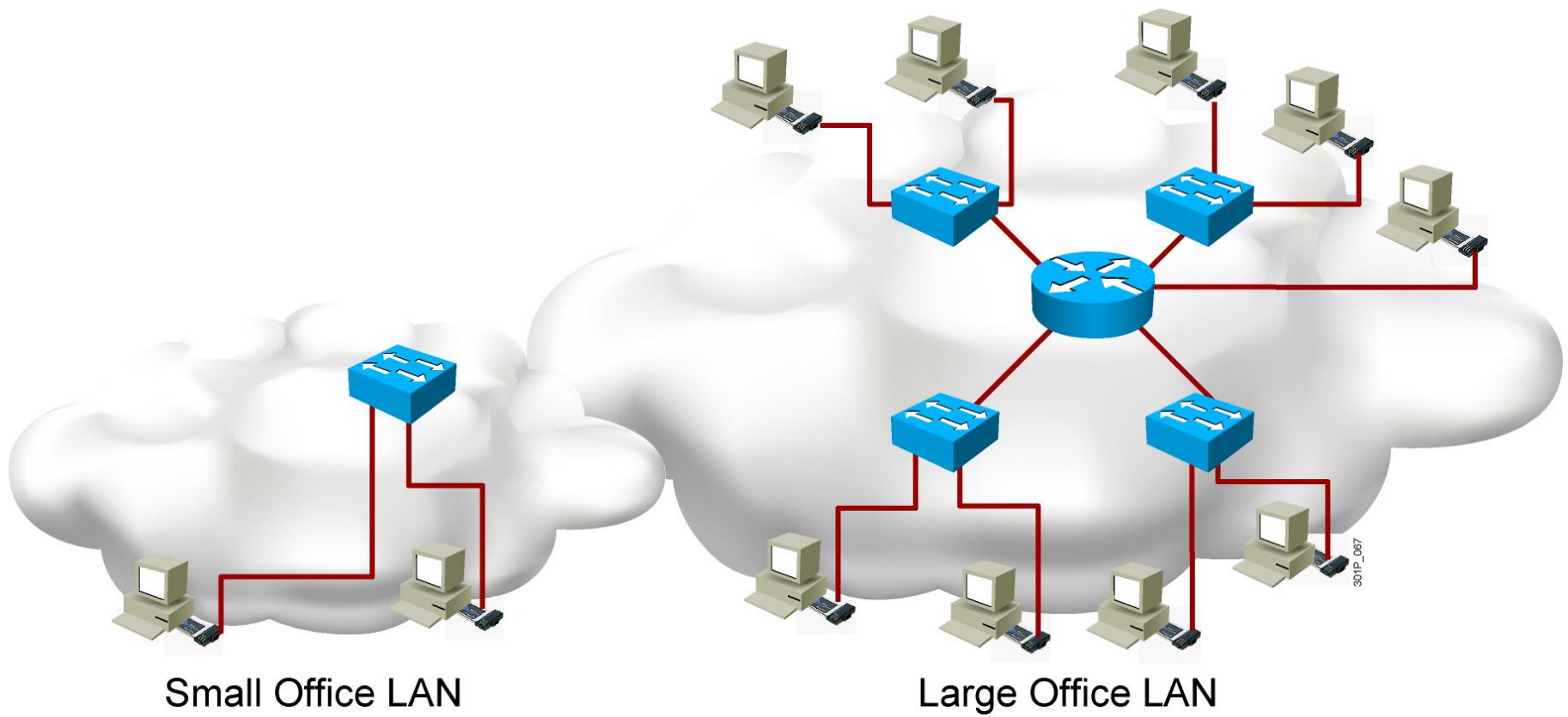




Understanding Ethernet

Local Area Network



LAN Components

- **Computers**

- PCs
- Servers

- **Interconnections**

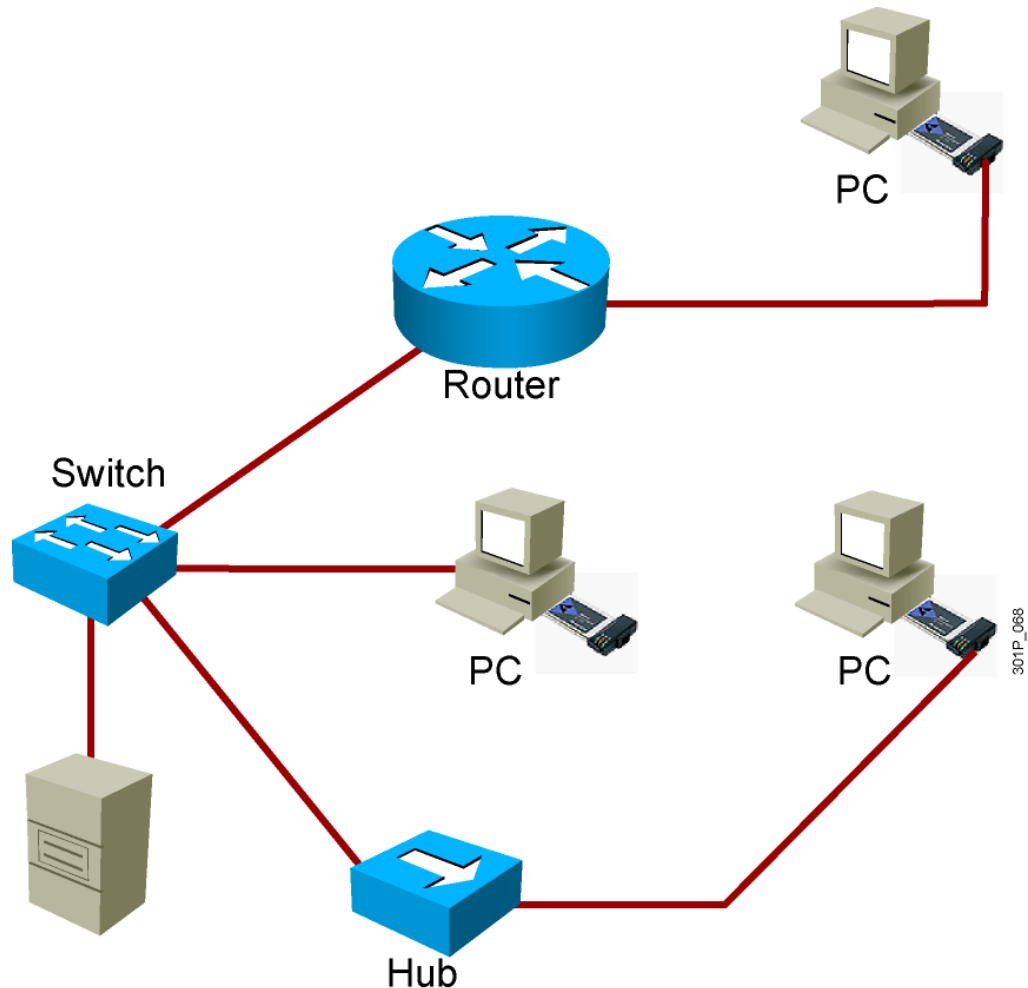
- NICs
- Media

- **Network devices**

- Hubs
- Switches
- Routers

- **Protocols**

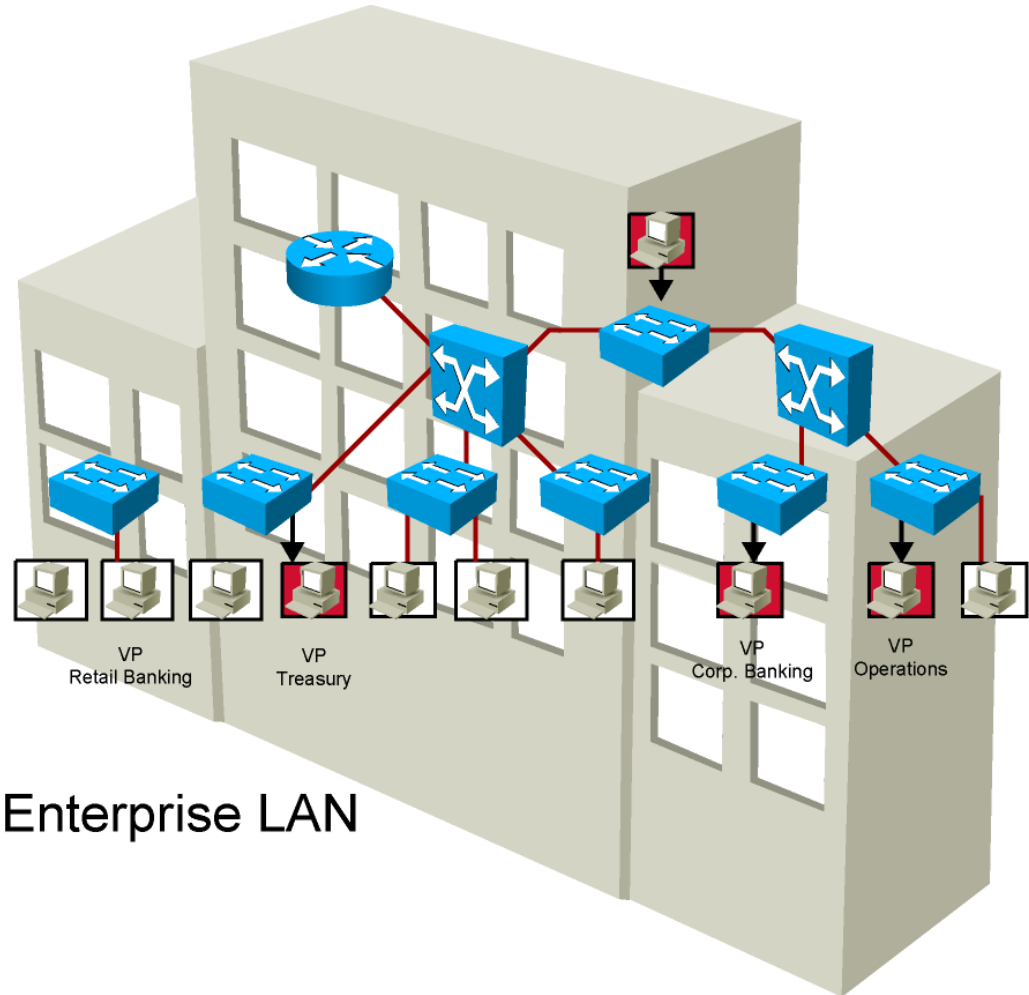
- Ethernet
- IP
- ARP
- DHCP



LAN Sizes

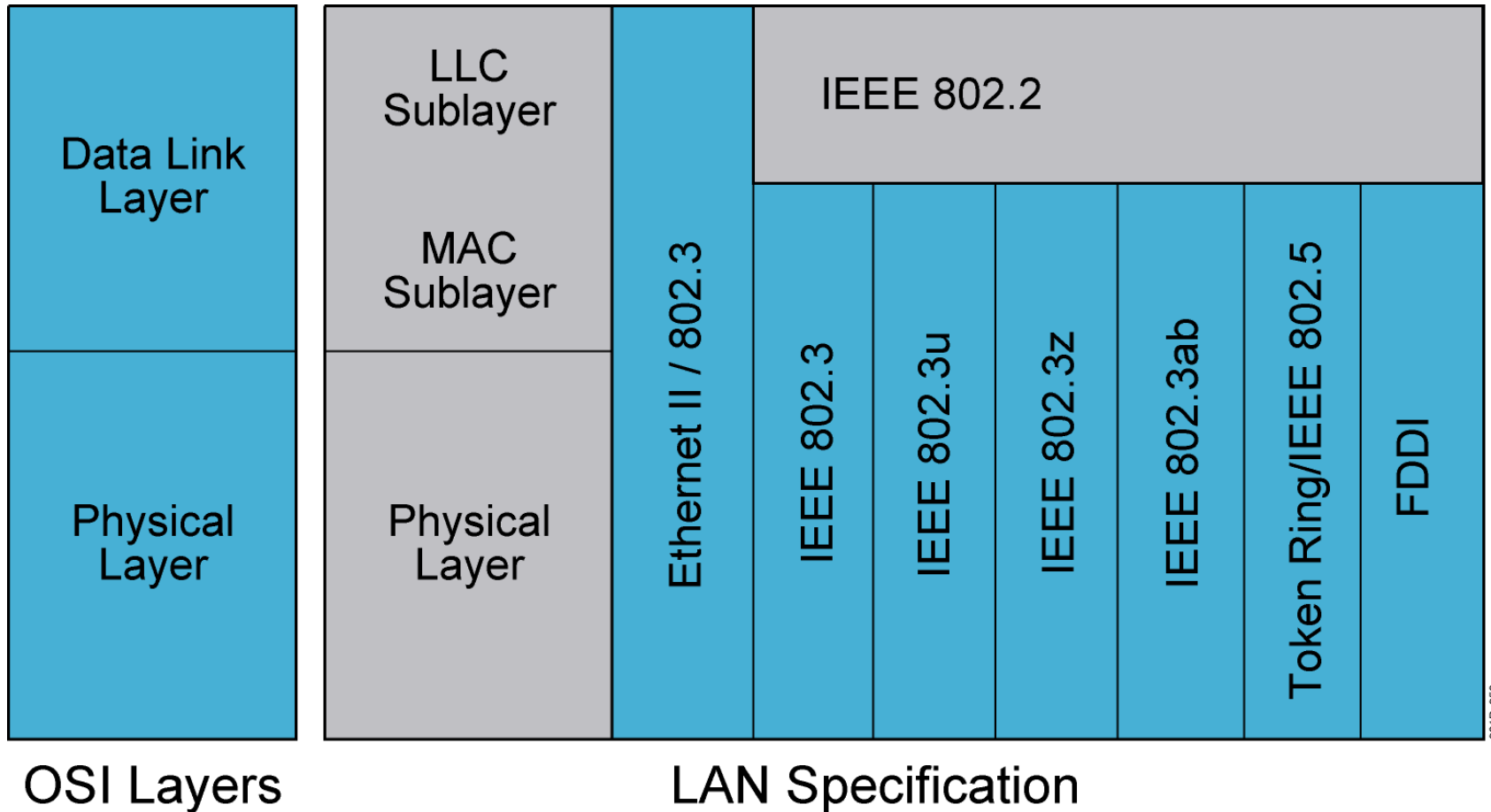


SOHO
LAN



Enterprise LAN

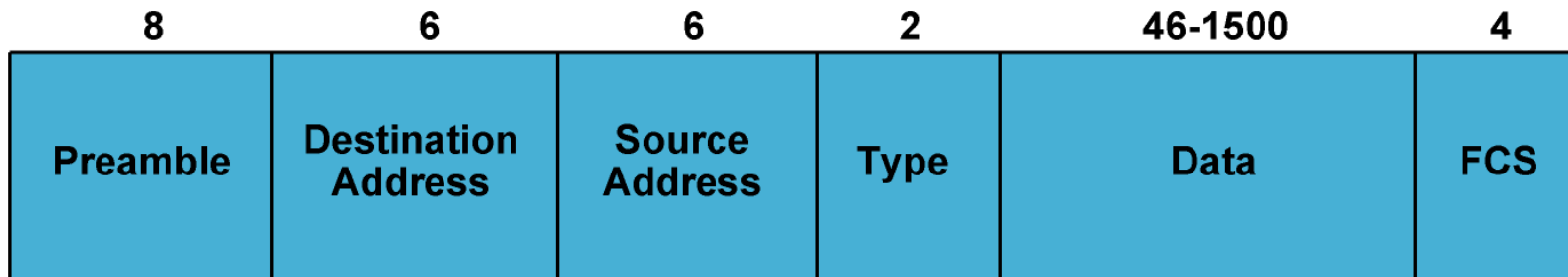
LAN Standards



Ethernet Frame Structure

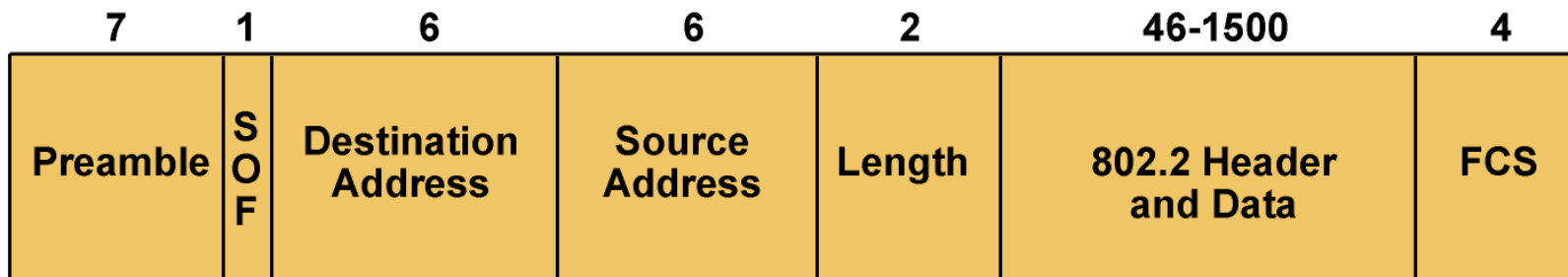
Field Length,
in Bytes

Ethernet



Field Length,
in Bytes

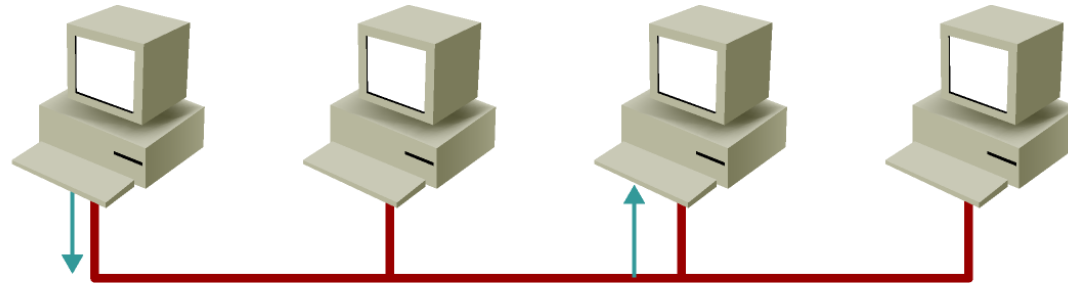
IEEE 802.3



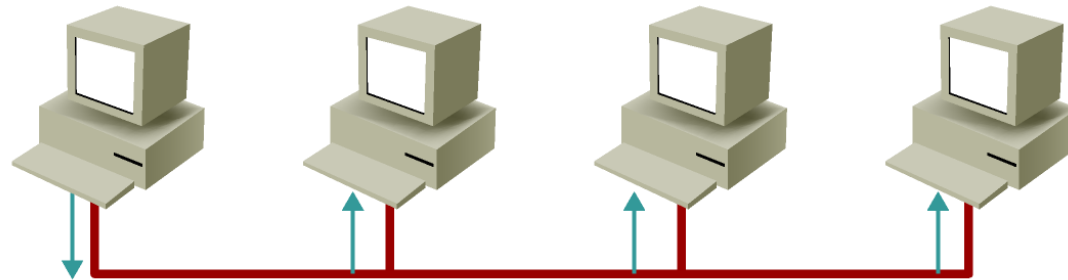
SOF = Start-of-Frame Delimiter
FCS = Frame Check Sequence

Communicating Within the LAN

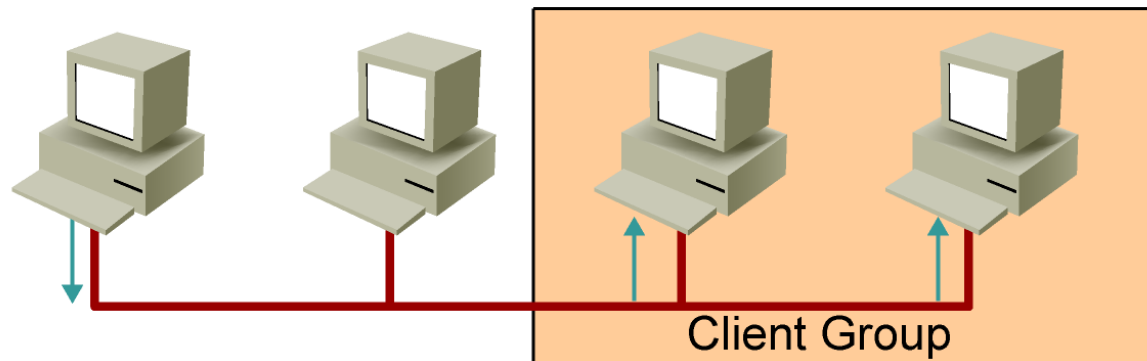
Unicast



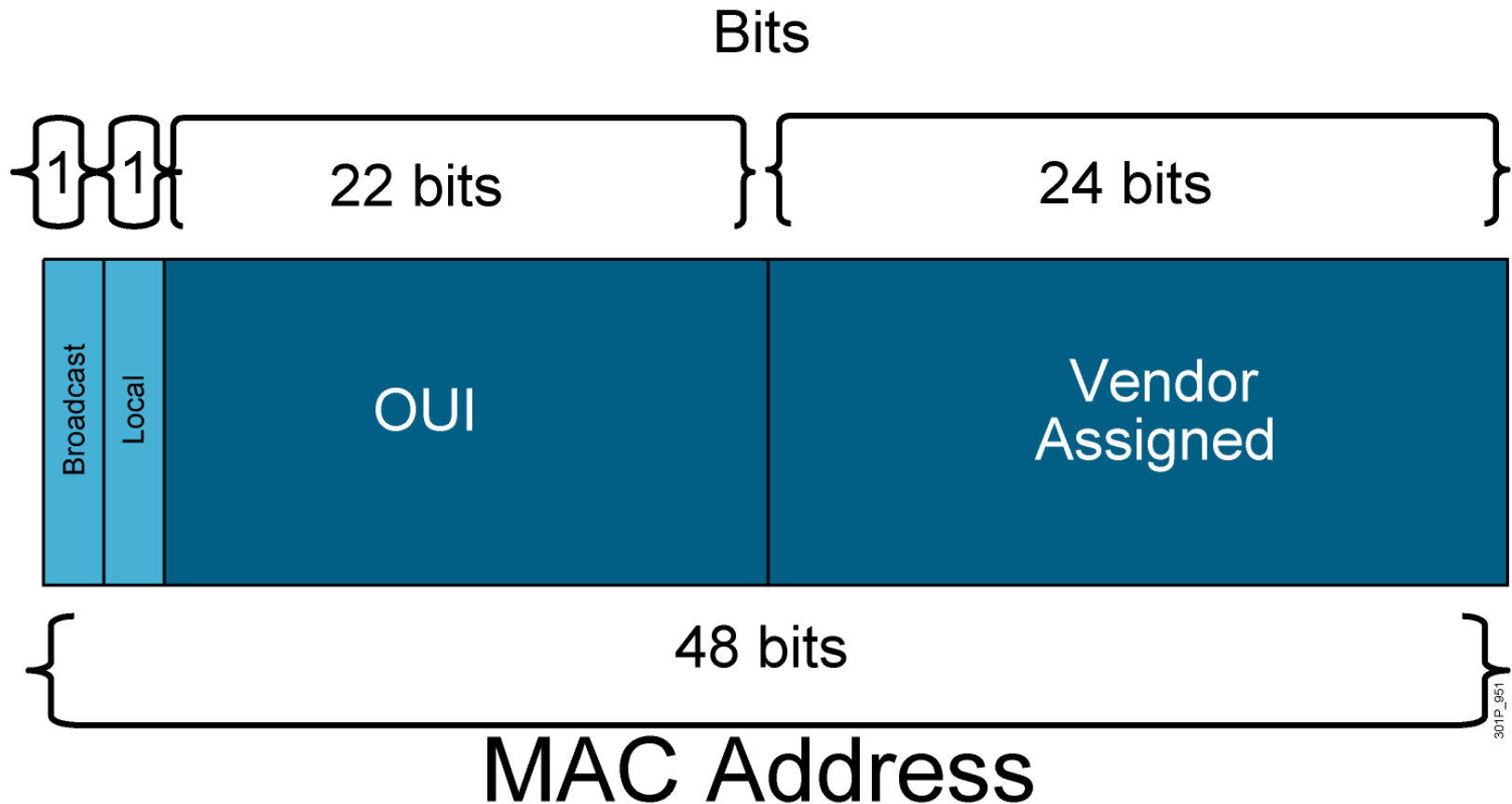
Broadcast



Multicast



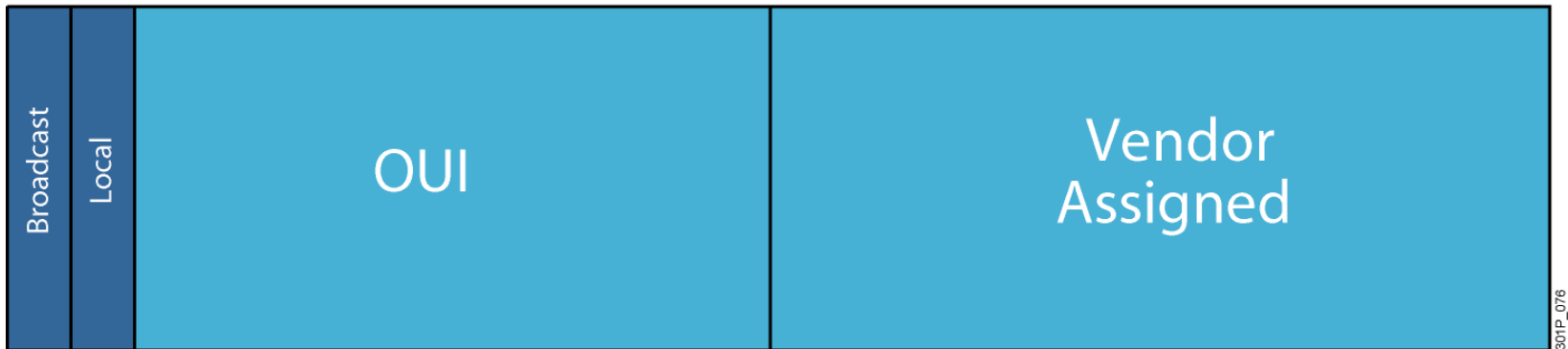
MAC Address Components



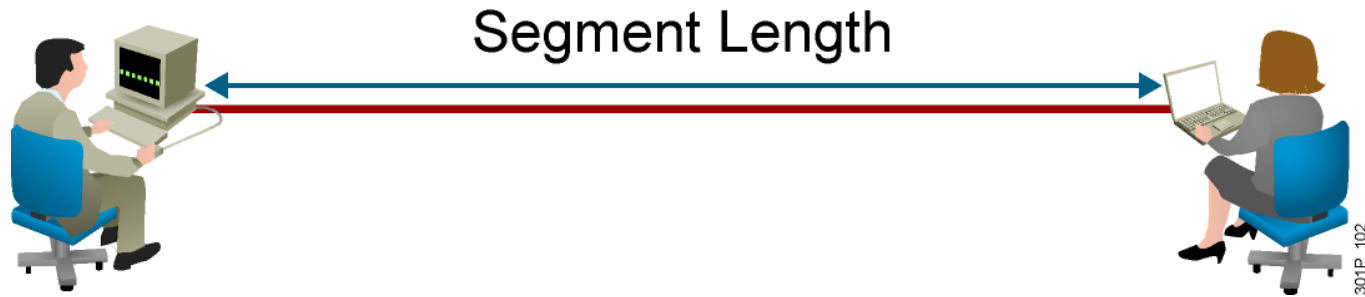
OUI: Organizational Unique Identifier

MAC Addresses

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

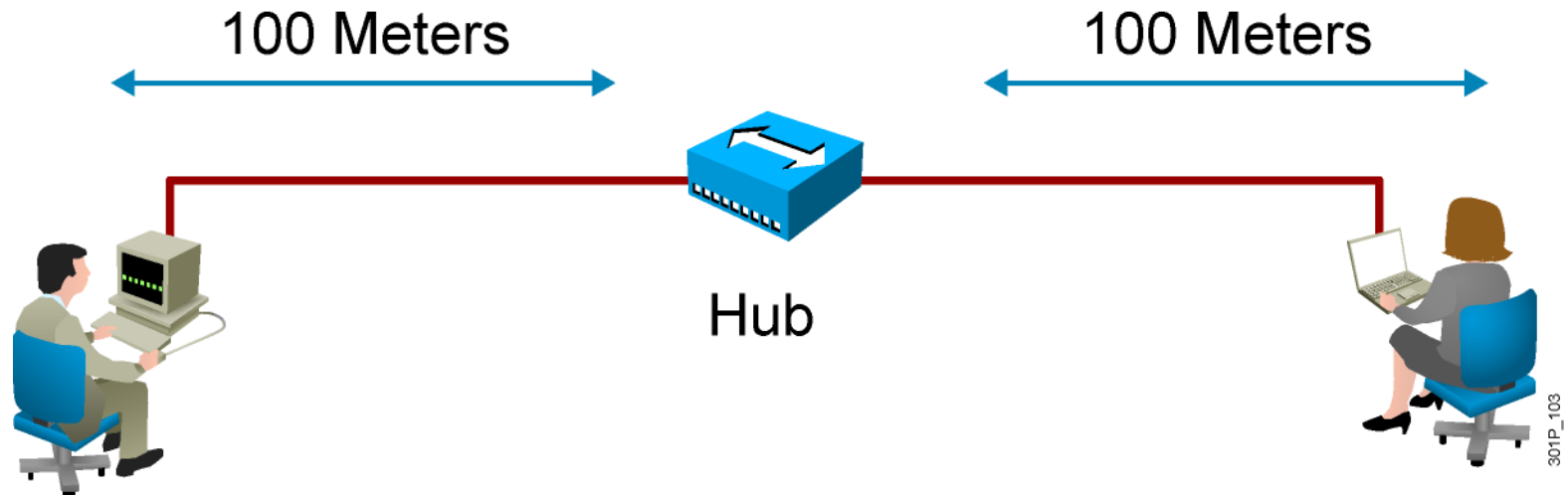


LAN Segment Limitations



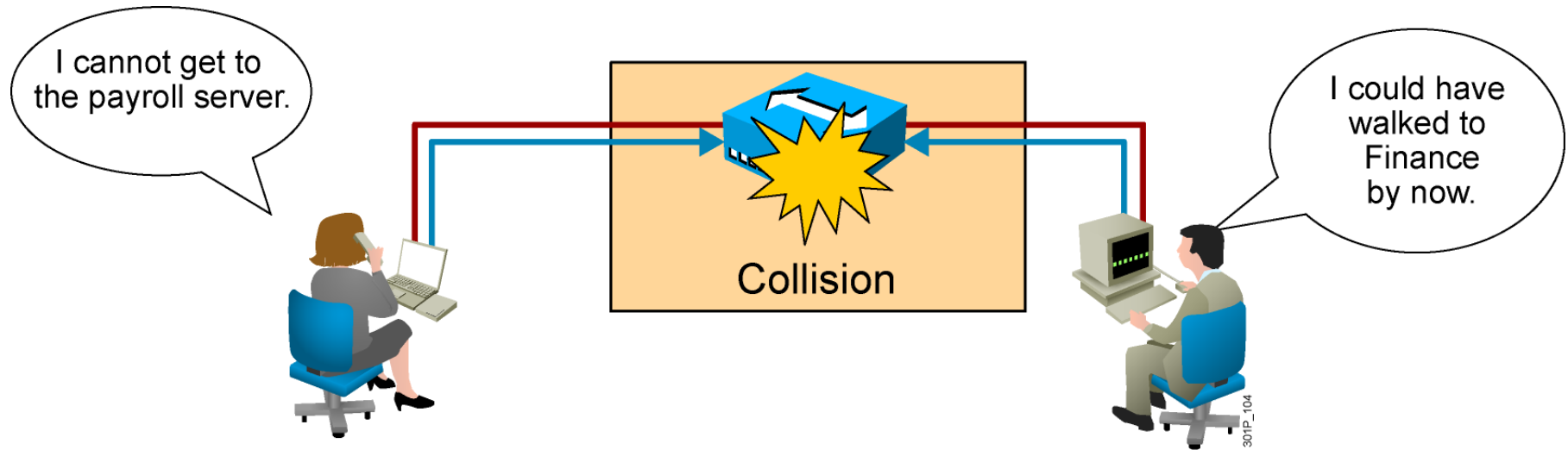
- Signals degrade with transmission distance.
- Each Ethernet type has a maximum segment length.

Extending LAN Segments

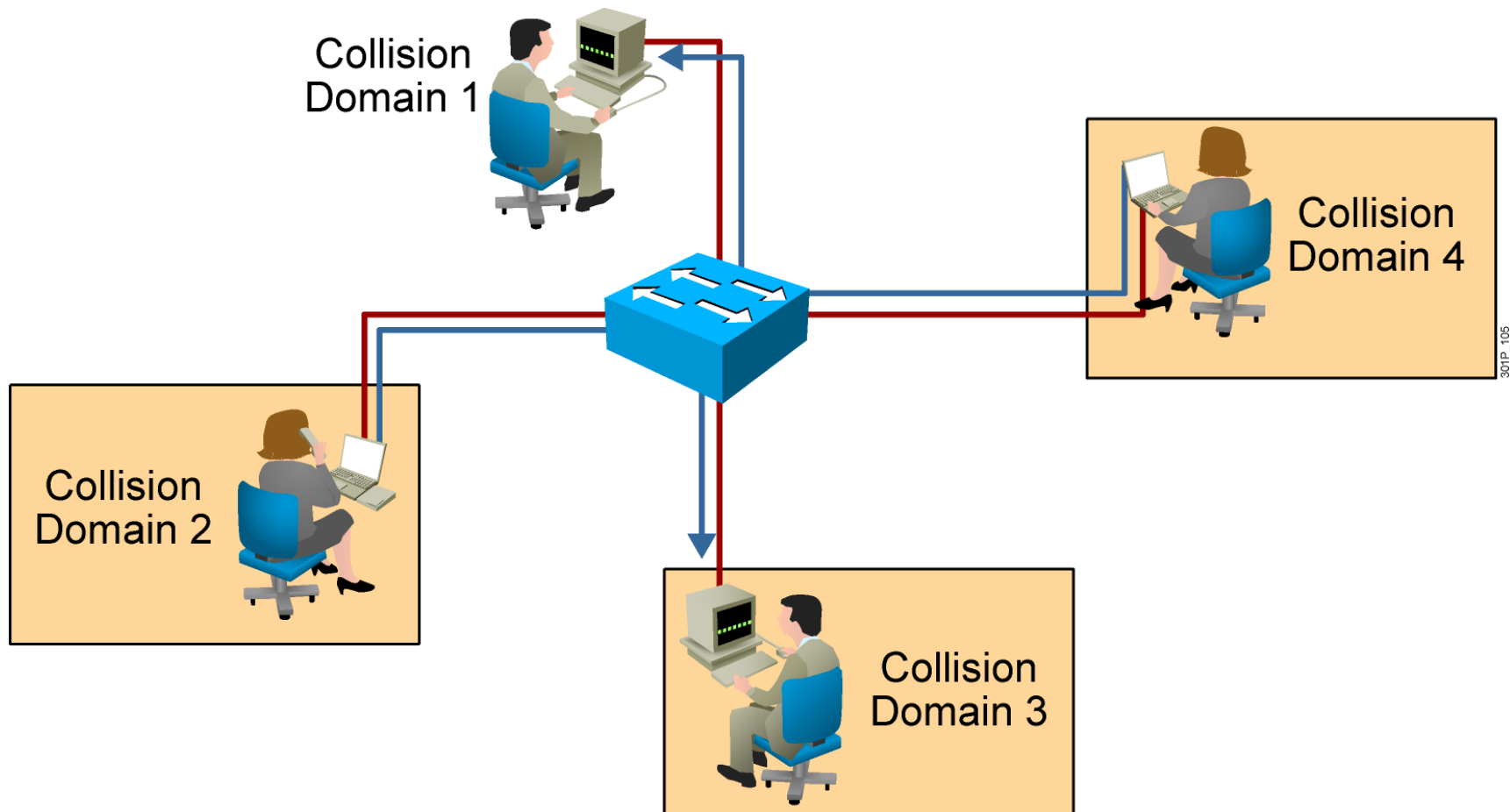


- Shares bandwidth
- Extends cable distances
- Repeats or amplifies signal
- Half-duplex

Collisions



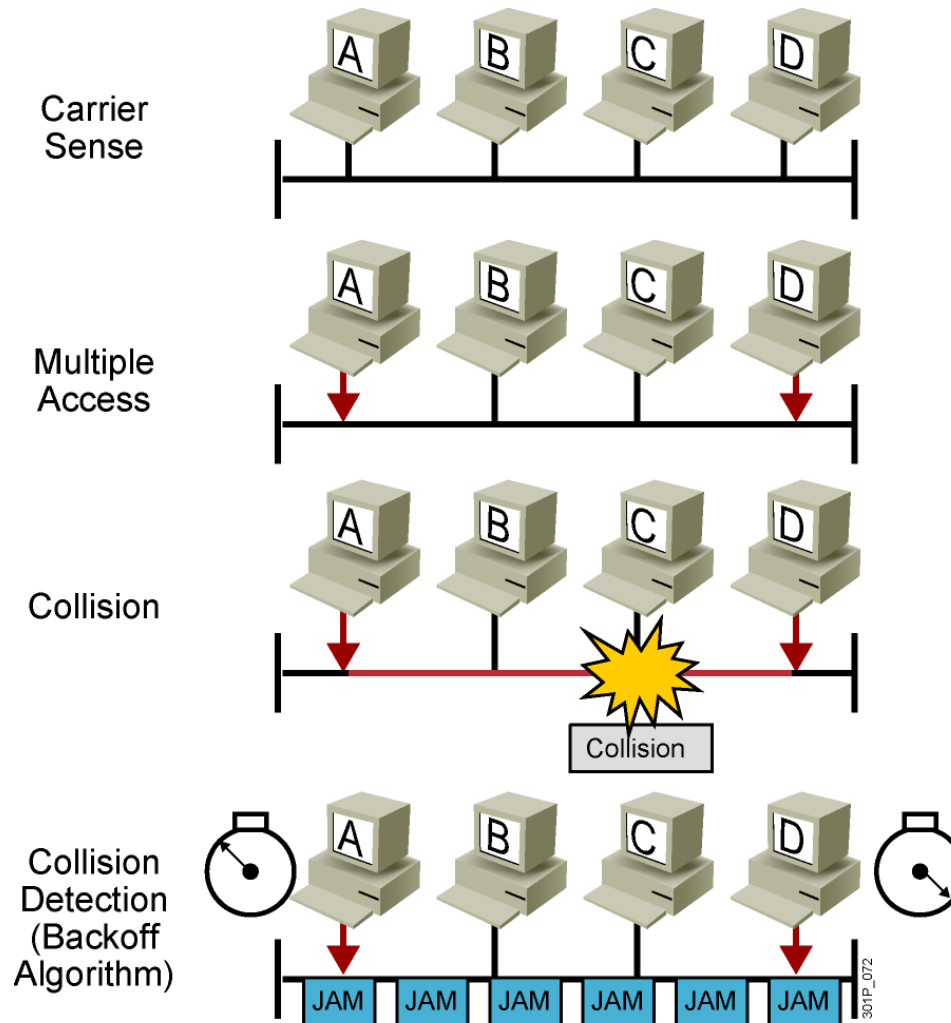
Multiple Collision Domains



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



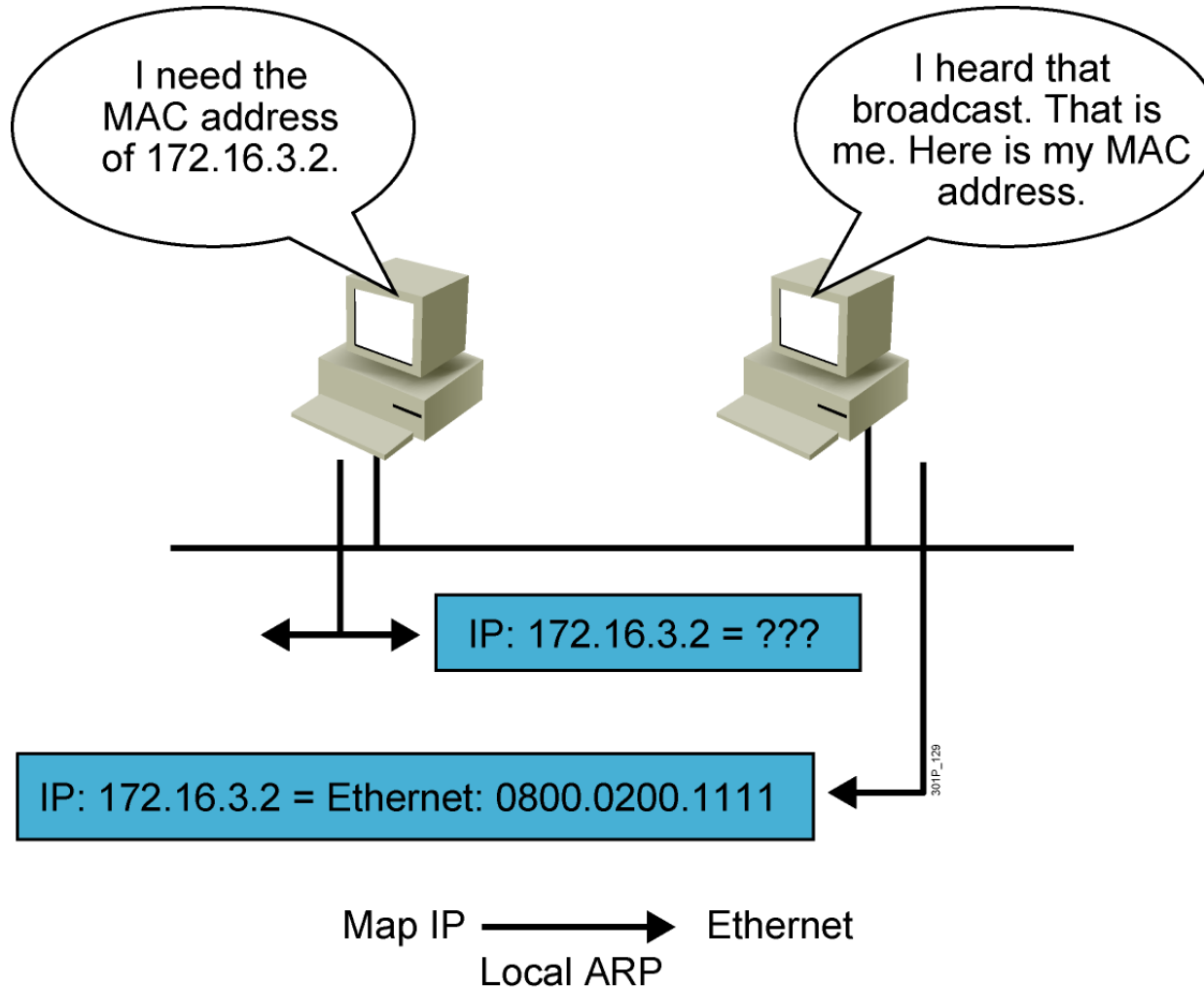
Carrier Sense Multiple Access Collision Detection (CSMA/CD)



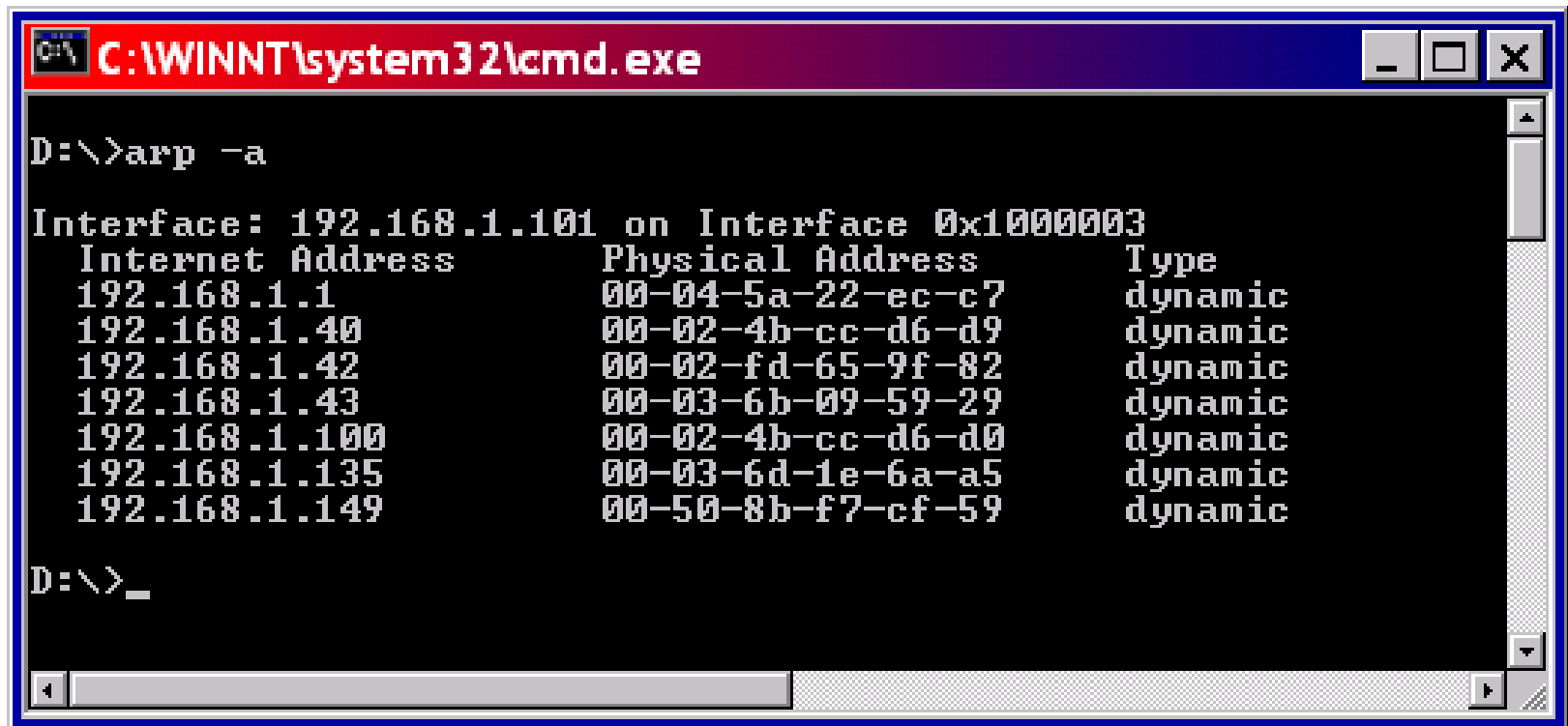
ARP

Exploring the Packet Delivery Process

ARP



ARP Table



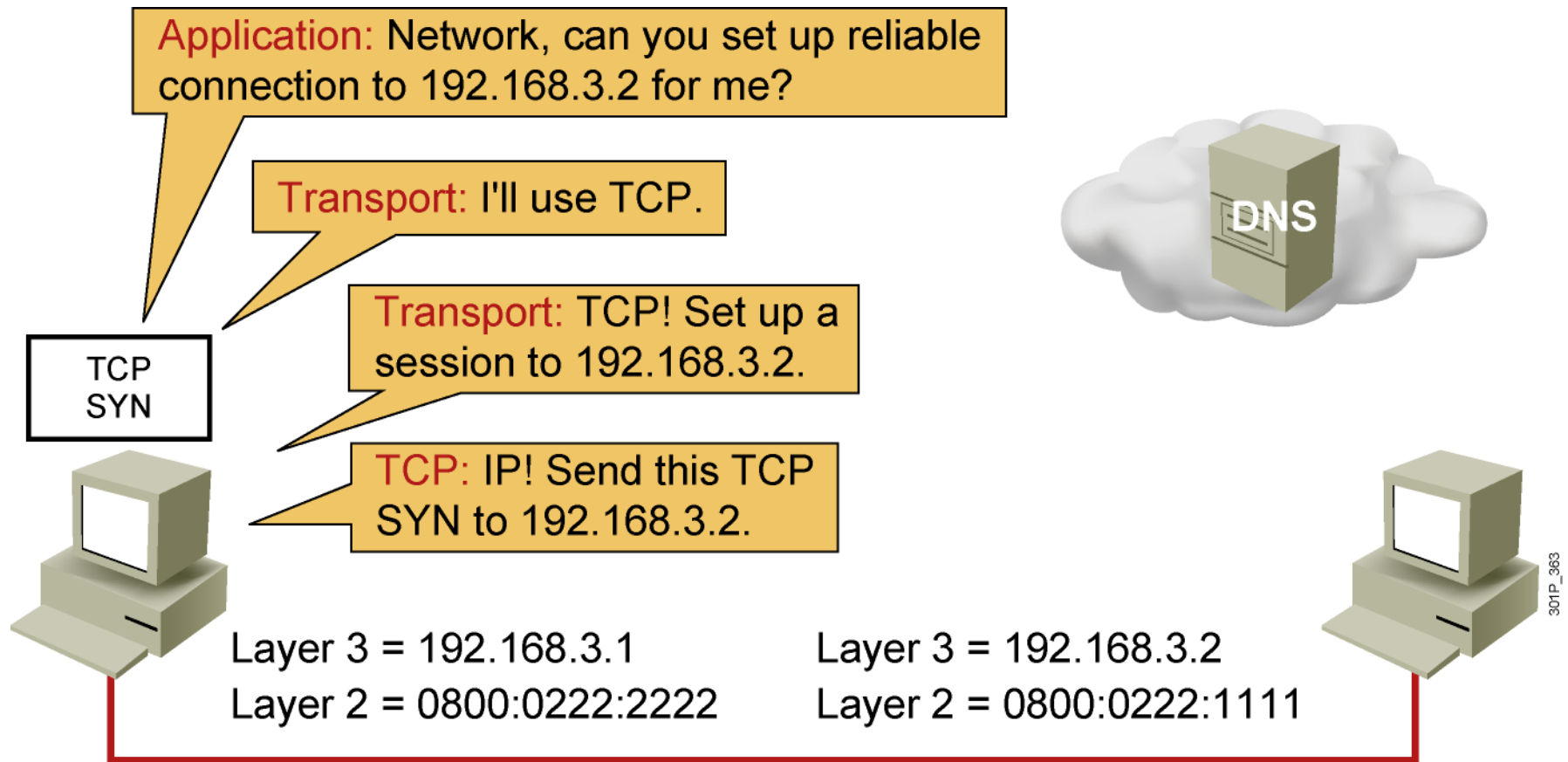
```
C:\WINNT\system32\cmd.exe

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
  192.168.1.40          00-02-4b-cc-d6-d9     dynamic
  192.168.1.42          00-02-fd-65-9f-82     dynamic
  192.168.1.43          00-03-6b-09-59-29     dynamic
  192.168.1.100         00-02-4b-cc-d6-d0     dynamic
  192.168.1.135         00-03-6d-1e-6a-a5     dynamic
  192.168.1.149         00-50-8b-f7-cf-59     dynamic

D:\>_
```

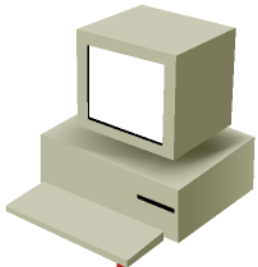
Host-to-Host Packet Delivery (1 of 22)



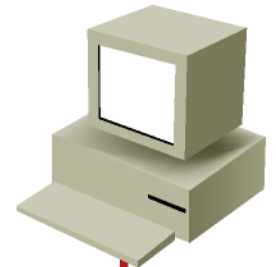
Host-to-Host Packet Delivery (2 of 22)

IP: Layer 2! Send this packet to 192.168.3.2 .

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



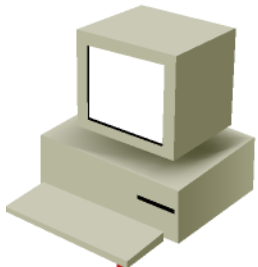
Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

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

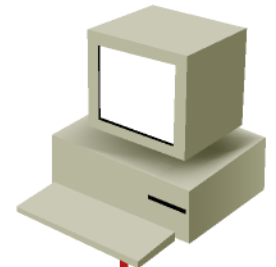
Layer 2: ARP, do you have a mapping for 192.168.3.2?

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
-----------------------	-----------------------	------------

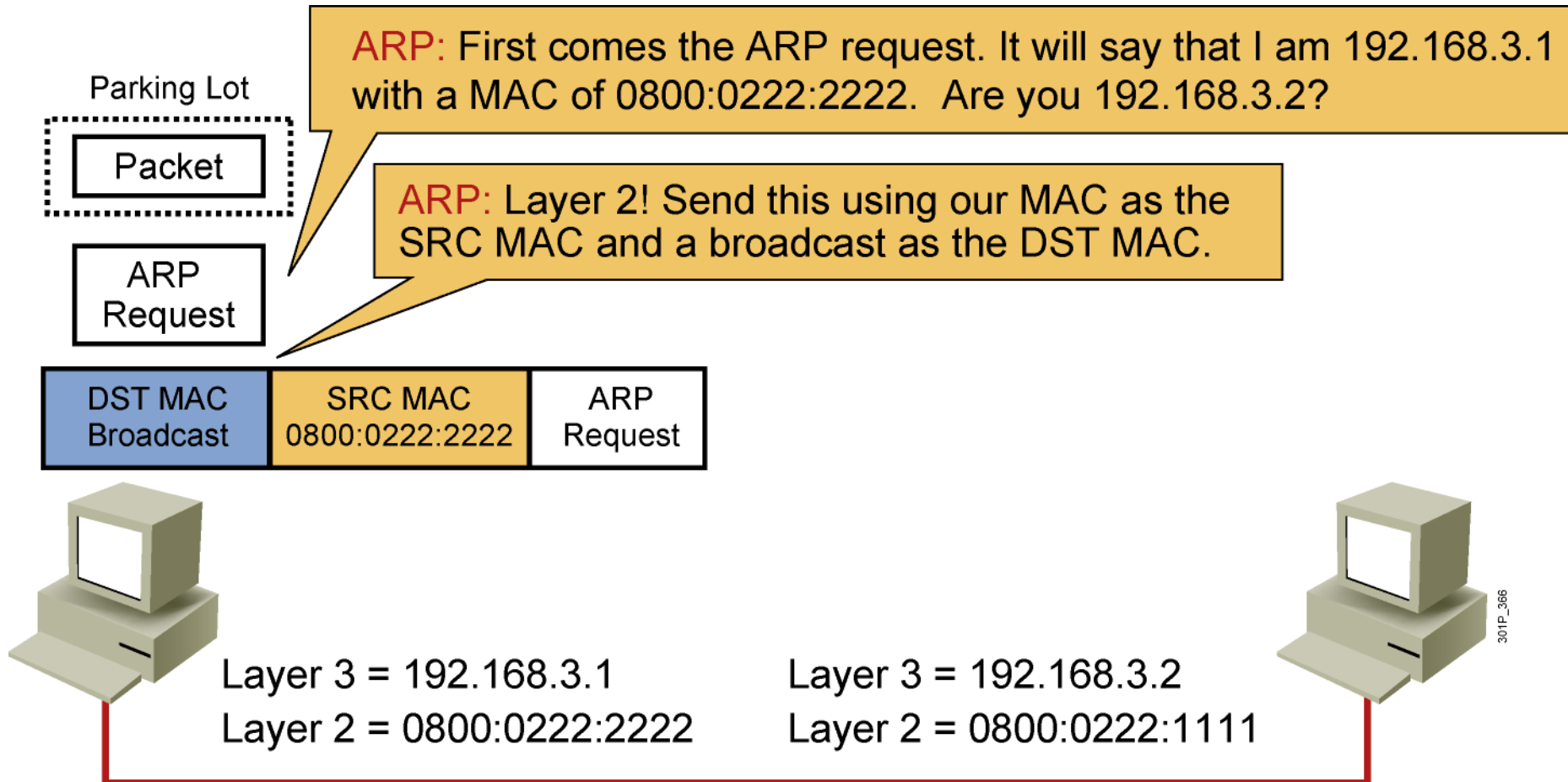


Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

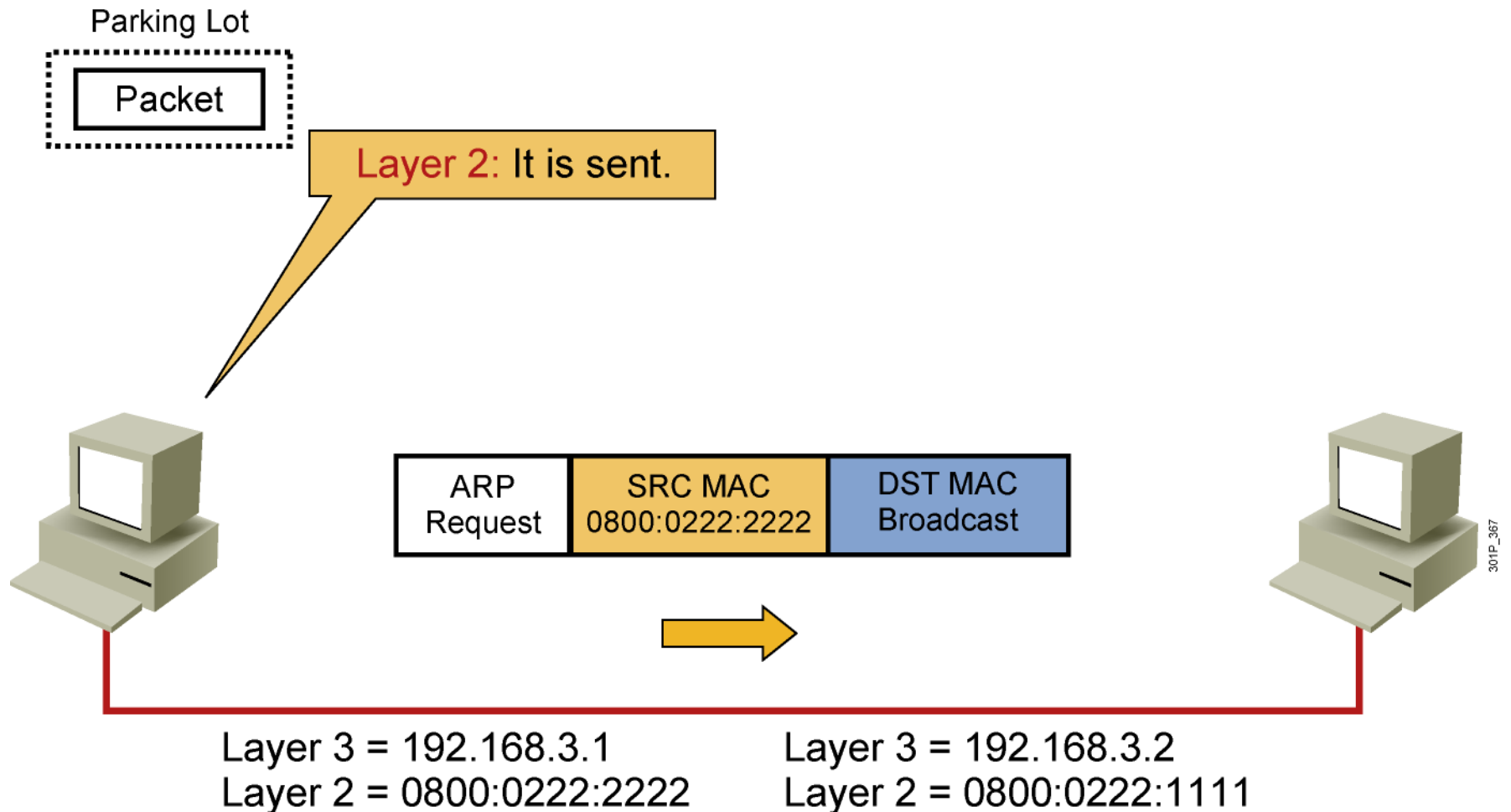


Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

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



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

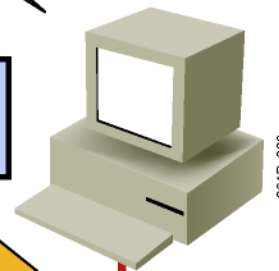
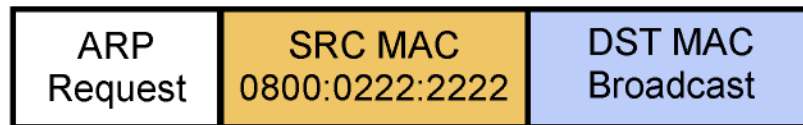
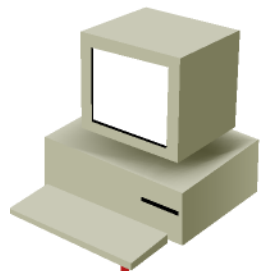


Host-to-Host Packet Delivery (6 of 22)

Parking Lot



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.

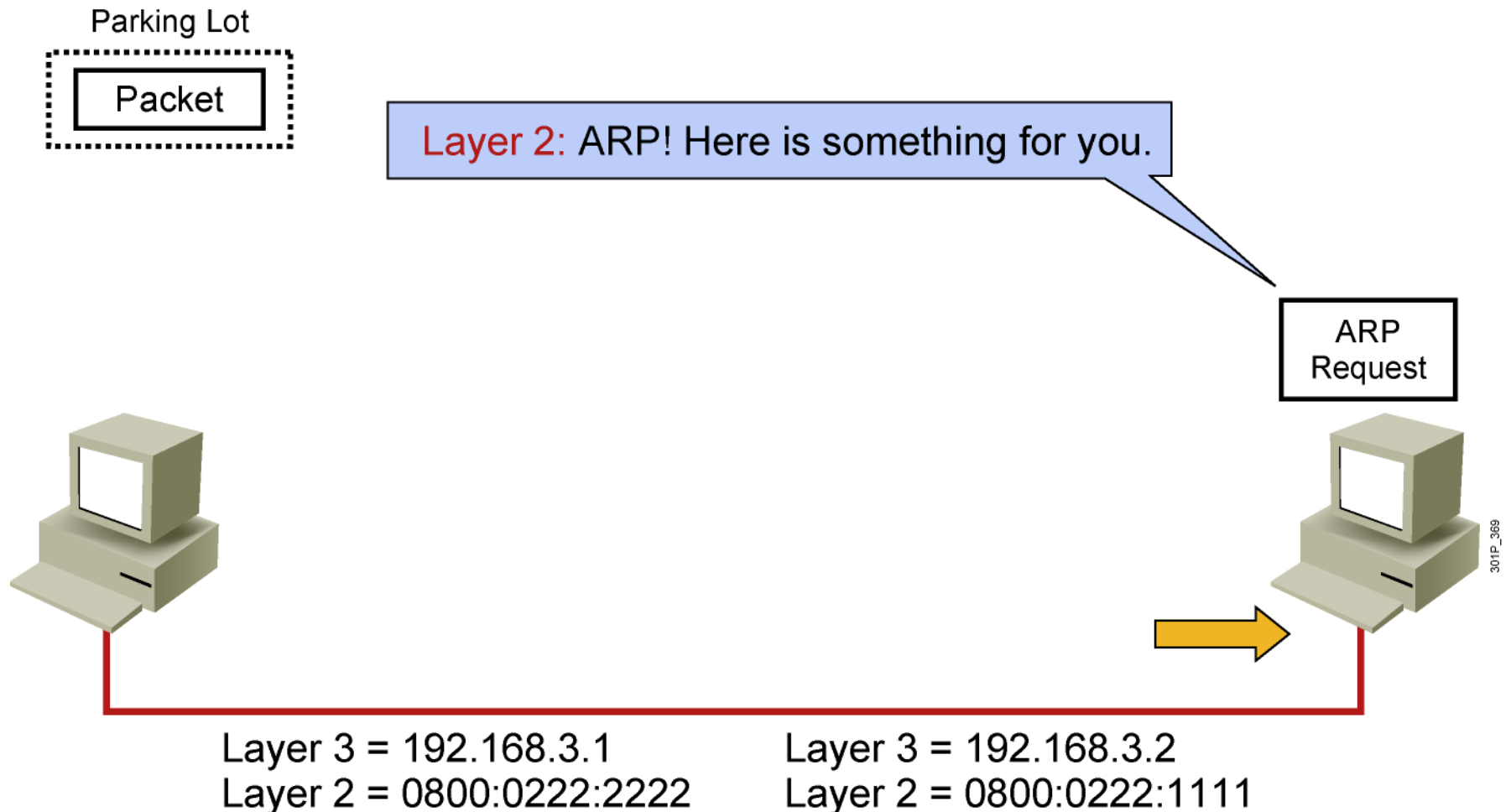


301P_368

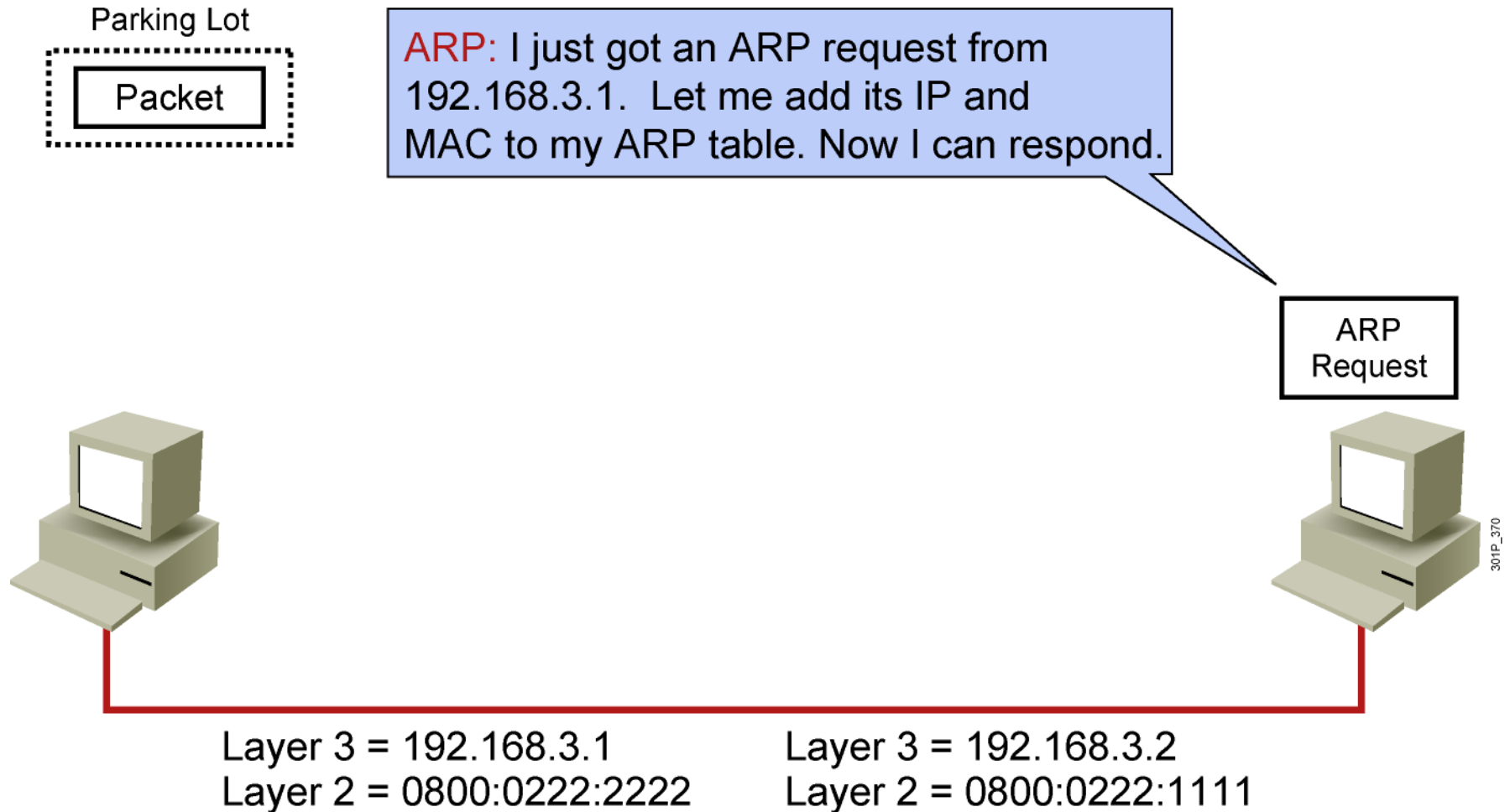
Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

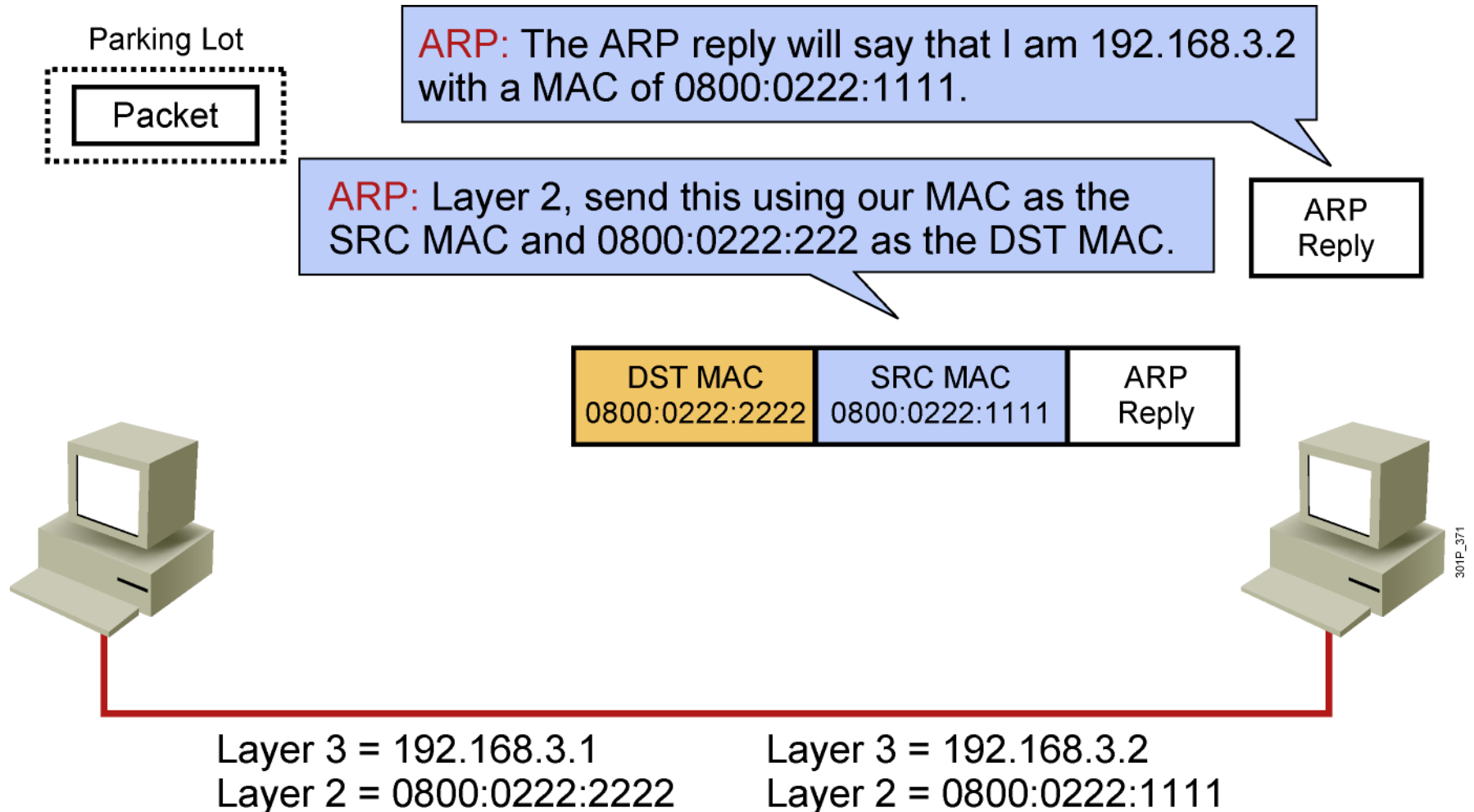
Host-to-Host Packet Delivery (7 of 22)



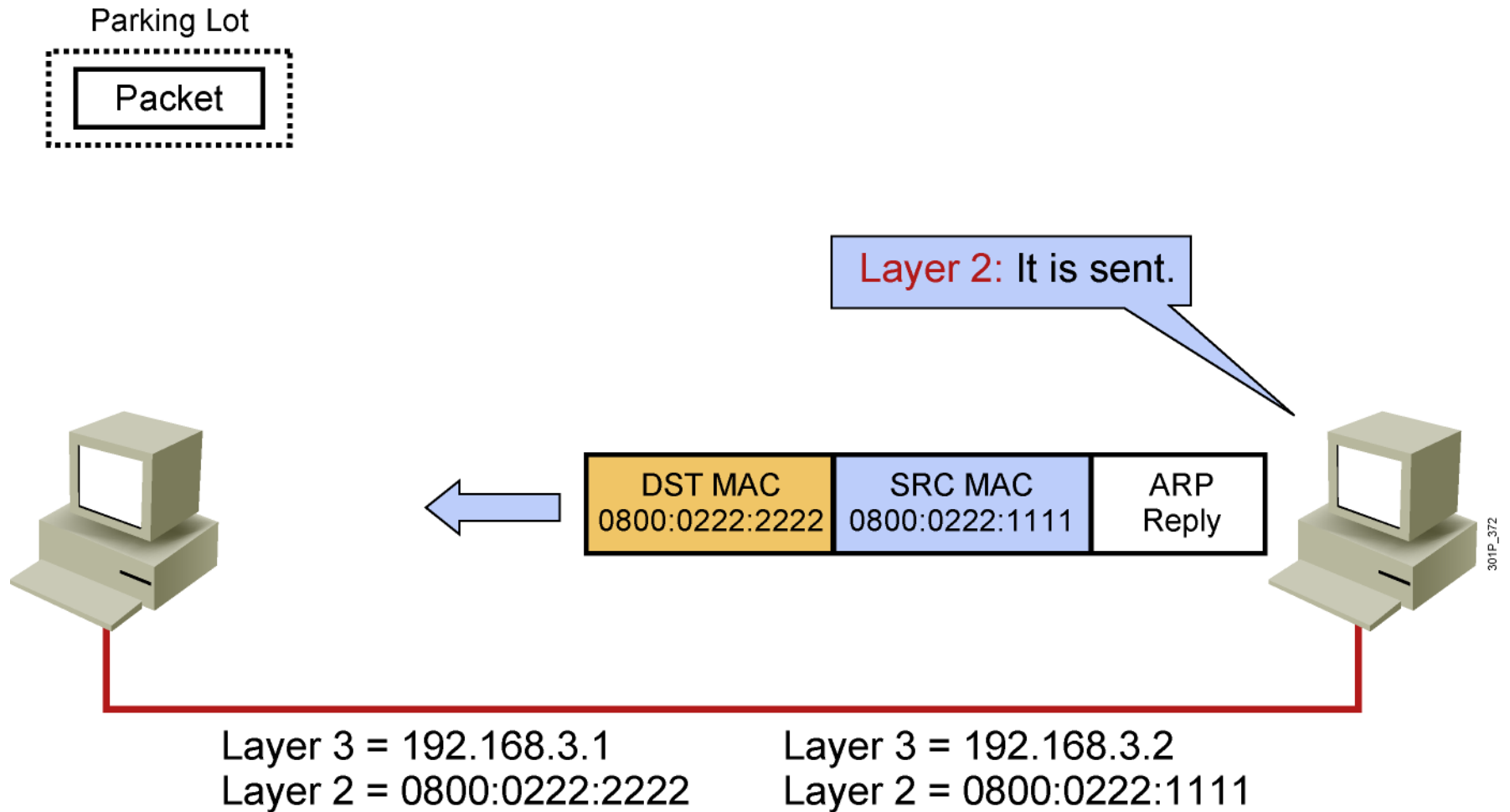
Host-to-Host Packet Delivery (8 of 22)



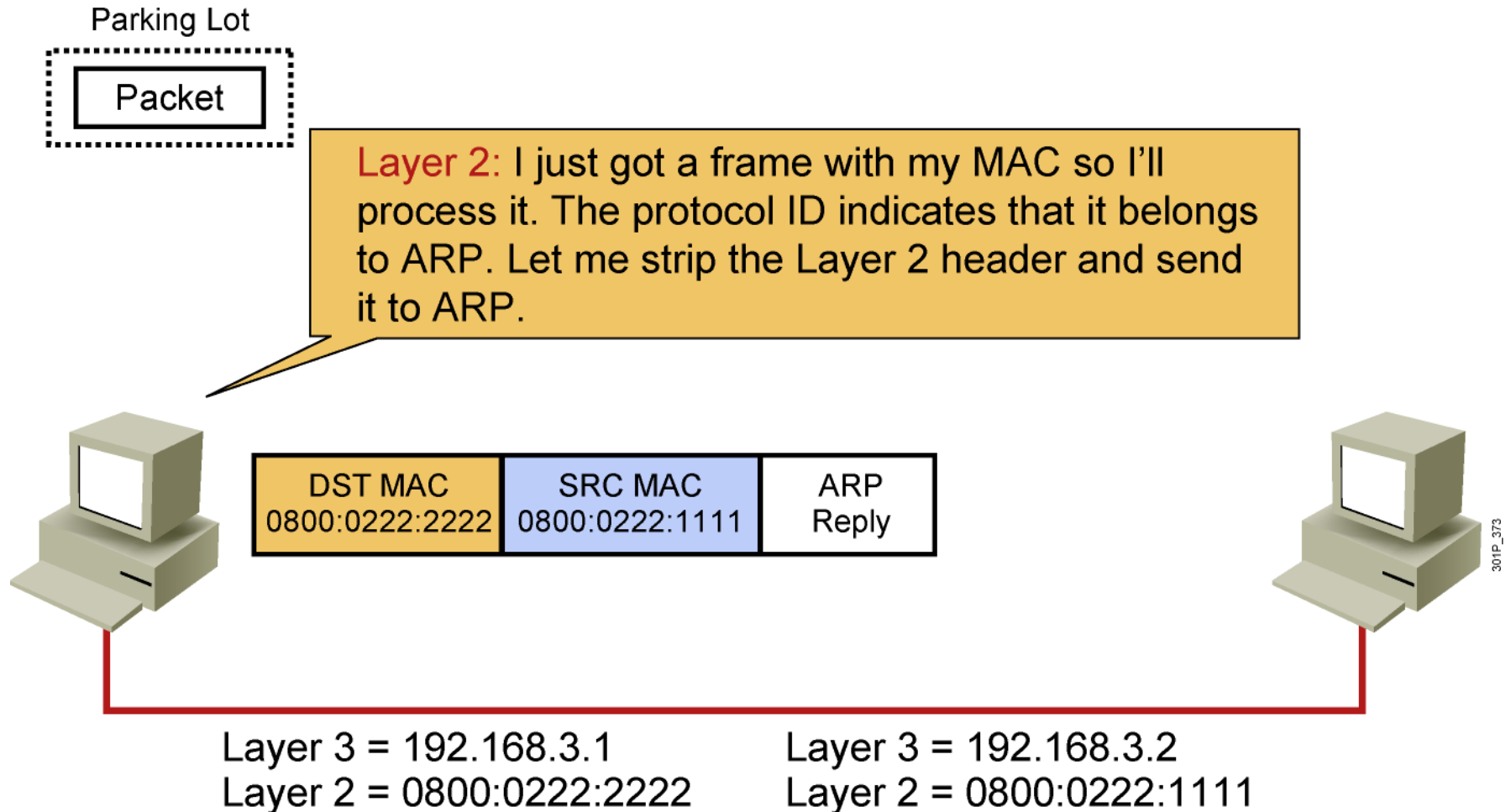
Host-to-Host Packet Delivery (9 of 22)



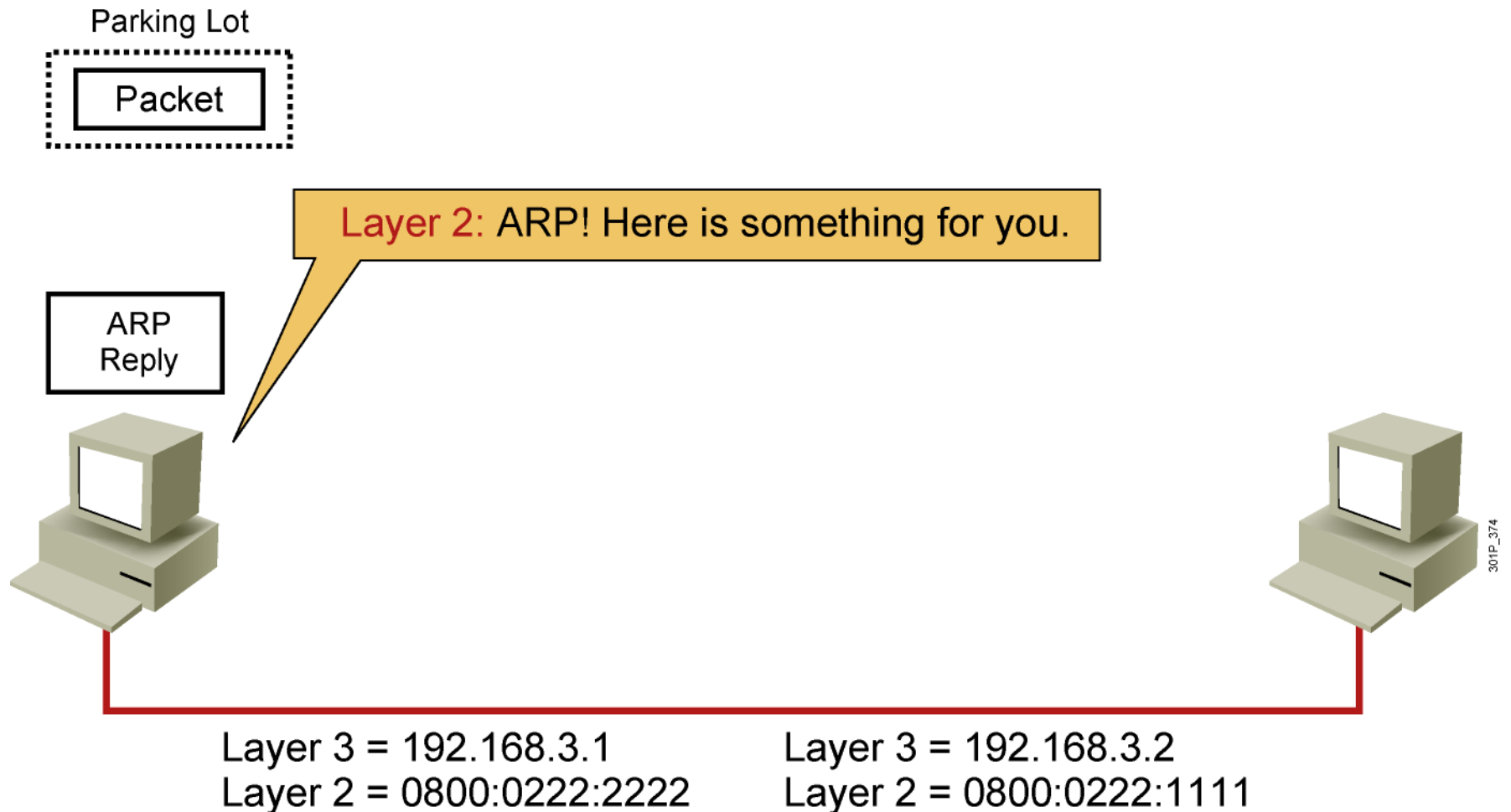
Host-to-Host Packet Delivery (10 of 22)



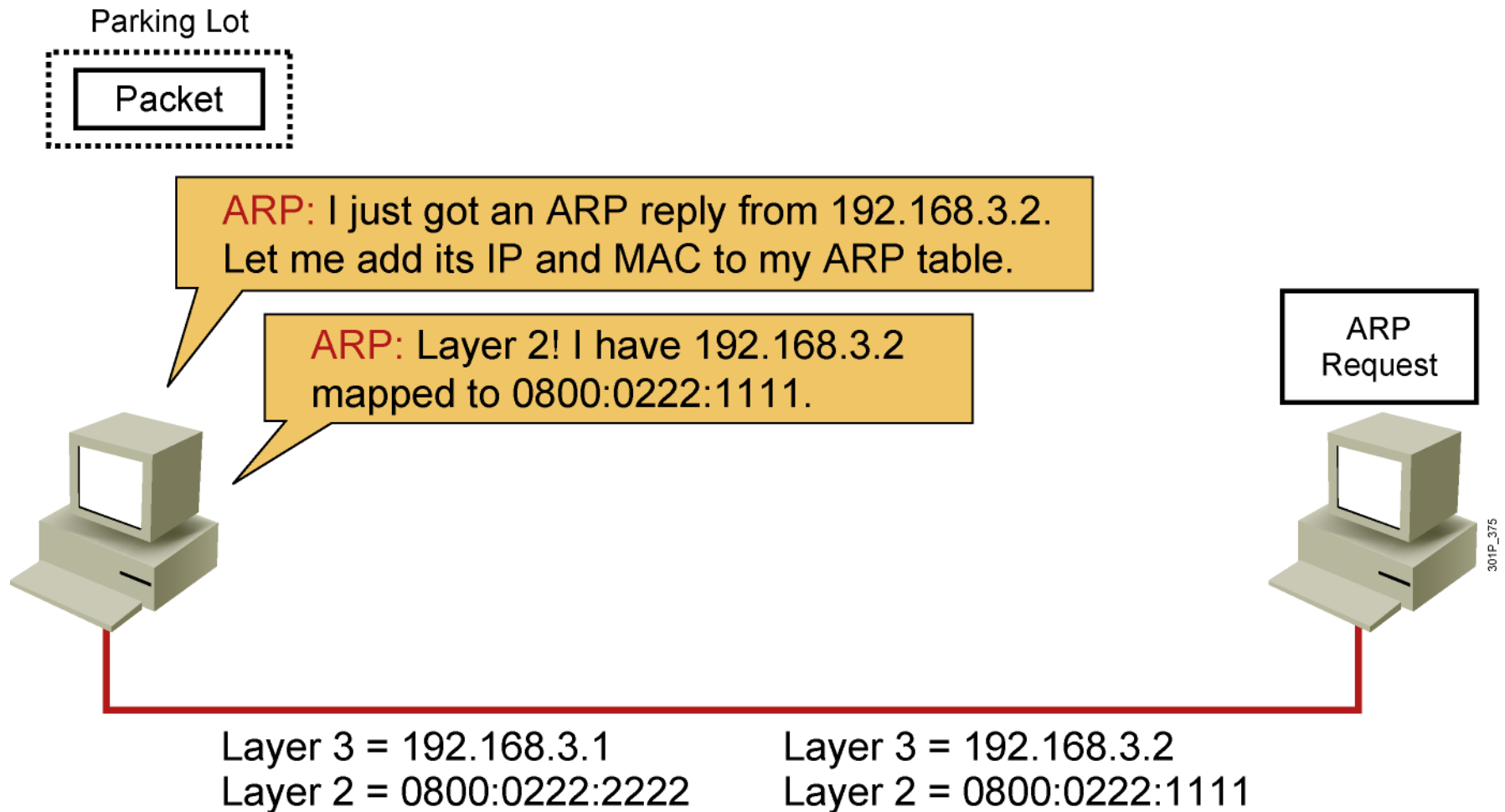
Host-to-Host Packet Delivery (11 of 22)



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

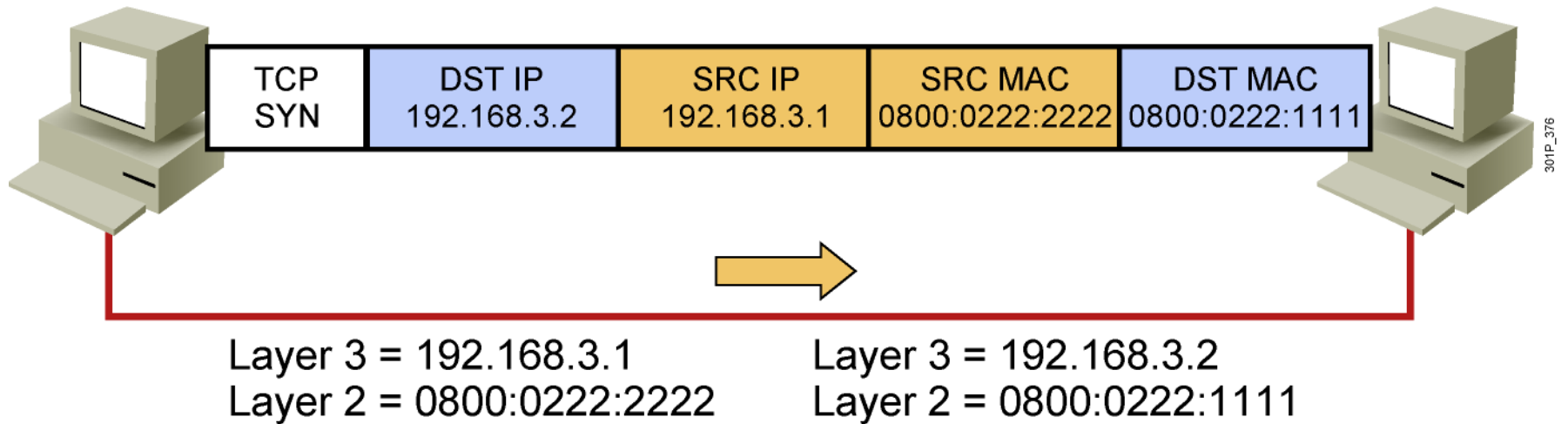


Host-to-Host Packet Delivery (13 of 22)



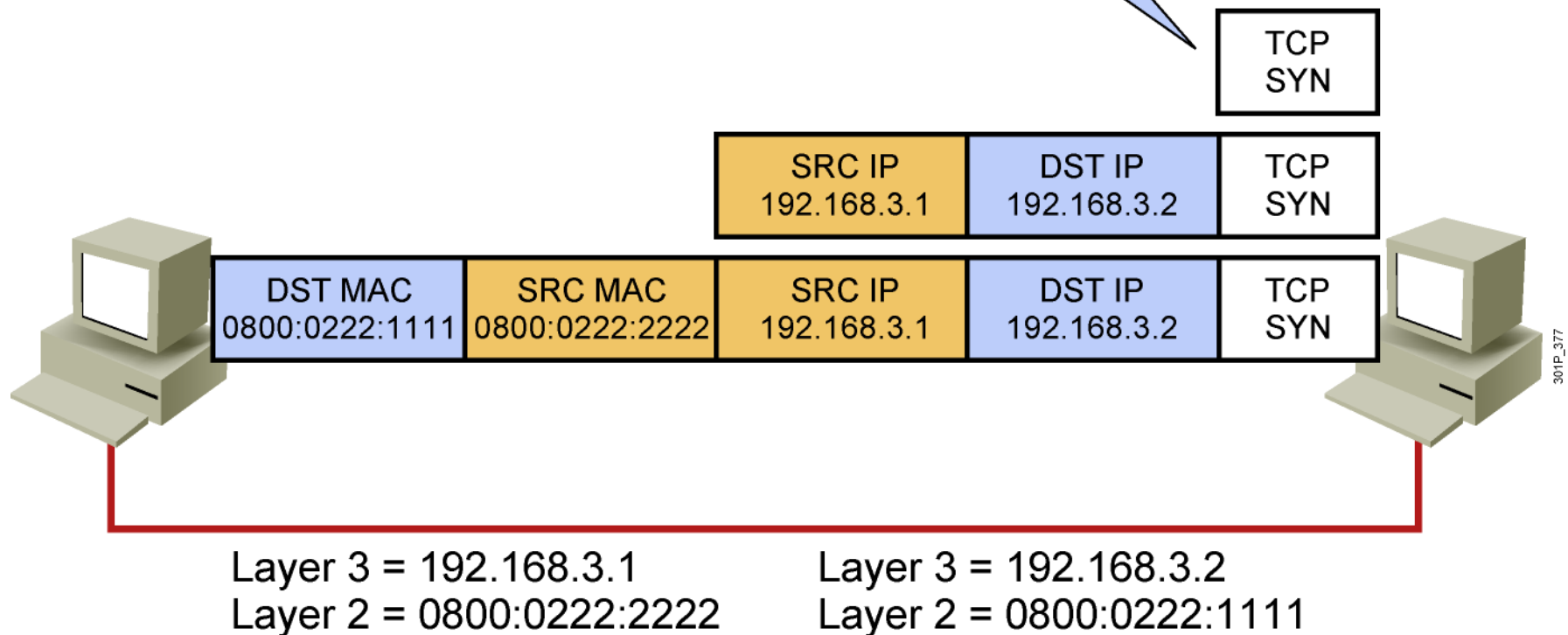
Host-to-Host Packet Delivery (14 of 22)

Layer 2: I can send out that pending packet.

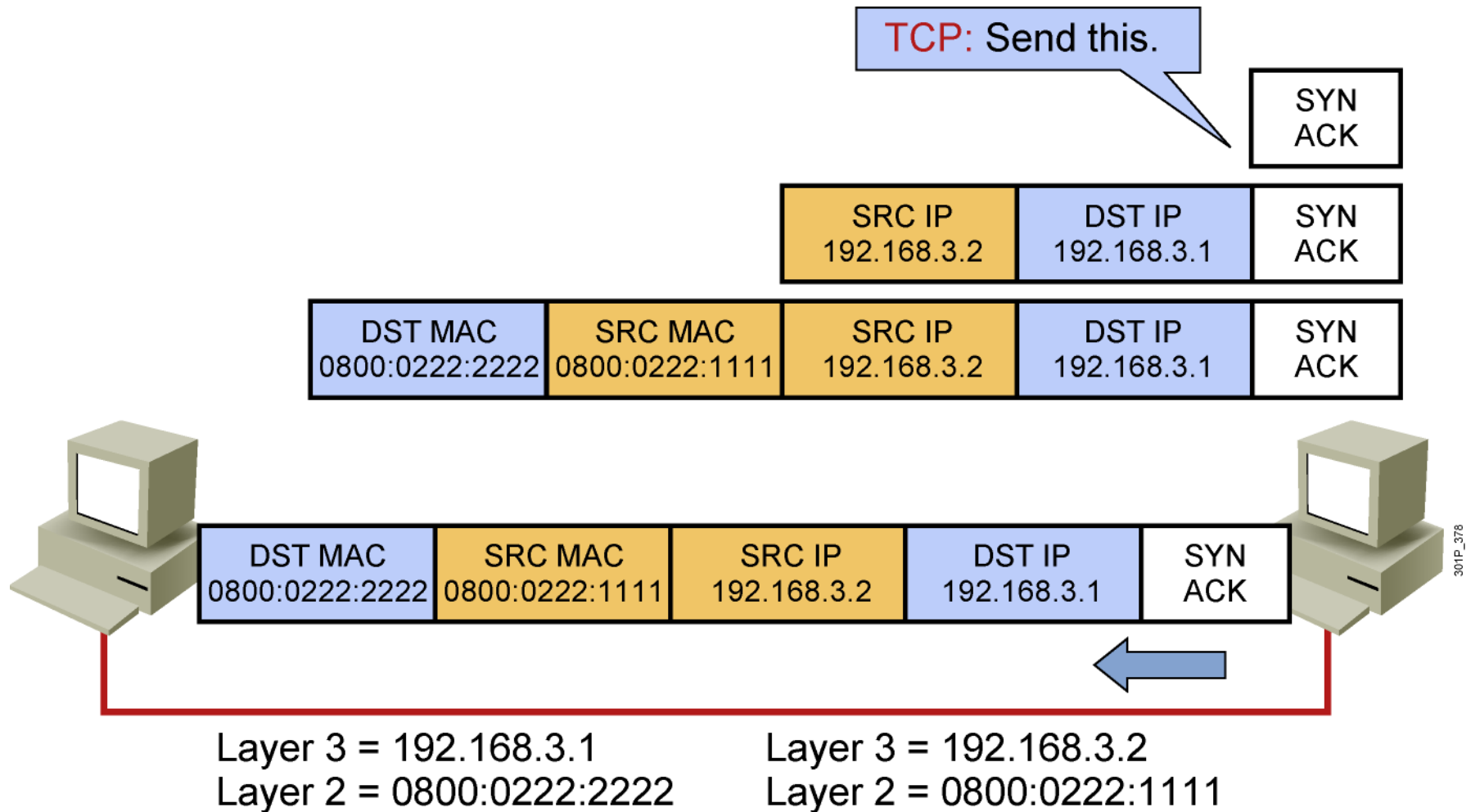


Host-to-Host Packet Delivery (15 of 22)

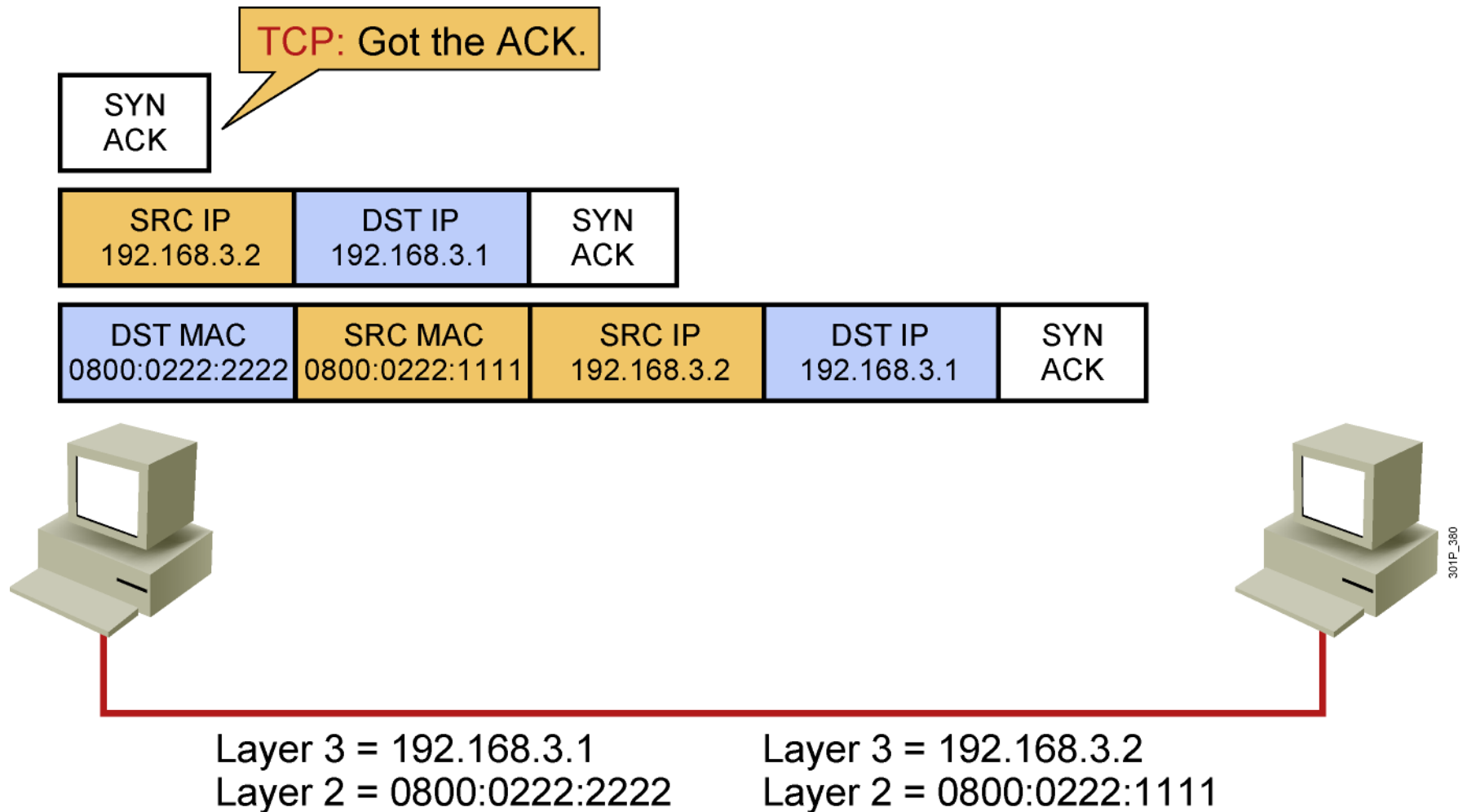
TCP: I need to send a SYN ACK to the TCP SYN that I received.



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



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



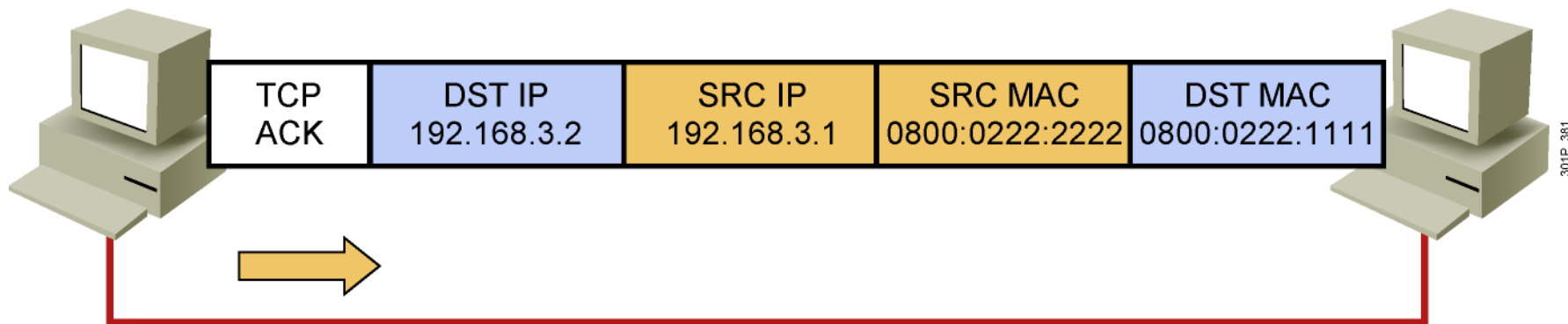
Host-to-Host Packet Delivery (18 of 22)

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

TCP
ACK

SRC IP 192.168.3.1	DST IP 192.168.3.2	TCP ACK
-----------------------	-----------------------	------------

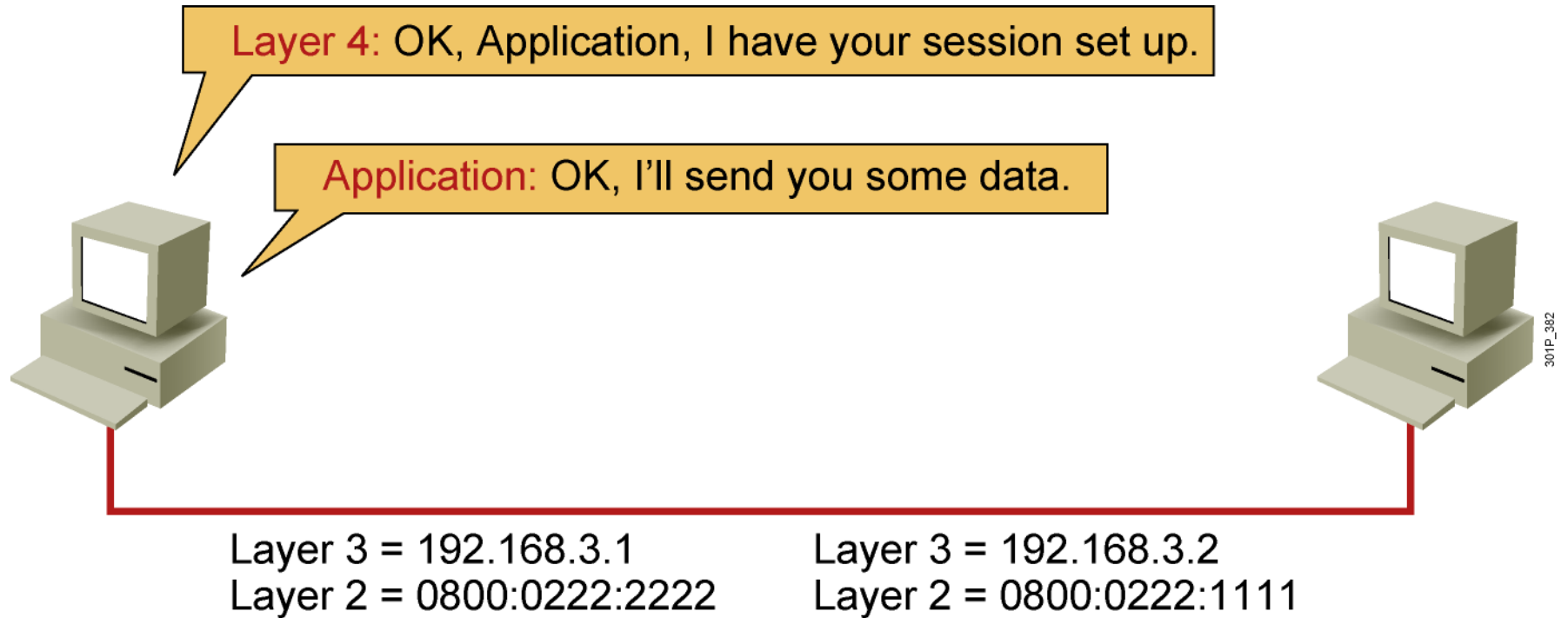
DST MAC 0800:0222:1111	SRC MAC 0800:0222:2222	SRC IP 192.168.3.1	DST IP 192.168.3.2	TCP ACK
---------------------------	---------------------------	-----------------------	-----------------------	------------



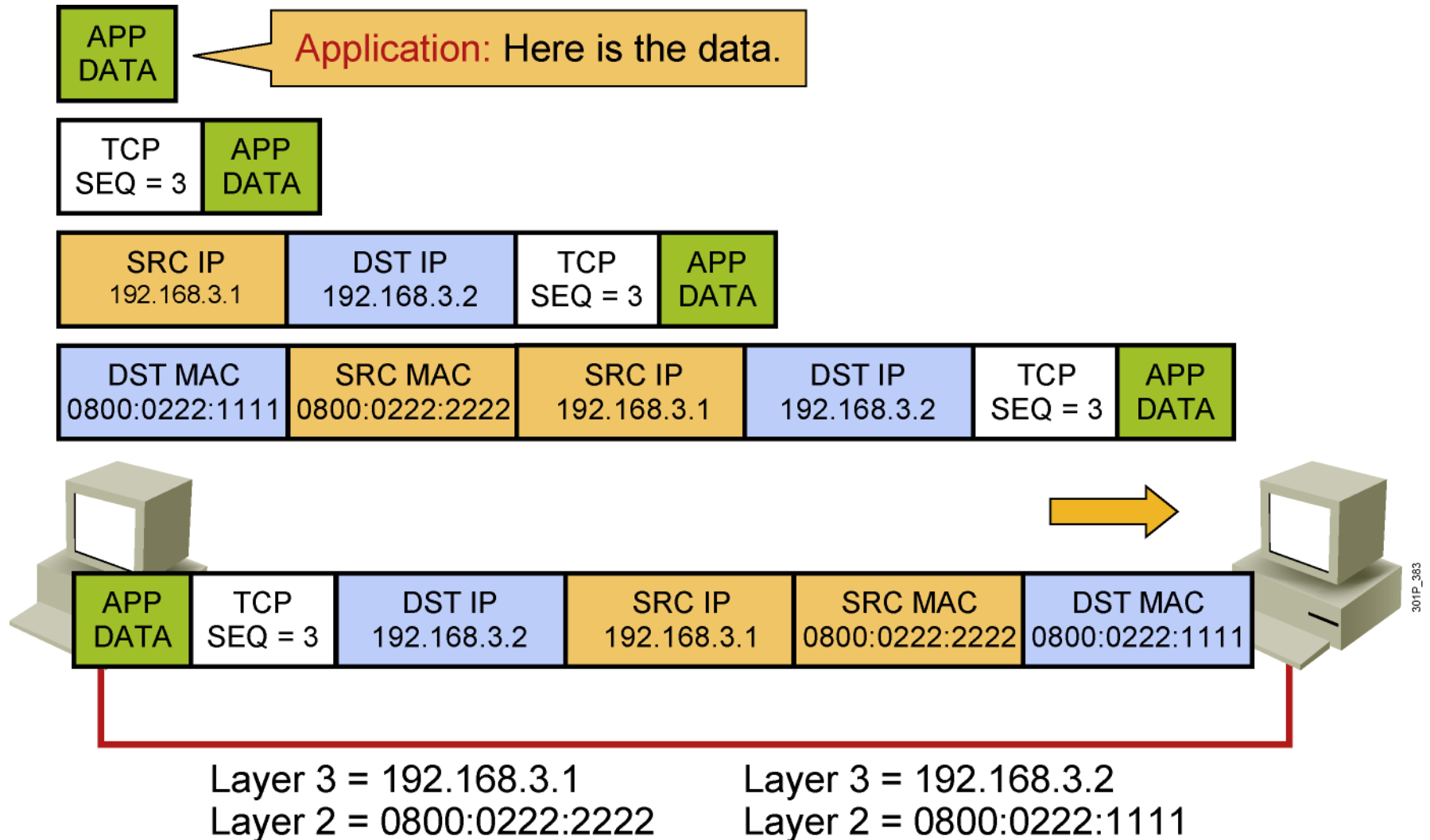
Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

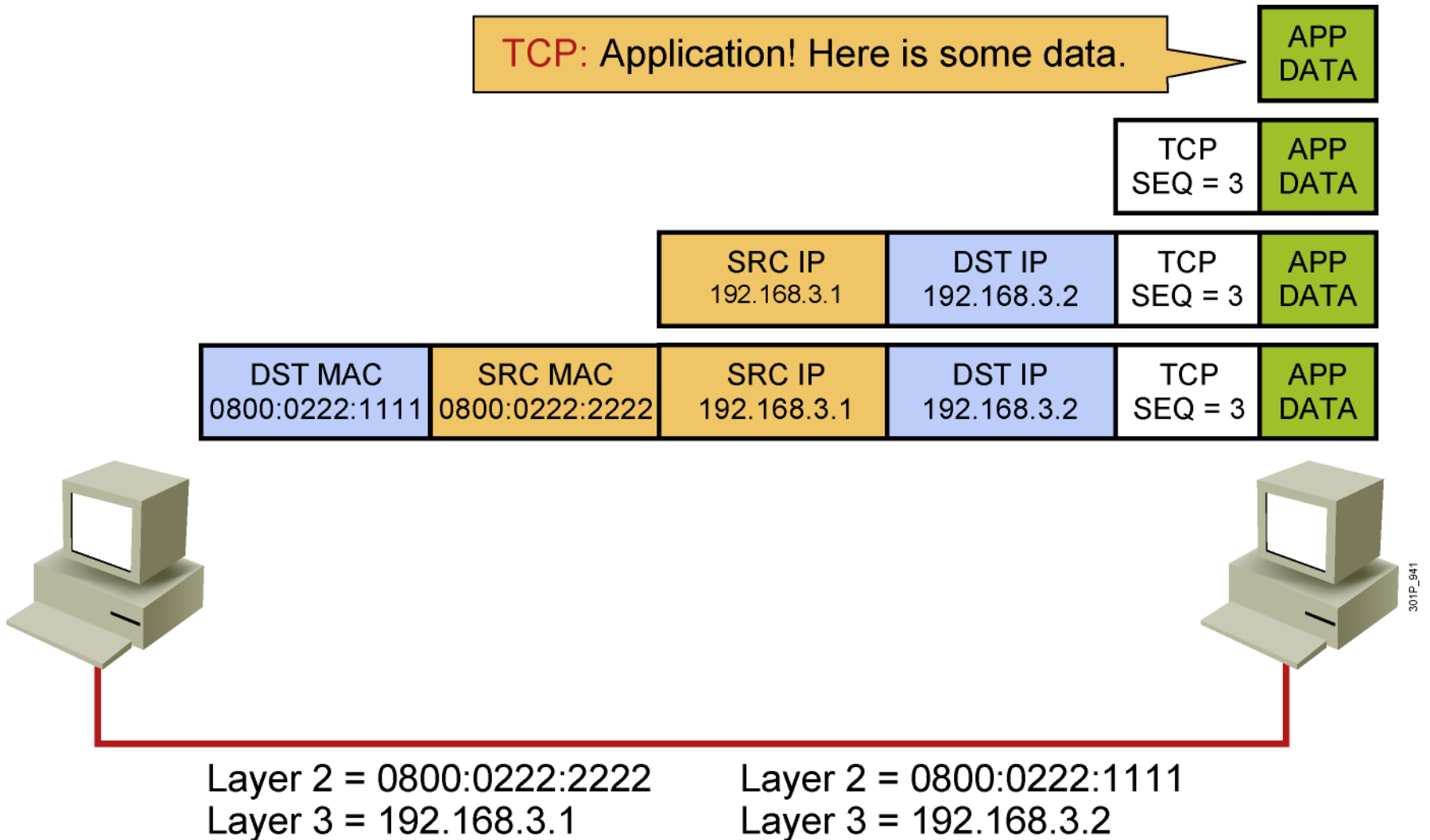
Host-to-Host Packet Delivery (19 of 22)



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



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



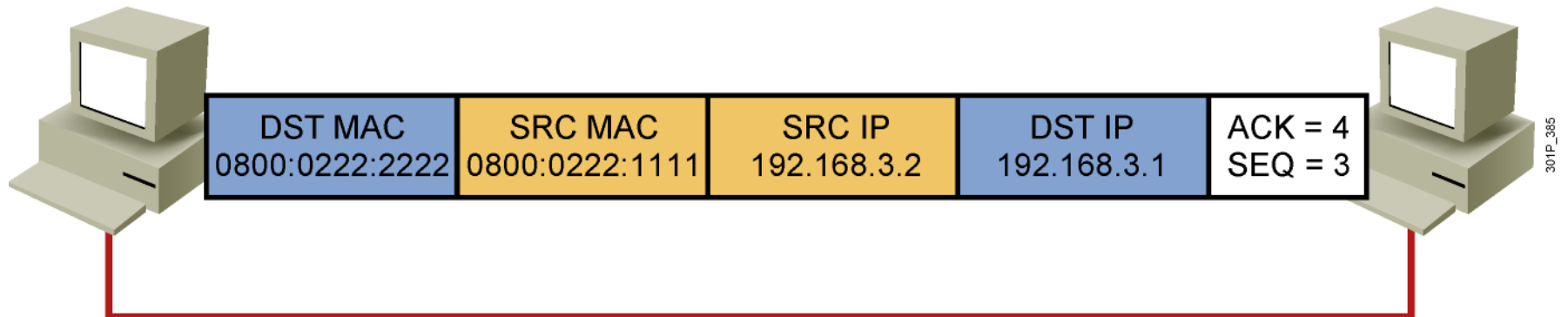
Host-to-Host Packet Delivery (22 of 22)

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

ACK = 4
SEQ = 3

SRC IP 192.168.3.2	DST IP 192.168.3.1	ACK = 4 SEQ = 3
-----------------------	-----------------------	--------------------

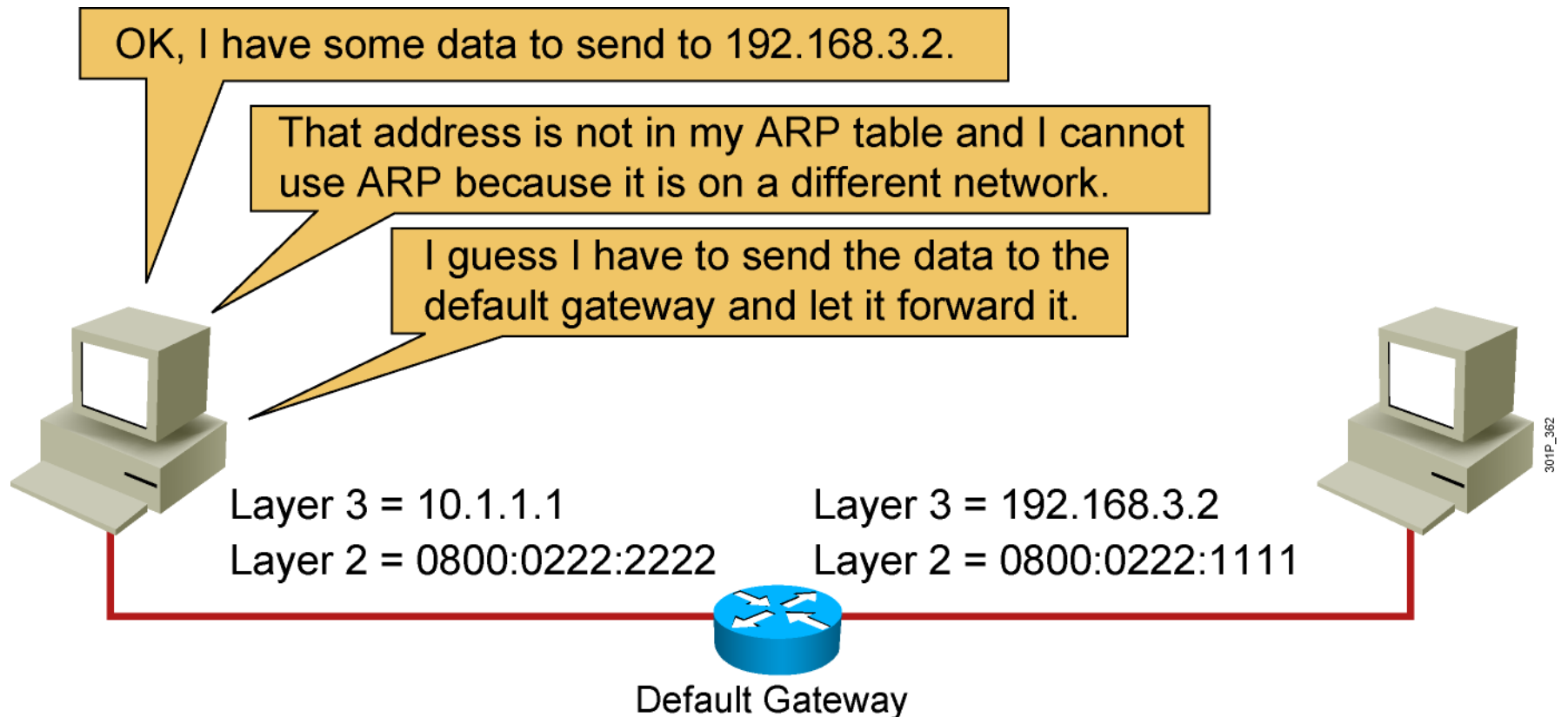
DST MAC 0800:0222:2222	SRC MAC 0800:0222:1111	SRC IP 192.168.3.2	DST IP 192.168.3.1	ACK = 4 SEQ = 3
---------------------------	---------------------------	-----------------------	-----------------------	--------------------



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

Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

Default Gateway





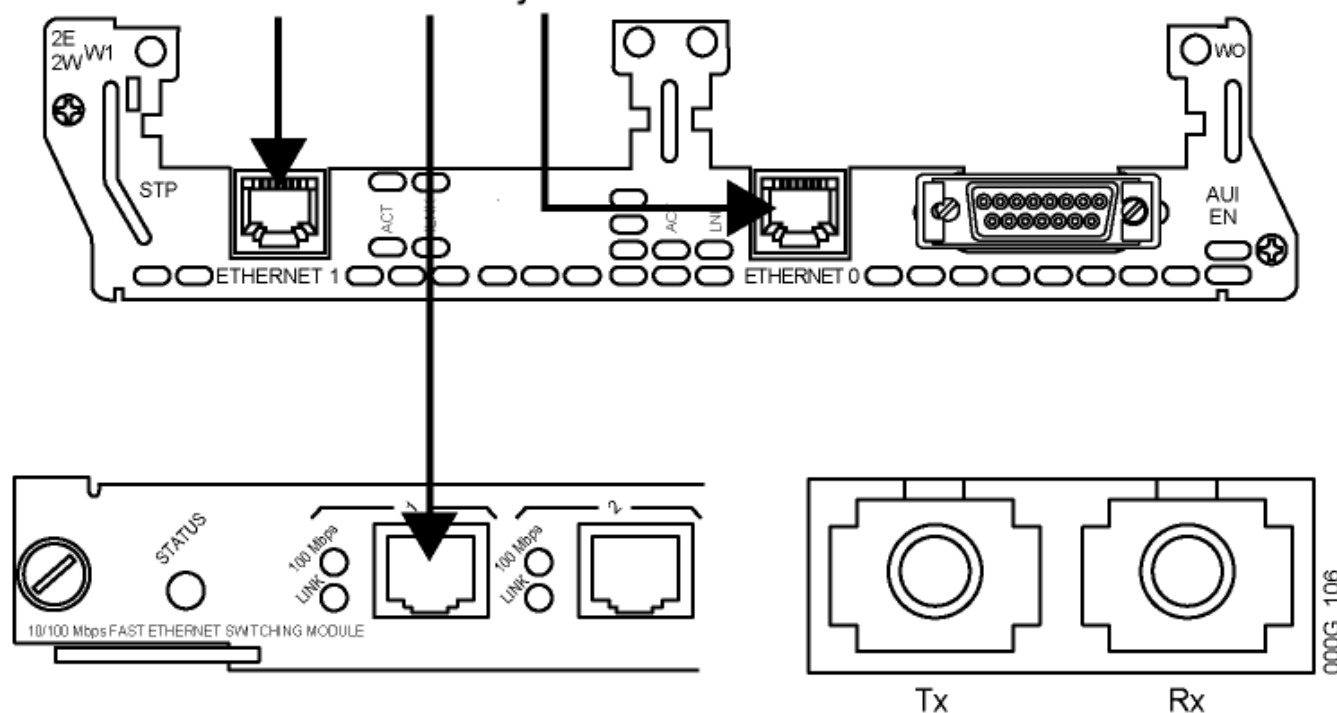
Cabling in Internetwork

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)	—	—

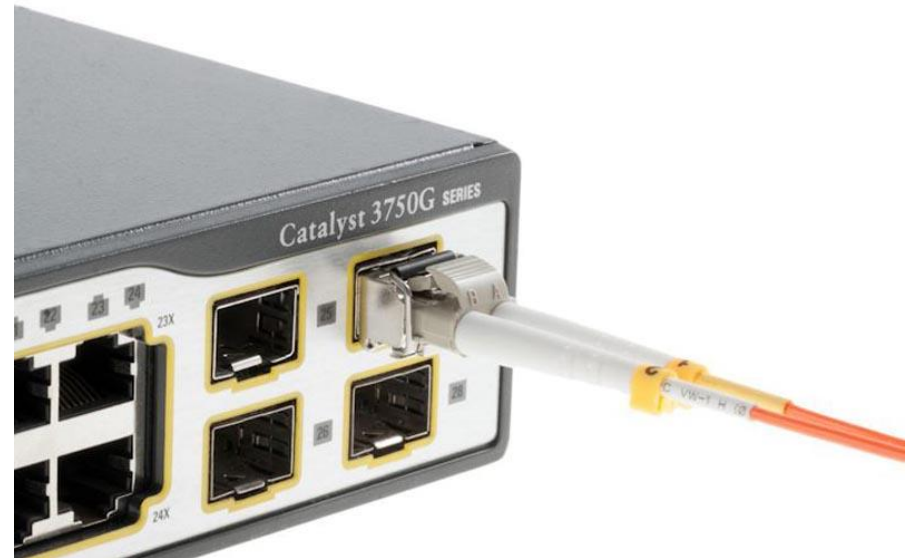
Differentiating Between Connections

ISO 8877 (RJ-45)
connectors and jacks
are slightly larger than
RJ-11 phone
connectors and jacks.



ISO = International Organization for Standardization

1000BASE-T GBIC



Cisco Fiber-Optic GBICs

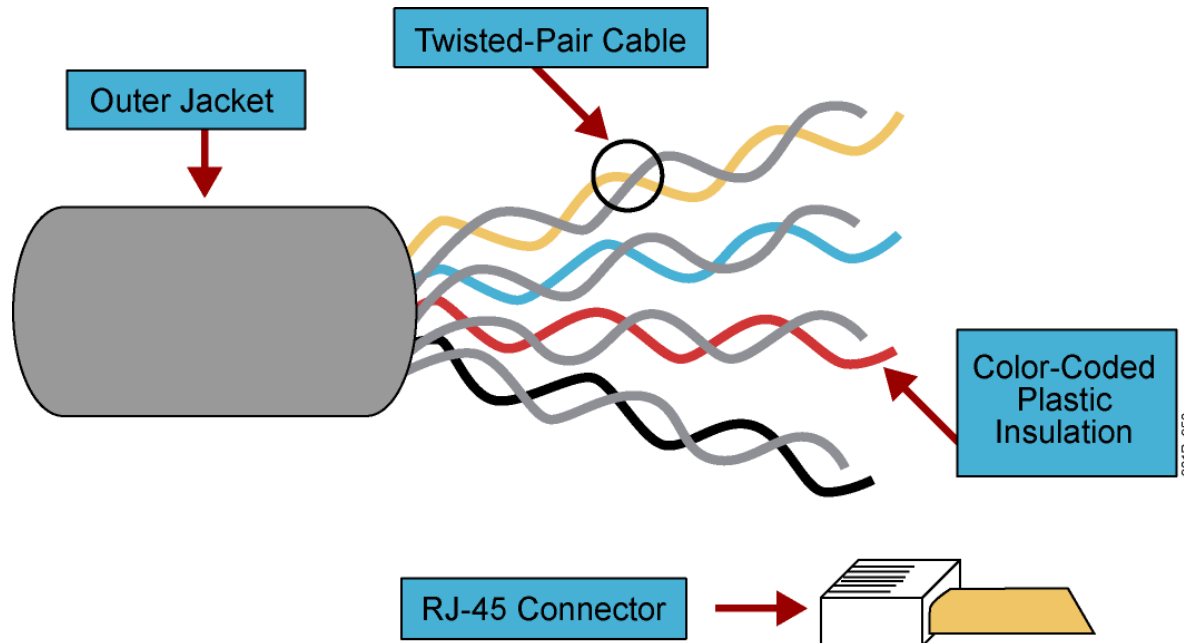
- Short wavelength (1000BASE-SX)
- Long wavelength/long haul (1000BASE-LX/LH)
- Extended distance (1000BASE-ZX)



1000BASE-LX SFP

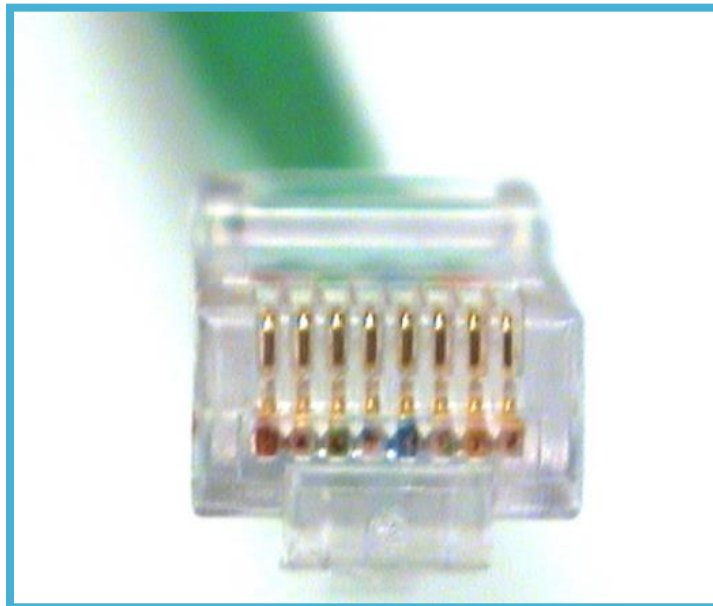


Unshielded Twisted-Pair Cable

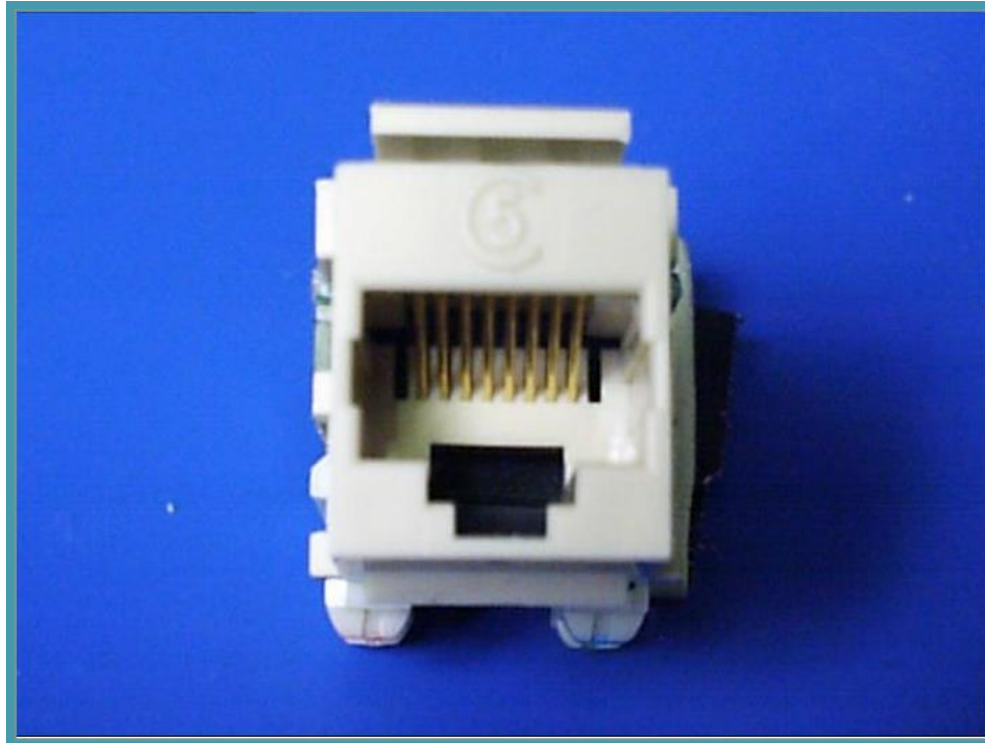


- Speed and throughput: 10 to 1000 Mb/s
- Average cost per node: Least expensive
- Media and connector size: Small
- Maximum cable length: Varies

RJ-45 Connector

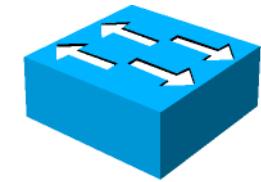


RJ-45 Jack

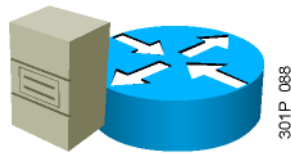


UTP Implementation (Straight-Through)

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



Hub/Switch



Server/Router

Pin Label

1	TX+	↔	1
2	TX-	↔	2
3	RX+	↔	3
4	NC		4
5	NC		5
6	RX-	↔	6
7	NC		7
8	NC		8

Pin Label

TX+
TX-
RX+
NC
NC
RX-
NC
NC

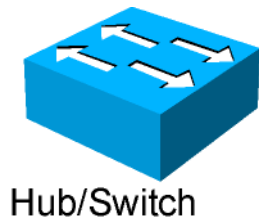
Straight-Through Cable



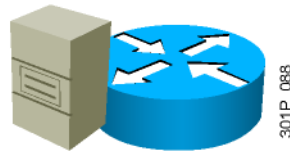
Wires on cable ends
are in same order.

UTP Implementation (Crossover)

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



Hub/Switch



Server/Router

Pin Label

1	TX+	1
2	TX-	2
3	RX+	3
4	NC	4
5	NC	5
6	RX-	6
7	NC	7
8	NC	8

Pin Label

TX+
TX-
RX+
NC
NC
RX-
NC
NC

Crossover Cable

EIA/TIA T568A



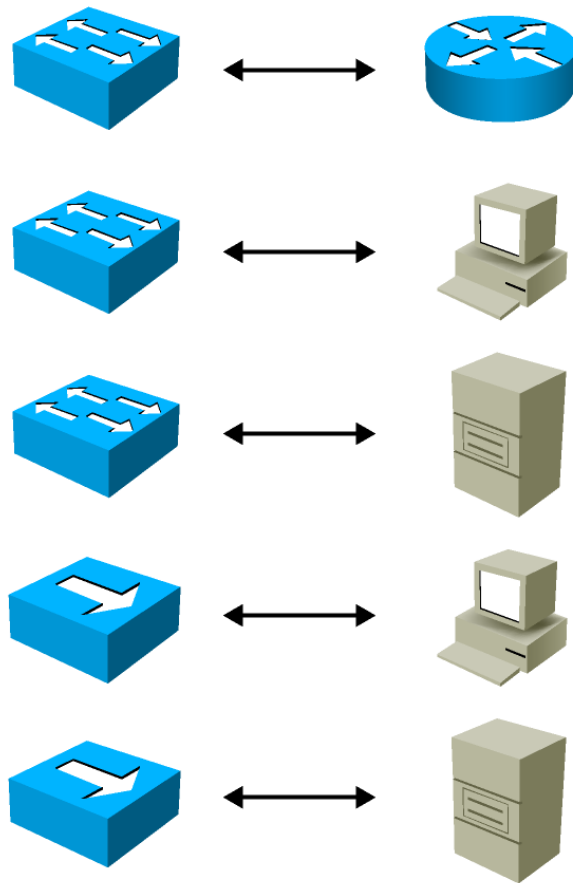
EIA/TIA T568B



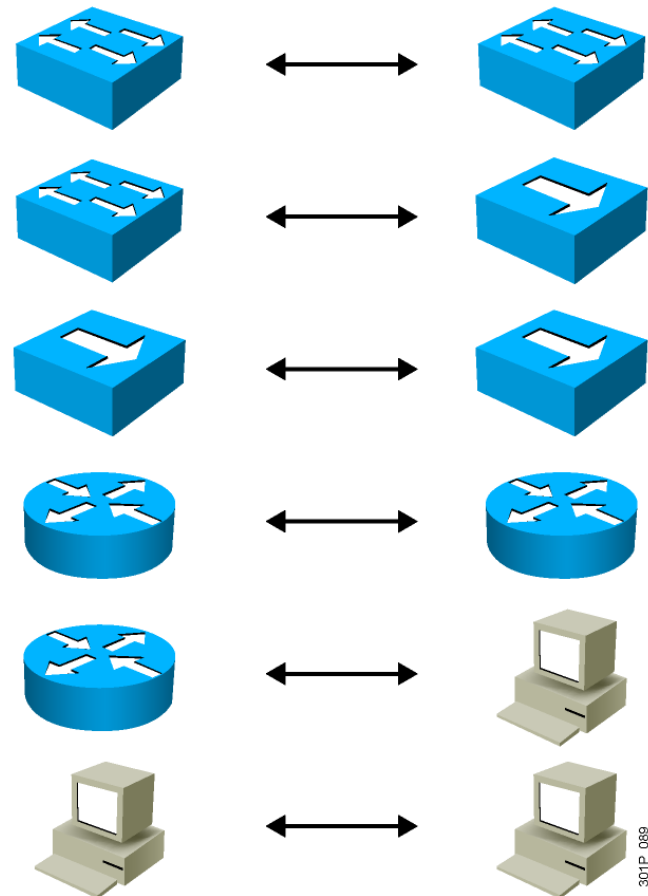
Some wires on cable
ends are crossed.

UTP Implementation: Straight-Through vs. Crossover

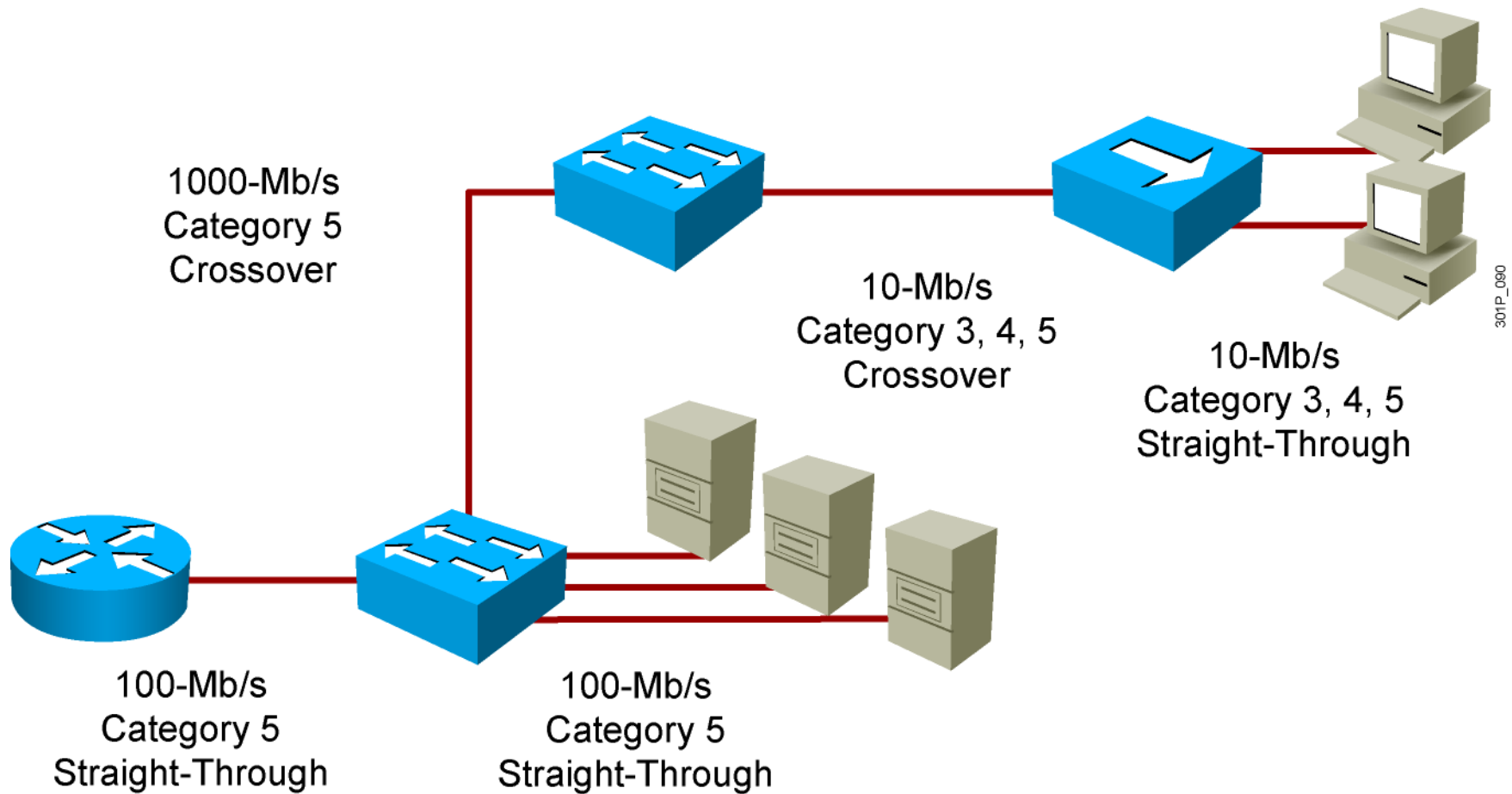
Straight-Through Cable



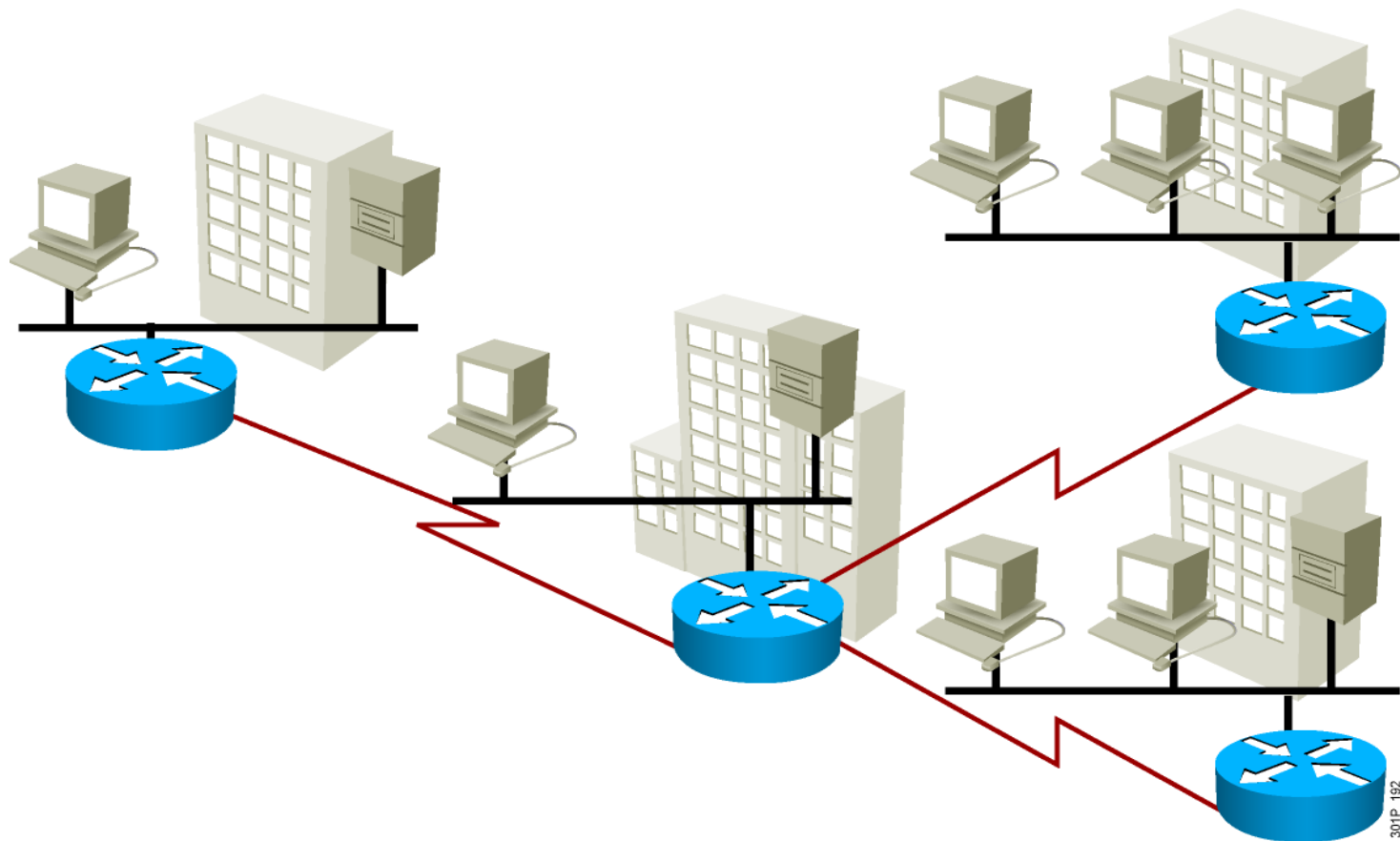
Crossover Cable



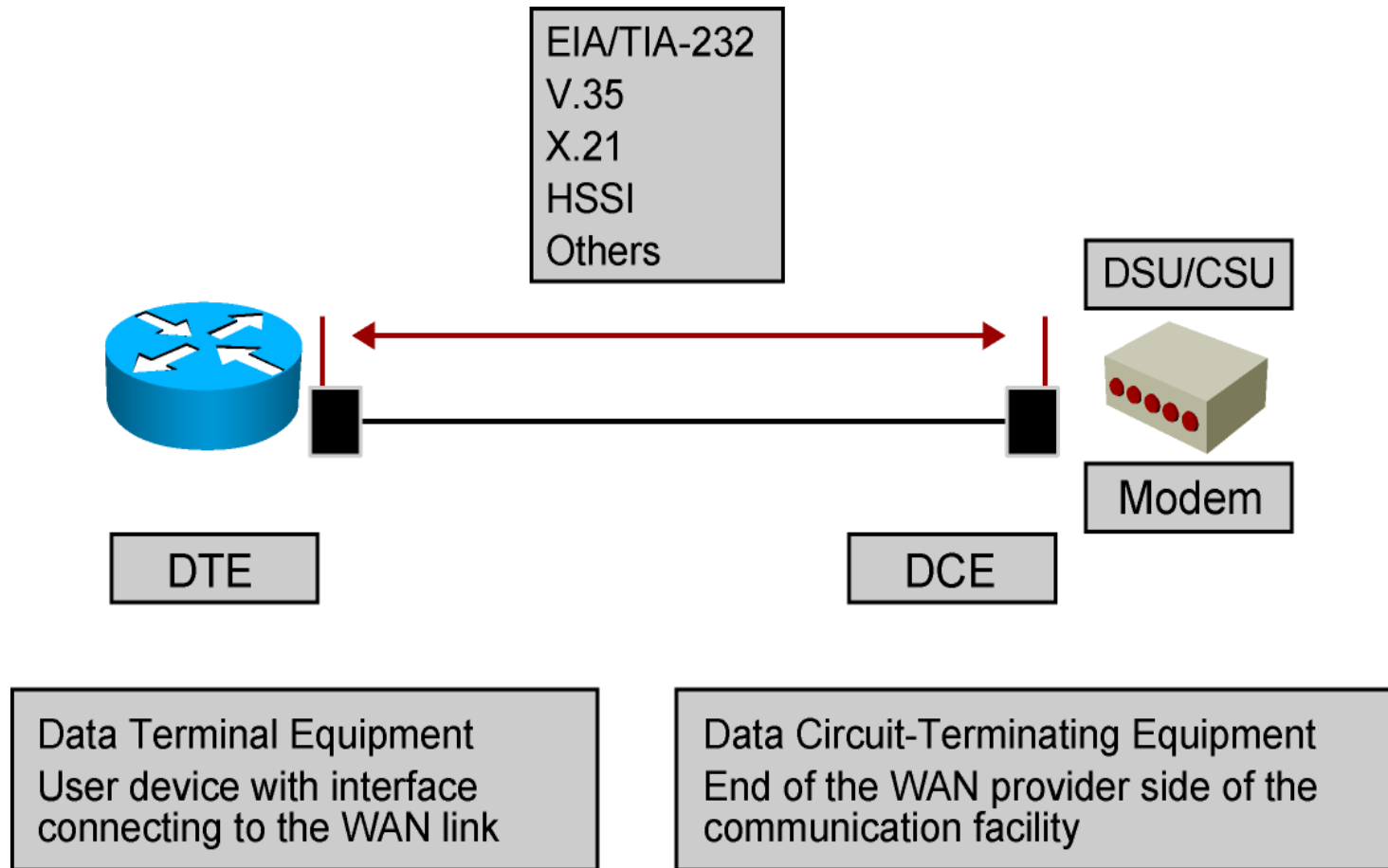
Using Varieties of UTP



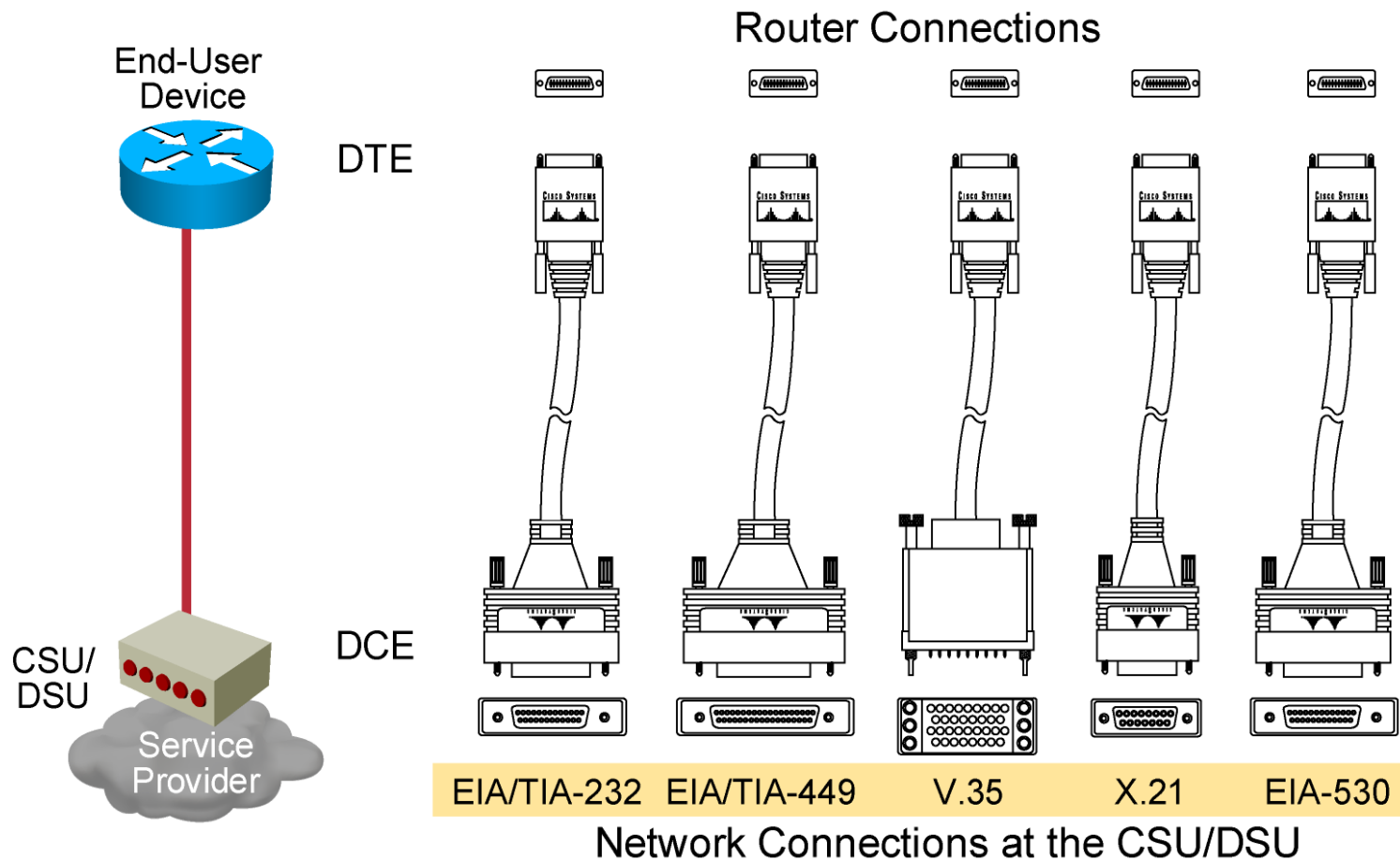
WAN—Multiple LANs



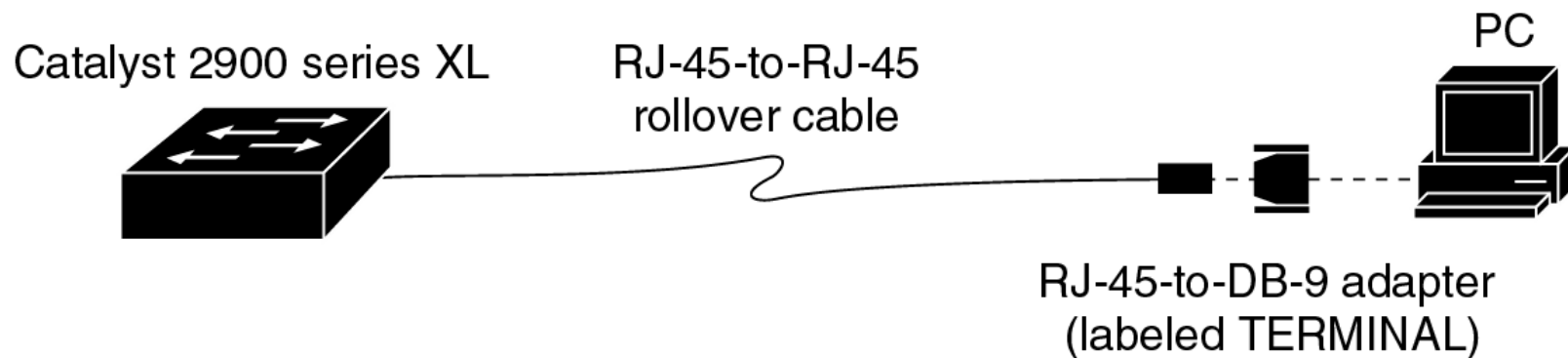
Physical Layer: WANs



Serial Point-to-Point Connections



Setting up a Console Connection



H10972

