Module Practice and Quiz

7.6.1

Packet Tracer - WAN Concepts

In this Packet Tracer activity, you will explore various WAN technologies and implementations.

WAN Concepts

WAN Concepts

7.6.2

What did I learn in this module?

Purpose of WANs

A Wide Area Network (WAN) is required to connect beyond the boundary of the LAN. A WAN is a telecommunications network that spans over a relatively large geographical area. A WAN operates beyond the geographic scope of a LAN. A private WAN is a connection that is dedicated to a single customer. A public WAN connection is typically provided by an ISP or telecommunications service provider using the internet. WAN topologies are described using a logical topology. WANs are implemented using the following logical topologies: Point-to-Point, Hub-and-Spoke, Dual-homed, Fully Meshed, and Partially Meshed. A single-carrier connection is when an organization connects to only one service provider. A dual-carrier connection provides redundancy and increases network availability. The organization negotiates separate SLAs with two different service providers. Network requirements of a company can change dramatically as the company grows over time. Distributing employees saves costs in many ways, but it puts increased demands on the network. Small companies may use a single LAN connected to a wireless router to share data and peripherals. Connection to the Internet is through a broadband service provider. A slightly larger company may use a Campus Area Network (CAN). A CAN interconnects several LANs within a limited geographical area. An even larger company may require a metropolitan area network (MAN) to interconnect sites within the city. A MAN is larger than a LAN but smaller than a WAN. A global company may require teleworking and virtual teams using web-based applications, including web-conferencing, e-learning, and online collaboration tools. Site-to-site and remote access Virtual Private Networks (VPNs) enable the company to use the Internet to securely connect with employees and facilities around the world.

WAN Operations

Modern WAN standards are defined and managed by a number of recognized authorities: TIA/EIA, ISO, and IEEE. Most WAN standards focus on the physical layer (OSI Layer 1) and the data link layer (OSI Layer 2). Layer 1 protocols describe the electrical, mechanical, and operational components needed to transmit bits over a WAN. Layer 1 optical fiber protocol standards include SDH, SONET, and DWDM. Layer 2 protocols define how data will be encapsulated into a frame. Layer 2 protocols include broadband, wireless, Ethernet WAN, MPLS, PPP, HDLC. The WAN physical layer describes the physical connections between the company network and the service provider network. There are specific terms used to describe WAN connections between the subscriber (i.e., the company / client) and the WAN service provider: DTE, DCE, CPE, POP, Demarcation Point, Local Loop, CO, Toll network, Backhaul network, and Backbone network. The end-to-end data path over a WAN is usually from source DTE to the DCE, then to the WAN cloud, then to the DCE to and finally to the destination DTE. Devices used in this path include voiceband modem, DSL and Cable modems, CSU/DSU, Optical converter, wireless router or access point, and other WAN core devices. Serial communication transmits bits sequentially over a single channel. In contrast, parallel communications simultaneously transmit several bits using multiple wires. A circuit-switched network establishes a dedicated circuit (or channel) between endpoints before the users can communicate. During transmission over a circuit-switched network, all communication uses the same path. The two most common types of circuit-switched WAN technologies are PSTN and ISDN. Packet-switching segments traffic data into packets that are routed over a shared network. Common types of packet-switched WAN technologies are Ethernet WAN and MPLS. There are two optical fiber OSI layer 1 standards. SDH/SONET define how to transfer multiple data, voice, and video communications over optical fiber using lasers or LEDs over great distances. Both standards are used on the ring network topology that contains redundant fiber paths allowing traffic to flow in both directions. DWDM is a newer technology that increases the data-carrying capacity SDH and SONET by simultaneously sending multiple streams of data (multiplexing) using different wavelengths of light.

Traditional WAN Connectivity

In the 1980s, organizations started to see the need to interconnect their LANs with other locations. They needed their networks to connect to the local loop of a service provider by using dedicated lines or by using switched services from a service provider. When permanent dedicated connections were required, a point-to-point link using copper media was used to provide a pre-established WAN communications path from the customer premises to the provider network. Dedicated leased lines were T1/E1 or T2/E3 lines. Circuit-switched connections were provided by PSTN carriers. The local loop connecting the CPE to the CO was copper media. ISDN is a circuit-switching technology that enables the PSTN local loop to carry digital signals. This provided higher capacity switched connections than dialup access. Packet switching segments data into packets that are routed over a shared network. Packet-switching networks allow many pairs of nodes to communicate over the same channel. Frame Relay is a simple Layer 2 NBMA WAN technology used to interconnect enterprise LANs. ATM technology is capable of transferring voice, video, and data through private and public networks. It is built on a cell-based architecture rather than on a frame-based architecture.

Modern WAN Connectivity

Modern WAN connectivity options include dedicated broadband, Ethernet WAN and MPLS (packet-switched), along with various wired and wireless version of internet-based broadband. Service providers now offer Ethernet WAN service using fiber-optic cabling. Ethernet WAN reduces expenses and administration, is easily integrated with existing networks, and enhances business productivity. MPLS is a high-performance service provider WAN routing technology to interconnect clients. MPLS supports a variety of client access methods (e.g., Ethernet, DSL, Cable, Frame Relay). MPLS can encapsulate all types of protocols including IPv4 or IPv6 traffic.

Internet-Based Connectivity

Internet-based broadband connectivity is an alternative to using dedicated WAN options. There are wired and wireless versions of broadband VPN. Wired options use permanent cabling e.g., copper or fiber) to provide consistent bandwidth, and reduce error rates and latency. Examples of wired broadband connectivity are Digital Subscriber Line (DSL), cable connections, and optical fiber networks. Examples of wireless broadband include cellular 3G/4G/5G or satellite internet services. DSL is a high-speed, always-on, connection technology that uses existing twisted-pair telephone lines to provide IP services to users. All forms of DSL are categorized as either ADSL or SDSL. The DSL modem converts the Ethernet signals from the teleworker device to a DSL signal, which is transmitted to a DSLAM at the provider location. The advantage that DSL has over cable technology is that DSL is not a shared medium. ISPs still use PPP as the Layer 2 protocol for broadband DSL connections. A DSL modem has a DSL interface to connect to the DSL network and an Ethernet interface to connect to the client device. Ethernet links do not natively support PPP. Cable technology is a high-speed always-on connection technology that uses a cable company coaxial cable to provide IP services to users. Cable operators deploy hybrid fiber-coaxial (HFC) networks to enable high-speed transmission of data to cable modems. The cable system uses a coaxial cable to carry radio frequency (RF) signals to the end user. Many municipalities, cities, and providers install fiber optic cable to the user location. This is commonly referred to as Fiber to the x (FTTx) and versions are FTTH, FTTB, and FTTN.

Wireless technology uses the unlicensed radio spectrum to send and receive data. The unlicensed spectrum is accessible to anyone who has a wireless router and wireless technology in the device they are using. Until recently, one limitation of wireless access has been the need to be within the local transmission range (typically less than 100 feet) of a wireless router or a wireless modem that has a wired connection to the internet. Newer developments in wireless technology include Municipal Wi-Fi, Cellular, Satellite Internet, and WiMAX. To address security concerns, broadband services provide capabilities for using Virtual Private Networks (VPN) connections to a network device that accepts VPN connections, which is typically located at the corporate site. A VPN is an encrypted connection between private networks over a public network, such as the internet. Instead of using a dedicated Layer 2 connection, such as a leased line, a VPN uses virtual connections called VPN tunnels. VPN tunnels are routed through the internet from the private network of the company to the remote site or employee host. Common VPN implementations include site-to-site and remote access. ISP connectivity options include single-homed, dual-homed, multihomed, and dual-multihomed. Cable, DSL, fiber-to-the-home, cellular/mobile, municipal Wi-Fi, and satellite internet all have advantages and disadvantages. Perform a cost-versus-benefit analysis before choosing an internet-based connectivity solution.

7.6.3

Module Quiz - WAN Concepts

1. A company is expanding its business to other countries. All branch offices must remain connected to corporate headquarters at all times. Which network technology is required to support this scenario?
   - (•) WAN
   - ( ) WLAN
   - ( ) LAN
   - ( ) MAN

2. What is the recommended technology to use over a public WAN infrastructure when a branch office is connected to the corporate site?
   - ( ) ATM
   - ( ) ISDN
   - (•) VPN
   - ( ) municipal Wi-Fi

3. Which medium do service providers use to transmit data over WAN connections with SONET, SDH, and DWDM?
   - ( ) Wi-Fi
   - ( ) copper
   - (•) fiber optic
   - ( ) satellite

4. Which statement describes a characteristic of a WAN?
   - (•) WAN networks are owned by service providers.
   - ( ) All serial links are considered WAN connections.
   - ( ) A WAN operates within the same geographic scope of a LAN, but has serial links.
   - ( ) A WAN provides end-user network connectivity to the campus backbone.

5. Which type of network would be used by a company to connect locations across the country?
   - (•) WAN
   - ( ) WLAN
   - ( ) SAN
   - ( ) LAN

6. A small company with 10 employees uses a single LAN to share information between computers. Which type of connection to the Internet would be appropriate for this company?
   - ( ) a dialup connection that is supplied by their local telephone service provider
   - (•) a broadband service, such as DSL, through their local service provider
   - ( ) private dedicated lines through their local service provider
   - ( ) Virtual Private Networks that would enable the company to connect easily and securely with employees

7. To which two layers of the OSI model do WAN technologies provide services? (Choose two.)
   - [x] physical layer
   - [ ] session layer
   - [ ] presentation layer
   - [ ] network layer
   - [x] data link layer
   - [ ] transport layer

8. A customer needs a metropolitan area WAN connection that provides high-speed, dedicated bandwidth between two sites. Which type of WAN connection would best fulfill this need?
   - ( ) circuit-switched network
   - ( ) MPLS
   - ( ) packet-switched network
   - (•) Ethernet WAN

9. An intercity bus company wants to offer constant Internet connectivity to the users traveling on the buses. Which two types of WAN infrastructure would meet the requirements? (Choose two.)
   - [ ] private infrastructure
   - [x] cellular
   - [ ] circuit-switched
   - [ ] dedicated
   - [x] public infrastructure

10. An enterprise has four branches. The headquarters needs full connectivity to all branches. The branches do not need to be connected directly to each other. Which WAN topology is most suitable?
    - ( ) point-to-point
    - ( ) bus
    - (•) hub and spoke
    - ( ) full mesh
    - ( ) mesh

11. What is a characteristic of a WAN?
    - ( ) WANs always use physical cables to connect LANs.
    - (•) WAN service providers include carriers such as a telephone network or satellite service.
    - ( ) A WAN is typically owned by an enterprise which wants to interconnect its LANs.
    - ( ) A WAN operates inside the geographic scope of a LAN.

12. What are two common types of circuit-switched WAN technologies? (Choose two.)
    - [ ] ATM
    - [ ] DSL
    - [ ] Frame Relay
    - [x] PSTN
    - [x] ISDN

13. A new corporation needs a data network that must meet certain requirements. The network must provide a low cost connection to sales people dispersed over a large geographical area. Which two types of WAN infrastructure would meet the requirements? (Choose two.)
    - [ ] satellite
    - [ ] private infrastructure
    - [x] public infrastructure
    - [x] Internet
    - [ ] dedicated

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