University of Technical Education of Ho Chi Minh City

NETWORKING ESSENTIALS

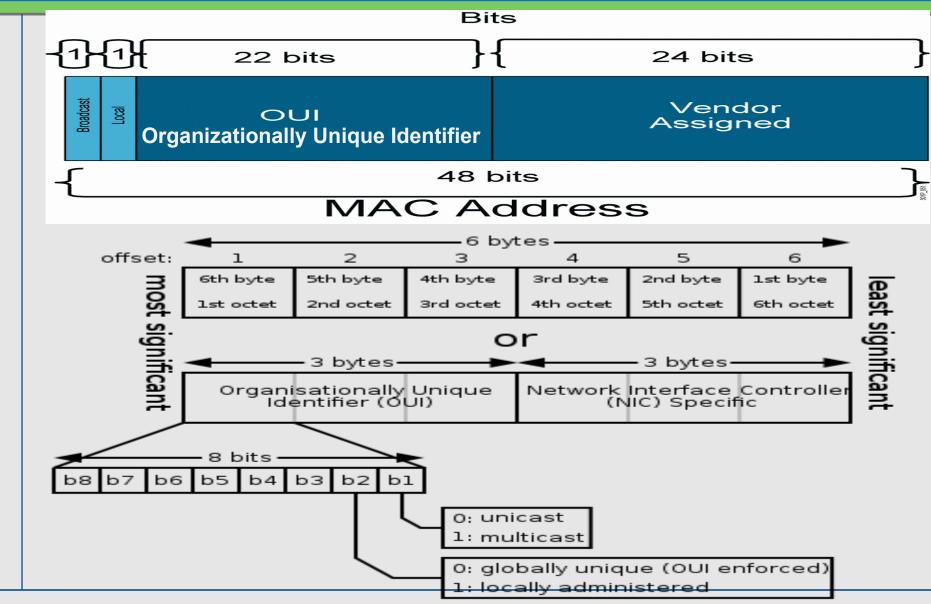
Chapter 3.

LAN Switching

Contents

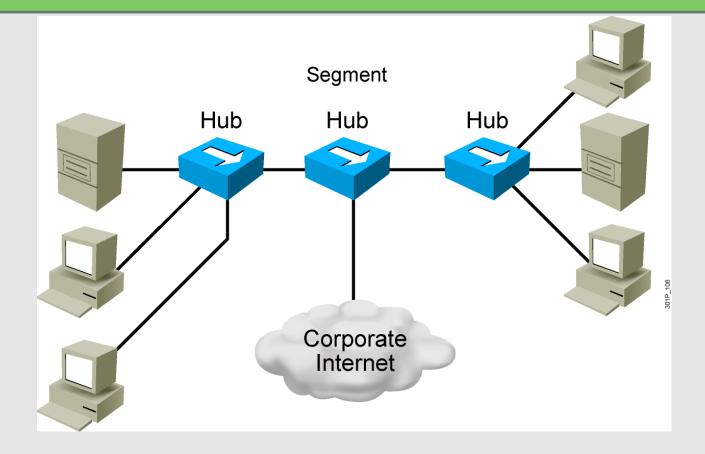
- Understanding the challenges with Switched LAN Technology
- II. Exploring the packet Delivery Process 1 (layer 1)
- III. Exploring the packet Delivery Process 2 (layer 2)
- IV. Exploring the packet Delivery Process 3 (layer 3)

MAC Address Components



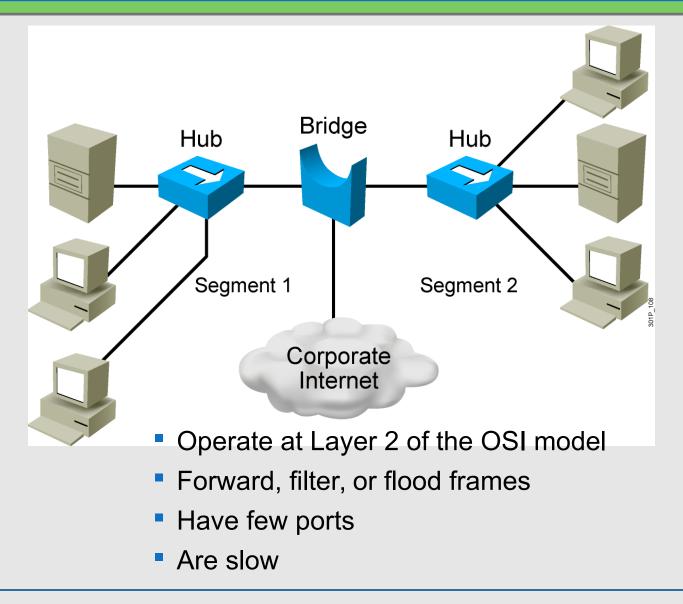
II. Understanding the challenges with Switched LAN Technology

Network Congestion



- High-performance PCs
- More networked data
- Bandwidth-intensive applications

Bridges

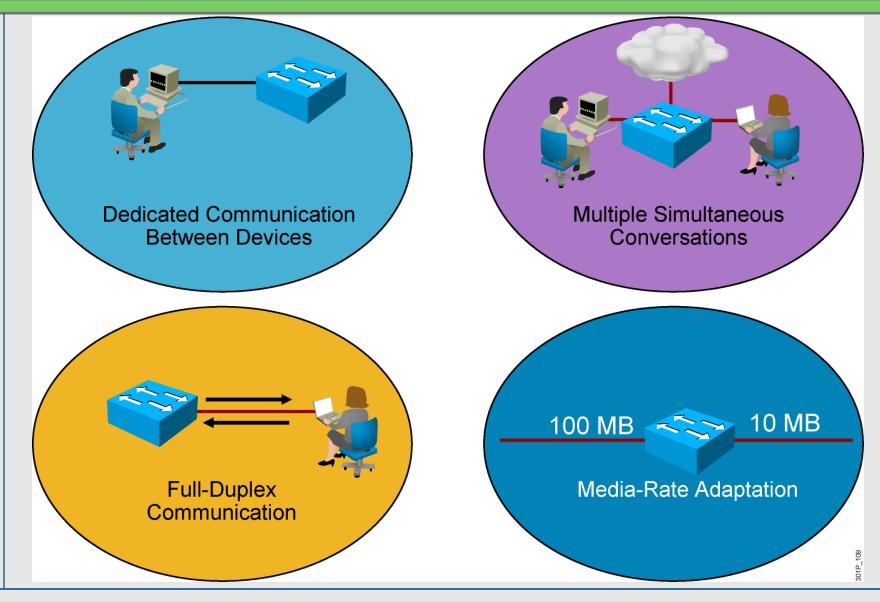


LAN Switch

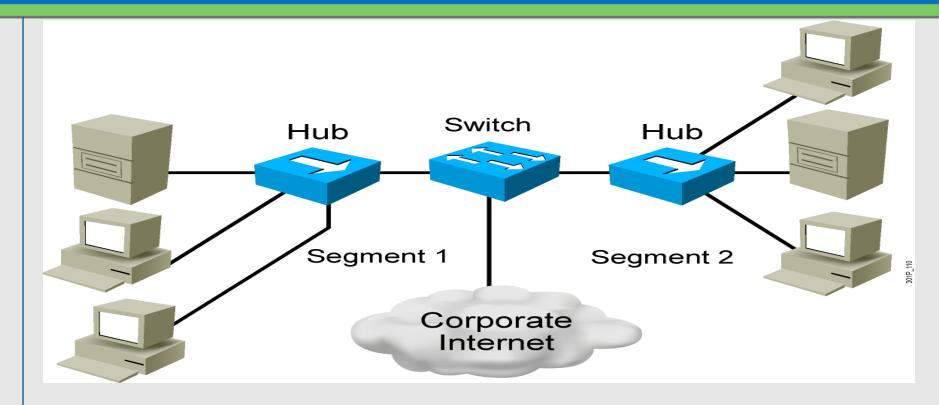
- High port density
- Large frame buffers
- Mixture of port speeds
- Fast internal switching
- Switching modes:
 - Cut-through
 - Store-and-forward
 - Fragment-free



LAN Switch Features

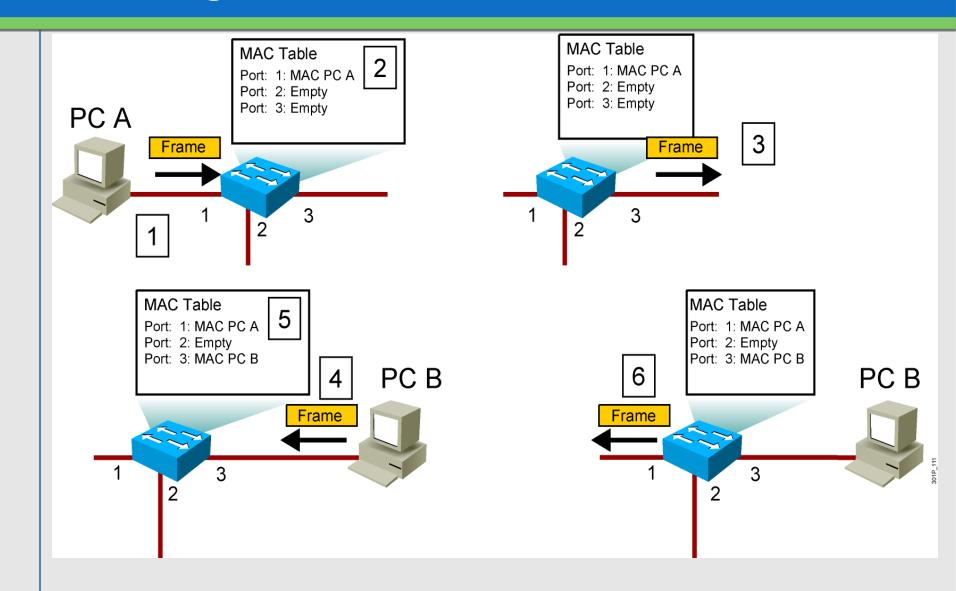


Switches Supersede Bridges

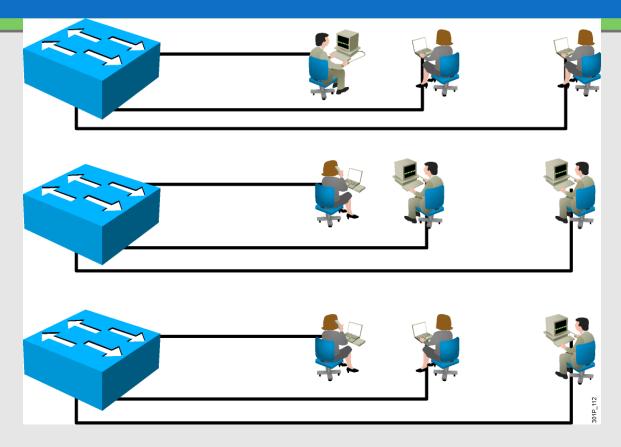


- Operate at Layer 2 of the OSI model
- Forward, filter, or flood frames
- Have many ports
- Are fast

Switching Frames



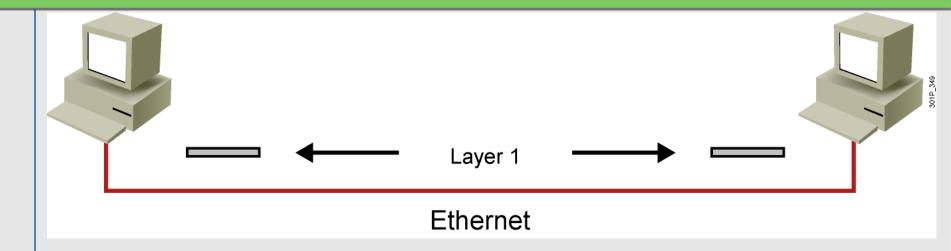
LANs Today



- Users grouped by physical location
- More switches added to networks
- Switches connected by high-speed links

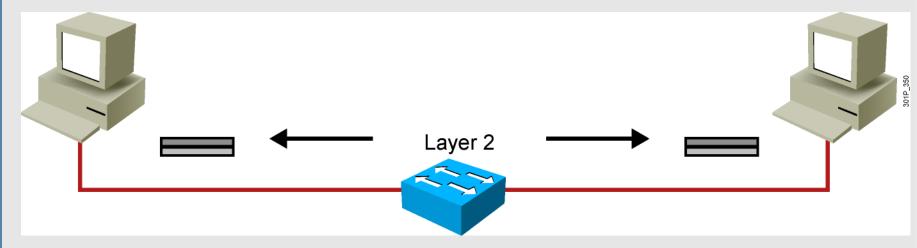
III. Exploring the packet Delivery Process 1 (layer 1)

Layer 1 Devices



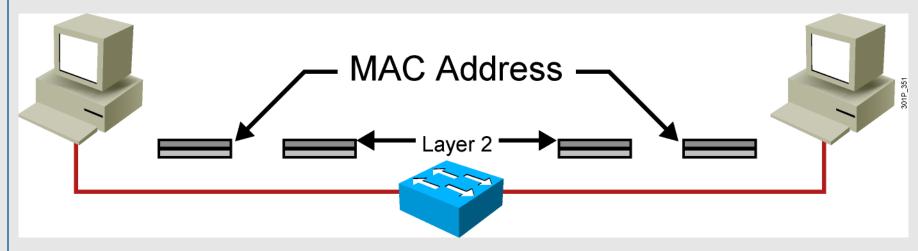
- Layer 1 provides the physical media and its encoding.
- Examples:
 - Ethernet
 - Serial
 - Repeater
 - Physical interface of the NIC

Layer 2 Devices



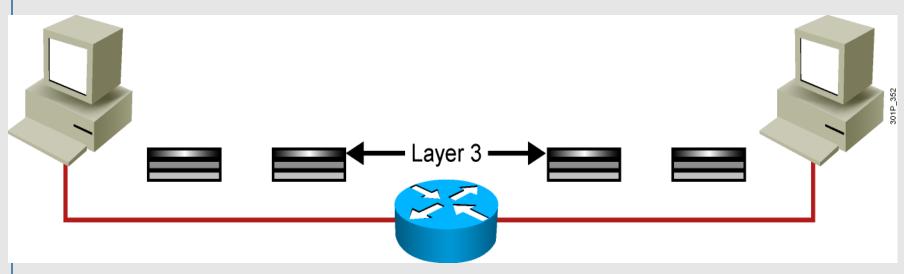
- Layer 2 devices provide an interface with the physical media.
- Examples:
 - NIC
 - Bridge
 - Switch

Layer 2 Addressing



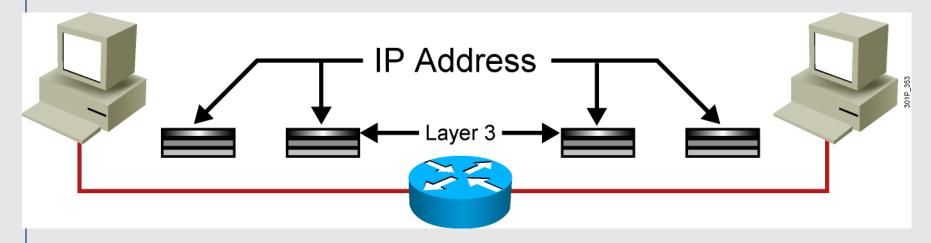
- MAC address
- Assigned to end devices

Layer 3 Devices and Their Function



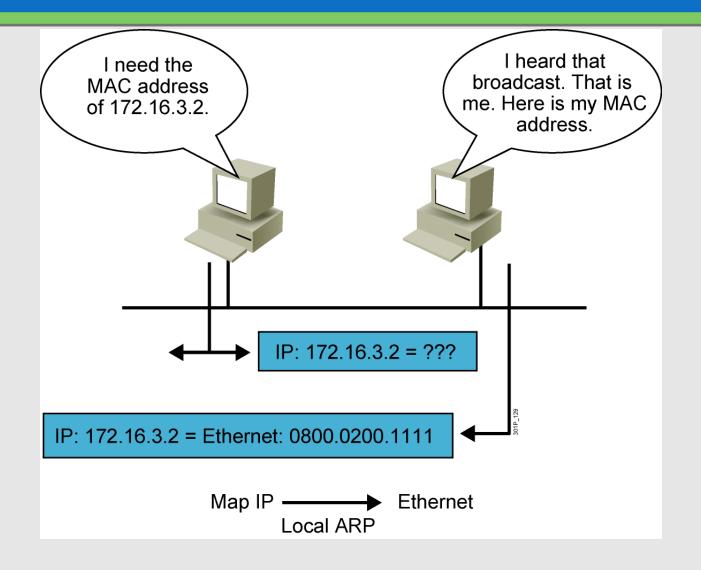
- The network layer provides connectivity and path selection between two host systems.
- In the host, this is the path between the data link layer and the upper layers of the Network Operating System(NOS).
- In the router, it is the actual path across the network.

Layer 3 Addressing



- Each NOS has its own Layer 3 address format.
- OSI uses an Network Service Access Point.
- TCP/IP uses IP.

ARP



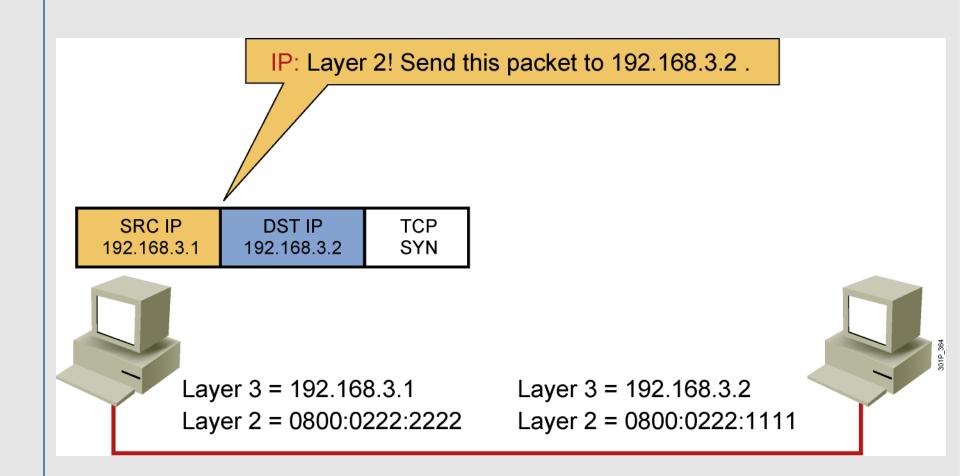
ARP Table

```
C:\WINNT\system32\cmd.exe
D:\>arp -a
Interface: 192.168.1.101 on Interface 0x1000003
  Internet Address
                         Physical Address
                                                Type
                         00-04-5a-22-ec-c7
                                                dynamic
                         00-02-4b-cc-d6-d9
                                                dvnamic
                         00-02-fd-65-9f-82
                                                dynamic
                         00-03-6b-09-59-29
                                                dynamic
                         00-02-4b-cc-d6-d0
                                               dynamic
  192.168.1.100
  192.168.1.135
                                               dynamic
                         00-03-6d-1e-6a-a5
  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** SYN TCP: IP! Send this TCP SYN to 192.168.3.2. Layer 3 = 192.168.3.2Layer 3 = 192.168.3.1Layer 2 = 0800:0222:2222 Layer 2 = 0800:0222:1111

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



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

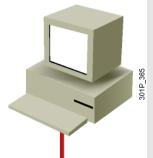


Layer 3 = 192.168.3.1

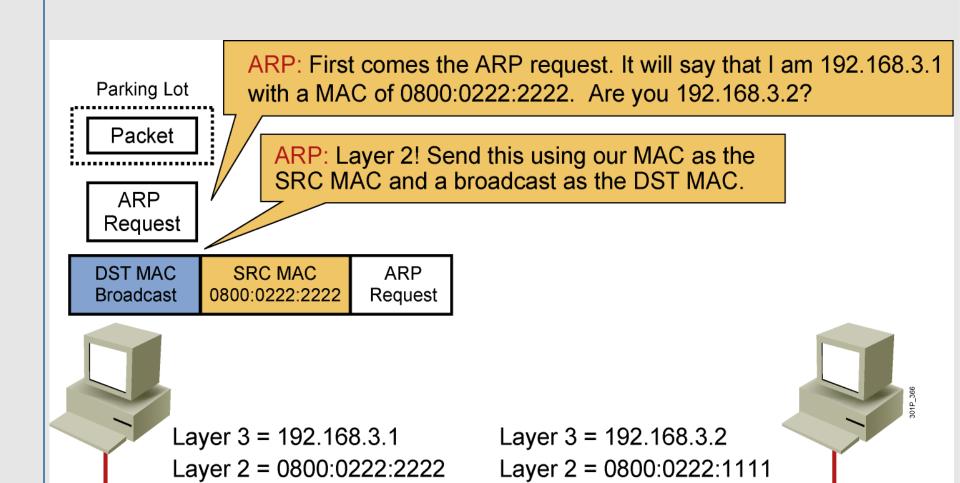
Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

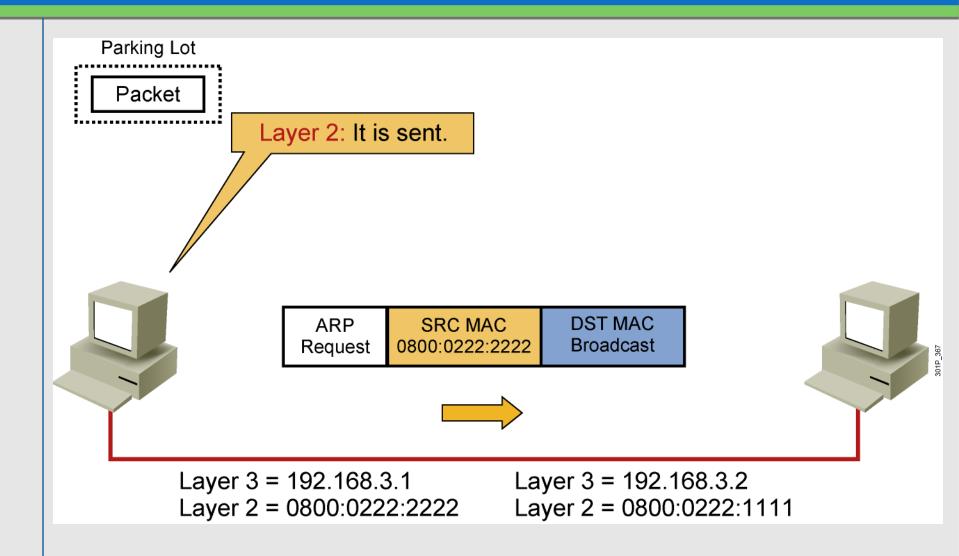
Layer 2 = 0800:0222:1111



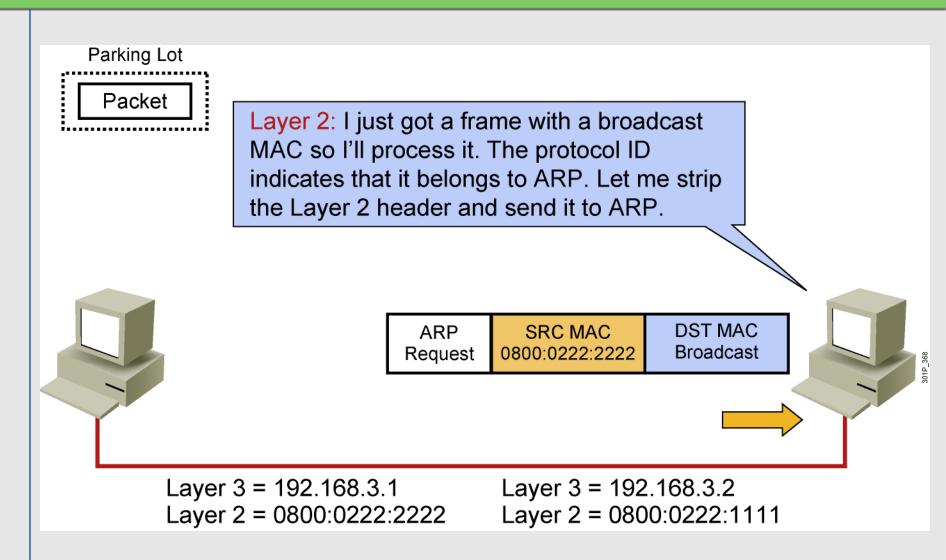
Host-to-Host Packet Delivery (4 of 22)



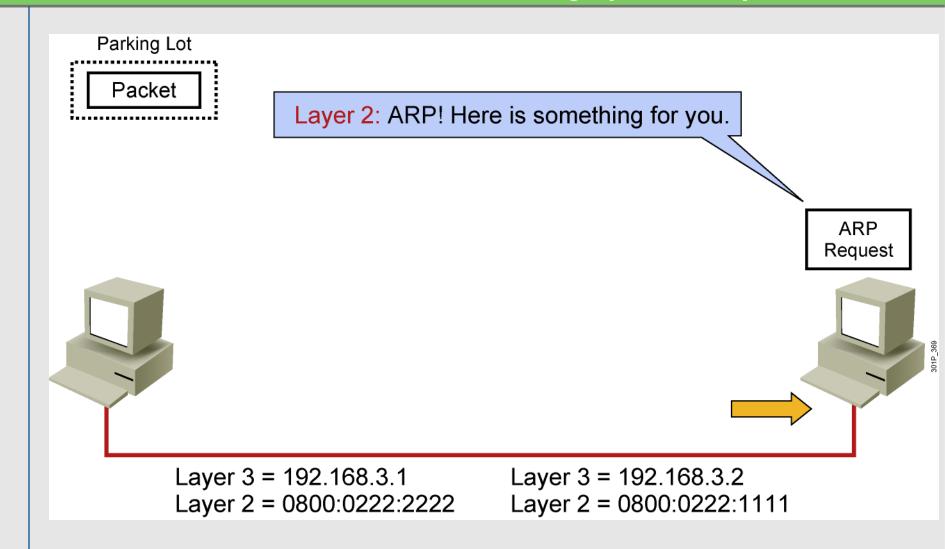
Host-to-Host Packet Delivery (5 of 22)



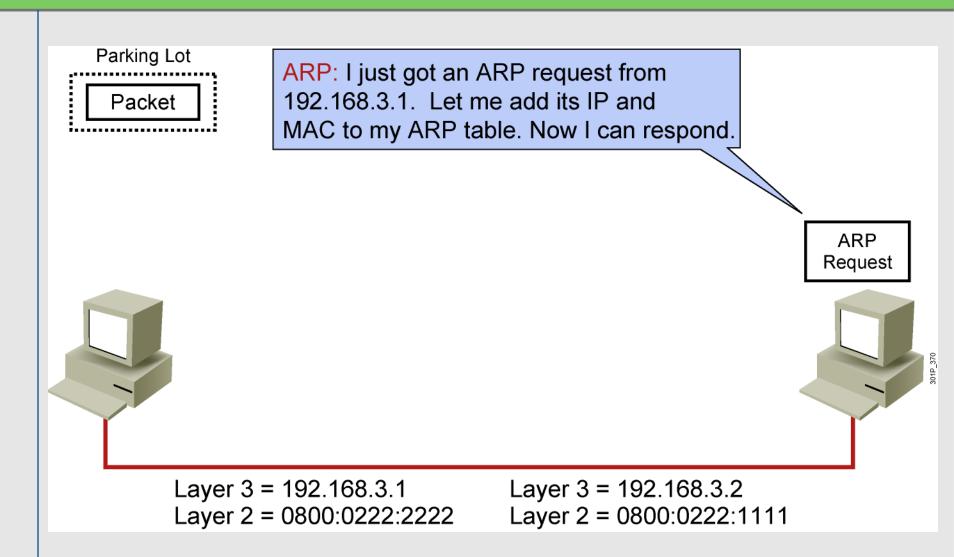
Host-to-Host Packet Delivery (6 of 22)



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



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



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

Parking Lot
Packet

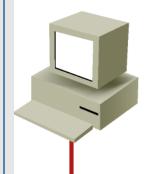
ARP: The ARP reply will say that I am 192.168.3.2 with a MAC of 0800:0222:1111.

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



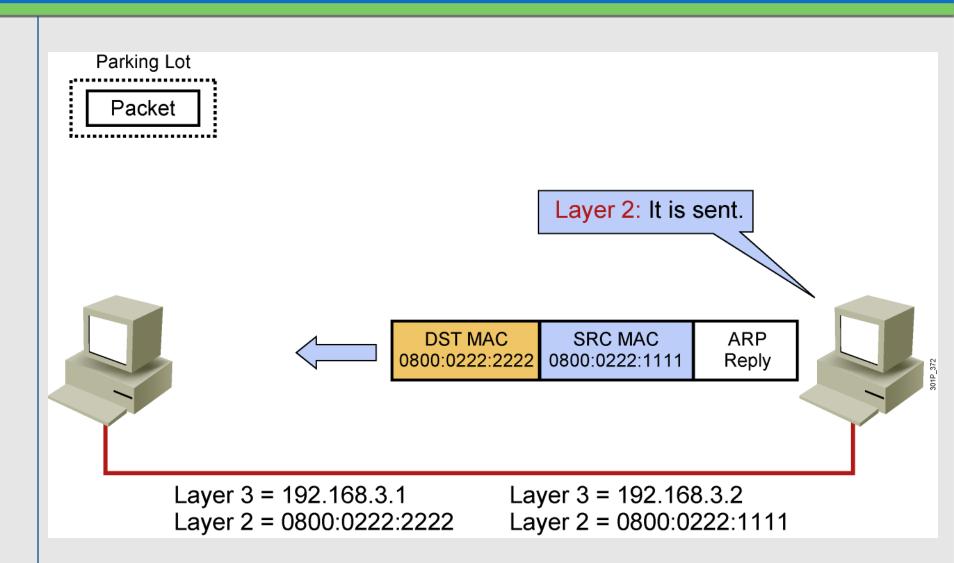


Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

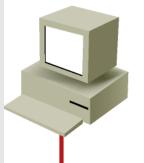
Host-to-Host Packet Delivery (10 of 22)





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 0800:0222:2222 SRC MAC 0800:0222:1111

ARP Reply



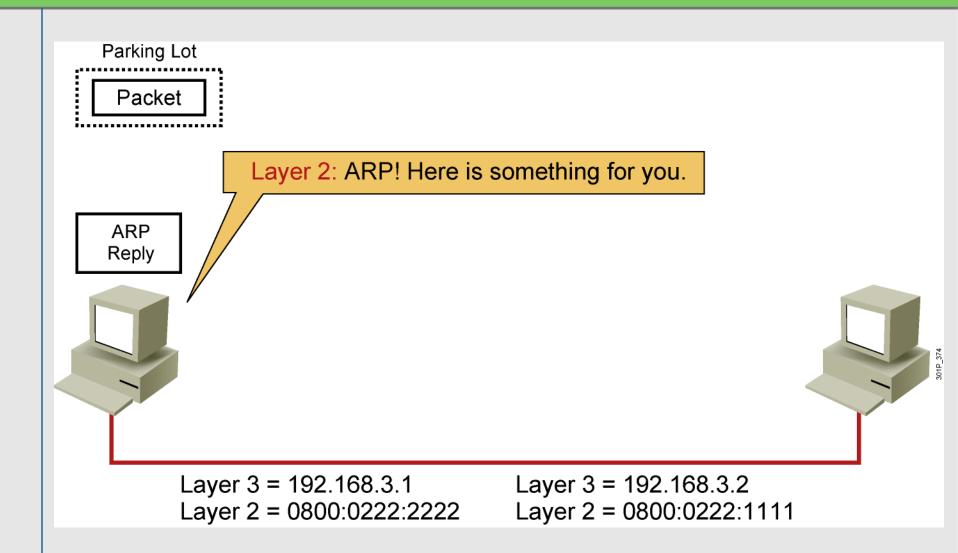
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

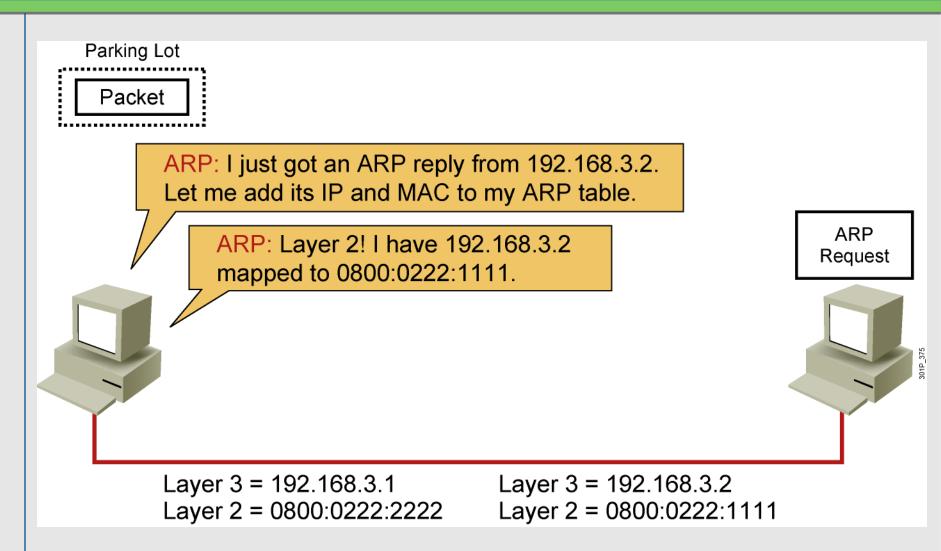
Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

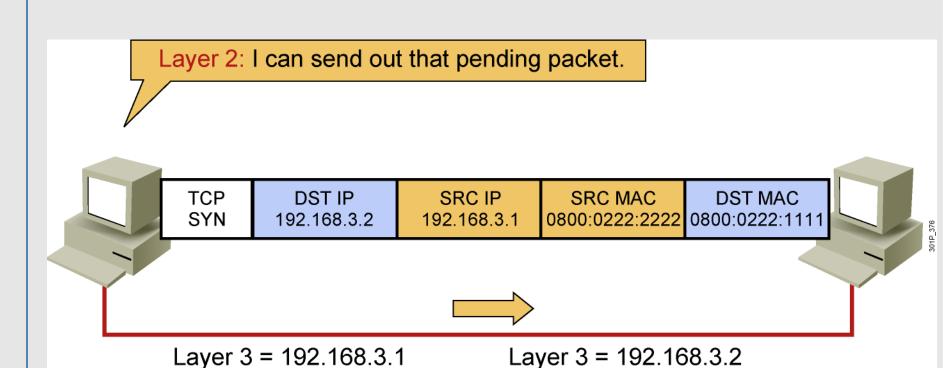
Host-to-Host Packet Delivery (12 of 22)



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



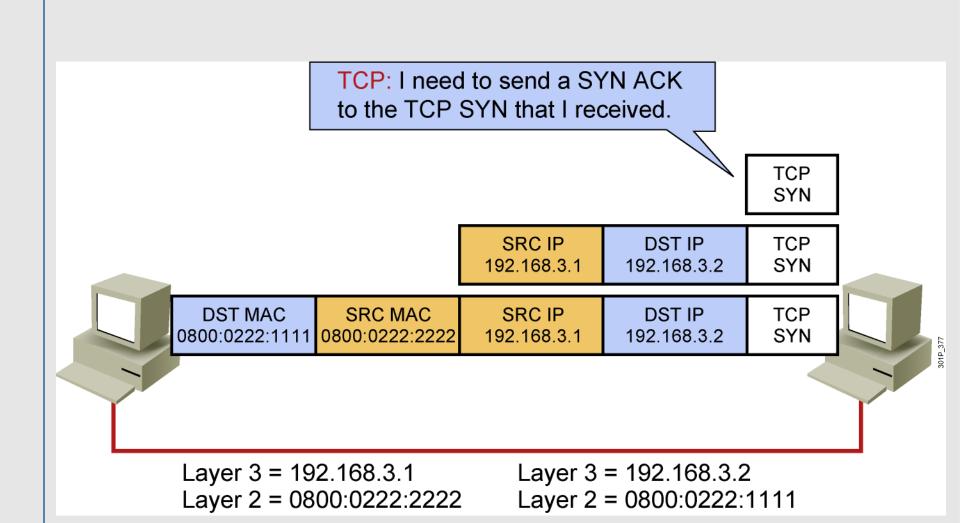
Host-to-Host Packet Delivery (14 of 22)



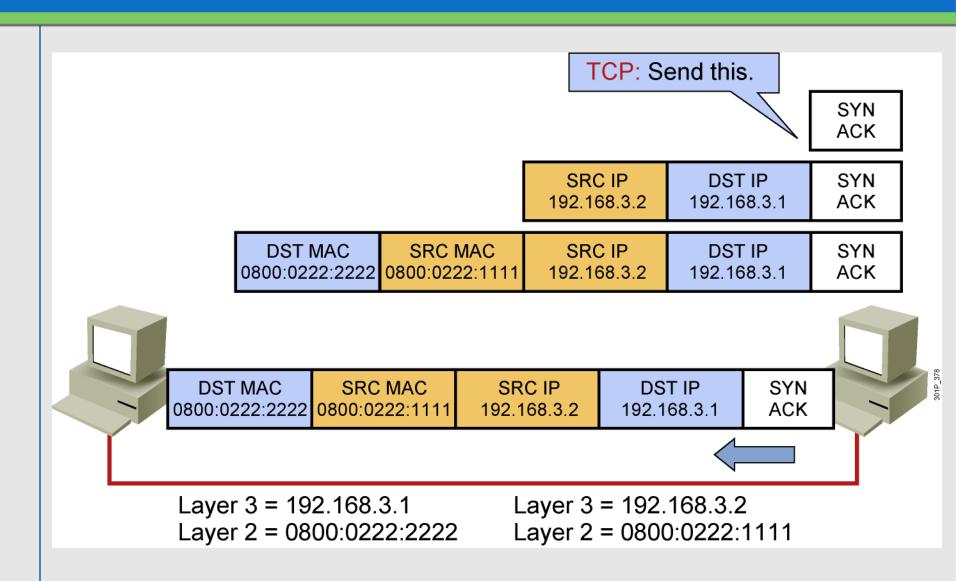
Layer 2 = 0800:0222:1111

Layer 2 = 0800:0222:2222

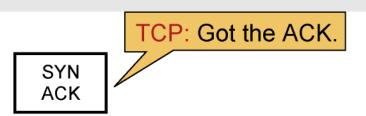
Host-to-Host Packet Delivery (15 of 22)



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

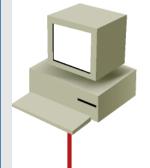


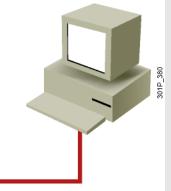
Host-to-Host Packet Delivery (17 of 22)



SRC IP	DST IP	SYN
192.168.3.2	192.168.3.1	ACK

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





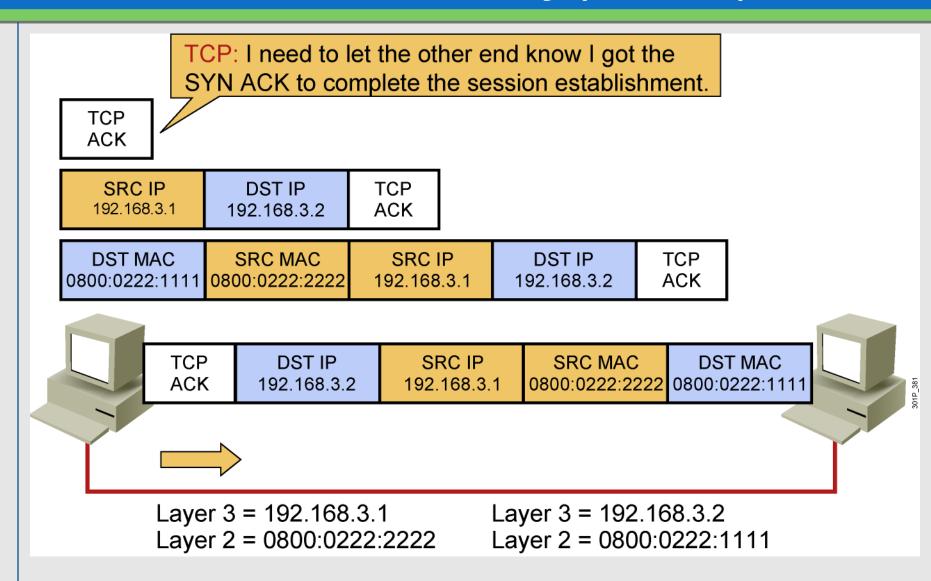
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

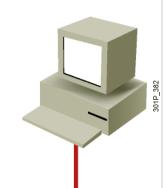
Host-to-Host Packet Delivery (18 of 22)



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.



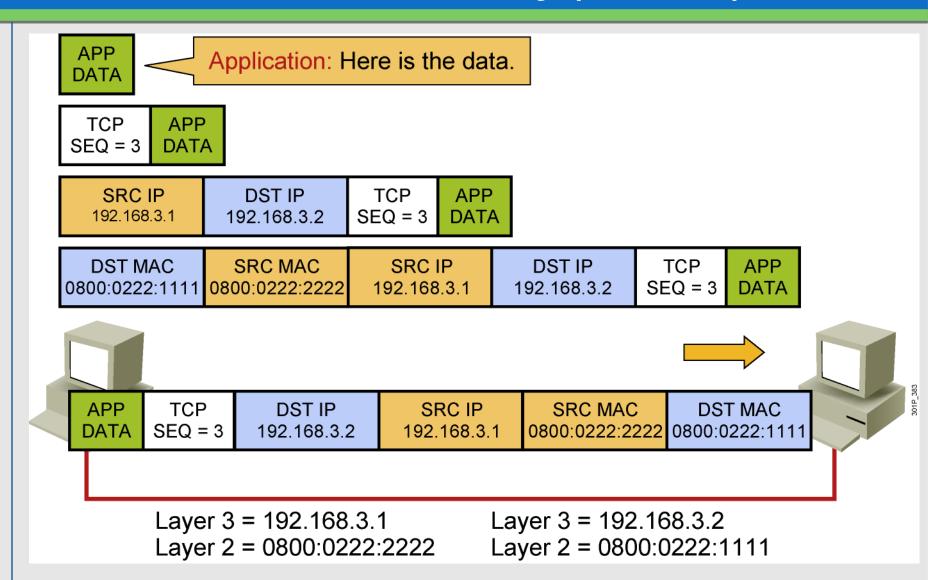
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

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



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

TCP: Application! Here is some data.

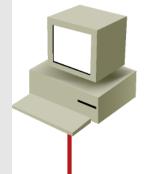
APP DATA

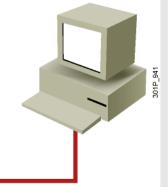
TCP APP SEQ = 3 DATA

 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 192.168.3.2 DST IP 192.168.3.1 ACK = 4SEQ = 3

DST MAC 0800:0222:2222

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

DST MAC 0800:0222:2222

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

Layer 3 = 192.168.3.1

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:2222

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
$$3 = 192.168.3.2$$



Default Gateway

Host-Based Tools: ping

```
C:\WINDOWS\system32\cmd.exe
C:\ping example.com
Pinging example.com [192.0.34.166] with 32 bytes of data:
Reply from 192.0.34.166: bytes=32 time=19ms TTL=45
Reply from 192.0.34.166: bytes=32 time=18ms TTL=45
Reply from 192.0.34.166: bytes=32 time=19ms TTL=45
Reply from 192.0.34.166: bytes=32 time=17ms TTL=45
Ping statistics for 192.0.34.166:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
   Minimum = 17ms, Maximum = 19ms, Average = 18ms
C:\
```

Host-Based Tools: Table

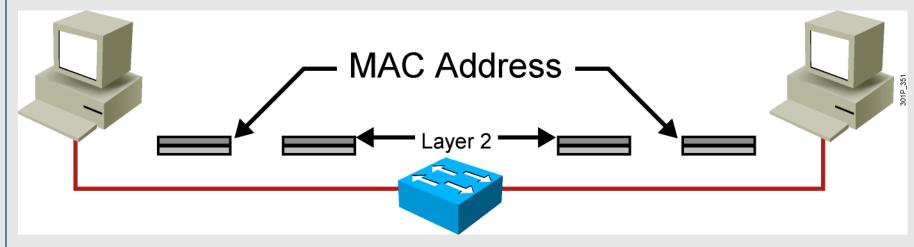
```
C:\WINNT\system32\cmd.exe
D:\>arp -a
Interface: 192.168.1.101 on Interface 0x1000003
  Internet Address
                         Physical Address
                                                 Type
                         <u> 00-04-5а-22-ес-с7</u>
  192.168.1.1
                                                 dynamic
                         00-02-4b-cc-d6-d9
                                                 dvnamic
                         00-02-fd-65-9f-82
                                                 dynamic
                                                 dynamic
                         00-03-6b-09-59-29
                         00-02-4b-cc-d6-d0
                                                 dynamic
                         00-03-6d-1e-6a-a5
                                                 dynamic
  192.168.1.149
                         00-50-8b-f7-cf-59
                                                 dynamic
|D:\>_
```

Host-Based Tools: tracert

```
C:\WINDOWS\system32\cmd.exe
                                                                               _ 🗆 ×
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.
C:\Documents and Settings\pvancil>tracert yahoo.com
Tracing route to yahoo.com [66.94.234.13]
over a maximum of 30 hops:
                                rtp-pvancil-vpn.cisco.com [10.83.2.161]
  1
2
3
        1 \text{ ms}
                 1 ms
                           1 ms
       67 ms
                59 ms
                          57 ms
                                 rtp5-access-sdg1-t10.cisco.com [10.82.96.2]
       58 ms
                58 ms
                          57 ms
                                 rtp5-access-gw1-vlan100.cisco.com [10.83.100.9]
456789
10
                                 rtp7-bb-gw1-ge5-8.cisco.com [10.81.254.117]
       58 ms
                58 ms
                          57 ms
                                 rtp5-rbb-gw1-ge4-2.cisco.com [10.81.254.181]
       60 ms
                59 ms
                          57 ms
       58 ms
                59 ms
                          60 ms
                                 rtp5-corp-gw1.cisco.com [10.81.254.194]
                                 rtp7-dmzbb-gw1.cisco.com [64.102.241.135]
       59 ms
                58 ms
                          58 ms
       60 ms
                          58 ms
                                 rtp1-isp-gw1-g1-2.cisco.com [64.102.254.193]
                60 ms
       59 ms
                                 rtp5-isp-ssw1-v110.cisco.com [64.102.254.174]
                58 ms
                          58 ms
       59 ms
                          58 ms
                59 ms
                                 rtp5-isp-ssw1-v151.cisco.com [64.102.254.249]
 11
       60 ms
                60 ms
                          59 ms
                                 rtp1-isp-gw1-v100.cisco.com [64.102.254.165]
 12
                          65 ms
       64 ms
                66 ms
                                 sl-gw20-rly-1-0.sprintlink.net [144.232.244.209]
 13
                                sl-bb20-rly-3-2.sprintlink.net [144.232.14.29]
       64 ms
                66 ms
                          68 ms
                                 sl-bb24-rly-9-0.sprintlink.net [144.232.14.122]
 14
       66 ms
                64 ms
                          65 ms
                                s1-st22-ash-5-0.sprintlink.net [144.232.20.155]
 15
       66 ms
                66 ms
                68 ms
                          67 ms
 16
       67 ms
                                 te-4-2.car4.Washington1.Level3.net [4.68.111.169
17
       67 ms
               127 ms
                          68 ms
                                 ae-2-54.bbr2.Washington1.Level3.net [4.68.121.97]
18
      136 ms
                         137 ms
                                 as-1-0.bbr2.SanJose1.Level3.net [64.159.0.242]
               136 ms
                         133 ms
                                 ae-23-52.car3.SanJose1.Level3.net [4.68.123.45]
      134 ms
      142 ms
               135 ms
                         135 ms
                                 4.71.112.14
                                 ge-3-0-0-p271.msr2.scd.yahoo.com [216.115.106.19
21
      133 ms
               134 ms
                         134 ms
22
23
      135 ms
               135 ms
                         135 ms
                                 ten-2-3-bas1.scd.yahoo.com [66.218.82.221]
      136 ms
               136 ms
                         135 ms
                                 w2.rc.vip.scd.yahoo.com [66.94.234.13]
Trace complete.
```

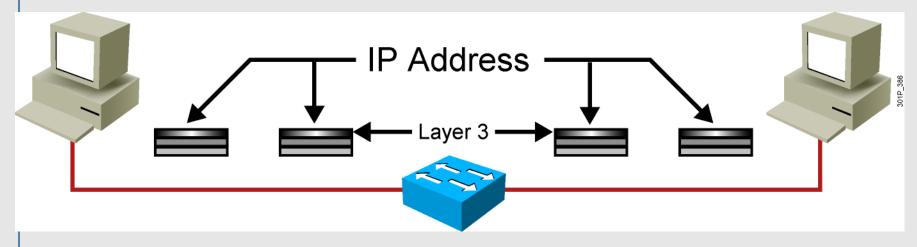
IV. Exploring the packet Delivery Process 2 (layer 2)

Layer 2 Addressing



- Uses MAC address
- Assigned to end devices

Layer 3 Addressing



- Each NOS has its own Layer 3 address format.
- OSI uses NSAP.
- TCP/IP uses IP.

Host-to-Host Packet Delivery (1 of 10)

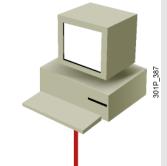
Application: Network, I have some data to send to 192.168.3.2 and I don't need a reliable connection.

Transport: I'll use UDP. Send me the data.

Application: Here is the data.

APP DATA





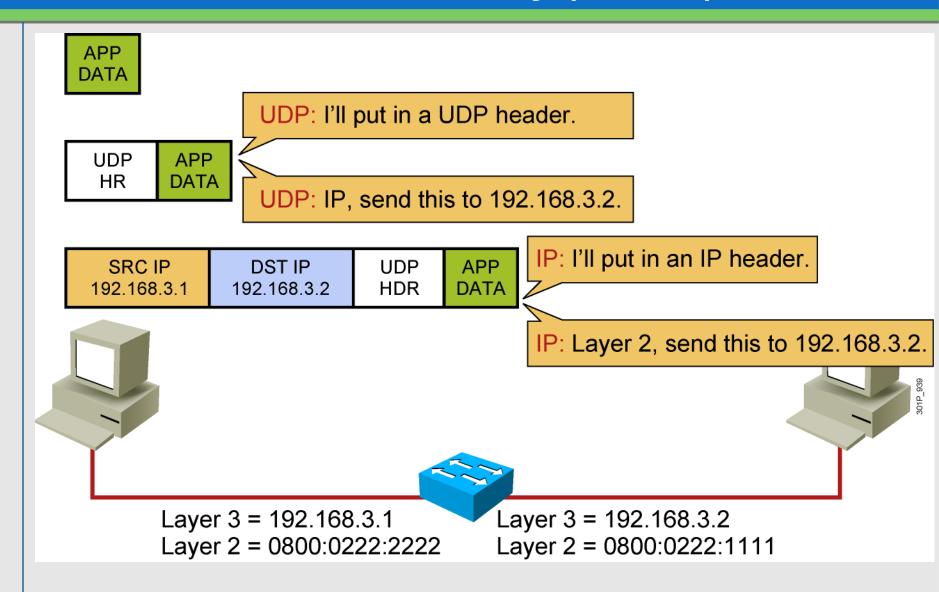
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

Host-to-Host Packet Delivery (2 of 10)



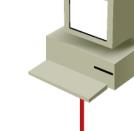
Host-to-Host Packet Delivery (3 of 10)

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 hold the packet while I resolve the addressing.

SRC IP 192.168.3.1 DST IP 192.168.3.2 UDP HDR APP DATA





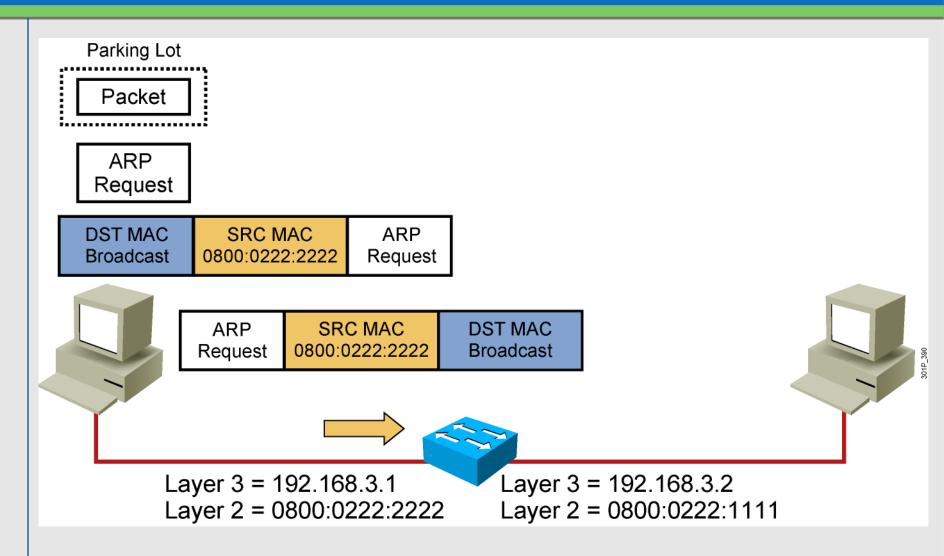
Layer 3 = 192.168.3.1

Layer 2 = 0800:0222:2222

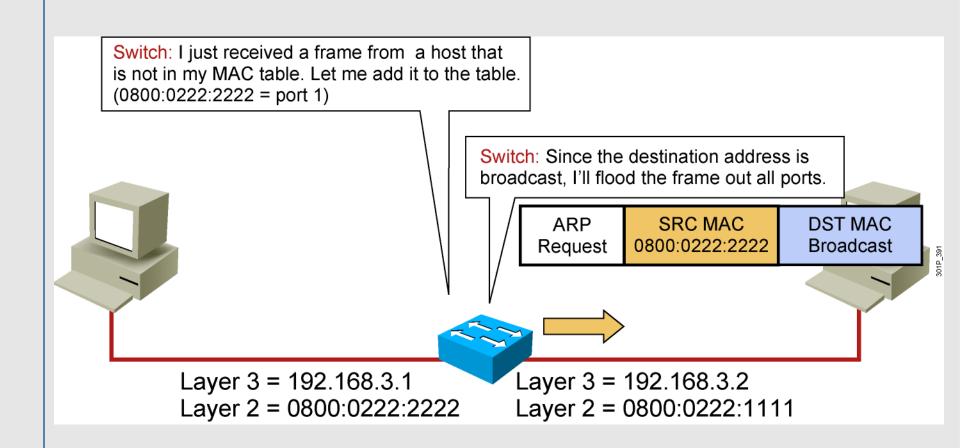
Layer 3 = 192.168.3.2

Layer 2 = 0800:0222:1111

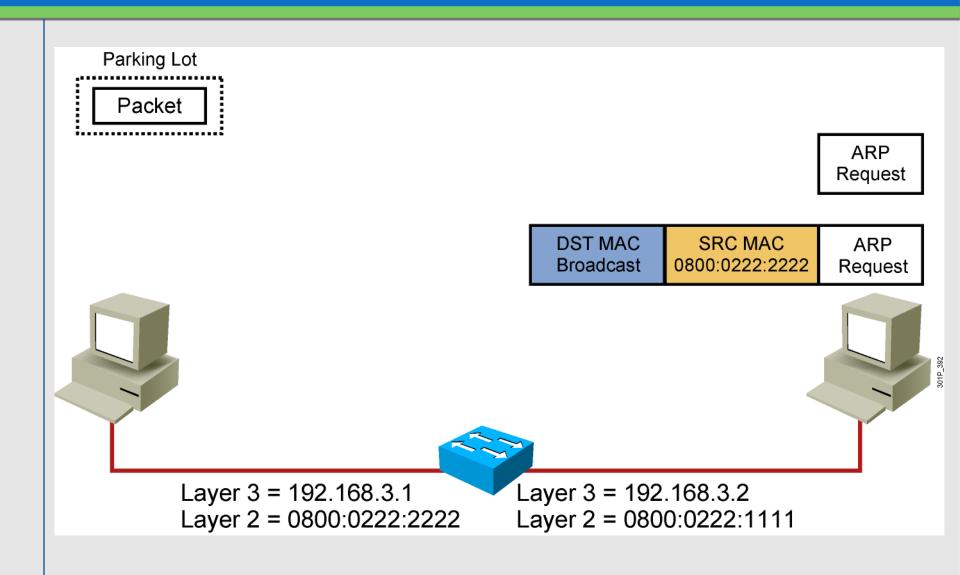
Host-to-Host Packet Delivery (4 of 10)



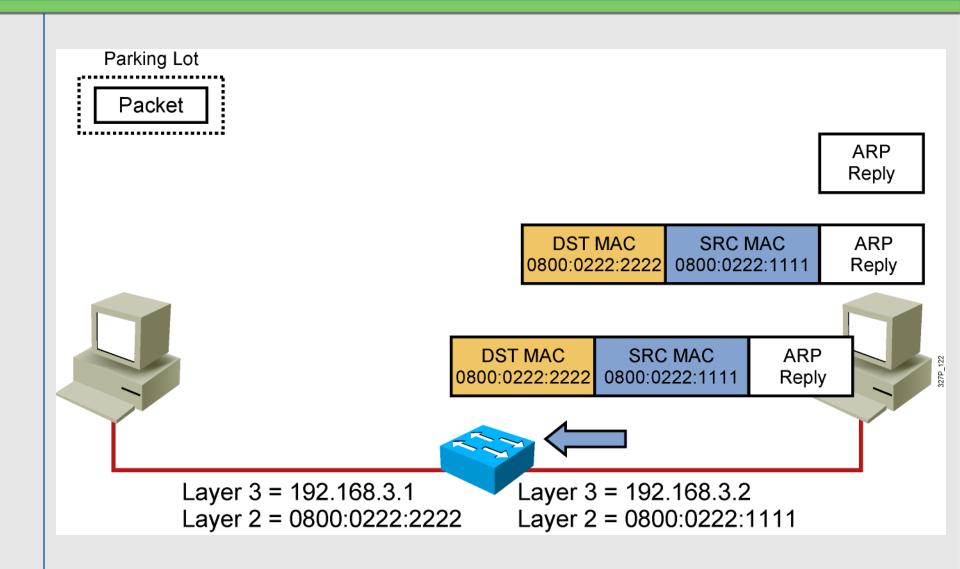
Host-to-Host Packet Delivery (5 of 10)



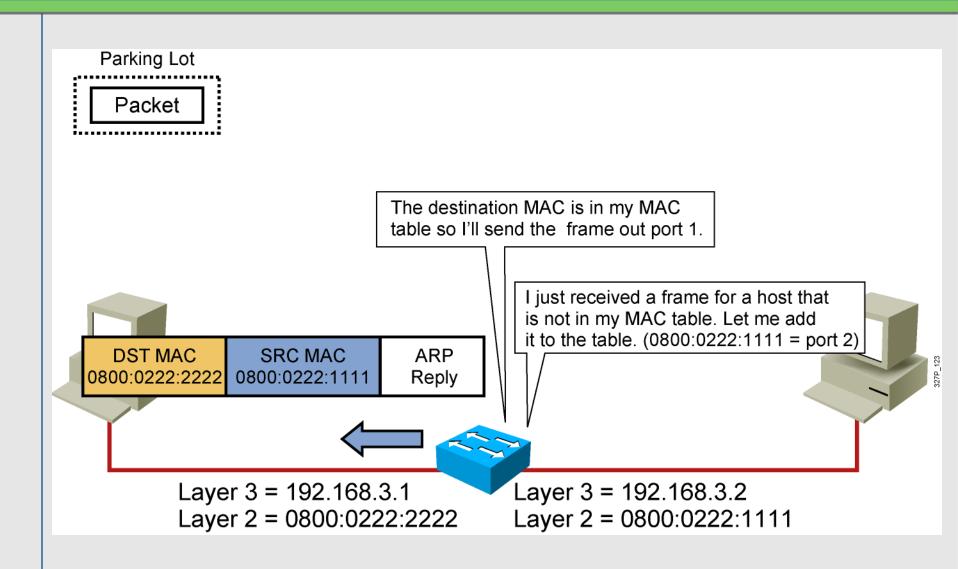
Host-to-Host Packet Delivery (6 of 10)



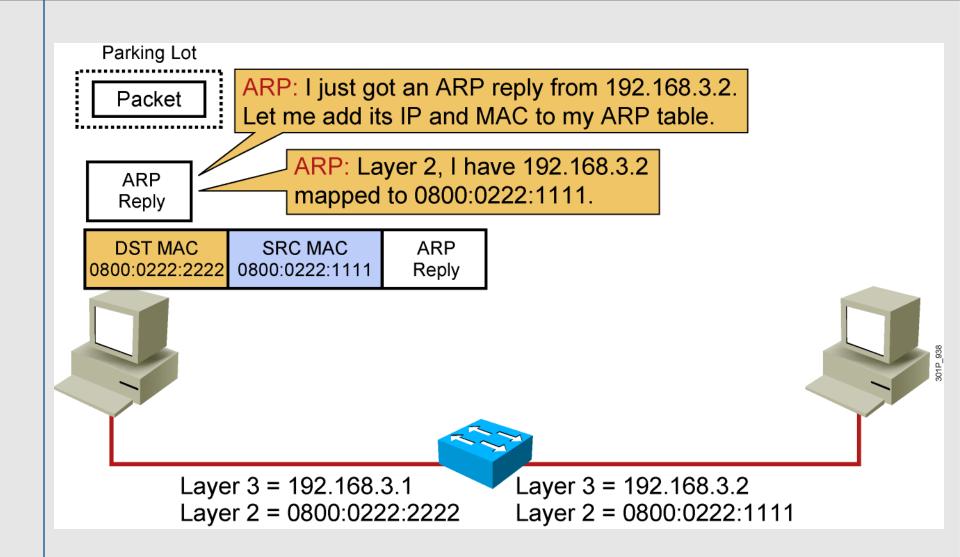
Host-to-Host Packet Delivery (7 of 10)



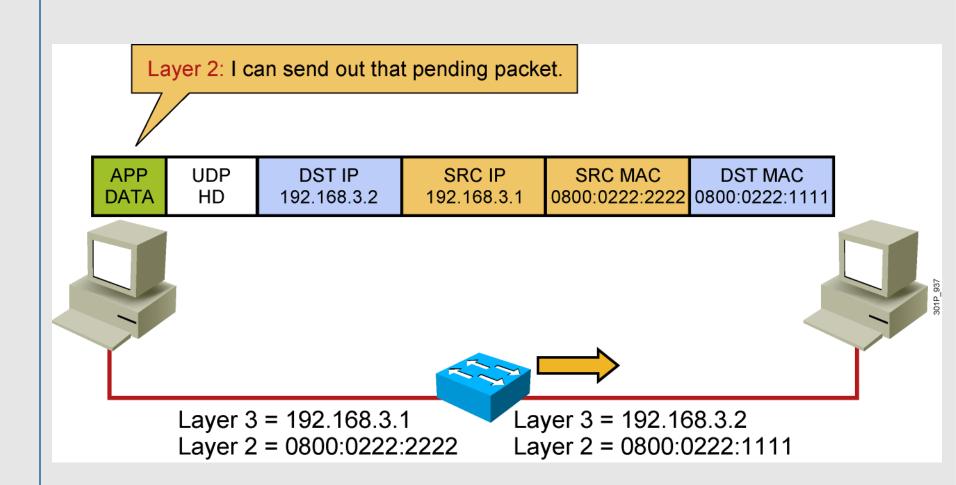
Host-to-Host Packet Delivery (8 of 10)



Host-to-Host Packet Delivery (9 of 10)

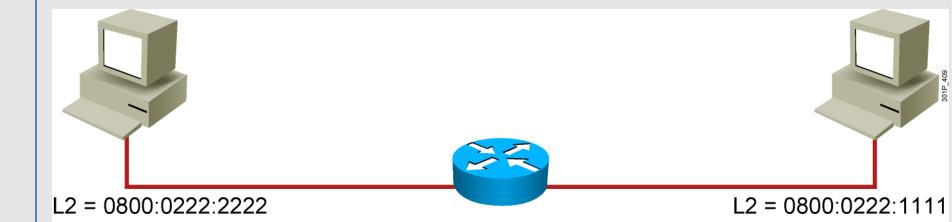


Host-to-Host Packet Delivery (10 of 10)



V. Exploring the packet Delivery Process 3 (layer 3)

Layer 2 Addressing

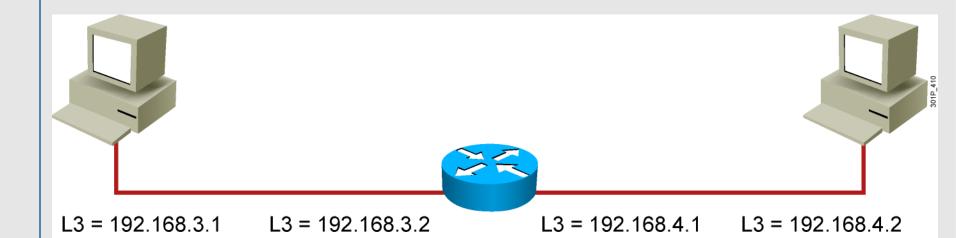


L2 = 0800:0333:1111

7/13/19

L2 = 0800:0333:2222

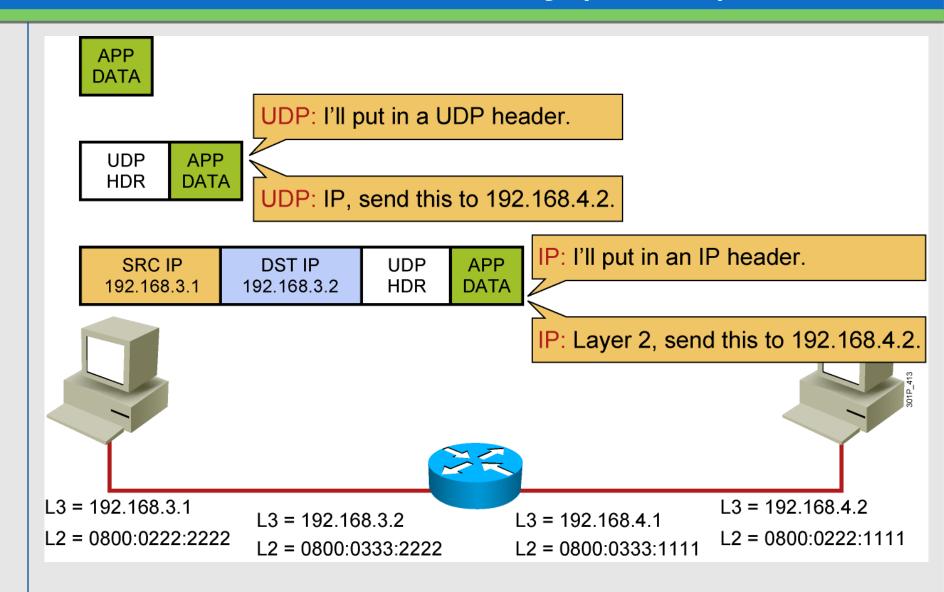
Layer 3 Addressing



Host-to-Host Packet Delivery (1 of 17)

Application: Network, I have some data to send to 192,168,4,2, and I don't need a reliable connection. Transport: I'll use UDP. Send me the data. Application: Here is the data. **APP** DATA L3 = 192.168.3.1 L3 = 192.168.4.2L3 = 192.168.3.2 L3 = 192.168.4.1L2 = 0800:0222:2222L2 = 0800:0222:1111 L2 = 0800:0333:2222 L2 = 0800:0333:1111

Host-to-Host Packet Delivery (2 of 17)



Host-to-Host Packet Delivery (3 of 17)

Layer 2: ARP, do you have a mapping for 192.168.4.2?

ARP: No, Layer 2 will have to hold the packet while I reselve the addressing.

SRC IP 192.168.3.1

DST IP 192.168.4.2 UDP HDR APP DATA





L2 = 0800:0222:2222

L3 = 192.168.3.2

L2 = 0800:0333:2222

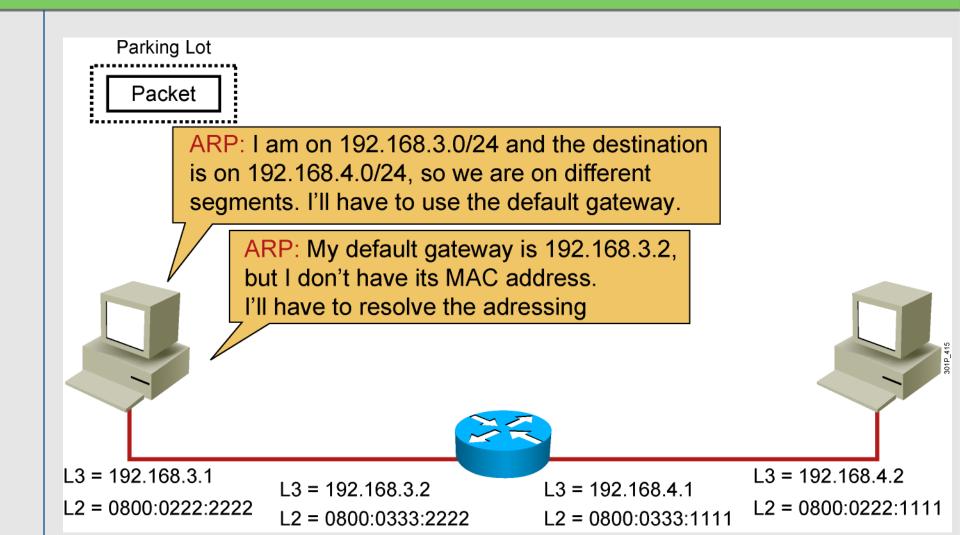
L3 = 192.168.4.1

L2 = 0800:0333:1111

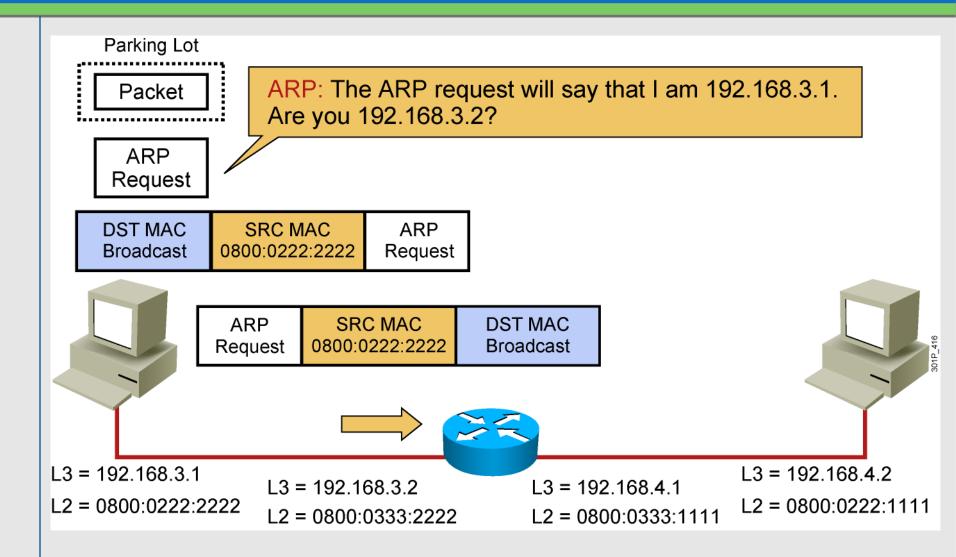
L3 = 192.168.4.2

L2 = 0800:0222:1111

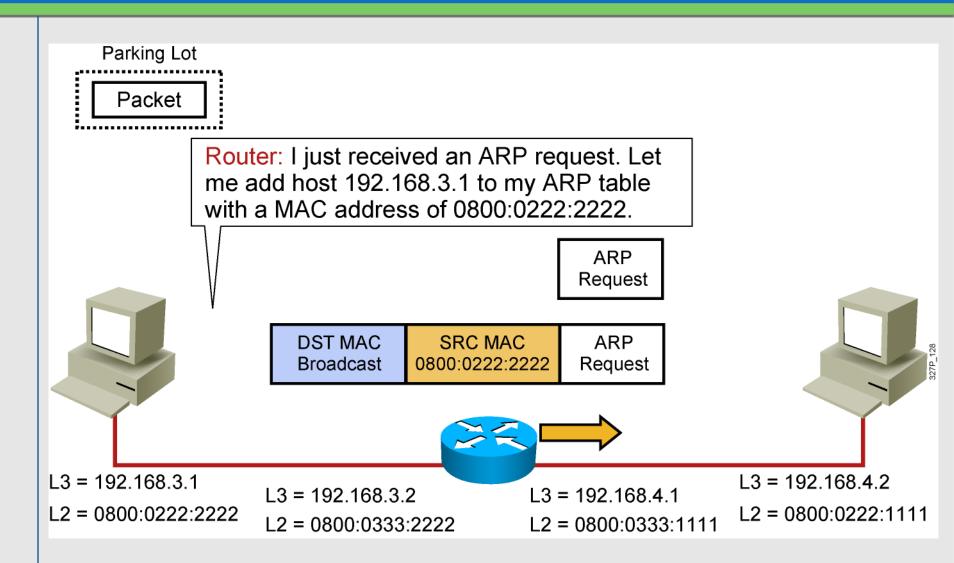




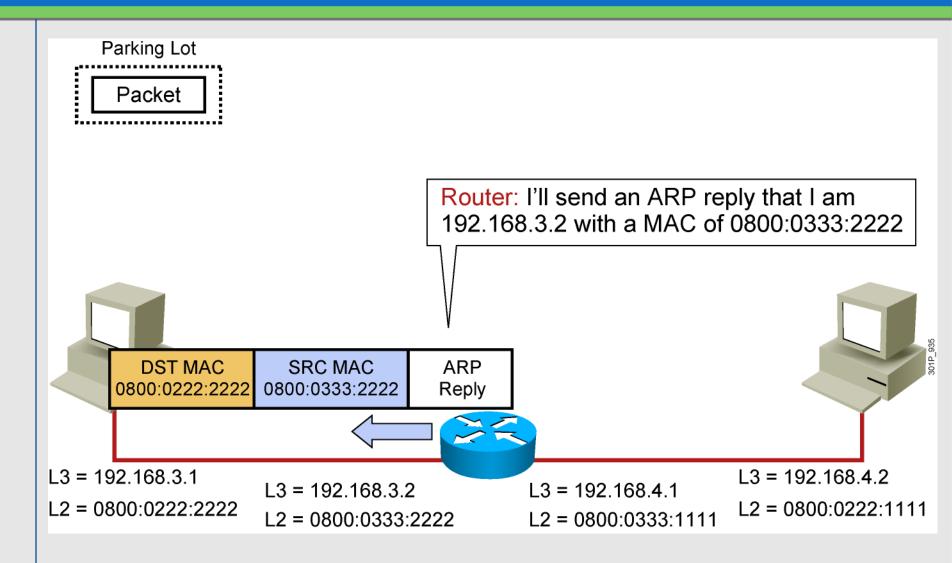
Host-to-Host Packet Delivery (5 of 17)



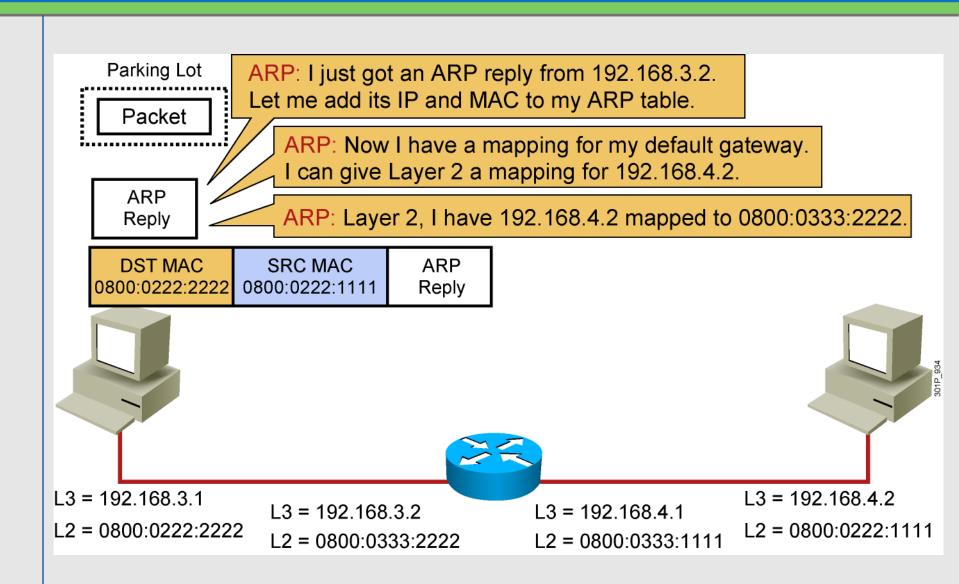
Host-to-Host Packet Delivery (6 of 17)



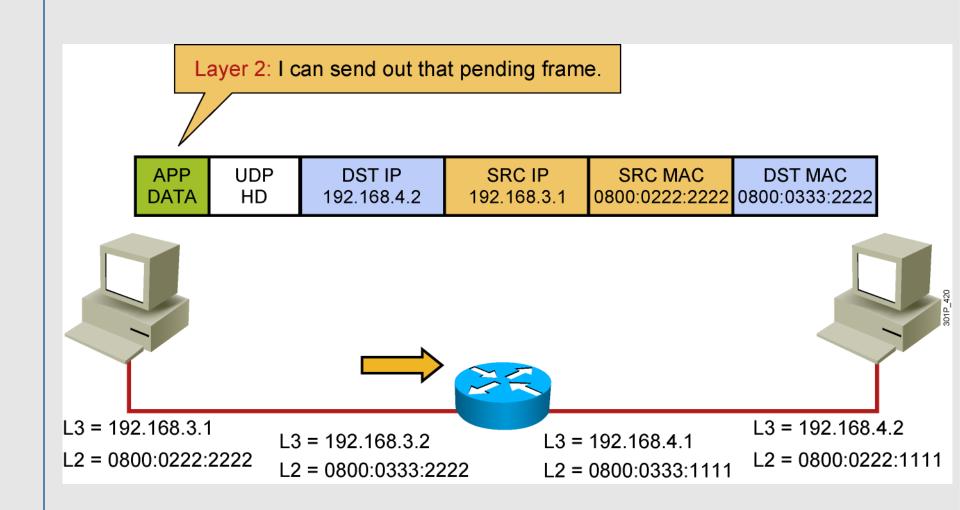
Host-to-Host Packet Delivery (7 of 17)



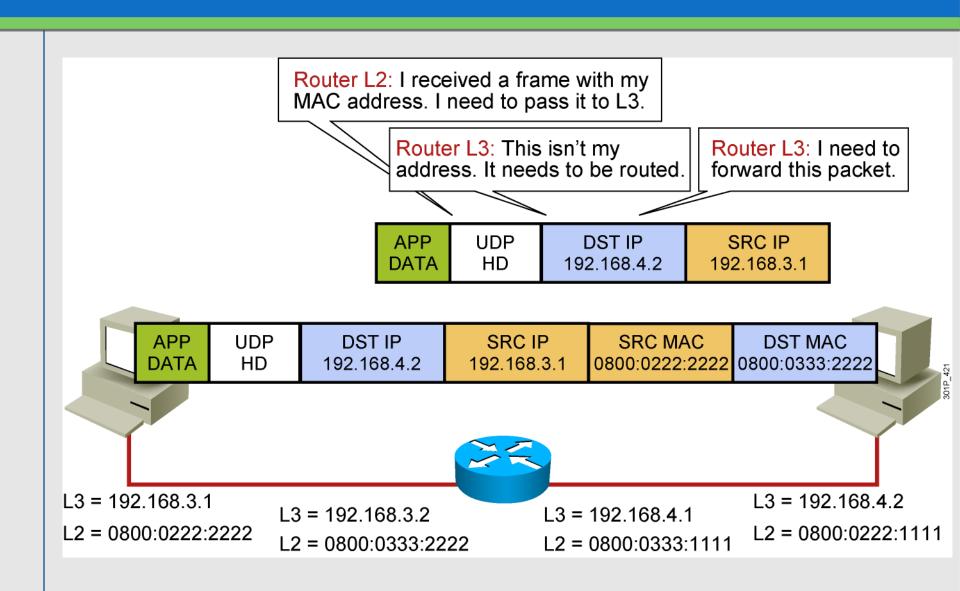
Host-to-Host Packet Delivery (8 of 17)



Host-to-Host Packet Delivery (9 of 17)



Host-to-Host Packet Delivery (10 of 17)



Host-to-Host Packet Delivery (11 of 17)

Destination	Next Hop	Interface
192.168.3.0/24	Connected	fa 0/0
192.168.4.0/24	Connected	fa 0/1

Router L3: I have an interface on the 192.168.4.0/24 segment. I can forward this packet directly to the host.

Router L3: L2, send this packet.



APP UDP DST IP SRC IP 192.168.4.2 192.168.3.1



L3 = 192.168.3.1

L2 = 0800:0222:2222

L3 = 192.168.3.2

L2 = 0800:0333:2222

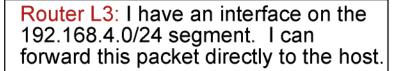
L3 = 192.168.4.1

L2 = 0800:0333:1111

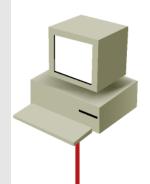
L3 = 192.168.4.2

L2 = 0800:0222:1111





Router L3: L2, send this packet.



APP DATA

UDP HDR

DST IP 192.168.4.2

SRC IP 192.168.3.1

L3 = 192.168.3.1

L2 = 0800:0222:2222

L3 = 192.168.3.2

L2 = 0800:0333:2222

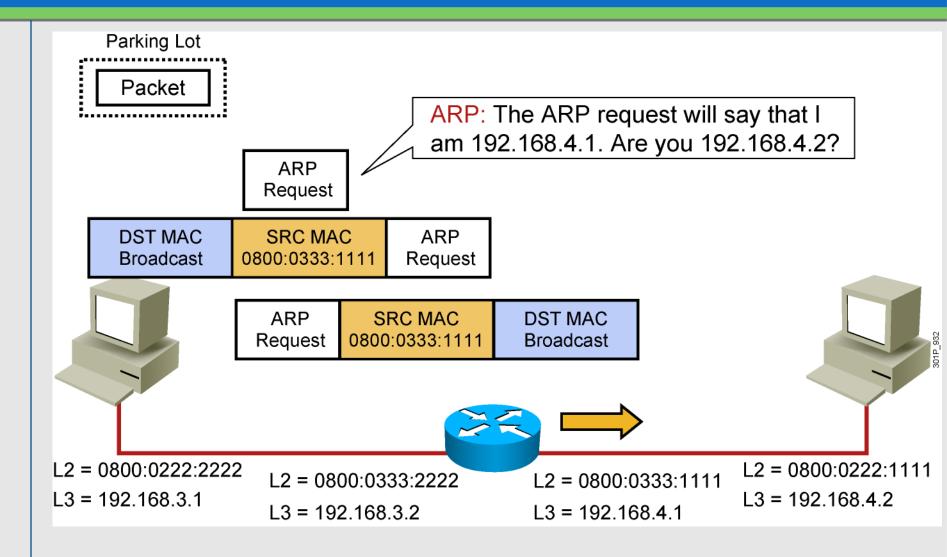
L3 = 192.168.4.1

L2 = 0800:0333:1111

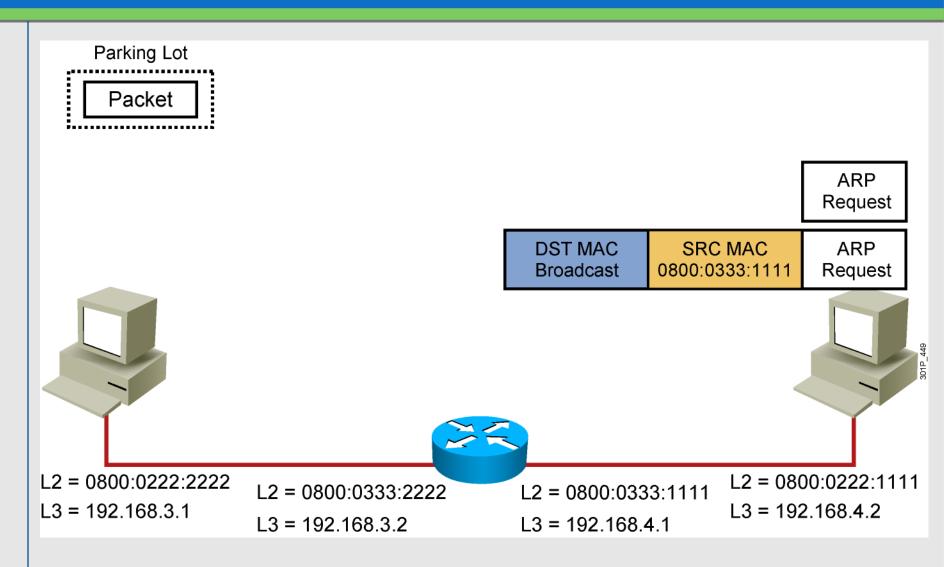
L3 = 192.168.4.2

L2 = 0800:0222:1111

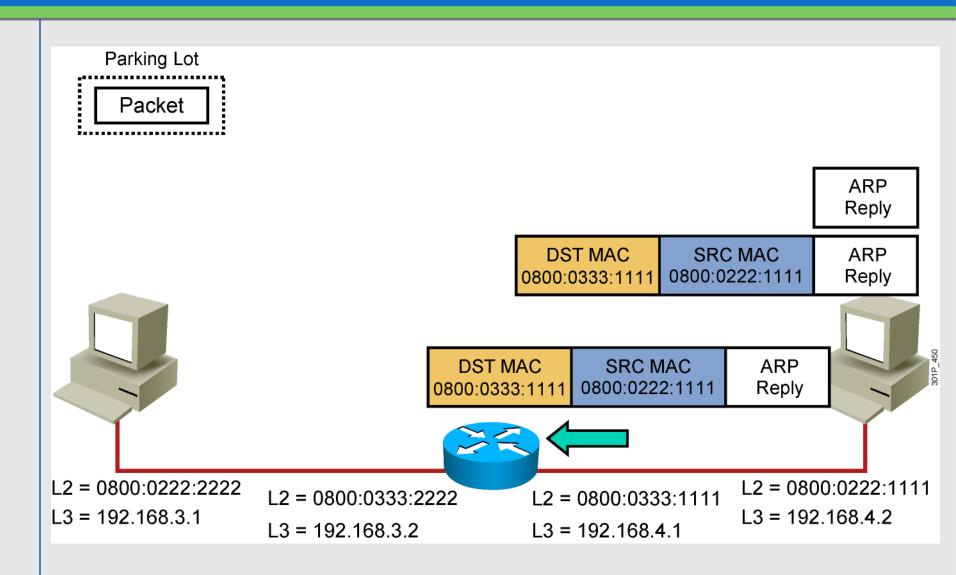
Host-to-Host Packet Delivery (13 of 17)



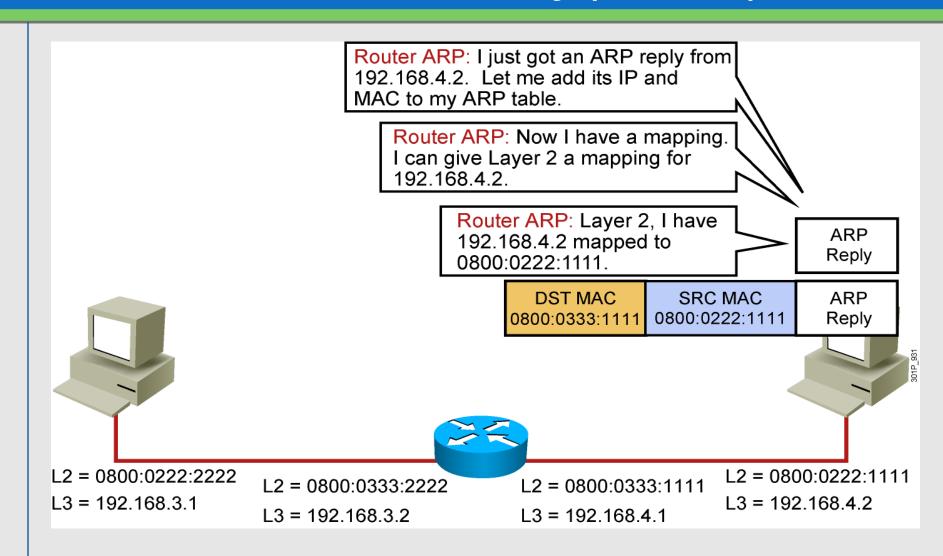
Host-to-Host Packet Delivery (14 of 17)



Host-to-Host Packet Delivery (15 of 17)



Host-to-Host Packet Delivery (16 of 17)



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

