WAN Technology

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Introduction

• A WAN is a data communications network that covers a relatively broad geographic area and often uses transmission facilities provided by common carriers, such as telephone companies.

• WANs are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations.
• WAN technologies function at the lower three layers of the OSI reference model: the physical layer, the data link layer, and the network layer.

• The common LAN technologies operating at Layer 1/2 (such as the forms of Ethernet or Wifi) are often geared towards physically localised networks, and thus cannot transmit data over tens, hundreds or even thousands of miles or kilometres.
Introduction (cont.)
Many WANs are built for one particular organization and are private. Others, built by Internet service providers, provide connections from an organization's LAN to the Internet.

Several options are available for WAN connectivity:

- **Leased line**: Point-to-Point connection between two computers or Local Area Networks (LANs)
- **Circuit switching**: A dedicated circuit path is created between end points. Best example is dialup connections
- **Packet switching**: Devices transport packets via a shared single point-to-point or point-to-multipoint link across a carrier internetwork. Variable length packets are transmitted over Permanent Virtual Circuits (PVC) or Switched Virtual Circuits (SVC)
- **Cell relay**: Similar to packet switching, but uses fixed length cells instead of variable length packets. Data is divided into fixed-length cells and then transported across virtual circuits
Point-to-Point Links (Leased Line)

- A point-to-point link provides a single, pre-established WAN communications path from the customer premises through a carrier network, such as a telephone company, to a remote network.
- A point-to-point link is also known as a leased line because its established path is permanent and fixed for each remote network reached through the carrier facilities.
Point-to-Point Links (Leased Line) (cont.)

• A typical point-to-point link operates through a WAN to a remote network.
Point-to-Point Links (Leased Line) (cont.)

- WANs are often built using leased lines. At each end of the leased line, a router connects the LAN on one side with a second router within the LAN on the other.

- Leased lines can be very expensive. Instead of using leased lines, WANs can also be built using less costly circuit switching or packet switching methods.
Point-to-Point Links (Leased Line) (cont.)

- A leased line, a type of dedicated line, is a permanent fiber optic or telephone line connection between two points set up by a telecommunications carrier.
- It can be used for telephone, data, or Internet services.
- Often, businesses will use a leased line to connect geographically distant offices because it guarantees bandwidth for network traffic. For example, a bank may use a leased line in order to easily transfer financial information from one branch office to another.
- Both long and short distances can be spanned by a leased line, and customers generally pay a flat monthly rate for the service.
Point-to-Point Links (Leased Line) (cont.)
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Point-to-Point Links (Leased Line) (cont.)

• Leased lines do not have telephone numbers because each side of the line is always connected to the other.

• The information sent through a leased line travels along dedicated secure channels, eliminating the congestion that occurs in shared networks.

• Connection speeds can range from 64 kilobits per second (Kbps) to 10 gigabits per second (Gbps).

• The advantage of Leased Line is that it is the most secure connection and its disadvantage is that it is expensive.
Circuit Switching

• Circuit switching is a WAN switching method in which a dedicated physical circuit is established, maintained, and terminated through a carrier network for each communication session.

• Circuit switching is a WAN connectivity technique that allows circuits to be created across a network on demand, and then terminated once they are no longer required.
Circuit Switching (cont.)

• The perfect example of circuit switching in action is a normal telephone call – after you pick up the phone and dial a number, a circuit is created between your phone and the phone of the person you are calling.

• Used extensively in telephone company networks, circuit switching operates much like a normal telephone call. Dial-up and Integrated Services Digital Network (ISDN) is an example of a circuit-switched WAN technology.
Circuit Switching (cont.)

• Circuit switching is commonly used to interconnect networks in cases where a permanent connection is not required.
• For example, a company might need to transfer data to a branch office just once or twice a day.
• In cases such as this, the cost of a permanent link wouldn’t be justified. While beneficial in cases where data traffic requirements are low, circuit switched connections generally provide slower throughput rates than other technologies.
Circuit Switching (cont.)

- **Dial-up Internet access** is a form of Internet access that uses the facilities of the public switched telephone network (PSTN) to establish a dialled connection to an Internet service provider (ISP) via telephone lines. The user's computer or router uses an attached modem to encode and decode Internet Protocol packets and control information into and from analogue audio frequency signals, respectively.
Circuit Switching (cont.)

- **Integrated Services Digital Network (ISDN)** is a set of communications standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network.
- It has been available for over a decade.
- With ISDN, voice and data are carried by bearer channels (**B channels**) occupying a bandwidth of 64 kb/s (bits per second).
Circuit Switching (cont.)

- A circuit-switched WAN undergoes a process similar to that used for a telephone call.
Packet Switching

- Packet switching is a WAN switching method in which network devices share a single point-to-point link to transport packets from a source to a destination across a carrier network.
- Packet switching is a technology that splits data in network communications into manageable small pieces, called packets.
- To be able to understand packet-switching, you need to know what a packet is. The Internet Protocol (IP), just like many other protocols, breaks data into chunks and wraps the chunks into structures called packets. Each packet contains, along with the data load, information about the IP address of the source and the destination nodes, sequence numbers and some other control information. A packet can also be called a segment or datagram.
Packet Switching (cont.)

• By sending a large file in several small chunks over a network, packet switching minimizes the impact of data transmission errors.
• Statistical multiplexing is used to enable devices to share these circuits.
• Asynchronous Transfer Mode (ATM), Frame Relay, Switched Multimegabit Data Service (SMDS), and X.25 are examples of packet-switched WAN technologies.
Packet Switching (cont.)

- Packet switching transfers packets across a carrier network.
Packet Switching (cont.)

• Circuit switching is old and expensive, and it is what PSTN uses. Packet switching is more modern.
• When you are making a PSTN call, you are actually renting the lines, with all it implies. See why international calls are expensive? So if you speak for, say 10 minutes, you pay for ten minutes of dedicated line. You normally speak only when your correspondent is silent, and vice versa. Taking also into consideration the amount of time no one speaks, you finally use much less than half of what you are paying for. With VoIP, you actually can use a network or circuit even if there are other people using it at the same time. There is no circuit dedication. The cost is shared.
Packet Switching (cont.)

• Circuit-switching is more reliable than packet-switching. When you have a circuit dedicated for a session, you are sure to get all information across. When you use a circuit which is open for other services, then there is a big possibility of congestion (which is for a network what a traffic jam is for the road), and hence the delays or even packet loss.

• This explains the relatively lower quality of VoIP voice compared to PSTN. But you actually have other protocols giving a helping hand in making packet-switching techniques to make connections more reliable. An example is the TCP protocol. Since voice is to some extent tolerant to some packet loss (unless text - since a comma lost can mean a big difference), packet-switching is finally ideal for VoIP.
Packet Switching (cont.)

• A type of communications in which a dedicated channel (or circuit) is established for the duration of a transmission. The most ubiquitous circuit-switching network is the telephone system, which links together wire segments to create a single unbroken line for each telephone call.

• The other common communications method is packet switching, which divides messages into packets and sends each packet individually. The Internet is based on a packet-switching protocol, TCP/IP.

• Circuit-switching systems are ideal for communications that require data to be transmitted in real-time. Packet-switching networks are more efficient if some amount of delay is acceptable.

• Circuit-switching networks are sometimes called connection-oriented networks. Note, however, that although packet switching is essentially connectionless, a packet switching network can be made connection-oriented by using a higher-level protocol. TCP, for example, makes IP networks connection-oriented.
WAN Virtual Circuits

• A virtual circuit is a logical circuit created to ensure reliable communication between two network devices. Two types of virtual circuits exist: *switched virtual circuits* (SVCs) and *permanent virtual circuits* (PVCs).

• **SVCs** are virtual circuits that are dynamically established on demand and terminated when transmission is complete. Communication over an SVC consists of three phases: circuit establishment, data transfer, and circuit termination.

• A PVC is a permanently established virtual circuit that consists of one mode: data transfer. PVCs are used in situations in which data transfer between devices is constant.
WAN Dialup Services

• Dialup services offer cost-effective methods for connectivity across WANs. Two popular dialup implementations are dial-on-demand routing (DDR) and dial backup.

• DDR is a technique whereby a router can dynamically initiate and close a circuit-switched session as transmitting end station demand.

• Dial backup is a service that activates a backup serial line under certain conditions. The secondary serial line can act as a backup link that is used when the primary link fails or as a source of additional bandwidth when the load on the primary link reaches a certain threshold. Dial backup provides protection against WAN performance degradation and downtime.
WAN Devices

• WANs use numerous types of devices that are specific to WAN environments.
• WAN switches, access servers, modems, CSU/DSUs, and ISDN terminal adapters are discussed in the following sections.
WAN Devices (cont.)

• A WAN switch is a multiport internetworking device used in carrier networks.
• These devices typically switch such traffic as Frame Relay, X.25, and SMDS and operate at the data link layer of the OSI reference model.
WAN Devices (cont.)

- An access server acts as a concentration point for dial-in and dial-out connections.
WAN Devices (cont.)

- A modem is a device that interprets digital and analog signals, enabling data to be transmitted over voice-grade telephone lines.
- At the source, digital signals are converted to a form suitable for transmission over analog communication facilities. At the destination, these analog signals are returned to their digital form.
WAN Devices (cont.)

• A channel service unit/digital service unit (CSU/DSU) is a digital-interface device (or sometimes two separate digital devices) that adapts the physical interface on a data terminal equipment (DTE) device (such as a terminal) to the interface of a data circuit-terminating (DCE) device (such as a switch) in a switched-carrier network.

• The CSU is responsible for the connection to the telecom network while the DSU is responsible for handling the interface with the DTE.

• The CSU/DSU also provides signal timing for communication between these devices.
WAN Devices (cont.)

- The CSU/DSU stands between the switch and the terminal.
WAN Devices (cont.)

- An ISDN terminal adapter is a device used to connect ISDN Basic Rate Interface (BRI) connections to other interfaces, such as EIA/TIA-232. A terminal adapter is essentially an ISDN modem.