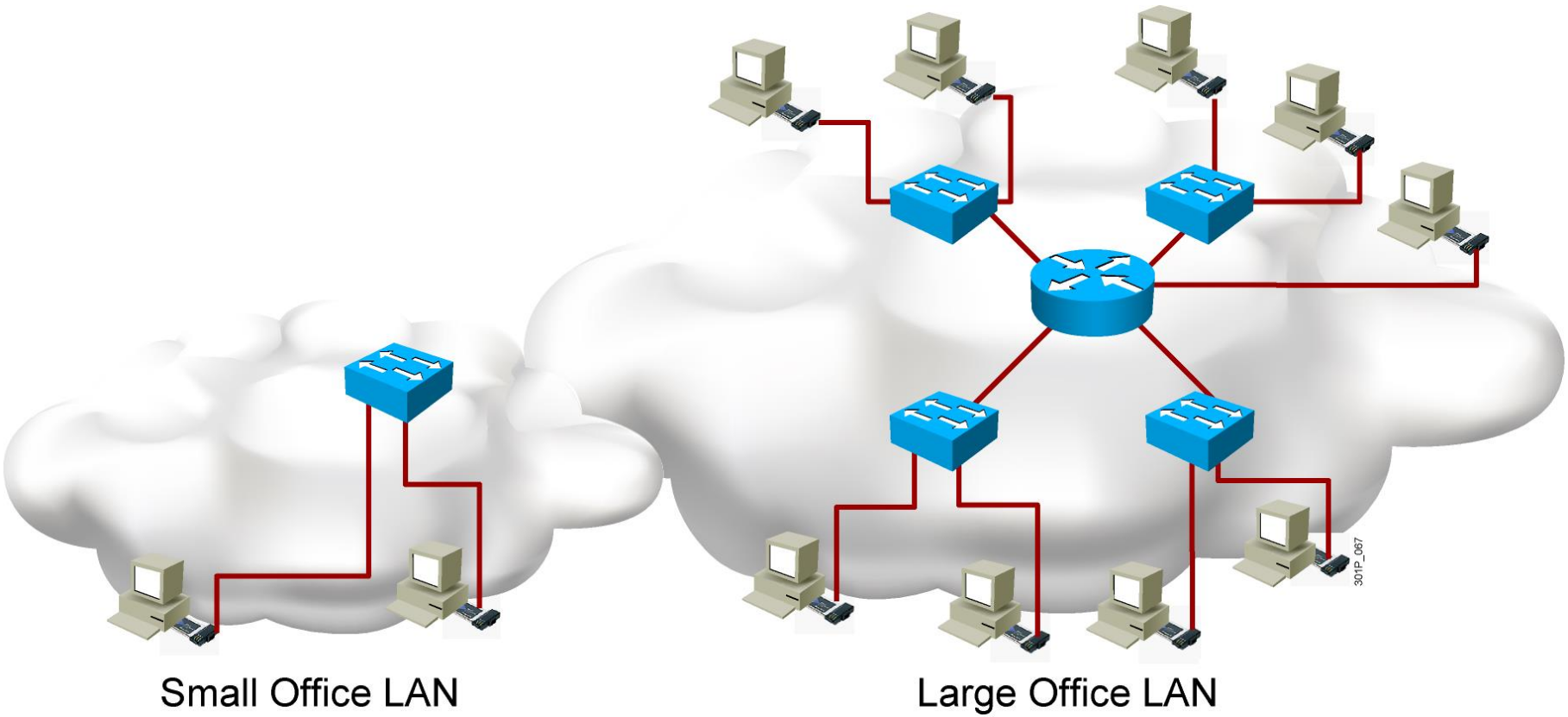
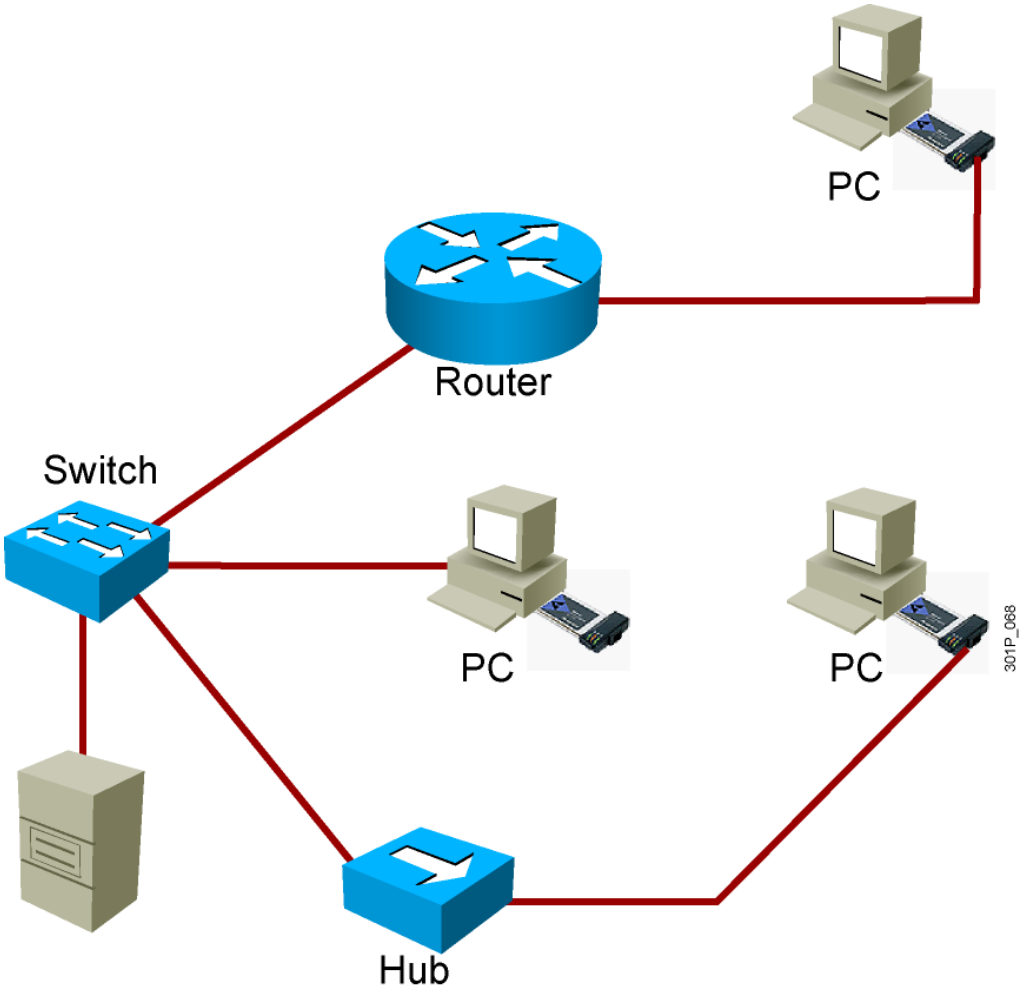
Understanding Ethernet

Local Area Network



LAN Components

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

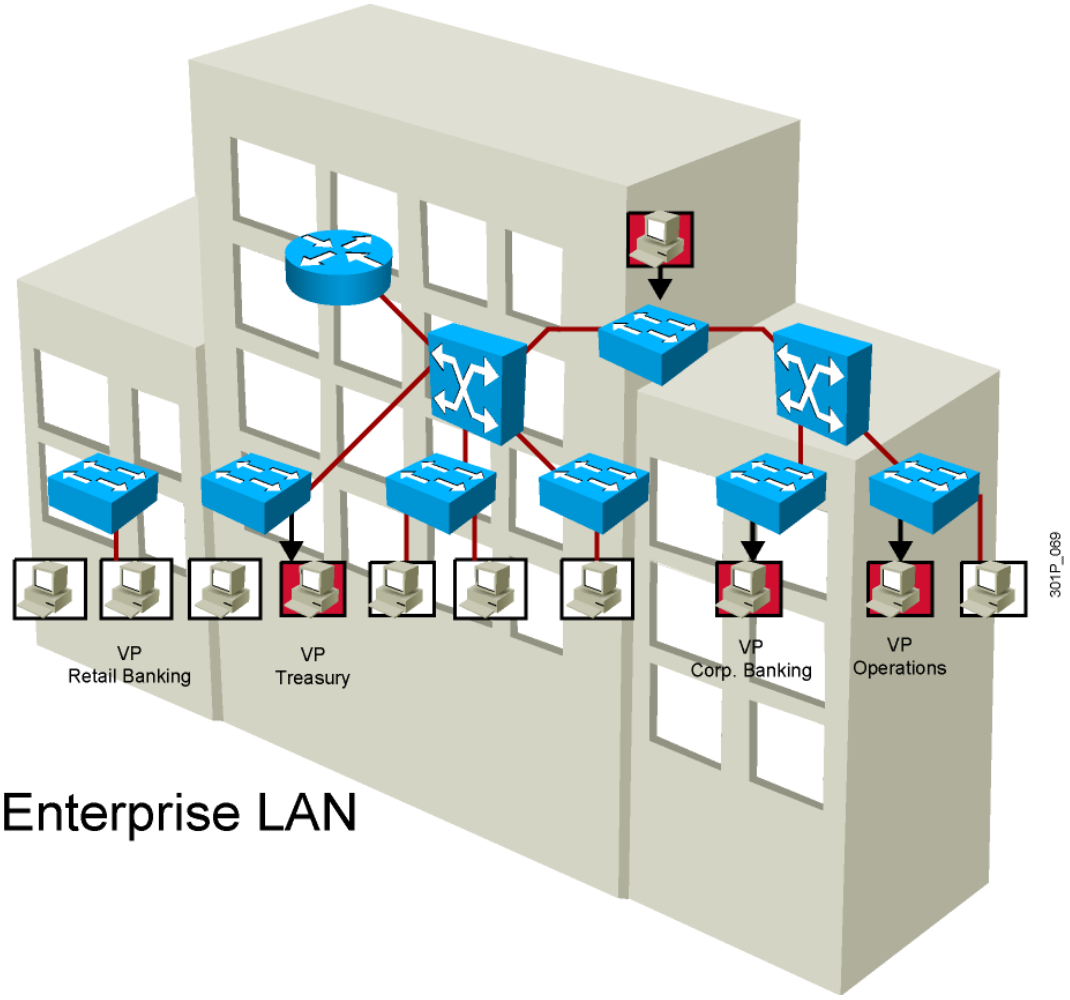


Functions of a LAN

- Data and applications
- Share resources
- Provide communication path to other networks

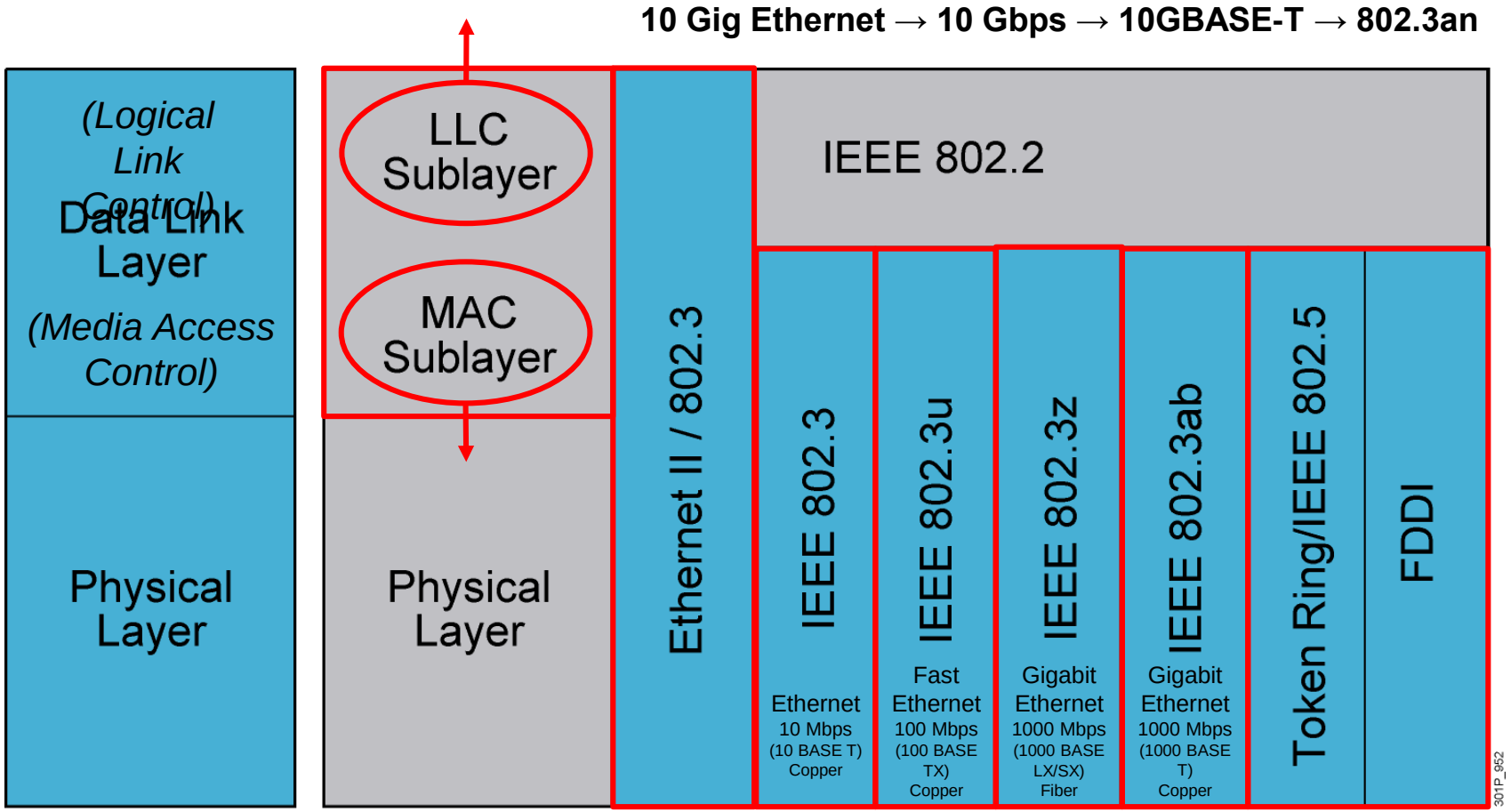
LAN Sizes

SOHO
LAN



Enterprise LAN

LAN Standards

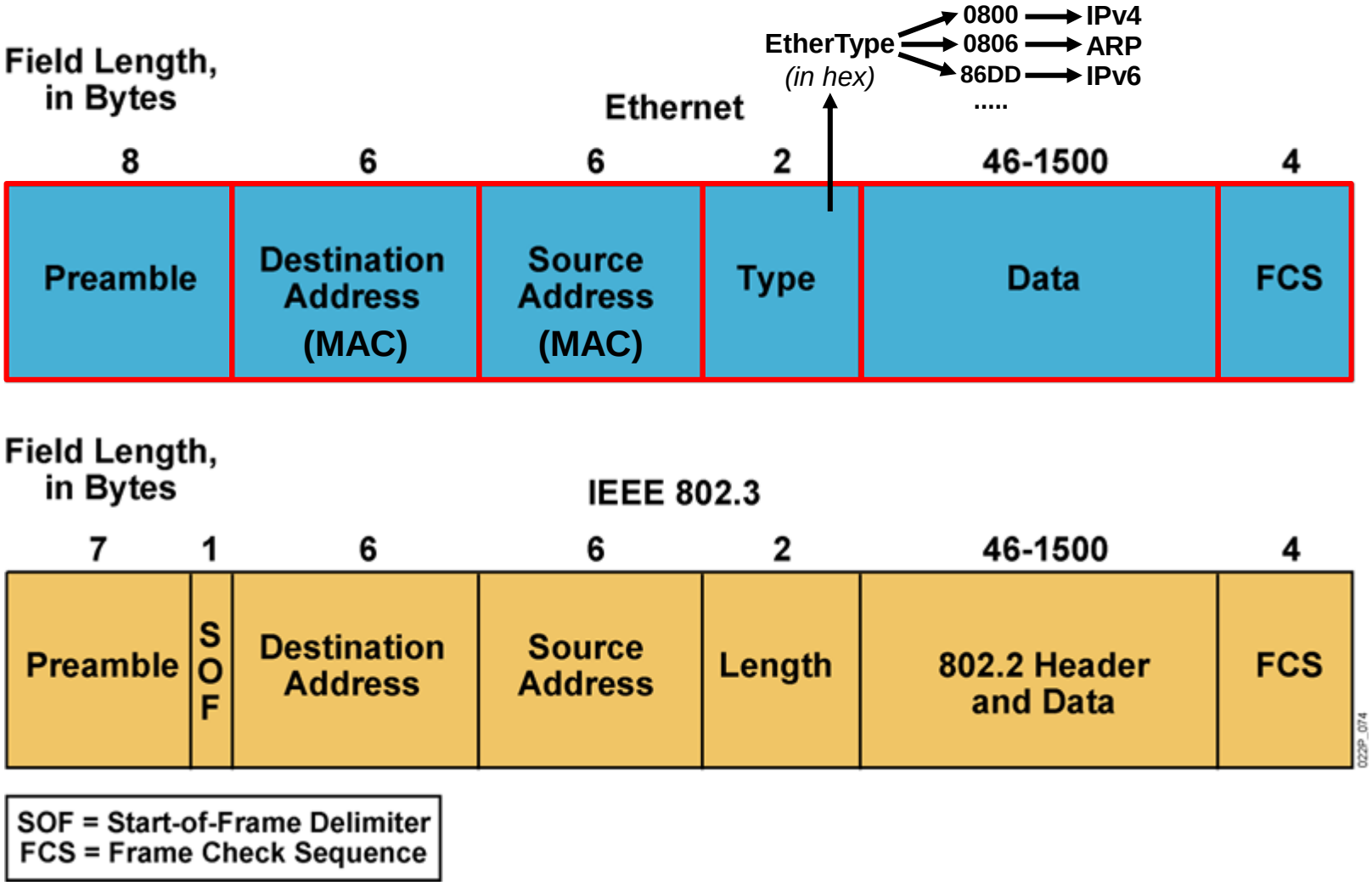


OSI Layers

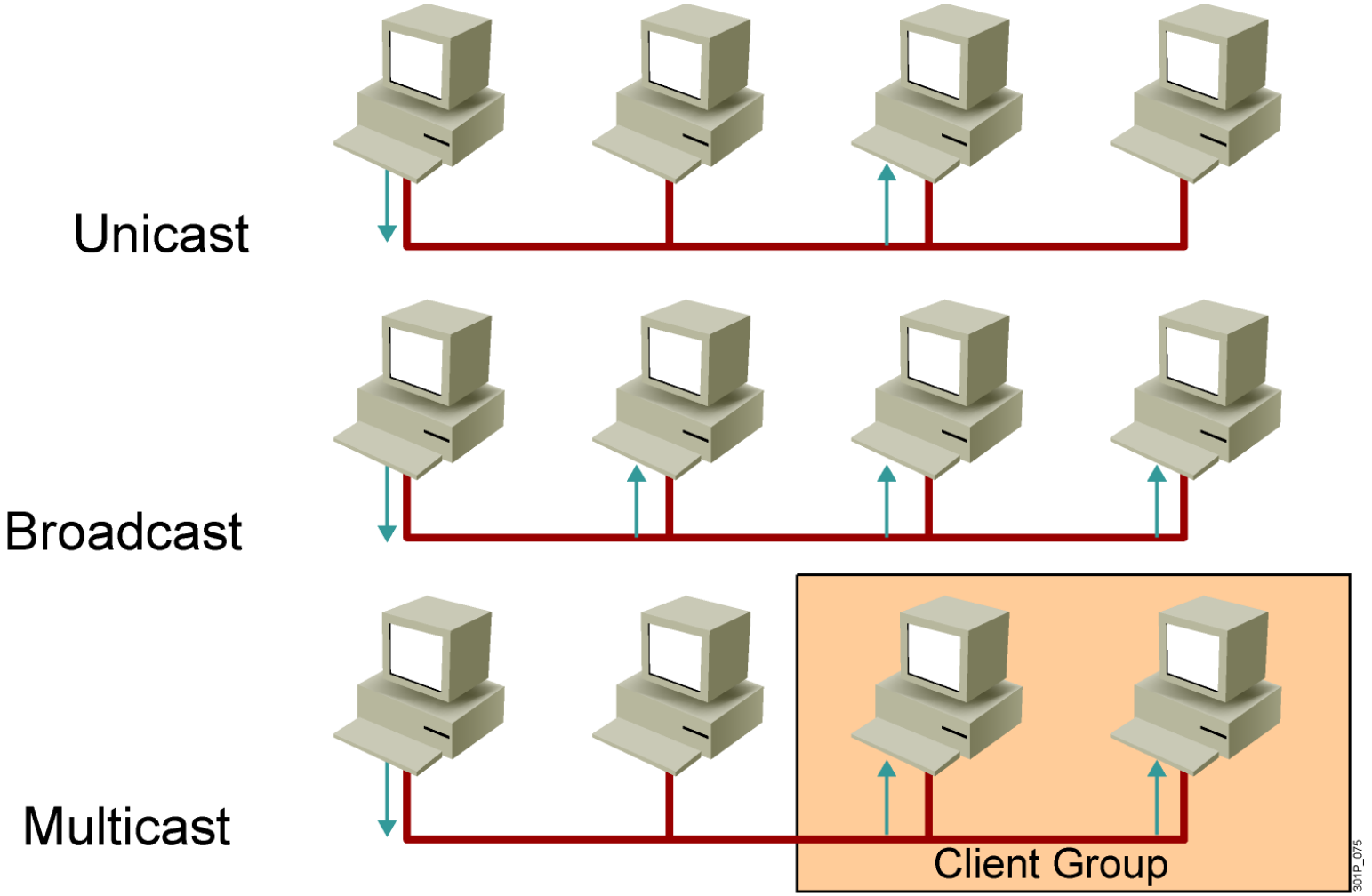
LAN Specification

IEEE (**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers)

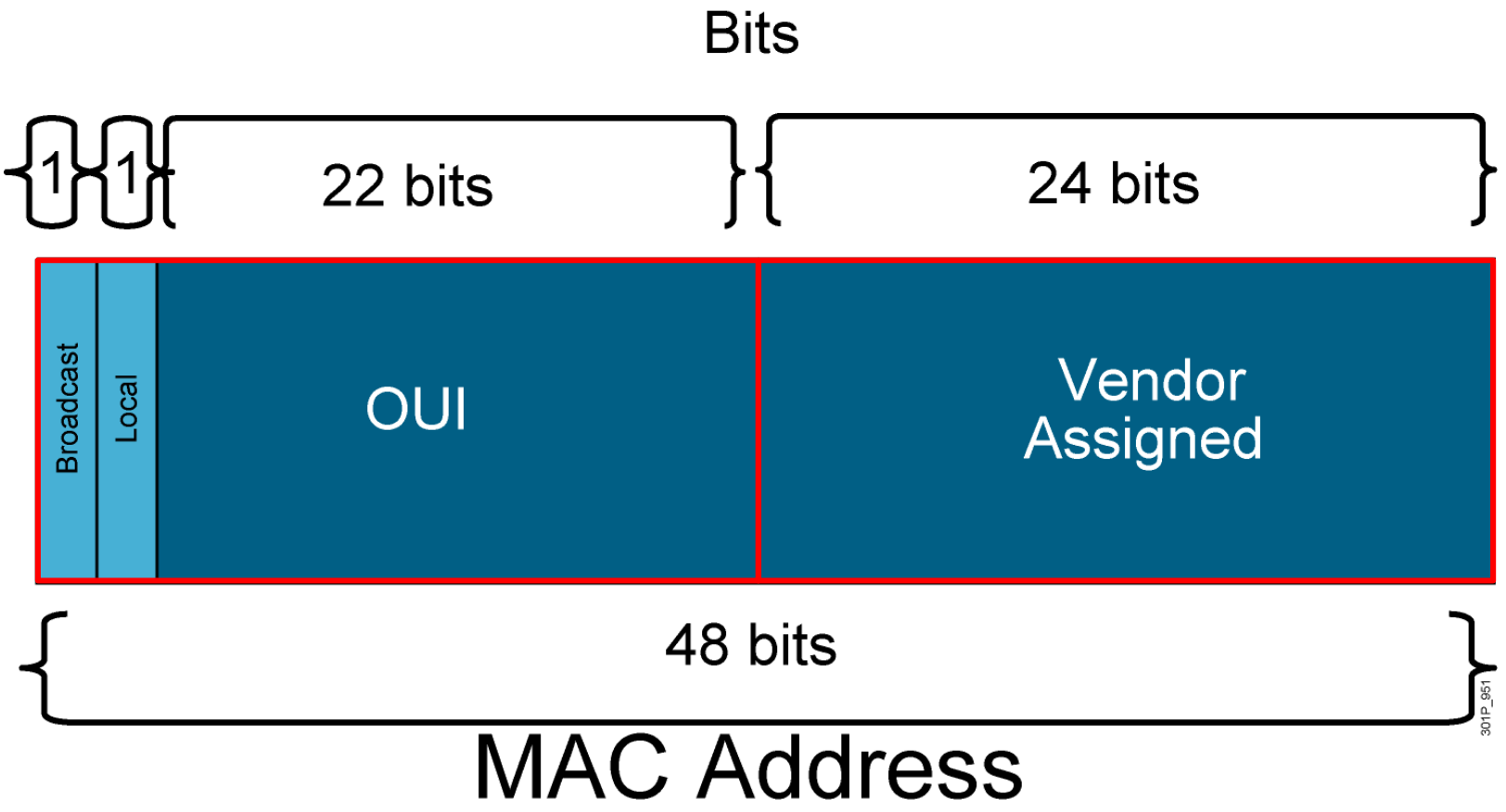
Ethernet Frame Structure



Communicating Within the LAN



MAC Address Components



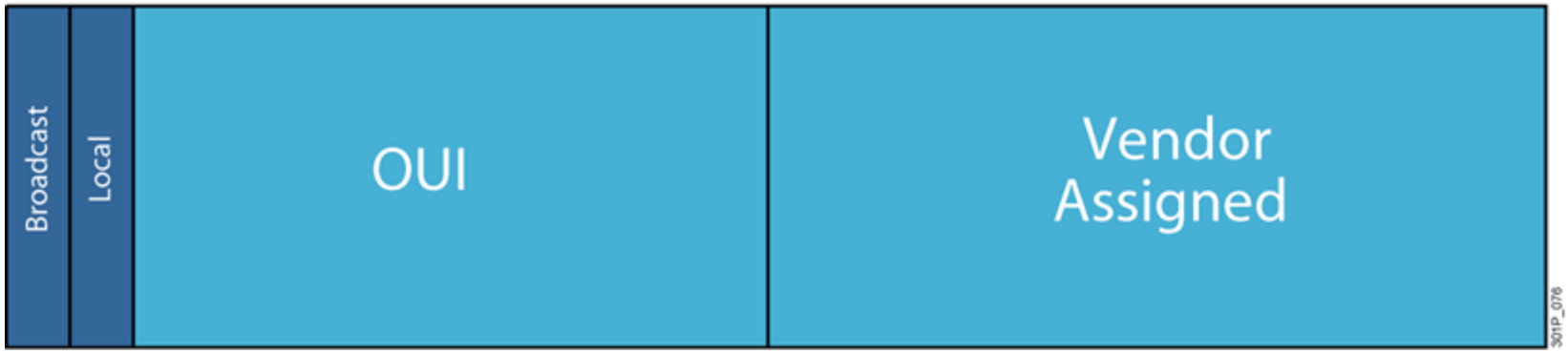
OUI: **O**rganizational **U**nique **I**dentifier

Decimal-Hexadecimal-Binary Conversion

Decimal (Base 10)	Hexadecimal (Base 16)	Binary (Base 2)
0	0	0 0 0 0
1	1	0 0 0 1
2	2	0 0 1 0
3	3	0 0 1 1
4	4	0 1 0 0
5	5	0 1 0 1
6	6	0 1 1 0
7	7	0 1 1 1
8	8	1 0 0 0
9	9	1 0 0 1
10	A	1 0 1 0
11	B	1 0 1 1
12	C	1 1 0 0
13	D	1 1 0 1
14	E	1 1 1 0
15	F	1 1 1 1

MAC Addresses

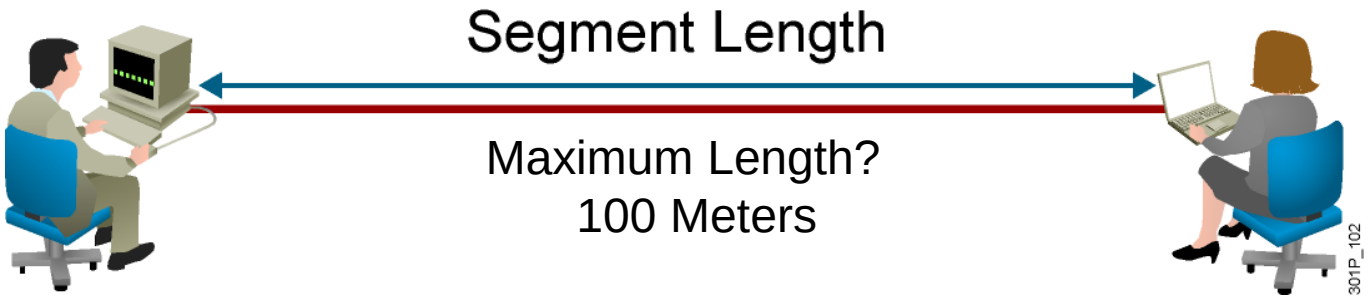
00:00:0c:43:2e:08



00-00-0c-43-2e-08 → **Windows, ...**

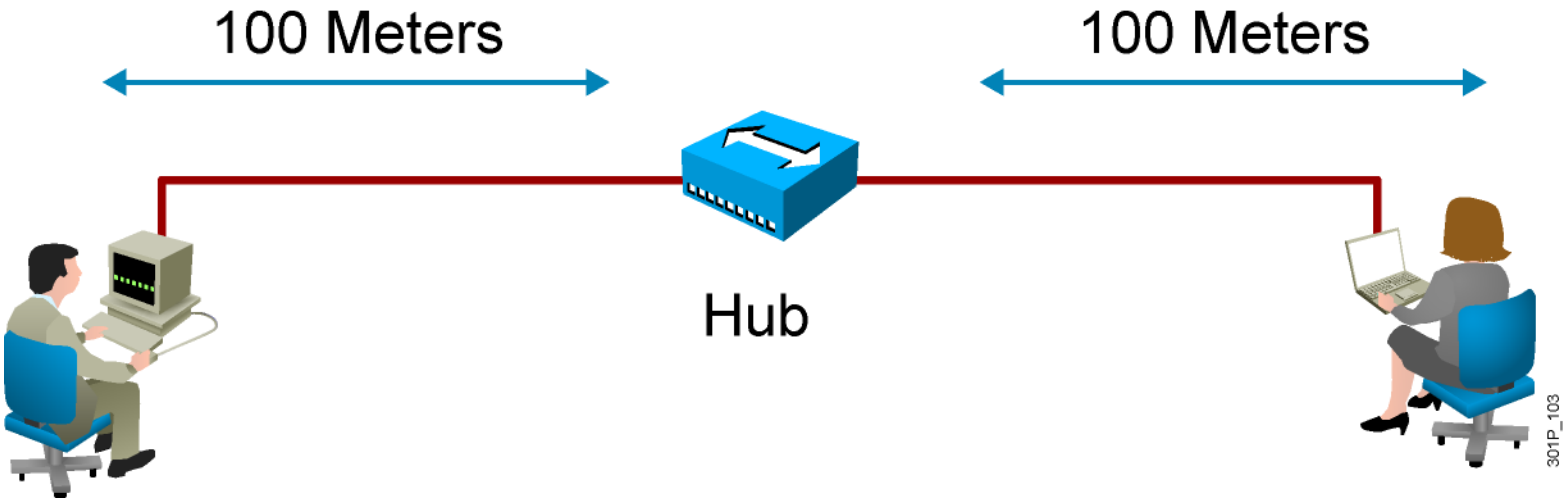
0000.0c43.2e08 → **Cisco Devices, ...**

LAN Segment Limitations



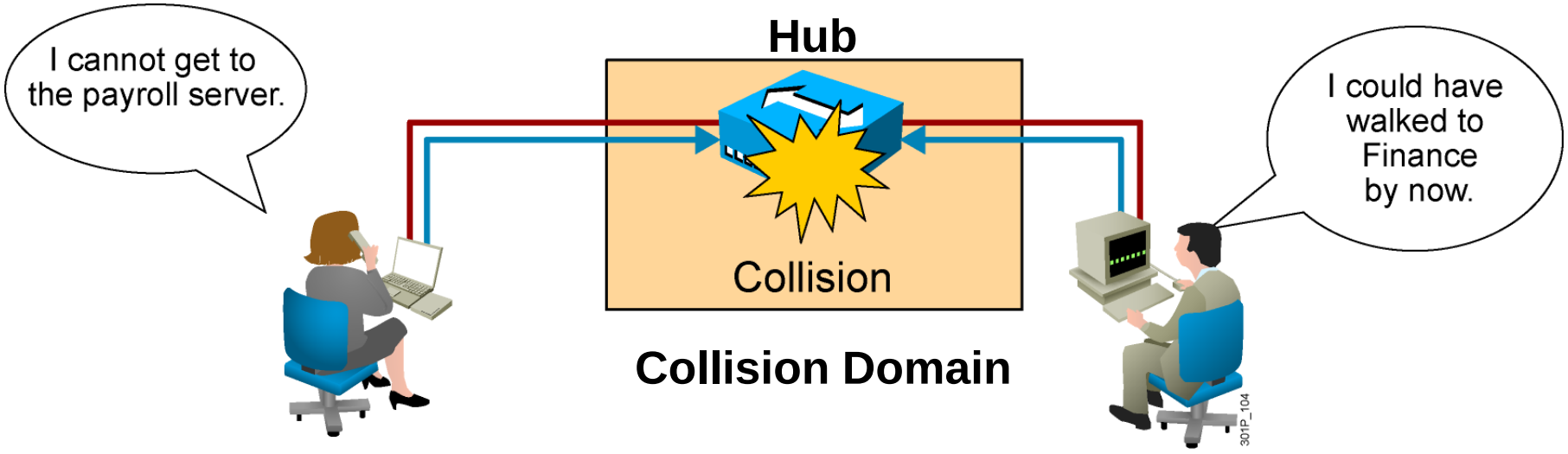
- Signals degrade with transmission distance.
- Each Ethernet type has a maximum segment length.

Extending LAN Segments

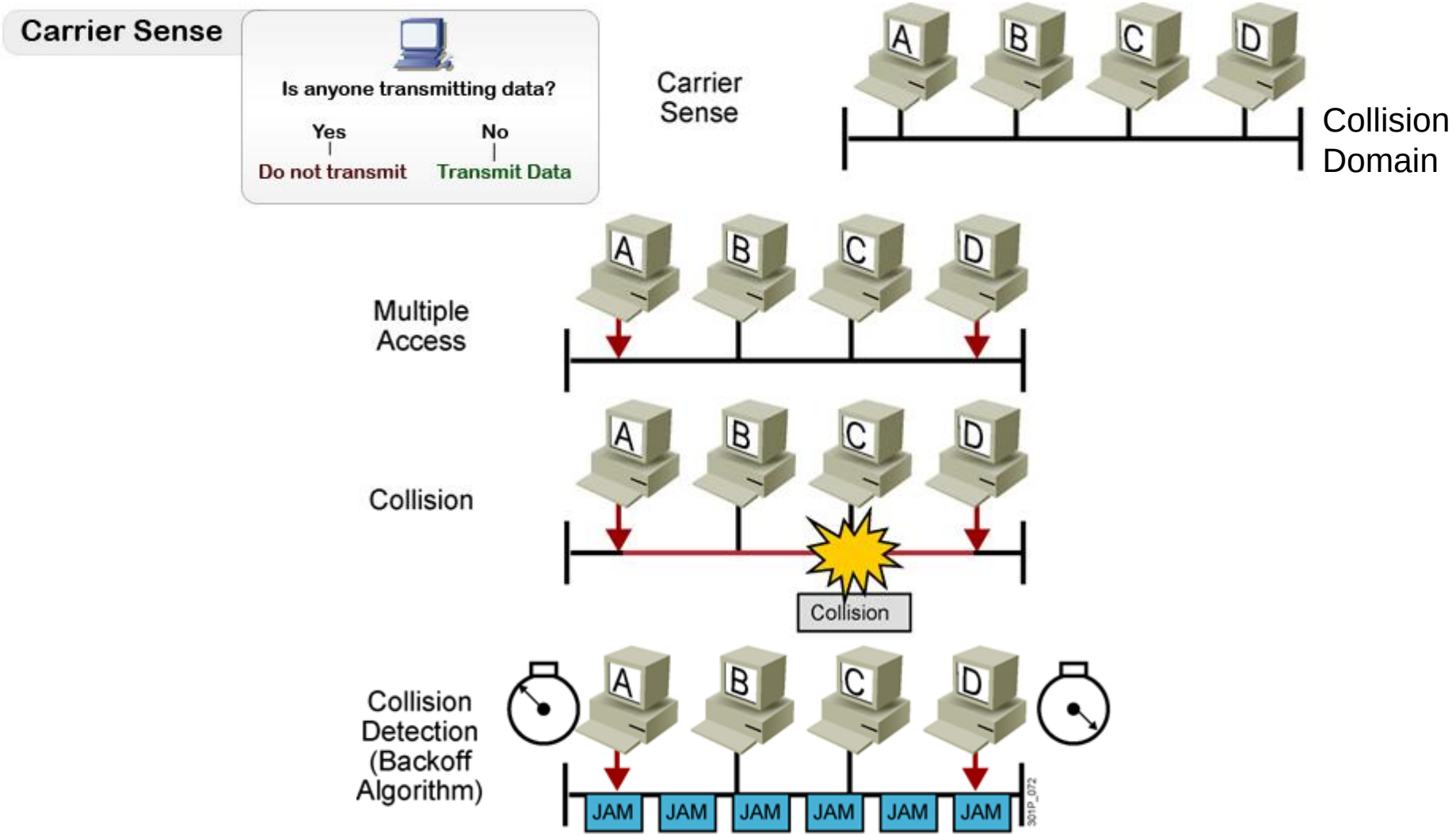


- Shares bandwidth
- Extends cable distances
- Repeats or amplifies signal
- Half-duplex

Collisions

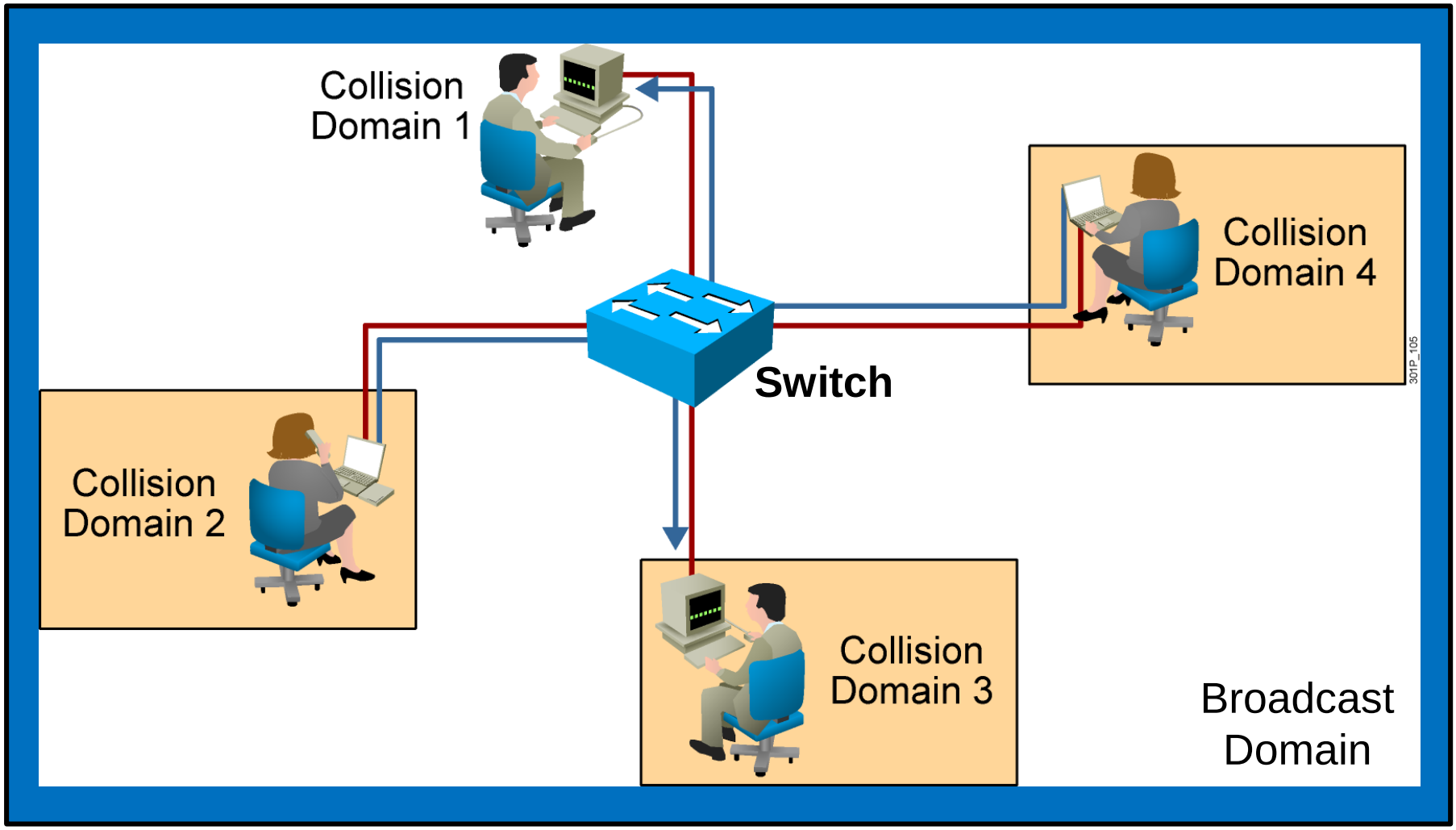

I cannot get to the payroll server.
Hub
Collision
Collision Domain
I could have walked to Finance by now.
301P_104

CSMA/CD

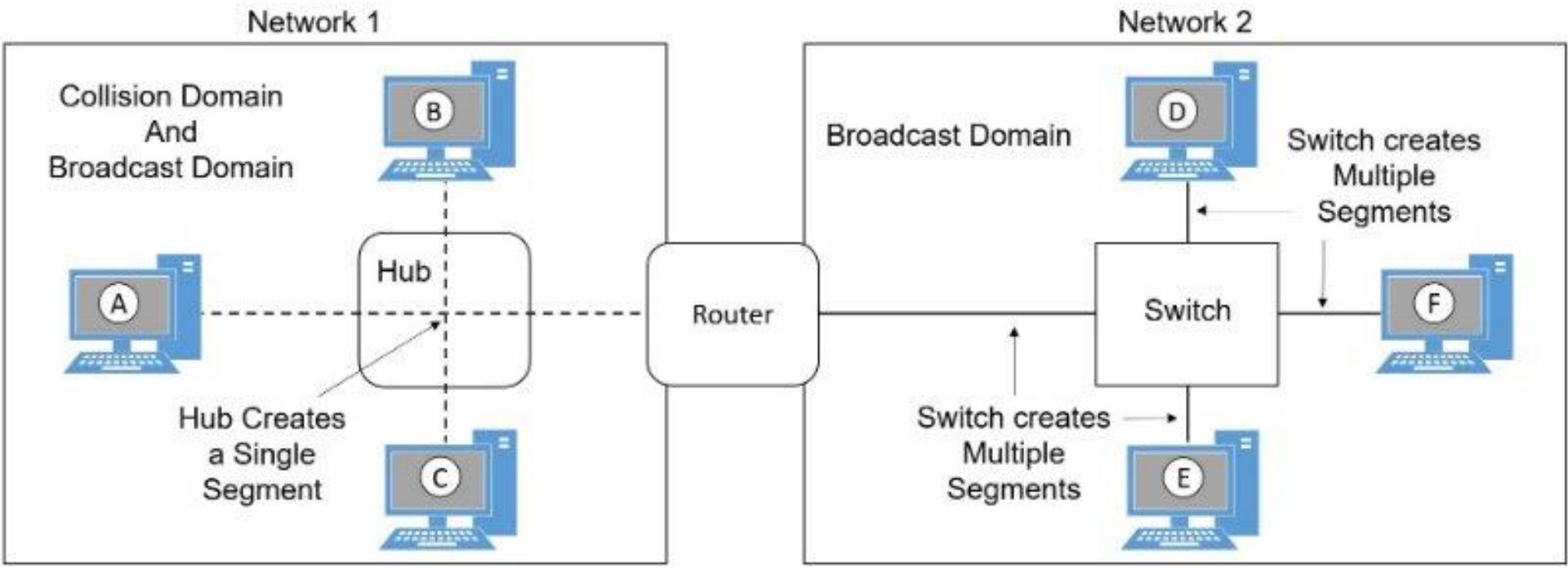


Carrier Sense Multiple Access Collision Detection (CSMA/CD)

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

Collision & Broadcast Domains (cont.)

This device:
- **Continues Collision Domains**
- **Continues Broadcast Domains**

Ethernet Hub

This device:
- **Ends Collision Domains**
- **Continues Broadcast Domains**

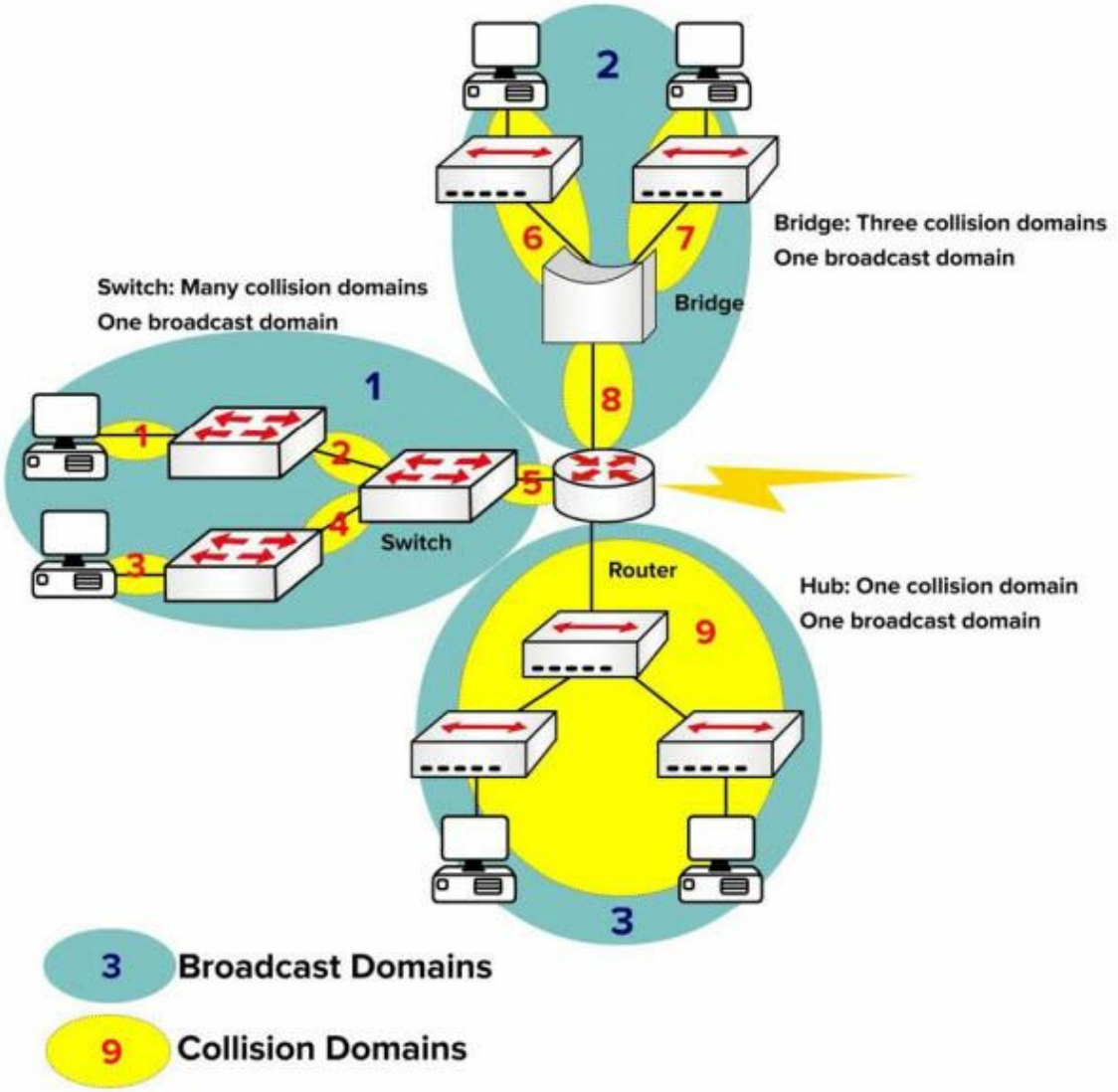
Ethernet Switch

These devices:
- **End Collision Domains**
- **End Broadcast Domains**

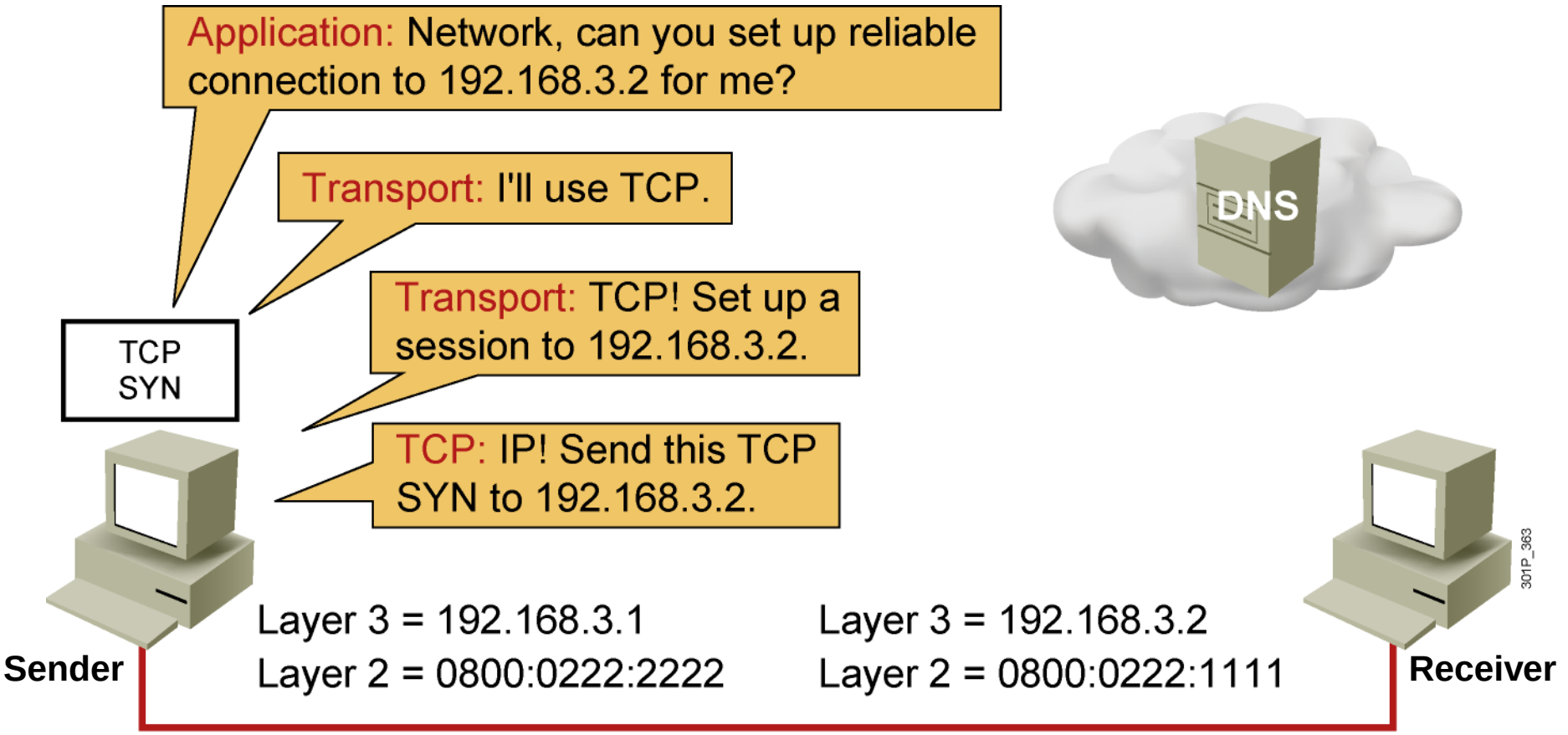
Router

Firewall

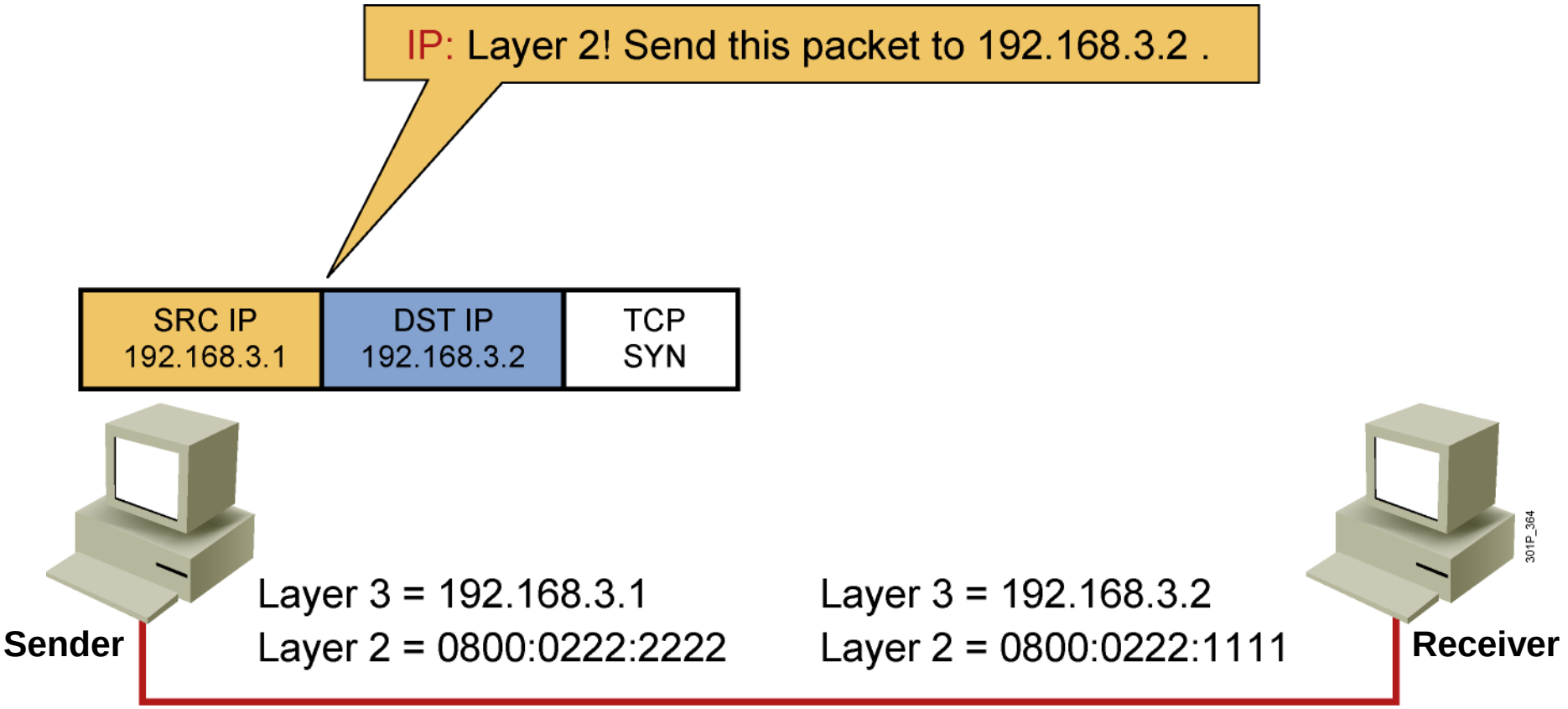
Collision & Broadcast Domains Counting Example



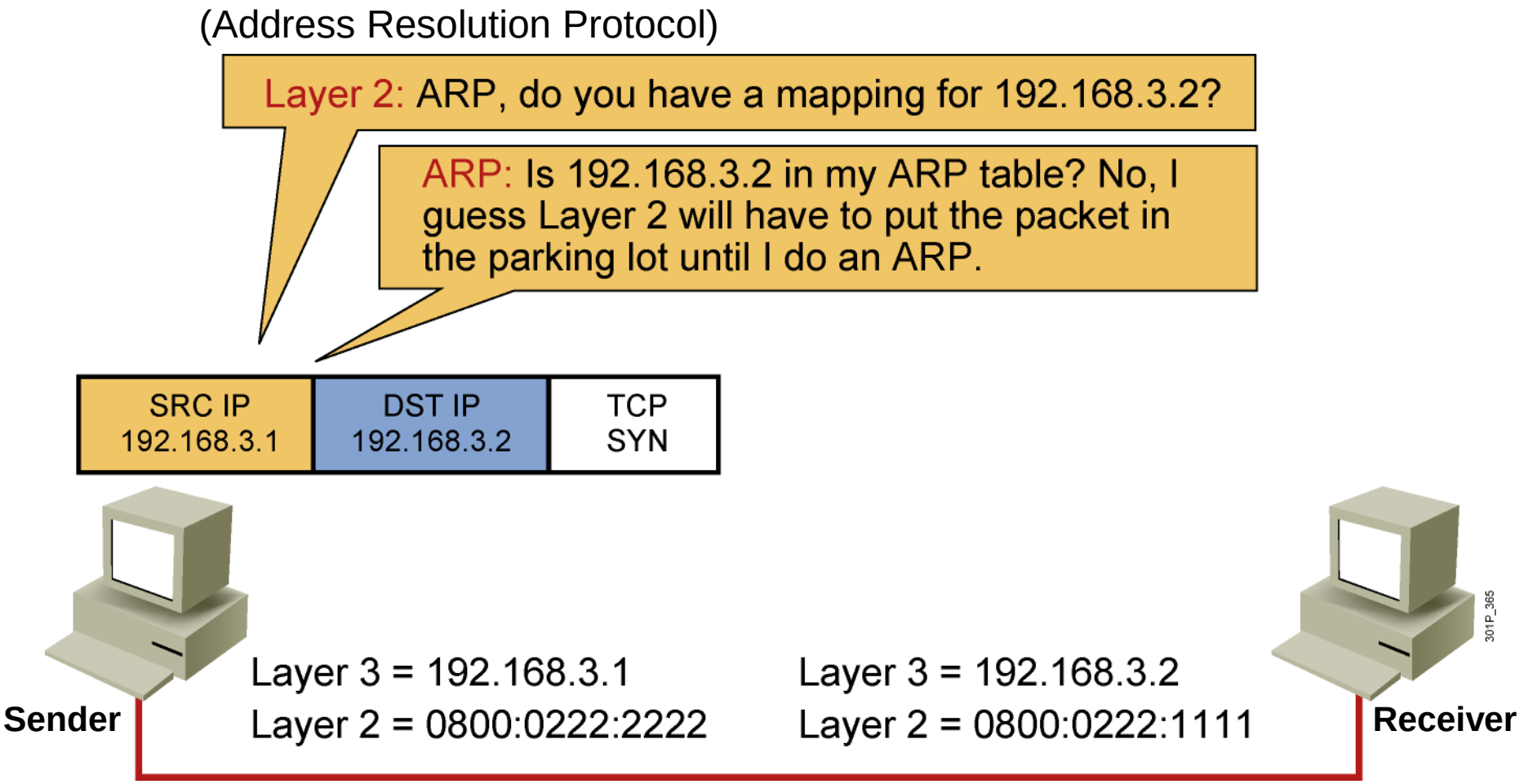
Host-to-Host Packet Delivery (1 of 22)



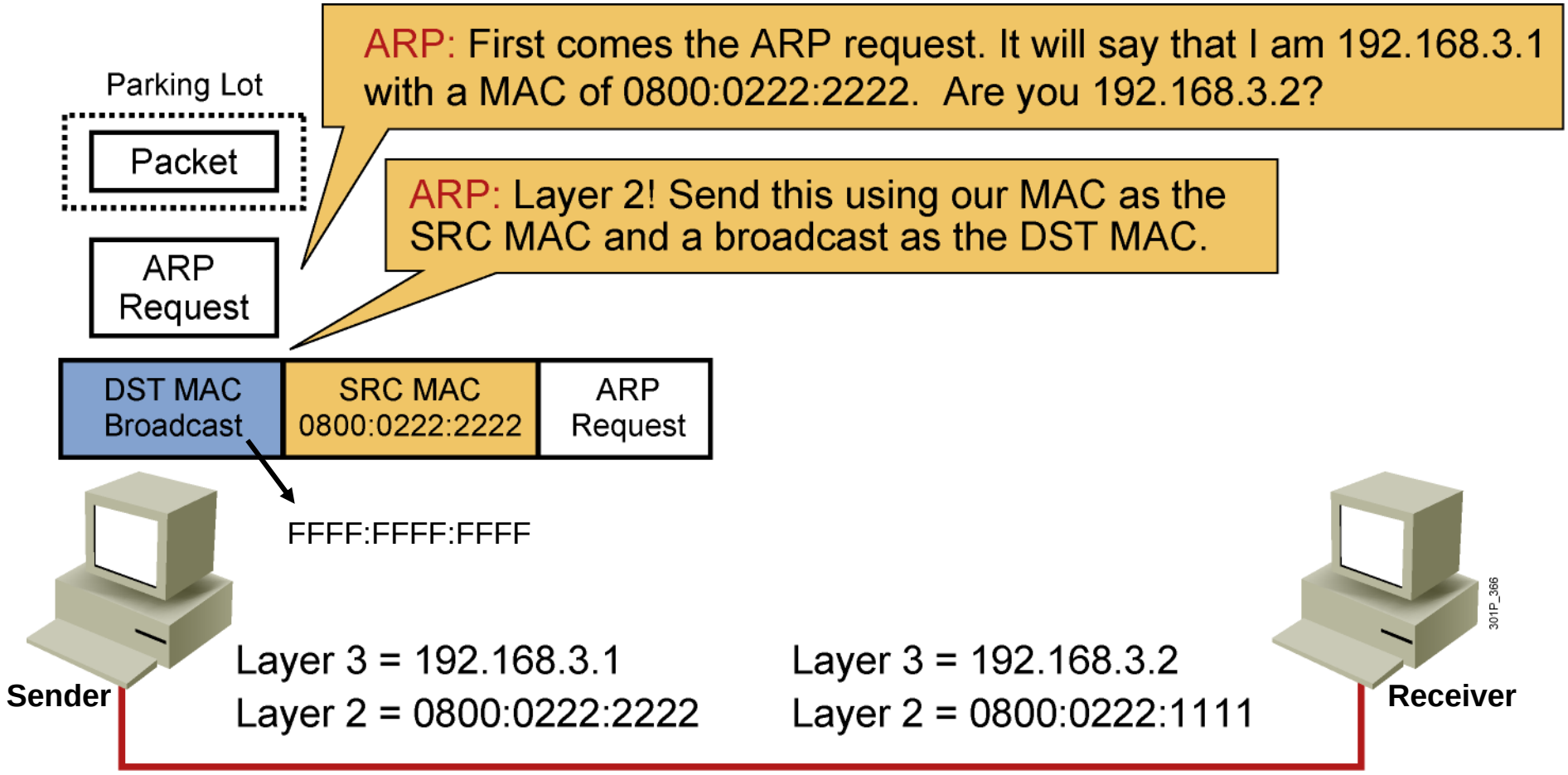
Host-to-Host Packet Delivery (2 of 22)



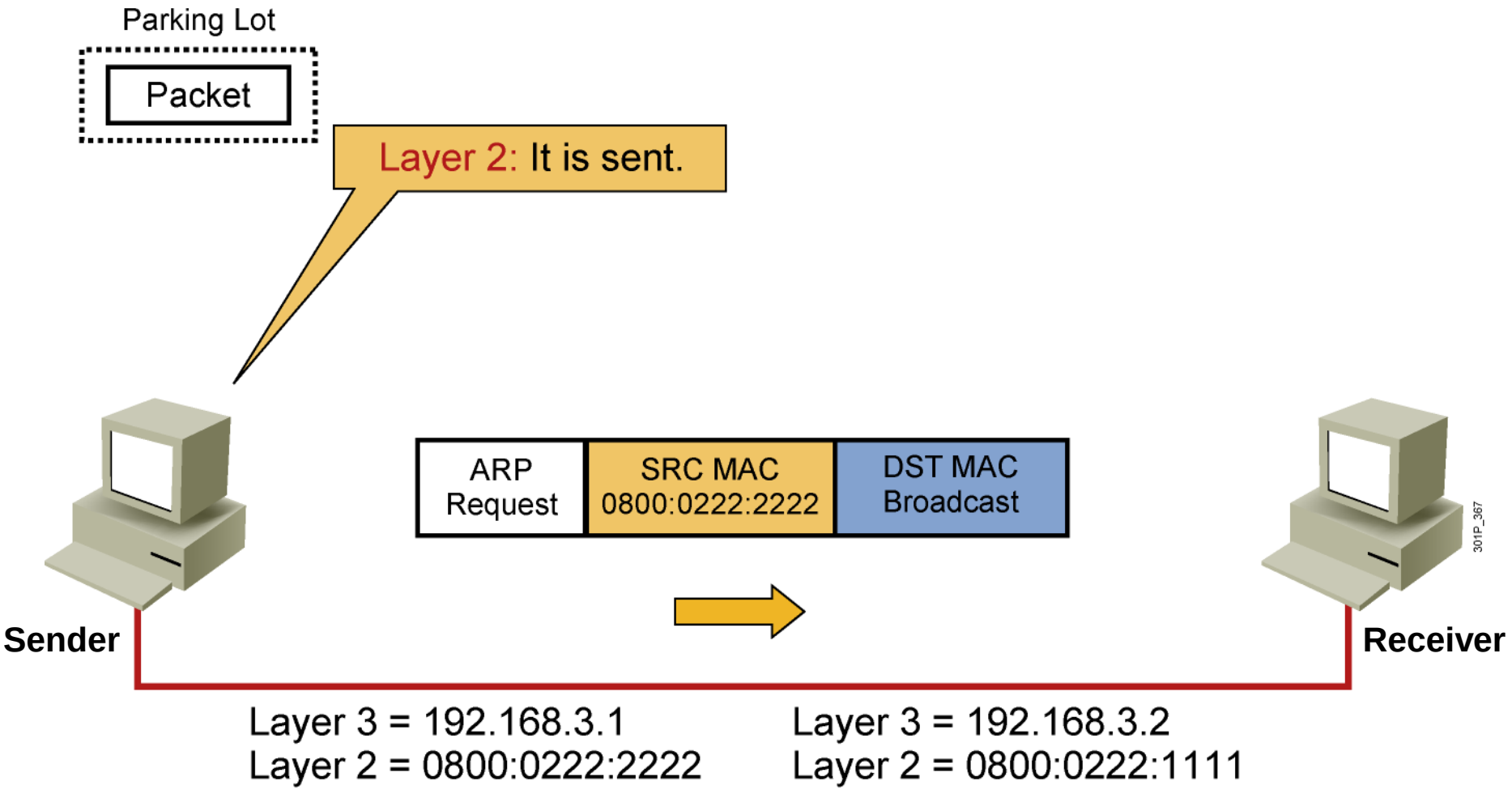
Host-to-Host Packet Delivery (3 of 22)



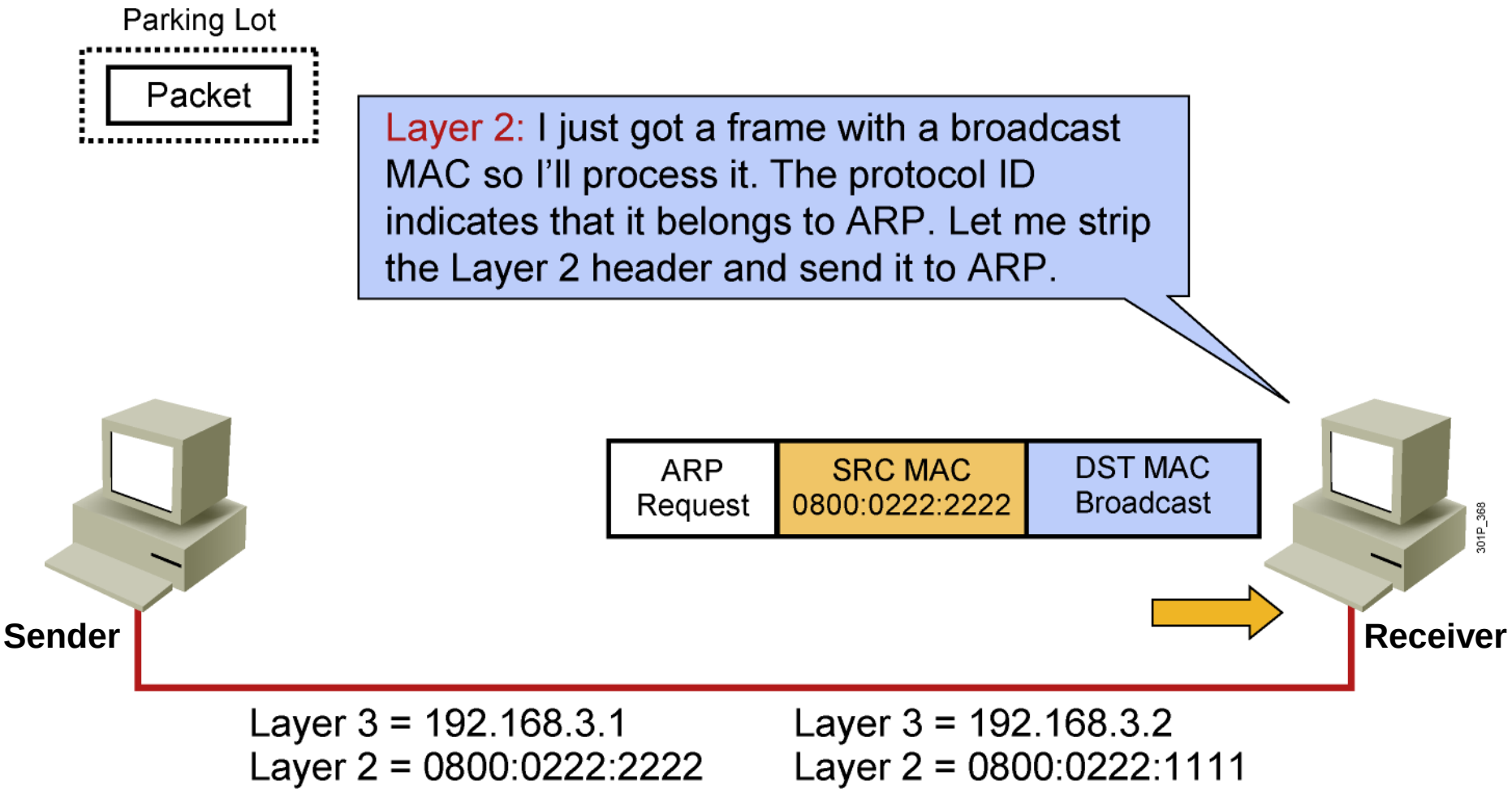
Host-to-Host Packet Delivery (4 of 22)



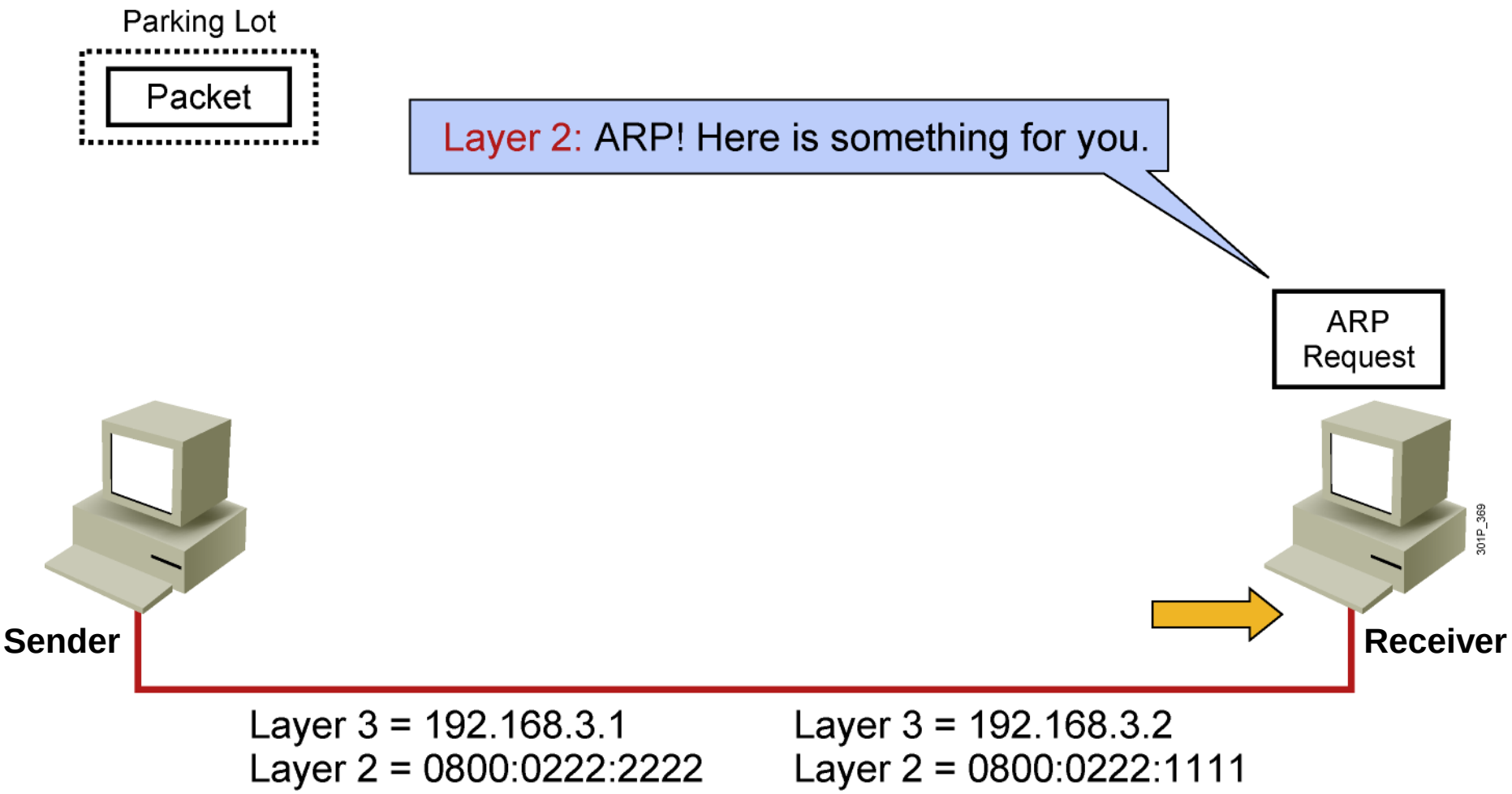
Host-to-Host Packet Delivery (5 of 22)



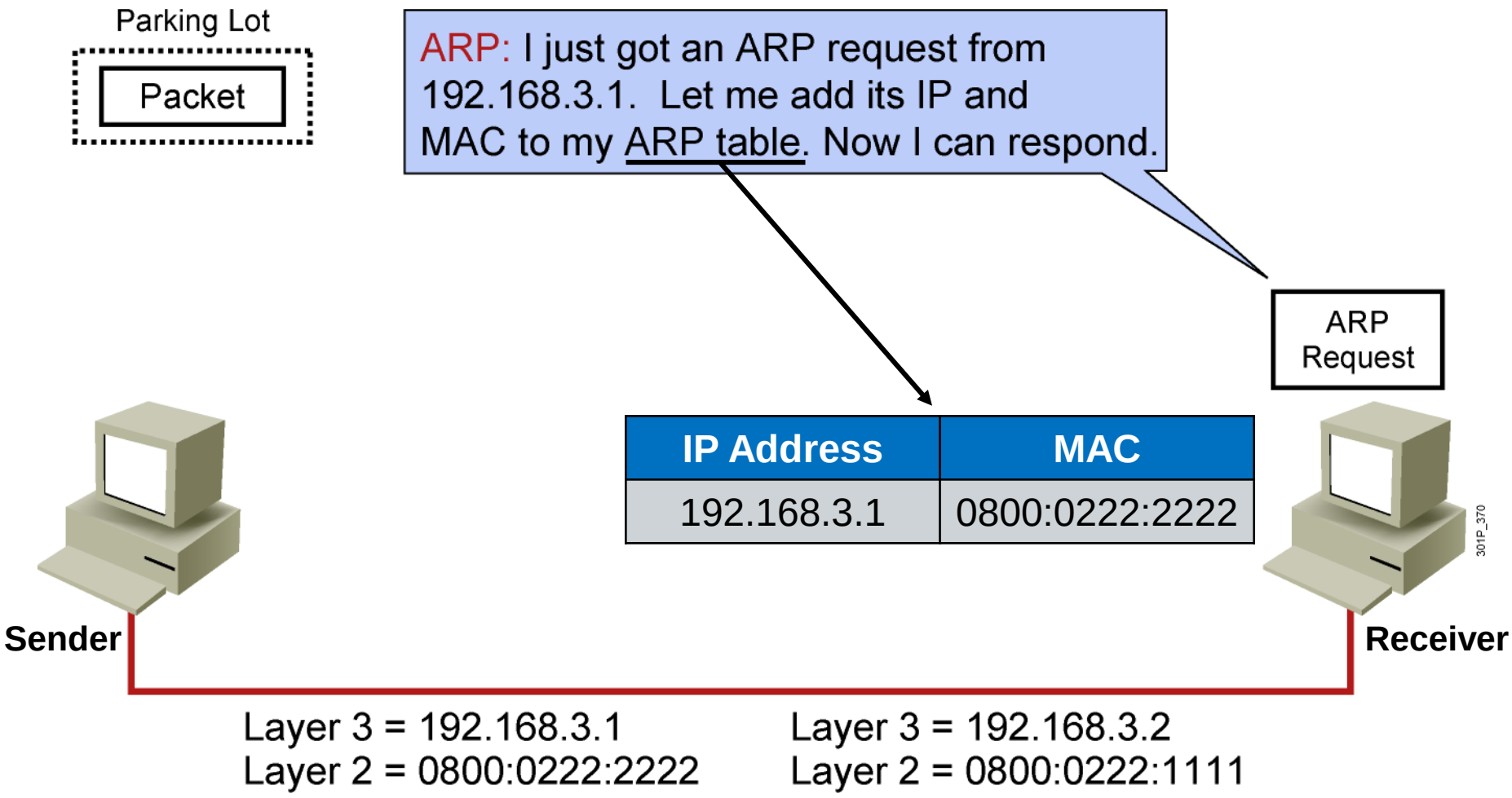
Host-to-Host Packet Delivery (6 of 22)



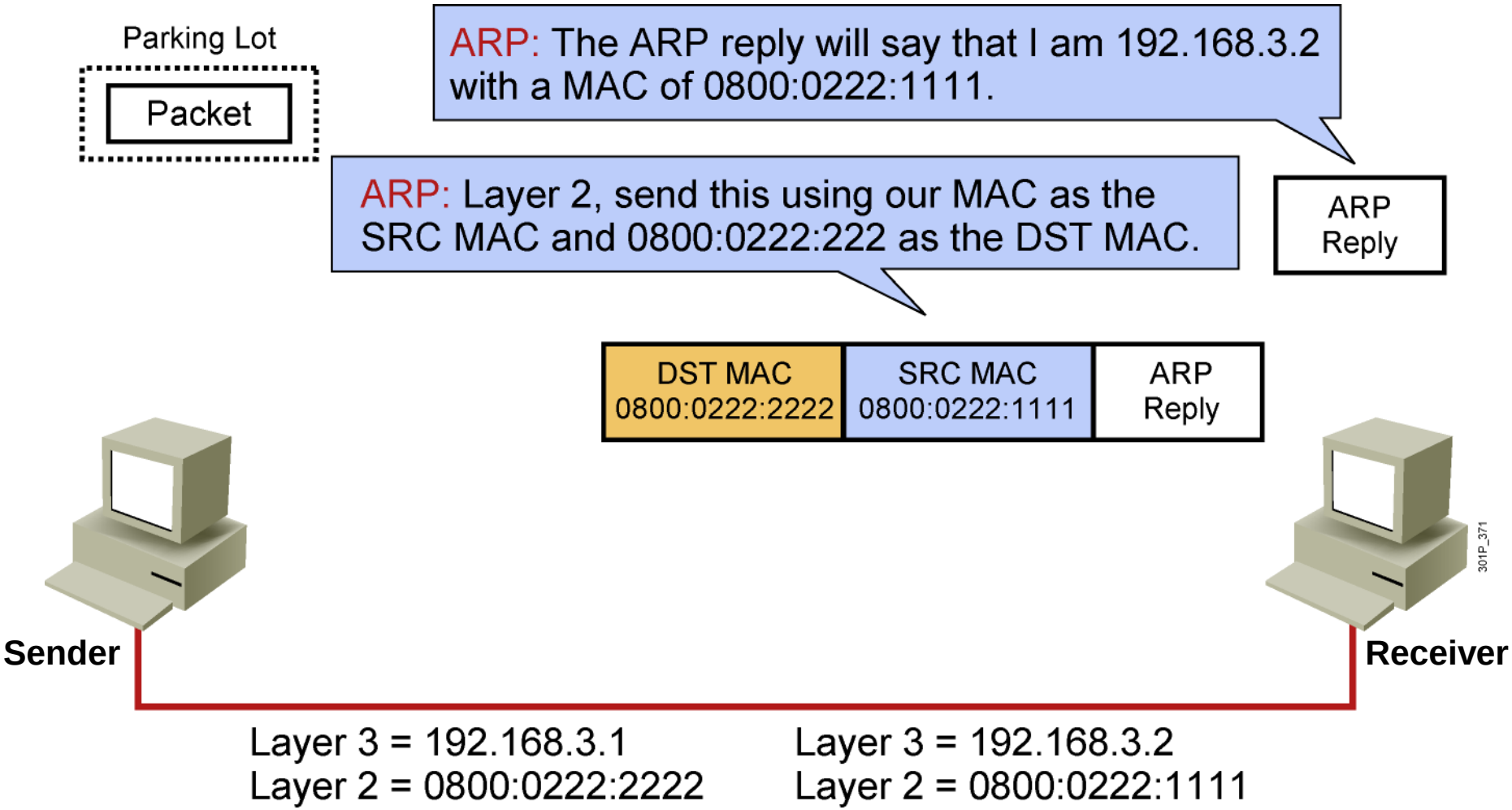
Host-to-Host Packet Delivery (7 of 22)



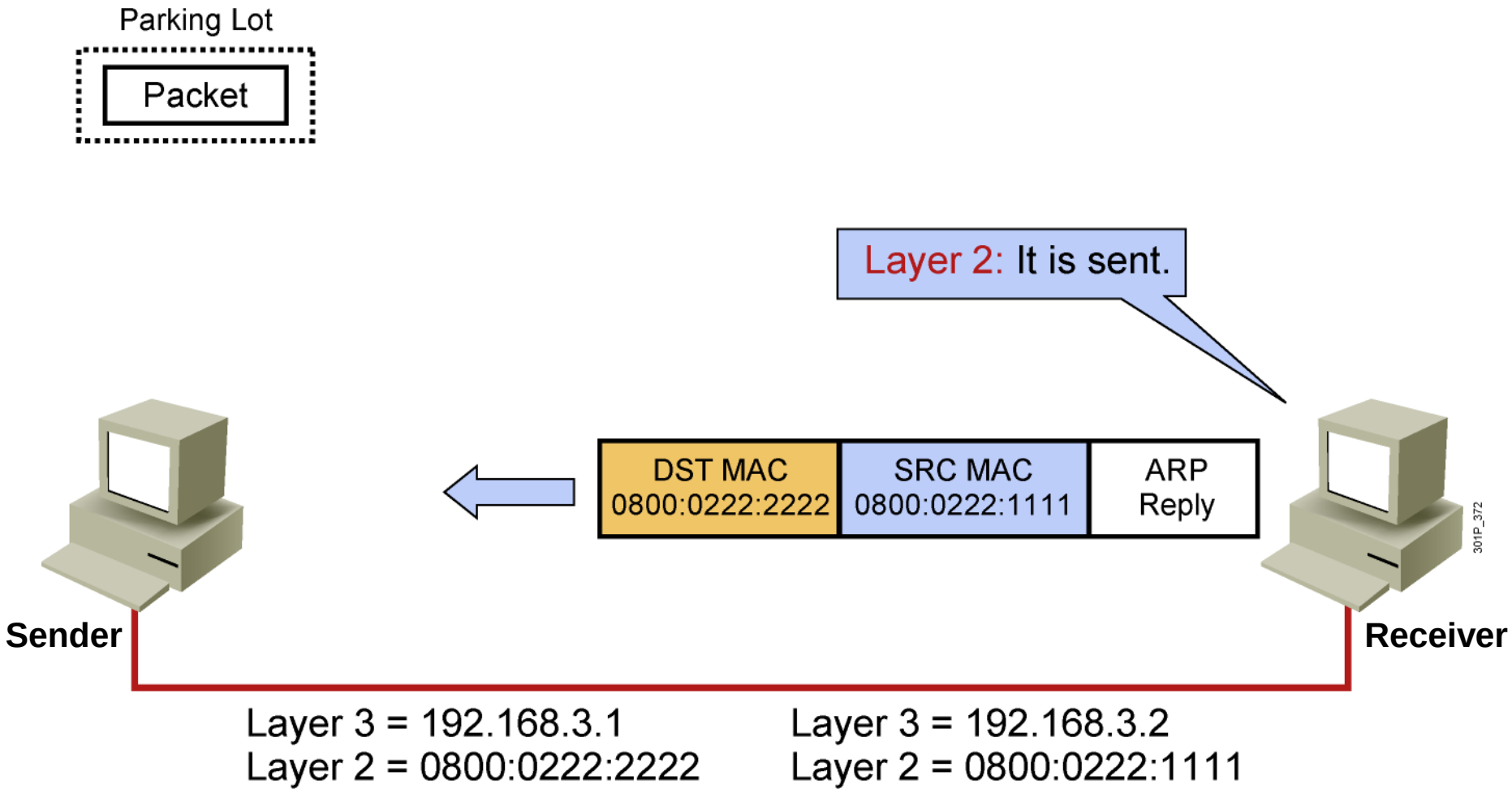
Host-to-Host Packet Delivery (8 of 22)



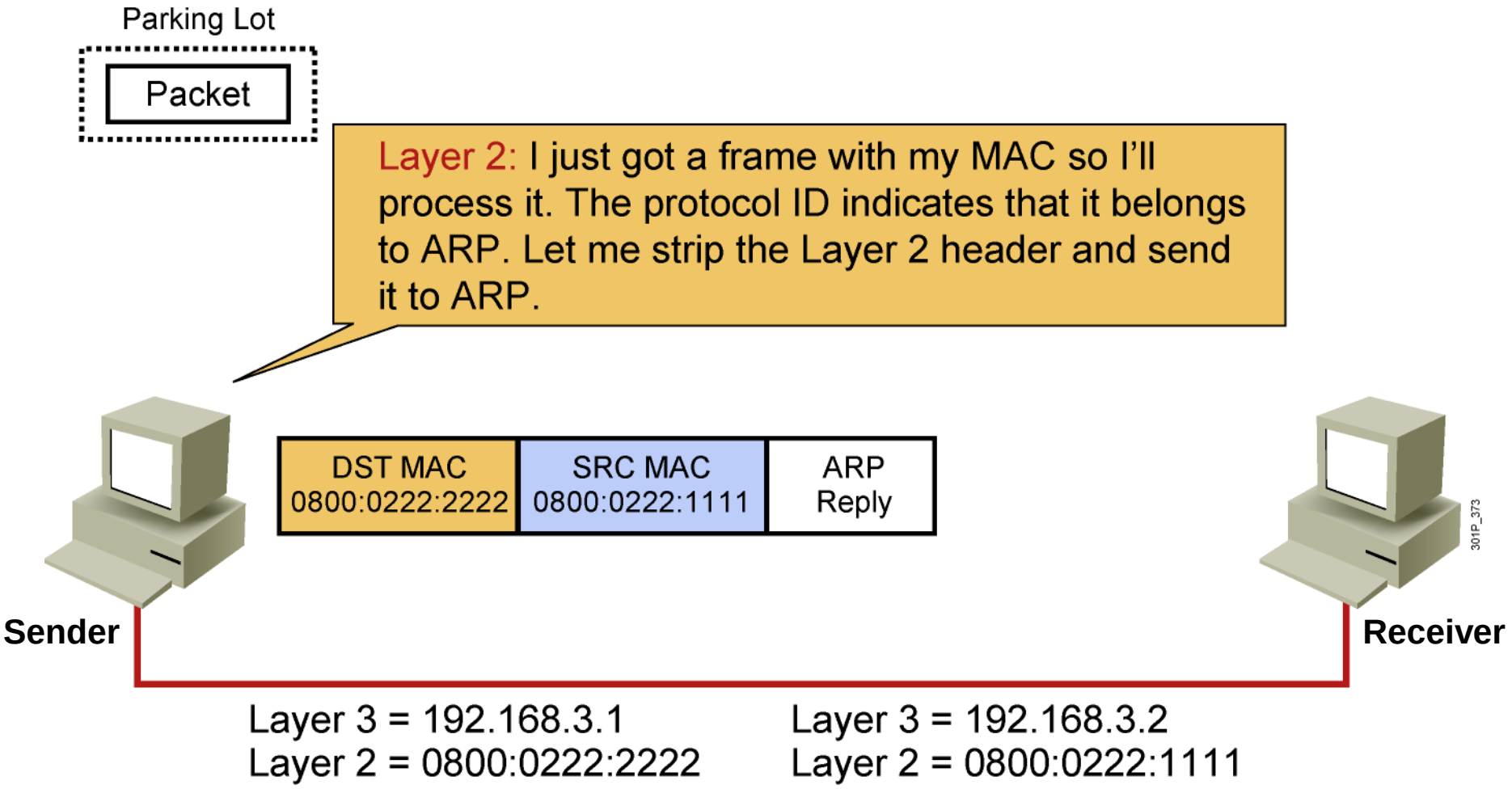
Host-to-Host Packet Delivery (9 of 22)



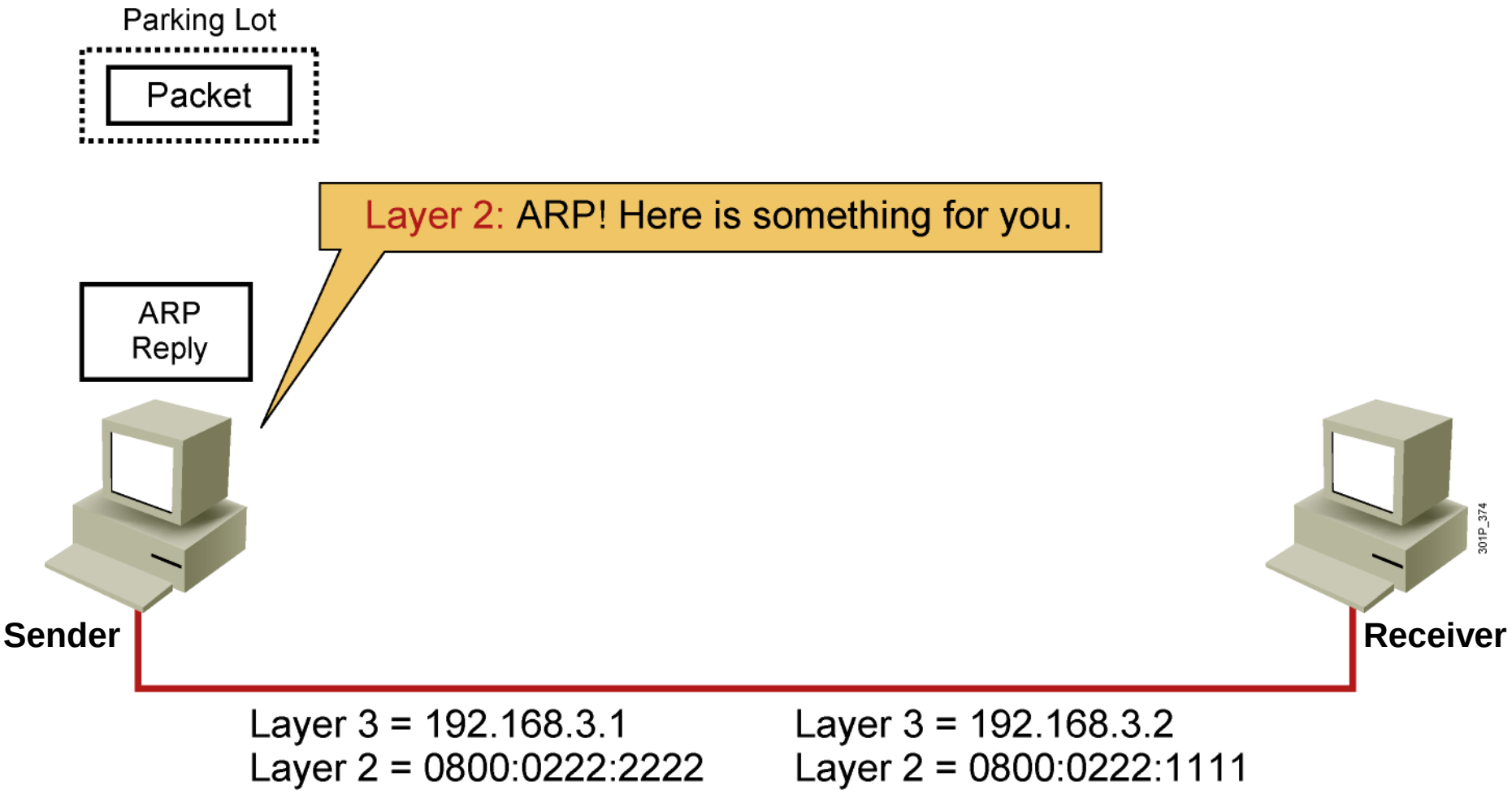
Host-to-Host Packet Delivery (10 of 22)



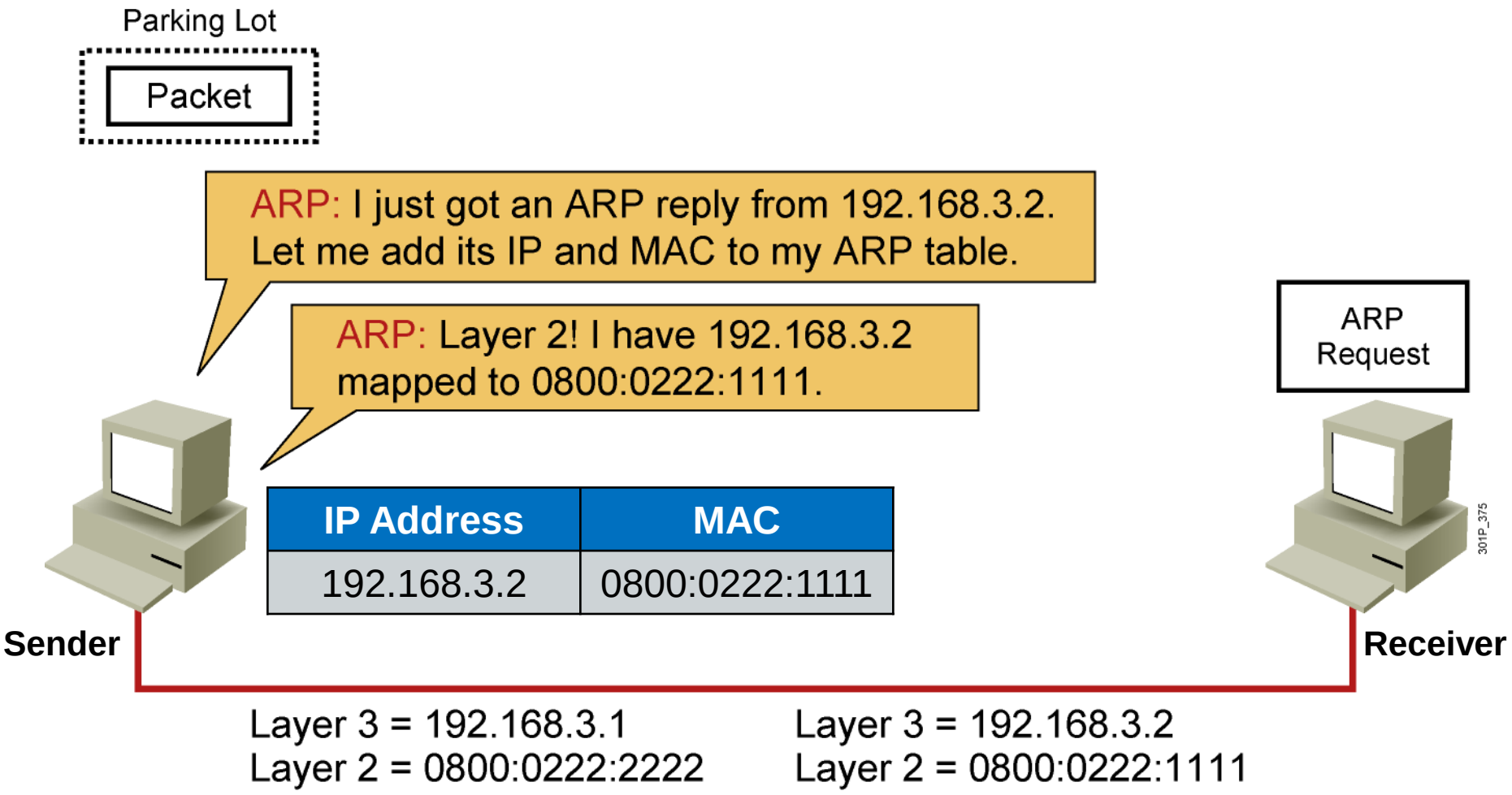
Host-to-Host Packet Delivery (11 of 22)



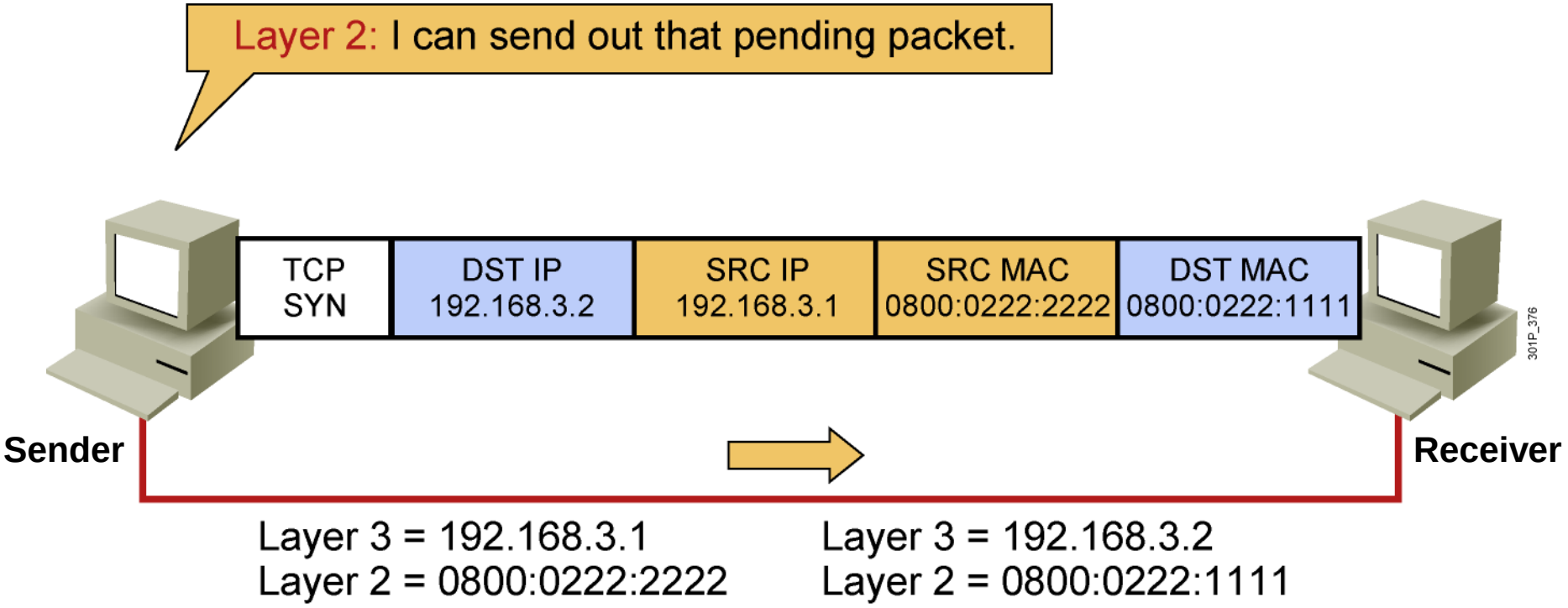
Host-to-Host Packet Delivery (12 of 22)



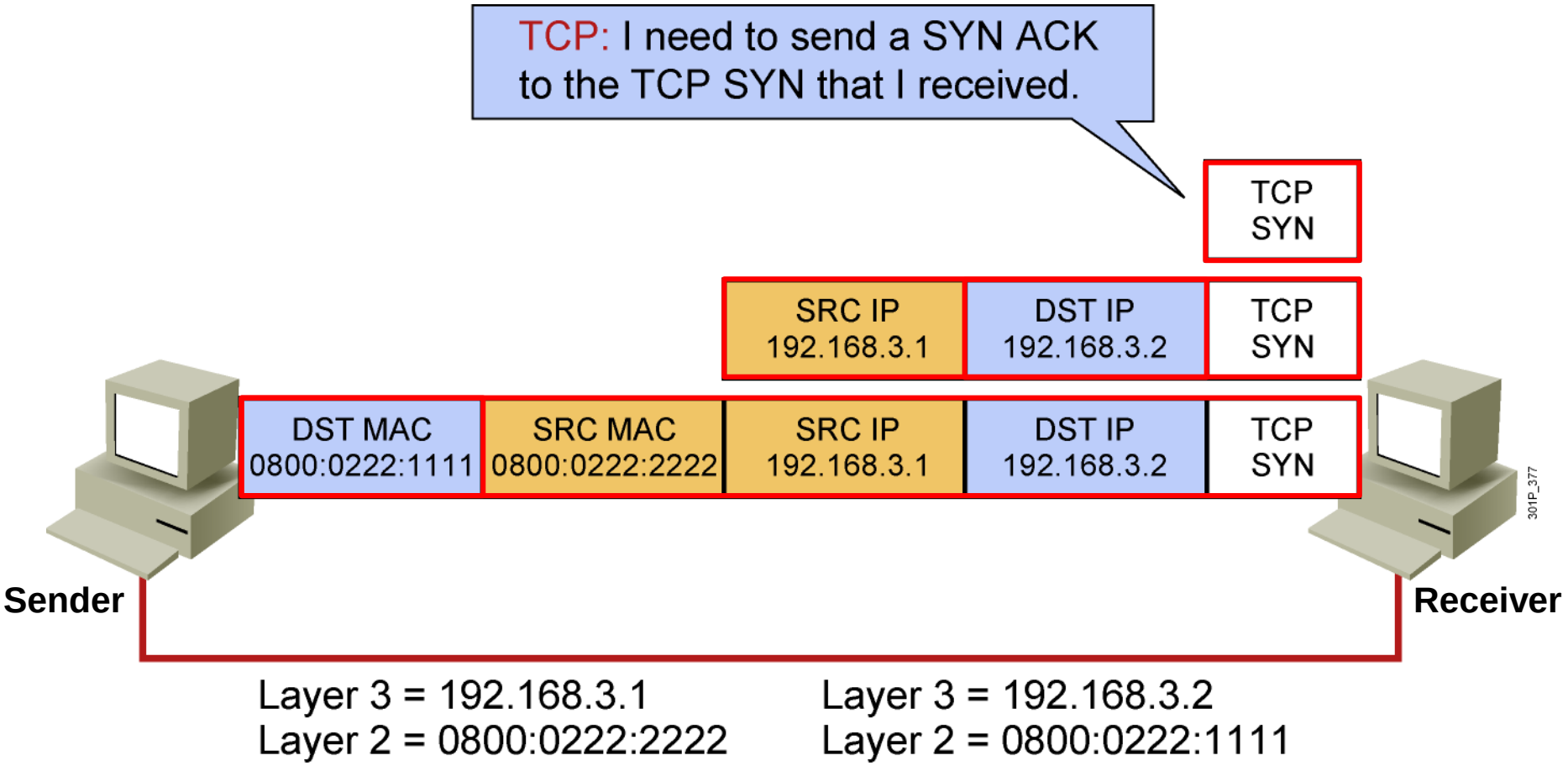
Host-to-Host Packet Delivery (13 of 22)



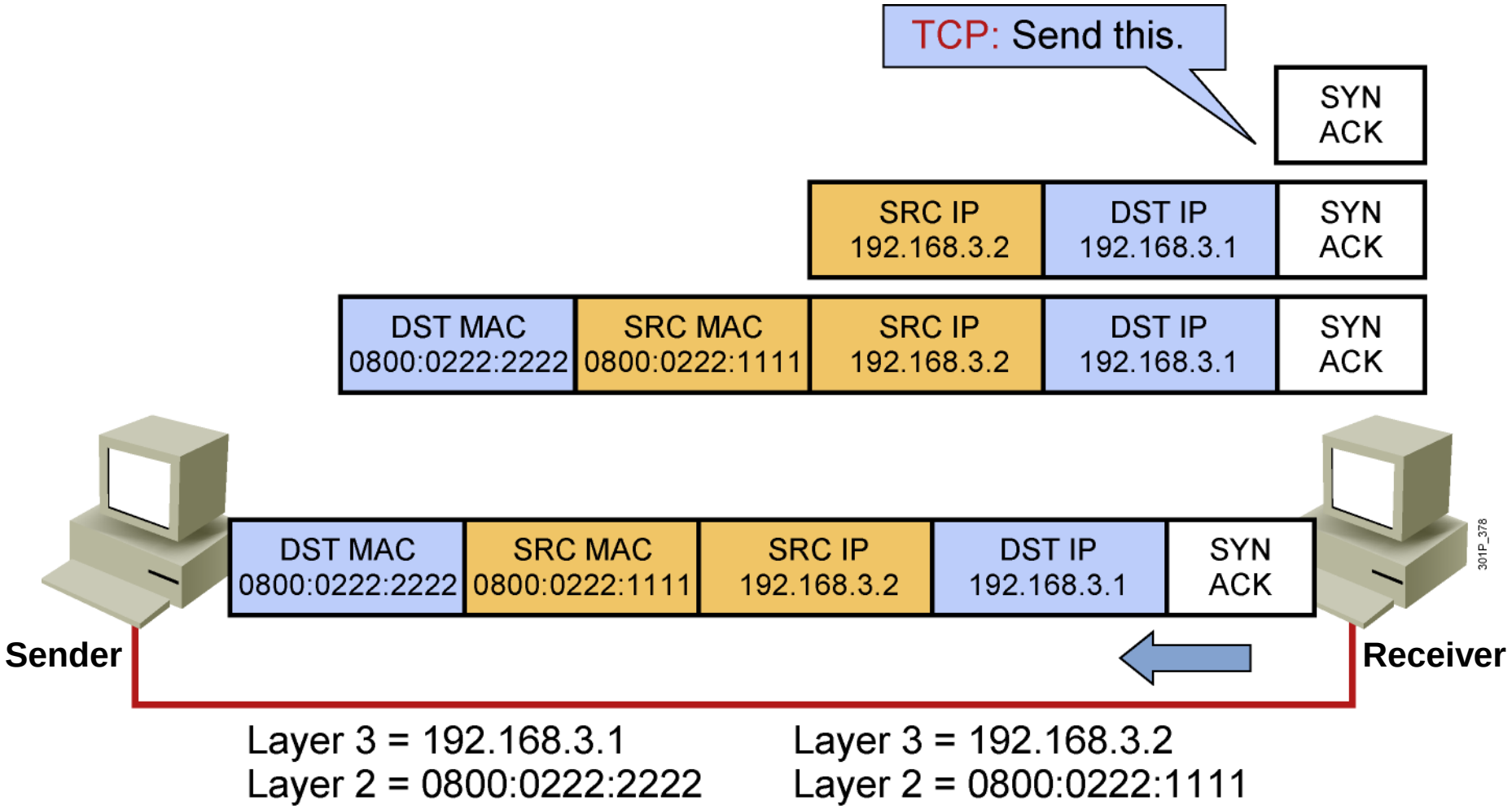
Host-to-Host Packet Delivery (14 of 22)



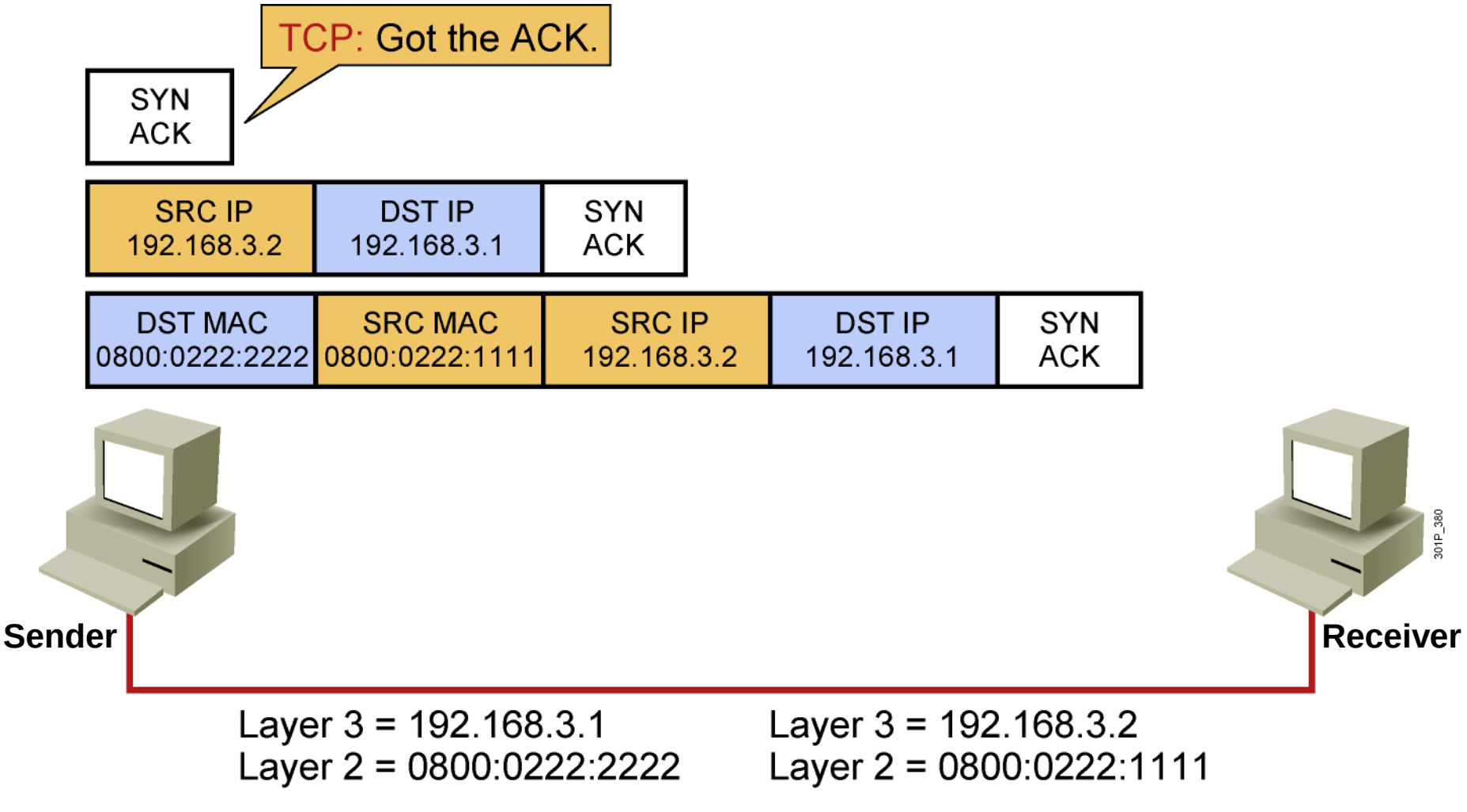
Host-to-Host Packet Delivery (15 of 22)



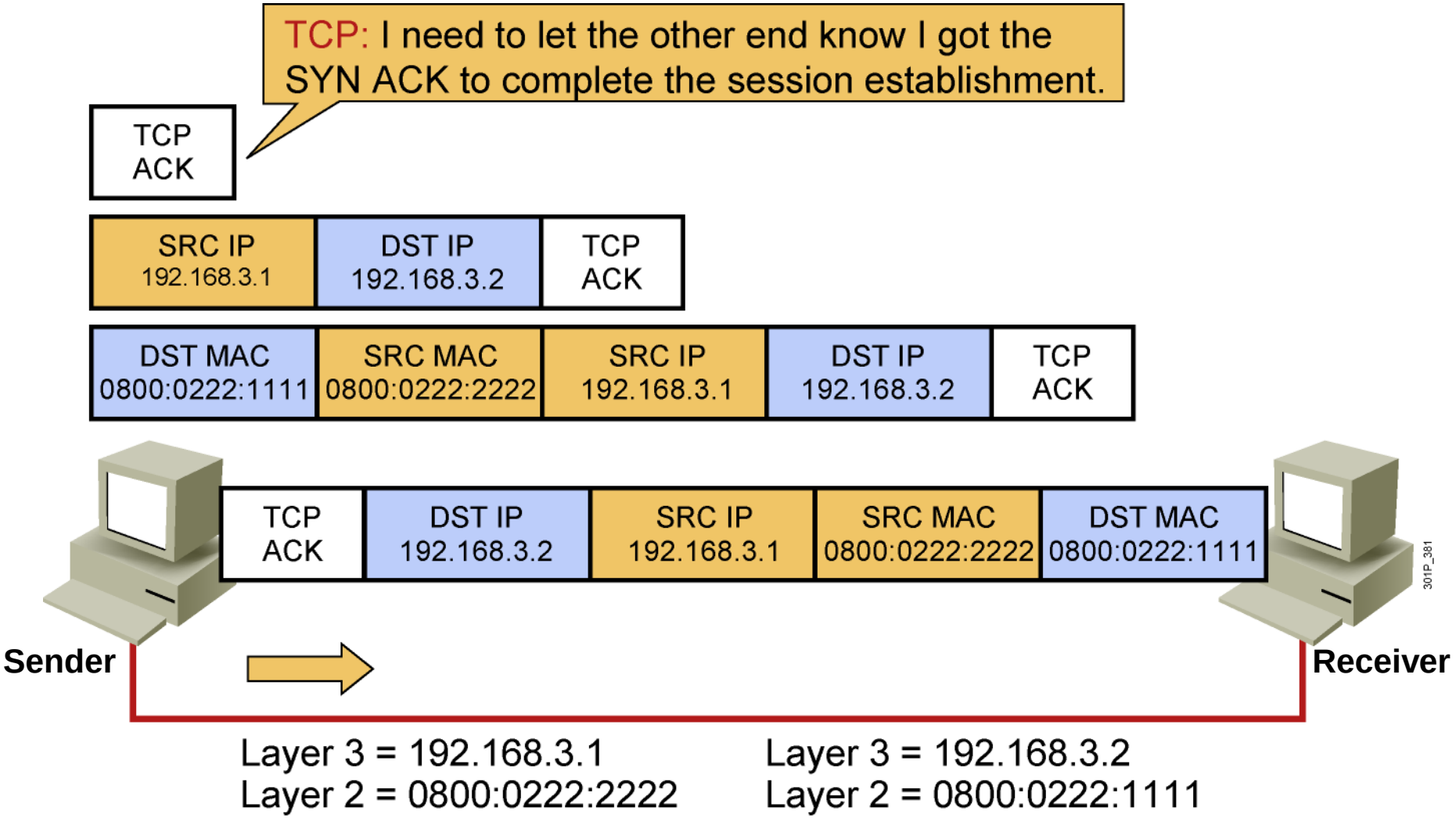
Host-to-Host Packet Delivery (16 of 22)



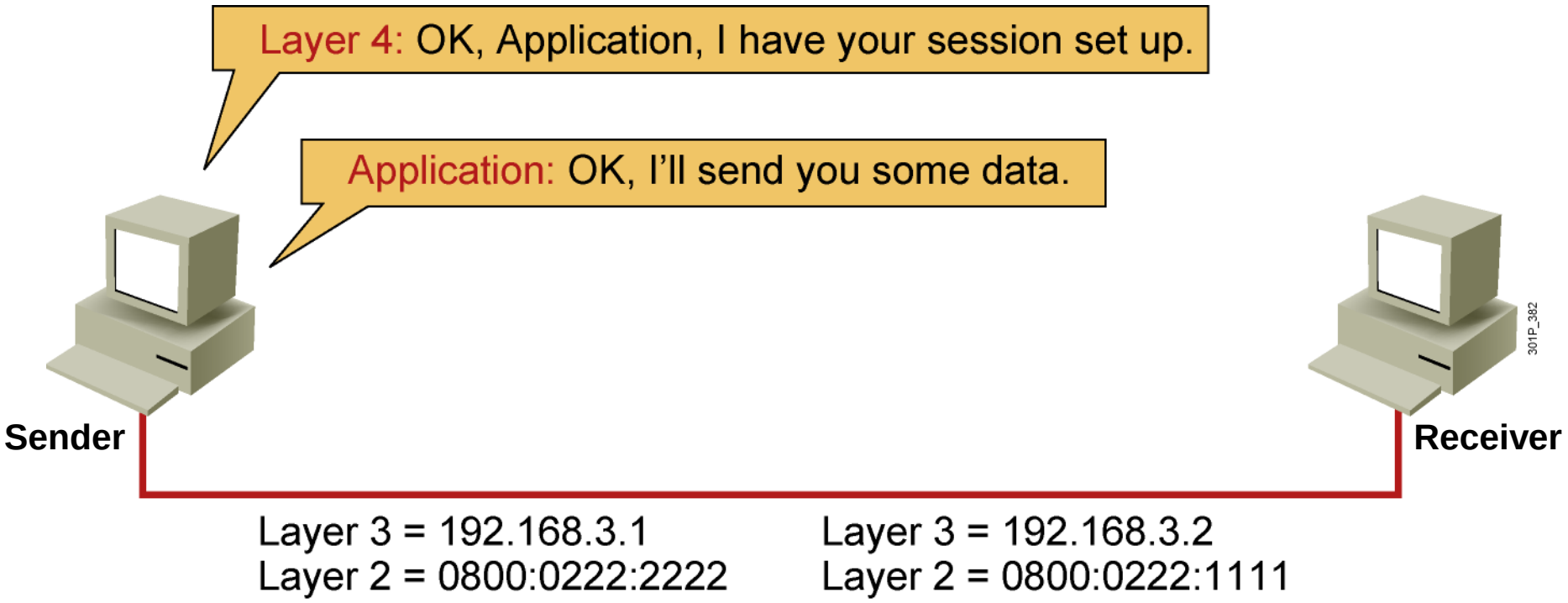
Host-to-Host Packet Delivery (17 of 22)



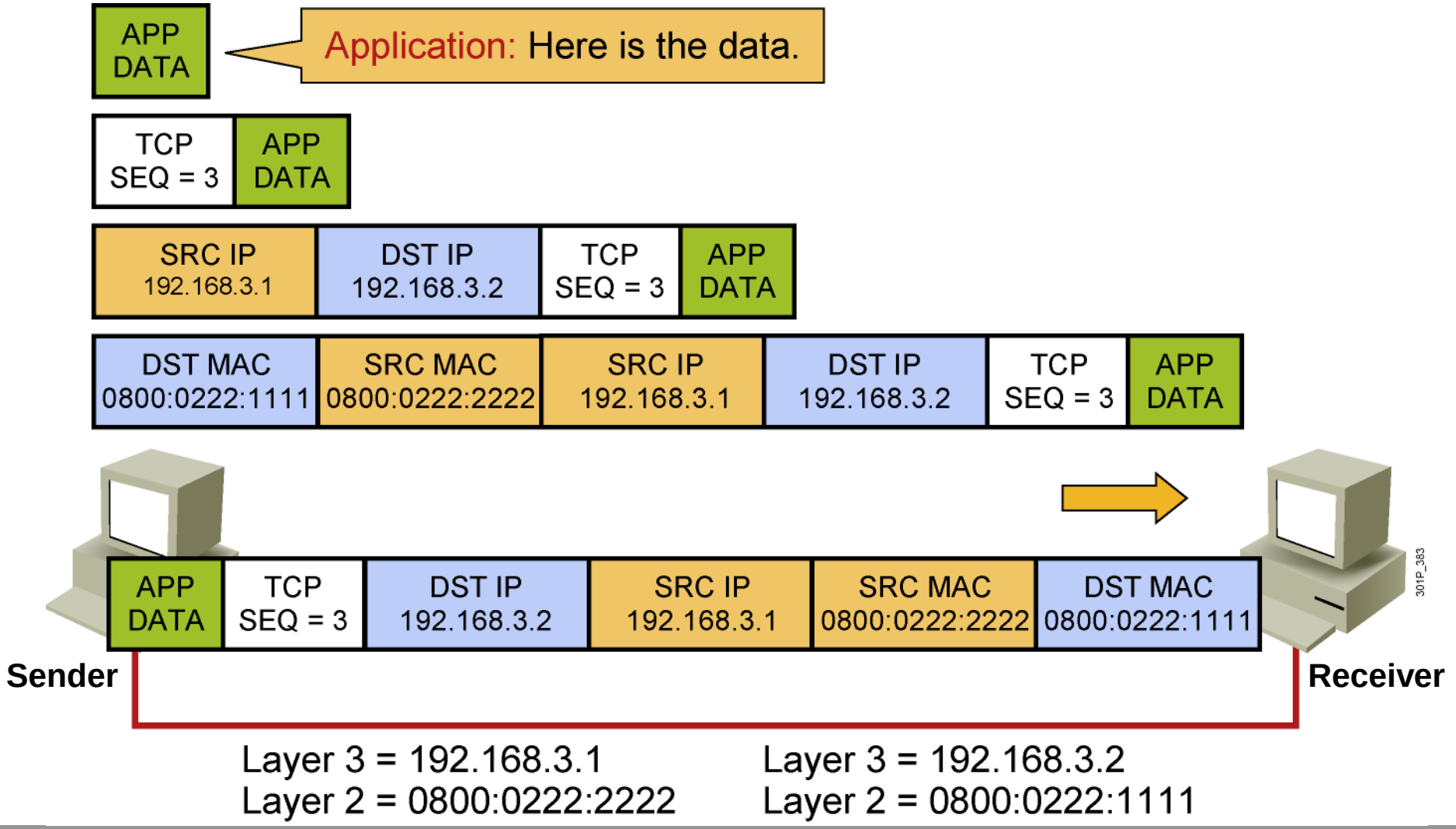
Host-to-Host Packet Delivery (18 of 22)



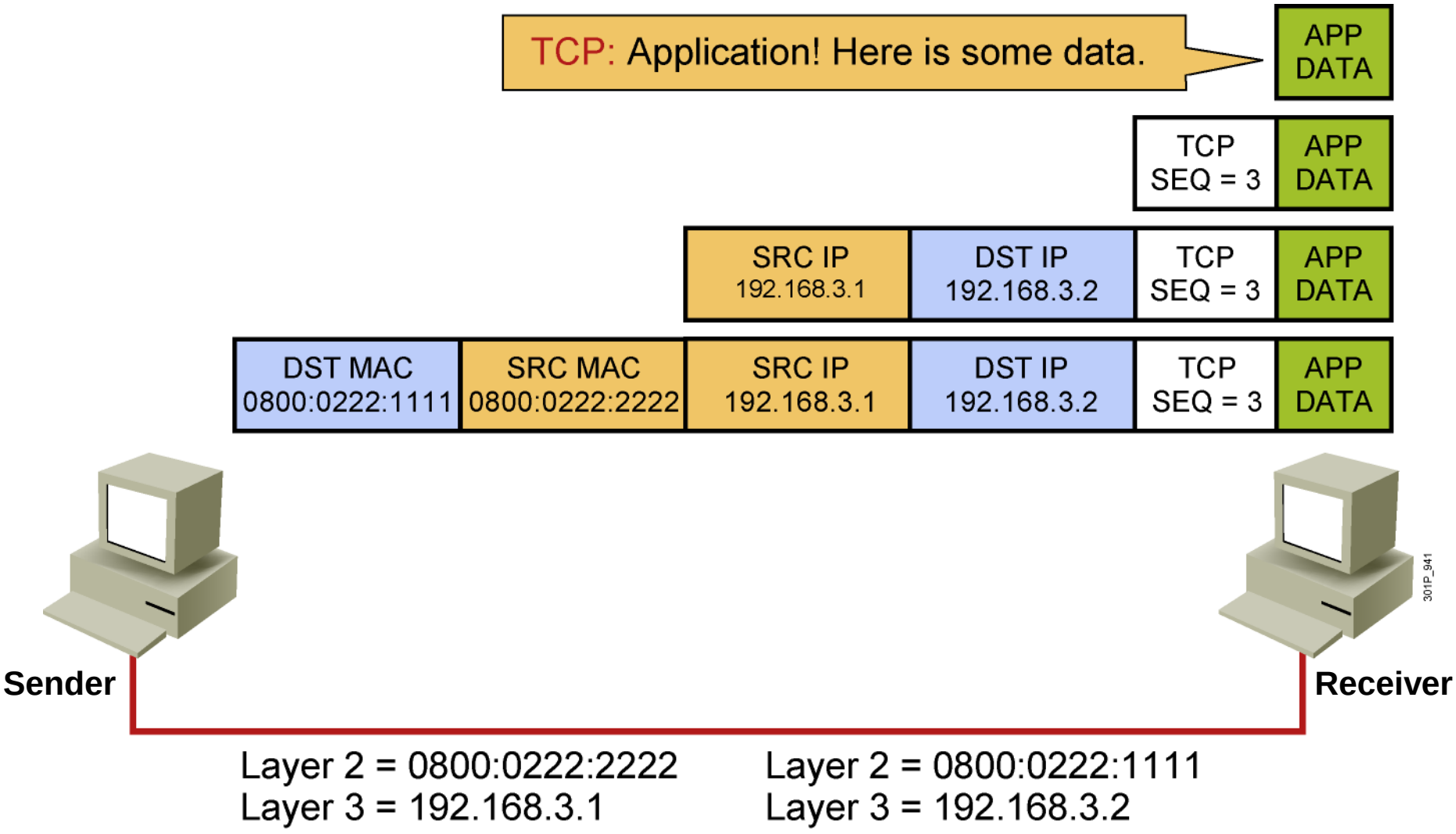
Host-to-Host Packet Delivery (19 of 22)



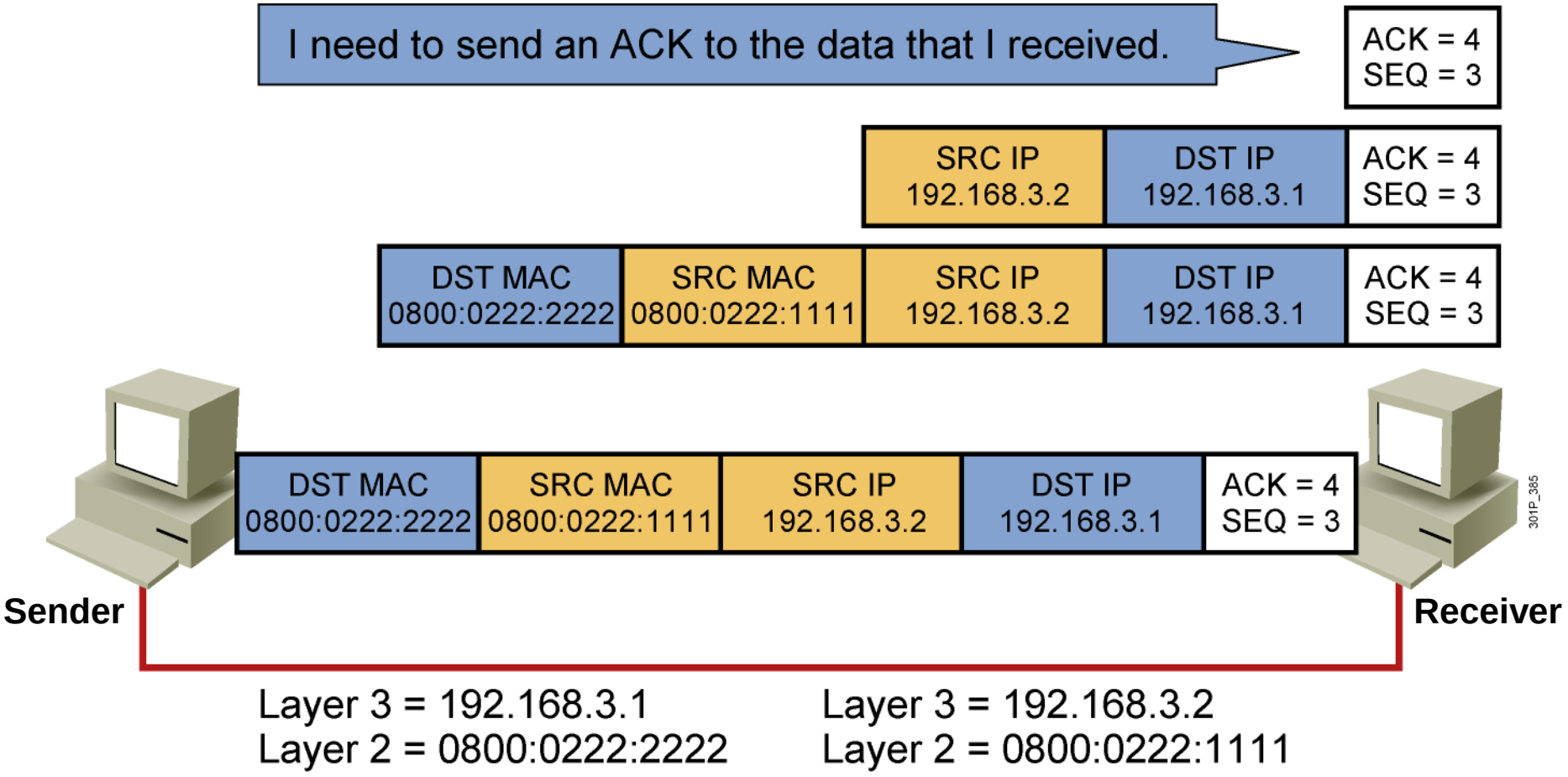
Host-to-Host Packet Delivery (20 of 22)



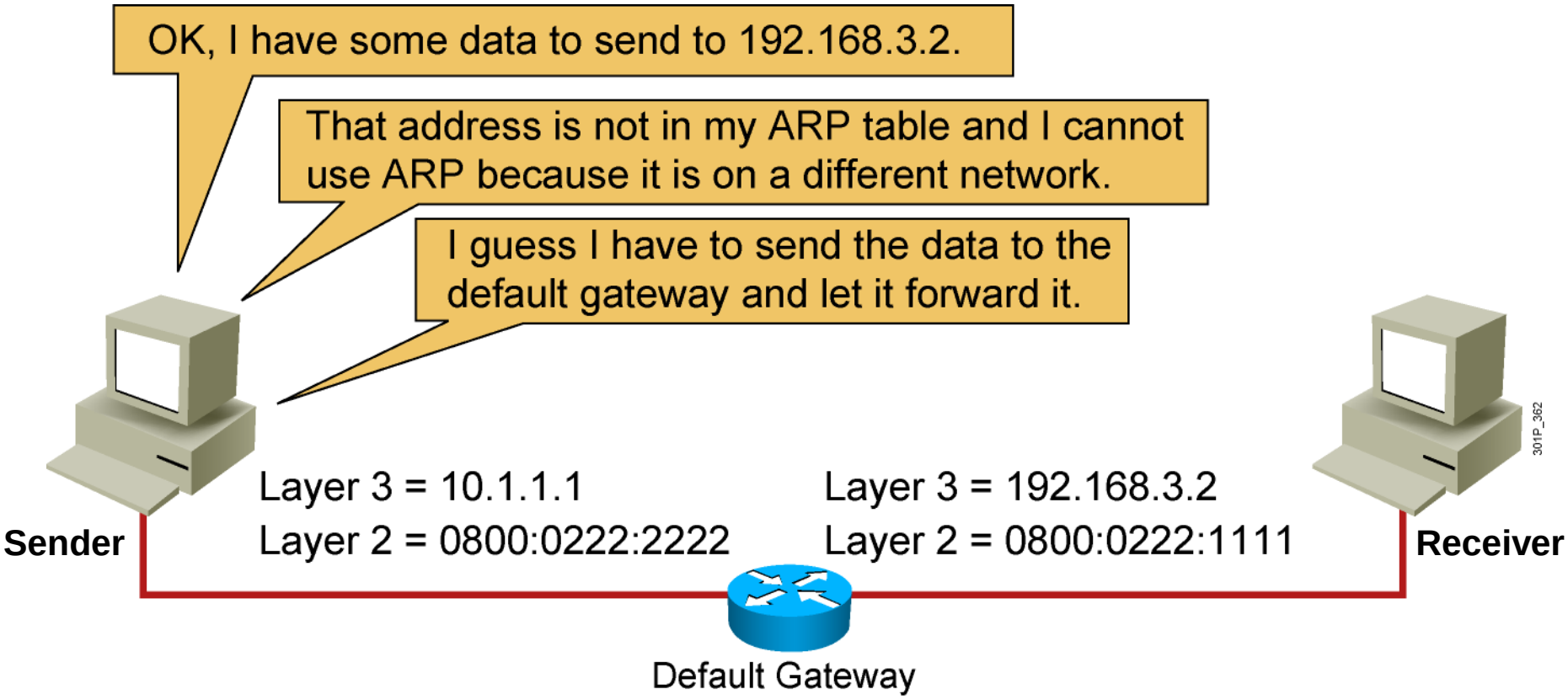
Host-to-Host Packet Delivery (21 of 22)



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

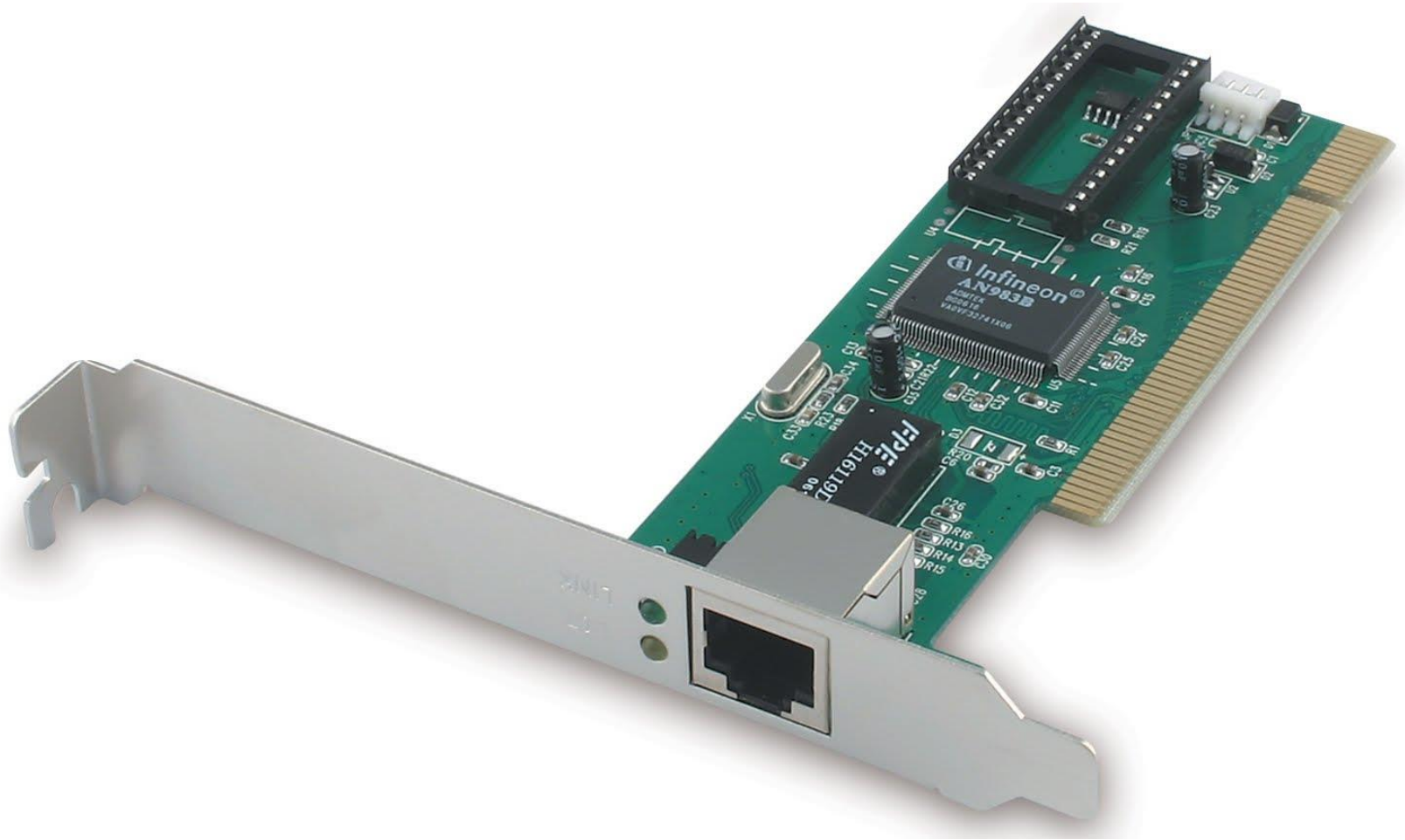


Default Gateway



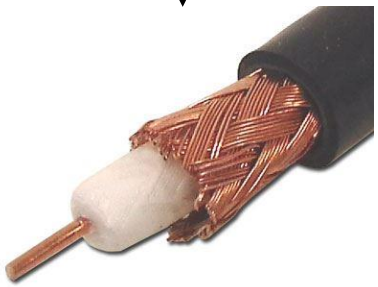
Cabling in Internetwork

Network Interface Card



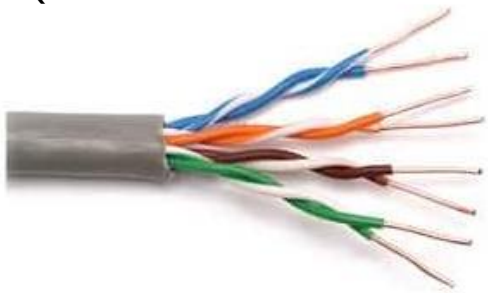
Common Network Cable Types - Copper

Coaxial



Twisted Pair

UTP
(**U**nshield **T**wisted **P**air)

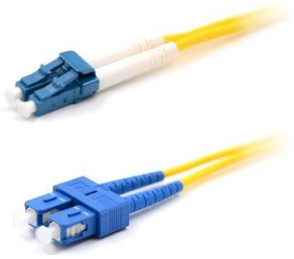


- More susceptible to noise and crosstalk
- Cheaper
- Easily installed as cables are smaller, lighter, and flexible

STP
(**S**hield **T**wisted **P**air)

- Less susceptible to noise and crosstalk
- Moderately expensive
- Installation of cables is difficult comparatively

Common Network Cable Types - Fiber Optic



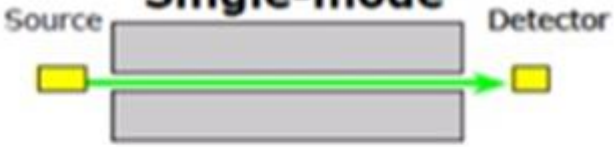
Multimode

+ Low cost sources
  + 850 nm and 1310 nm LEDs
  + 850 nm lasers at 1 & 10 Gb/s
  + Low precision packaging
+ Low cost connectors
+ Lower installation cost
- Higher fiber cost
+ **Lower system cost**
- Higher loss, lower bandwidth
- Distance up to 2 km

Best for:

- ***LAN, SAN, Data Center, CO***

Single-mode



- High cost sources
  - 1310+ nm lasers 1 and 10 Gb/s
  - 1 Gb/s + w/ DWDM
  - High precision packaging
- Higher cost connectors
- Higher installation cost
+ Lower fiber cost
- **Higher system cost**
+ Lower loss, higher bandwidth
+ Distance to 60 km+

Best for:

- ***WAN, MAN, Access, Campus***

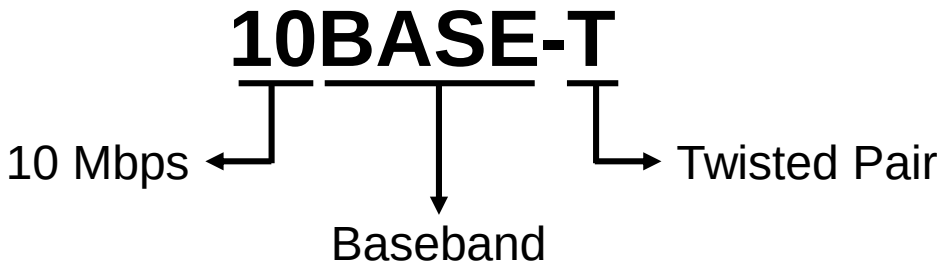
UTP Category

UTP Category	Data Rate	Max. Length	Application
CAT1	Up to 1 Mbps	-	Old Telephone Cable
CAT2	Up to 4 Mbps	-	Token Ring Networks
CAT3	Up to 10 Mbps	100m	Token Ring & 10BASE-T Ethernet
CAT4	Up to 16 Mbps	100m	Token Ring Networks
CAT5	Up to 100 Mbps	100m	Ethernet, Fast Ethernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Ethernet, Fast Ethernet, Gigabit Ethernet
CAT6	Up to 10 Gbps	100m	Gigabit Ethernet, 10G Ethernet (55 meters)
CAT6a	Up to 10 Gbps	100m	Gigabit Ethernet, 10G Ethernet (55 meters)
CAT7	Up to 10 Gbps	100m	Gigabit Ethernet, 10G Ethernet (100 meters)

Comparing Ethernet Media Requirements

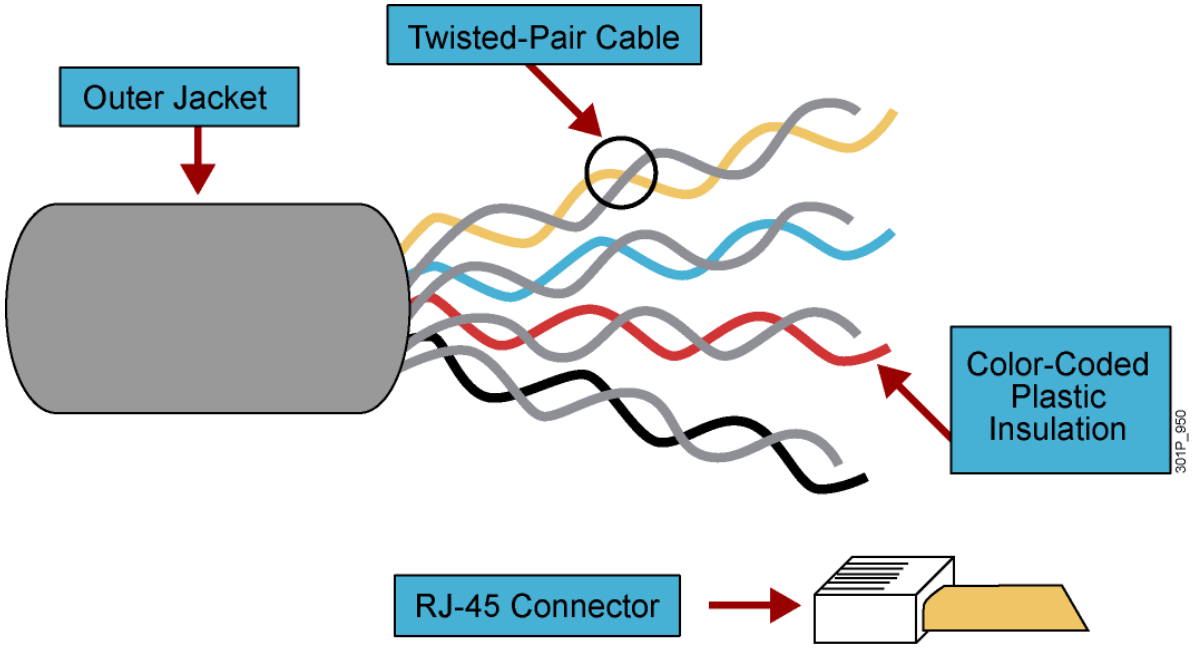
Requirement	10 BASE-T	100 BASE-TX	100 BASE-FX	1000 BASE-CX	1000 BASE-T	1000 BASE-SX	1000 BASE-LX
Media	EIA/TIA Category 3, 4, 5 UTP 2 pair	EIA/TIA Category 5 UTP 2 pair	62.5/125 micron multimode fiber	STP	EIA/TIA Category 5 UTP 4 pair	62.5/50 micron multimode fiber	9 micron single-mode fiber
Maximum 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)	—	—

301P_084



Baseband: commonly used for digital transmission.
Broadband: commonly used for analog transmission.
The broadband systems can cover a bigger area than baseband systems.

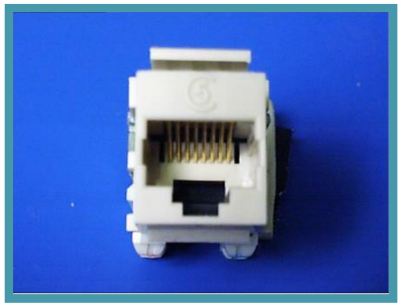
Unshielded Twisted-Pair Cable



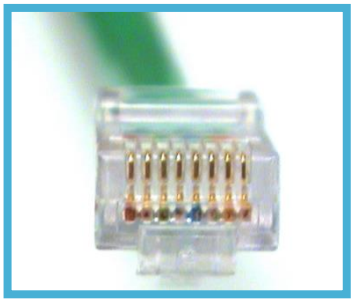
- Speed and throughput: 10 to 1000 Mb/s
- Average cost per node: Least expensive
- Media and connector size: Small
- Maximum cable length: Varies

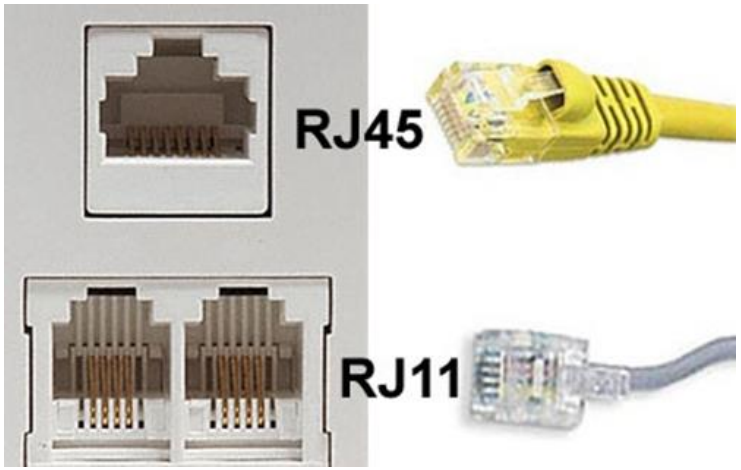
RJ45 Connector & RJ45 Jack

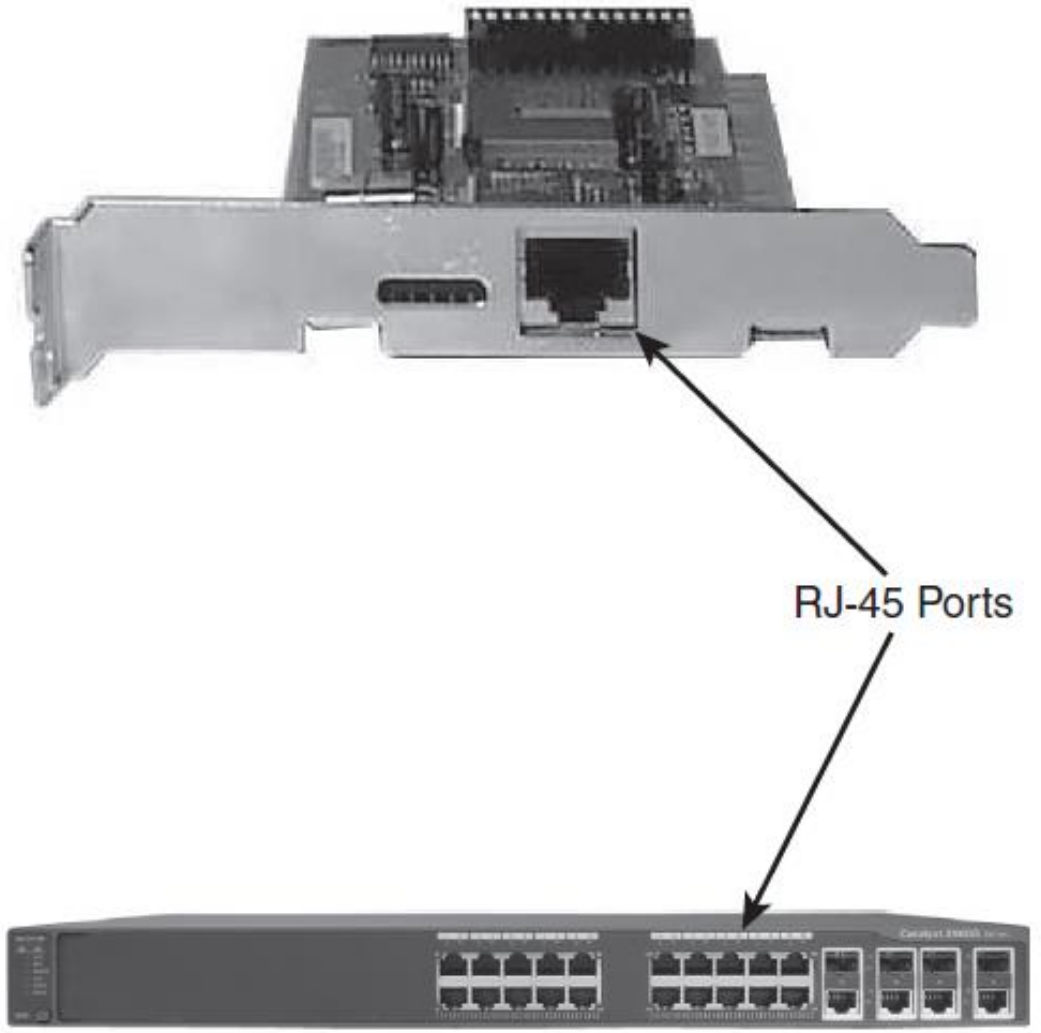
RJ45 Jack (Female)



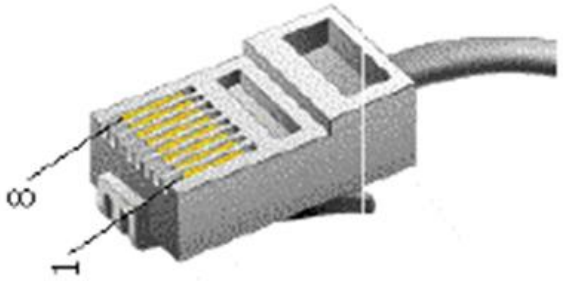
RJ45 Connector (Male)





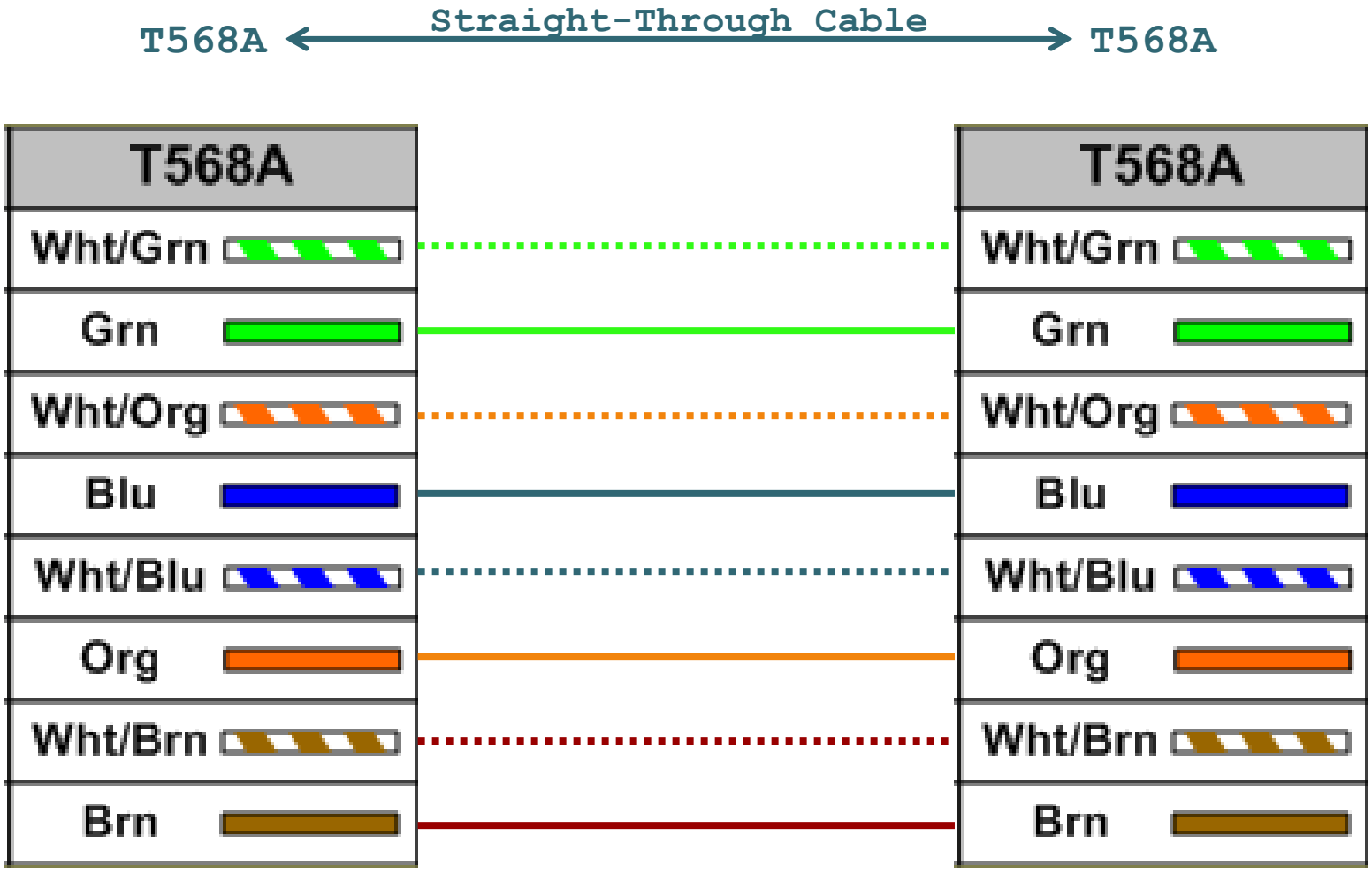


EIA/TIA T568A & T568B

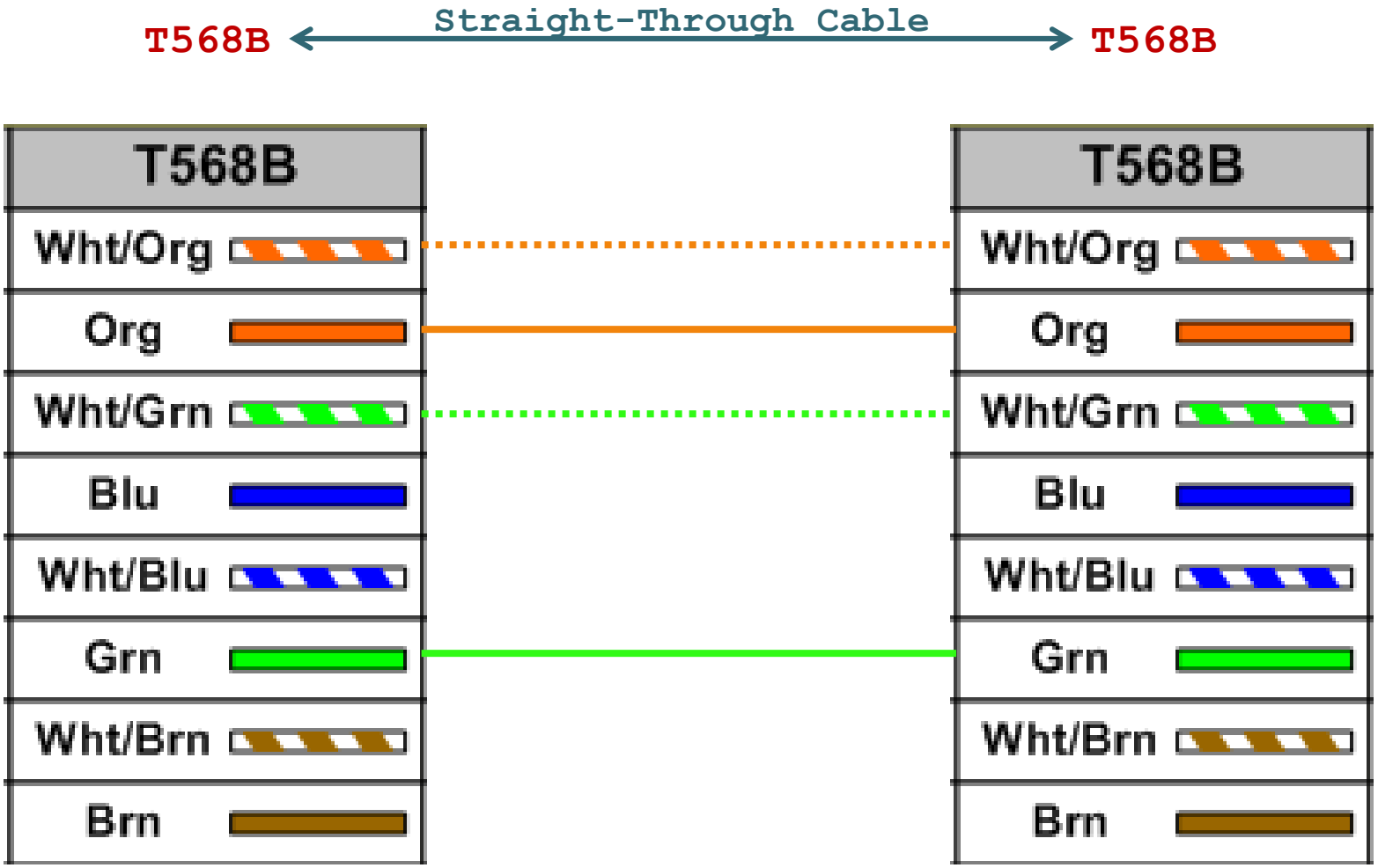


Pin	T568A	T568B	Signal 10/100BaseTx
1	Wht/Grn	Wht/Org	Tx+
2	Grn	Org	Tx-
3	Wht/Org	Wht/Grn	Rx+
4	Blu	Blu	Unused
5	Wht/Blu	Wht/Blu	Unused
6	Org	Grn	Rx-
7	Wht/Brn	Wht/Brn	Unused
8	Brn	Brn	Unused

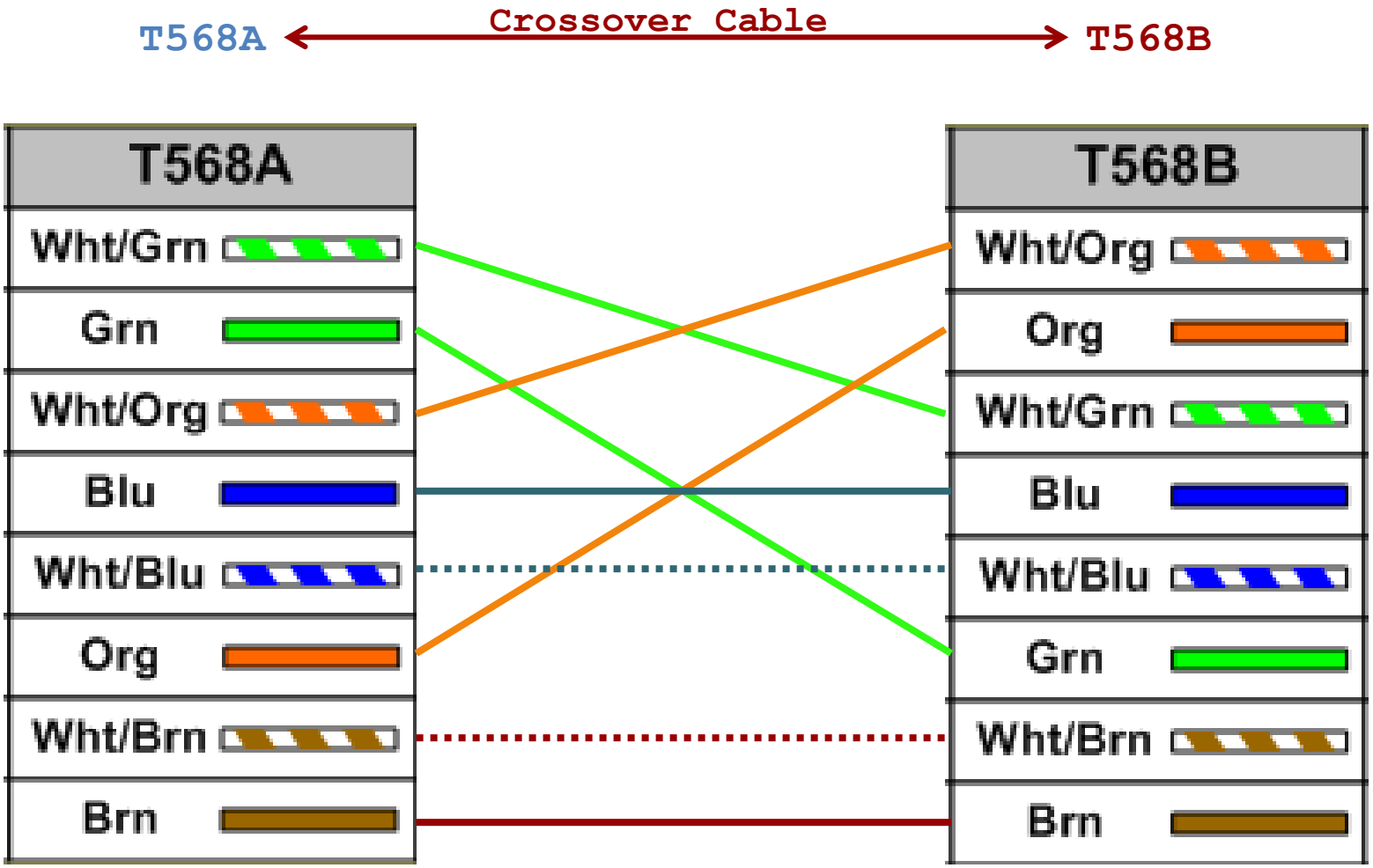
UTP Implementation (Straight-Through)



UTP Implementation (Straight-Through)

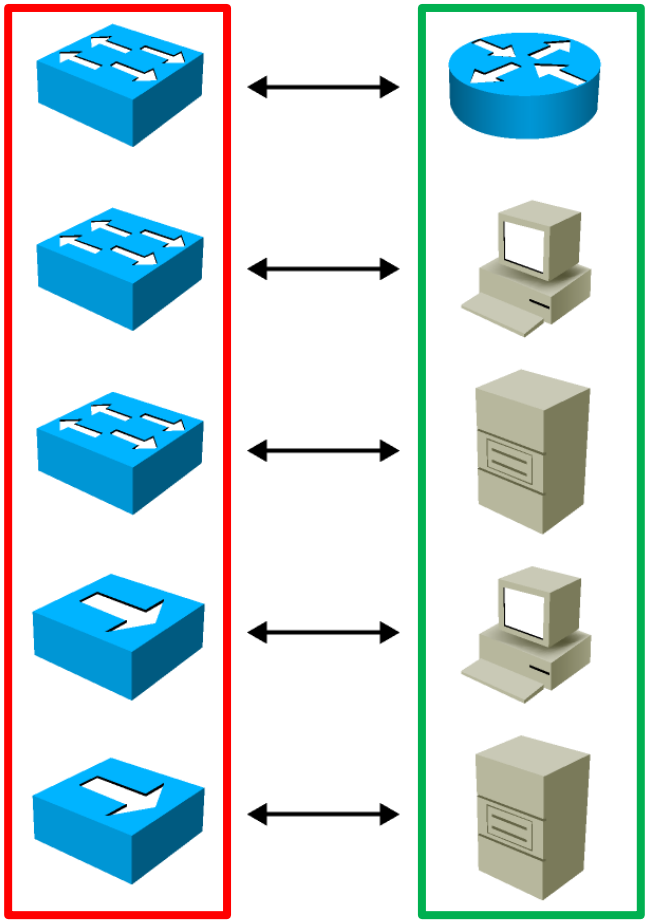


UTP Implementation (Crossover)

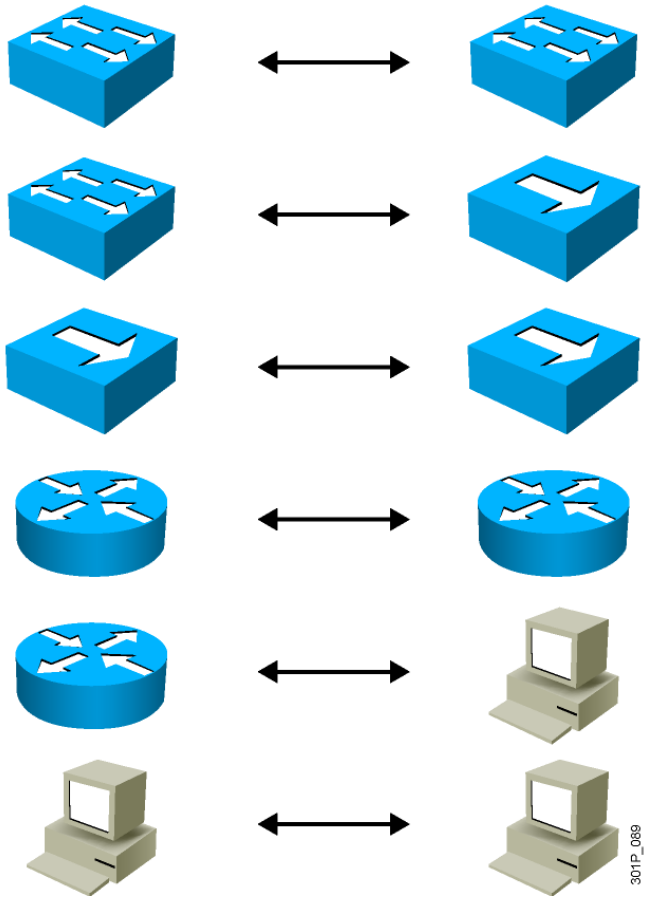


UTP Implementation: Straight-Through vs. Crossover

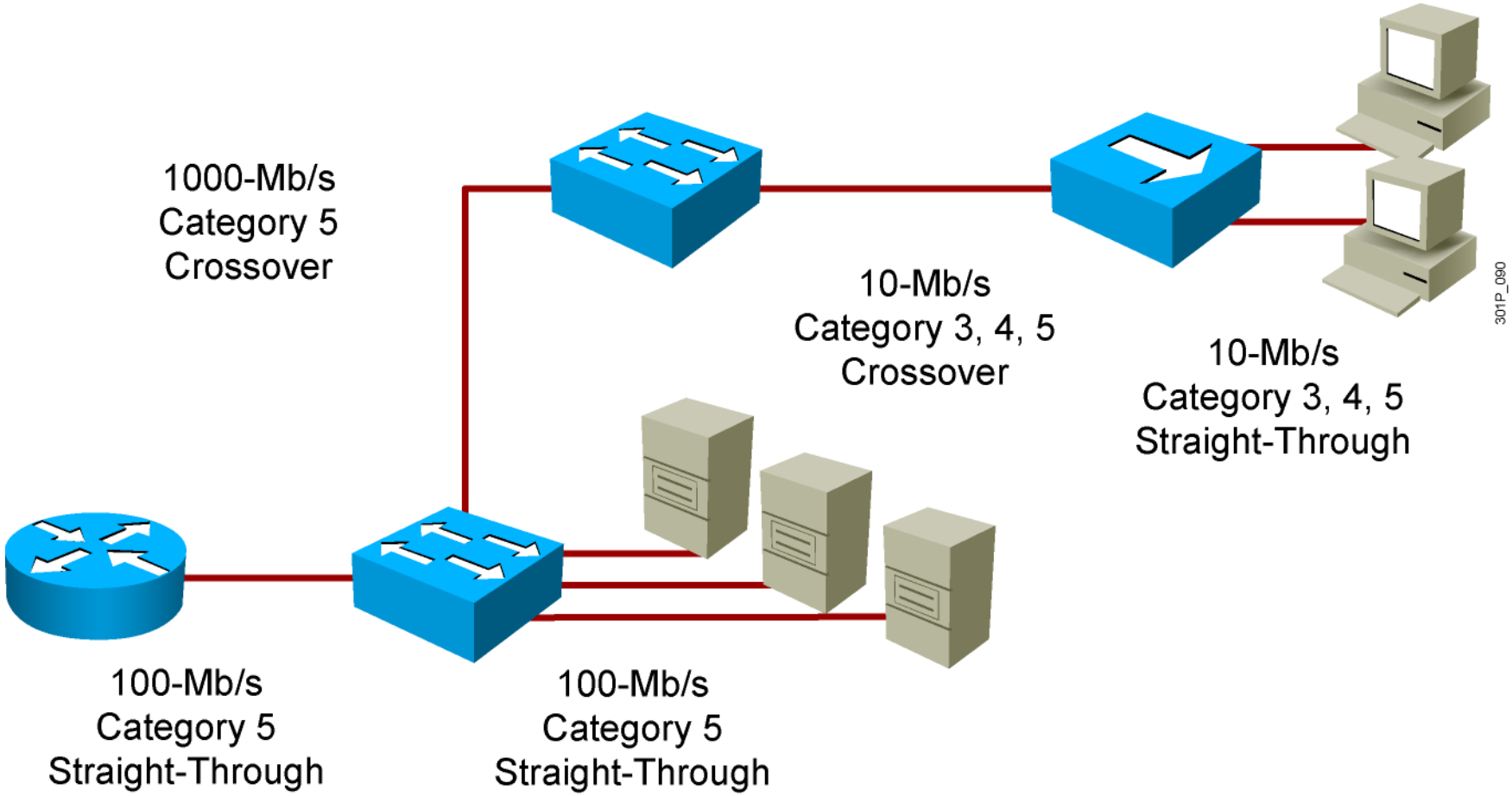
Straight-Through Cable



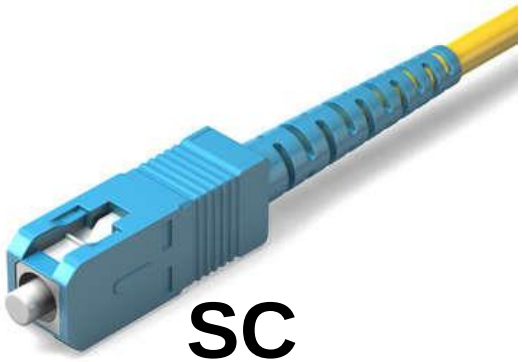
Crossover Cable



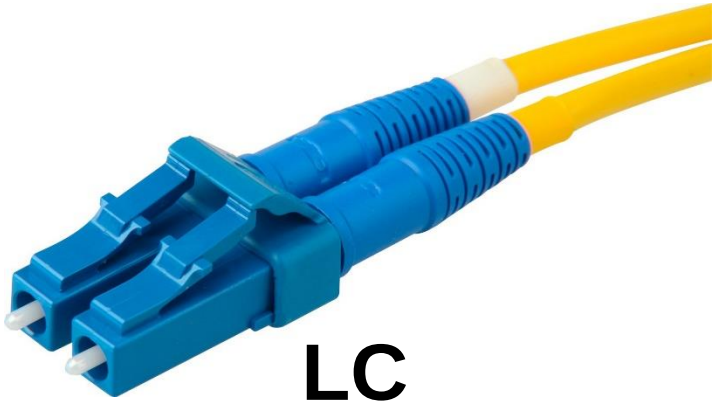
Using Varieties of UTP



Fiber Optic Connectors



SC

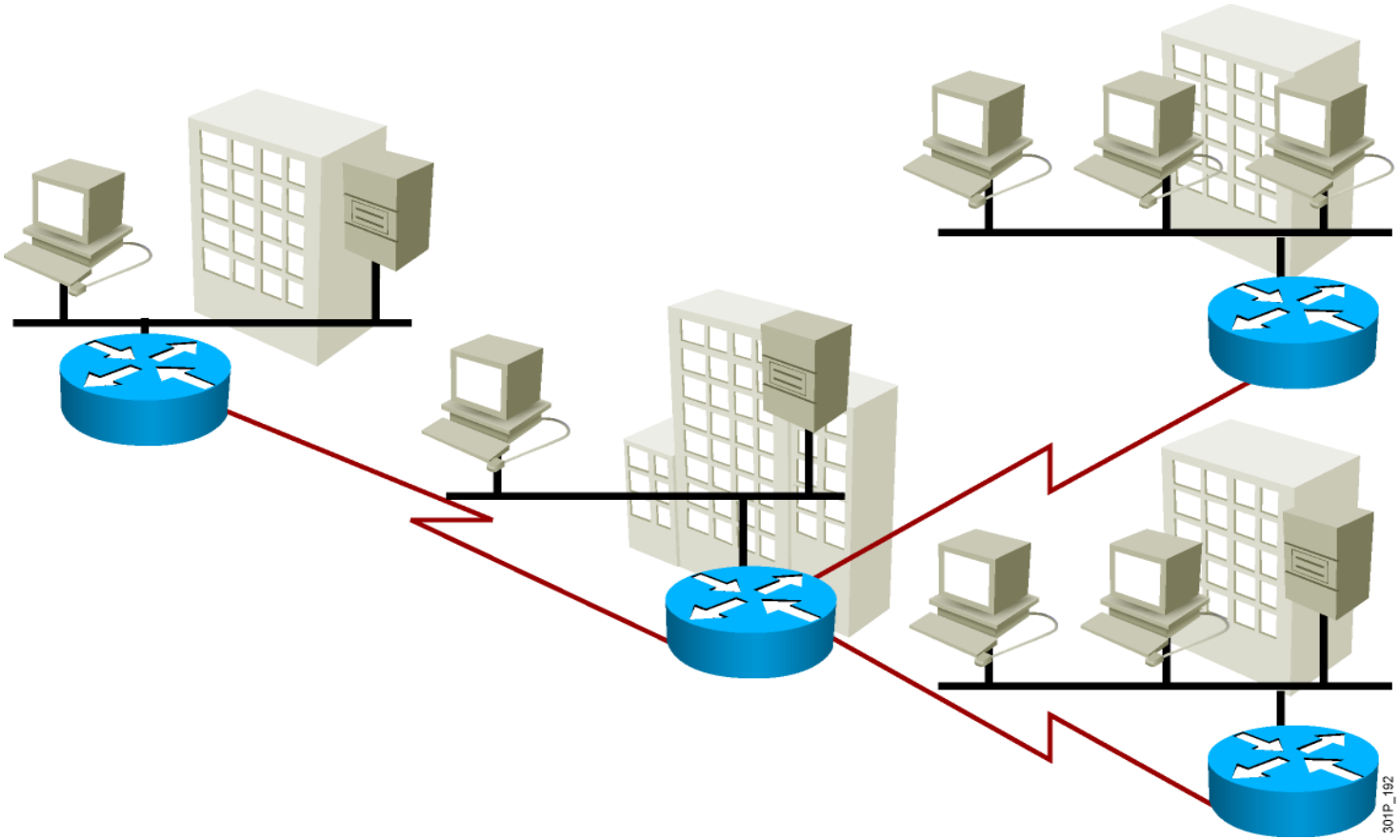


LC

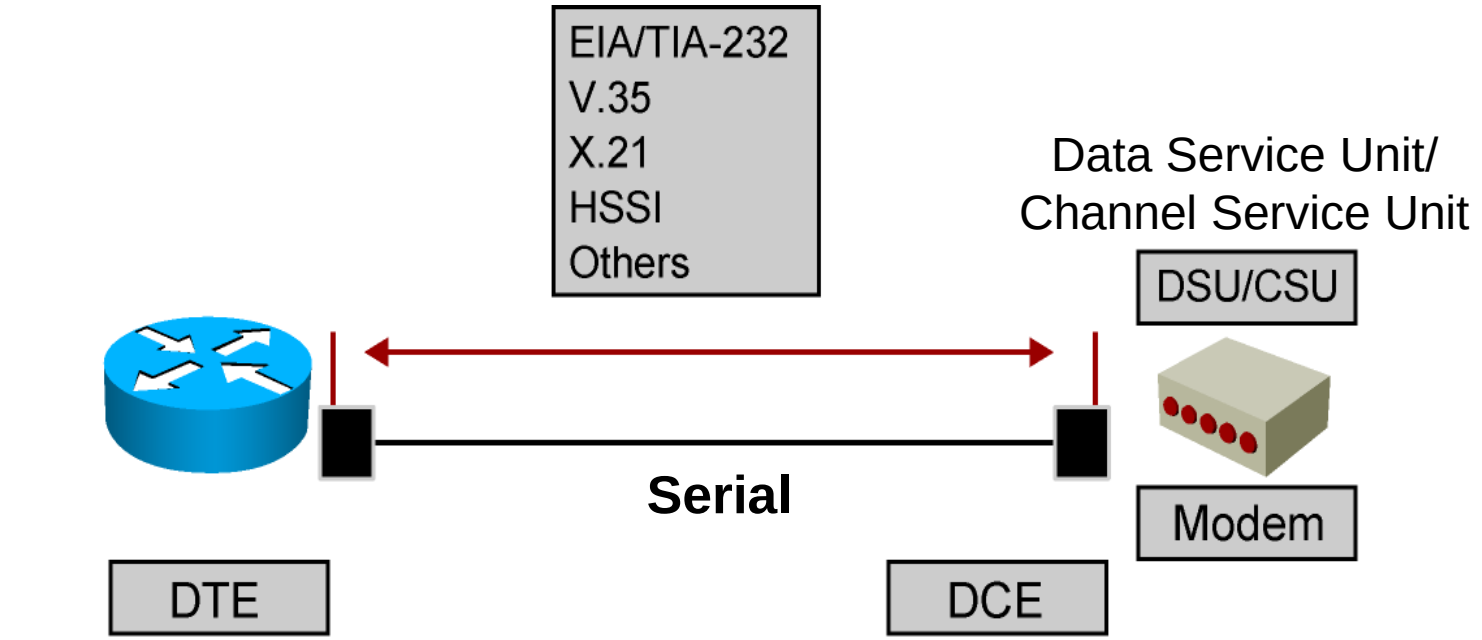
FC

ST

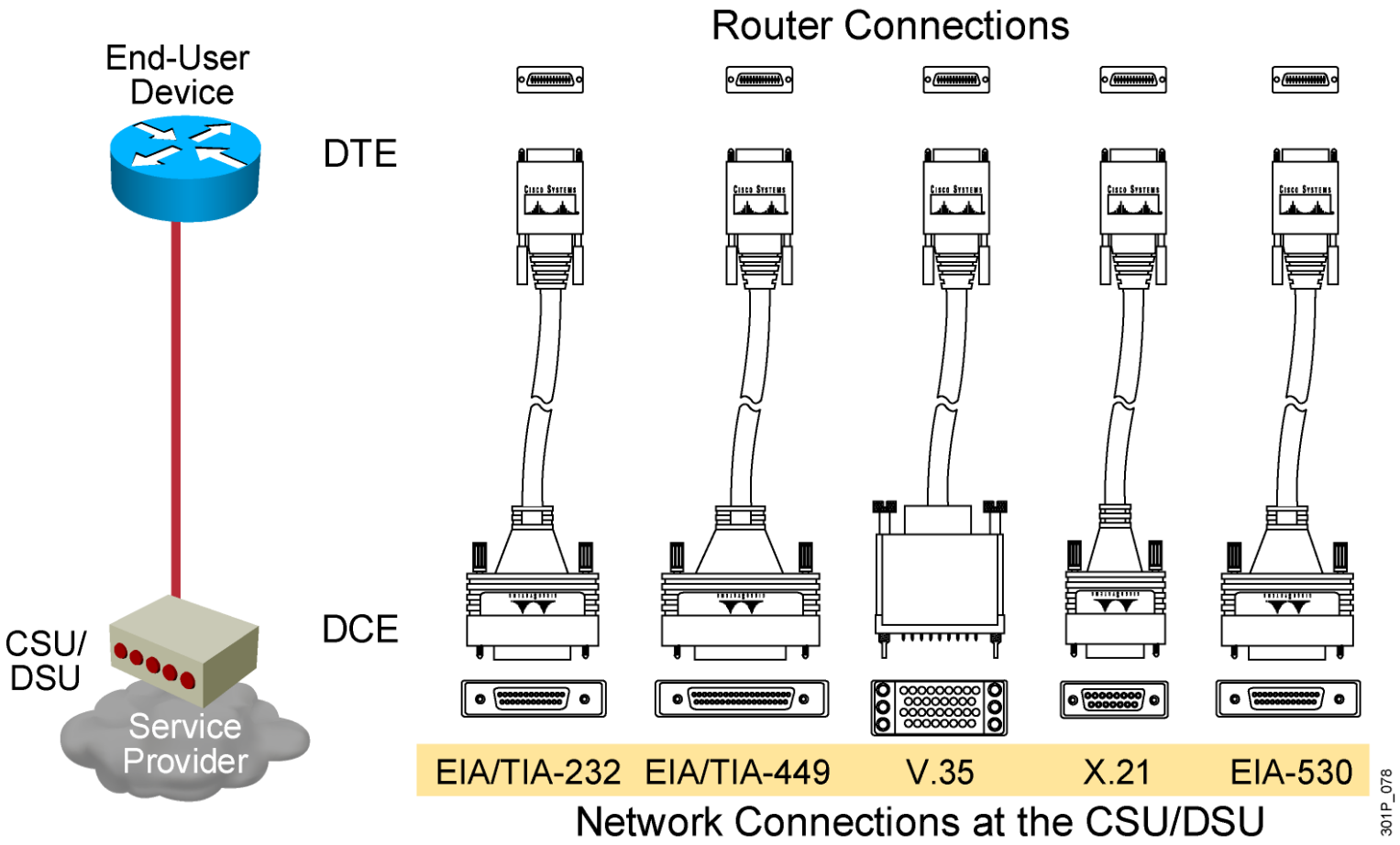
WAN—Multiple LANs



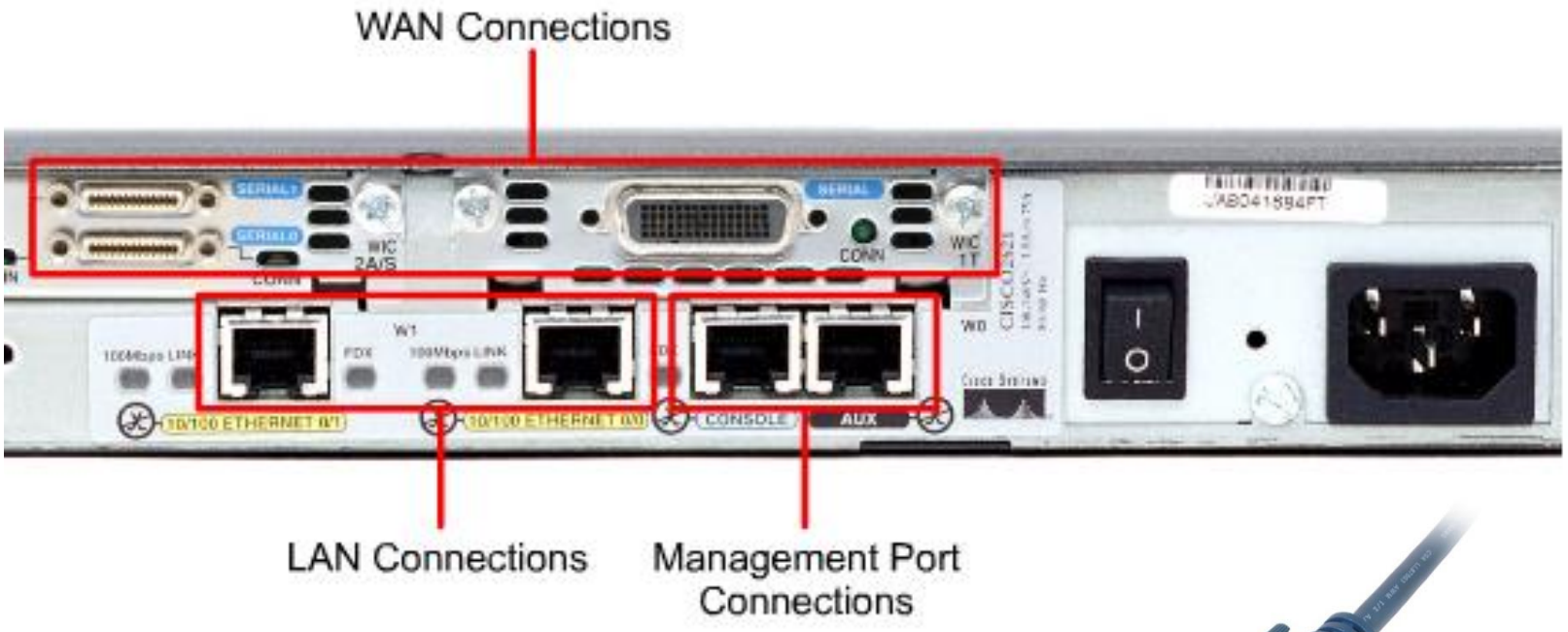
Physical Layer: WANs



Serial Point-to-Point Connections



WAN Devices



To T1 circuit

To router

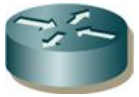
Setting up a Console Connection

Console
Rollover
Null-modem

HyperTerminal
SecureCRT
Putty

COM
RS232

RJ-45
CONSOLE



Start → Program → Accessories → Communication → Hyper Terminal


CISCO