13(A). Point-to-Point WANs

WAN CONCEPTS

WAN (Wide Area Network)—Generally refers to a link connecting two distinct locations under the same control (branch offices of the same company). Almost always, traffic across the link is controlled by the enterprise, while the link itself is physically owned and maintained by some third party service provider, like a telephone company (telco).

Leased Line—Like a phone call that never hangs up. A leased line delivers bits in both directions from one fixed location to another for as long as you pay the bill. The line itself is owned by some third party, often a telephone company. It operates at OSI layer 1 (physical), just delivering bits, which means that you need to provide an L2 encapsulation, like HDLC or PPP.

Full Duplex—a bidirectional link; the two directions don't have to take turns, they each have their own wires.

Symmetric—leased lines deliver bits in both directions at the same speed.

Asymmetric—The speed of one direction is faster than the other. Often seen in home connections like DSL and cable, where speeds into the home are 6-7 times faster than speeds out..

LEASED LINE (LAYER 1)

Leased Line—Full duplex, symmetric

CPE (Customer Premises Equipment)—Equipment physically located on the customer's premises, even if it's owned and administered by the service provider.

CSU/DSU (Channel Service Unit / Data Service Unit)—AKA CSU, handles clocking to control router output speed

Serial Cable—CSU to the router. Router end is smart-serial. Order the cable with the right connector for your CSU/DSU on the other end (EIA/TIA-231, V.35 (big), X.21 (15 pin D-sub)

WIC (WAN Interface Card), HWIC (High-speed WIC), NM (Network Module), NIM (Network Interface Module)—Various formats for add-on cards in Cisco routers which can provide a serial connection. NIMs are new; NMs are huge and old.

TDM (Time Division Multiplexing)—E1 and E3 are European alternatives to T1 and T3

- DS0—One 64 Kb/s channel
- DS1 (T1)—24 x DS0 + 8 Kb/s overhead = 1.544 Mb/s
- Fractional T1—Customer can by multiples of 64 up to DS1 or multiples of T1 up to T3
- DS3 (T3)—28 x DS1 + overhead = 44.736 Mbps

DCE (Data Circuit-terminating Equipment)—The CSU/DSU. Controls clocking, telling router when to send each bit. This end of a smart serial cable has a female V.35 connector and is crossed over.

DTE (Data Terminal Equipment)—The router. The DTE end of a Cisco cable has a male V.35. Connecting a DCE cable to a DTE cable gives you a crossover between 2 routers, good for practicing. Or, just get a special smart serial crossover cable online.

You can also find out if a DCE or DTE cable is connected to your router with "show controllers."

R5	R7
R5# **show controllers s0/2/0** Interface Serial0/2/0 Hardware is GT96K DTE V.35idb at 0x49CF9B34, …	R7# **show controllers s0/2/0** Interface Serial0/2/0 Hardware is GT96K DCE V.35, clock rate 2000000 …

One difference between serial lines and Ethernet is that routing protocols can't automatically determine the speed of a serial line's clock. To give OSPF or EIGRP accurate bandwidth information for metric calculation and prevent the protocol from hogging the link with its own traffic (by default, EIGRP restricts its overhead to 50% of available bandwidth), you can manually specify the "real" bandwidth of a link [line 5], overriding the T1 (1.544 Mbps) default. You can also insert a description [line 2]. Adding an L3 address, such as IPv4 is predictable and doesn't change from one L2 encapsulation to another [Line 7].

```
1 R7(config)# interface s0/2/0
2 R7(config-if)# Description WAN to Chicago Office
3 R7(config-if)# clock rate 64000
4                 Specified in bps (bits per second)
5 R7(config-if)# bandwidth 64
6                 Specified in Kbps
7 R7(config-if)# ip address 172.16.0.1 255.255.255.252
8 R7(config-if)# no shutdown
```

Configuration Verification

OSI layer 1 information, such as clock rate, can be seen using the "show controllers" command (top of page). L2 and L3 information can be shown in a number of ways, regardless of encapsulation. The command "show interfaces status," available on switches, returns no information on a router.

COMMAND	IP	L2 ENCAP	STATUS	CLOCK	B/W	DESCRIP
show ip interface brief	•		•			
show interfaces description			•			•
show interfaces [s0/0/0]	•	•	•		•	•
show controllers [s0/0/0]				DCE only		

```
1 R7# show ip interface brief
2 Interface                  IP-Address      OK? Method Status                Protocol
3 GigabitEthernet0/0         10.13.0.3       YES NVRAM  up                    up
4 GigabitEthernet0/1         10.23.0.3       YES NVRAM  up                    down
5 Serial0/2/0                172.16.0.1      YES manual down                  down
6 Serial0/2/1                unassigned      YES NVRAM  administratively down down
```

```
1 R7# show interfaces description
2 Interface                    Status         Protocol Description
3 Gi0/0                        up             up
4 Gi0/1                        up             down
5 Se0/2/0                      down           down     WAN to Chicago Office
6 Se0/2/1                      admin down     down
```

```
R7# show interfaces s0/2/0
Serial0/2/0 is down, line protocol is down
  Hardware is GT96K Serial
  Description: WAN to Chicago Office
  Internet address is 172.16.0.1/30
  MTU 1500 bytes, BW 64 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  CRC checking enabled
  Last input never, output 07:41:25, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes, 0 no buffer
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     1 packets output, 24 bytes, 0 underruns
     0 output errors, 0 collisions, 53 interface resets
     0 unknown protocol drops
     0 output buffer failures, 0 output buffers swapped out
     1 carrier transitions
     DCD=up  DSR=up  DTR=down  RTS=down  CTS=up
```

HDLC (Layer 2)

A Cisco HDLC frame looks almost exactly like an Ethernet frame. If you ignore the start frame delimeter, it's really only missing the source address—not needed in a point-to-point topology.

Flag	Address	Control	Type (Cisco Only)	Data	FCS
1 byte	1	1	2	(Amount Varies)	2 bytes

- The *Flag* simply tells the receiver to expect a frame, just like Ethernet
- *Address* (destination) and *Control* are left over from the days of multi-drop lines. There is no source address like there is with Ethernet
- The *Type* flag allows Cisco frames to identify which L3 protocol is encapsulated in the *Data*
- The *FCS (Frame Check Sequence)* allows corrupt frames to be identified and discarded

HDLC is the default Cisco encapsulation, so it won't actually appear in your running-config. It can be specified by either of the following:

```
R1(config-if)# encapsulation hdlc
```

Or, if there was already another encapsulation declared, you can revert to default HDLC…

```
R1(config-if)# no encapsulation <something else>
```