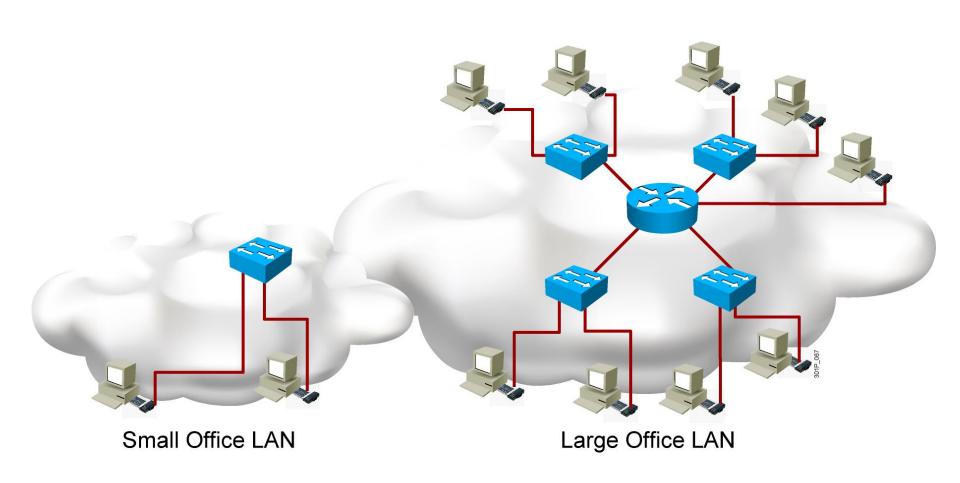


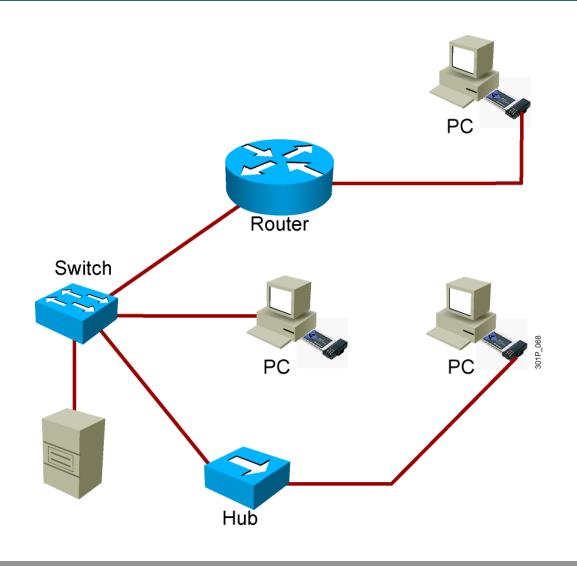
Understanding Ethernet

Local Area Network



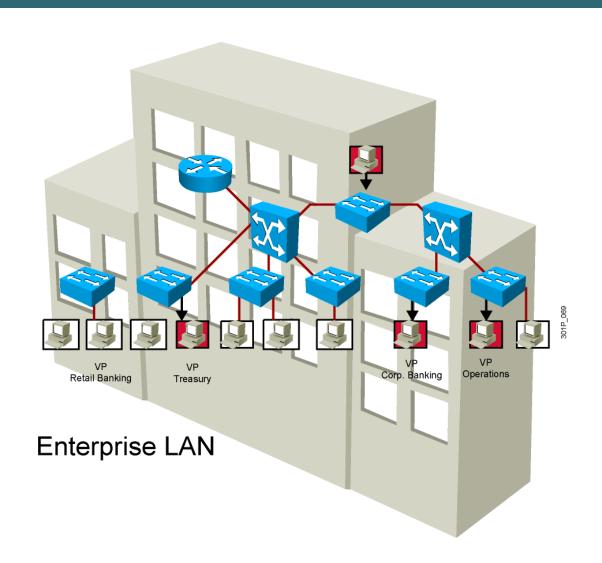
LAN Components

- Computers
 - PCs
 - Servers
- Interconnections
 - NICs
 - Media
- Network devices
 - Hubs
 - Switches
 - Routers
- Protocols
 - Ethernet
 - IP
 - ARP
 - DHCP

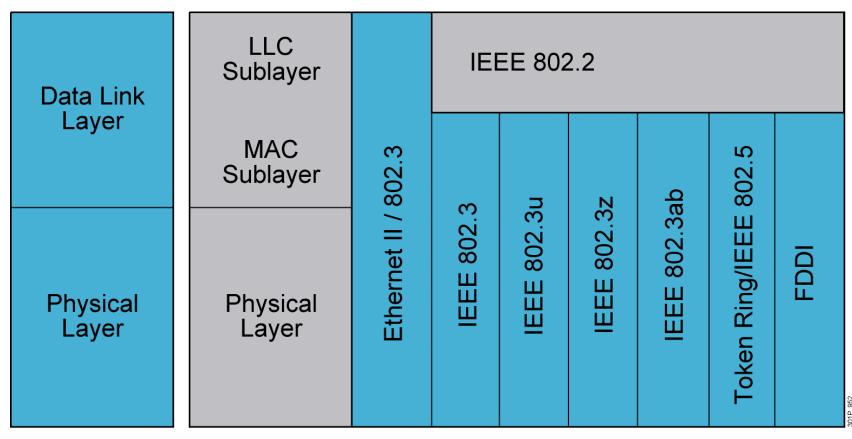


LAN Sizes





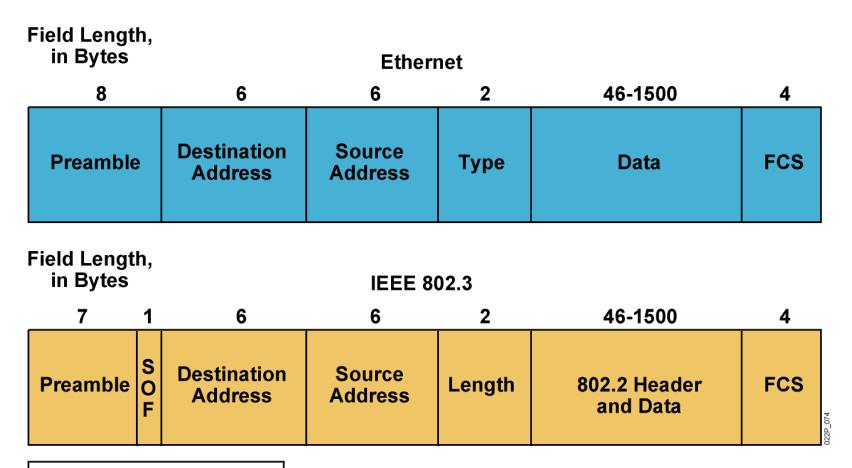
LAN Standards



OSI Layers

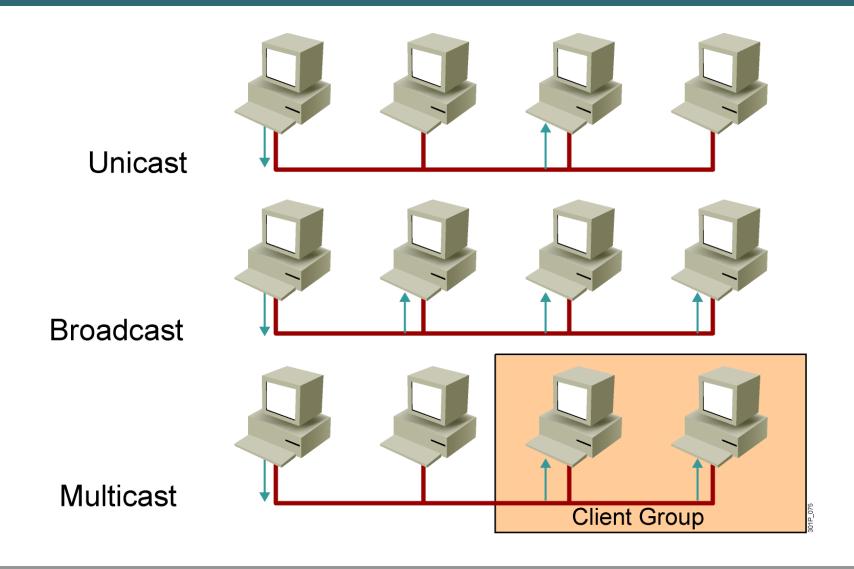
LAN Specification

Ethernet Frame Structure

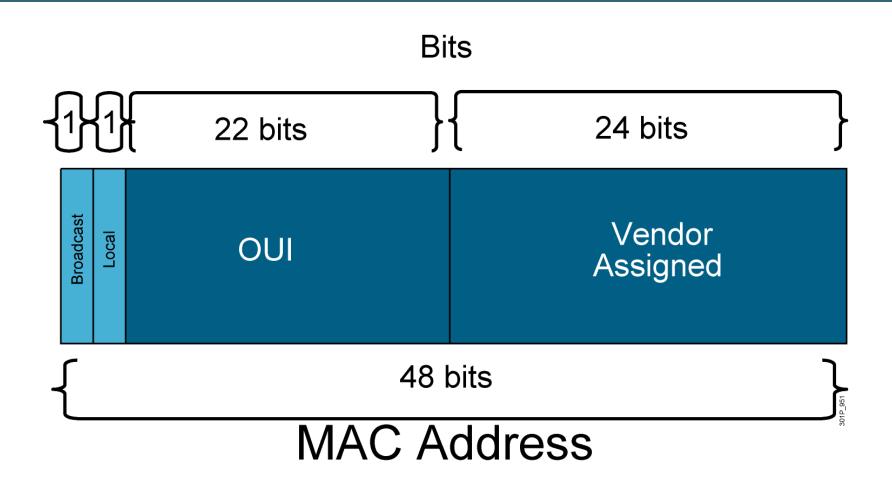


SOF = Start-of-Frame Delimiter FCS = Frame Check Sequence

Communicating Within the LAN



MAC Address Components



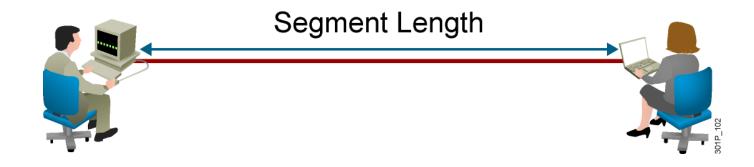
OUI: Organizational Unique Identifier

MAC Addresses

00:00:0c:43:2e:08

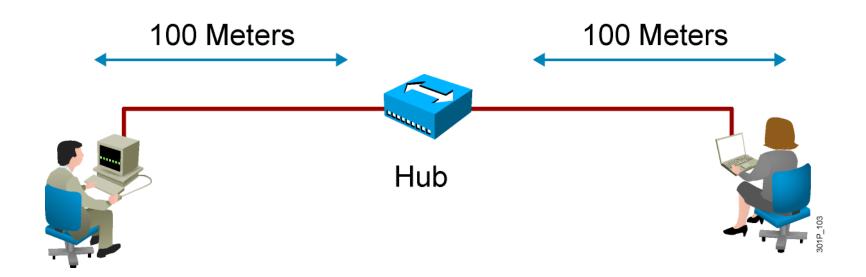
Broadcast	Local	OUI	Vendor Assigned
			30F 076

LAN Segment Limitations



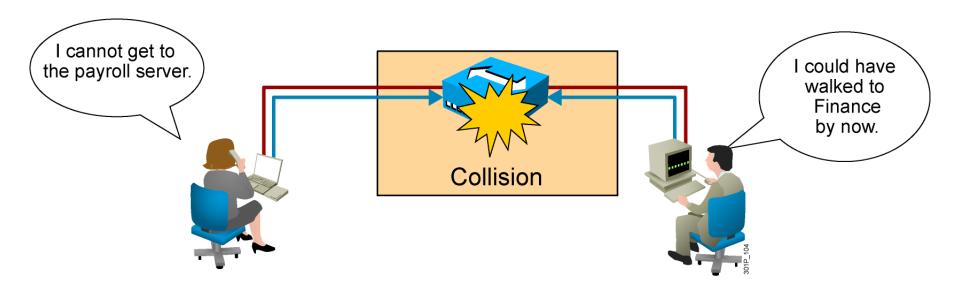
- Signals degrade with transmission distance.
- Each Ethernet type has a maximum segment length.

Extending LAN Segments

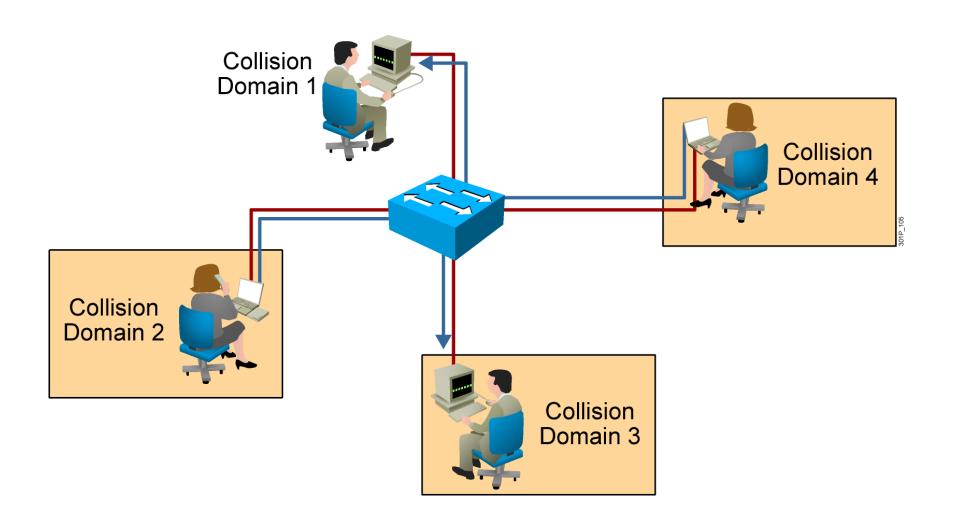


- Shares bandwidth
- Extends cable distances
- Repeats or amplifies signal
- Half-duplex

Collisions



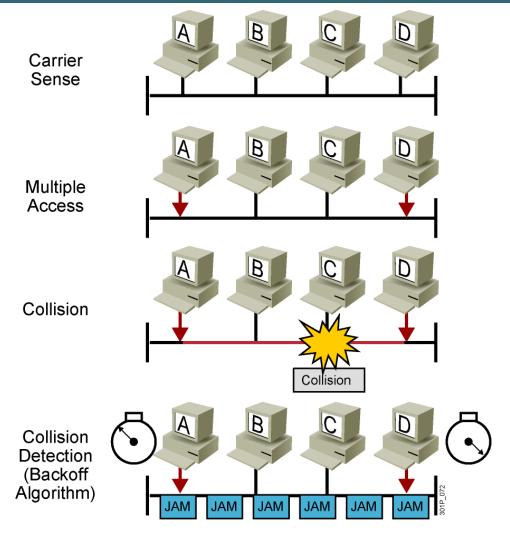
Multiple Collision Domains



Collision & Broadcast Domains

- No. of Broadcast domains = No. of every active interface of the Routers
- No. of Collision domains = No. of every active interface of the Switches & Routers

CSMA/CD



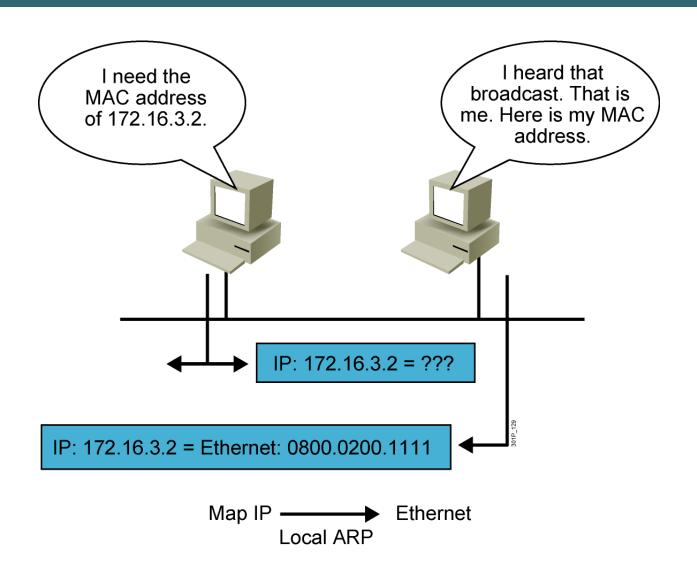
Carrier Sense Multiple Access Collision Detection (CSMA/CD)



ARP

Exploring the Packet Delivery Process

ARP



ARP Table

```
C:\WINNT\system32\cmd.exe
D:\>arp -a
Interface: 192.168.1.101 on Interface 0x1000003
  Internet Address
                        Physical Address
                                               Type
  192.168.1.1
                         00-04-5a-22-ec-c7
                                               dynamic
                         00-02-4b-cc-d6-d9
                                               dynamic
                         00-02-fd-65-9f-82
                                               dynamic
                        00-03-6b-09-59-29
                                               dynamic
                        00-02-4b-cc-d6-d0
  192.168.1.100
                                               dynamic
                        00-03-6d-1e-6a-a5
  192.168.1.135
                                               dynamic
  192.168.1.149
                        00-50-8b-f7-cf-59
                                               dynamic
D:\>_
```

Host-to-Host Packet Delivery (1 of 22)

Application: Network, can you set up reliable connection to 192.168.3.2 for me?

Transport: I'll use TCP.

Transport: TCP! Set up a session to 192.168.3.2.

TCP: IP! Send this TCP SYN to 192.168.3.2.

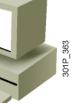
Layer 3 = 192.168.3.1

TCP SYN

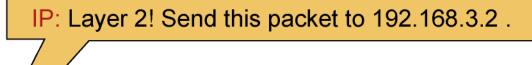
Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2





Host-to-Host Packet Delivery (2 of 22)



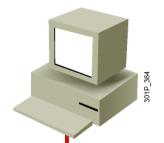
SRC IP 192.168.3.1

DST IP 192.168.3.2 TCP SYN



Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

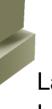


Host-to-Host Packet Delivery (3 of 22)

Layer 2: ARP, do you have a mapping for 192.168.3.2?

ARP: Is 192.168.3.2 in my ARP table? No, I guess Layer 2 will have to put the packet in the parking lot until I do an ARP.

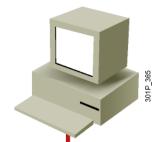
SRC IP 192.168.3.1 DST IP 192.168.3.2 TCP SYN



Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2



Host-to-Host Packet Delivery (4 of 22)

ARP: First comes the ARP request. It will say that I am 192.168.3.1 Parking Lot with a MAC of 0800:0222:2222. Are you 192.168.3.2? **Packet** ARP: Layer 2! Send this using our MAC as the

ARP Request SRC MAC and a broadcast as the DST MAC.

DST MAC Broadcast

SRC MAC 0800:0222:2222

ARP Request



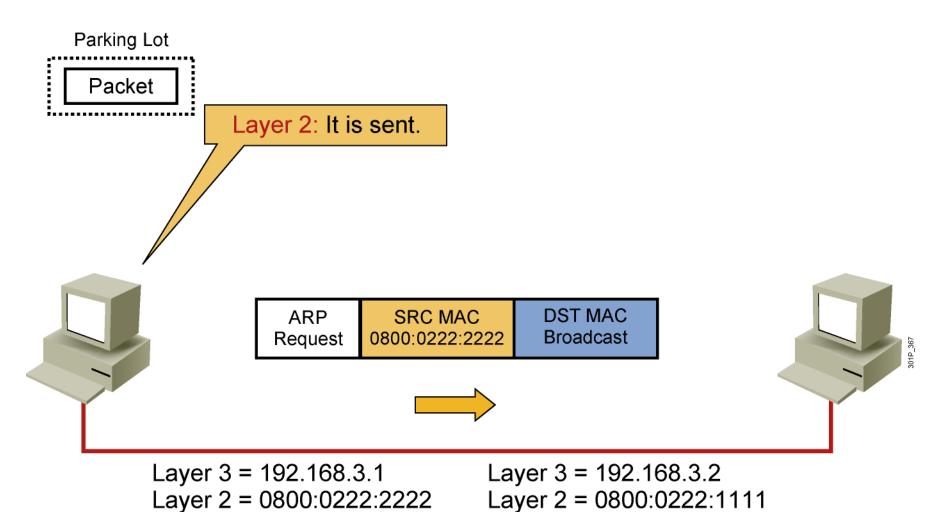
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2



Host-to-Host Packet Delivery (5 of 22)

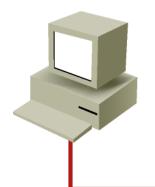


Host-to-Host Packet Delivery (6 of 22)



Packet

Layer 2: I just got a frame with a broadcast MAC so I'll process it. The protocol ID indicates that it belongs to ARP. Let me strip the Layer 2 header and send it to ARP.



ARP SRC MAC 0800:0222:2222

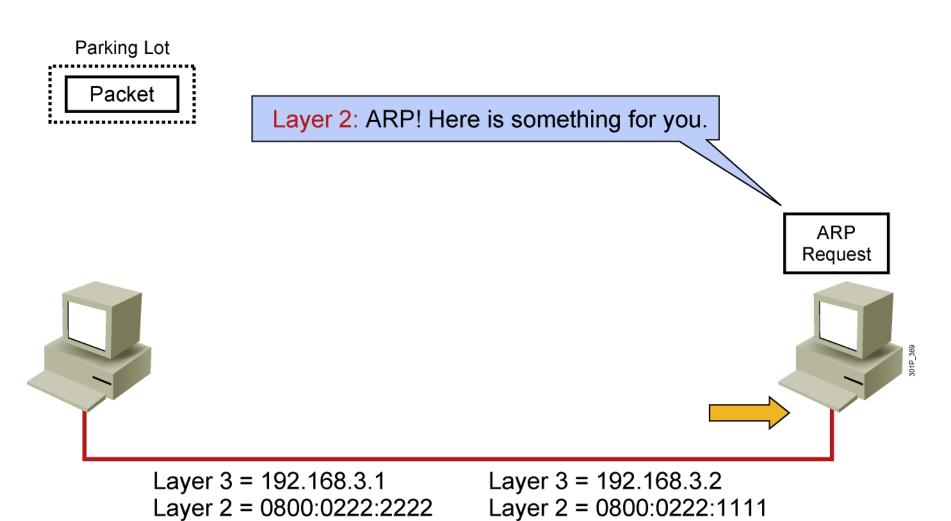
DST MAC Broadcast

Layer 3 = 192.168.3.1

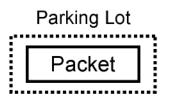
Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

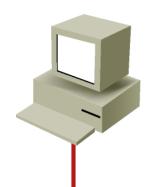
Host-to-Host Packet Delivery (7 of 22)



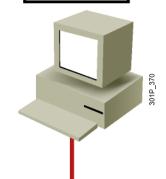
Host-to-Host Packet Delivery (8 of 22)



ARP: I just got an ARP request from 192.168.3.1. Let me add its IP and MAC to my ARP table. Now I can respond.



ARP Request



Layer 3 = 192.168.3.1 Layer 2 = 0800:0222:2222 Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (9 of 22)

Parking Lot

Packet

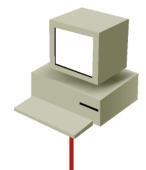
ARP: The ARP reply will say that I am 192.168.3.2 with a MAC of 0800:0222:1111.

ARP: Layer 2, send this using our MAC as the SRC MAC and 0800:0222:222 as the DST MAC.

ARP Reply

DST MAC 0800:0222:2222

SRC MAC 0800:0222:1111 ARP Reply

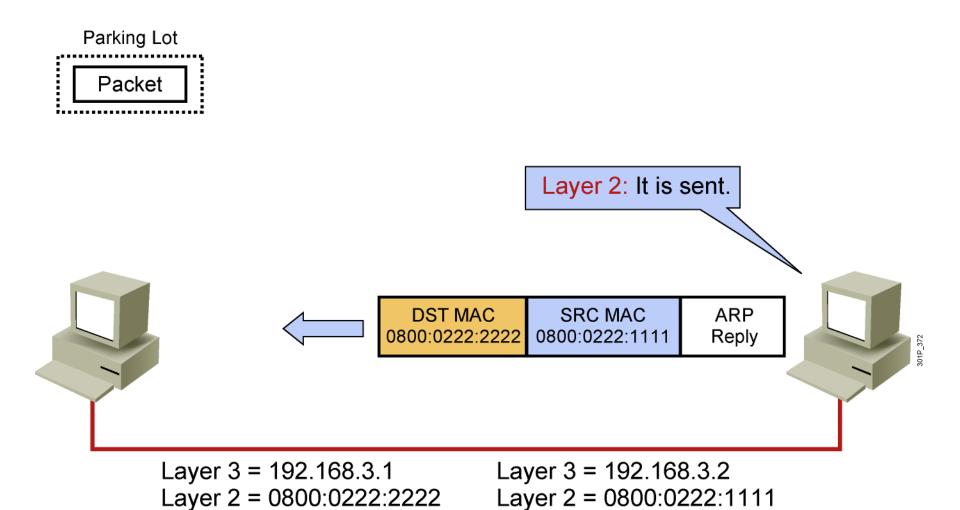


Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (10 of 22)

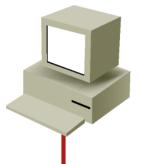


Host-to-Host Packet Delivery (11 of 22)

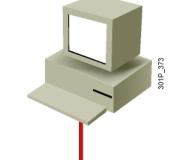
Parking Lot

Packet

Layer 2: I just got a frame with my MAC so I'll process it. The protocol ID indicates that it belongs to ARP. Let me strip the Layer 2 header and send it to ARP.



DST MAC SRC MAC ARP 0800:0222:2222 0800:0222:1111 Reply

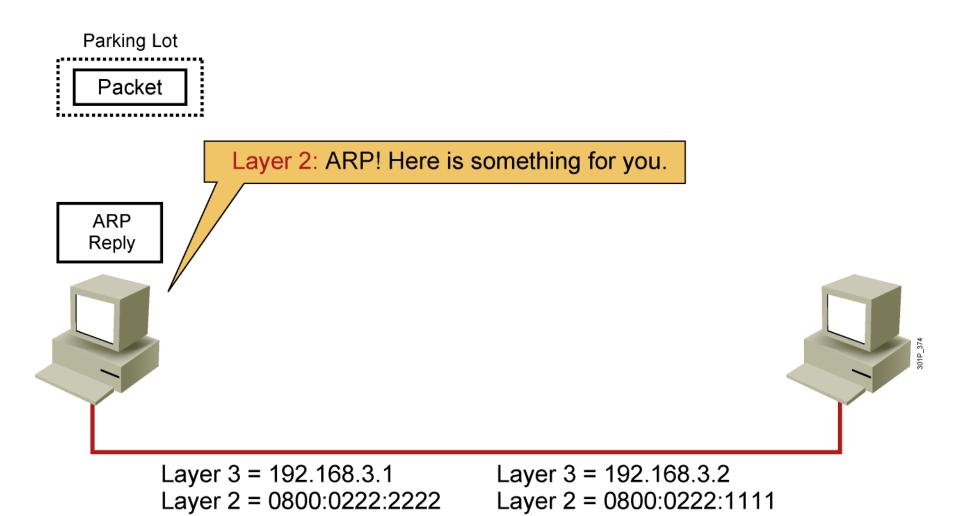


Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (12 of 22)



Host-to-Host Packet Delivery (13 of 22)

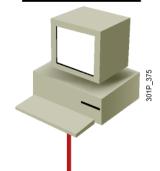


Packet

ARP: I just got an ARP reply from 192.168.3.2. Let me add its IP and MAC to my ARP table.

ARP: Layer 2! I have 192.168.3.2 mapped to 0800:0222:1111.

ARP Request



Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (14 of 22)

Layer 2: I can send out that pending packet.

TCP DST IP SRC IP SRC MAC DST MAC 0800:0222:2222 0800:0222:1111

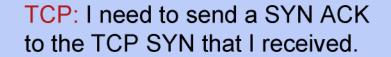
 \Rightarrow

Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (15 of 22)



TCP SYN

SRC IP	DST IP	TCP
192.168.3.1	192.168.3.2	SYN

DST MAC 0800:0222:1111

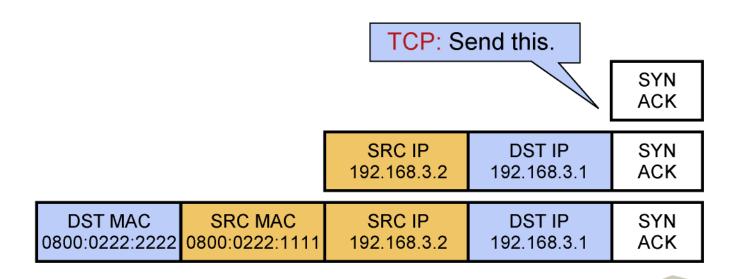
SRC MAC 0800:0222:2222 SRC IP 192.168.3.1 DST IP 192.168.3.2 TCP SYN

Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (16 of 22)



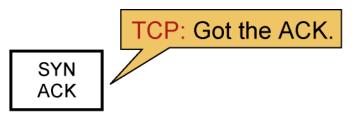


Layer 3 = 192.168.3.1

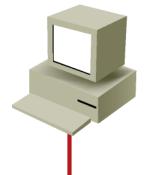
Layer 2 = 0800:0222:2222

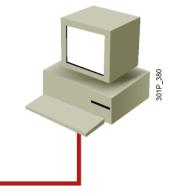
Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (17 of 22)



	DST MAC	SRC MAC	SRC IP	DST IP	SYN
08	300:0222:2222	0800:0222:1111	192.168.3.2	192.168.3.1	ACK





Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (18 of 22)

TCP: I need to let the other end know I got the SYN ACK to complete the session establishment.

TCP ACK

SRC IP DST IP TCP 192.168.3.1 ACK

TCP DST IP SRC IP SRC MAC DST MAC 192.168.3.2 192.168.3.1 0800:0222:2222 0800:0222:1111

Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

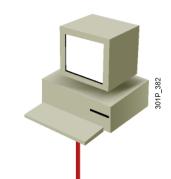
Layer 2 = 0800:0222:1111

0.50

Host-to-Host Packet Delivery (19 of 22)

Layer 4: OK, Application, I have your session set up.

Application: OK, I'll send you some data.



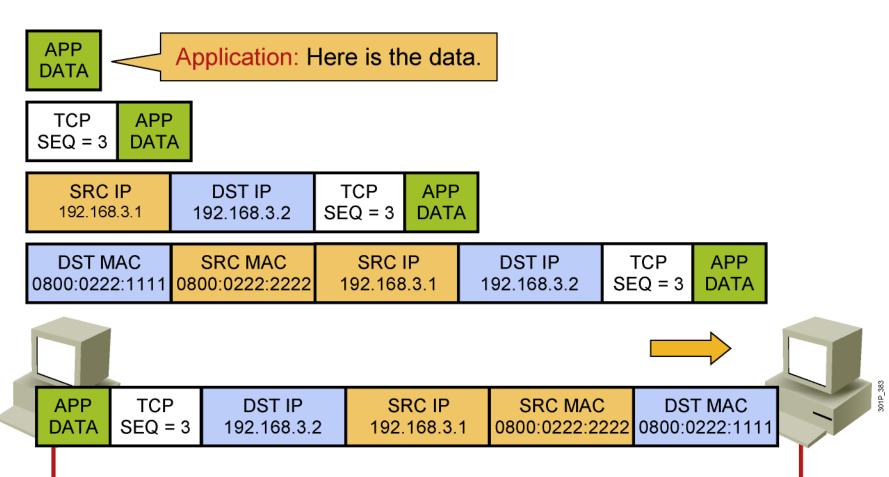
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

Host-to-Host Packet Delivery (20 of 22)



Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

Host-to-Host Packet Delivery (21 of 22)

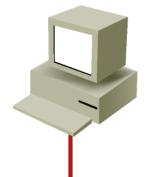
TCP: Application! Here is some data.

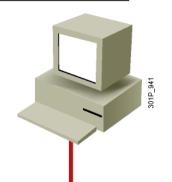
APP DATA

TCP APP SEQ = 3 DATA

SRC IP	DST IP	TCP	APP
192.168.3.1	192.168.3.2	SEQ = 3	DATA

DST MAC	SRC MAC	SRC IP	DST IP	TCP	APP
0800:0222:1111	0800:0222:2222	192.168.3.1	192.168.3.2	SEQ = 3	DATA





Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:1111

Layer 3 = 192.168.3.2

Host-to-Host Packet Delivery (22 of 22)

I need to send an ACK to the data that I received.

ACK = 4SEQ = 3

SRC IP **DST IP** ACK = 4SEQ = 3192.168.3.2 192.168.3.1

DST MAC SRC MAC SRC IP **DST IP** ACK = 4SEQ = 30800:0222:2222 0800:0222:1111 192.168.3.1 192.168.3.2

DST MAC 0800:0222:2222 0800:0222:1111

SRC MAC

SRC IP 192.168.3.2

DST IP 192.168.3.1 ACK = 4SEQ = 3

Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

Default Gateway

OK, I have some data to send to 192.168.3.2.

That address is not in my ARP table and I cannot use ARP because it is on a different network.

> I guess I have to send the data to the default gateway and let it forward it.

Layer 3 = 10.1.1.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111



Default Gateway



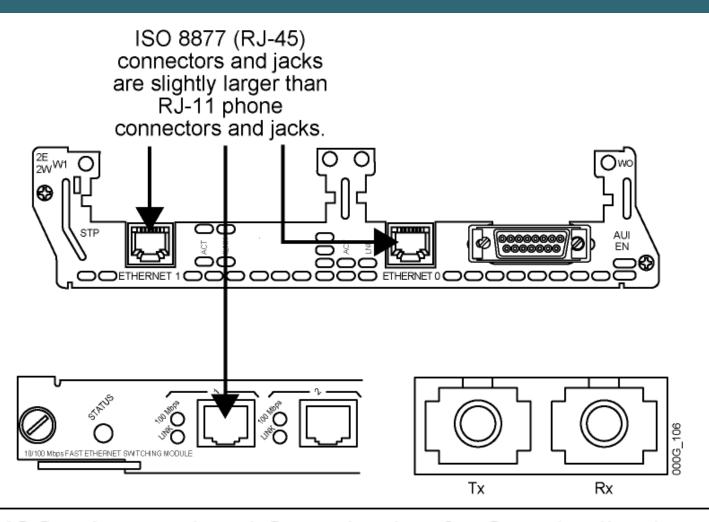


Cabling in Internetwork

Comparing Ethernet Media Requirements

Requirement	10 BASE-T	100 BASE-TX	100 BASE-FX	1000 BASE-CX	1000 BASE-T	1000 BASE-SX	1000 BASE-LX
Media	EIA/TIA Category 3, 4, 5 UTP 2 pair	EIA/TIA Category 5 UTP 2 pair	62.5/125 micron multimode fiber	STP	EIA/TIA Category 5 UTP 4 pair	62.5/50 micron multimode fiber	9 micron single-mode fiber
Maximum Segment Length	100 m (328 ft)	100 m (328 ft)	400 m (1312.3 ft)	25 m (82 ft)	100 m (328 ft)	275 m (62.5 micron) 550 m (50 micron)	3-10 km (1.86-6.2 miles)
Connector	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)	Duplex media interface connector (MIC) ST	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)	_	_

Differentiating Between Connections



ISO = International Organization for Standardization

1000BASE-T GBIC





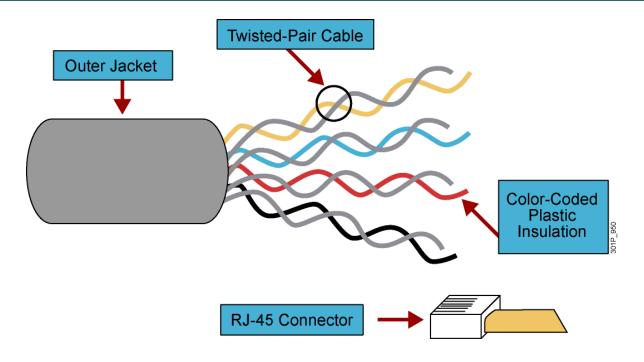
Cisco Fiber-Optic GBICs

- Short wavelength (1000BASE-SX)
- Long wavelength/long haul (1000BASE-LX/LH)
- Extended distance (1000BASE-ZX)



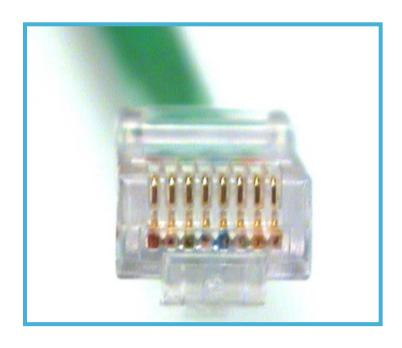


Unshielded Twisted-Pair Cable



- Speed and throughput: 10 to 1000 Mb/s
- Average cost per node: Least expensive
- Media and connector size: Small
- Maximum cable length: Varies

RJ-45 Connector



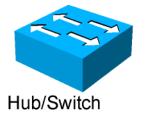
RJ-45 Jack



UTP Implementation (Straight-Through)

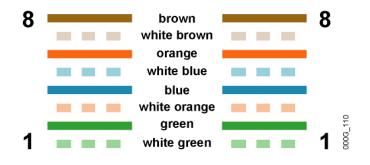
Cable 10BASE-T/ 100BASE-TX Straight-Through

Straight-Through Cable





Pin Label		Pin Label		
1 TX+ ←	→ 1	TX+		
2 TX- ←	→ 2	TX-		
3 RX+ ←	→ 3	RX+		
4 NC	4	NC		
5 NC	5	NC		
6 RX-	→ 6	RX-		
7 NC	7	NC		
8 NC	8	NC		



Wires on cable ends are in same order.

UTP Implementation (Crossover)

Cable 10BASE-T or 100BASE-TX Straight-Through

RX-

NC

NC

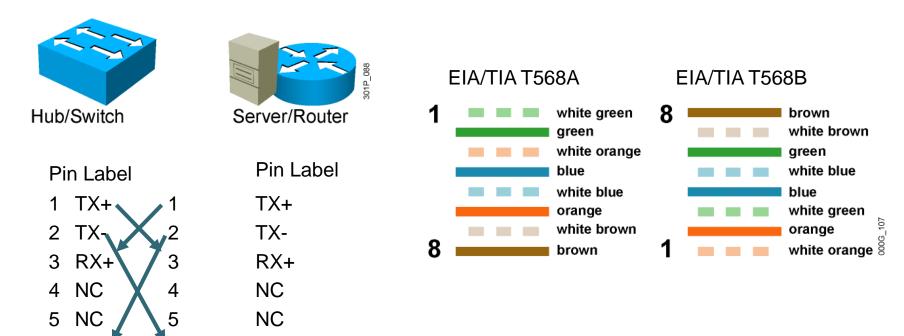
RX-

8

7 NC

8 NC

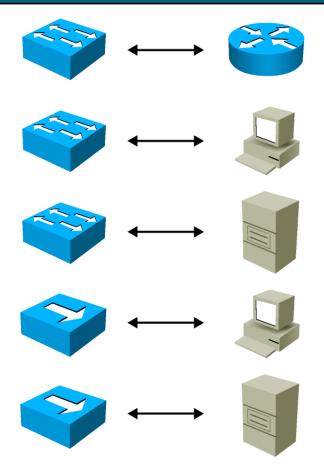
Crossover Cable



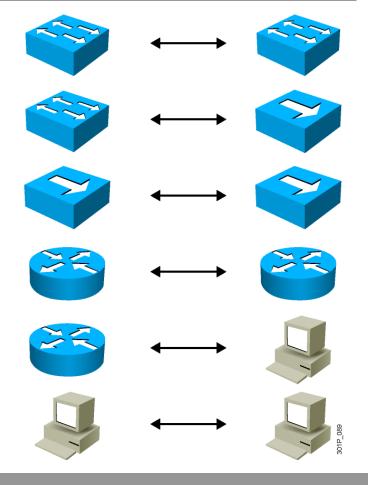
Some wires on cable ends are crossed.

UTP Implementation: Straight-Through vs. Crossover

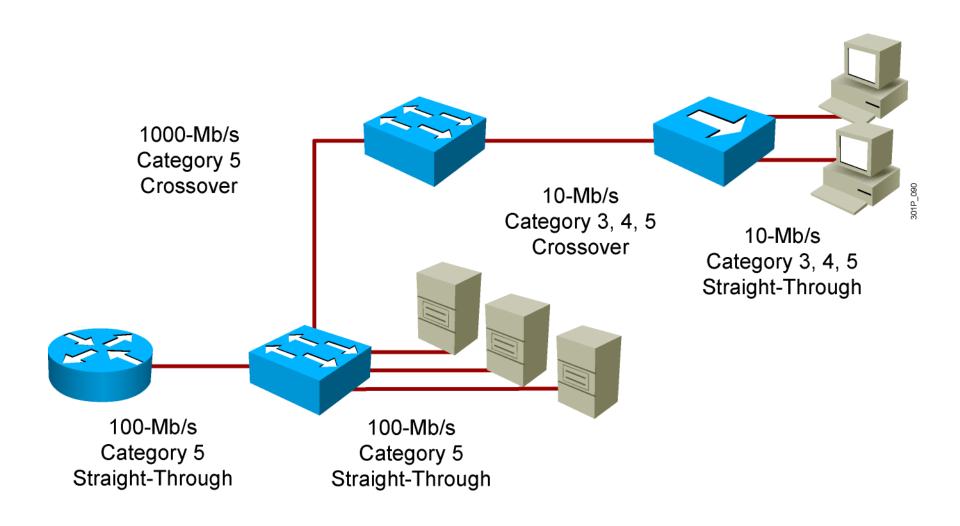
Straight-Through Cable



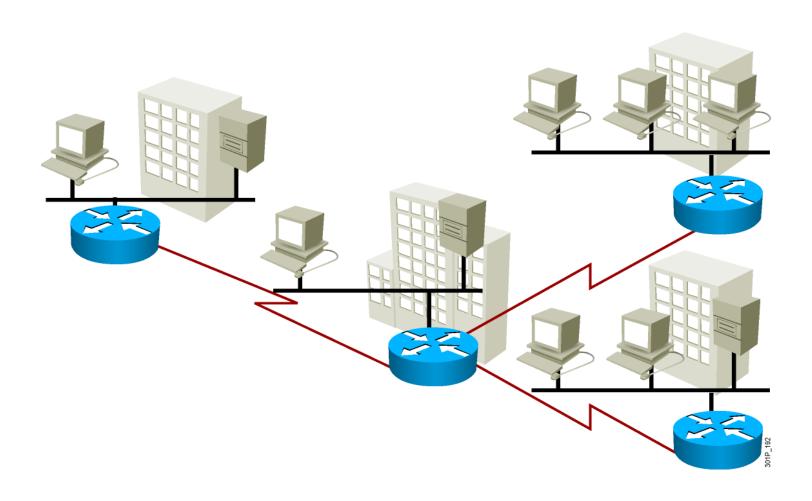
Crossover Cable



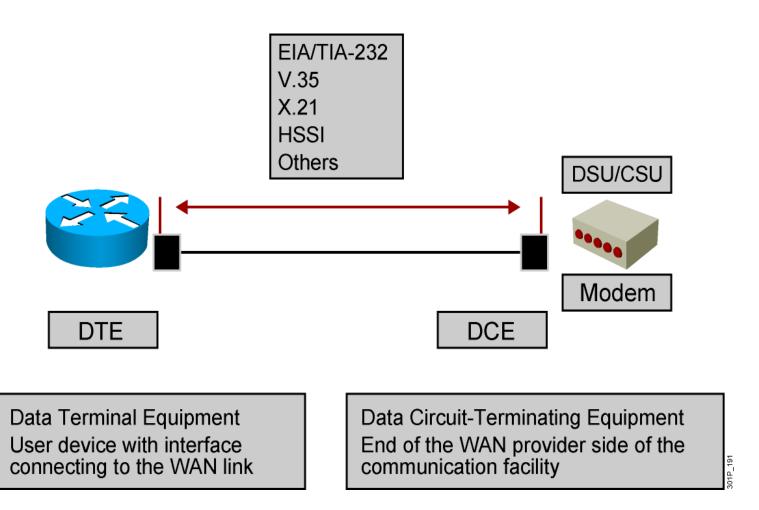
Using Varieties of UTP



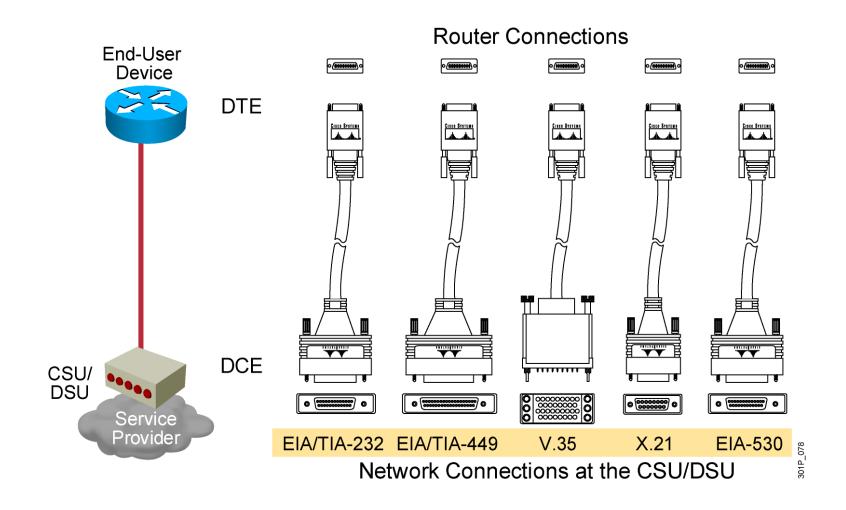
WAN—Multiple LANs



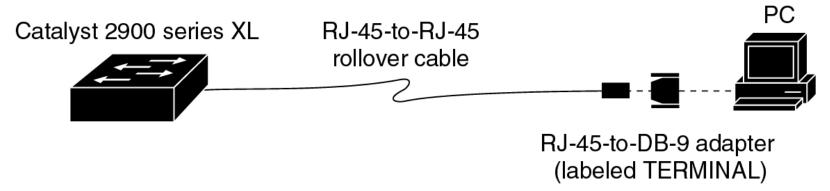
Physical Layer: WANs



Serial Point-to-Point Connections



Setting up a Console Connection



H10972

#