CTS2134
Introduction to Networking

Module 07:
Wide Area Networks
WAN components

• WAN cloud
• Central Office (CO)
• Local loop
• Demarcation point (demarc)
• Consumer Premises Equipment (CPE)
• Channel Service Unit/Data Service Unit (CSU/DSU)
Data Transfer Methods

Circuit Switching

- Dedicated connection between sites. Data that must arrive in the order it is sent (real-time video)

Packet Switching

- Data is broken up into packets. Packets are transmitted along the most efficient route to the destination. Packet switching is ideal for transmitting data that can handle transmission delays.
PSTN
(Public Switched Telephone Network)

• Uses the Plain Old Telephone Service (POTS)
• Dedicated circuit switched analog signals over phone lines connected with a modem.
• Maximum transfer rate: 56 Kbps.
• Offers “sufficient” network connectivity for a minimal investment.
• Available virtually anywhere that regular voice grade communications are available.
• The phone line cannot be used for voice and the Internet concurrently.
DSL
(Digital Subscriber Line)

• Sends **digital signals** over copper telephone lines using multiple channels (up to 20Mbps). One channel is dedicated to the phone line, additional channels are used for data.

• Requires a **DSL router** to connect to the phone line.

• Requires a location to be within a fixed distance of network switching equipment (**local loop**).
ISDN
(Integrated Services Digital Network)

A digital virtual circuit is established over copper telephone lines as a local loop technology. Implemented widely in Europe.

**BRI (Basic Rate Interface) or 2B + 1D**
- 2 B (bearer) channels (at 64 Kbps) transfer data.
- 1 D (delta) channel (at 16 Kbps) for connection control.

**PRI (Primary Rate Interface) or 23B + 1D**
- 23 B channels (at 64 Kbps) transfer data.
- 1 D channel (at 64 Kbps) for connection control.
Cable

• High-speed bi-directional channel connected directly to an Internet Service Provider (ISP) through cable TV lines.
• Uses a cable modem to convert multiplexed analog signals over multiple channels.
• Dependent upon service offerings from the regional cable television company.
Satellite

• Satellite service providers offer nearly 100% global network coverage.
• Requires a dish directed skywards to a Satellite.
• Requires direct line of sight.
• Subject to mild atmospheric and weather conditions (fog or slight wind can disrupt service).
• Downloading is very fast. A POTS modem may be required to upload (very slow).
Wireless

• Very short range
• Offers continuous network access through strategic placement of Wireless Access Points.
• Broadcasts openly and can be easily detected (data encryption is advisable).
• Availability is increasing (businesses, hotels, airports, and even some communities currently provide wireless service).
Frame Relay

Frame Relay is a protocol used to connect to a WAN over dedicated (leased) lines.

- Frame Relay is a packet switching technology, that establishes a permanent virtual circuit between two locations.
- Customer’s routers connect to the T1 line through a CSU/DSU.
- Frame Relay networks provide error detection but not error recovery. End devices request retransmission of lost packets.
- Committed Information Rate (CIR) represents the maximum guaranteed data transmission rate you will receive on the Frame Relay network.
ATM (Asynchronous Transfer Mode)

ATM is connection-oriented communication technology designed for carrying time-sensitive data such as voice and video.

• ATM is a packet switching technology that uses fixed-length data units called cells. Each cell is 53-bytes.
• ATM establishes a virtual circuit between two locations.
• The cell header includes labels that identify the virtual path information. ATM switches in the WAN cloud use the virtual path to switch cells within the WAN to the destination.
SONET
(Synchronous Optical Networking)

SONET is a packet switching technology that uses different frame sizes that can carry other types of traffic such as ATM, Ethernet, and IP.

• Most PSTN networks use SONET within the long-distance portion of the PSTN network.
• SONET networks use dual, counter-rotating fiber optic rings. If a break occurs in one ring, data can be routed over the other ring to keep traffic flowing.
• Data rates vary from between 51 Mbps up to about 160 Gbps.
**MPLS**
(Multiprotocol Label Switching)

MPLS is a connection-oriented, packet switching technology that supports variable-length frames.

- MPLS adds a label to packets when the packet enters the MPLS network, and removes the label when the packet exits the network.
- Information in the label is used to switch the packet through the MPLS network to the destination.
- MPLS labels can identify the route or even the network type to use. MPLS labels are often used to provide different classes of service for data streams.
WAN Service Bandwidth Standards

When you contract for WAN services, you will need to understand your bandwidth needs to choose the appropriate cabling option.

Frame Relay: 1.54 Mbps
T1: 1.544 (24 channels at 64Kbps) over UTP
T3: 44.736 Mbps (672 channels at 64Kbps)
OC-1: 51.84 Mbps (SONET fiber optic cabling)
Remote Access Facts

Remote access allows a host to connect remotely to a private server or a network to access resources on that server or network.

• Allows users access when they're away from the office.
• Once authenticated, users can map network drives, modify files and data, and connect to shared folders as if they were at a computer in the office.

Connection parameters
• The Point-to-Point Protocol (PPP) is used for dial-up connections.
• PPP over Ethernet (PPPoE) is used for connections that are "always on“ such as DSL
Remote Access Authentication Facts

**PAP** (Password Authentication Protocol)
- Username and password are sent in clear text for authentication.

**CHAP** (Challenge Handshake Authentication Protocol)

**MS-CHAP** (Microsoft Challenge Handshake Authentication Protocol)
- Encrypts both password and username and Uses a three-way handshake (challenge/response).

**EAP** (Extensible Authentication Protocol)
- Uses passwords, certificates, or smart cards.
AAA servers
(authentication, authorization, and accounting)

**RADIUS** (Remote Authentication Dial-In User Service)
- Used by Microsoft servers for centralized remote access administration.
- Uses UDP
- Encrypts only the password.
- RADIUS solutions from different vendors might not be compatible.

**TACACS+** (Terminal Access Controller Access-Control System Plus)
- Developed by Cisco for centralized remote access administration
- Used 3 protocols for authentication authorization, and accounting. This allows each service to be provided by a different server.
- Uses TCP.
- Encrypts the entire packet contents.