Post 2

Thursday, January 24, 2019 11:22 PM

CONNECTING TO THE WAN

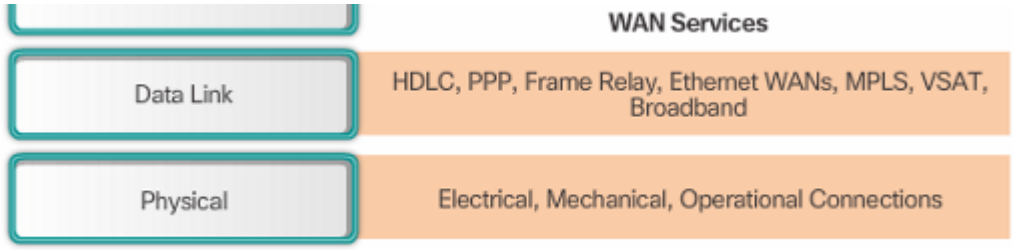
WAN: Wide Area Networks: Connects LAN's: City/country/global region: Owned by SP: Business pays fee to use

- Diff tech used for WAN's than LAN's: Beyond geographic scope of LAN

WAN provider examples: Carriers (phone/cable/satellite)

- Provide links to remote sites
- LANs: Local/peripherals/devices: W/in single building/small area: Speed/cost-efficiency for data

WANs in OSI



WAN operations: Primarily L1/L2: Addressing/flow control/encapsulation

Access standards defined by # of authorities:

- **TIA:EIA:** Telecomm Industry Association/Electronic Industries Alliance
- **ISO:** International Org Standardization
- **IEEE:** Institute of Electrical/EE's

L1: Protocols to provide electrical/mechanical/operational/functional connections

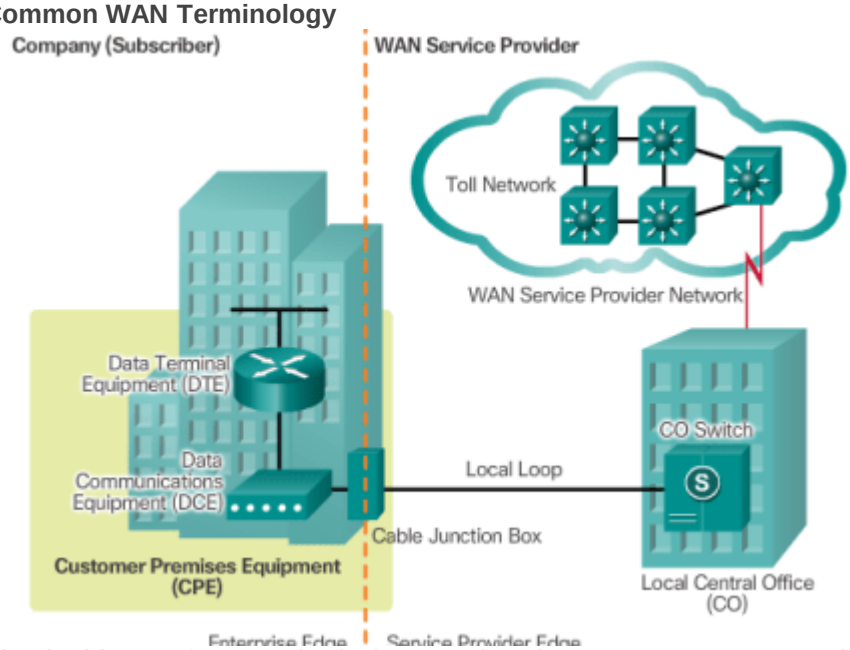
L2: Protocols define how data is encapsulated for transmission to remote location/mechanisms for transferring frames

Diff tech used:

- PPP: Point-to-Point Protocol
- Frame Relay
- ATM
- Some: Framing/subset of HDLC: High-Lvl Data Link Control mechanism

Most WAN links: Point-to-point: Addr field in L2 frame not usually used

Common WAN Terminology



Physical layer of WAN: Physical connections between company network/SP network

CPE	**Customer Premises Equipment** • Devices inside wiring closet: Located on enterprise edge connecting to carrier link

	• Sub either owns/leases CPE from SP
DCE	**Data Communications Equipment:** AKA: **Data Circuit-Terminating Equipment** • Consists of devices that put data on local loop • Primarily provides an int to connect subs to comm link on WAN cloud
DTE	**Data Terminal Equipment** • Customer devices that pass data from customer network/host computer for transmission over WAN • Connects to local loop through DCE
Demarcation Point	Point established in building that separates customer equip from SP's • Physically: Cabling junction box on customer site • Connects CPE wiring to local loop • Where responsibility changes from usr to SP
Local Loop	**AKA: Last-mile:** Actual copper/fiber that connects CPE to CO of SP
CO	**Central Office:** Local SP facility/building that connects CPE to provider network
Toll network	Long-haul/all-digital/fiber-op comm lines/switches/routers/other inside WAN provider network

WAN Devices: Many types of devices specific to WAN envs:

Dialup modem	**Legacy:** Voiceband modem converts/modulates digital sigs produced by machine into voice frequencies • Can be transmitted over analog lines of phone network • Other side: Digital sig/demodulates
Access server	**Legacy:** Dialup modem/dial-in/dial-out comm: May mix analog/digital ints
Broadband modem	Digital modem w/DSL/cable: Similar to voiceband: Uses higher frequencies/transmission speeds
CSU/DSU	**Channel Service Unit/Data Service Unit:** Digital-leased lines require: Can be separate/int on rtr **CSU:** Term for digital sig: Ensures connection integrity through error correction/line monitoring **DSU:** Converts line frames into frames LAN can interpret/vice versa
WAN switch	Multiport internetworking device used in SP networks: Switch traffic (Frame Relay/ATM): L2
Router	Internetworking/WAN access int ports: Connects to SP: • Serial/Ethernet/WAN ints/external device (DSU/CSU/modem/analog/cable/DSL)
Core rtr/Multilayer switch	In middle/backbone of WAN: Must support multiple telecomm ints of highest speed in WAN core • Must be able to fwd packets at full speed on all those ints • Must also support r-protocols being used in core

WAN: Circuit or packet switched
Circuit Switching: Network establishes dedicated circuit/channel bet nodes/terminals before usrs may comm

- Dynamically establishes dedicated virtual connection for voice/data bet sender/receiver
- Before comm: Necessary to establish connection through network SP

2 types of circuit-switched tech:

1. **PSTN: Public Switched Phone Network**
2. **ISDN: Integrated Services Digital Network**

Packet Switching: Splits traffic into packets routed over shared network

- No circuit required to establish
- Many pairs of nodes comm over same chan

PSN: Packet-Switched Network: Determine links packets must be sent over: Via addr info in each
2 approaches to link determination:

1. **Connectionless systems:** Full addressing info must be carried in each packet
    - Switches must eval addr to determine where to send packet

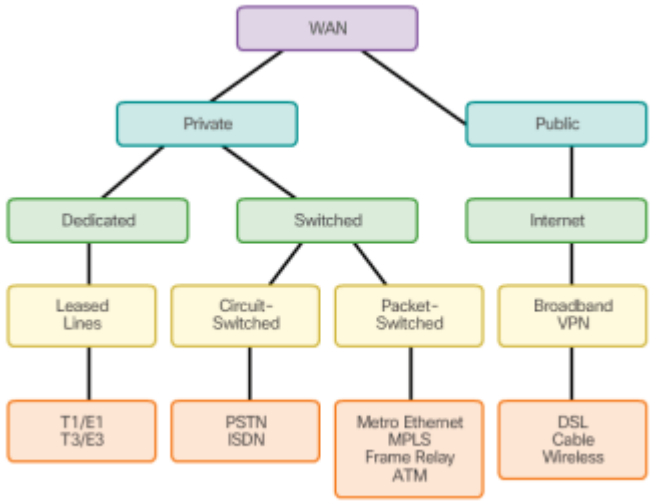
Example: Internet

1. **Connection-oriented systems:** Network predetermines route for packet
    - Each packet only needs identifier
    - Switch determines route by looking up identifier in tables/mem
    - Set of entries in tables ID's particular route/circuit through sys

Example: Frame Relay: **DLCI's: Data-link Connection Identifiers**
VC: Virtual Circuit: When circuit established temp while packet travels through it: Then breaks down again
Cost of packet switching is lower than that of circuit-switching

- Delays [latency]/variability of delay [jitter]: Greater in PSN's
- Links shared: Packets must be entirely received at 1 switch before moving
- Despite latency/jitter: Modern tech allows good transport of voice/video comms

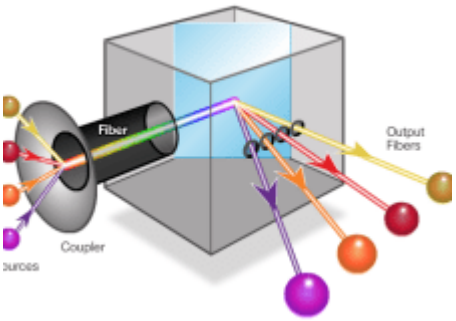
WAN Link Connection Options



Enterprise can get WAN access over:

Private WAN infrastructure	**SP's may offer dedicated:** • Point-to-point leased lines/circuit-switched links (PSTN/ISDN) • Packet-switched links (Ethernet/WAN/ATM/Frame Relay)
Public WAN infrastructure	**SP's may offer Internet using:** DSL/Satellite • Sites over public WAN should be protected w/VPNs

SP Infrastructure



Long-range comms: Usually between ISPs/bet branch offices in large companies

- **SONET: Synchronous Optical Networking:** American-based ANSI standard
- **SDH: Synchronous Digital Hierarchy (SDH):** EU-based ETSI/ITU standard
    - Standards define how to transfer multiple data/voice/video traffic over fiber using lasers/LEDs
- **DWDM: Dense Wavelength Division Multiplexing:** Newer fiber media dev for long-range comms
    - Multiplies amt of BW single strand of fiber can support

DWDM: Dense Wavelength Division Multiplexing:

- Bidirectional comm over 1 strand of fiber: Multiplex 80+ diff data chans onto single fiber
- Each chan: 10Gb/s multiplexed sig
- Assigns incoming optical sigs to wavelengths of light (freq)
- Supports SONET/SDH/Amplifies wavelengths to boost sig str
- Circuits used in submarine comm cable systems

Leased Lines: Since 1950s: Referred to as leased circuits/serial link/serial line/P2P link/T1/E1/T3/E3 lines

- Leased line: Refers to the fact org pays mo fee to SP to use
- America: SP's use T-carrier sys to define digital transmission capability of serial copper media link
- EU: E-carrier sys

OC: Optical Carrier transmission rates used to define digital capacity of fiber network
T1: 1.544 Mb/s
E1: 2.048 Mb/s
T3: 43.7 Mb/s
E3: 34.368 Mb/s

Advantages	Disadvantages
Simplicity	Cost
Quality	Limited Flexibility
Availability	L2 protocol usually HDLC/PPP

Dialup: May be required when no other WAN tech avail

- Traditional telephony: Copper cable (AKA local loop) to connect phone in sub loc to CO
- Sig on local loop: Continuously varying sig translation of sub voice into analog sig
- Local loops: Transport binary data using modem
- Modem modulates binary into analog sig at source/vice versa
- Less than 56 kb/s

Advantages	Disadvantages
Simplicity	Low data rates
Availability	Long connection time
Low cost	NO voice/video traffic

ISDN: Integrated Services Digital Network: Circuit-switching tech: Enables local loop of PSTN to carry digital sigs

- Higher capacity connections
- Changes internal connections of PSTN from carrying analog sigs to **TDM: Time-Division Multiplexed** digital sigs
- TDM: Allows 2/more sigs (bit streams) to be transferred as subchannels in 1 comm chan
- Signals appear to transfer simultaneously: Physically: They take turns on chan

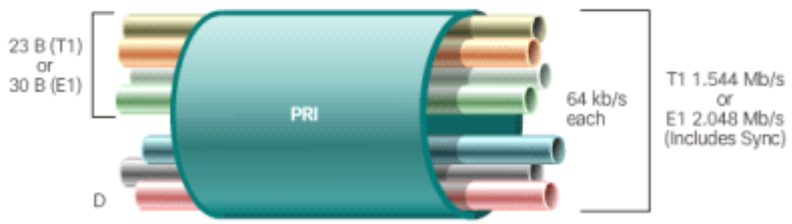
TA: Terminal Adapter: Device used to connect ISDN **BRI: Basic Rate Int** connection to a router
ISDN turns local loop into TDM digital connection:

- Enables local loop to carry digital sigs: Higher capacity
- 64 kb/s bearer chan (B): Voice/data
- Sig/delta chan (D): Call setup

2 Types of ISDN ints:

BRI: Basic Rate Interface: Intended for SOHO:

- 2 64 kb/s B chans/16 kb/s D chan
- D chan: Designed for control
- Call setup time: Less than sec



PRI: Primary Rate Interface: Larger installs: America: Delivers:

- 23 B chans w/64 kb/s and 1 D chan w/64 kb/s: Total bit rate of up to 1.544 Mb/s
- Includes add overhead for synchronization
- EU/AUS: 30 B chans/1 D chan: Total bit rate of up to 2.048 Mb/s

Frame Relay	L2 **NBMA: Non-broadcast Multiaccess** WAN tech: Interconnects enterprise LANs • Single router int can be used to connect to multiple sites using PVCs • PVCs: Used to carry both voice/data traffic bet source/destination • Support rates up to 4 Mb/s • Edge router only reqs single int ○ Frame Relay creates PVCs: Uniquely ID's by DLCI: Data-Link Connection Identifier ○ PVCs/DLCIs: Ensure bidirectional comm from 1 DTE device to another
ATM	**Asynchronous Transfer Mode:** Capable of transferring voice/video/data: Public/private networks • Built on cell-based arch, not frame-based • ATM cells: Always 53 bytes • 5-byte ATM header: 48 byte payload • Less efficient than bigger frames/packets of Frame Relay • At least 5 bytes of overhead for each 48-byte payload **When cell carrying segmented network layer packets:** Overhead higher b/c • ATM switch must reassemble packets at destination • Needs almost 20% greater BW than Frame Relay to carry same vol of network layer data • Extremely scalable • Supports link speeds: T1/E1/OC-12 (622 Mb/s)/more • Both PVCs/SVCs

Ethernet WAN: Originally to be a LAN tech:
- 1000BASE-LX: Fiber lengths of 5 km
- 1000BASE-ZX: Up to 70 km cable lengths

Many names: MetroE: Metropolitan Ethernet/EoMPLS: Ethernet over MPLS/VPLS: Virtual Private LAN Service
Benefits: Reduced expenses/Easy integration/Productivity
MPLS: Multiprotocol Label Switching: High-performance WAN tech: Directs data from 1 rtr to next
- Based on short path labels: Not IP network addr

Defining chars: Multiprotocol: Ability to carry any payload: IPv4/IPv6/Ethernet/ATM/DSL/Frame Relay
- Labels tell rtr what to do w/packet
- Labels ID paths bet distant rtrs rather than endpoints
- SP tech: Bits bet sites/Frame Relay/Ethernet WAN frames bet sites
- Can deliver any type of packet bet sites
- Can encapsulate packets of various network protocols
- Supports wide range of WAN tech: T-carrier/E-carrier links/Carrier Ethernet/ATM/Frame Relay/DSL

VSAT: Very Small Aperture Terminal: Creates private WAN using satellite comm: Small dish
- Rtr connects to dish pointed to SP satellite: Geosynchronous orbit in space
- Sigs must travel approx. 35,786 kilometers (22,236 miles) to satellite/back

DSL: Always-on connection tech: Uses existing twisted-pair phone lines to transport BW
- DSL modem: Converts eth0 sig from usr device to DSL sig: Transmitted to CO
- Multiple DSL sub lines multiplexed into single link using **DSLAM: DSL Access Multiplexer**at provider

DSLAMs: Incorporate TDM to aggregate many sub lines into a 1 medium: T3 (DS3)
Cable: Coaxial widely used in urban areas to distribute TV sigs: Greater BW than phone local loop
- Always-on connection
- Cable modem: Translates digital sigs into broadband frequencies used for transmitting TV

Cable headend: Local cable TV office
CMTS: Cable Modem Termination System: Sends/receives digital modem sigs on network
- All local subs share same BW

Wireless: Unlicensed radio spectrum/3G/4G:

Municipal Wi-Fi	High-speed access for free/substantially less: OR: City use: Police • Modem: Stronger radio/directional antenna than reg
WiMAX	**Worldwide Interoperability for Microwave Access:** 802.16

	• Similar to Wi-Fi/cell towers • Higher speeds/greater distances/greater # of usrs • Sub to ISP w/WiMAX tower w/in 30 miles • Receiver/special encryption code to get access to base STA
Satellite	VSAT: 2-way (UL/DL) data comm: UL speed 1/10th of 500 kb/s DL
3G/4G	Radio waves comm through nearby mobile tower: 3rd/4th gen cell access
LTE	**Long-Term Evolution:** 4th gen tech

VPN: Encrypted connection bet private networks over public network (Internet)

- Instead of dedicated L2 connection: VPN uses virtual connections called tunnels
- Routed through Internet from private network to remote site/employee host

Benefits: Cost savings/Security/Scalability/Compatibility w/broadband

2 Types of VPN access:

Site-to-site	Connect entire networks to each other: Each site equipped w/gateway
Remote-access	Individual hosts access company network securely over net: Host has VPN SW