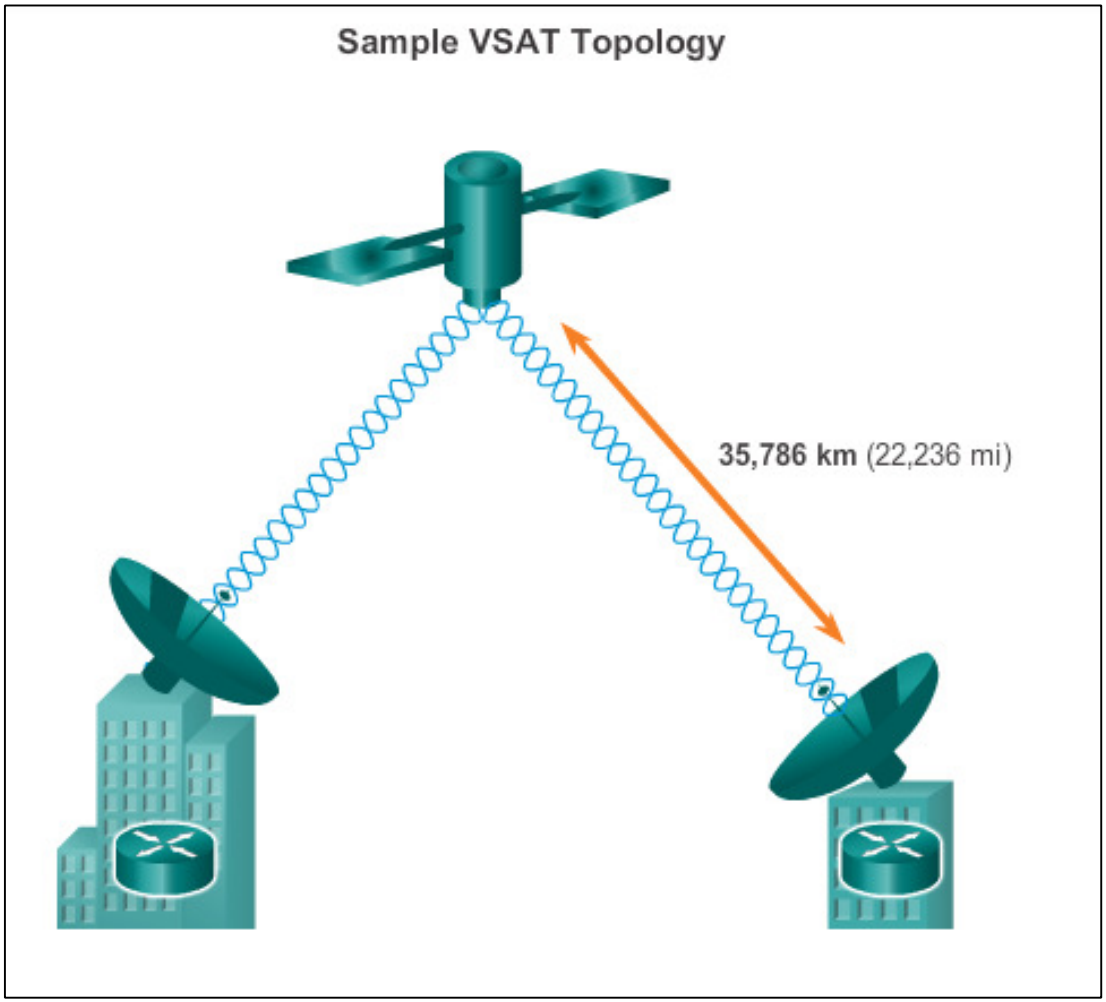
VSAT

Very small aperture terminal (VSAT) - a solution that creates a private WAN using satellite communications.



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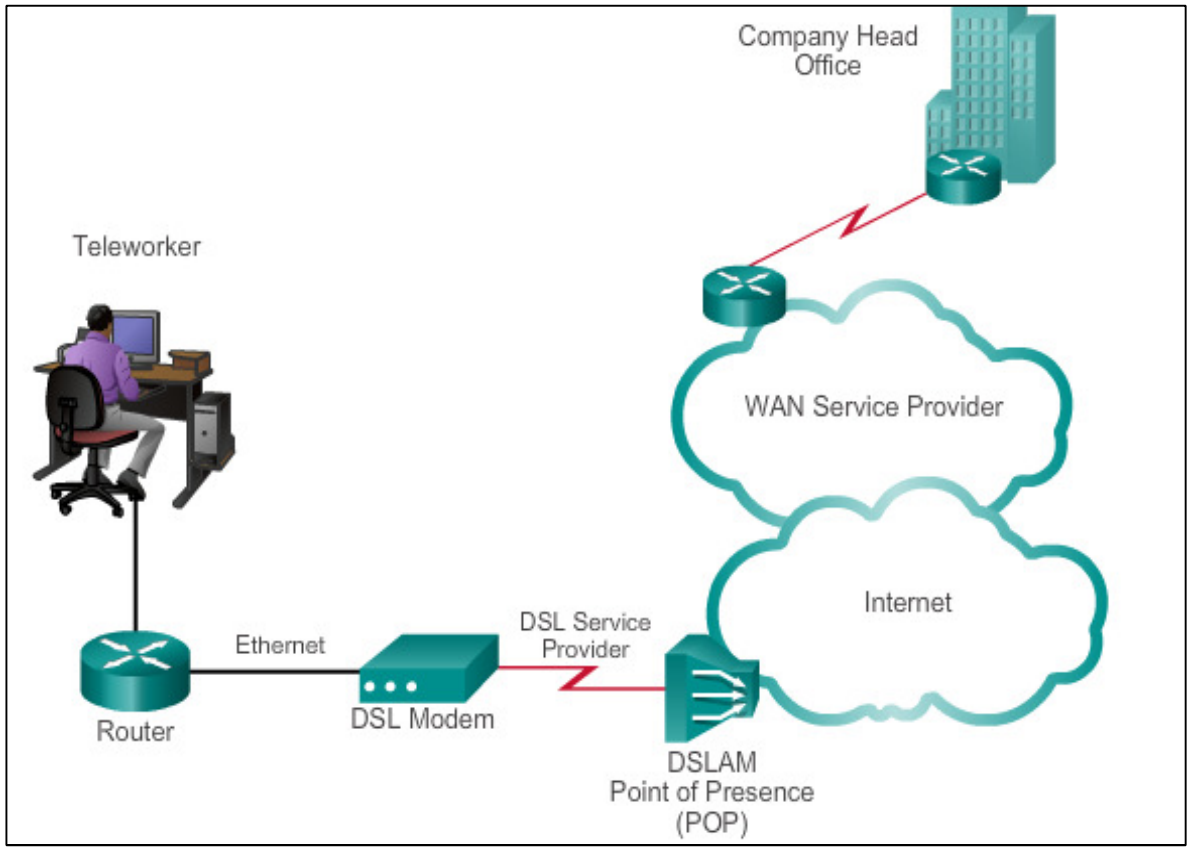
DSL

- 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.



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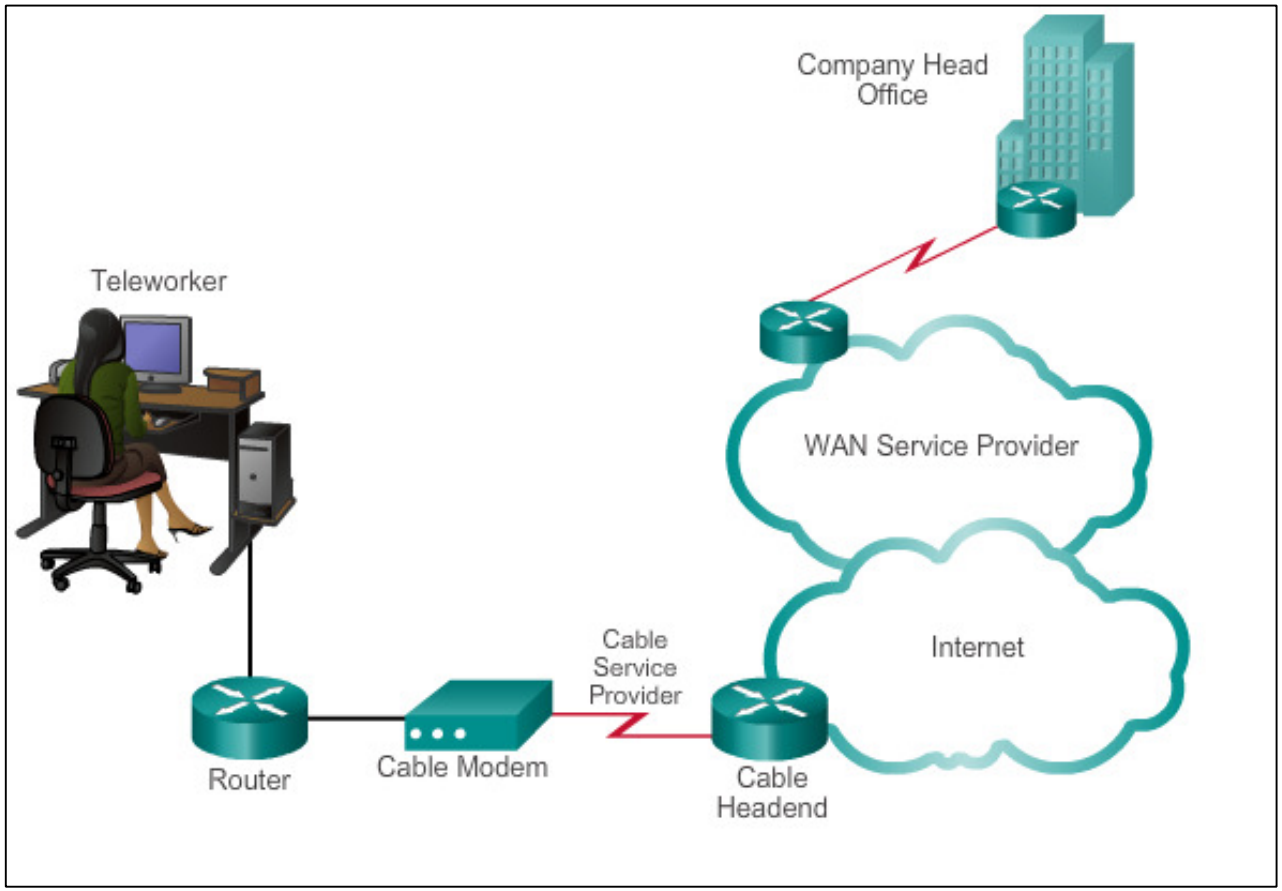
Cable

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



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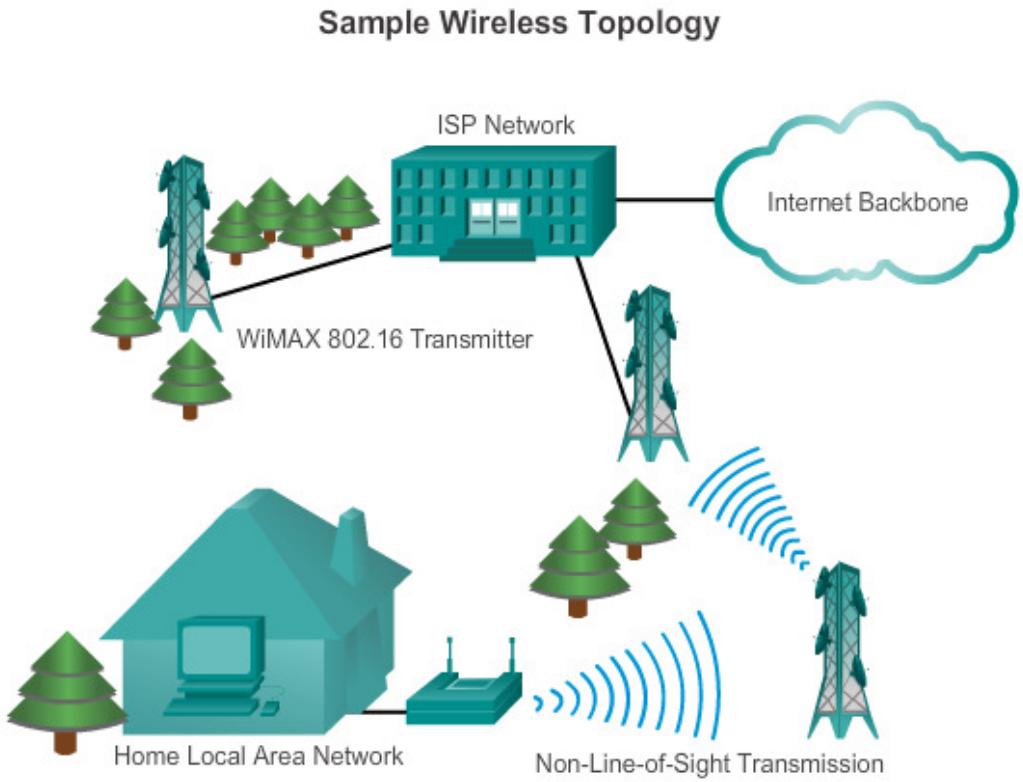
Wireless

New developments in broadband wireless technology:

- **Municipal Wi-Fi** – Many cities have begun setting up municipal wireless
- **WiMAX** – Worldwide Interoperability for Microwave Access (WiMAX) is a new technology that is just beginning to come into use.
- **Satellite Internet**



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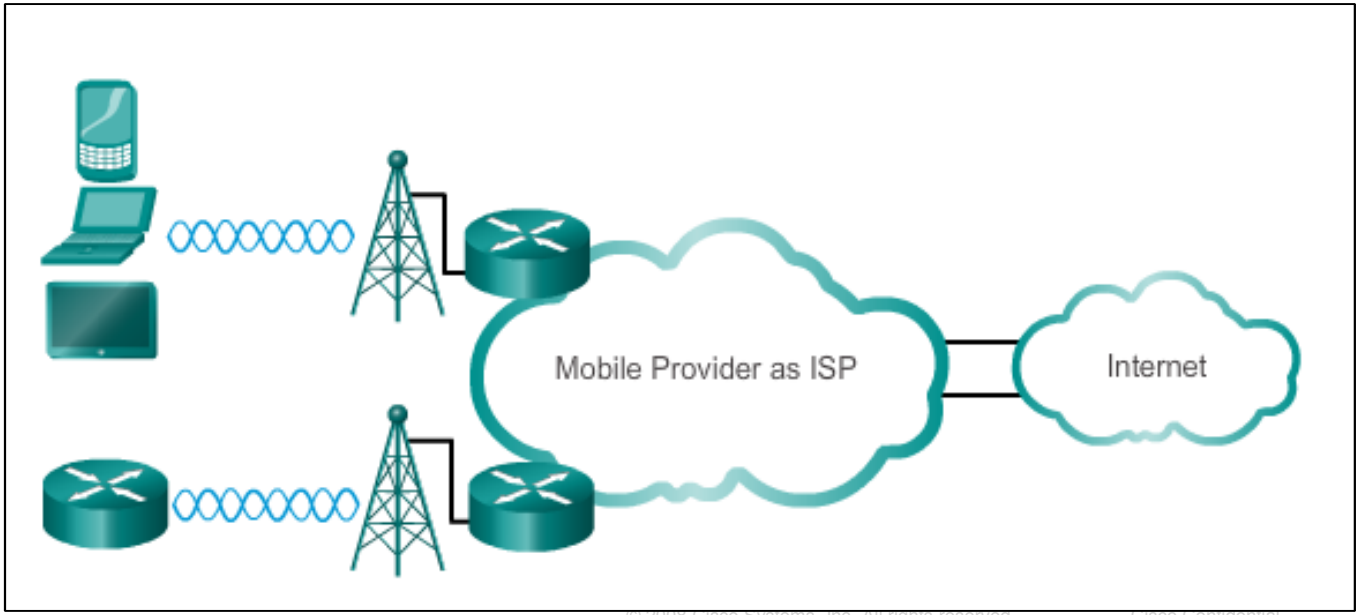
3G/4G Cellular

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.



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VPN Technology

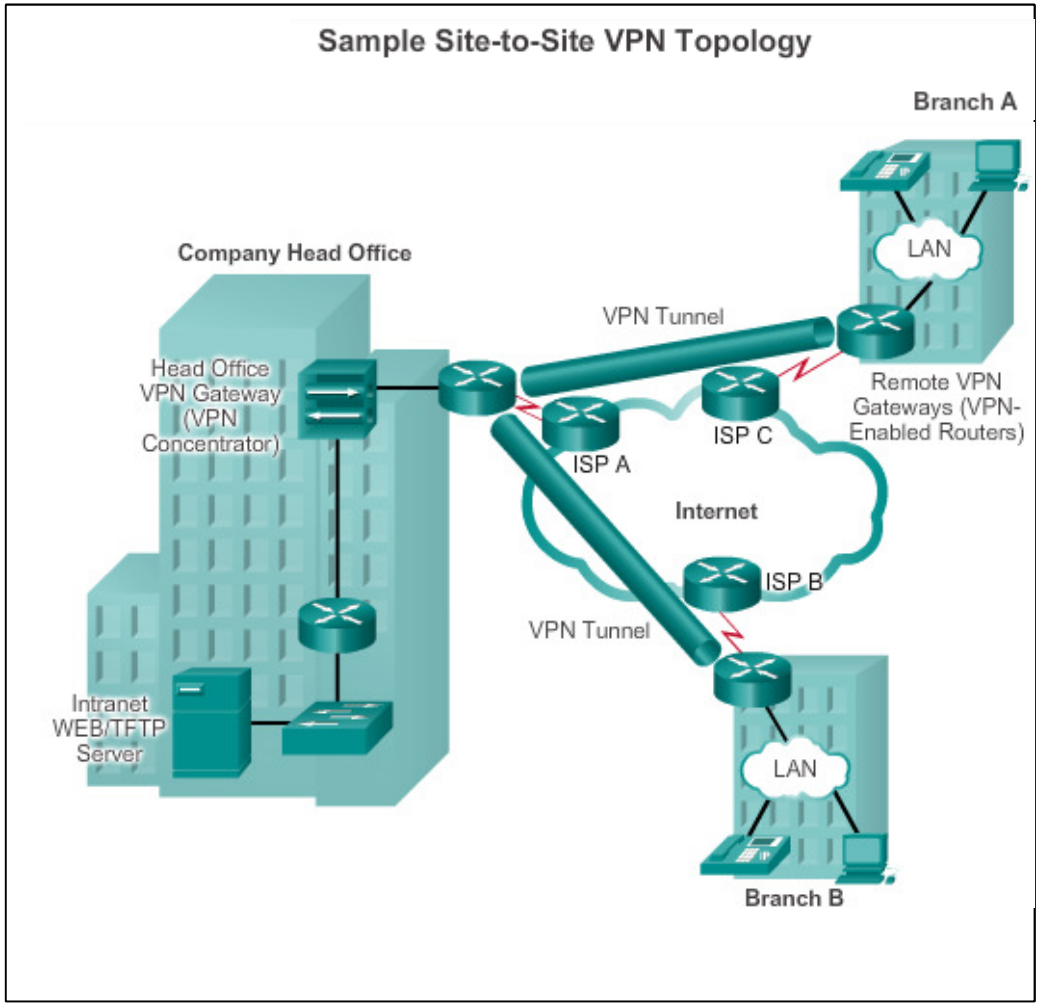
VPN is an encrypted connection between private networks over a public network.

Benefits:

- Cost savings
- Security
- Scalability
- Compatibility with broadband technology

Two types of VPN:

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



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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?

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Choosing a WAN Link Connection

- 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?

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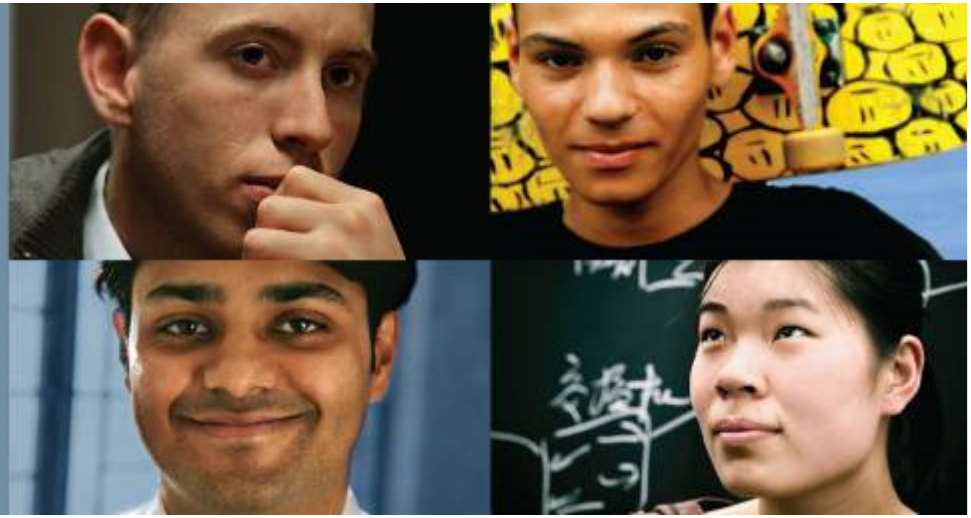
2.3 Summary



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Chapter 2: Summary

- A business can use private lines or the public network infrastructure for WAN connections.
- WAN access standards operate at layers 1 and 2 of the OSI model, and are defined and managed by the TIA/EIA, ISO, and IEEE.
- A WAN may be circuit-switched or packet-switched.
- There is common terminology used to identify the physical components of WAN connections and who, the service provider or the customer, is responsible for which components.
- Service provider networks are complex and the service provider's backbone networks consist primarily of high-bandwidth fiber optic media.

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Chapter 2: Summary (cont.)

- Permanent, dedicated point-to-point connections are provided by using leased lines.
- Public infrastructure connections include DSL, cable, wireless, and 3G/4G cellular.
- Security over public infrastructure connections can be provided by using remote-access or site-to-site VPNs.

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