**WAN TECHNOLOGIES**

A WAN is a data communications network that covers a relatively broad geographical area and often uses transmission facilities provided by carriers such as telephone operators. They function at the three lower layers.

# **POINT-POINT LINKS**

This 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. The carrier company reserves point-point links for the private use of the customer. These links accommodate two types of transmissions: data gram transmissions which are composed of individually addressed frames, and data-stream transmissions which are composed of a stream of data for which address checking occurs only once.

# **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 accommodates two types of transmissions: data gram transmissions and data-stream transmissions. It is used extensively in telephone company networks, circuit switching, and operates much like a normal telephone call. ISDN is an example of circuit switching.

# **PACKET SWITCHING**

This is a WAN switching method in which network devices share a single point-point link to transport packets from source to a destination across a carrier network. 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.

# **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 (SVC’s) and permanent virtual circuits (PVC’s).

SVC’s 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. The establishment phase involves creating the virtual circuit between the source and destination devices. Data transfer involves transmitting data between the devices over the virtual circuit, and the circuit termination phase involves tearing down the virtual circuit between the source and destination devices. SVC’s are used in situations whereby data transmission is sporadic, largely because SVC’s increase bandwidth used due to the circuit establishment and termination phases, but decrease the cost associated with constant virtual circuit availability.

PVC is a permanently established virtual circuit that consists of one mode: data transfer. PVC’s are used in situations in which data transfer between devices is constant. PVC’s decrease the bandwidth use associated with the establishment and termination of virtual circuits, but increase costs due to constant virtual circuit availability.

# **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. A router is configured to consider certain traffic interesting and other traffic uninteresting. When the router receives interesting traffic destined for a remote network, a circuit is established and the traffic is transmitted normally. If the router receives uninteresting traffic and a circuit is already established, that traffic is also transmitted normally. The router maintains an idle timer that is reset only when interesting traffic is received. If the router receives no interesting traffic before the idle timer expires, however the circuit is terminated. Likewise if uninteresting traffic is received and no circuit exists the router drops the traffic. Upon receiving interesting traffic the router initiates a new circuit. DDR can be used to replace point-point links and switched multi-access WAN services.

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.

# **Wan switch**

It is a multiport internetworking device used in carrier networks. These devices switch such traffic as frame relay, x.25 and SMDS and operate at the data link layer of the OSI reference model.

# **Access server**

It acts as a concentration point for dial-in-out connections.

# **Modem**

This 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 signals are returned to their digital form.

# **CSU/DSU**

A channel service unit/ digital service unit is a digital interface device that adapts the physical interface on a data terminal equipment (DTE) device e.g. terminal, to the interface of a data circuit terminating (DCE) device e.g. switch in a switched carrier network.

# **FRAME RELAY**

It is a high performance WAN protocol that operates at the physical and data link layers. Devices attached to a Frame relay WAN fall into two categories

* Data terminal equipment (DTE’s) e.g. pc;s routers, bridges
* Data circuit- terminating equipment (DCE’s). e.g. switches

Connection between DTE and DCE involves physical components that define mechanical, electrical, functional and procedural specifications. It also involves the link layer component that defines the protocol that establishes the connection between the DTE device.

# **THE FRAME RELAY PROTOCOL**

It provides connection-oriented data link layer communication. A logical connection is created between two DTE devices across a frame relay packet-switched network (PSN).

Virtual circuits are uniquely identified by a data link connection Identifier (DLCI).

Frame relay virtual circuits fall into 2 categories

* Switched virtual circuits (SVC’s)

These are temporary connections used in situations requiring only sporadic data transfers. It involves establishing a virtual circuit, data transfer, idle time (no data transfer) and virtual-circuit termination.

* Permanent virtual circuits (PVC’s)

These are permanently established connections that are used for frequent and consistent data transfers between DTE devices. It involves data transfer4 and idle states (connection active but no data transfer).

# **CONGESTION CONTROL MECHANISMS**

Frame relay implements two congestion notification mechanisms namely:

* Forward-explicit congestion notification (FECN)
* Backward-explicit congestion notification (BECN)

**INTERGRATED SERVICES DIGITAL NETWORK(ISDN)**

ISDN involves the digitization of the telephone network that permits voice, data, text, graphics, music ,video and other sources to be transmitted over existing telephone wires.

There are two types of services

* BRI (basic rate interface) It offers two B channels and one D chaneel-2B+D. B channel operates at 64 kbps and is meant to carry user data. Channel D operates at 16kbps and is meant to carry control and signaling information.
* PRI (primary rate interface) it offers 23 B channels and 1 D channel.

# **X.25**

This is a protocol that defines how connections between user devices are established and maintained. X.25 is designed to operate effectively regardless of the type of systems connected to the network. The following protocols are used in X.25 implementations

* Packet layer protocol (PLP).

It manages packet exchanges between DTE (data terminal equipment) devices across virtual circuits. It operates in five distinct modes

* 1. Call setup: is used for transferring data between two DTE devices across a virtual circuit
  2. Idle: used when a virtual circuit is established but data transfer is not occurring
  3. Call clearing: is used to end communication sessions between DTE devices and to terminate SVCs
  4. Restarting: Used to synchronize transmission between a DTE device and a locally connected DCE device.
* Link access procedure balance (LAPB)

This protocol manages communication between DTE and DCE equipment. It ensures that frames are correctly ordered and error free.

**ROUTING PROTOCOLS**

Internet routing devices traditionally have been called gateways. The term gateway refers specifically to a device that performs application layer protocol translation between devices. Interior gateways refer to devices that perform these protocol functions between machines or networks under the same administrative control or authority. These are known as autonomous systems.

Exterior gateways perform protocol functions between independent networks. Routers within the Internet are organized hierarchically. Routers used for information exchange within autonomous systems are called interior routers; they use a variety of interior gateway protocols to accomplish this purpose. Routers that move information between autonomous systems are called exterior routers. These routers use an exterior gateway protocol to exchange information between autonomous systems.

These are protocols that implement routing algorithms and they direct protocols through an internetwork. Examples of these protocols include: interior Gateway routing protocol (IGRP), enhanced interior gateway routing protocol (Enhanced IGRP), Open shortest path first (OSPF), Exterior gateway protocol (EGP), Border gateway protocol (BGP), Intermediate system to Intermediate system (IS-IS) and Routing information protocol (RIP).

**BORDER GATEWAY PROTOCOL (BGP)**

This is an inter-autonomous system routing protocol. BGP is used to exchange routing information for the Internet and is the protocol used between Internet service providers (ISP). Customer networks usually employ an interior gateway protocol (IGP) for the exchange of routing information within their networks. Customers connect to ISPs and ISPs use BGP to exchange customer and ISP routes. When BGP is used between autonomous systems, the protocol is referred to as the External BGP (EBGP). If a service provider is using BGP to exchange routes within an AS, then the protocol is referred to as Interior BGP (IBGP)

BGP ATTRIBUTES

Routers learned via BGP have associated properties that are used to determine the best route to a destination when multiple paths exist to a particular destination. These properties are referred to as BGP attributes. They include:

* Weight: If the router learns about more than one route to the same destination the route with the highest weight will be preferred
* Local preference: used to prefer an exit point from the local autonomous system
* Multi exit discriminator: is used as a suggestion to an external AS regarding the preferred route into the AS
* Origin attribute: indicates how BGP learned about a particular route.