

Introduction to WAN

What is a WAN?

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

WANs are different from LANs in several ways. While a LAN connects computers, peripherals, and other devices in a single building or other small geographic area, a WAN allows the transmission of data across greater geographic distances. In addition, an enterprise must subscribe to a WAN service provider to use WAN carrier network services. LANs are typically owned by the company or organization that uses them.

When an enterprise grows to include branch offices, e-commerce services, or global operations, a single LAN network is no longer sufficient to meet its business requirements. Wide-area network (WAN) access has become essential for larger businesses today.

There are a variety of WAN technologies to meet the different needs of businesses and many ways to scale the network. Adding WAN access introduces other considerations, such as network security and address management. Consequently, designing a WAN and choosing the correct carrier network services is not a simple matter.

WANs use facilities provided by a service provider, or carrier, such as a telephone or cable company, to connect the locations of an organization to each other, to locations of other organizations, to external services, and to remote users.

WANs generally carry a variety of traffic types, such as voice, data, and video.

Three major Characteristics of WANs:

- WANs generally connect devices that are separated by a broader geographical area than can be served by a LAN.
- WANs use the services of carriers, such as telephone companies, cable companies, satellite systems, and network providers.
- WANs use serial connections of various types to provide access to bandwidth over large geographic areas.

Why Are WANs Necessary?

LAN technologies provide both speed and cost-efficiency for the transmission of data in organizations over relatively small geographic areas. However, there are other business needs that require communication among remote sites, including the following:

- 1- People in the regional or branch offices of an organization need to be able to communicate and share data with the central site.
- 2- Organizations often want to share information with other organizations across large distances. For example, software manufacturers routinely communicate product and promotion information to distributors that sell their products to end users.

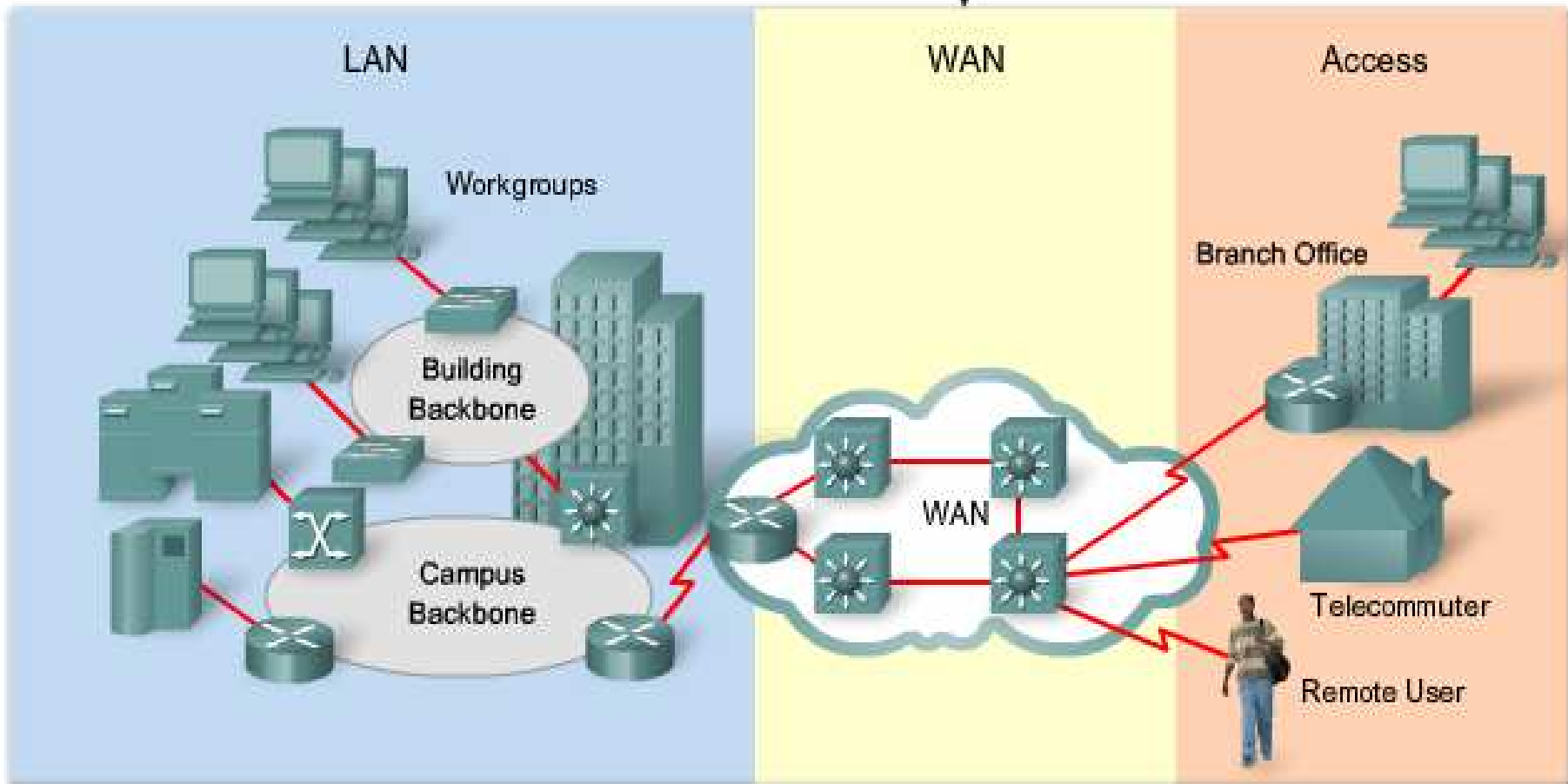
3- Employees who travel on company business frequently need to access information that resides on their corporate networks.

In addition, home computer users need to send and receive data across increasingly larger distances. Here are some examples:

- It is now common in many households for consumers to communicate with banks, stores, and a variety of providers of goods and services via computers.
- Students do research for classes by accessing library indexes and publications located in other parts of their country and in other parts of the world.

What is a WAN?

Wide Area Network



Since it is obviously not feasible to connect computers across a country or around the world in the same way that computers are connected in a LAN with cables, different technologies have evolved to support this need.

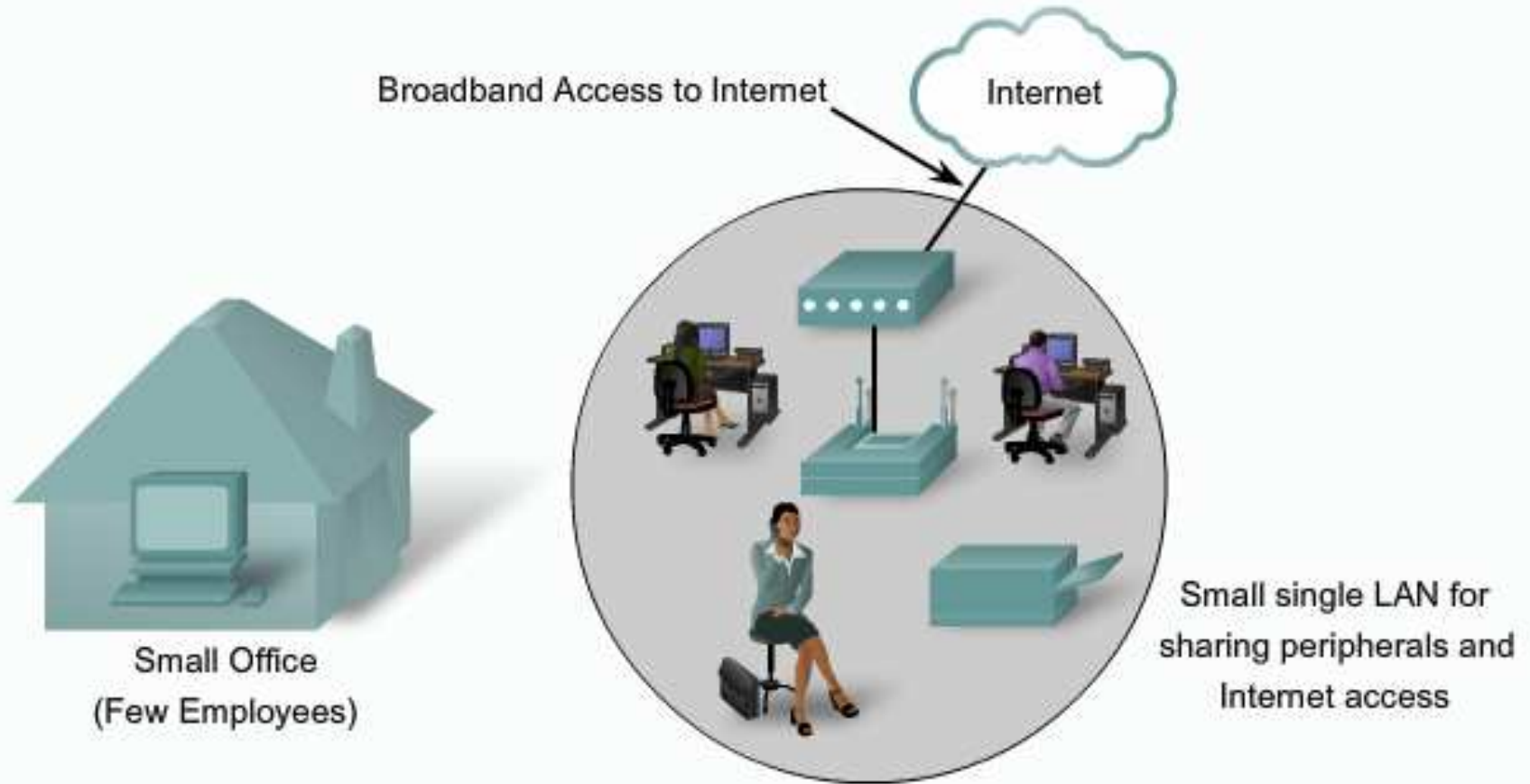
Increasingly, the Internet is being used as an inexpensive alternative to using an enterprise WAN for some applications. New technologies are available to businesses to provide security and privacy for their Internet communications and transactions. WANs used by themselves, or in concert with the Internet, allow organizations and individuals to meet their wide-area communication needs.

The Evolving Enterprise

Let us look at an example of a company called Span Engineering, and watch how its network requirements change as the company grows from a small local business into a global enterprise.

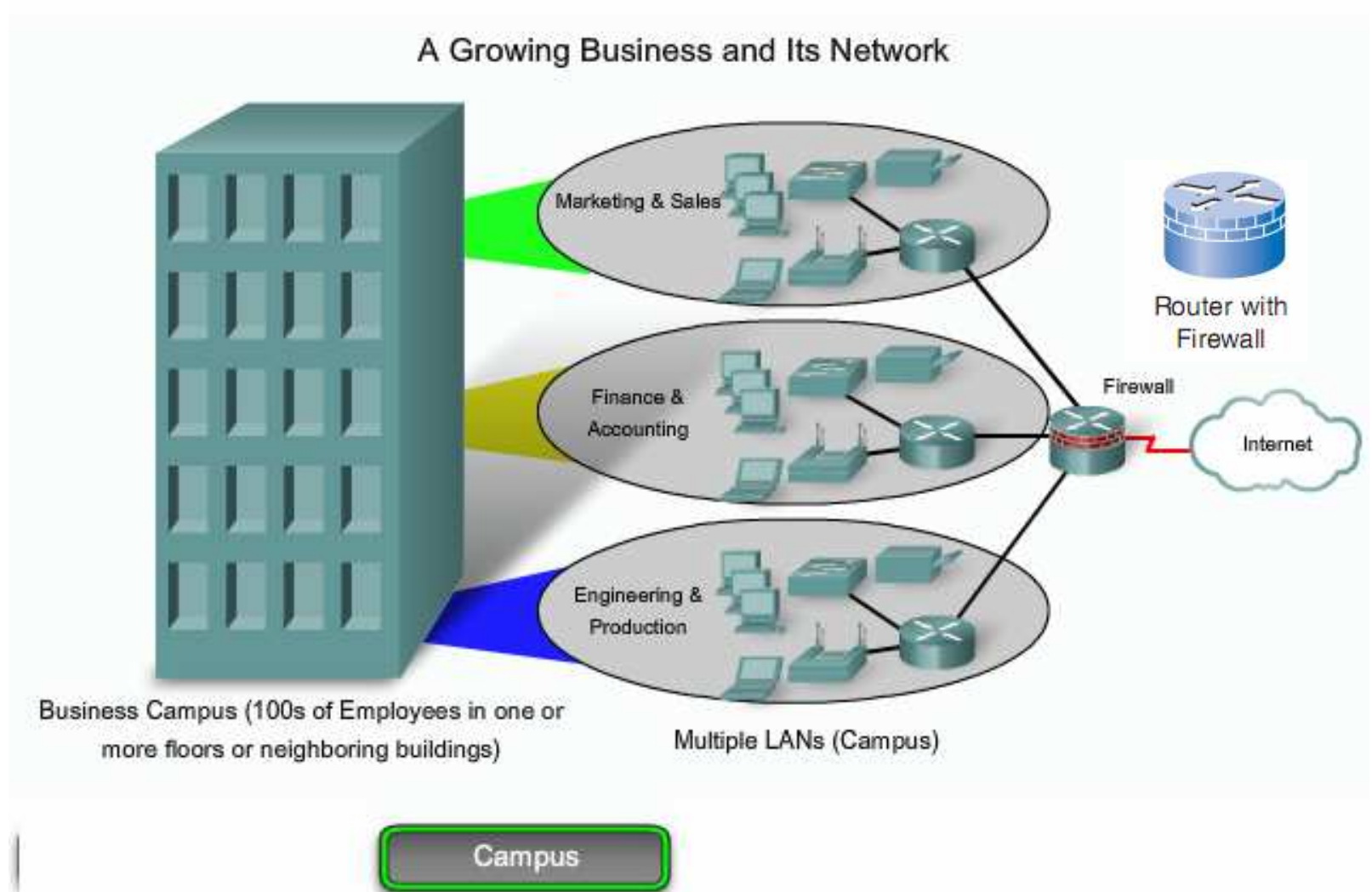
1- Small Office (Single LAN)

A Growing Business and Its Network



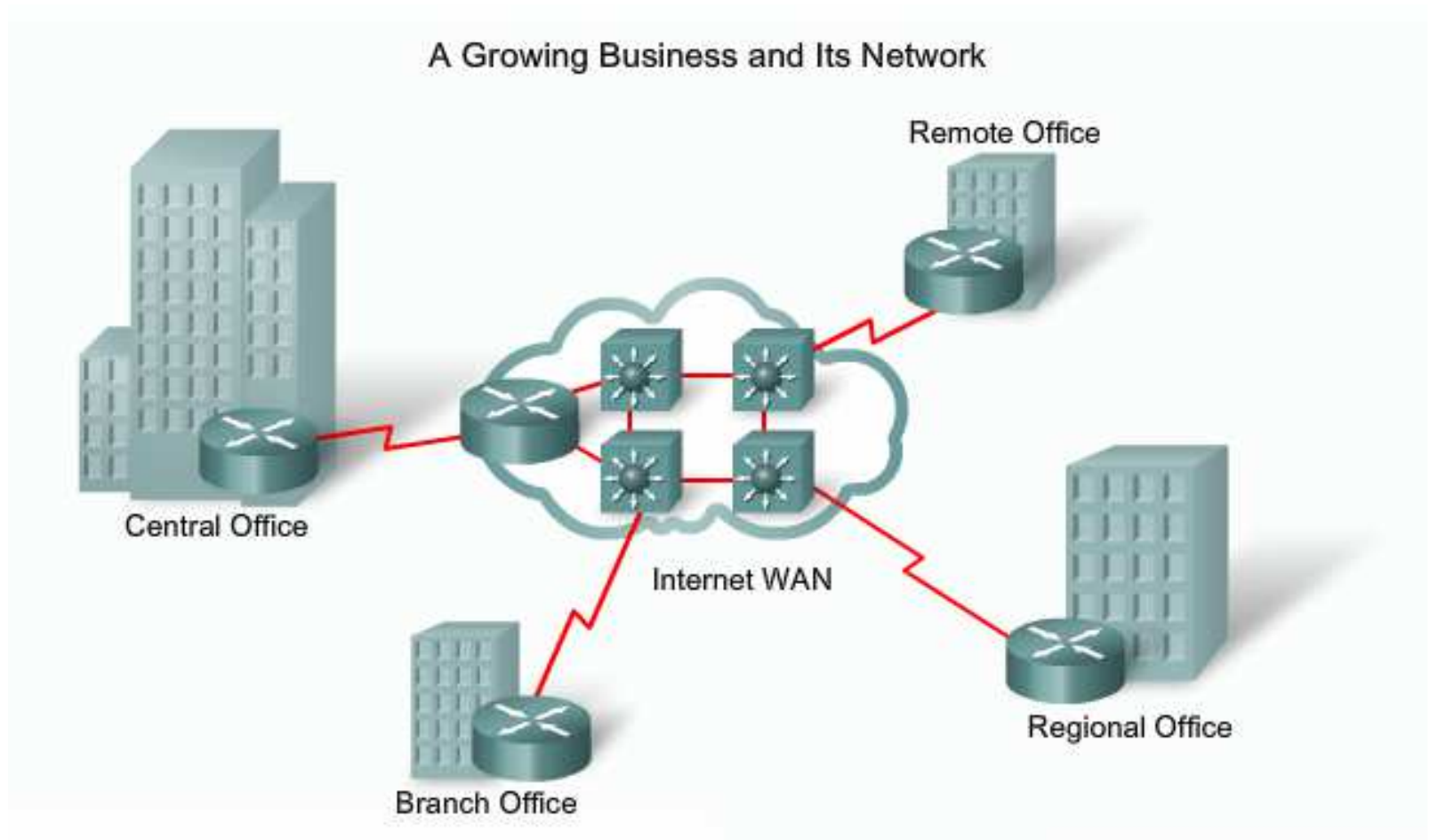
Small Office

2- Campus (Multiple LANs)



Multiple LANs are joined to create a company-wide network, or **campus**, which spans several floors of the building.

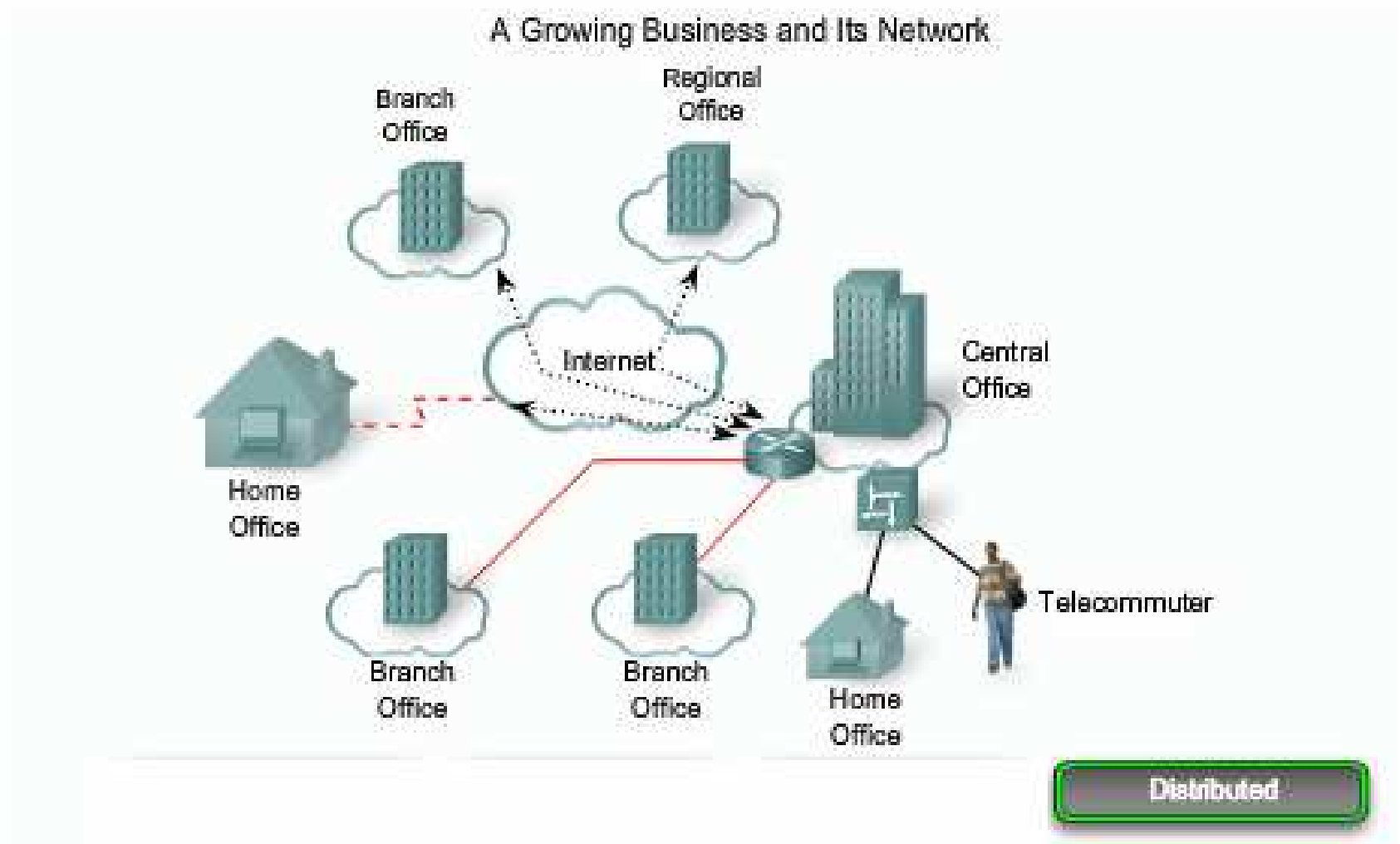
3- Branch (WAN)



Branch

For its branch offices that are in nearby cities, the company decides to use private dedicated lines through their local service provider. However, for those offices that are located in other countries, the Internet is now 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.

Distributed (Global)



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. To meet these requirements, the network must provide the necessary converged services and secure Internet WAN connectivity to remote offices and individuals.

Distributing employees saves costs in many ways, but it puts increased demands on the network. Not only must a network meet the day-to-day operational needs of the business, but it needs to 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 using many of the techniques we teach in this series of courses.

The Hierarchical Design Model

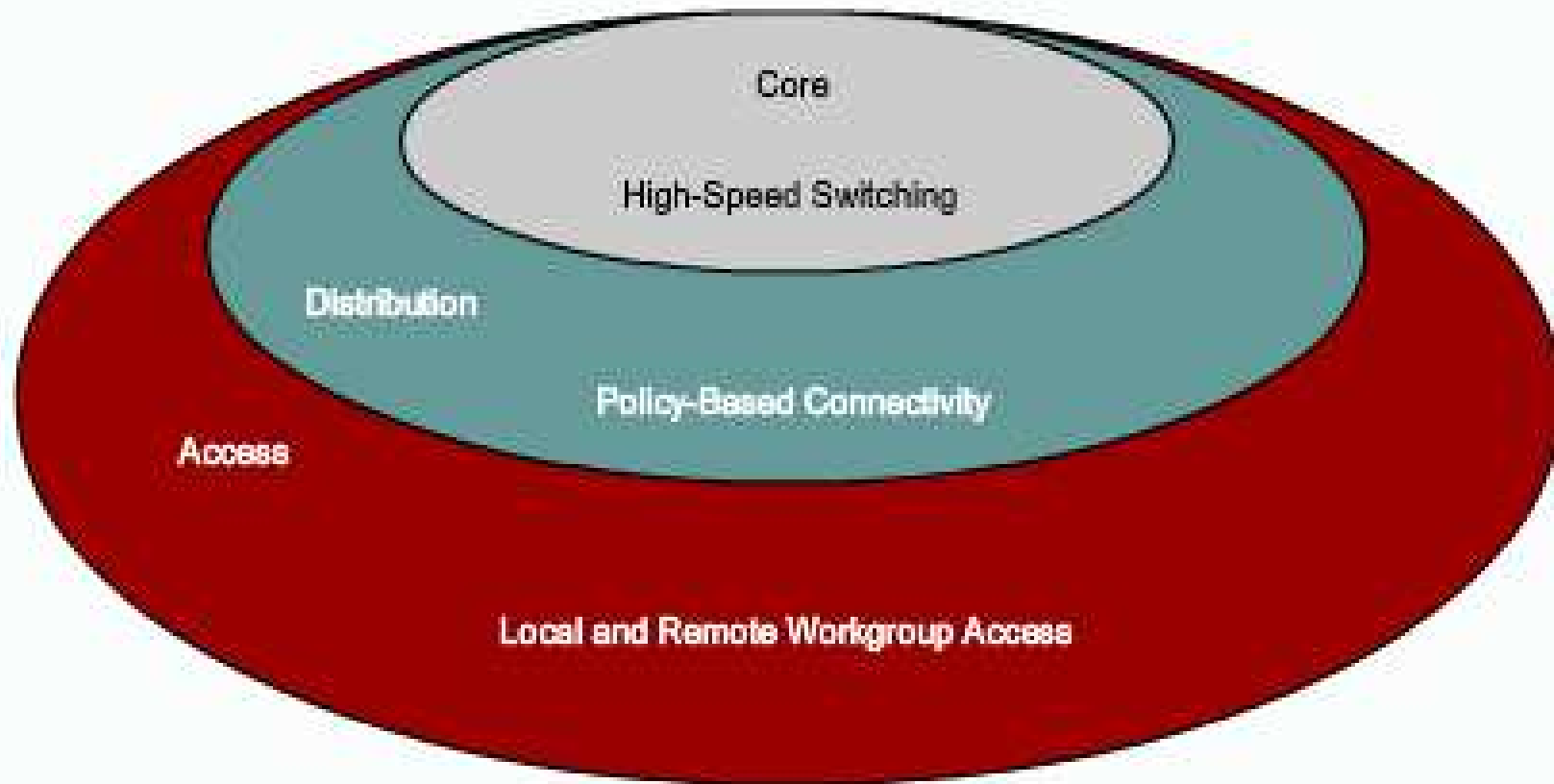
The hierarchical network model divides a network into three layers:

- 1- **Access layer**-Grants user access to network devices. In a network campus, the access layer generally incorporates switched LAN devices with ports that provide connectivity to workstations and servers. In the WAN environment, it may provide teleworkers or remote sites access to the corporate network across WAN technology.

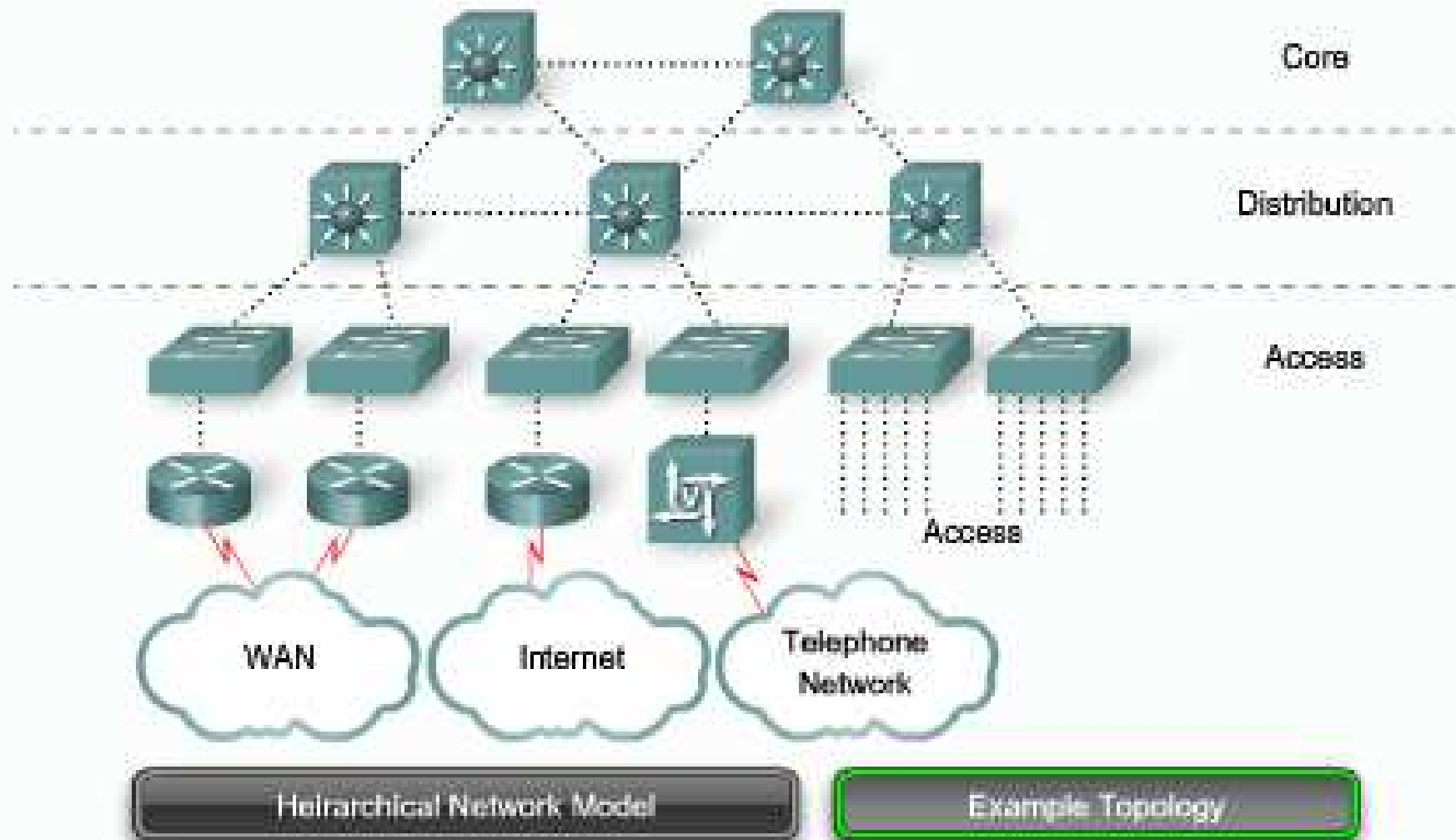
2- Distribution layer- Primary functions include routing, filtering (*Security and network policies such as address translation and firewalling.*), WAN access, and determining how packets can access the Core layer if necessary.

Core layer (also referred to as the **backbone**) - A high-speed backbone that is designed to switch packets as fast as possible. Because the core is critical for connectivity, it must provide a high level of availability and adapt to changes very quickly. It also provides scalability and fast convergence.

The Hierarchical Network Model



The Hierarchical Network Model



The figure represents the Hierarchical Network Model in campus environments. The Hierarchical Network Model provides a modular framework that allows flexibility in network design, and facilitates ease of implementation and troubleshooting in the infrastructure. However, it is important to understand that the network infrastructure is only the foundation to a comprehensive architecture.

WANs and the OSI Model

WAN operations focus primarily on Layer 1 and Layer 2. WAN access standards typically describe both Physical layer delivery methods and Data Link layer requirements, including physical addressing, flow control, and encapsulation.

The Physical layer (OSI Layer 1) protocols describe how to provide electrical, mechanical, operational, and functional connections to the services of a communications service provider.

The Data Link layer (OSI Layer 2) protocols define how data is encapsulated for transmission toward a remote location and the mechanisms for transferring the resulting frames. A variety of different technologies are used, such as Frame Relay and ATM. Some of these protocols use the same basic framing mechanism, High-Level Data Link Control (HDLC).

OSI Model



WAN Services

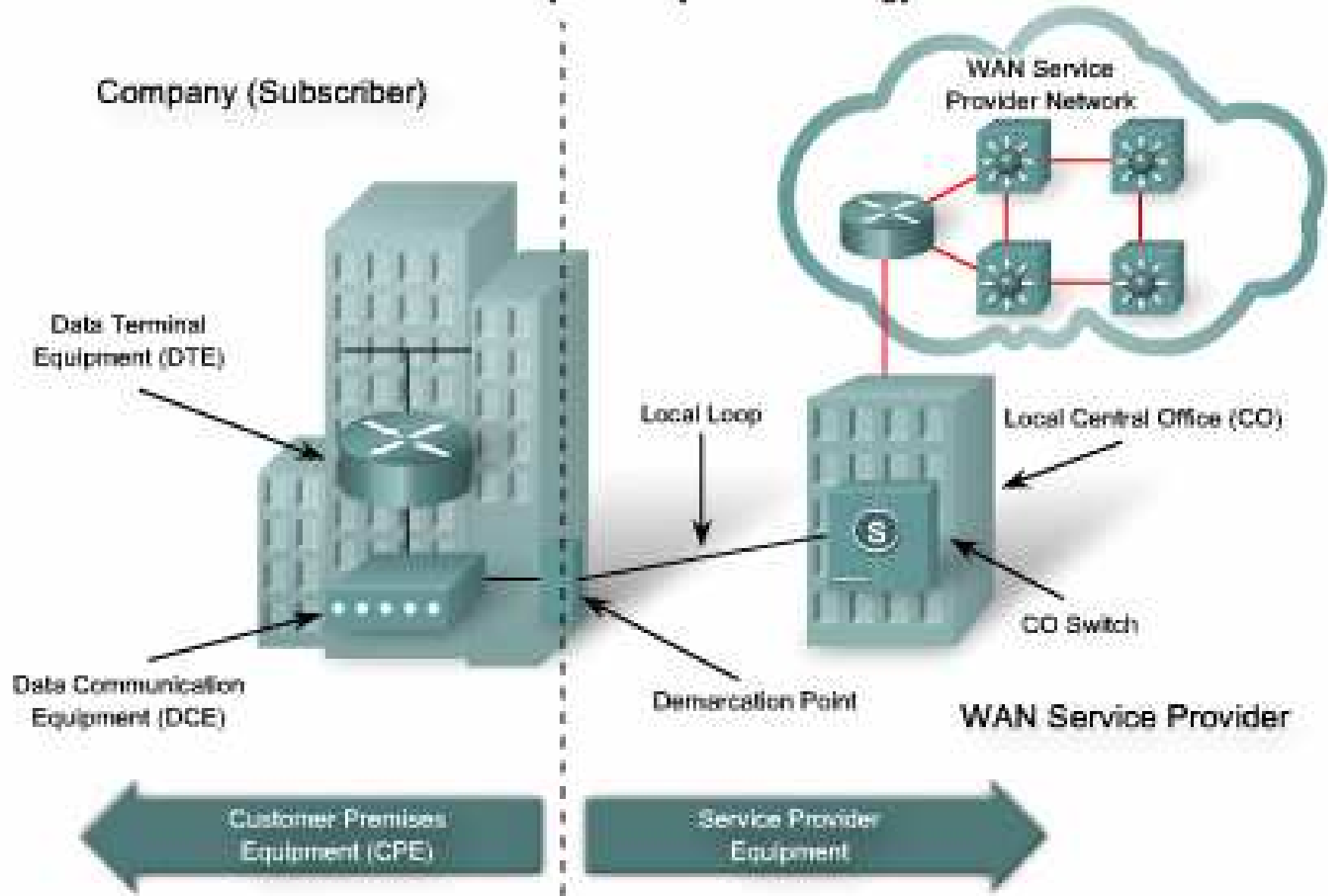


WAN Physical Layer Terminology

One primary difference between a WAN and a LAN is that a company or organization must subscribe to an outside WAN service provider to use WAN carrier network services. A WAN uses data links provided by *carrier services* to access the Internet and connect the locations of an organization to each other, to locations of other organizations, to external services, and to remote users

The WAN access *Physical layer* describes the physical connection between the company network and the service provider network. The figure illustrates the terminology commonly used to describe physical WAN connections, including:

WAN Physical Layer Terminology



Customer Premises Equipment (CPE)-
are the devices and inside wiring located
at the subscriber which connected with a
telecommunication channel of a carrier.

A subscriber, is a company that arranges for
WAN services from a service provider or
carrier.

Data Communications Equipment (DCE)-

Also called data circuit-terminating equipment, the DCE consists of devices that put data on the local loop. The DCE primarily provides an interface to connect subscribers to a communication link on the WAN cloud.

Data Terminal Equipment (DTE)-The customer devices that pass the data from a customer network or host computer for transmission over the WAN. The DTE connects to the local loop through the DCE.

Demarcation Point-A point established in a building or complex to separate customer equipment from service provider equipment. Physically, the demarcation point is the cabling junction box, located on the customer premises, that connects the CPE wiring to the local loop. It is usually placed for easy access by a technician.

The demarcation point is the place where the responsibility for the connection changes from the user to the service provider. This is very important because when problems arise, it is necessary to determine whether the user or the service provider is responsible for troubleshooting or repair.

- **Local Loop**-The copper or fiber telephone cable that connects the CPE at the subscriber site to the CO of the service provider. The local loop is also sometimes called the "last-mile."

Central Office (CO)-A local service provider facility or building where local telephone cables link to long-haul, all-digital, fiber-optic communications lines through a system of switches and other equipment.

WAN Devices

Modem-Modulates an analog carrier signal to encode digital information, and also demodulates the carrier signal to decode the transmitted information. A voice band modem converts the digital signals produced by a computer into voice frequencies that can be transmitted over the analog lines of the public telephone network. On the other side of the connection, another modem converts the sounds back into a digital signal for input to a computer or network connection. Faster modems, such as cable modems and DSL modems, transmit using higher broadband frequencies.

CSU/DSU-Digital lines, such as T1 or T3 carrier lines, require a channel service unit (CSU) and a data service unit (DSU). The two are often combined into a single piece of equipment, called the CSU/DSU. The CSU provides termination for the digital signal and ensures connection integrity through error correction and line monitoring. The DSU converts the T-carrier line frames into frames that the LAN can interpret and vice versa.

- **Access server**-Concentrates dial-in and dial-out user communications. An access server may have a mixture of analog and digital interfaces and support hundreds of simultaneous users.

WAN switch-A multiport internetworking device used in carrier networks. These devices typically switch traffic such as Frame Relay, ATM, or X.25, and operate at the Data Link layer of the OSI reference model.

Public switched telephone network (PSTN) switches may also be used within the cloud for circuit-switched connections like Integrated Services Digital Network (ISDN) or analog dialup.

- **Router**-Provides internetworking and WAN access interface ports that are used to connect to the service provider network. These interfaces may be serial connections or other WAN interfaces. With some types of WAN interfaces, an external device such as a DSU/CSU or modem (analog, cable, or DSL) is required to connect the router to the local point of presence (POP) of the service provider.

- **Core router**-A router that resides within the middle or backbone of the WAN rather than at its periphery. To fulfill this role, a router must be able to support multiple telecommunications interfaces of the highest speed in use in the WAN core, and it must be able to forward IP packets at full speed on all of those interfaces. The router must also support the routing protocols being used in the core.

WAN Devices

