

Understanding the Host-to-Host Communications Model



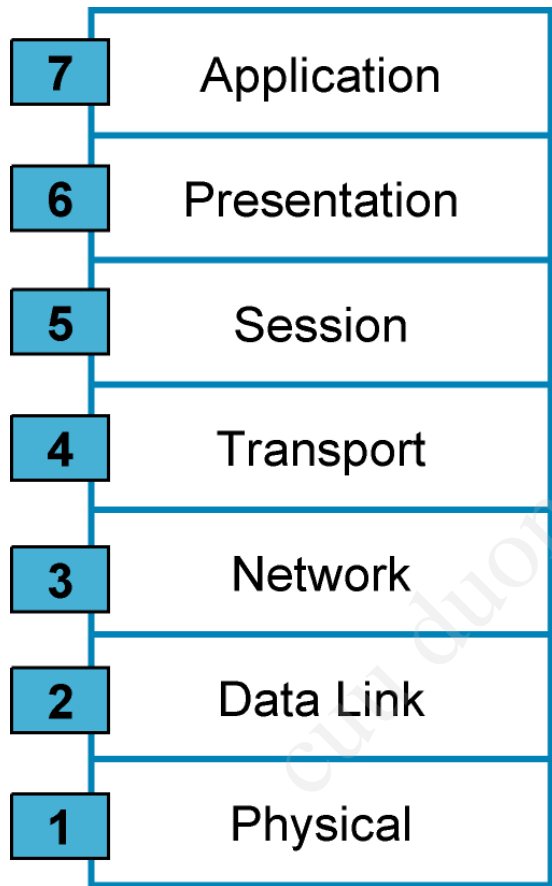
Building a Simple Network

Understanding Host-to-Host Communications



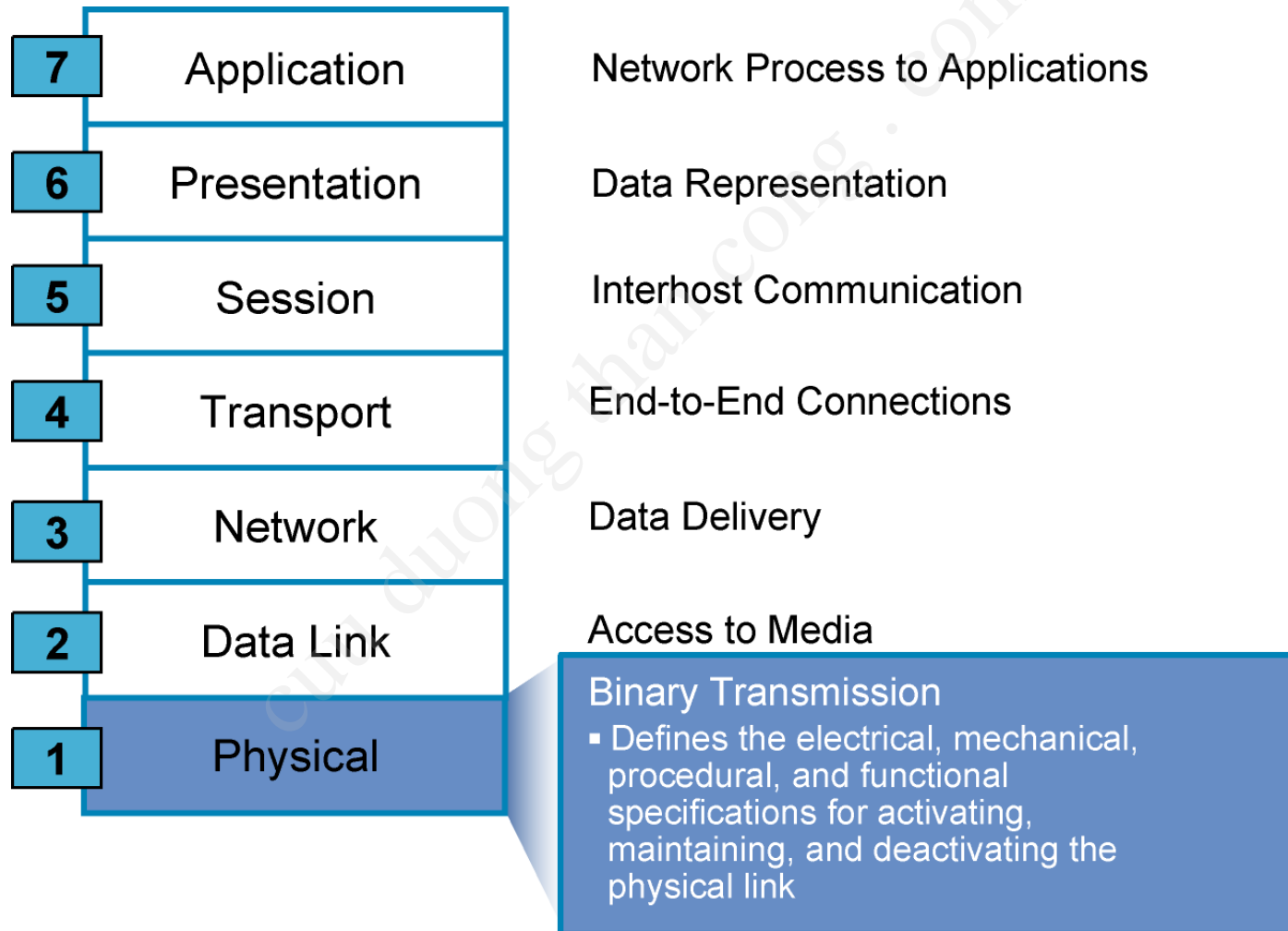
- Older model
 - Proprietary
 - Application and combinations software controlled by one vendor
- Standards-based model
 - Multivendor software
 - Layered approach

Why a Layered Network Model?

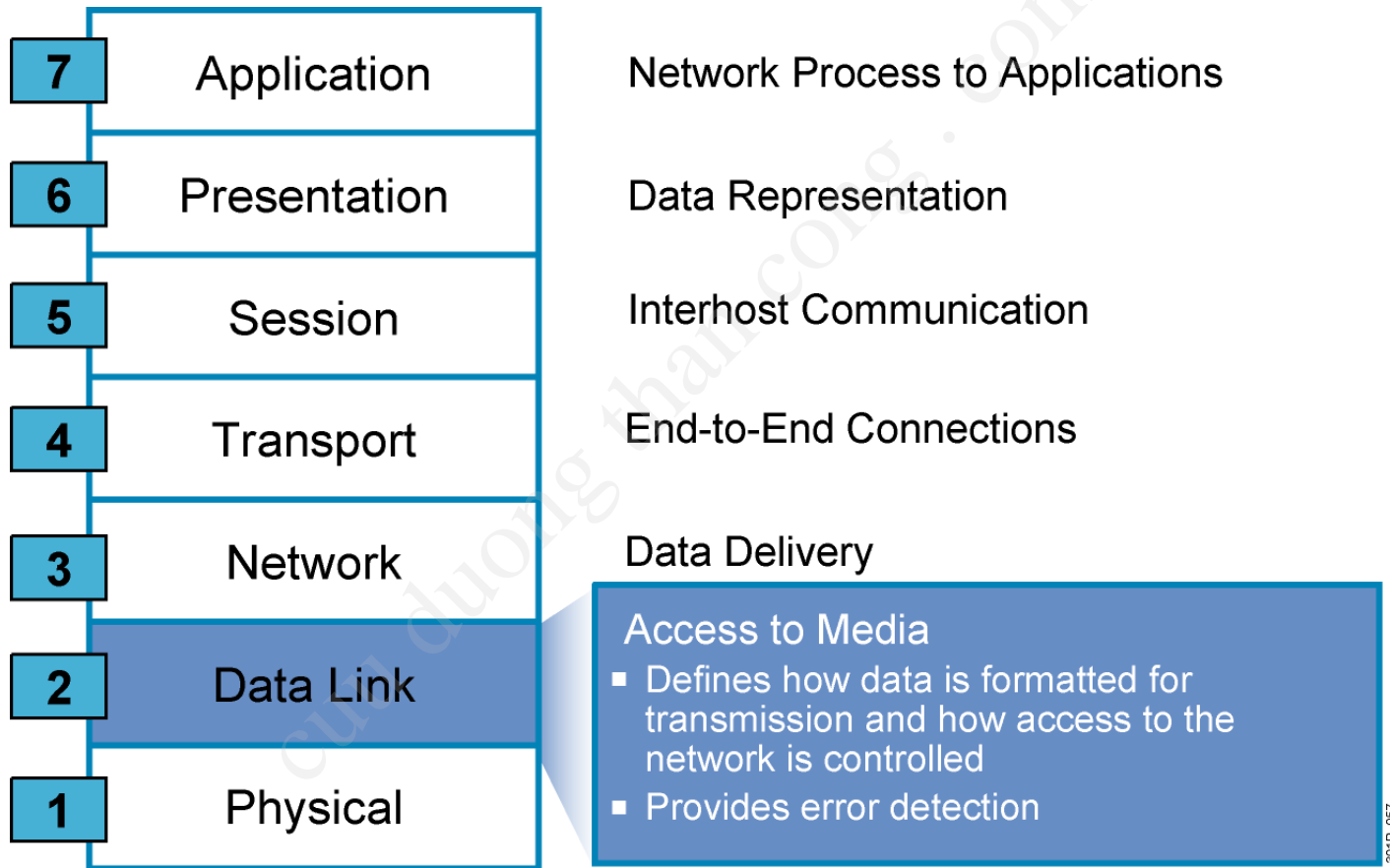


- Reduces complexity
- Standardizes interfaces
- Facilitates modular engineering
- Ensures interoperable technology
- Accelerates evolution
- Simplifies teaching and learning

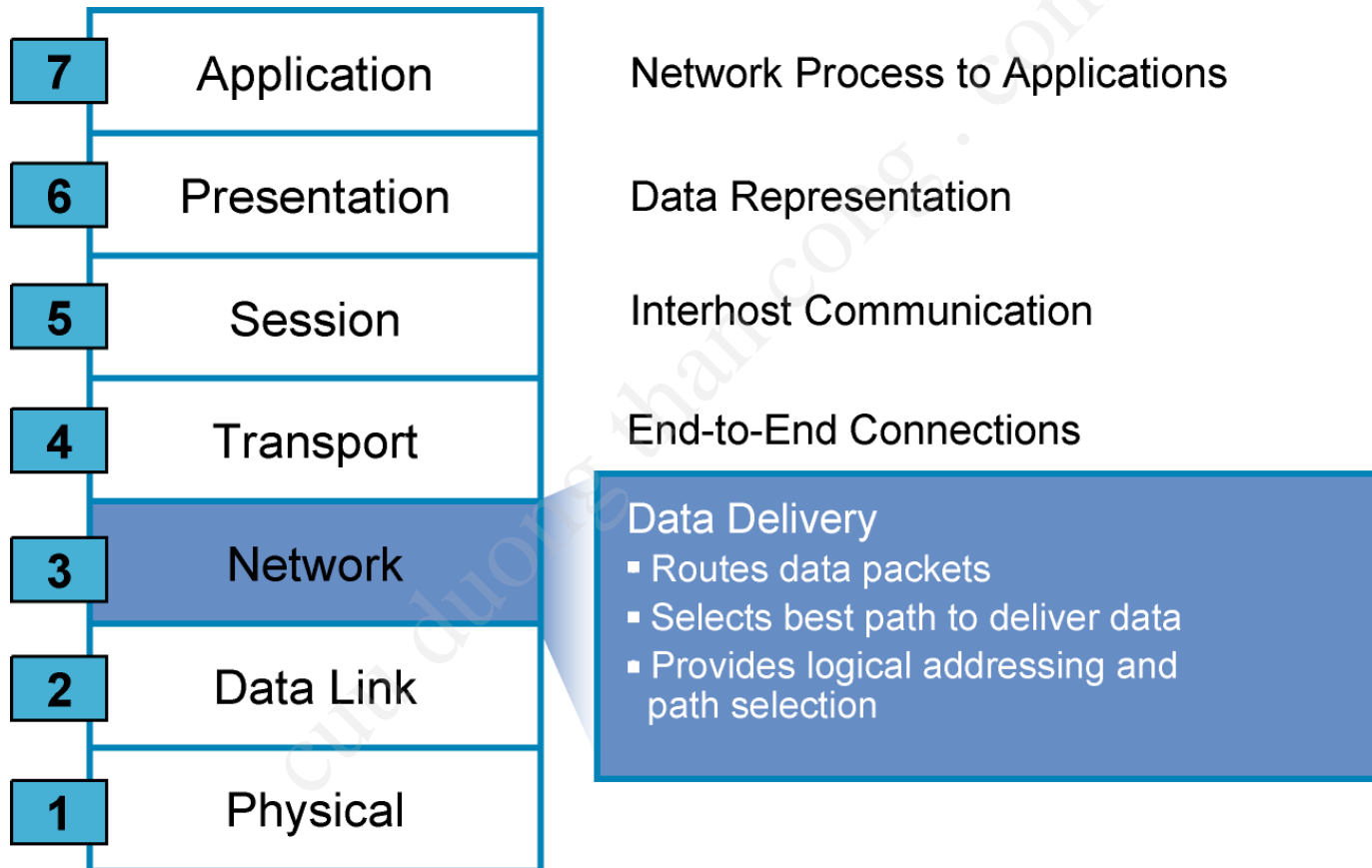
The Seven Layers of the OSI Model



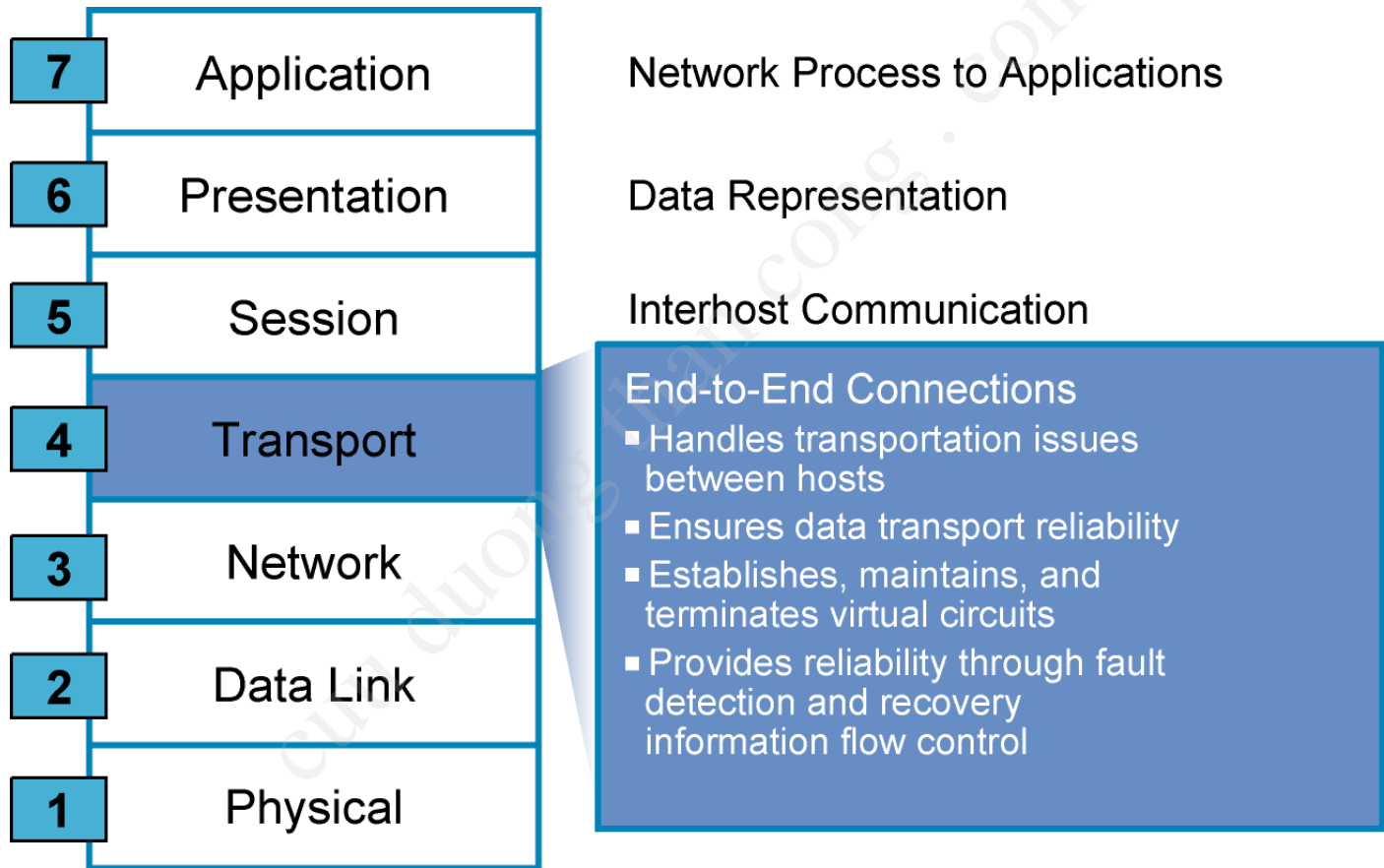
The Seven Layers of the OSI Model (Cont.)



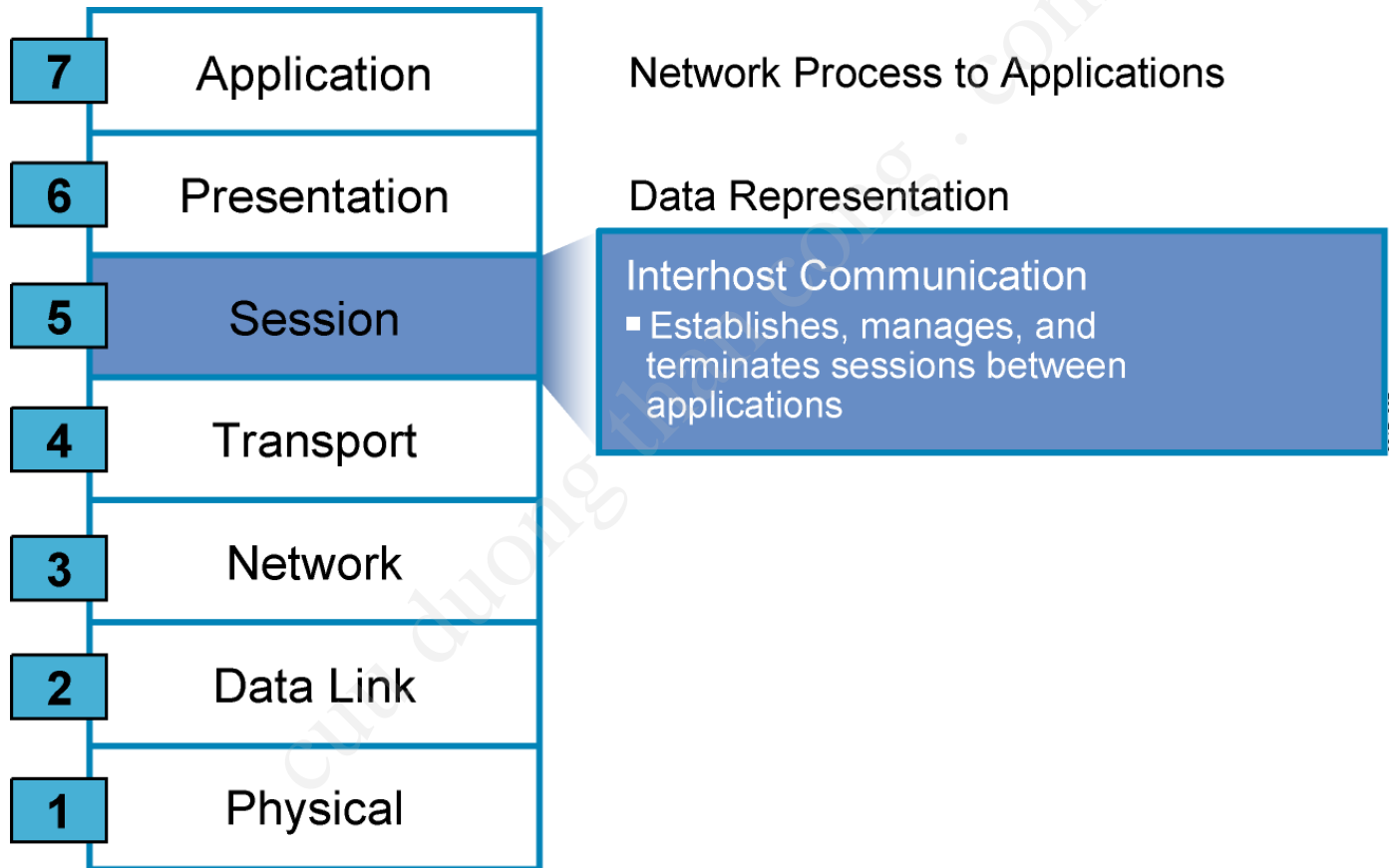
The Seven Layers of the OSI Model (Cont.)



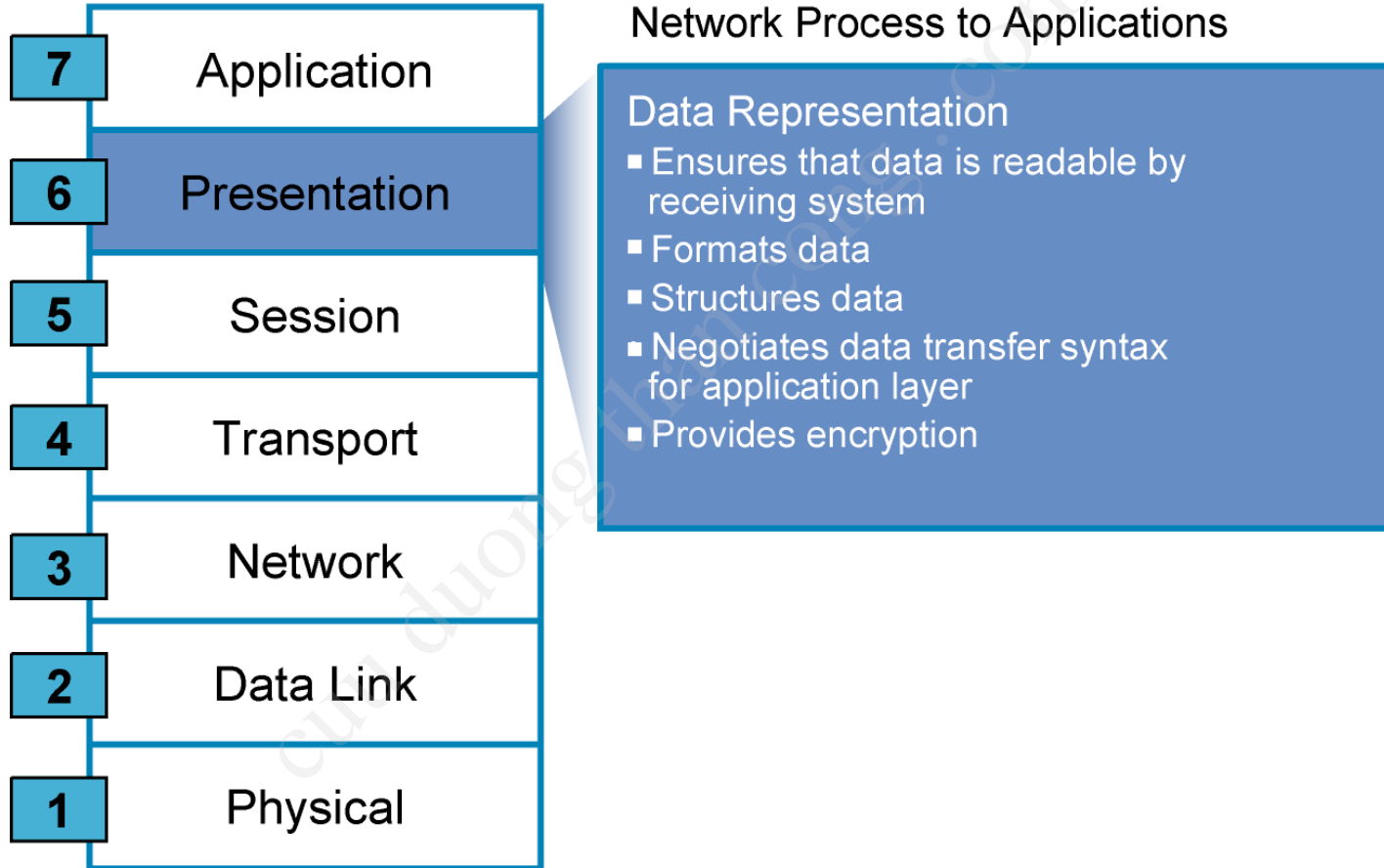
The Seven Layers of the OSI Model (Cont.)



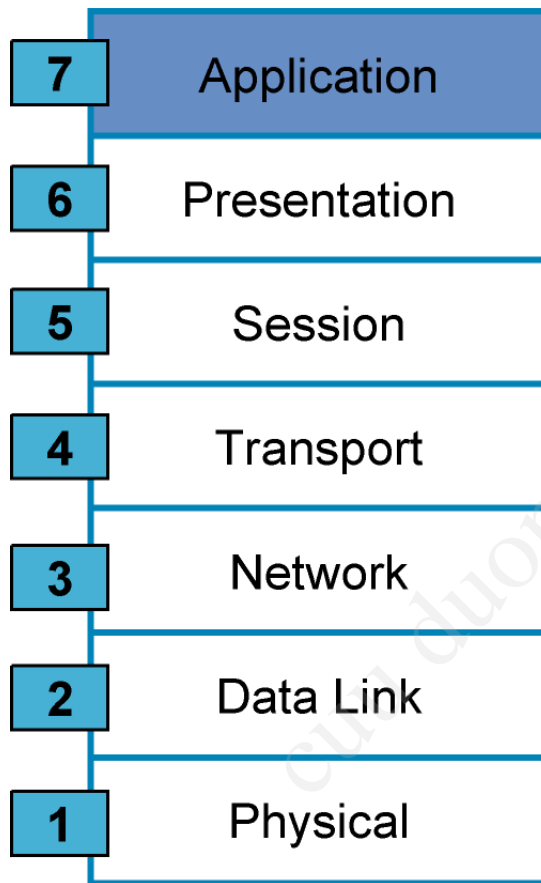
The Seven Layers of the OSI Model (Cont.)



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The Seven Layers of the OSI Model (Cont.)



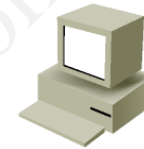
Network Processes to Applications

- Provides network services to application processes (such as electronic mail, file transfer, and terminal emulation)
- Provides user authentication

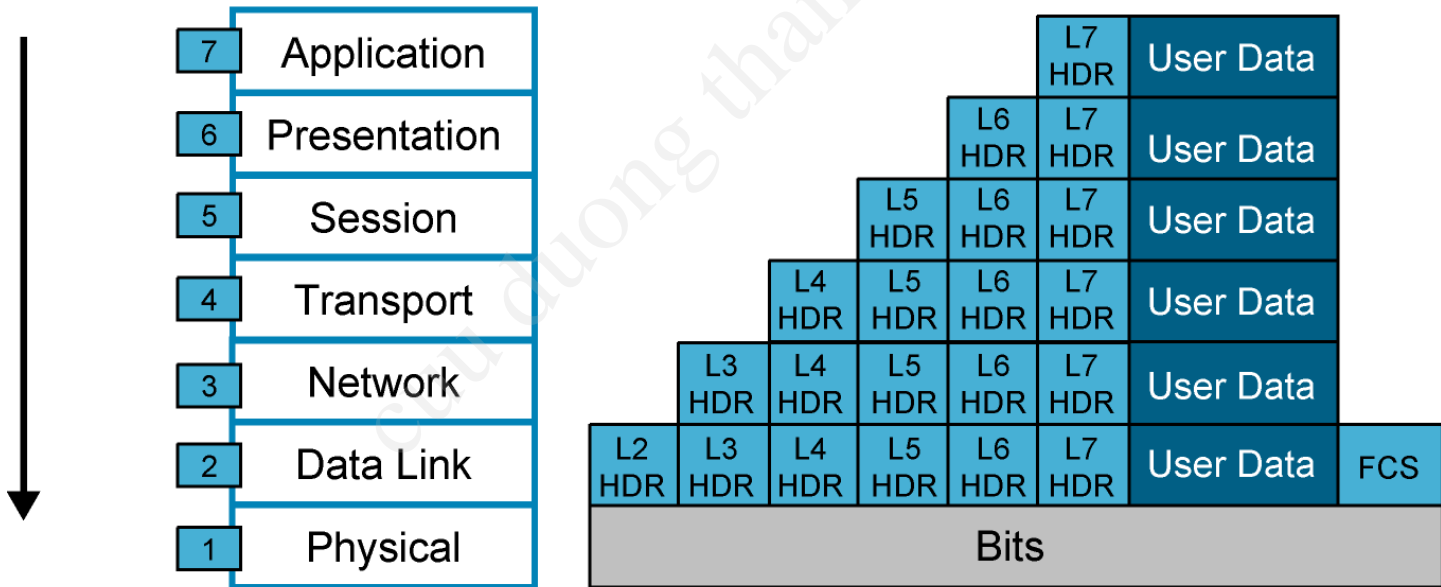
301P_905

Data Encapsulation

Sender

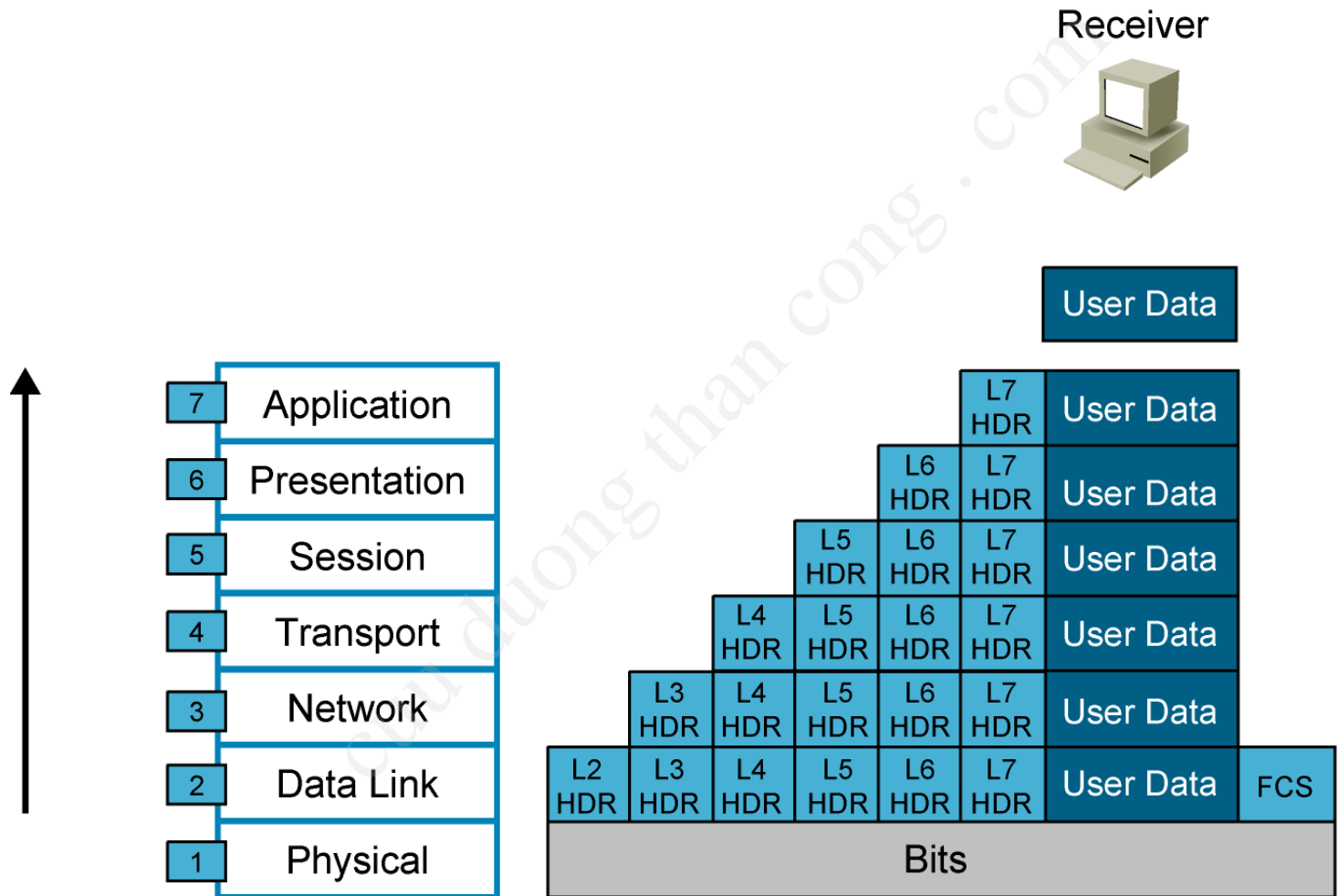


User Data



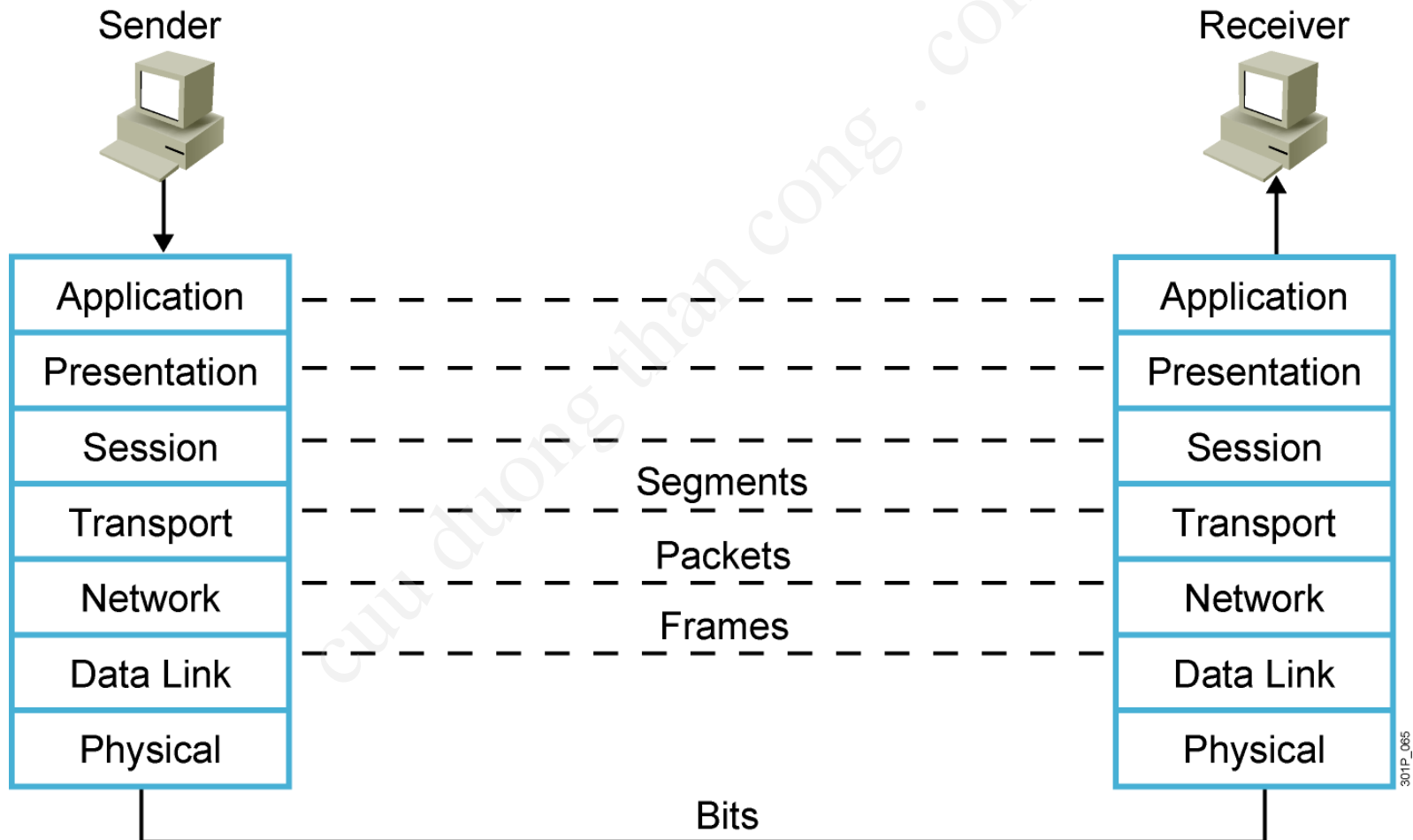
HDR = Header

Data De-Encapsulation



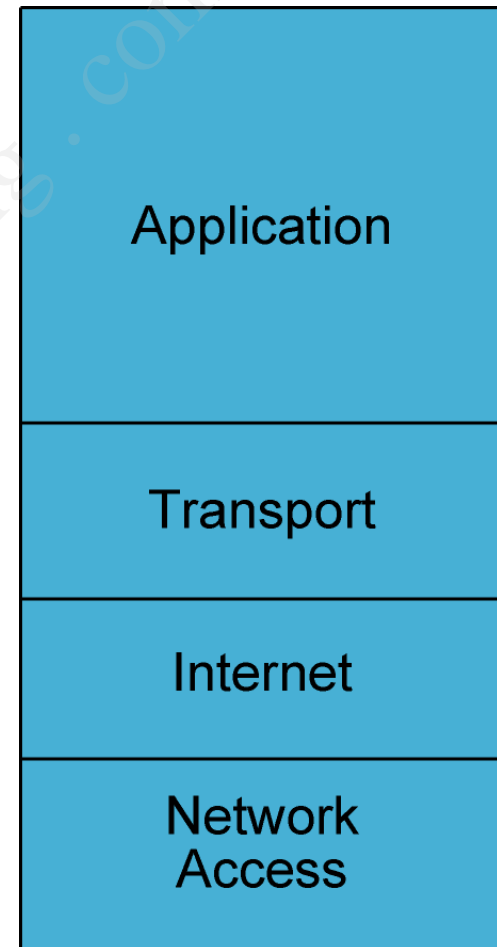
HDR = Header

Peer-to-Peer Communication

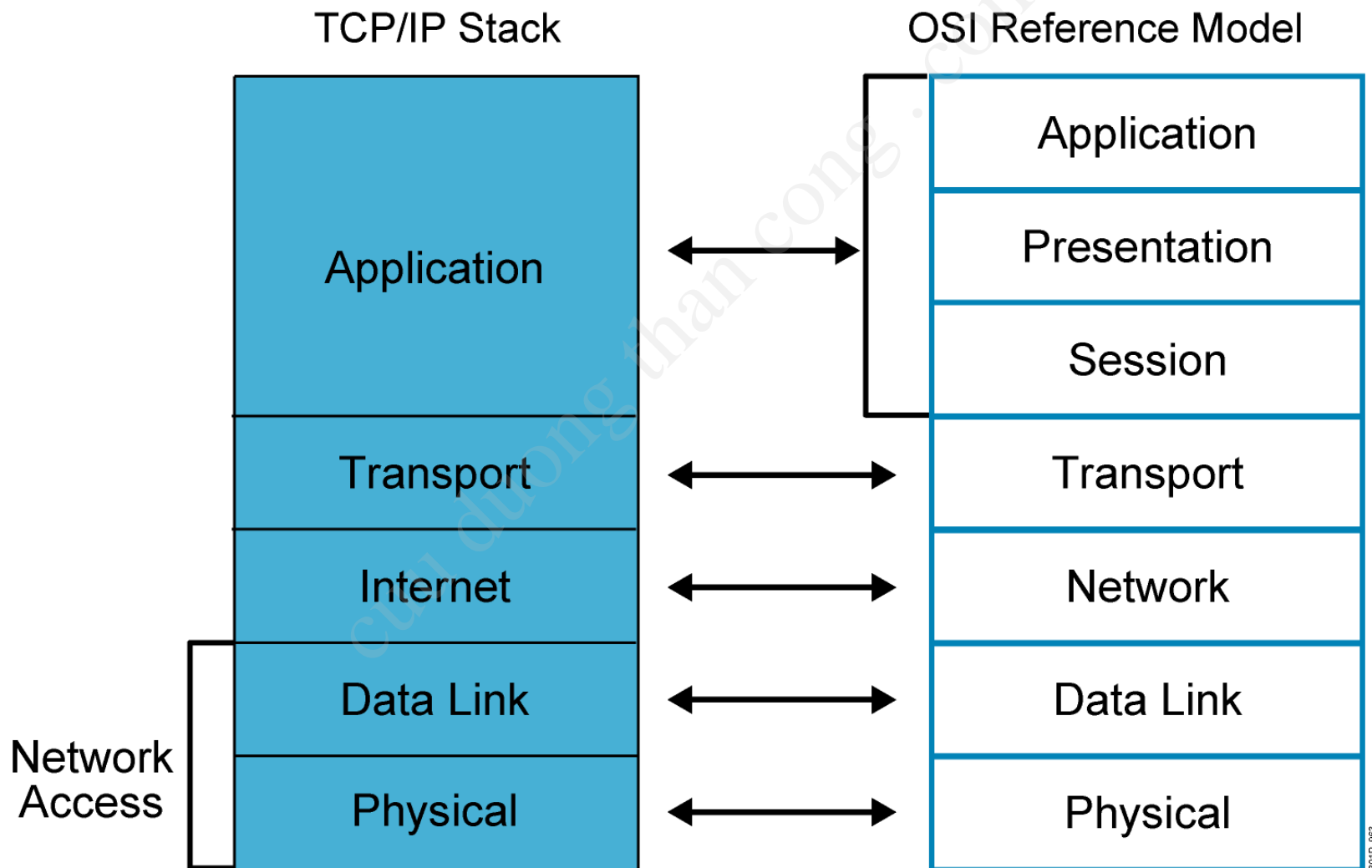


TCP/IP Stack

- Defines four layers
- Uses different names for Layers 1 through 3
- Combines Layers 5 through 7 into single application layer



TCP/IP Stack vs. the OSI Model

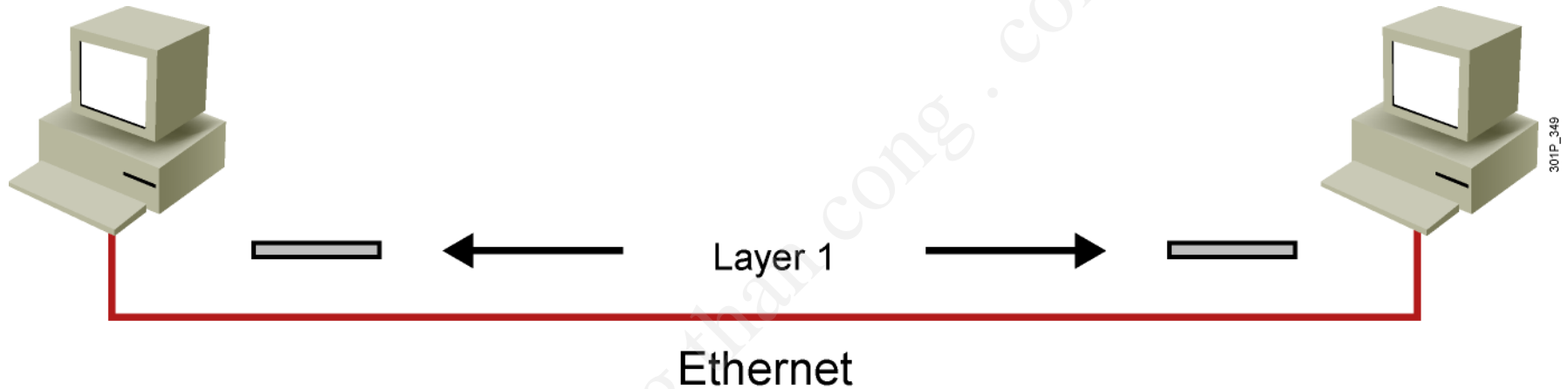


Exploring the Packet Delivery Process



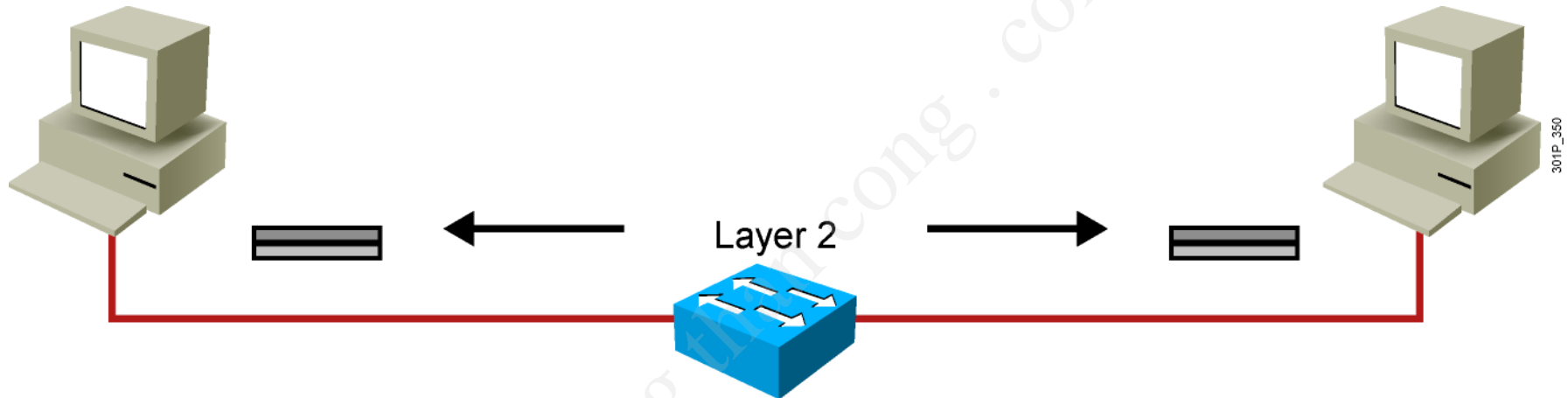
Building a Simple Network

Layer 1 Devices



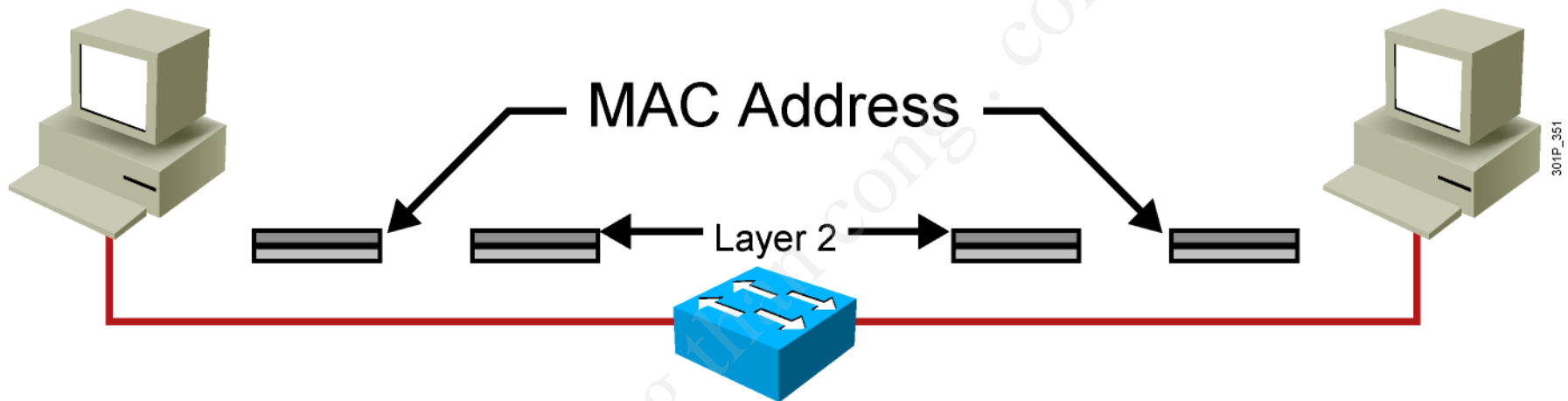
- Layer 1 provides the physical media and its encoding.
- Examples:
 - Ethernet
 - Serial
 - Repeater
 - Physical interface of the NIC

Layer 2 Devices



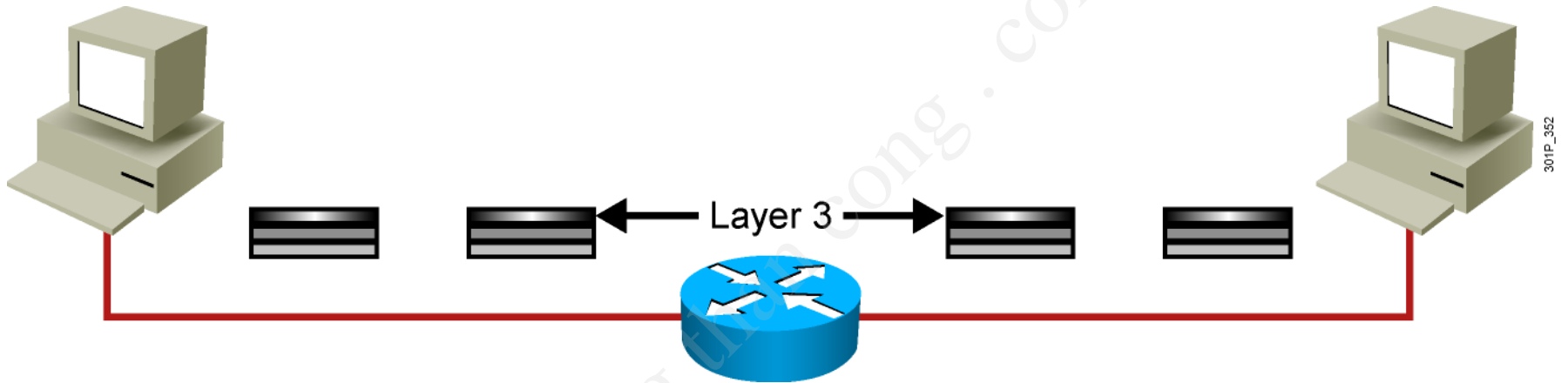
- Layer 2 devices provide an interface with the physical media.
- Examples:
 - NIC
 - Bridge
 - Switch

Layer 2 Addressing

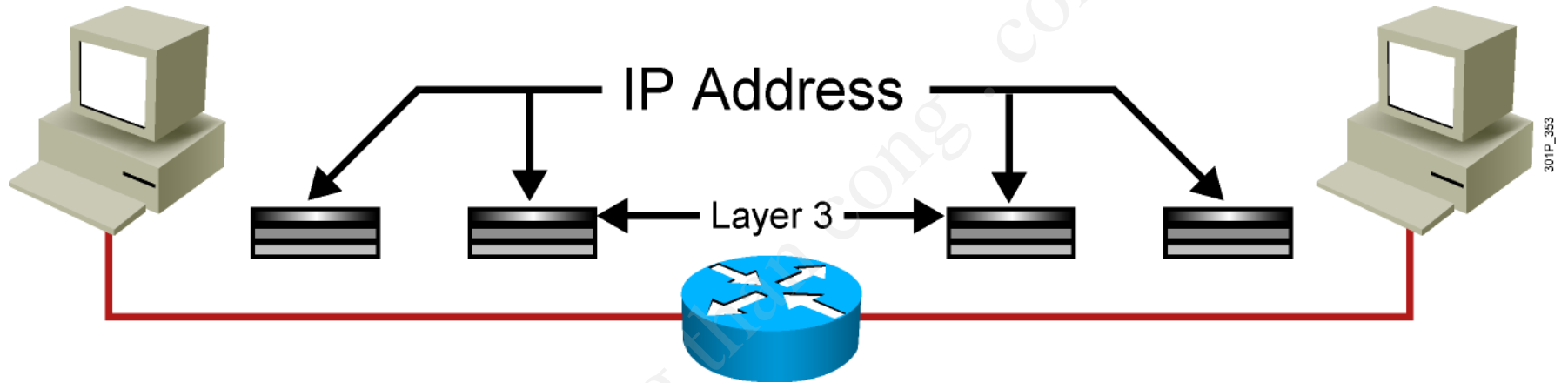


- MAC address
- Assigned to end devices

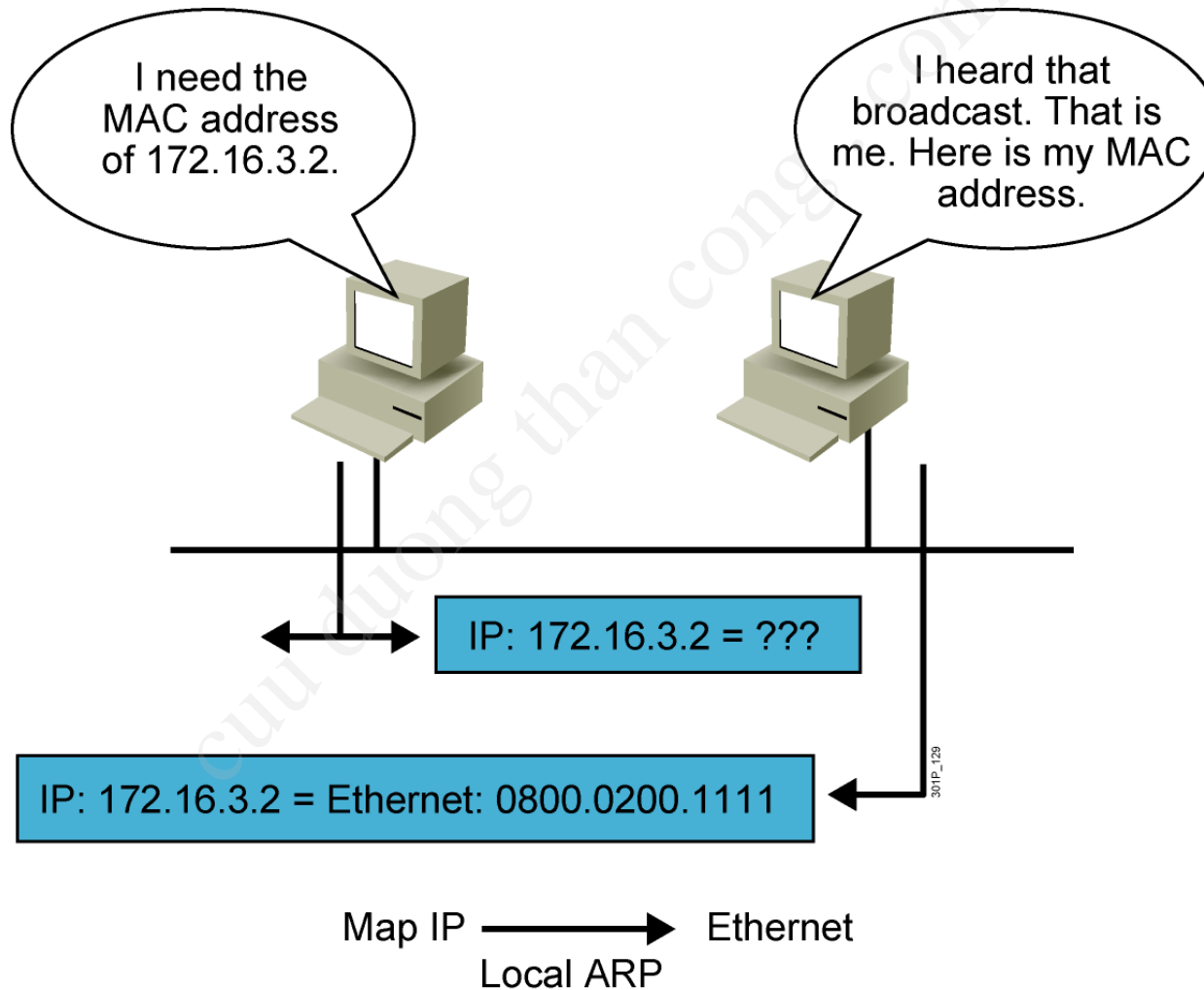
Layer 3 Devices and Their Function



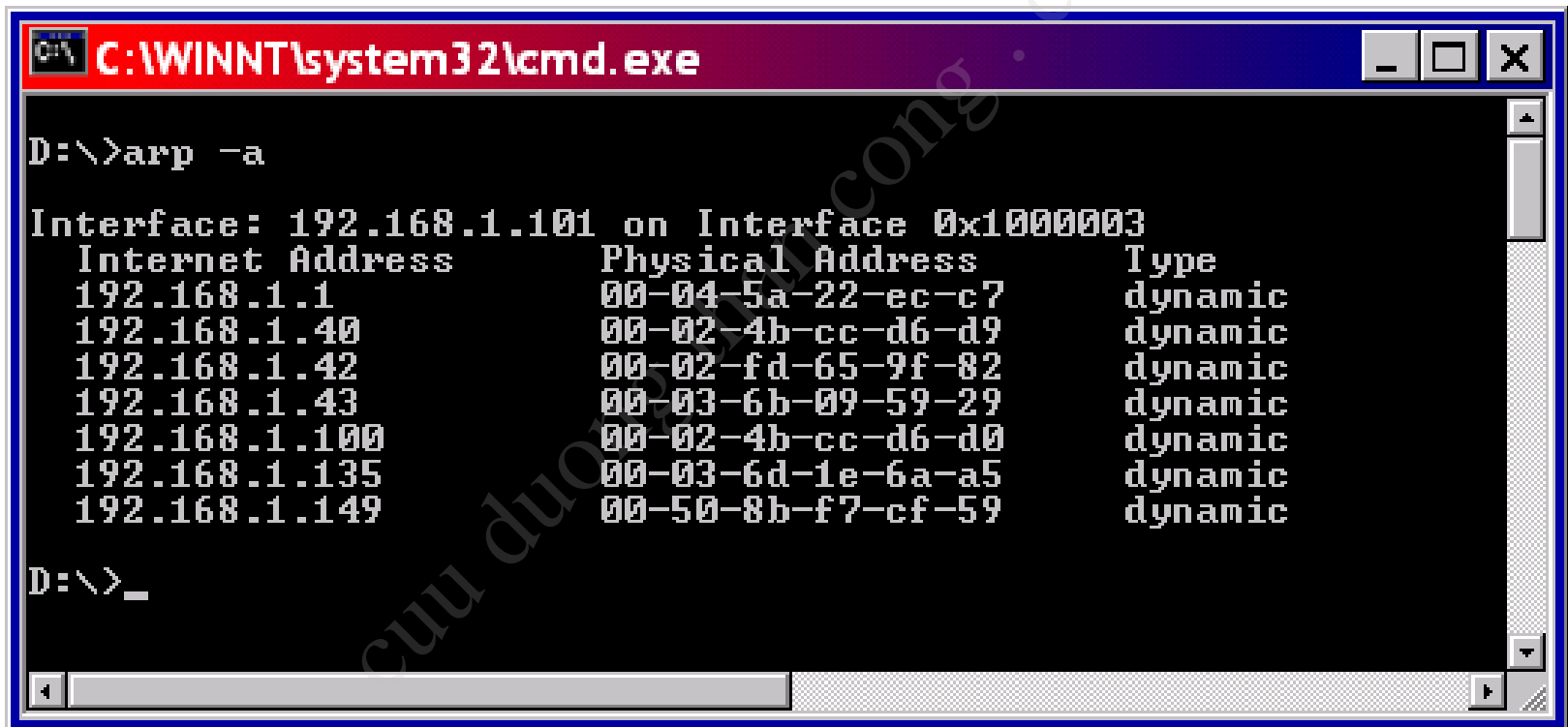
Layer 3 Addressing



ARP



ARP Table



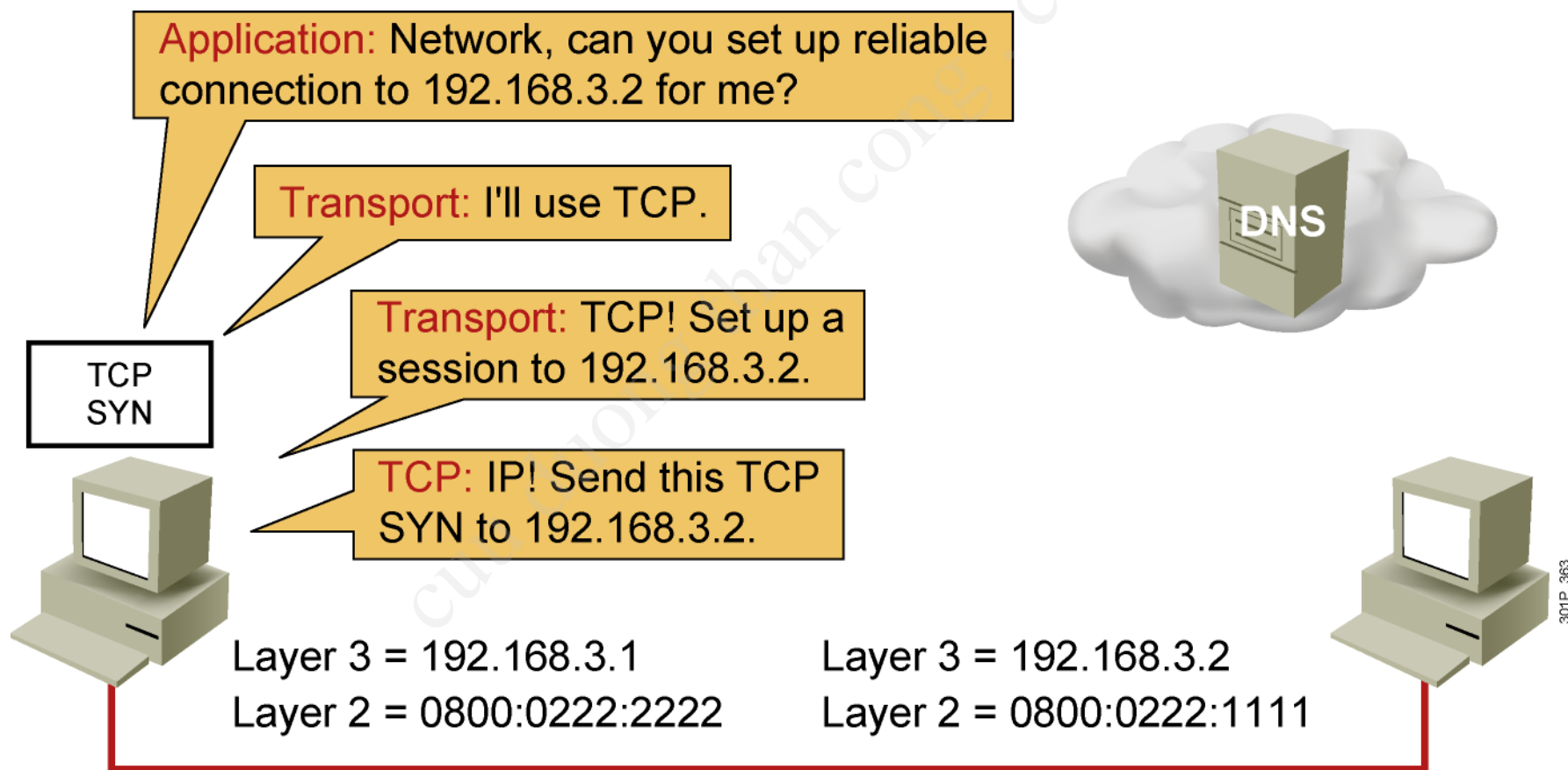
```
C:\WINNT\system32\cmd.exe

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:\>_
```

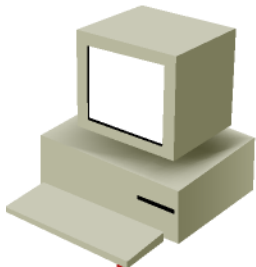
Host-to-Host Packet Delivery (1 of 22)



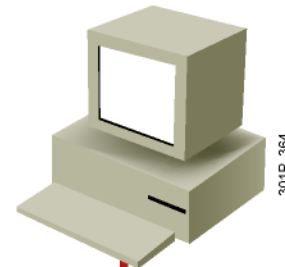
Host-to-Host Packet Delivery (2 of 22)

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



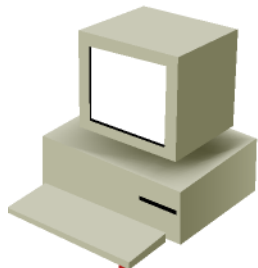
Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

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

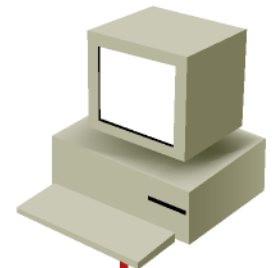
Layer 2: ARP, do you have a mapping for 192.168.3.2?

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
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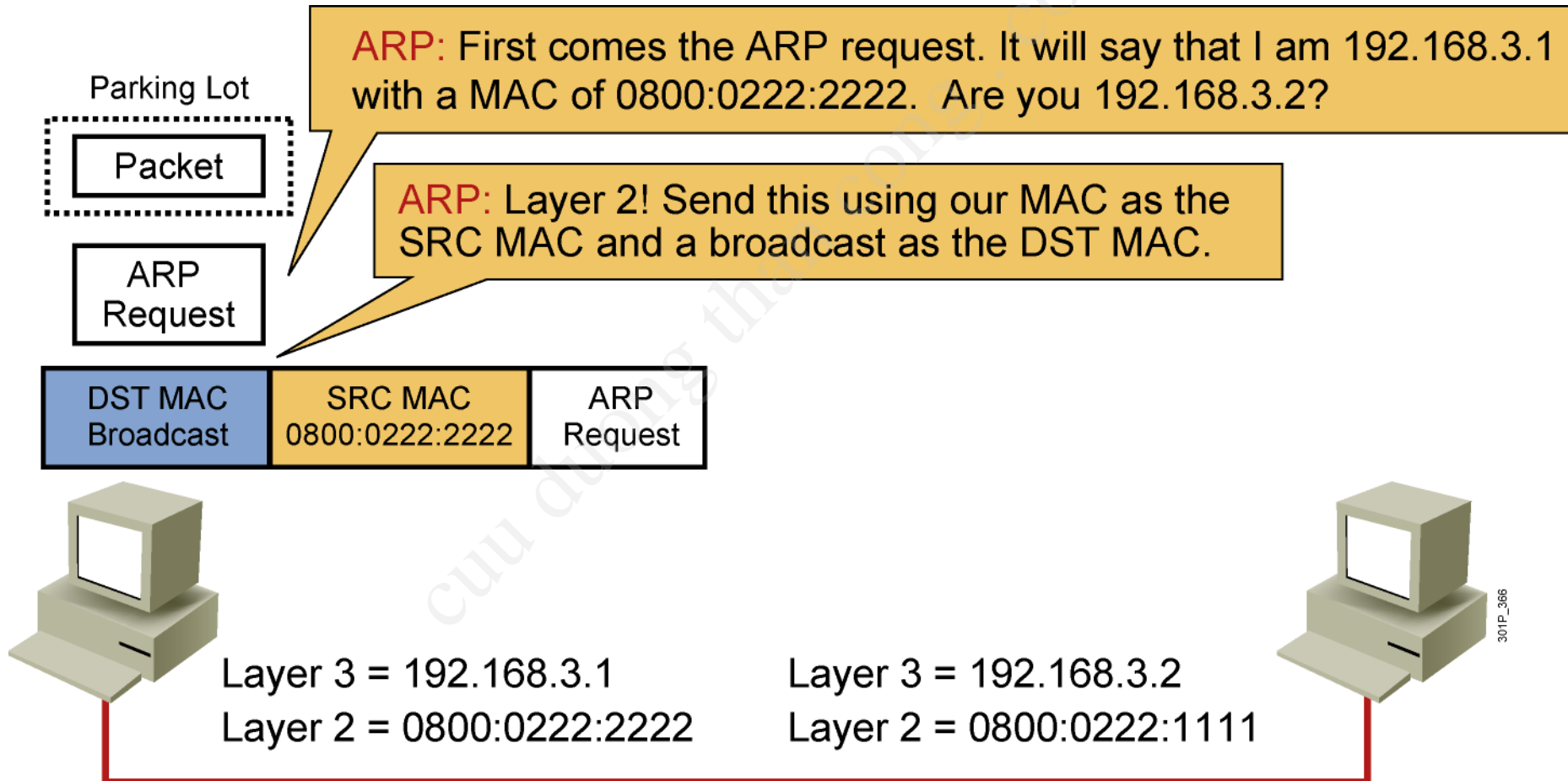


Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

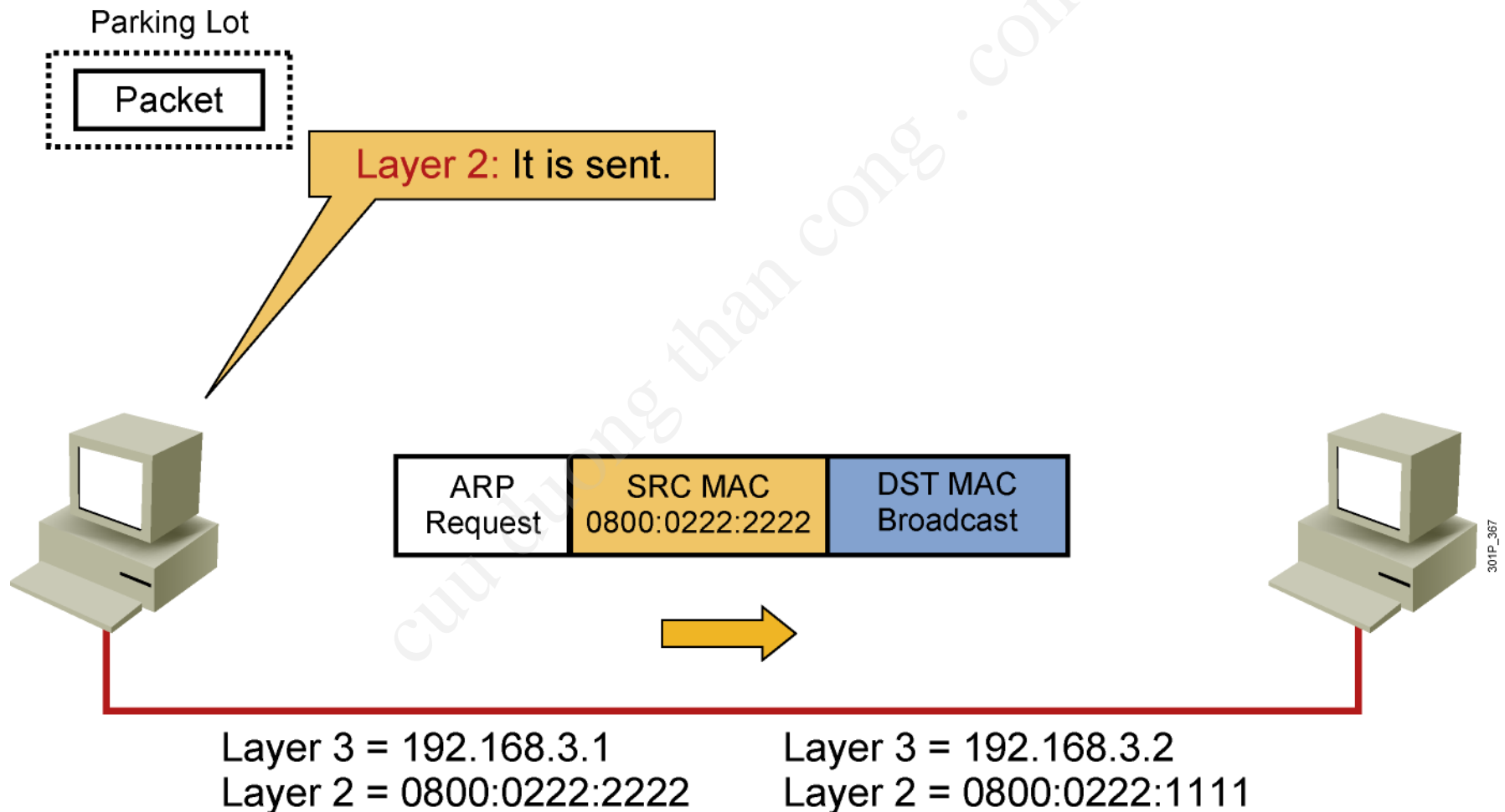


Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

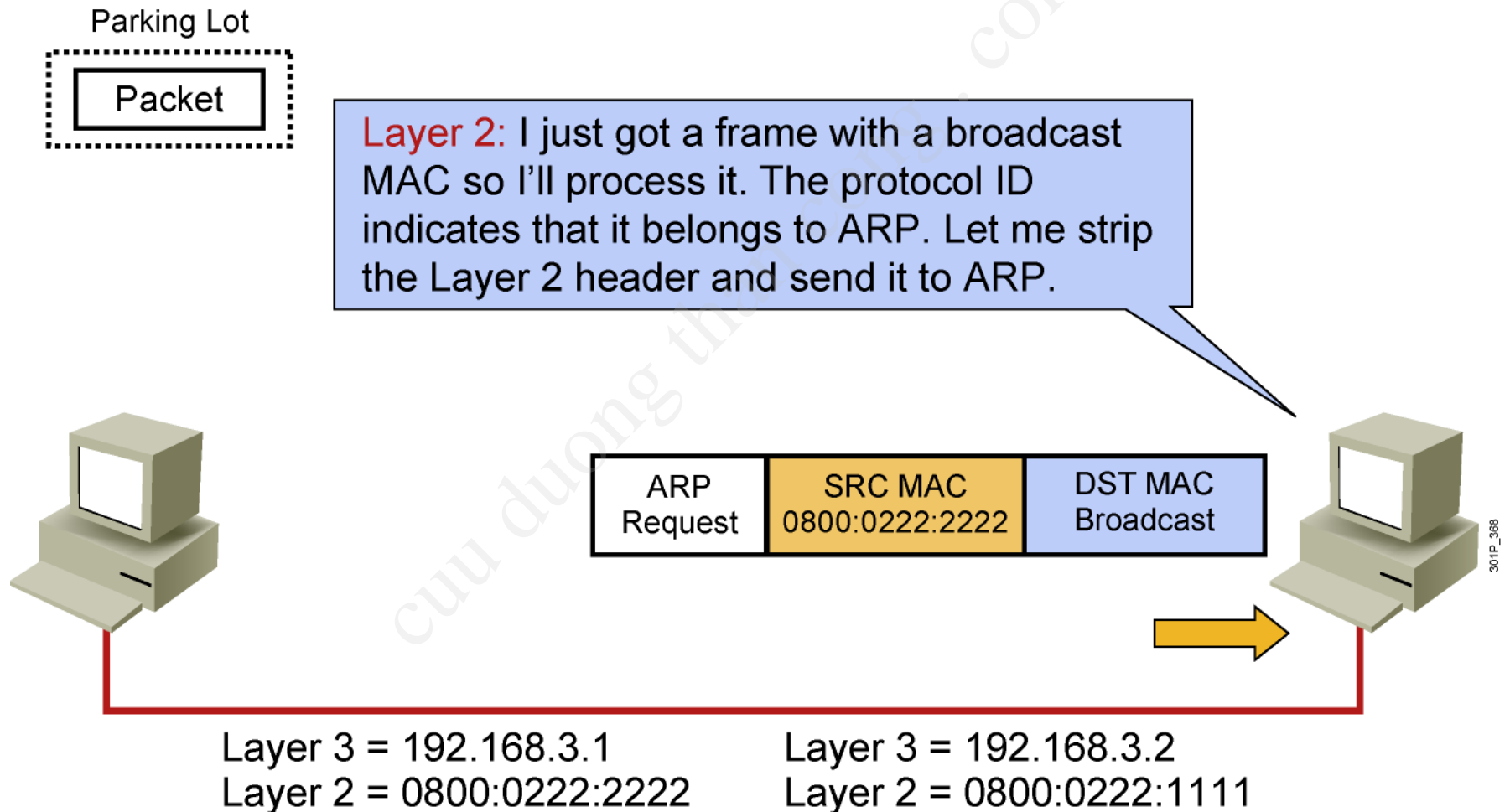
Host-to-Host Packet Delivery (4 of 22)



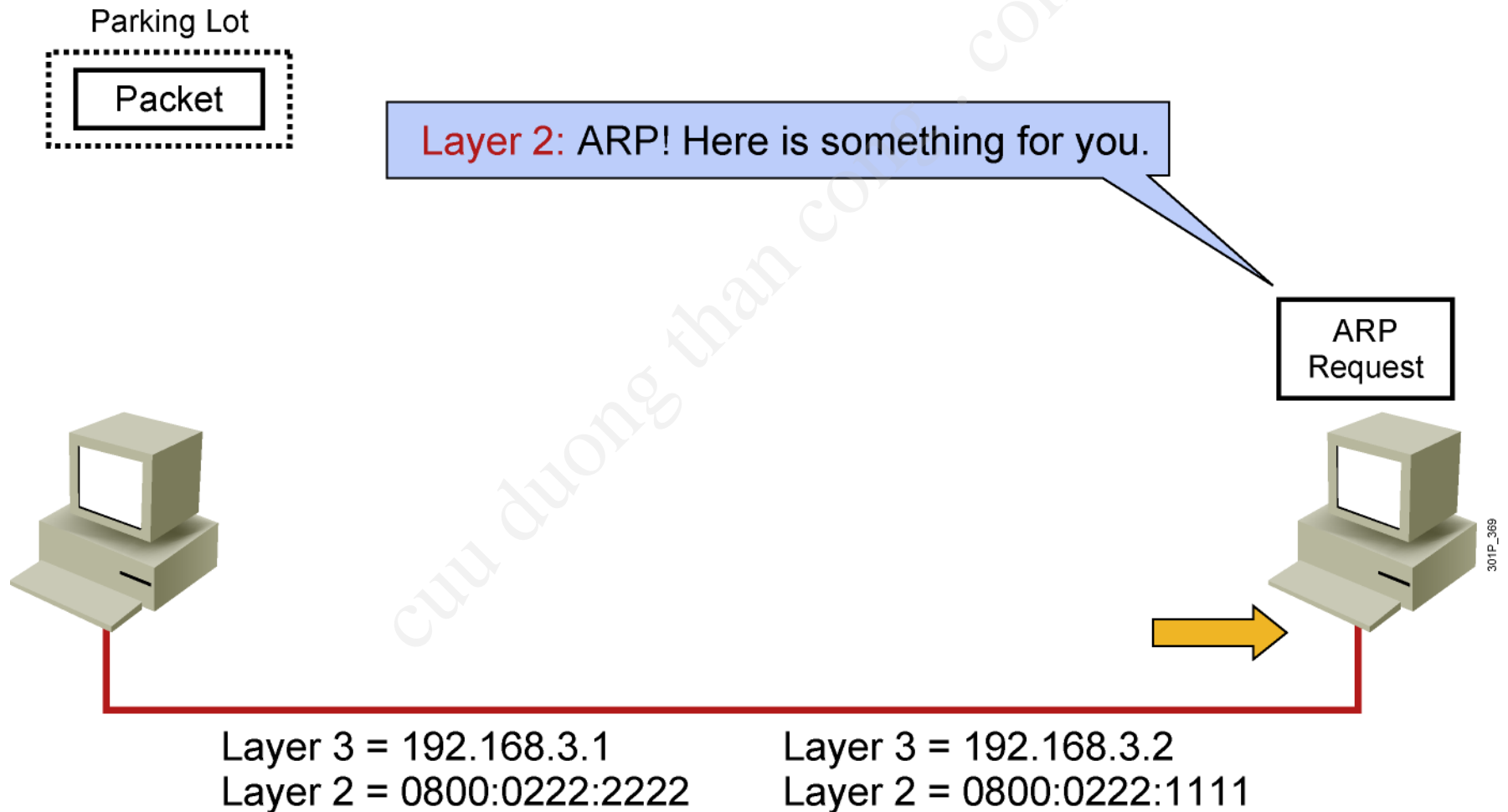
Host-to-Host Packet Delivery (5 of 22)



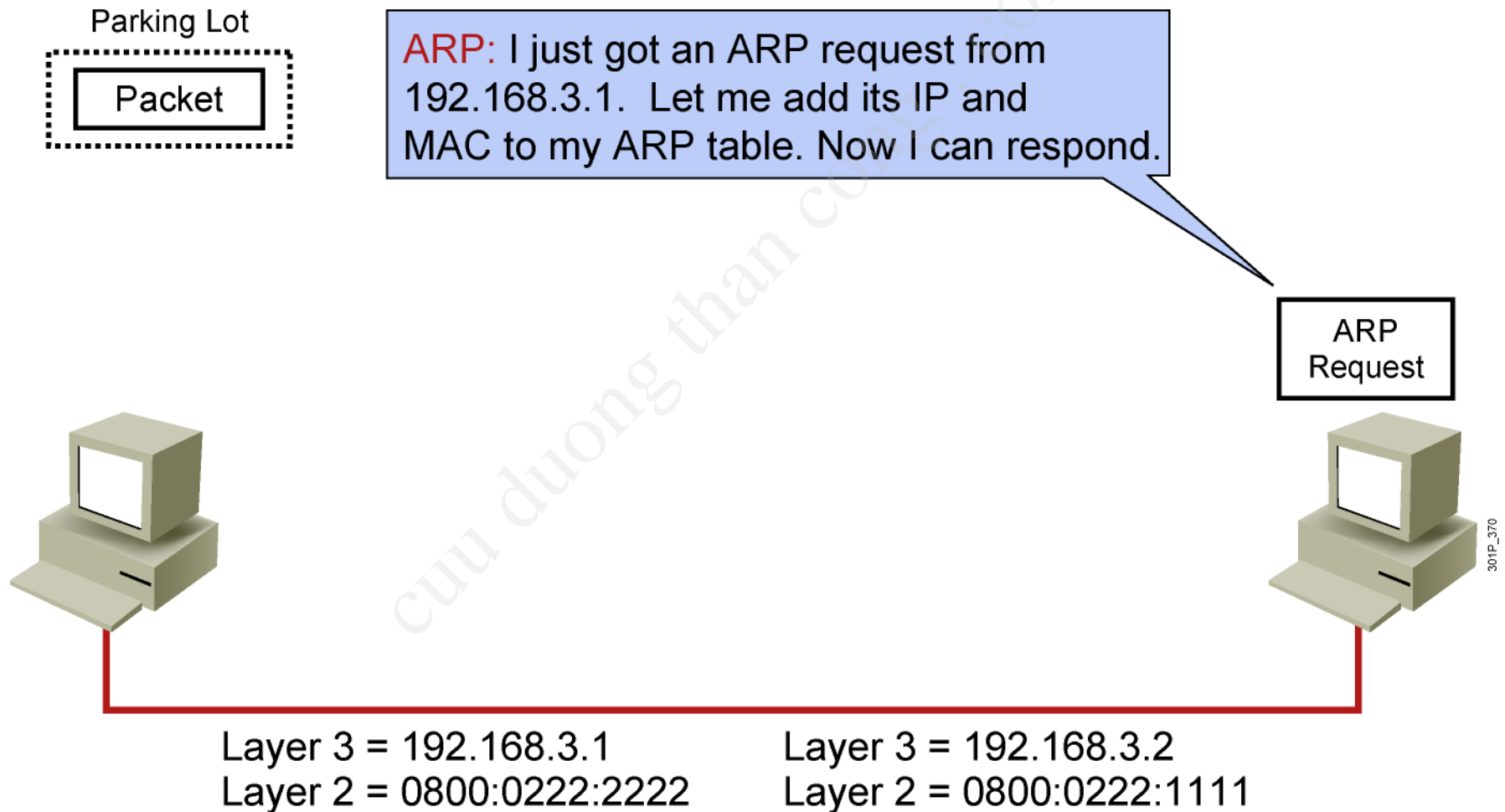
Host-to-Host Packet Delivery (6 of 22)



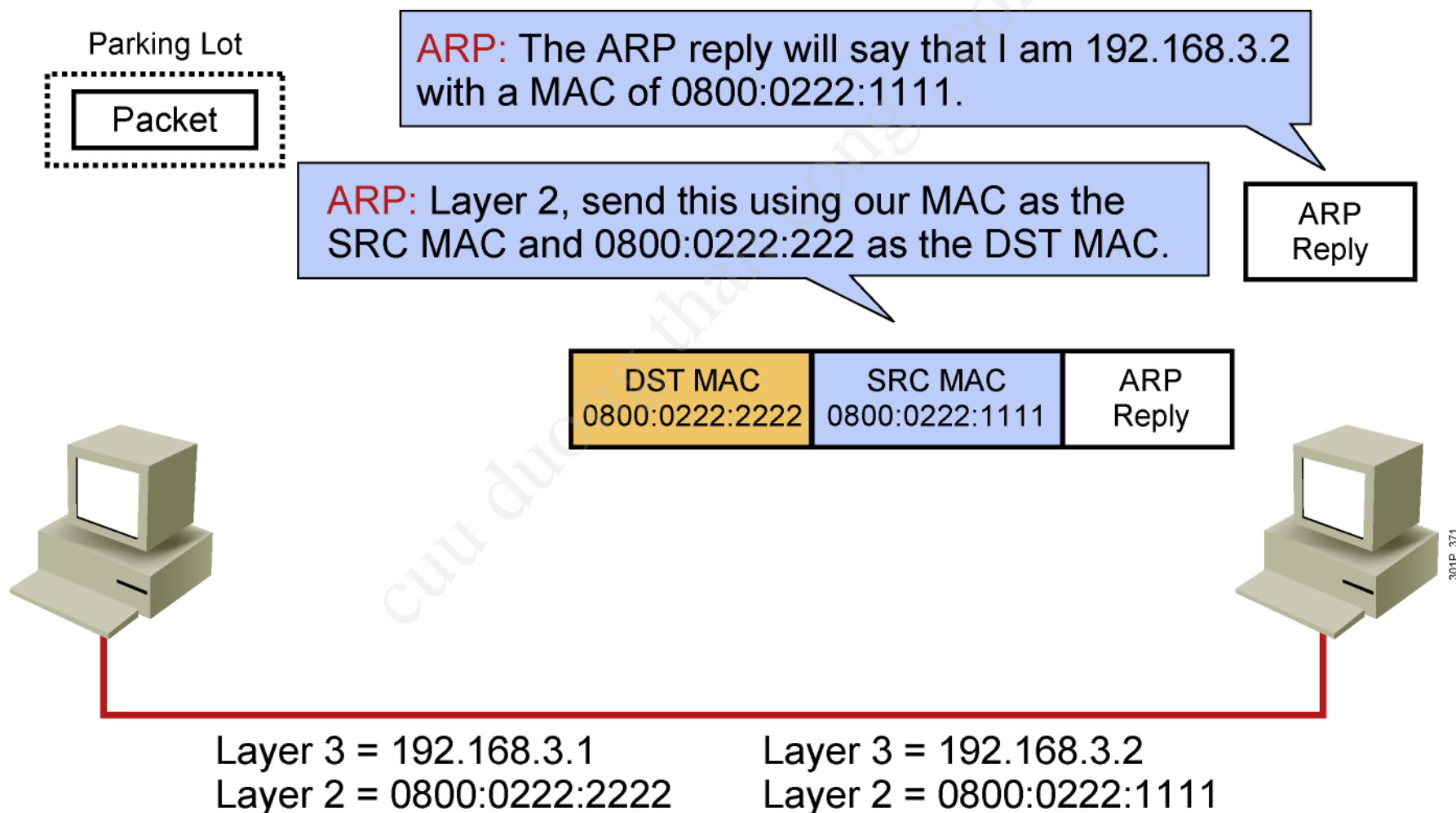
Host-to-Host Packet Delivery (7 of 22)



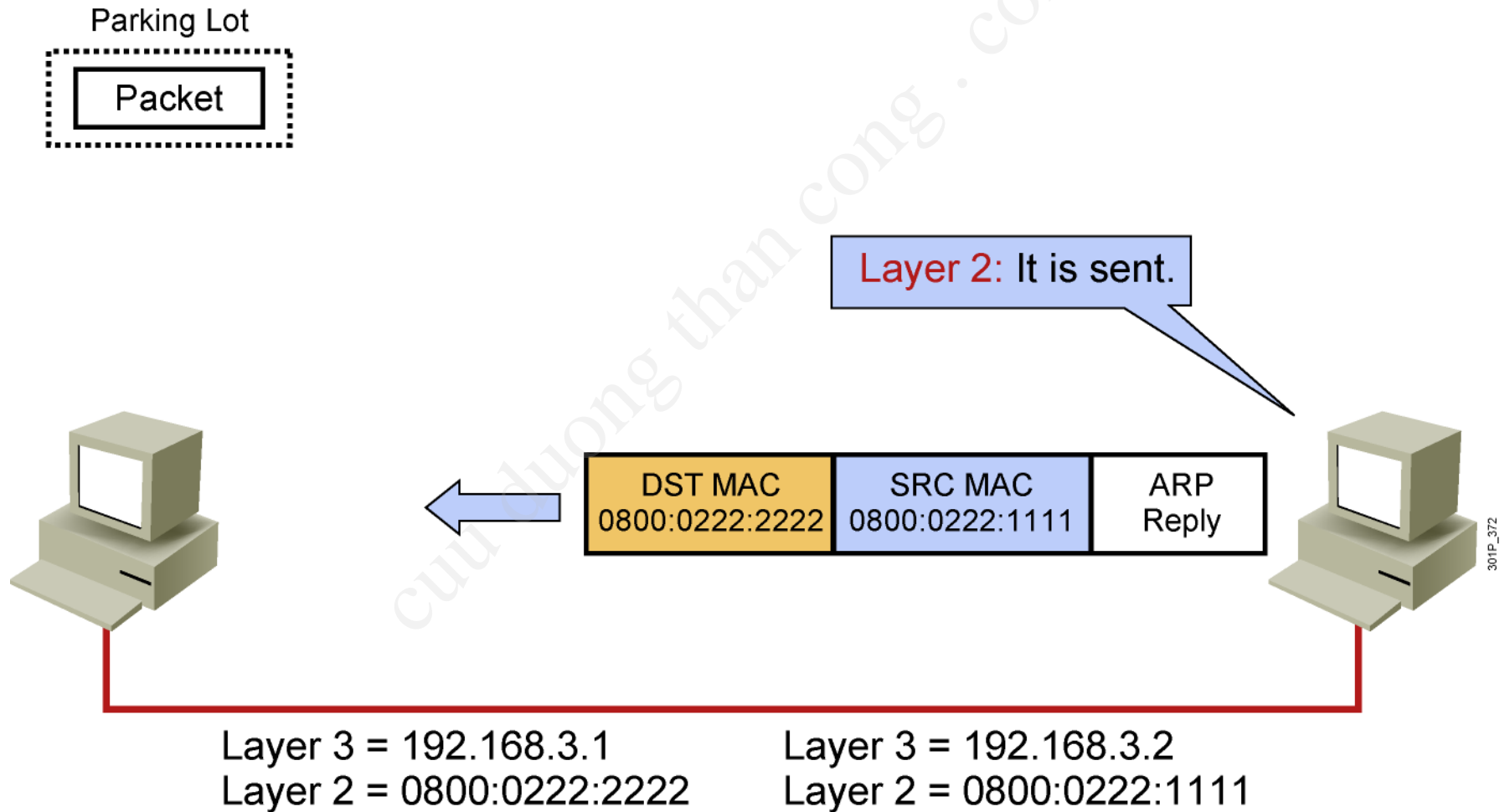
Host-to-Host Packet Delivery (8 of 22)



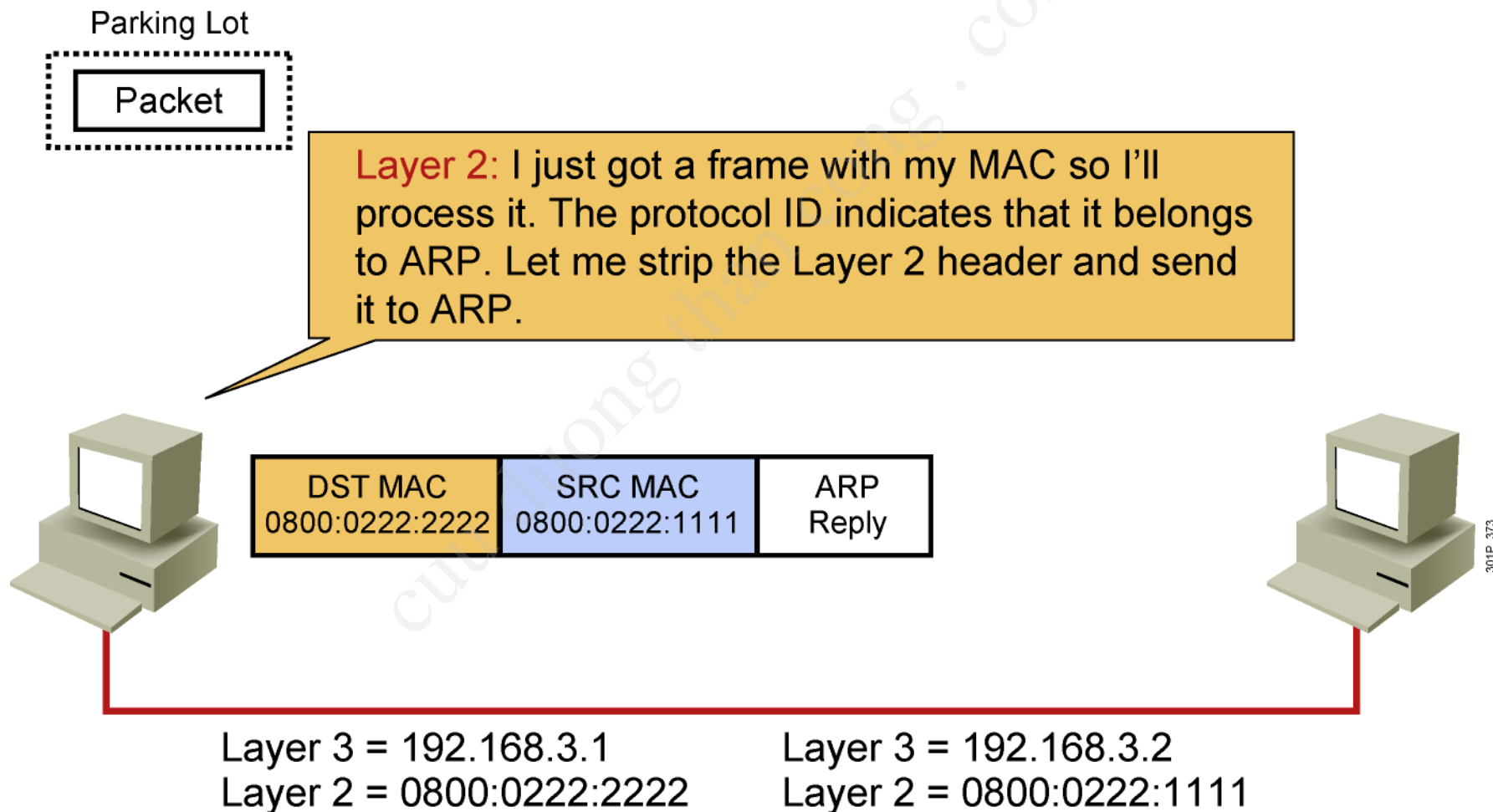
Host-to-Host Packet Delivery (9 of 22)



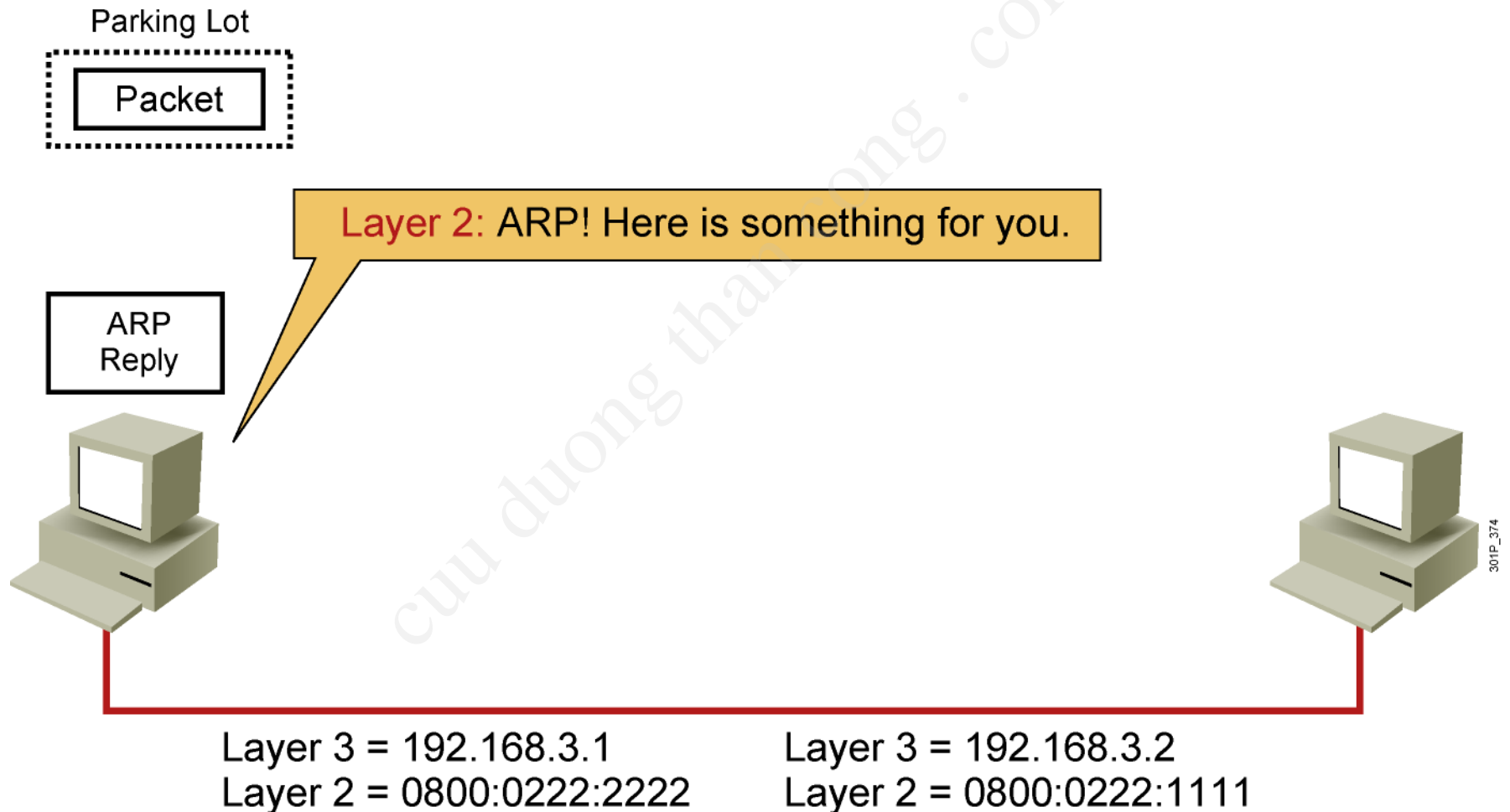
Host-to-Host Packet Delivery (10 of 22)



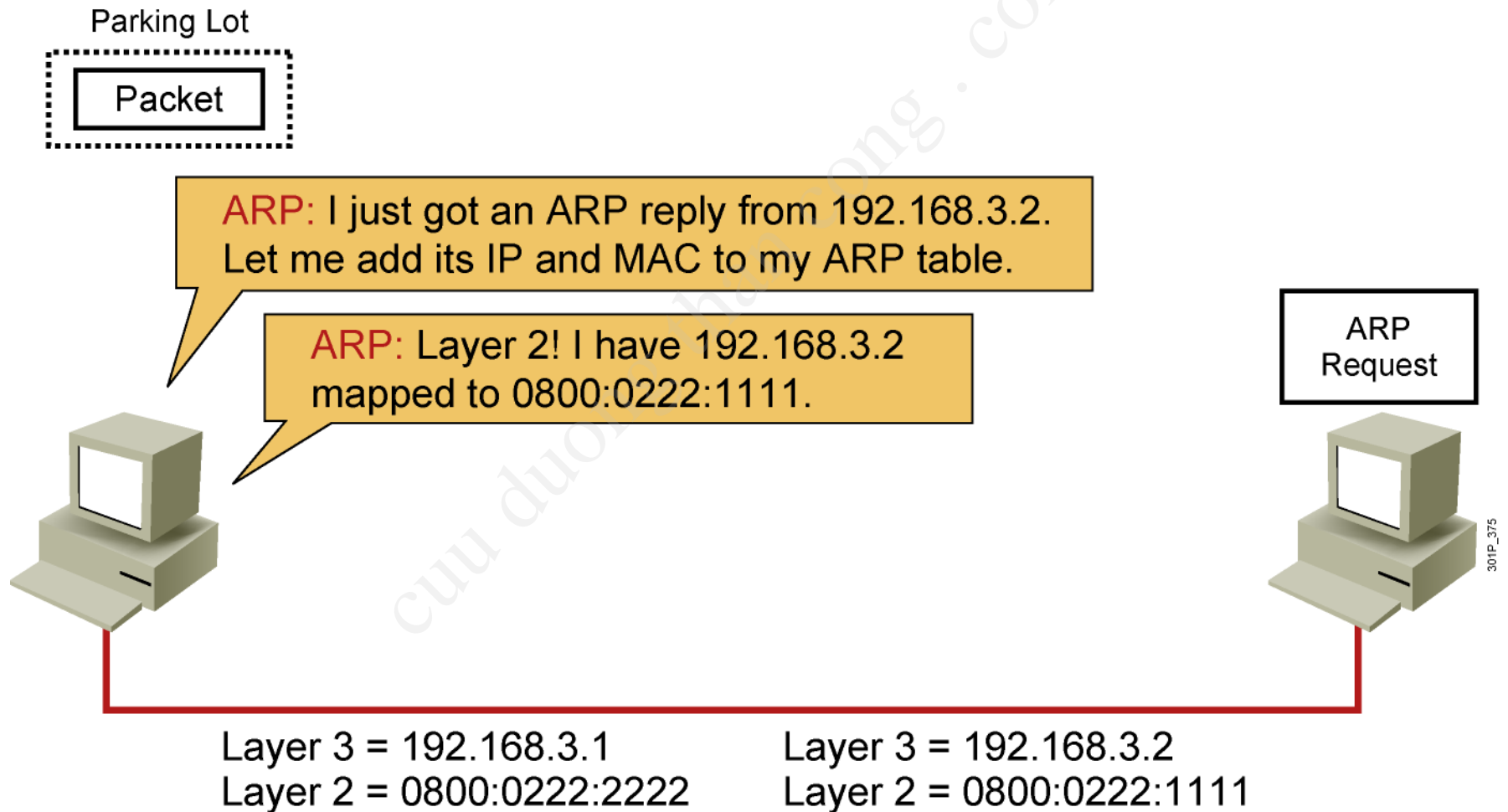
Host-to-Host Packet Delivery (11 of 22)



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

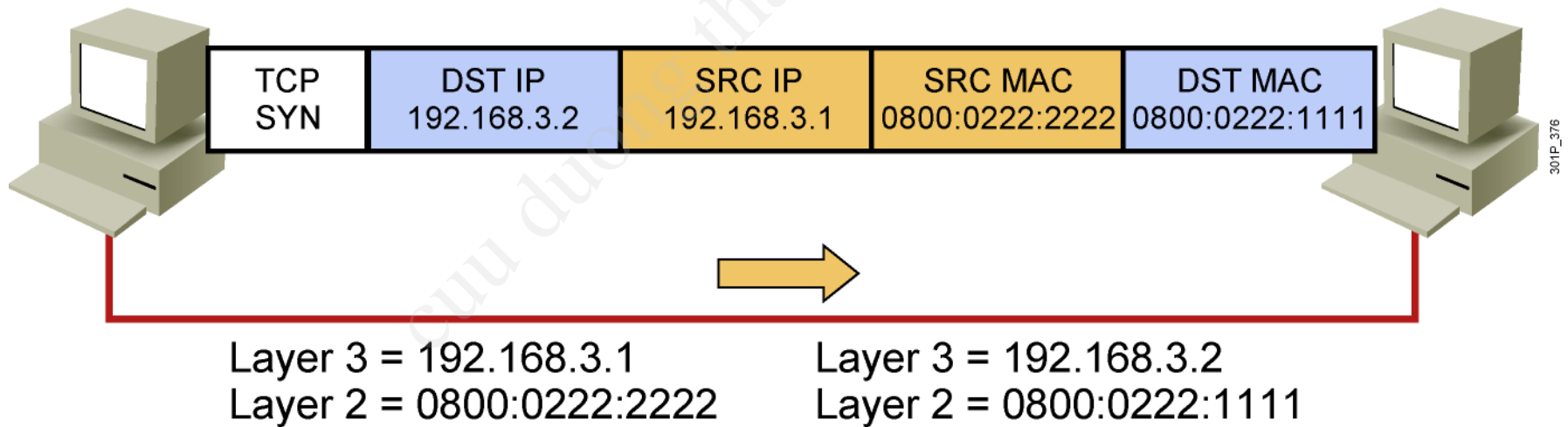


Host-to-Host Packet Delivery (13 of 22)



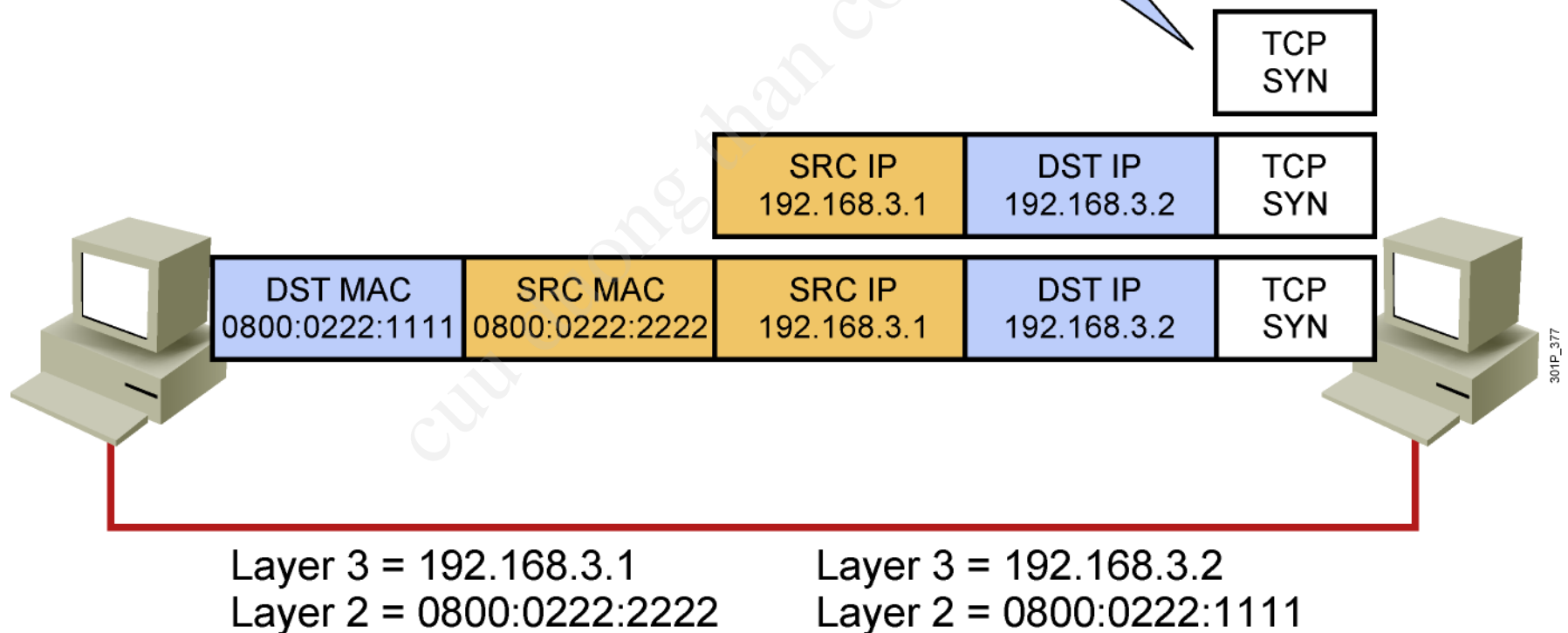
Host-to-Host Packet Delivery (14 of 22)

Layer 2: I can send out that pending packet.

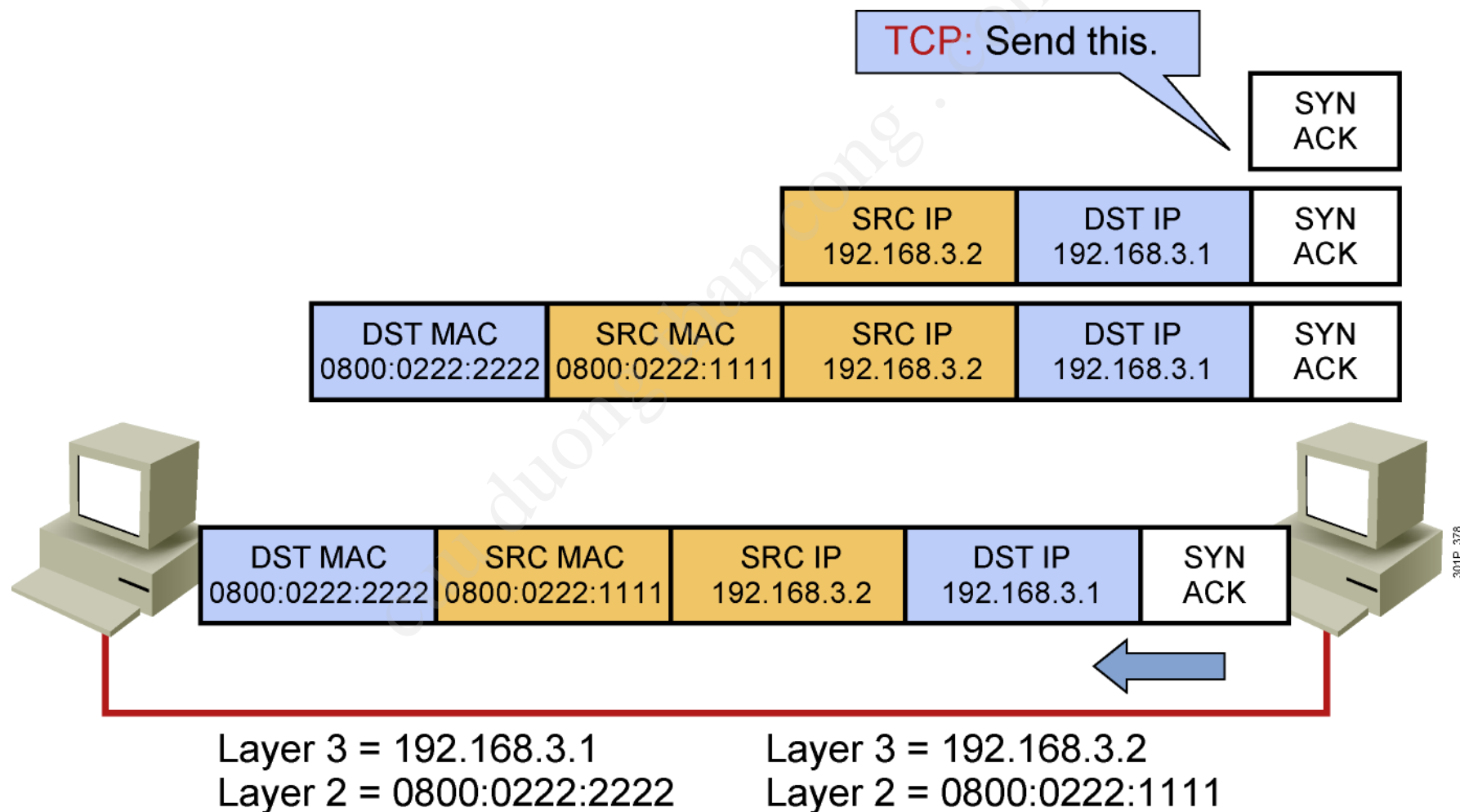


Host-to-Host Packet Delivery (15 of 22)

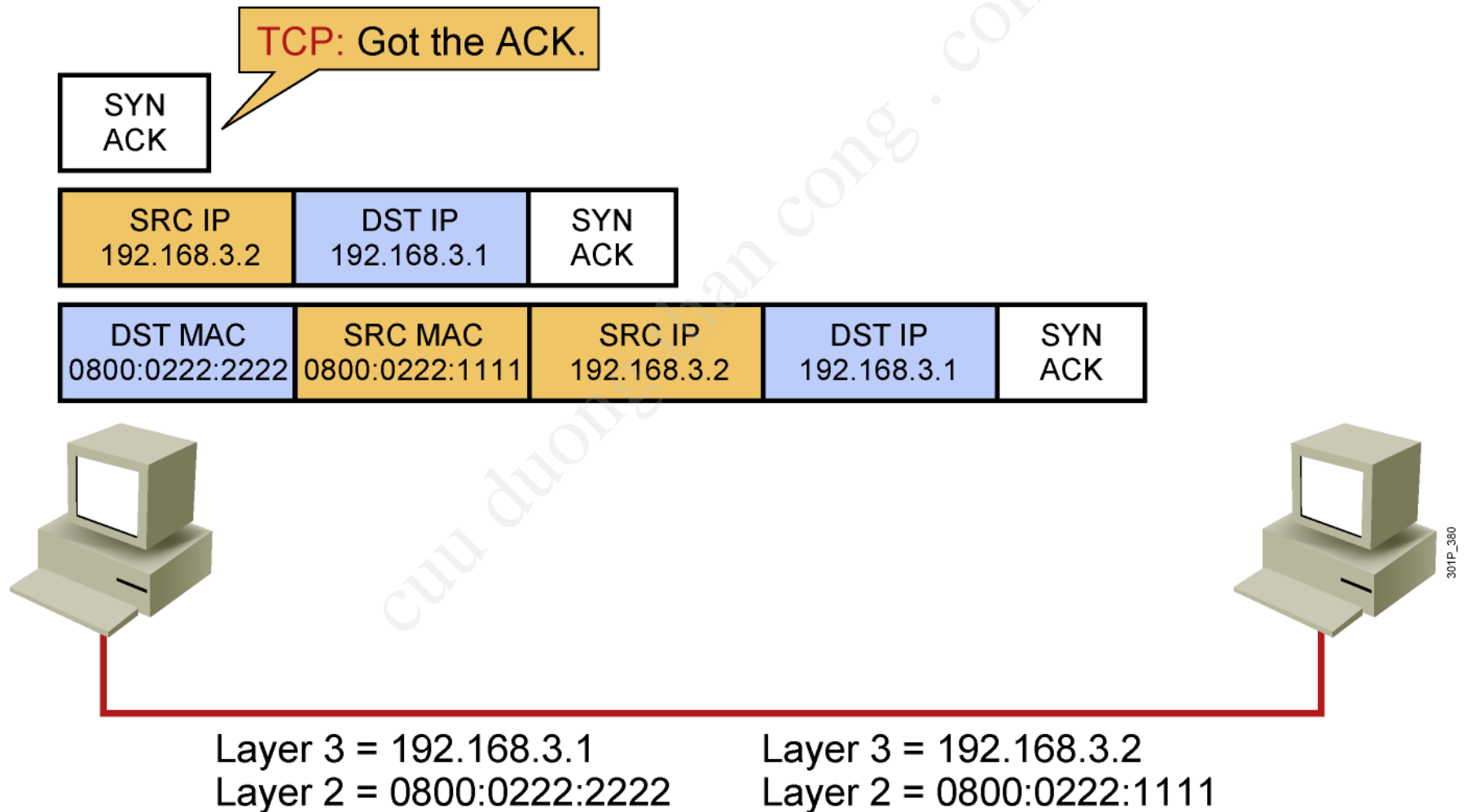
TCP: I need to send a SYN ACK to the TCP SYN that I received.



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



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



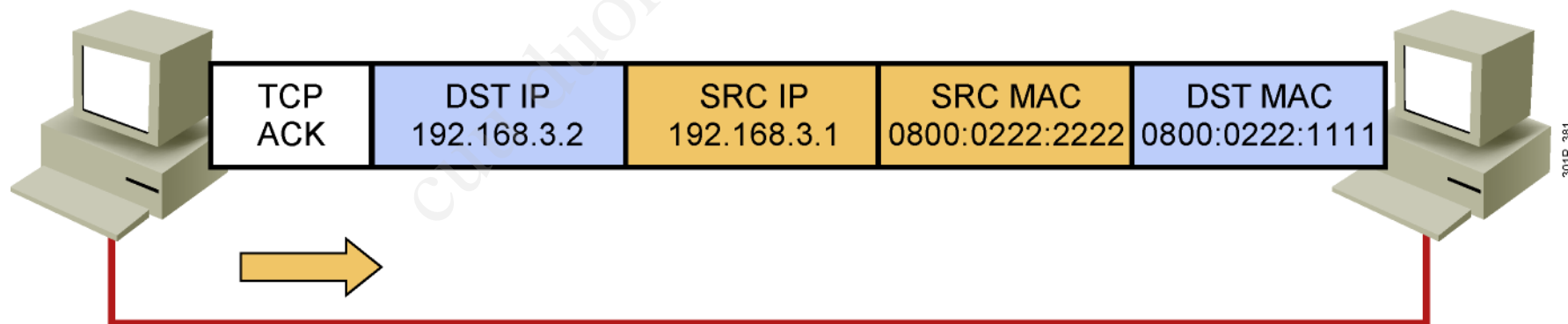
Host-to-Host Packet Delivery (18 of 22)

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
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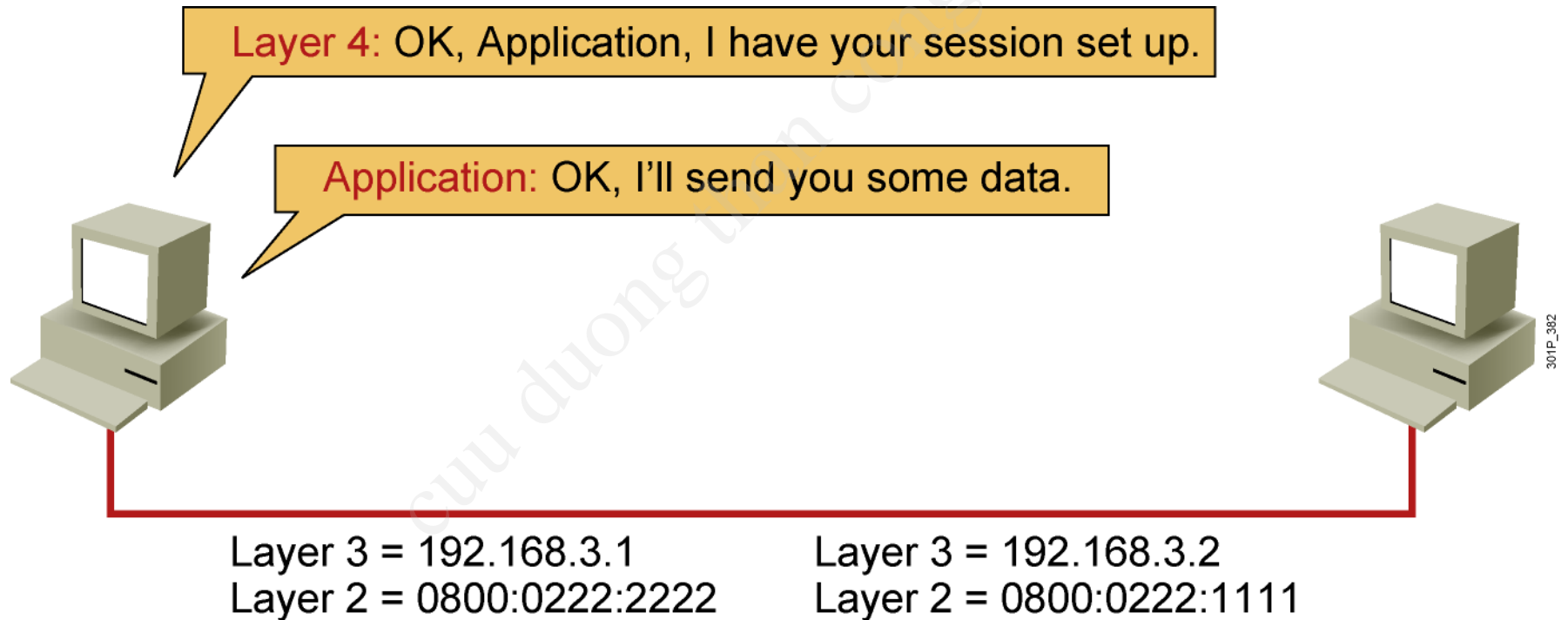
DST MAC 0800:0222:1111	SRC MAC 0800:0222:2222	SRC IP 192.168.3.1	DST IP 192.168.3.2	TCP ACK
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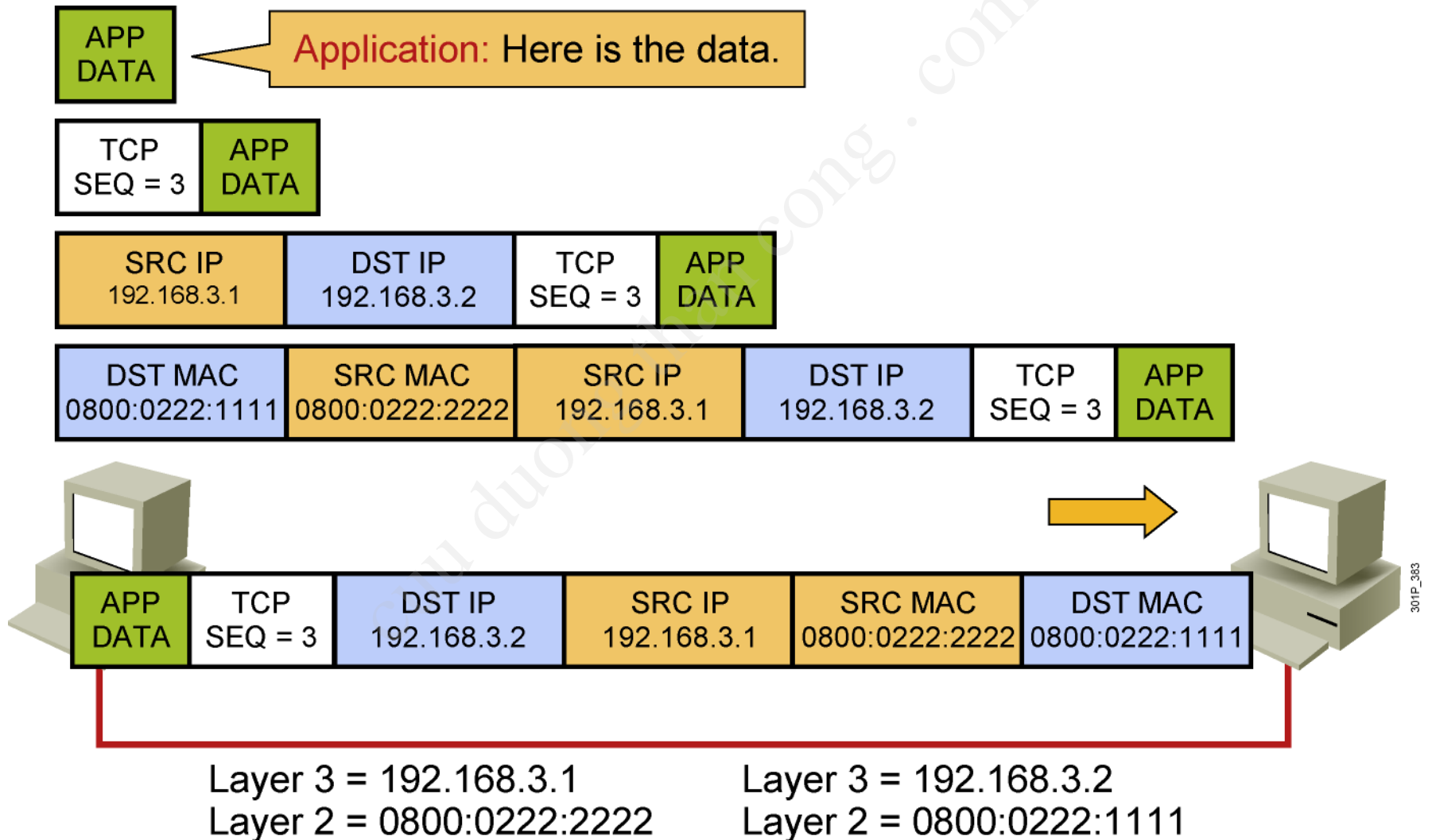
Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

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

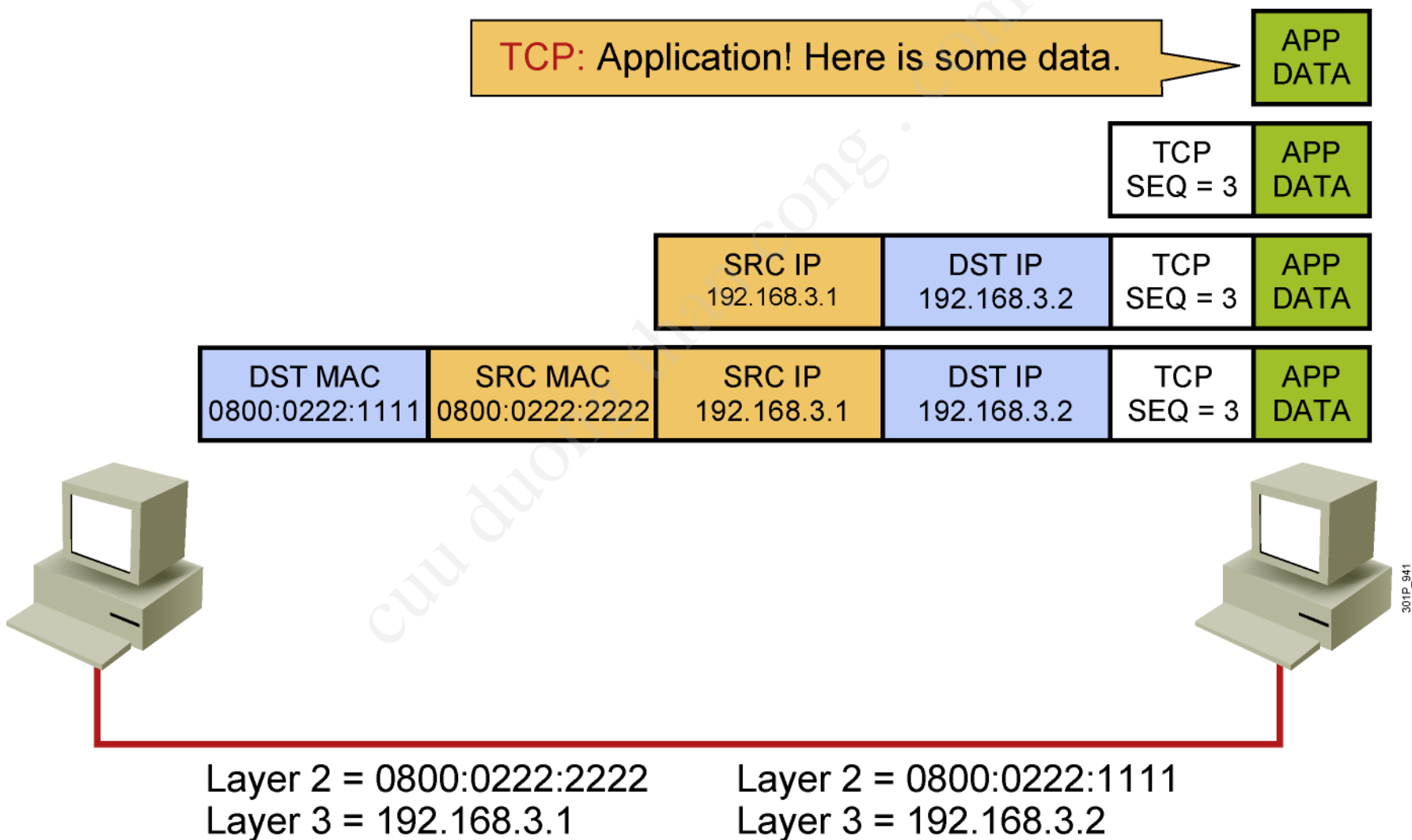
Host-to-Host Packet Delivery (19 of 22)



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

DST MAC
0800:0222:2222

SRC MAC
0800:0222:1111

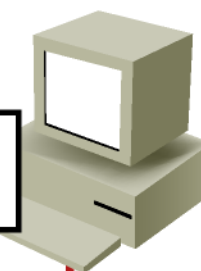
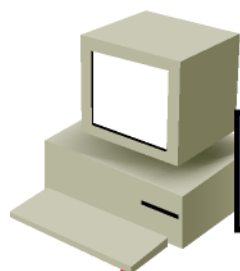
SRC IP
192.168.3.2

DST IP
192.168.3.1

ACK = 4
SEQ = 3

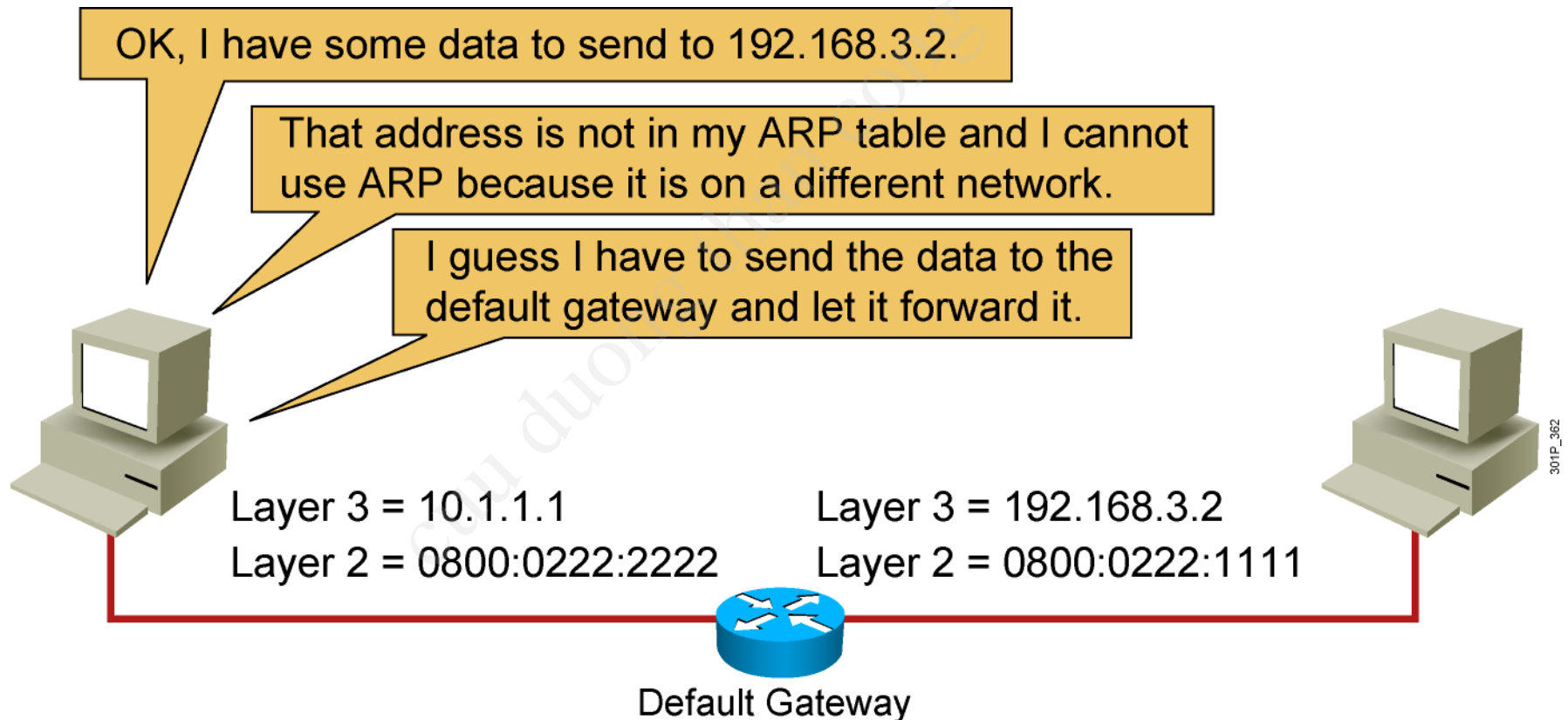
Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

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



301P_385

Default Gateway

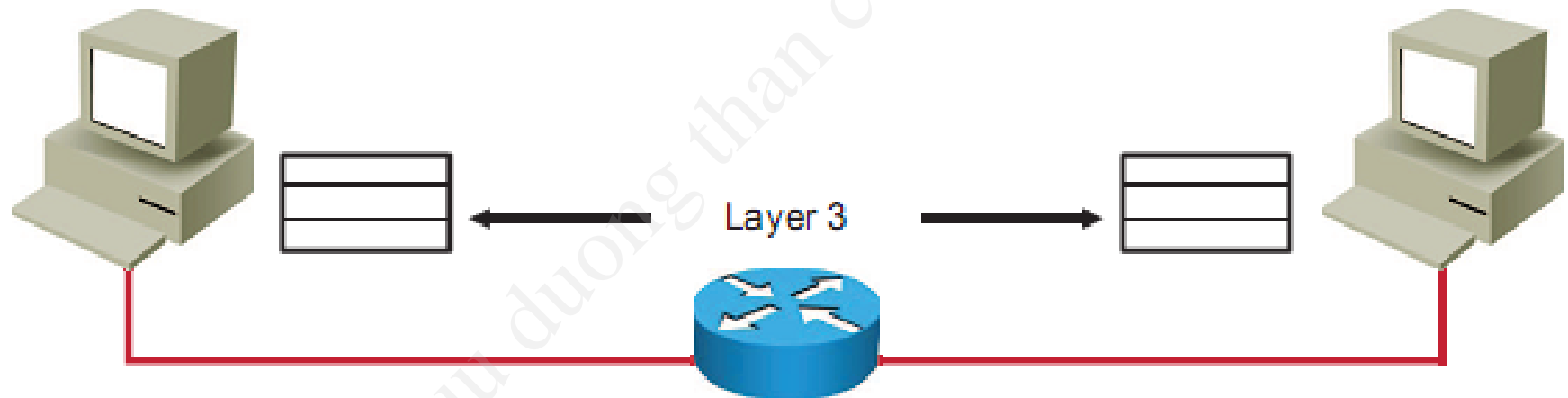


Layer 3 Addressing (Cont.)

Layer 3 addressing:

Layer 3 addresses must include identifiers that enable intermediary network devices to locate hosts on different networks.

TCP/IP protocol stack uses IP.



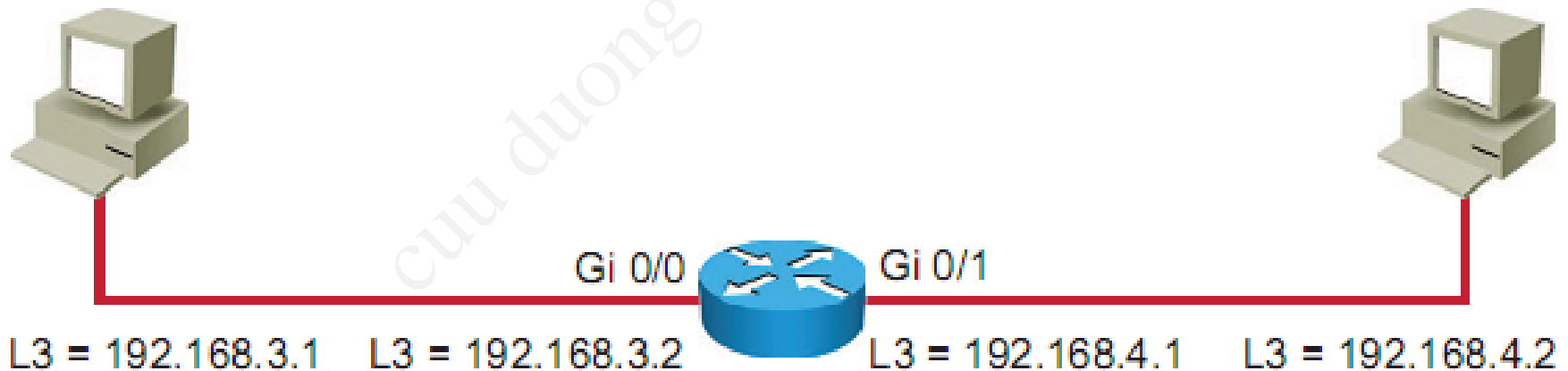
Layer 3 Addressing (Cont.)

Layer 3 addresses are assigned to hosts and network devices that provide Layer 3 functions.

Network devices maintain a routing table.

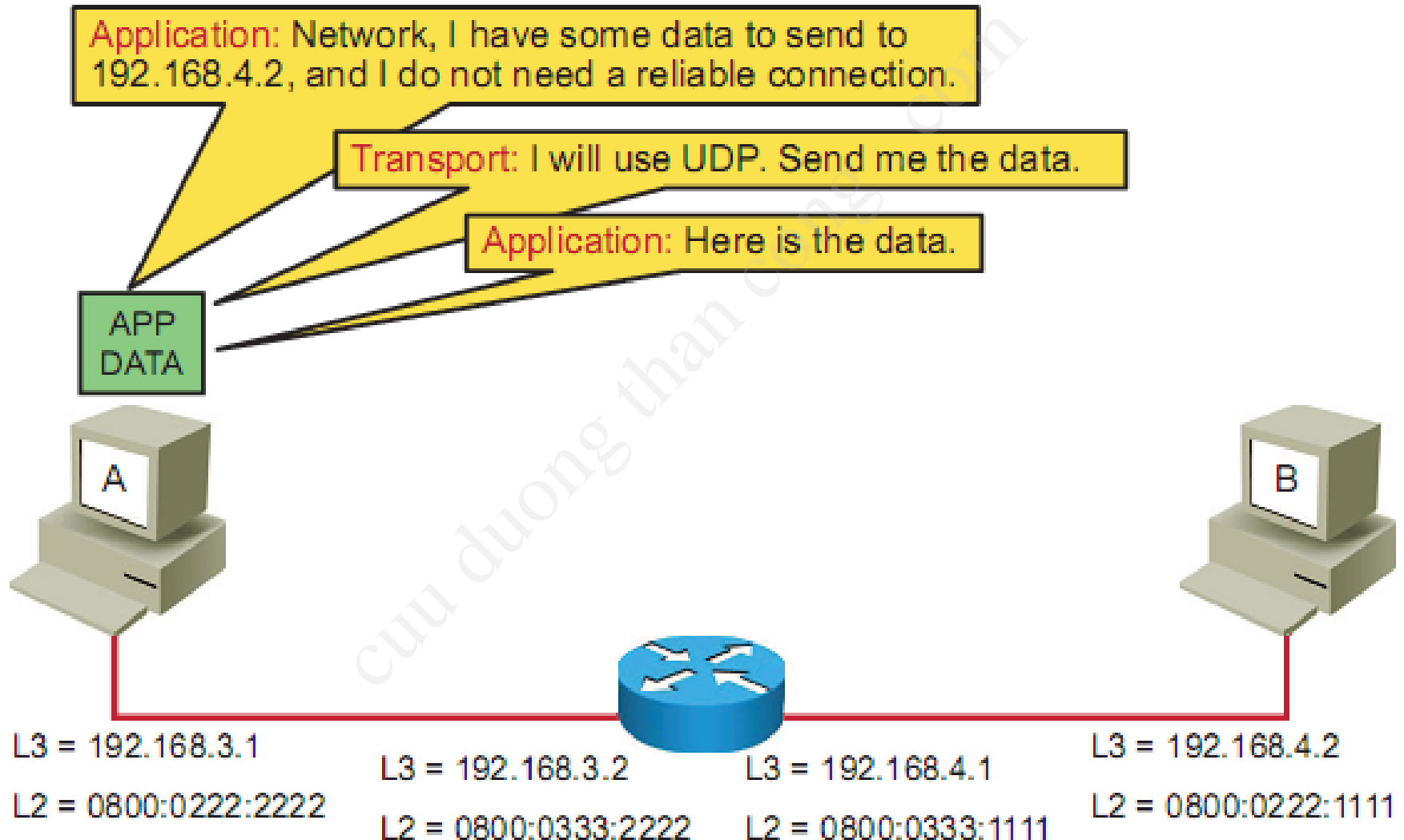
Routing Table

192.168.3.0/24	Interface Gi0/0
192.168.4.0/24	Interface Gi0/1

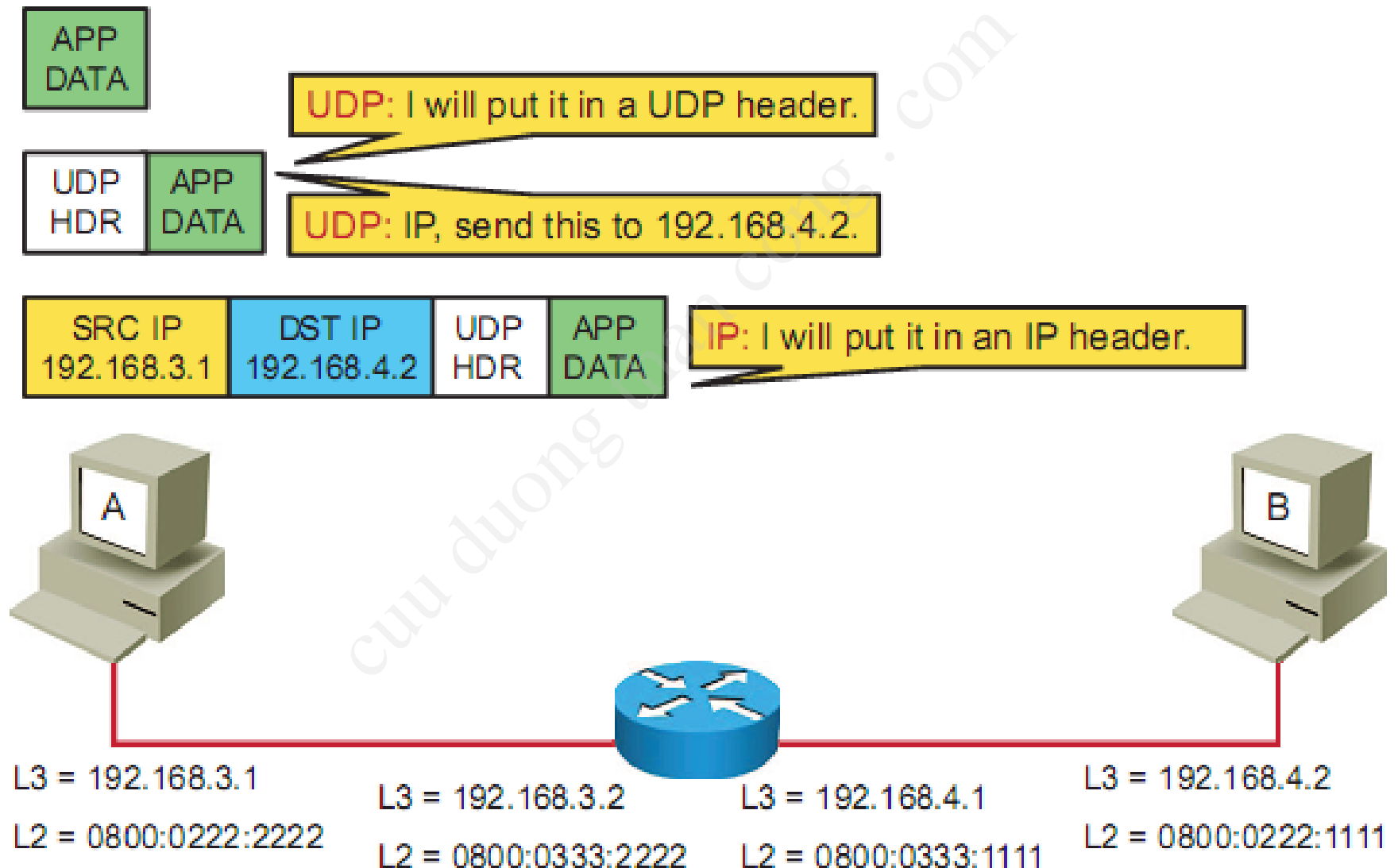


L3 = Layer 3

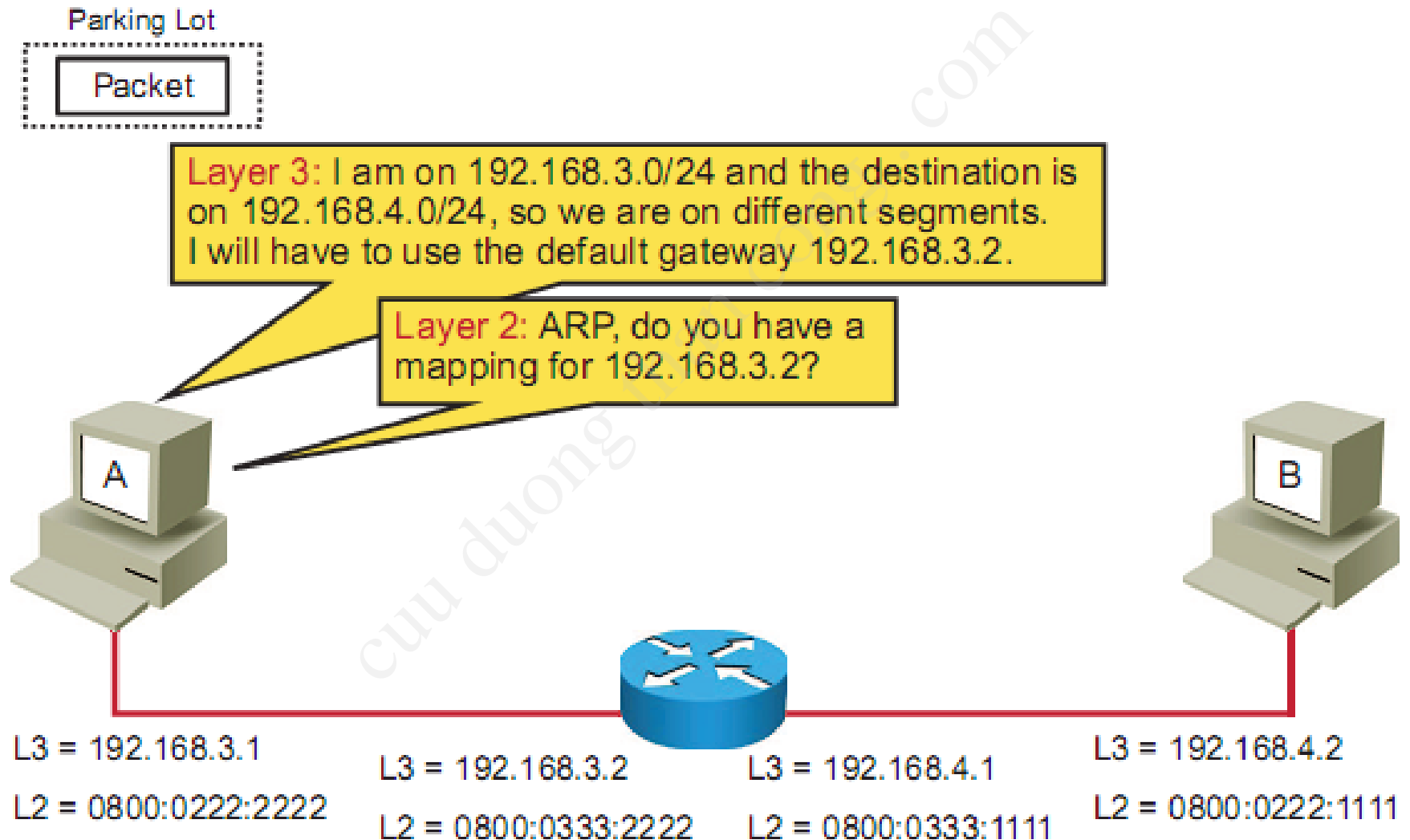
Host-to-Host Packet Delivery (Step 1 of 16)



Host-to-Host Packet Delivery (Step 2 of 16)



Host-to-Host Packet Delivery (Step 3 of 16)

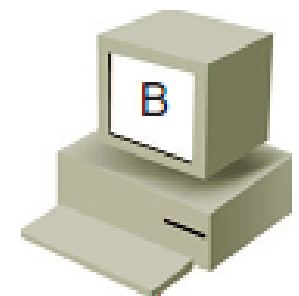
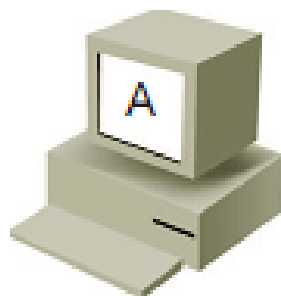


Host-to-Host Packet Delivery (Step 4 of 16)

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

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

SRC IP	DST IP	UDP HDR	APP DATA
192.168.3.1	192.168.4.2		



L3 = 192.168.3.1

L2 = 0800:0222:2222

L3 = 192.168.3.2

L2 = 0800:0333:2222

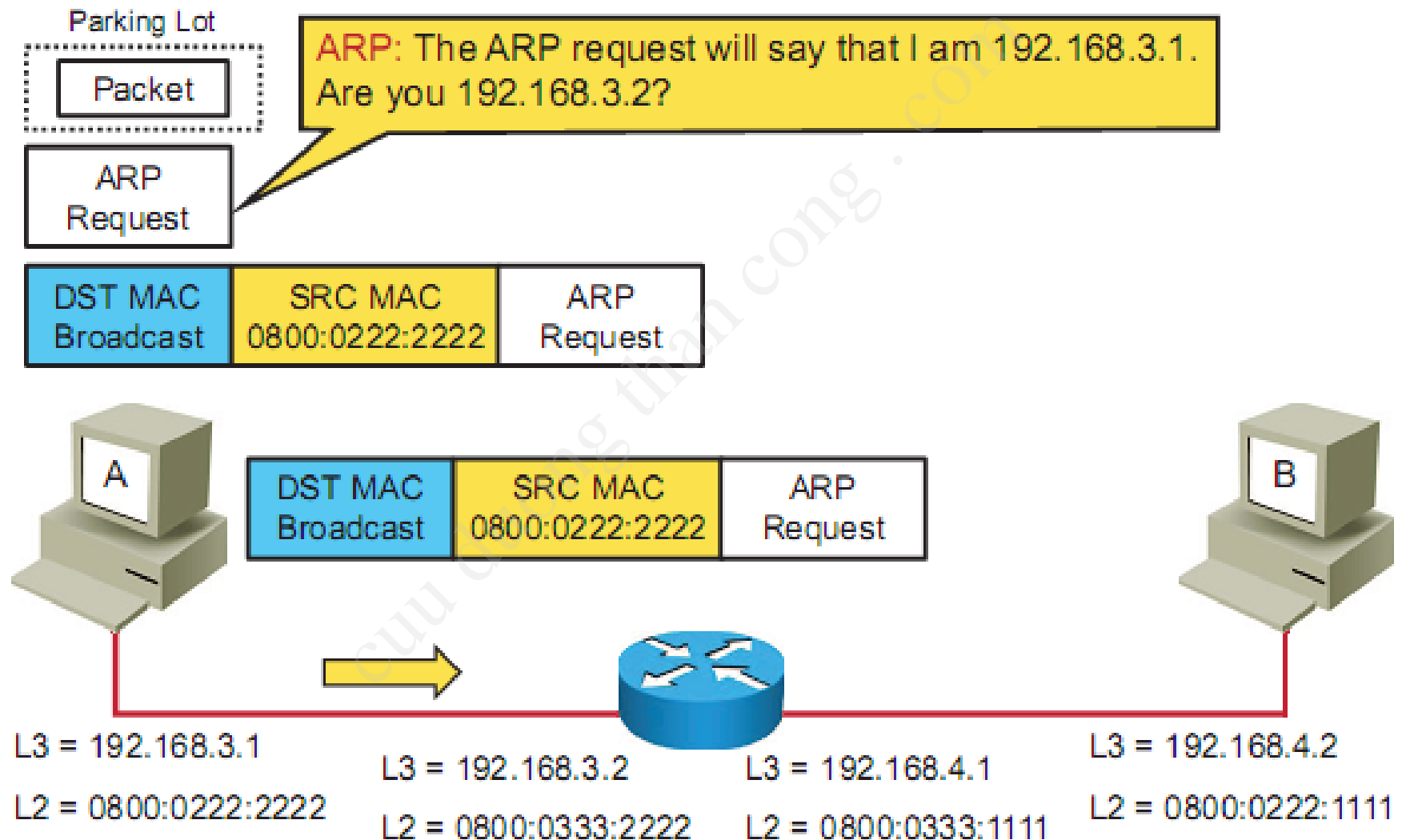
L3 = 192.168.4.1

L2 = 0800:0333:1111

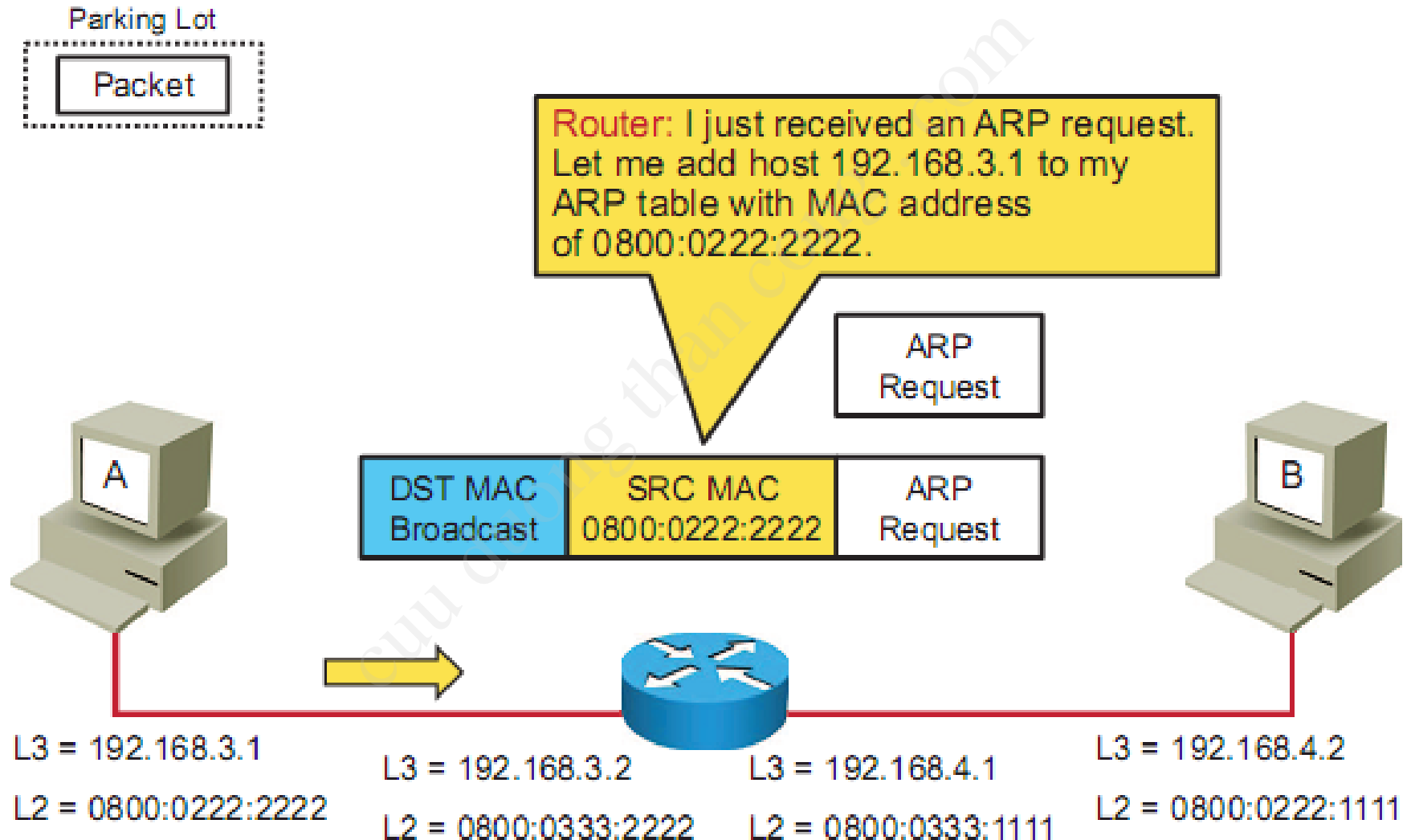
L3 = 192.168.4.2

L2 = 0800:0222:1111

Host-to-Host Packet Delivery (Step 5 of 16)



Host-to-Host Packet Delivery (Step 6 of 16)

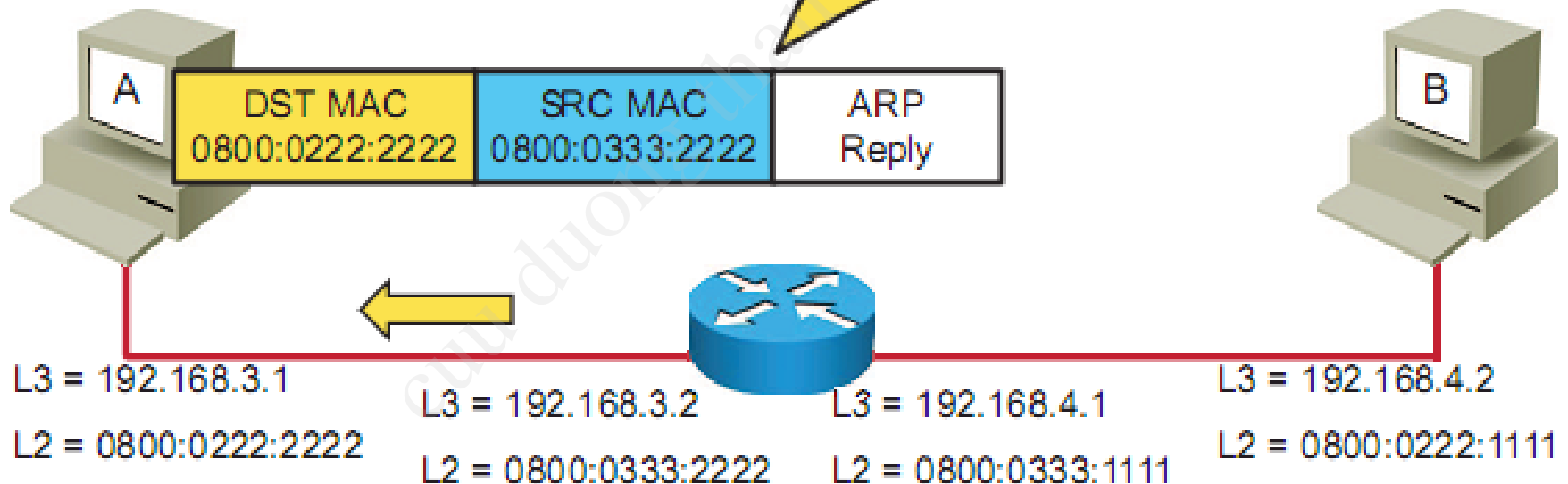


Host-to-Host Packet Delivery (Step 7 of 16)

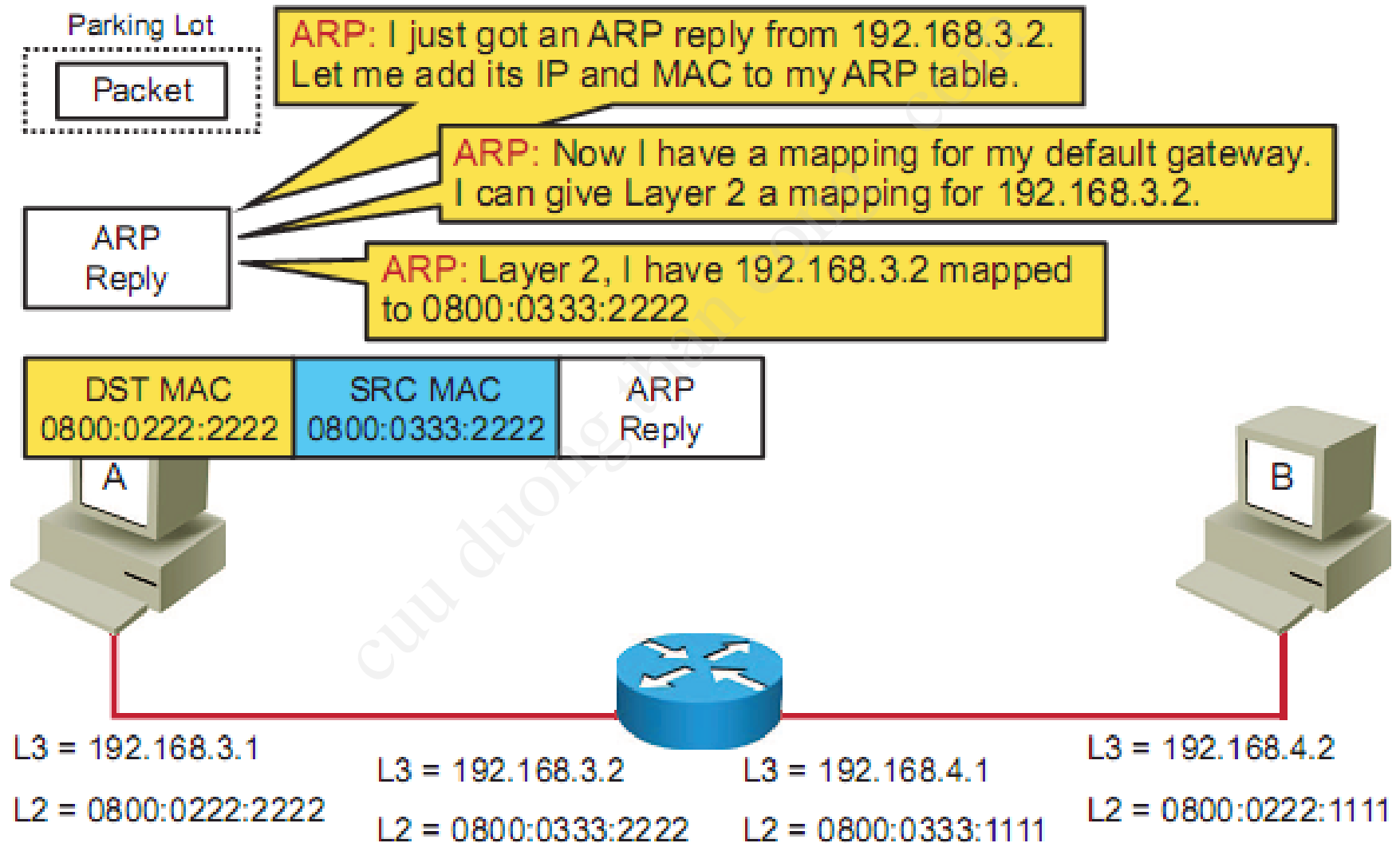
Parking Lot

Packet

Router: I will send an ARP reply that I am 192.168.3.2 with MAC address 0800:0333:2222.



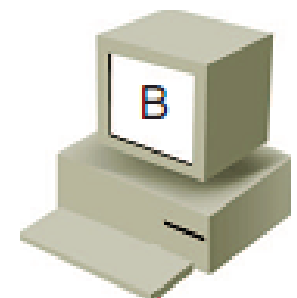
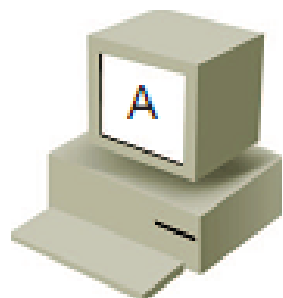
Host-to-Host Packet Delivery (Step 8 of 16)



Host-to-Host Packet Delivery (Step 9 of 16)

Layer 2: I can send out that pending frame.

APP DATA	UDP HDR	DST IP 192.168.4.2	SRC IP 192.168.3.1	SRC MAC 0800:0222:2222	DST MAC 0800:0333:2222
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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

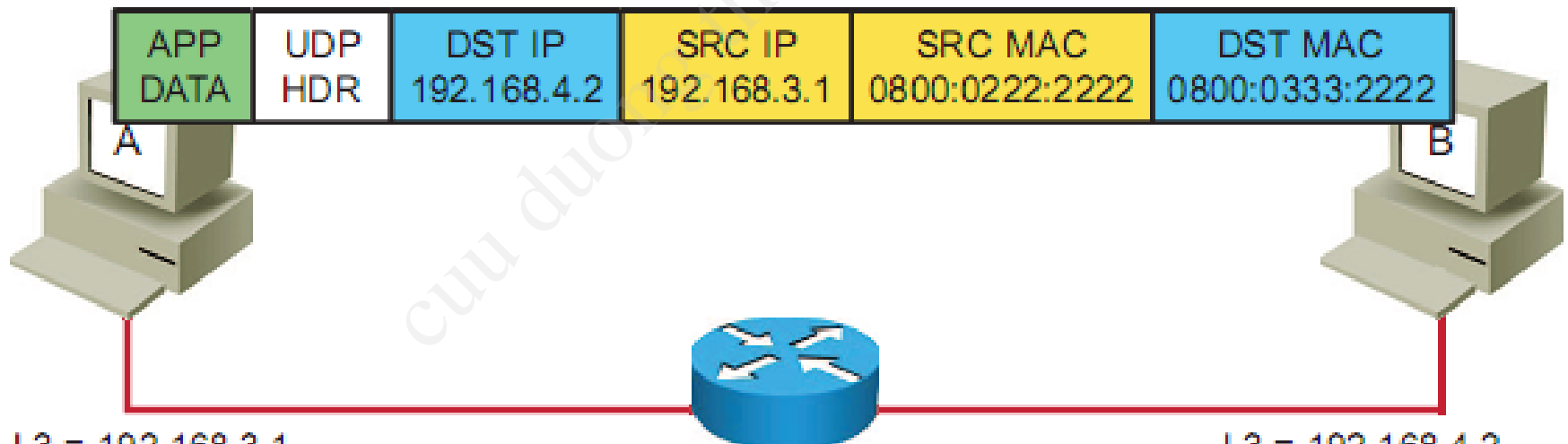
L3 = 192.168.4.2
L2 = 0800:0222:1111

Host-to-Host Packet Delivery (Step 10 of 16)

Router L2: I received a frame with my MAC address. I need to pass it to L3.

Router L3: This is not my address. It needs to be routed.

Router L3: I need to forward this packet.



L3 = 192.168.3.1

L3 = 192.168.3.2

L3 = 192.168.4.1

L3 = 192.168.4.2

L2 = 0800:0222:2222

L2 = 0800:0333:2222

L2 = 0800:0333:1111

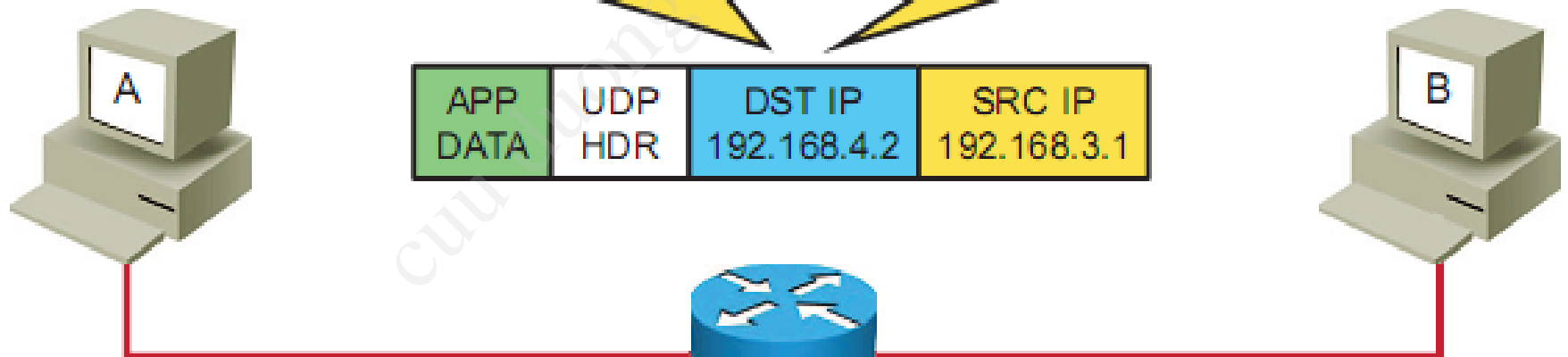
L2 = 0800:0222:1111

Host-to-Host Packet Delivery (Step 11 of 16)

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

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

Router L3: L2, send this packet.



L3 = 192.168.3.1

L2 = 0800:0222:2222

L3 = 192.168.3.2

L2 = 0800:0333:2222

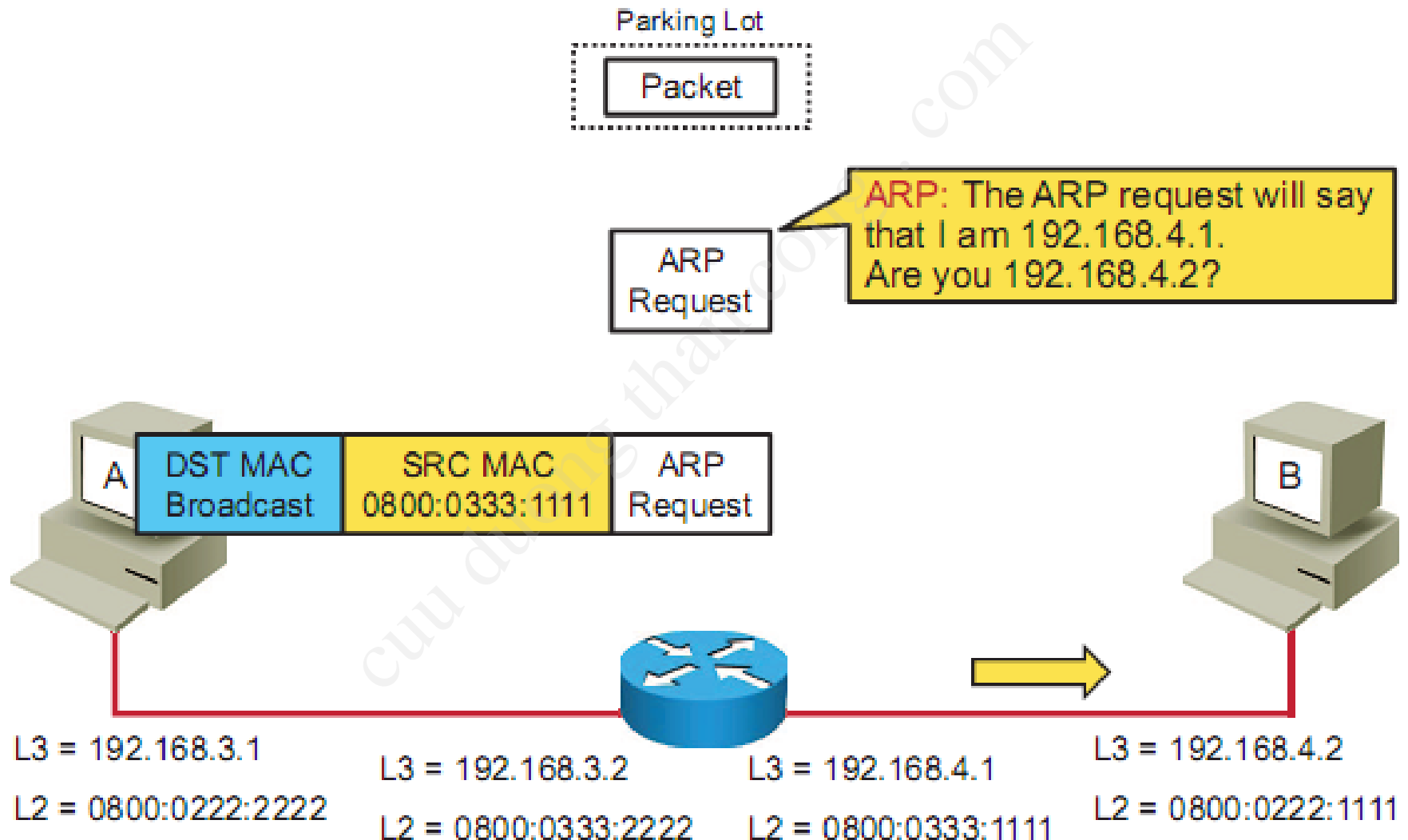
L3 = 192.168.4.1

L2 = 0800:0333:1111

L3 = 192.168.4.2

L2 = 0800:0222:1111

Host-to-Host Packet Delivery (Step 12 of 16)



Host-to-Host Packet Delivery (Step 13 of 16)

Parking Lot

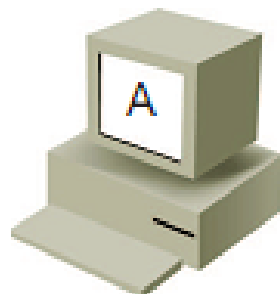
Packet

ARP Request

DST MAC
Broadcast

SRC MAC
0800:0333:1111

ARP Request

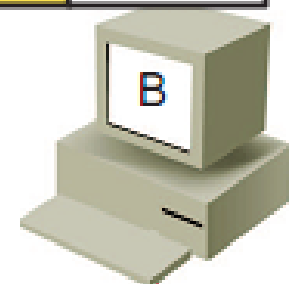


L3 = 192.168.3.1
L2 = 0800:0222:2222



L3 = 192.168.3.2
L2 = 0800:0333:2222

L3 = 192.168.4.1
L2 = 0800:0333:1111

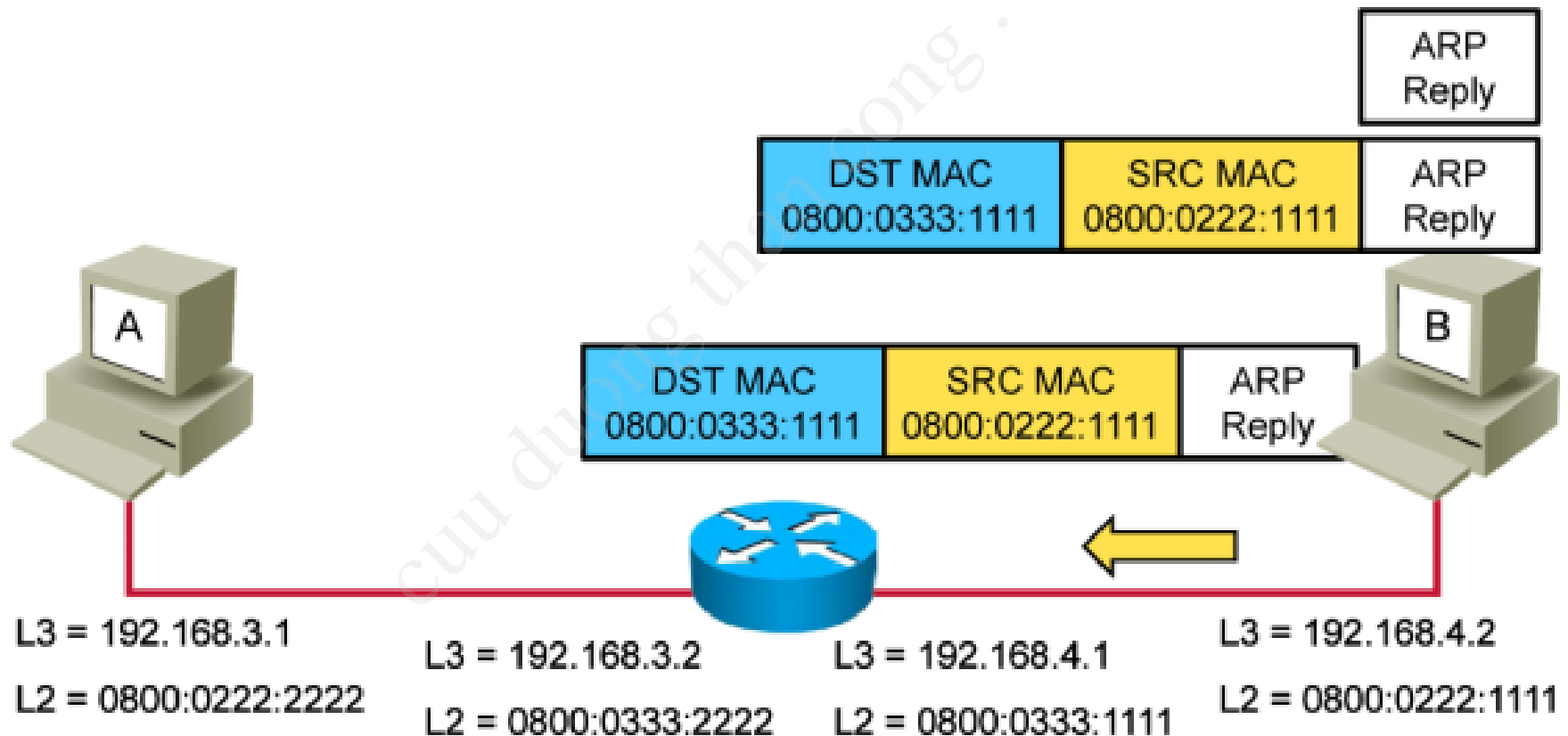


L3 = 192.168.4.2
L2 = 0800:0222:1111

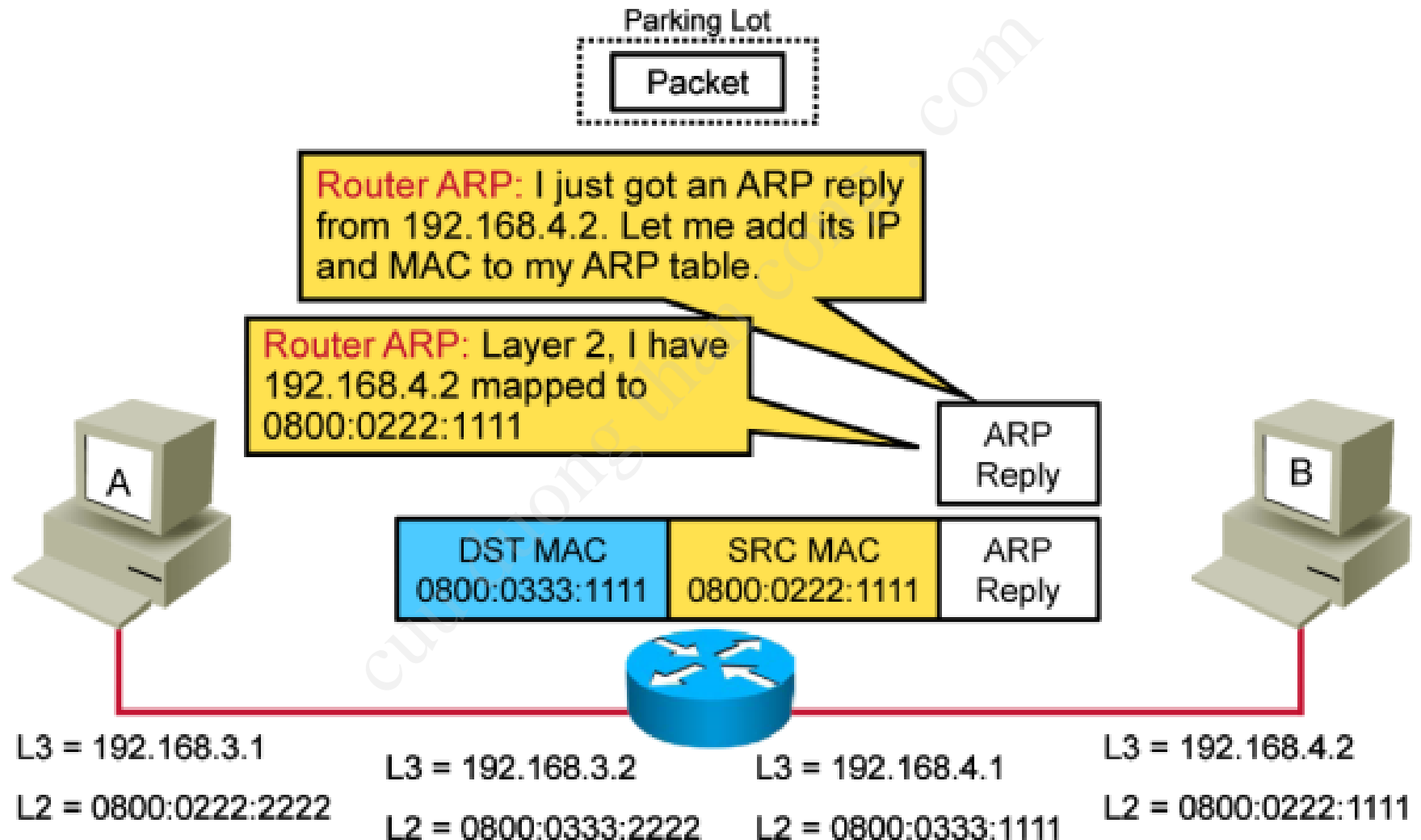
Host-to-Host Packet Delivery (Step 14 of 16)

Parking Lot

Packet

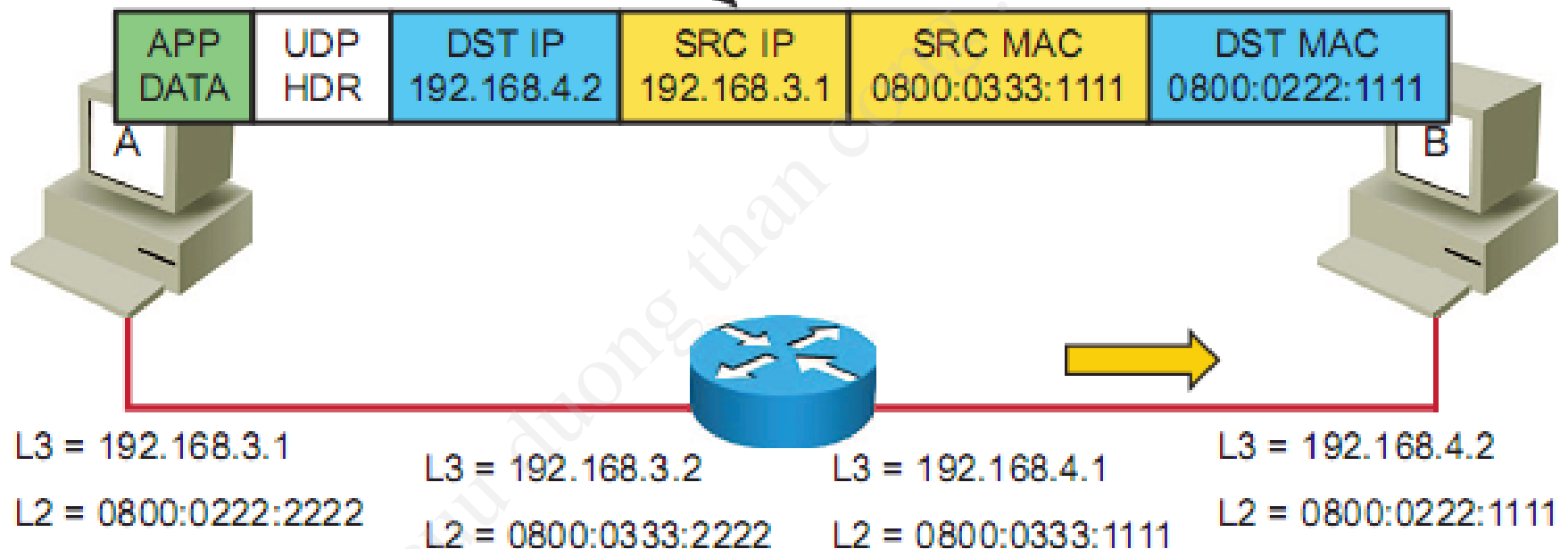


Host-to-Host Packet Delivery (Step 15 of 16)

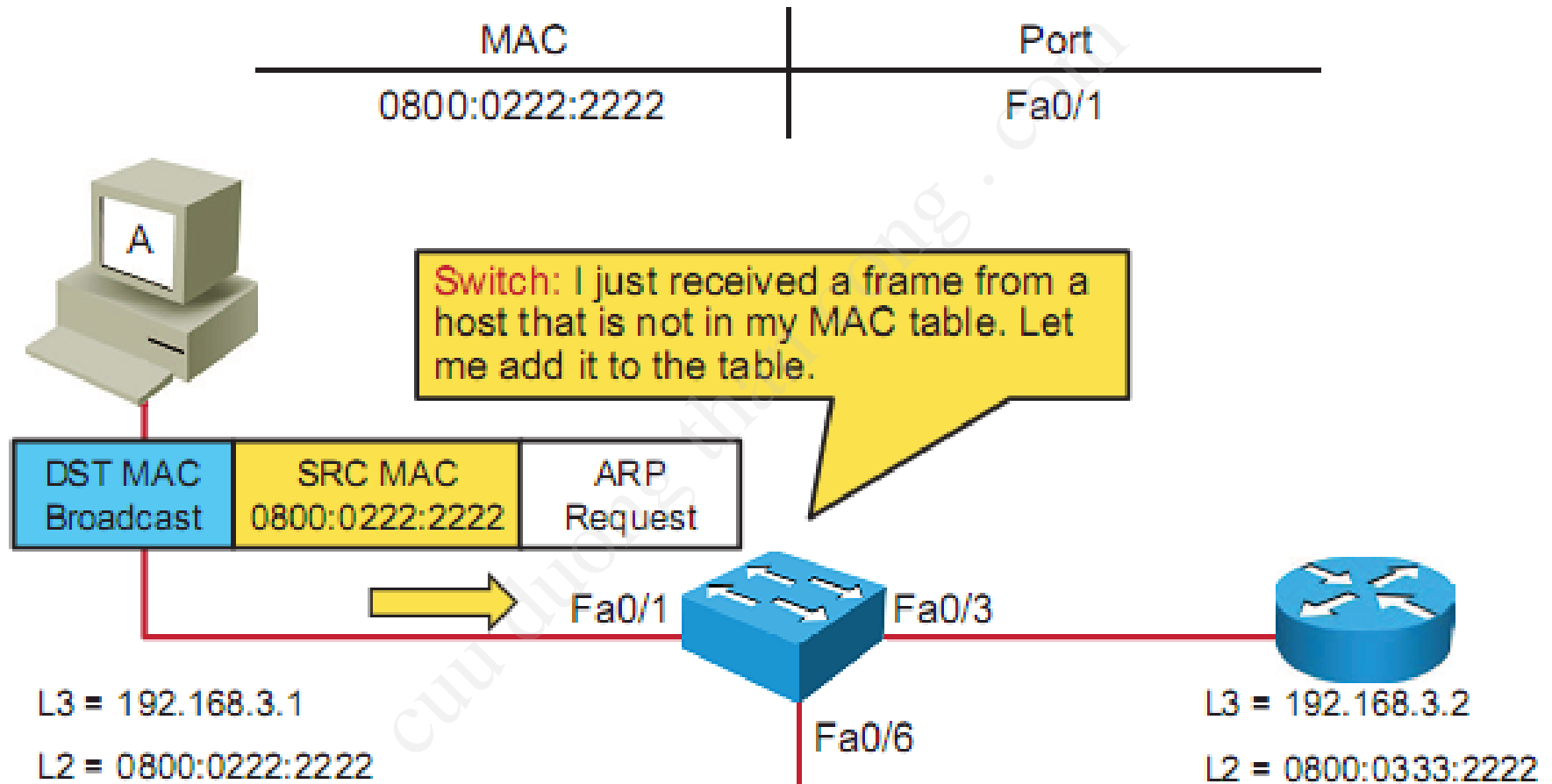


Host-to-Host Packet Delivery (Step 16 of 16)

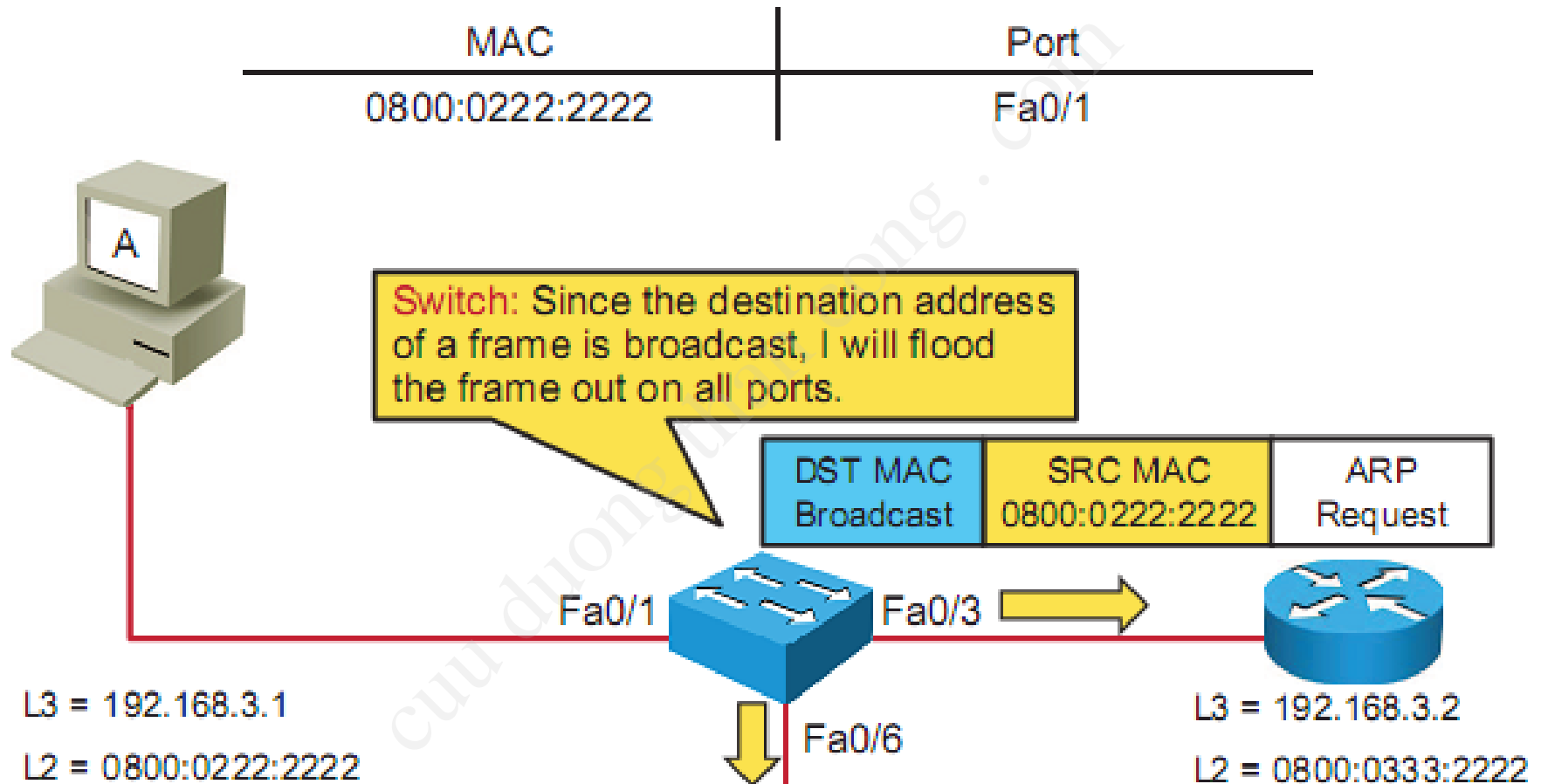
Router L2: I can send out that pending packet.



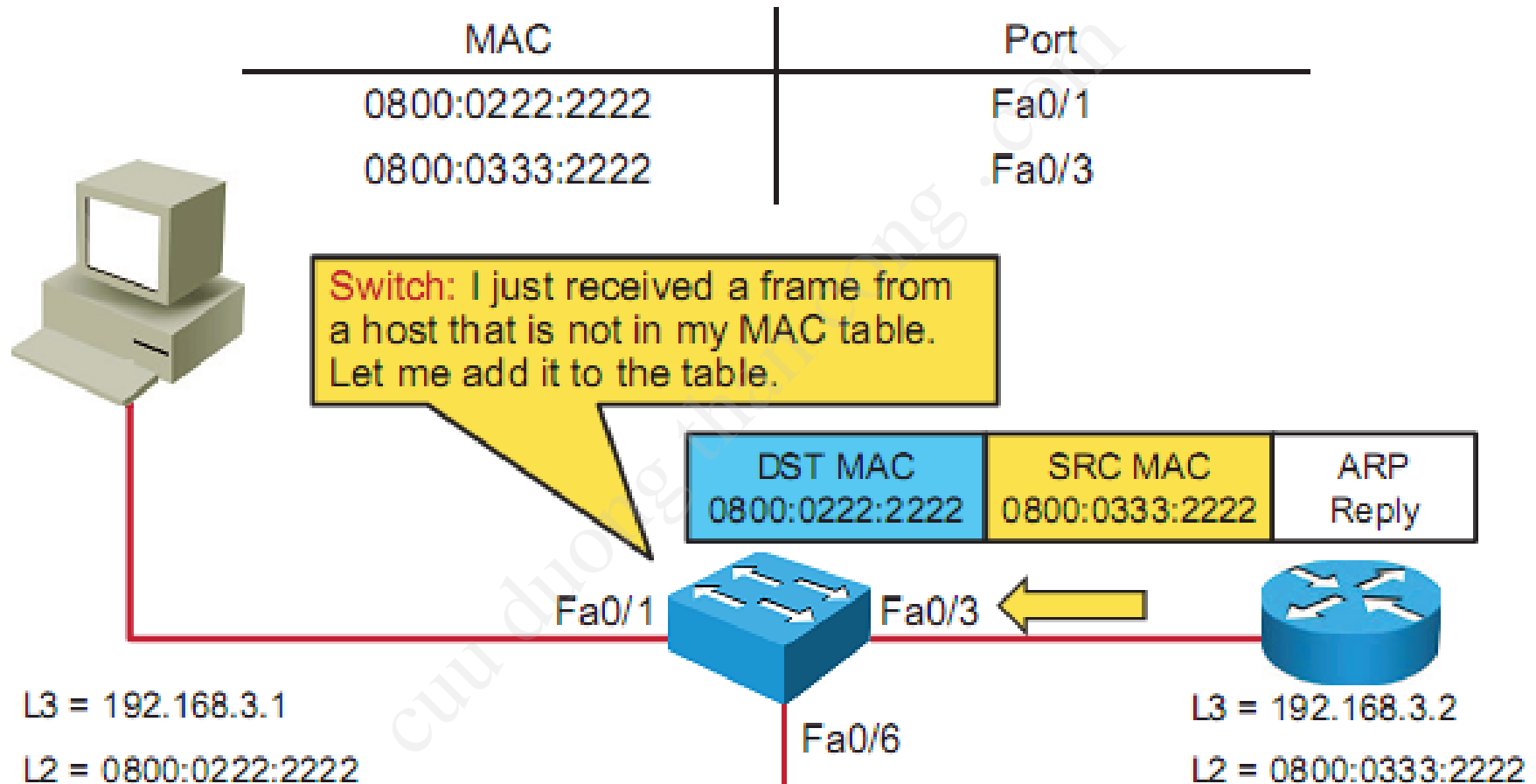
Role of a Switch in Packet Delivery (Step 1 of 4)



Role of a Switch in Packet Delivery (Step 2 of 4)



Role of a Switch in Packet Delivery (Step 3 of 4)



Role of a Switch in Packet Delivery (Step 4 of 4)

