CCNA I

Network Fundamentals

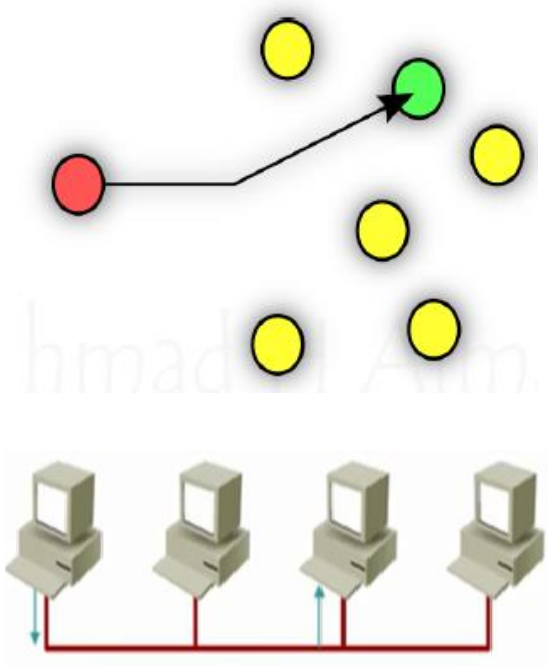
Eng. Eman Osama

Cisco Networking Academy®
Mind Wide Open™

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

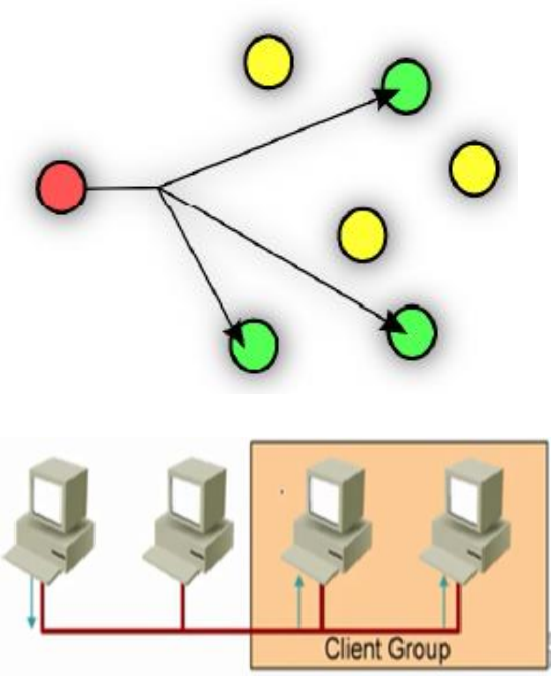
Methods of Sending Data in the Network

Unicast



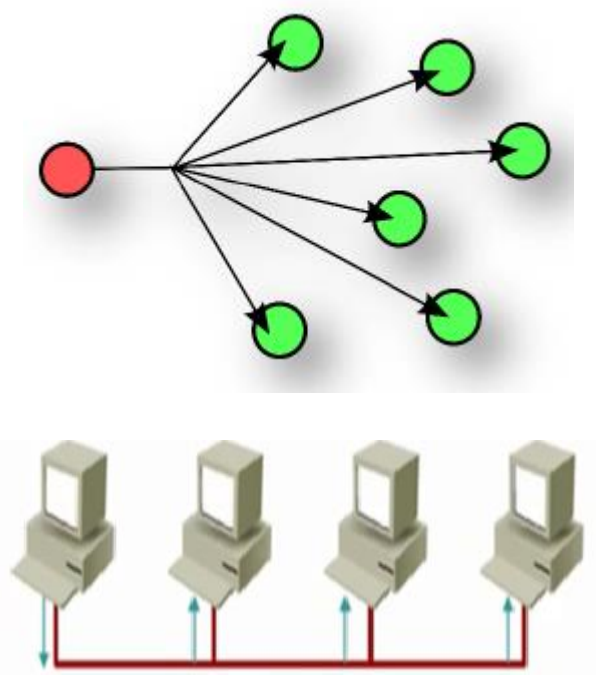
means send data for one or all receivers.

- **Multicast**



means send data for some receivers or all.

- **Broadcast**



means send data for all receivers.

Transmission types

Single

Transmission in one direction only

- Half duplex

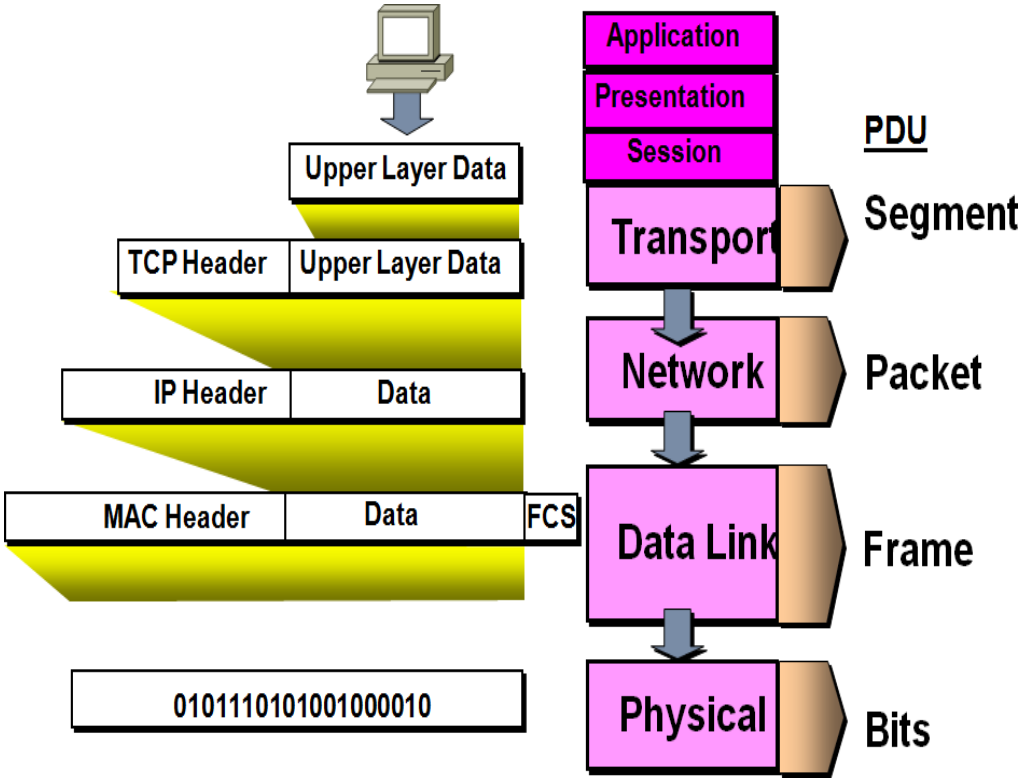
Transmission in the two directions but not at the same time

- Full duplex

Transmission in the two directions at the same time

2- Data link

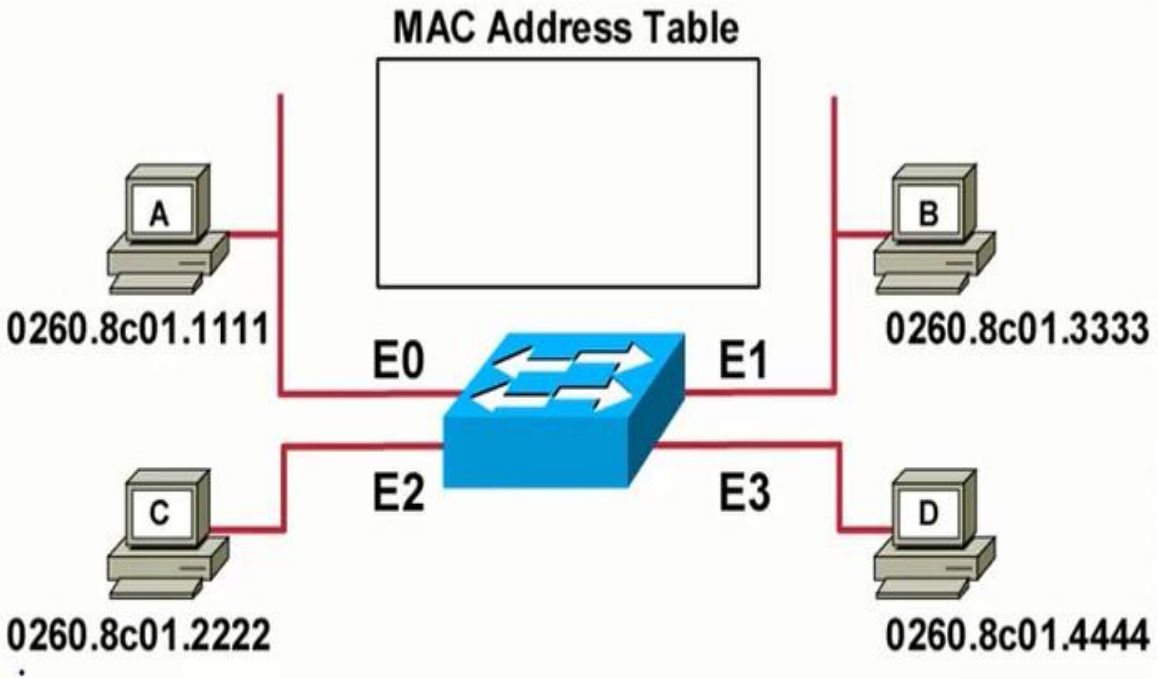
- Data frame format
- MAC Address.



- Error detection

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

MAC address table

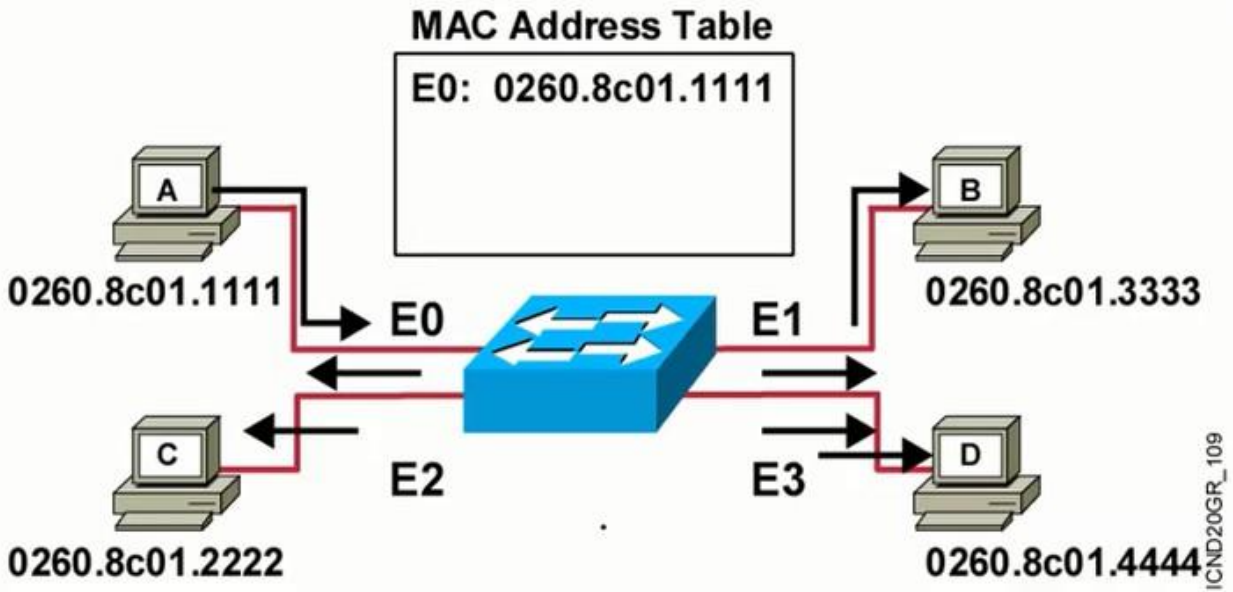


- Initial MAC address table is empty.

- Address learning
- Forward/filter decision

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

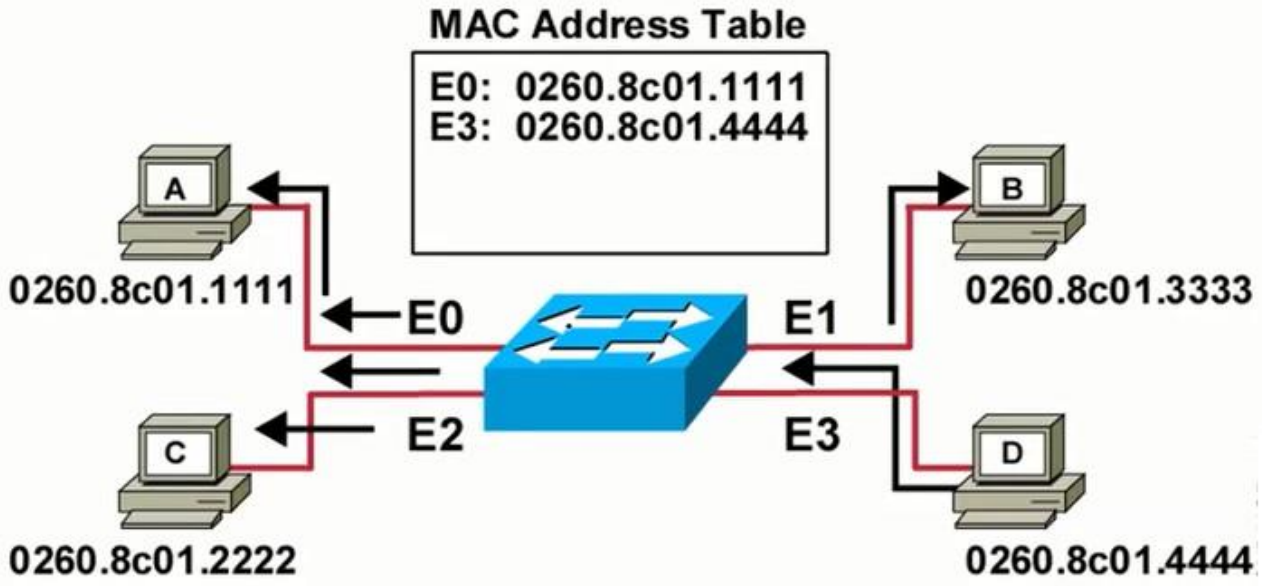
Learning addresses



- Station A sends a frame to station C.
- Switch caches the MAC address of station A to port E0 by learning the source address of data frames.
- The frame from station A to station C is flooded out to all ports except port E0 (unknown unicasts are flooded).

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

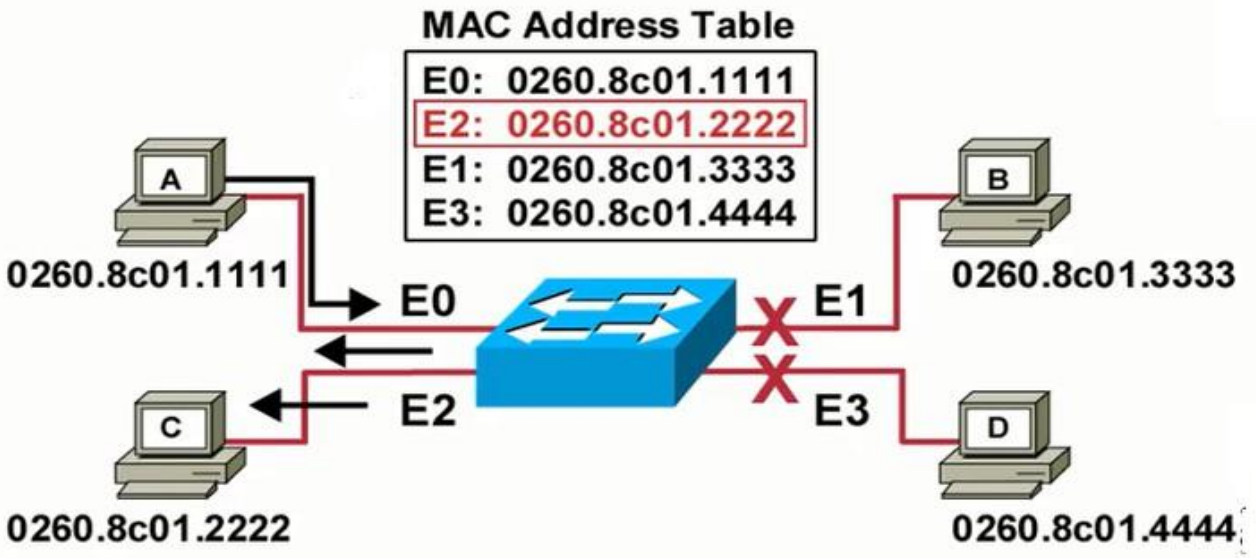
Learning addresses



- Station D sends a frame to station C.
- Switch caches the MAC address of station D to port E3 by learning the source address of data frames.
- The frame from station D to station C is flooded out to all ports except port E3 (unknown unicasts are flooded).

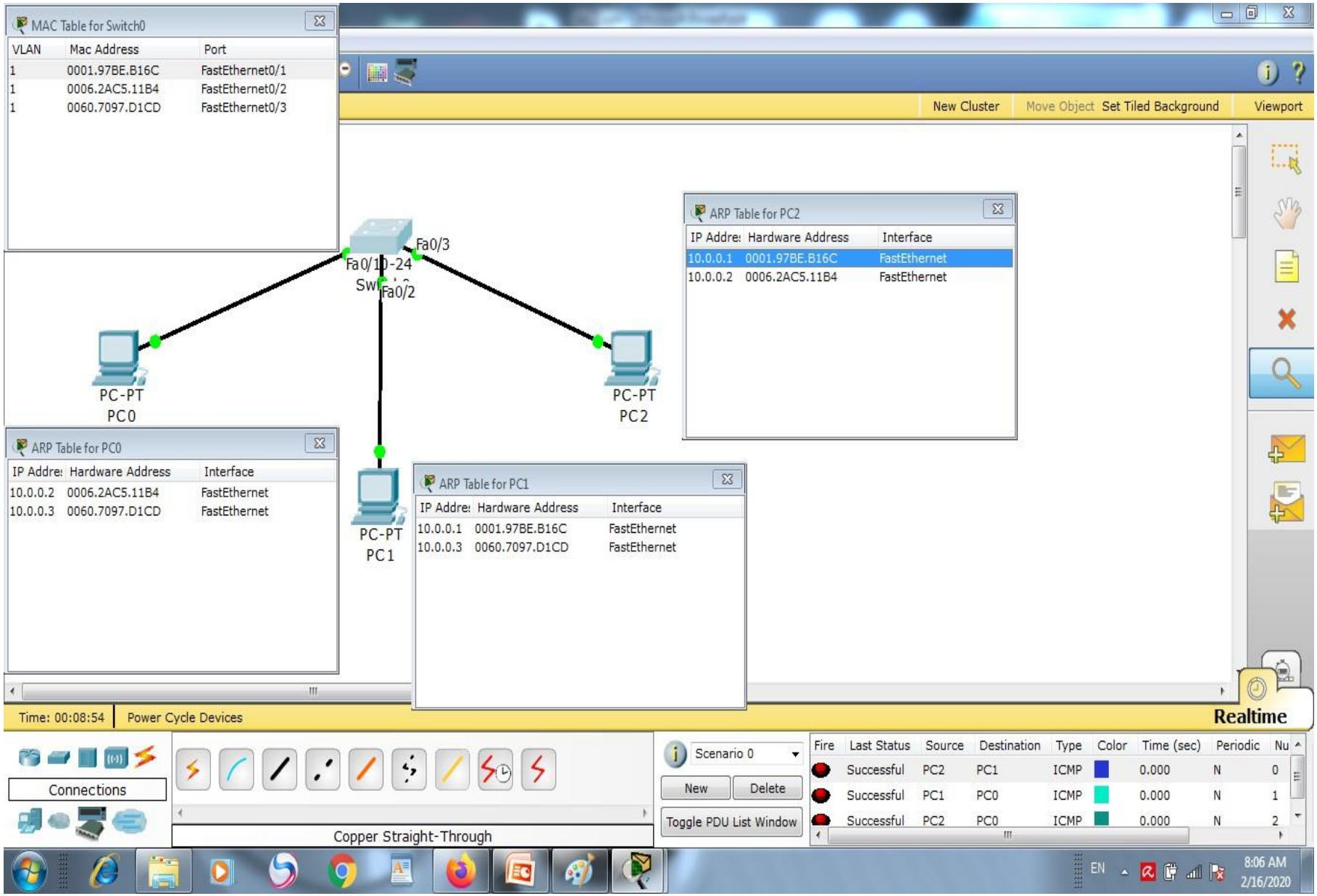
© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Filtering frames



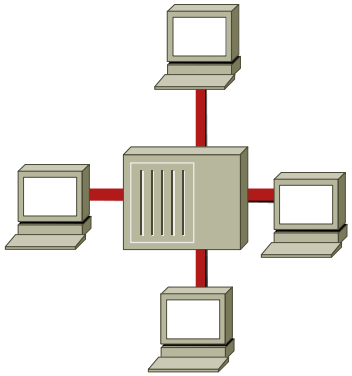
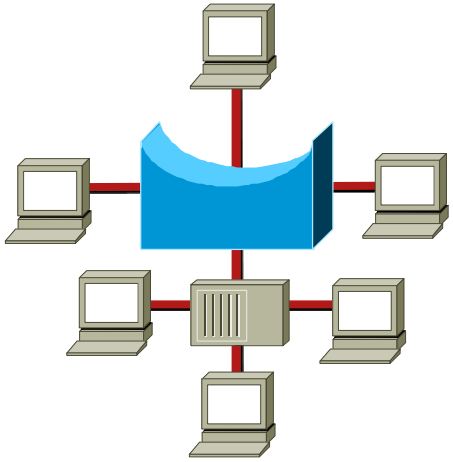
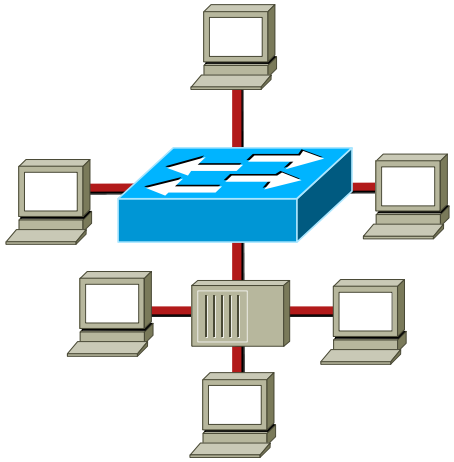
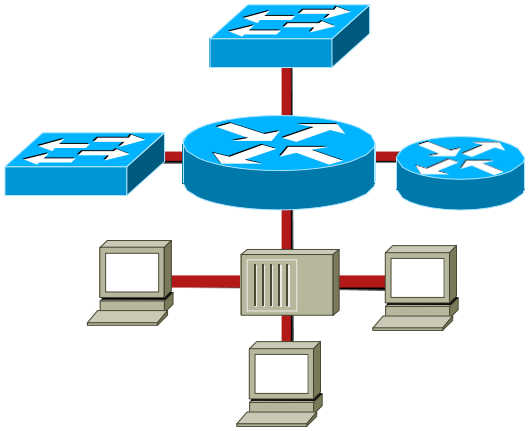
- Station A sends a frame to station C.
- Destination is known; frame is not flooded.

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Network Device Domains

Hub	Bridge	Switch	Router
Layer 1 device	Layer 2 device	Layer 2 device	Layer 3 device
			

- **Collision Domains:**

1	4	4	4

- **Broadcast Domains:**

1	1	1	4

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

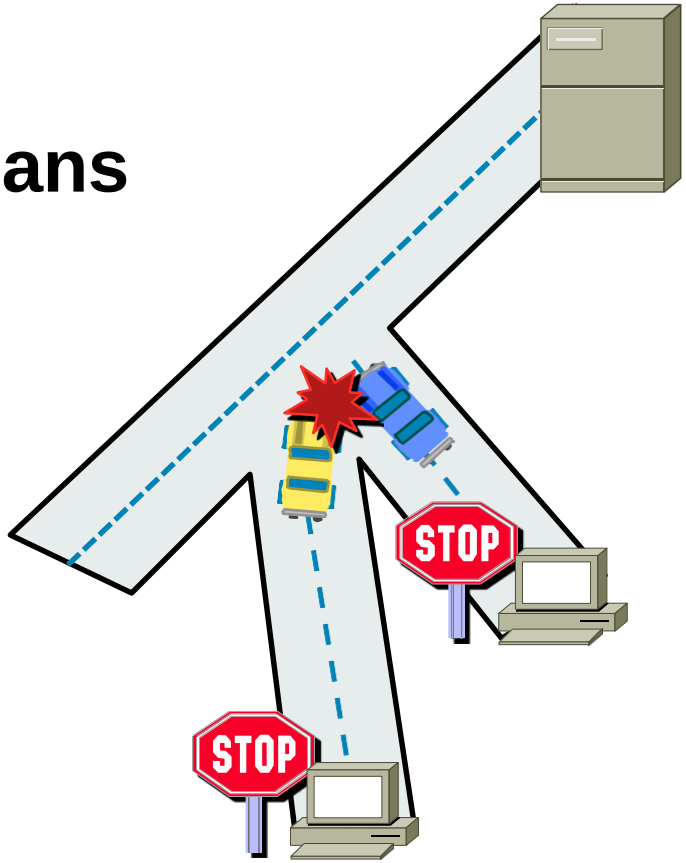
Devices and the layers at which they operate

Layer	Name of Layer	Device
3	Network	Routers, layer 3 switches
2	Data Link	Switches, bridges
1	Physical	Hubs

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

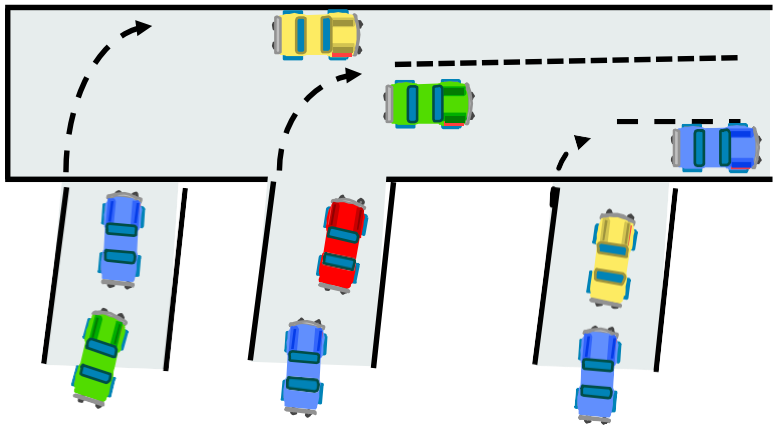
Hubs: One Collision Domain

- More end stations means more collisions

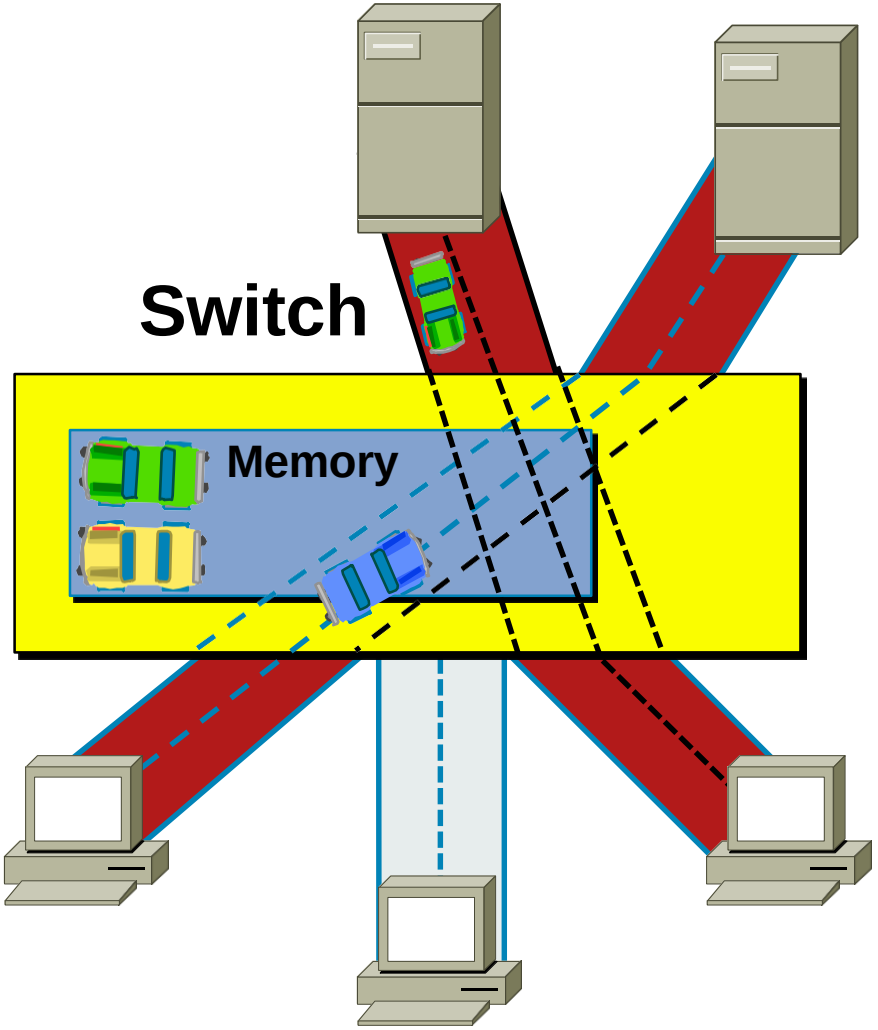


© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Switches

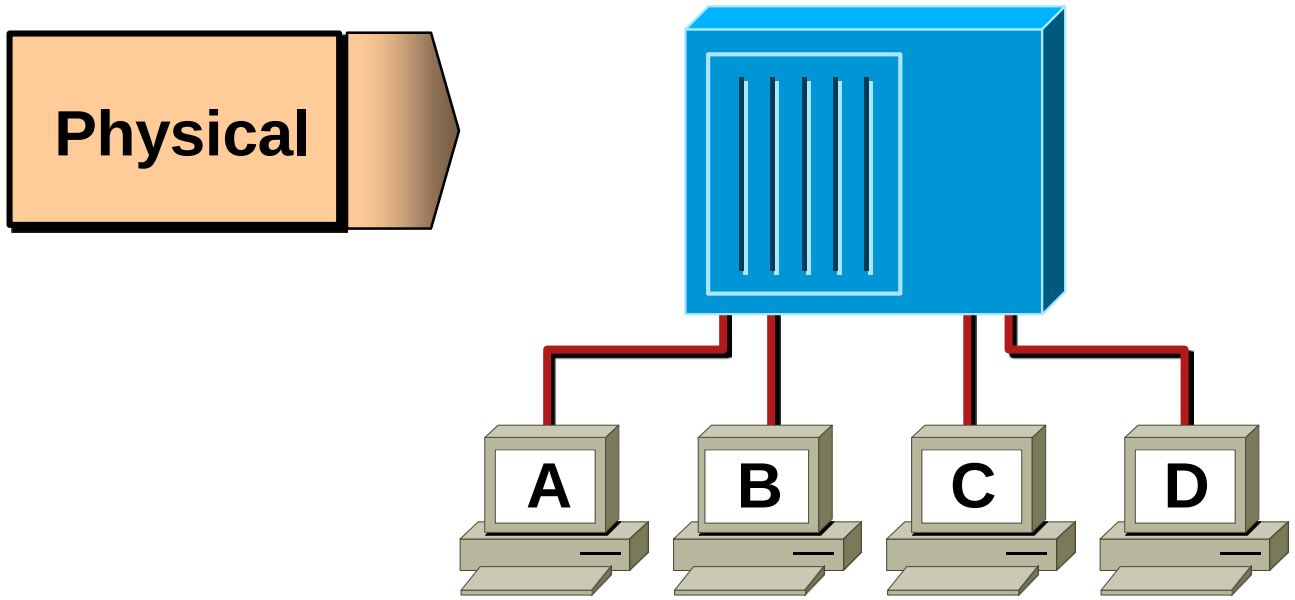


- Each segment has its own collision domain
- Broadcasts are forwarded to all segments



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

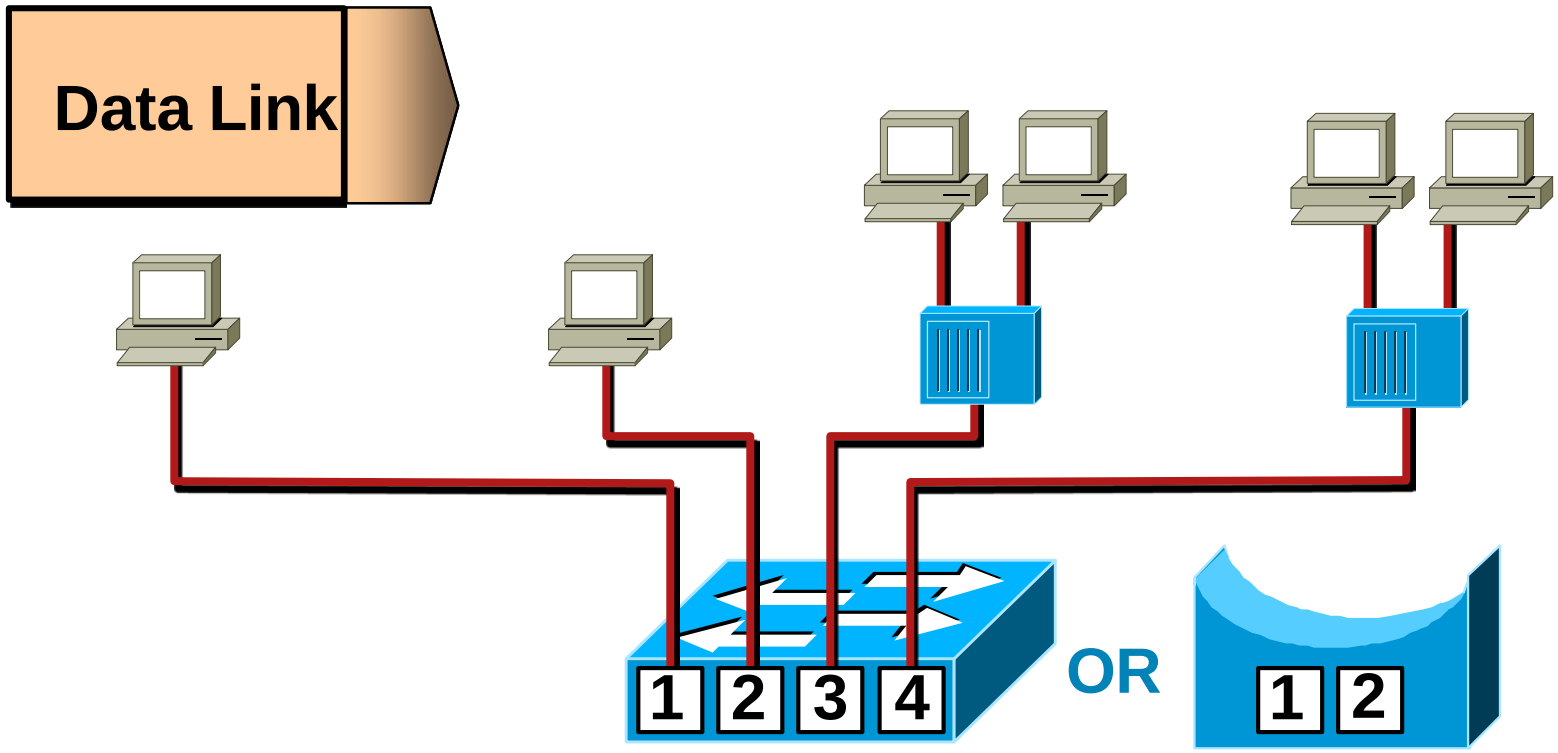
Hubs Operate at Physical layer



- All devices in the same collision domain
- All devices in the same broadcast domain
- Devices share the same bandwidth

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

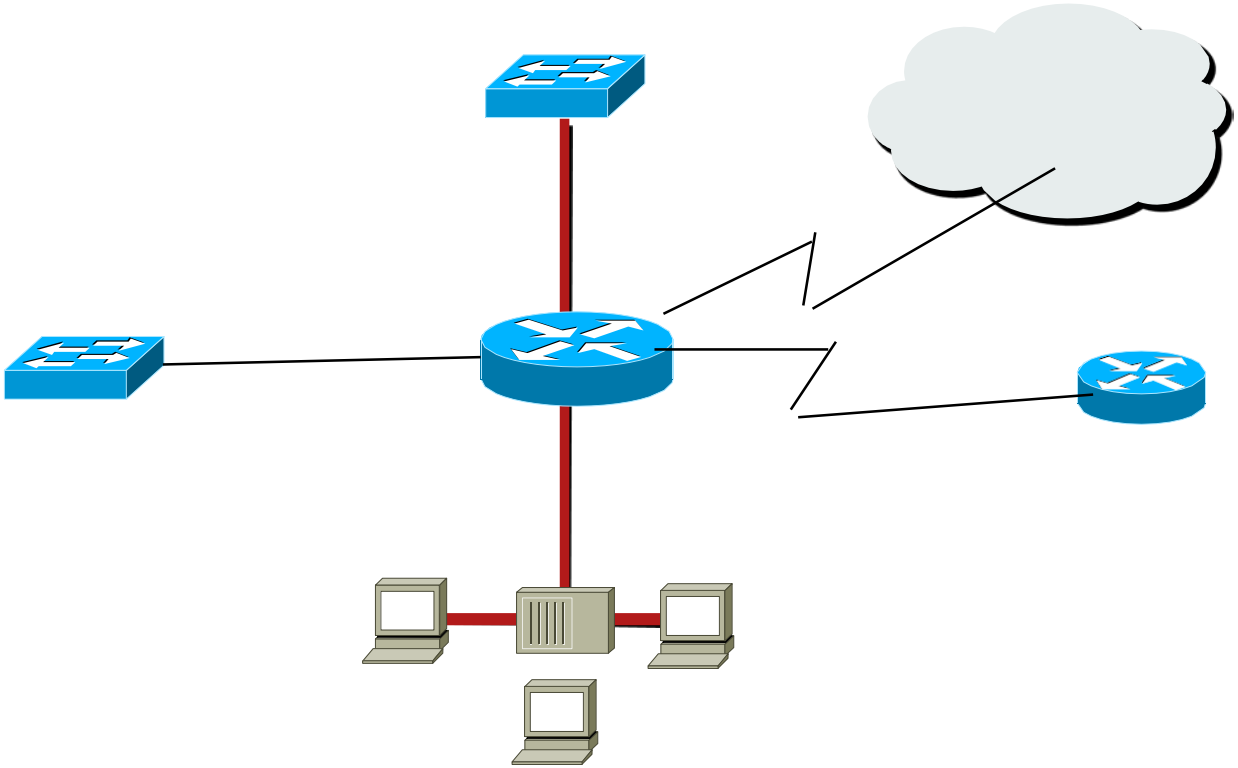
Switches and Bridges Operate at Data Link Layer



- Each segment has its own collision domain
- All segments are in the same broadcast domain

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

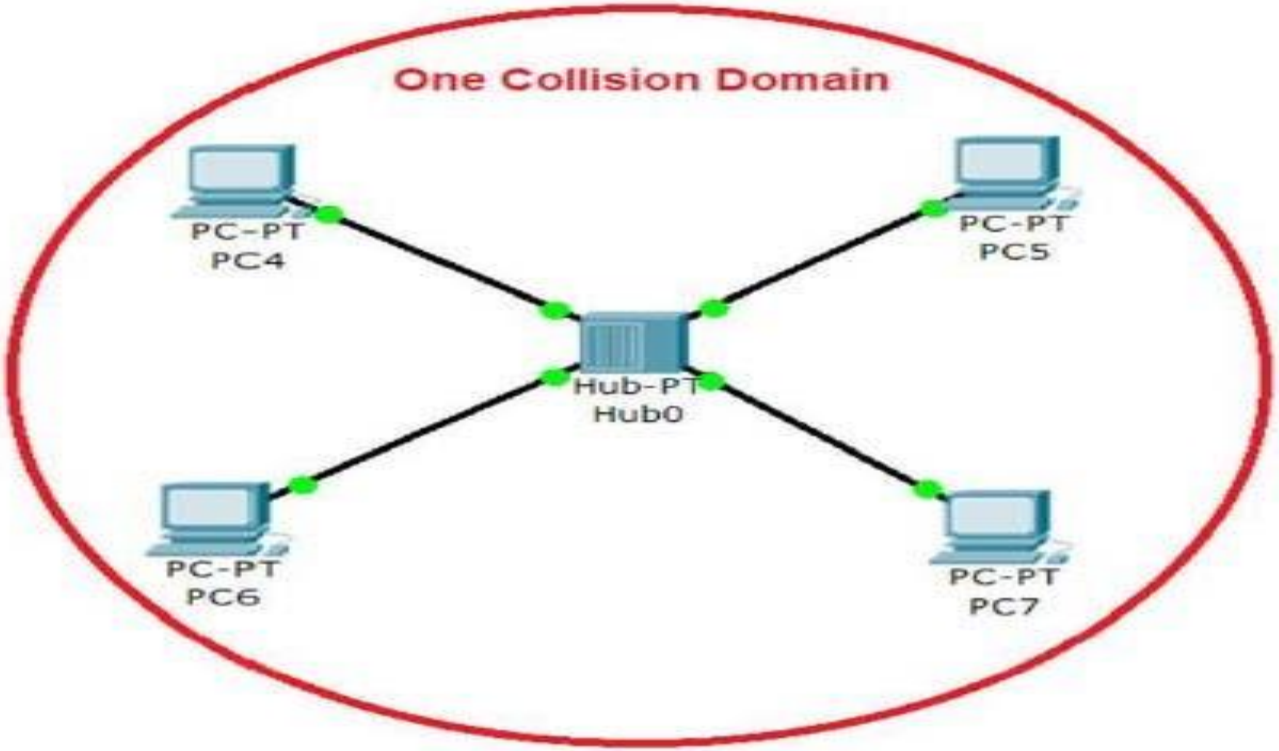
Router Operate at Network layer



All interfaces of the router are members in a multiple broadcast domain, and multiple collision domains

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Find number of broadcast domains and number of collision domains



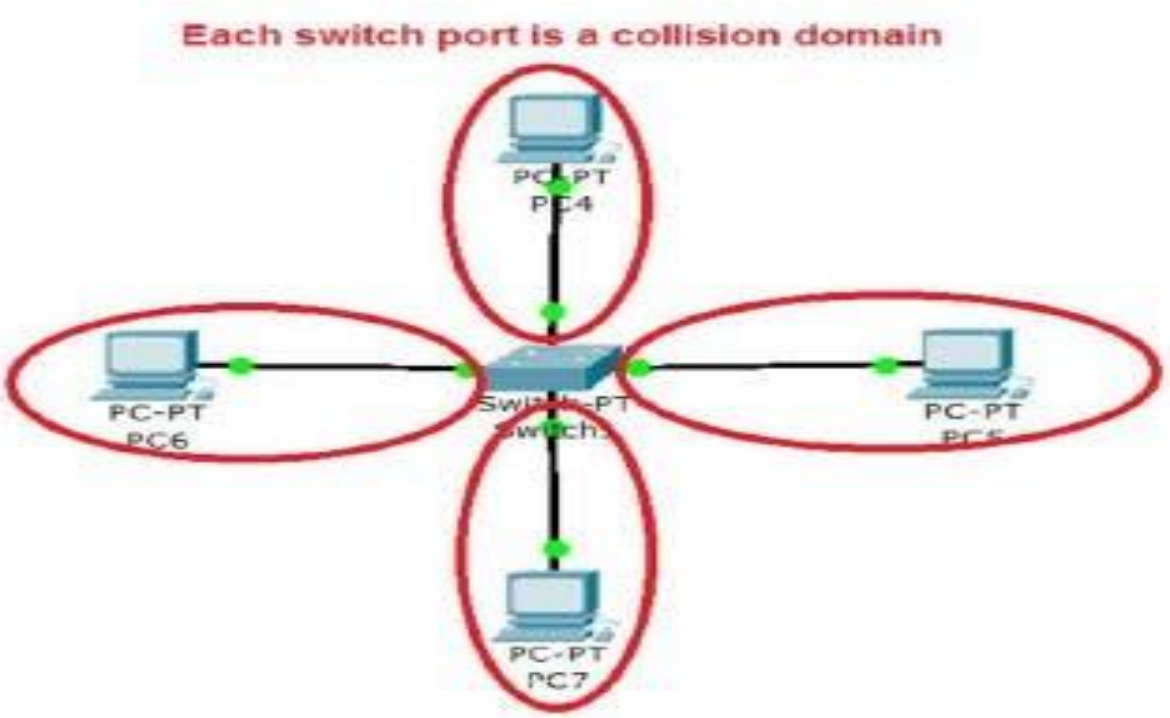
Solution :

no. of broadcast domains = 1

no. of collision domains = 1

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Find number of broadcast domains and number of collision domains



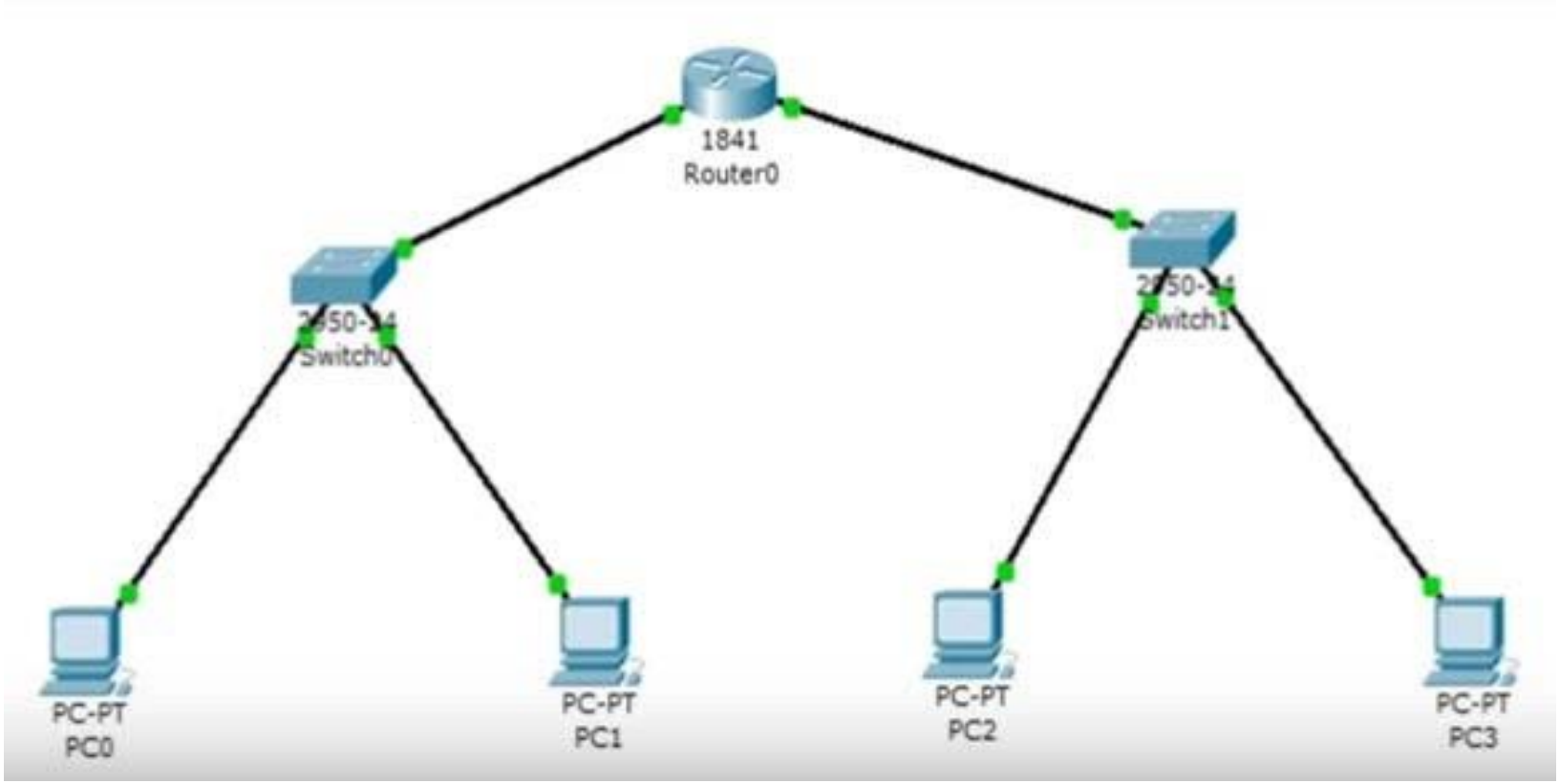
Solution :

no. of broadcast domains = 1

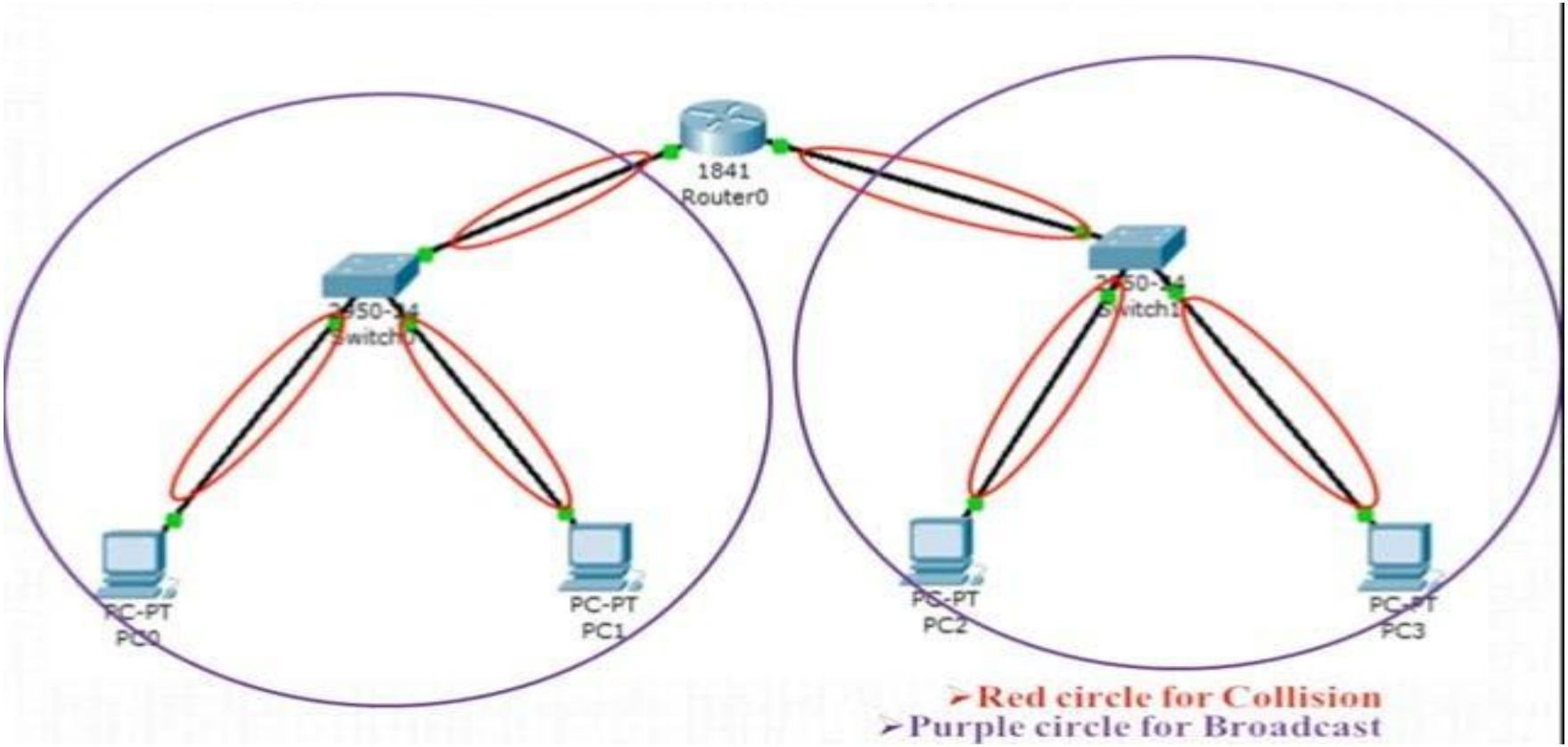
no. of collision domains = 4

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Find number of broadcast domains and number of collision domains



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



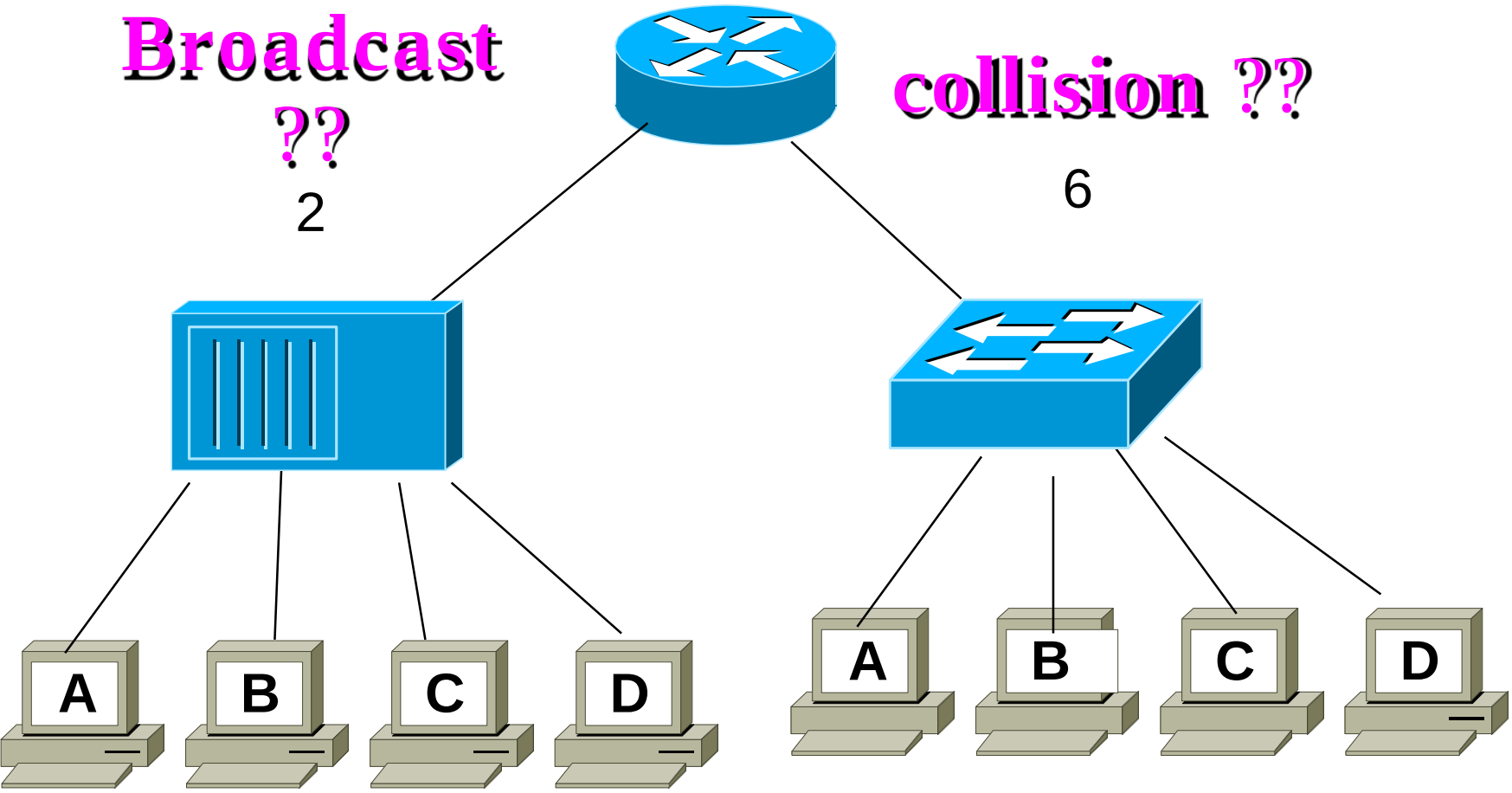
Solution :

no. of broadcast domains = 2

no. of collision domains = 6

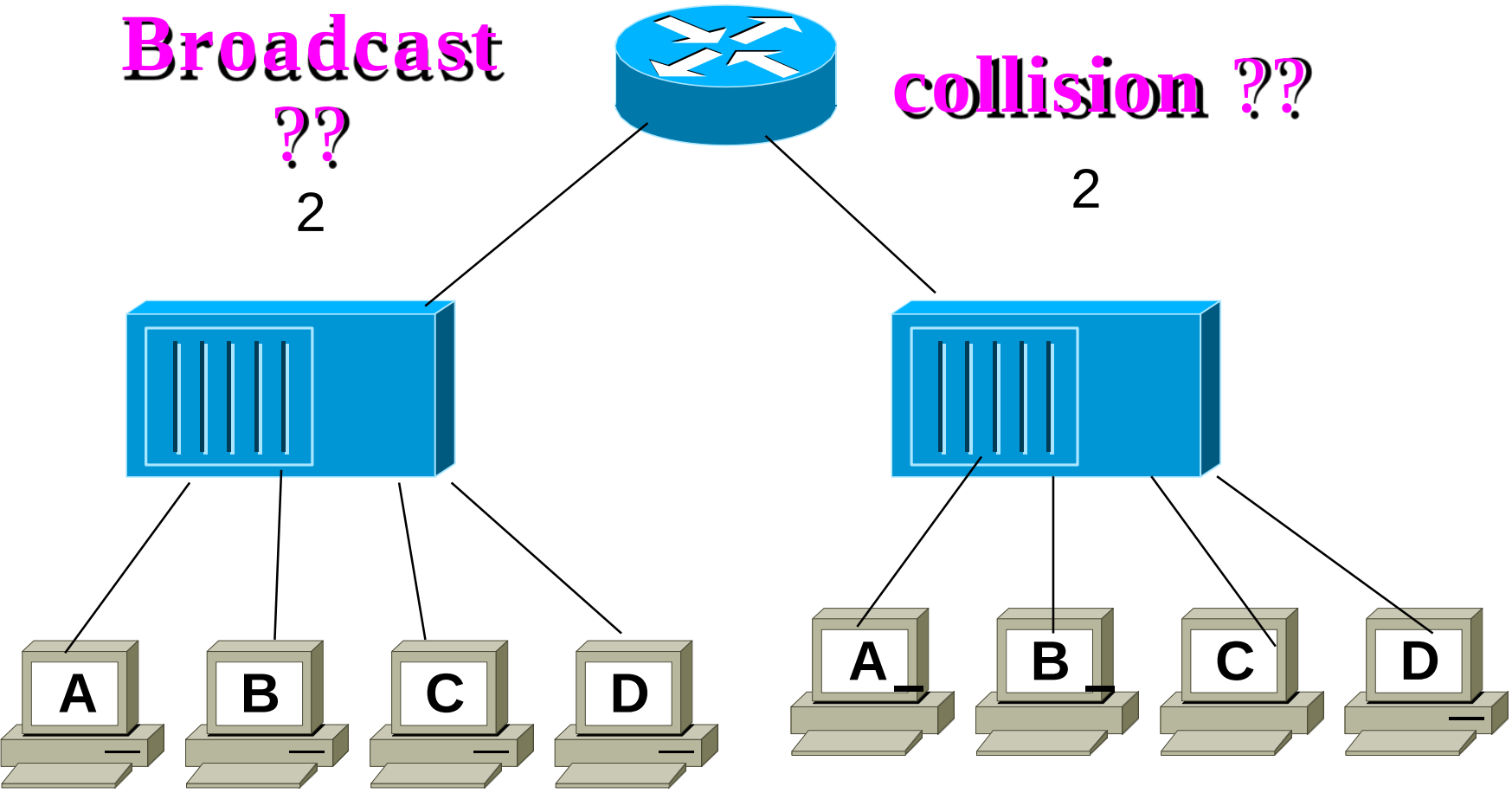
© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Question



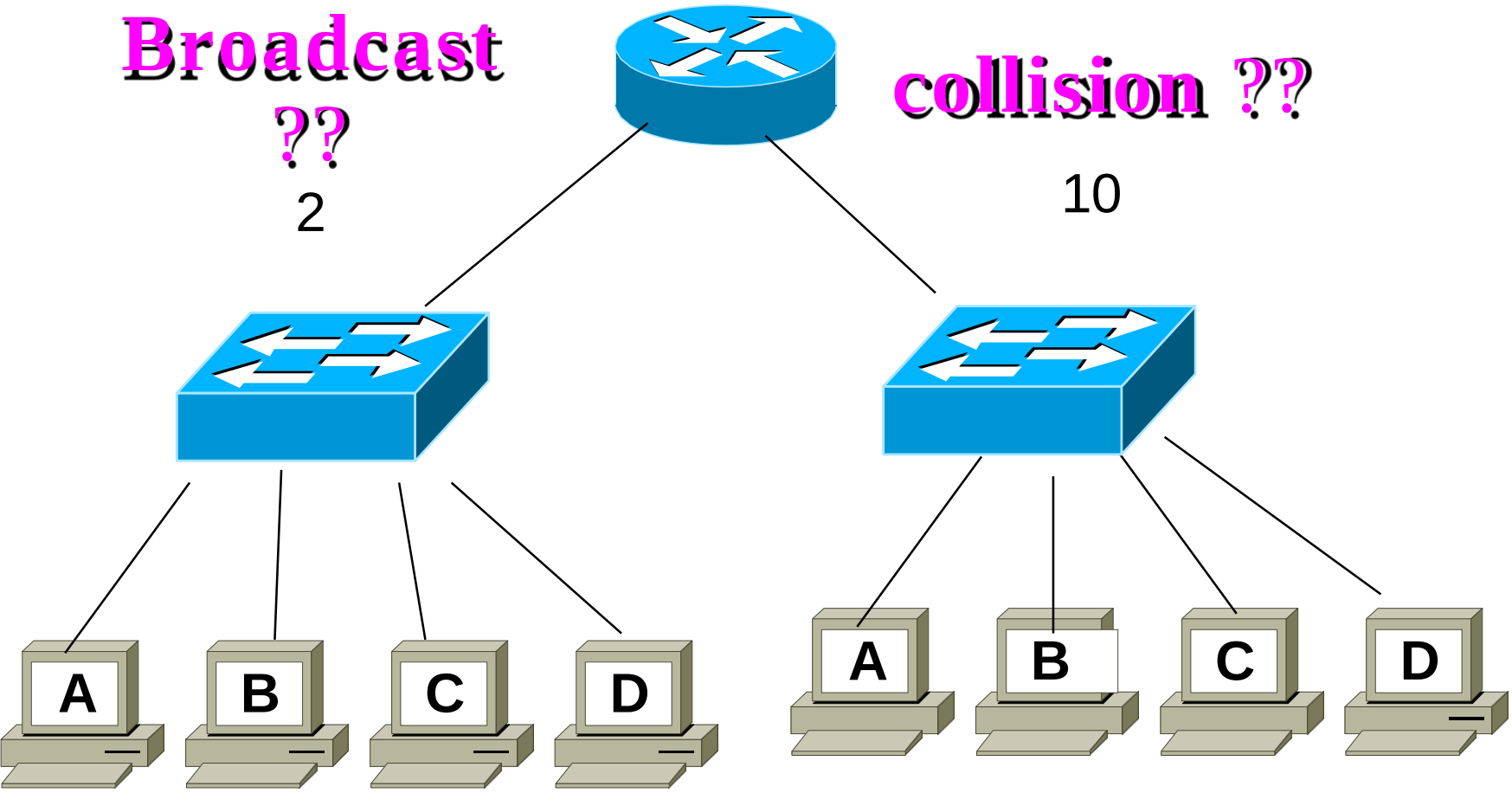
© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Question



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Question



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

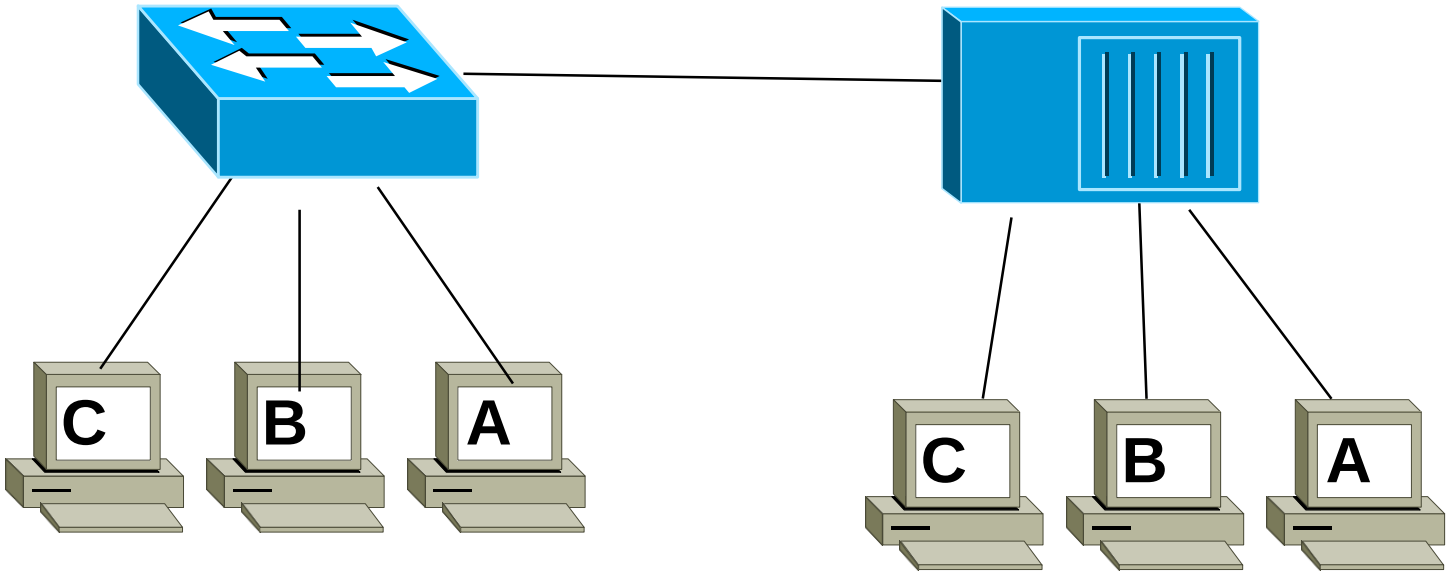
Question

Broadcast ??

1

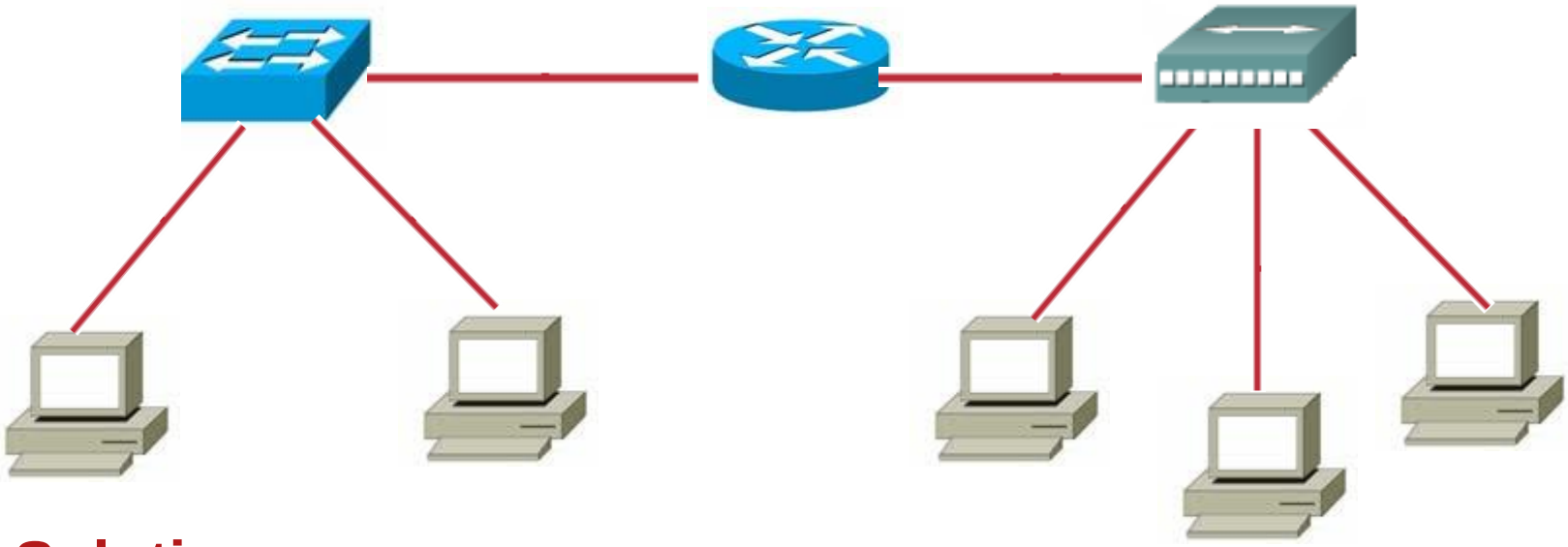
collision ??

4



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Find number of broadcast domains and number of collision domains



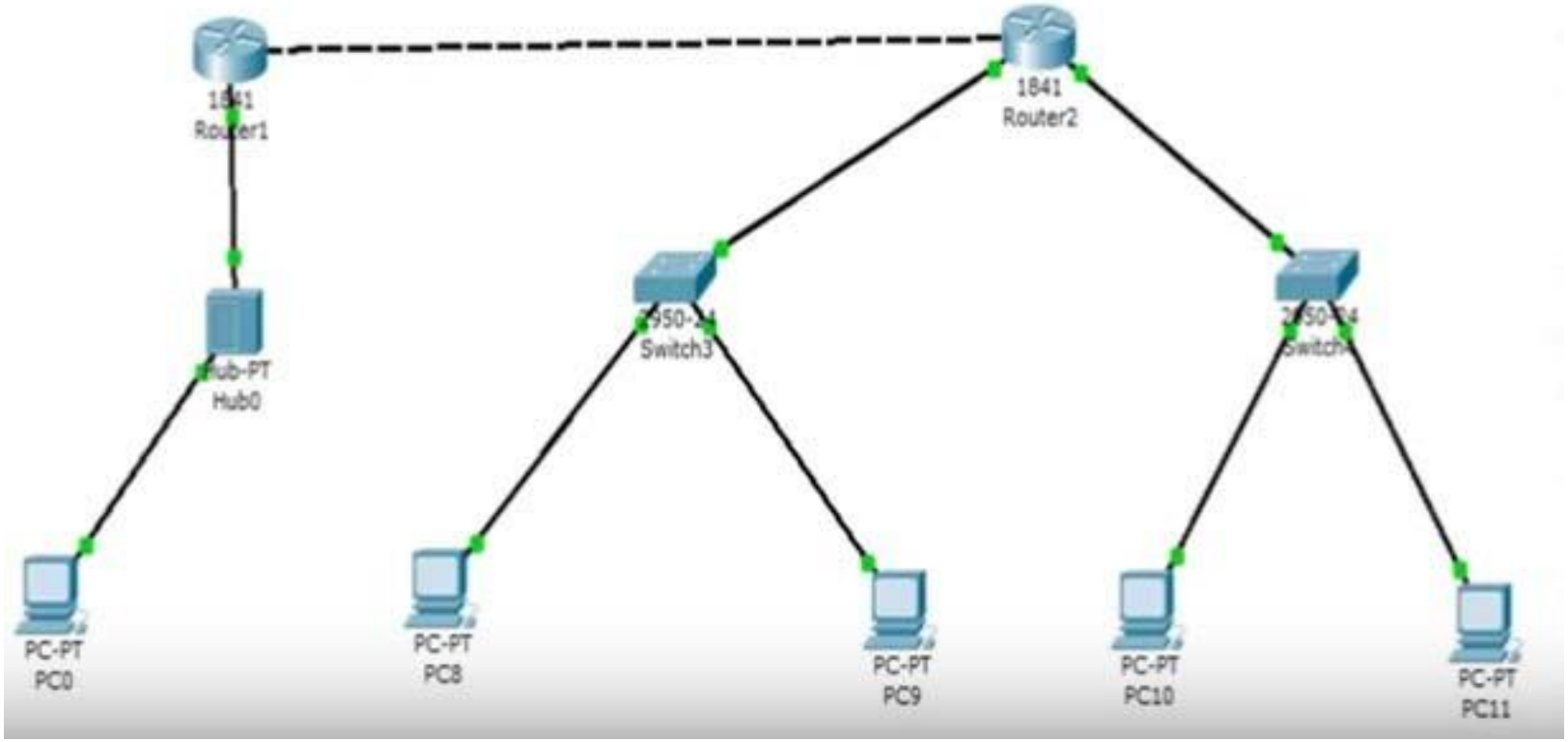
Solution :

no. of broadcast domains =

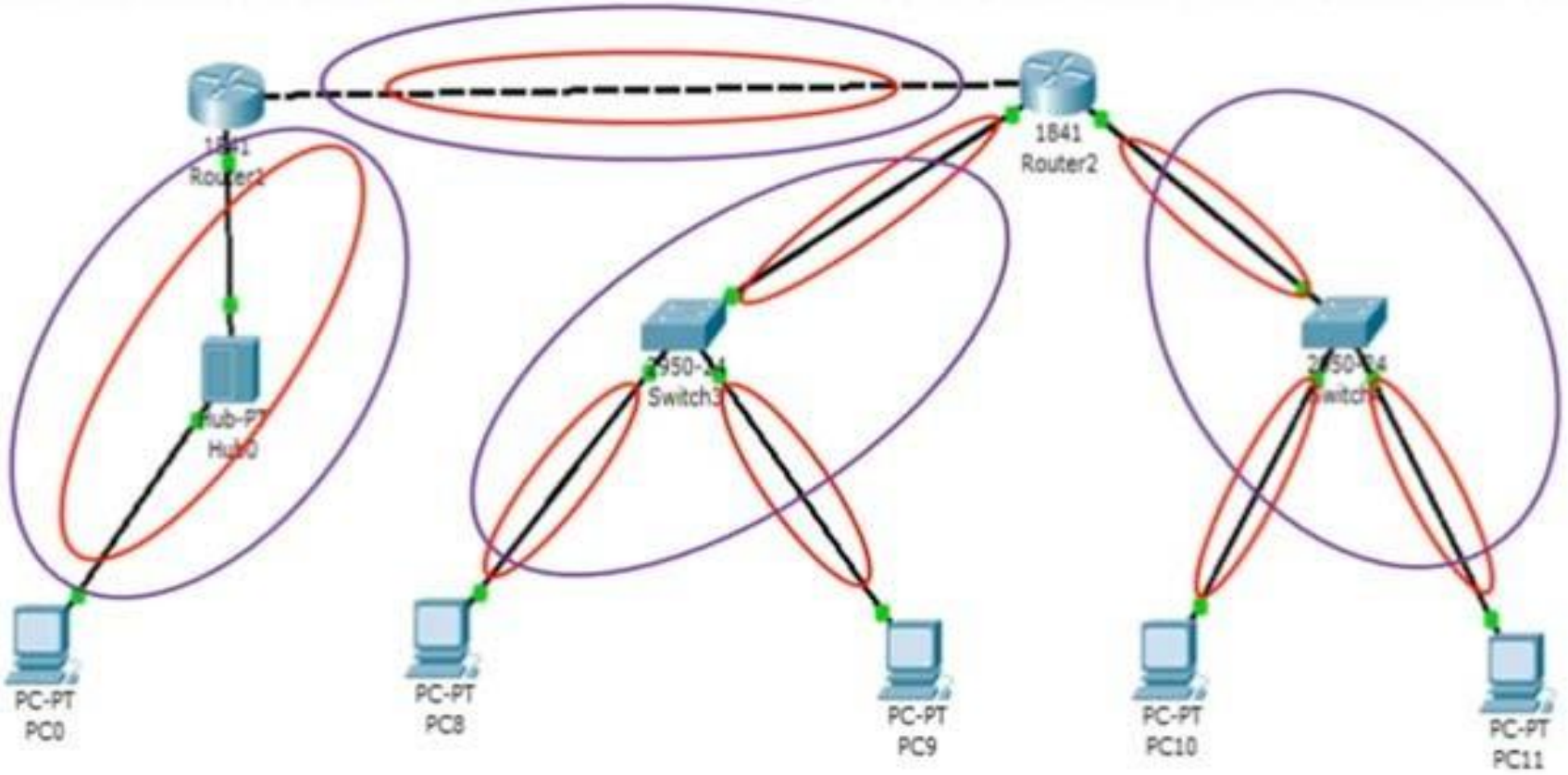
no. of collision domains =

© 2007 Cisco Systems, Inc. All rights reserved.

Find number of broadcast domains and number of collision domains



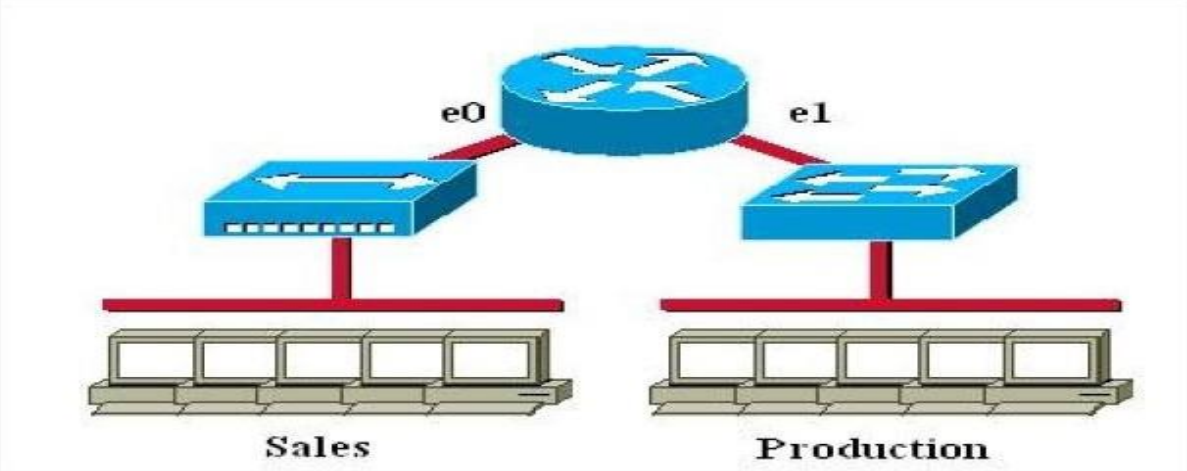
© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



- Red circle for Collision
- Purple circle for Broadcast

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Which of the following statements describe the network shown in the graphic? (Choose two.)

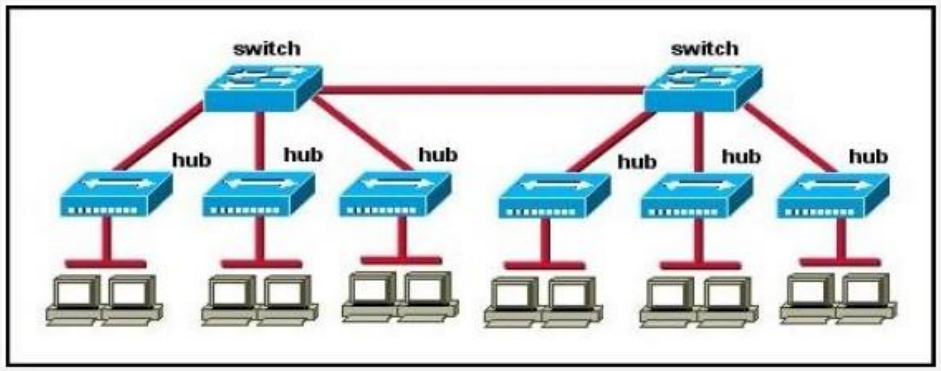


A. There are two broadcast domains in the network.
B. There are four broadcast domains in the network.
C. There are six broadcast domains in the network.
D. There are four collision domains in the network.
E. There are five collision domains in the network.
F. There are seven collision domains in the network.

Correct Answers: A,F

Explanation:
Only router can break up broadcast domains so in the exhibit there are 2 broadcast domains: from e0 interface to the left is a broadcast domain and from e1 interface to the right is another broadcast domain.
Both router and switch can break up collision domains so there is only 1 collision domain on the left of the router (because hub doesn't break up collision domain) and there are 6 collision domains on the right of the router (1 collision domain from e1 interface to the switch + 5 collision domains for 5 PCs in Production).

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



How many broadcast domains are shown in the graphic assuming only the default VLAN is configured on the switches?

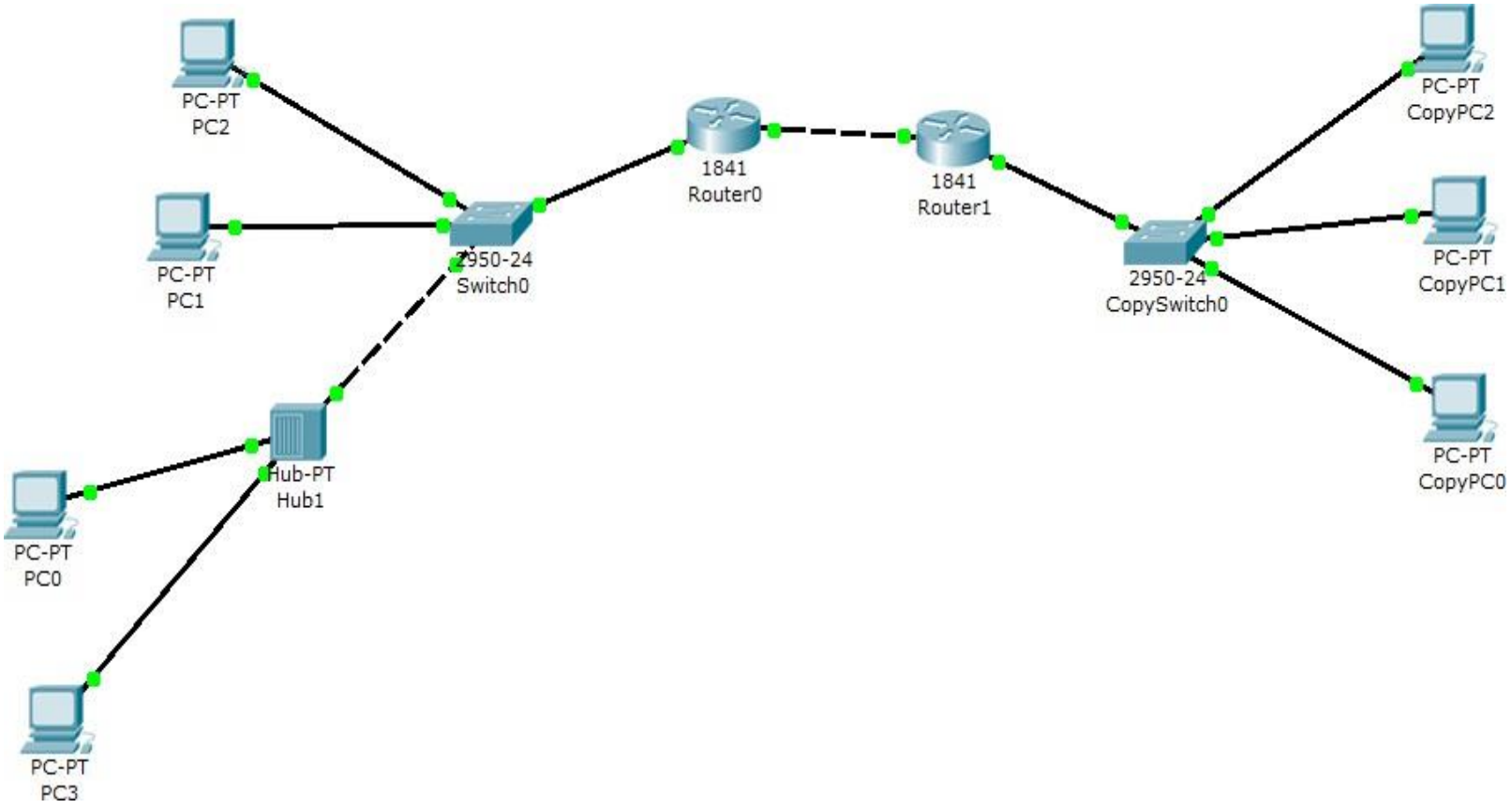
A. one
B. two
C. six
D. twelve

Correct Answer: A

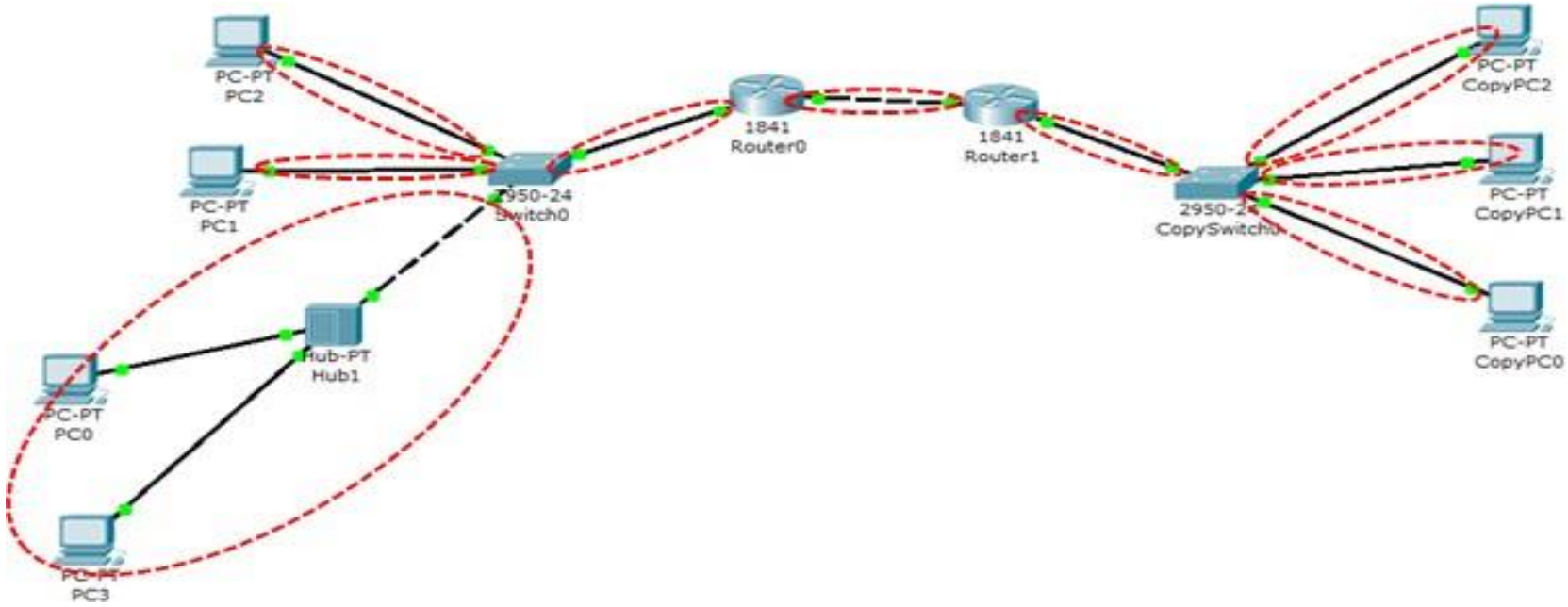
Explanation:
Only router can break up broadcast domains but in this exhibit no router is used so there is only 1 broadcast domain.
For your information, there are 7 collision domains in this exhibit (6 collision domains between hubs & switches + 1 collision between the two switches).

© 2007 Cisco Systems, Inc. All rights reserved.

Find number of number of collision domains



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



Solution :

No. of broadcast domains = 3

No. of collision domains = 9

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

IP-V4 Addressing

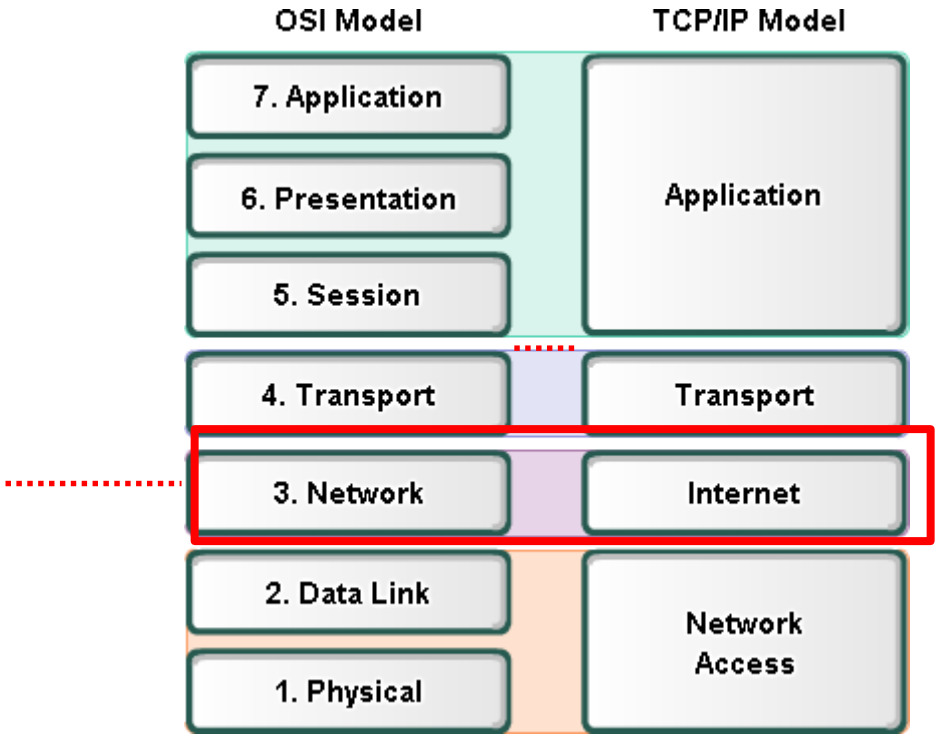
Network Fundamentals

Cisco | Networking Academy®
Mind Wide Open™

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

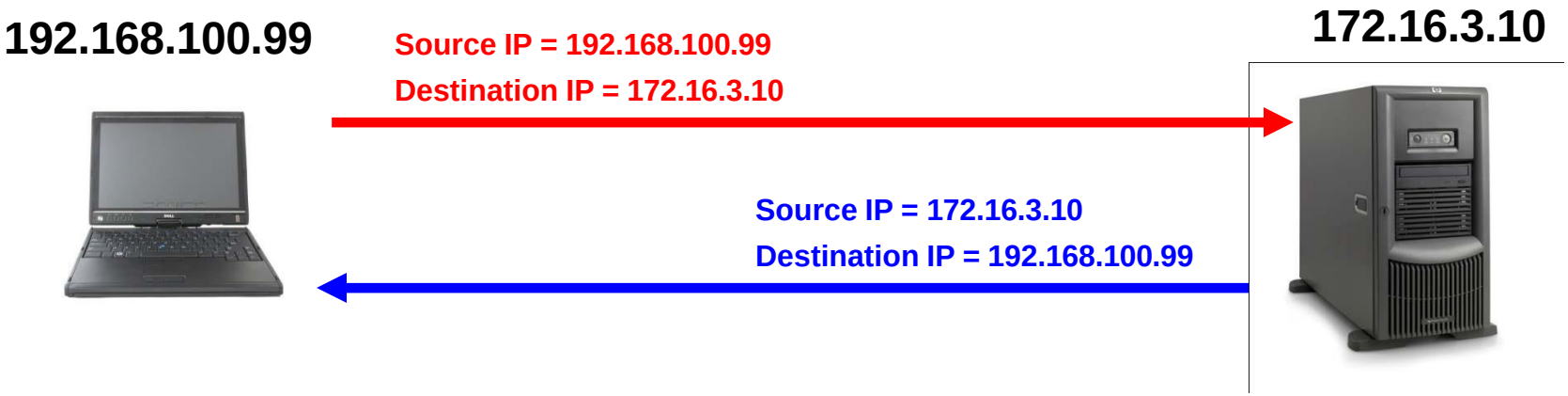
Network Layer

IPv4



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

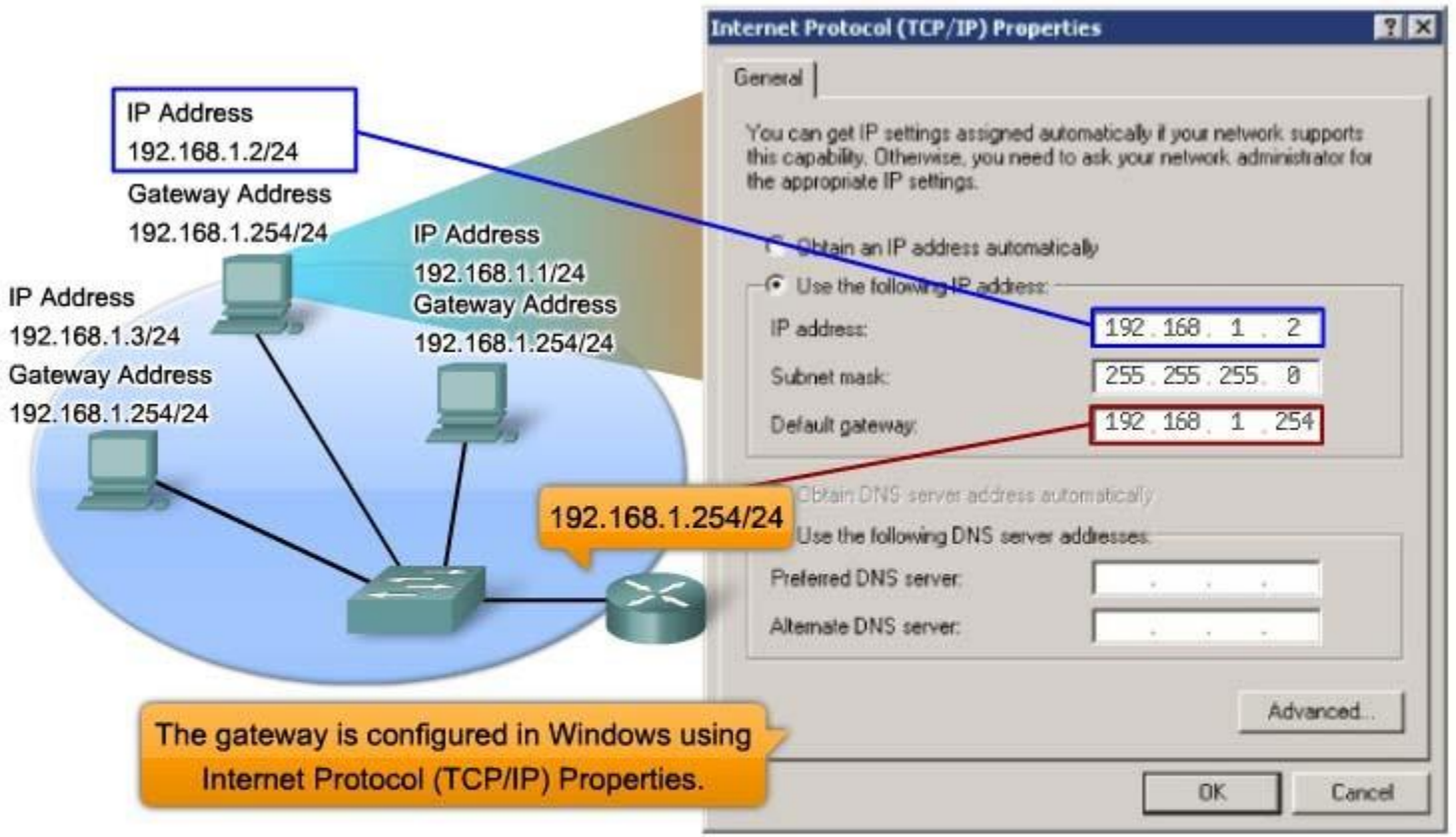
Addressing at layer 3



- Source IP Address
- Destination IP Address

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

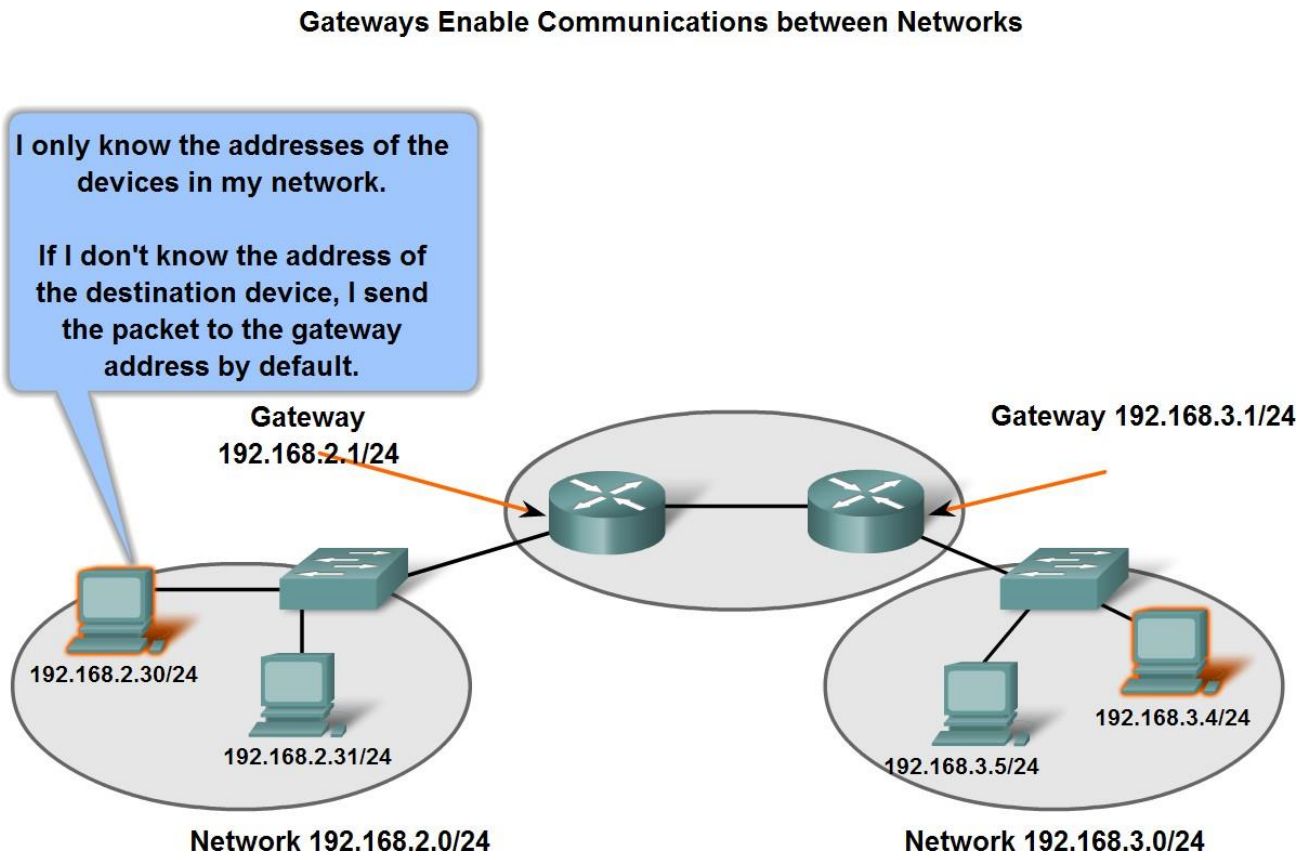
A gateway - the way out of our network



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Device parameters – ip addresses

- Describe the role of an intermediary gateway device in allowing devices to communicate across sub-divided networks



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

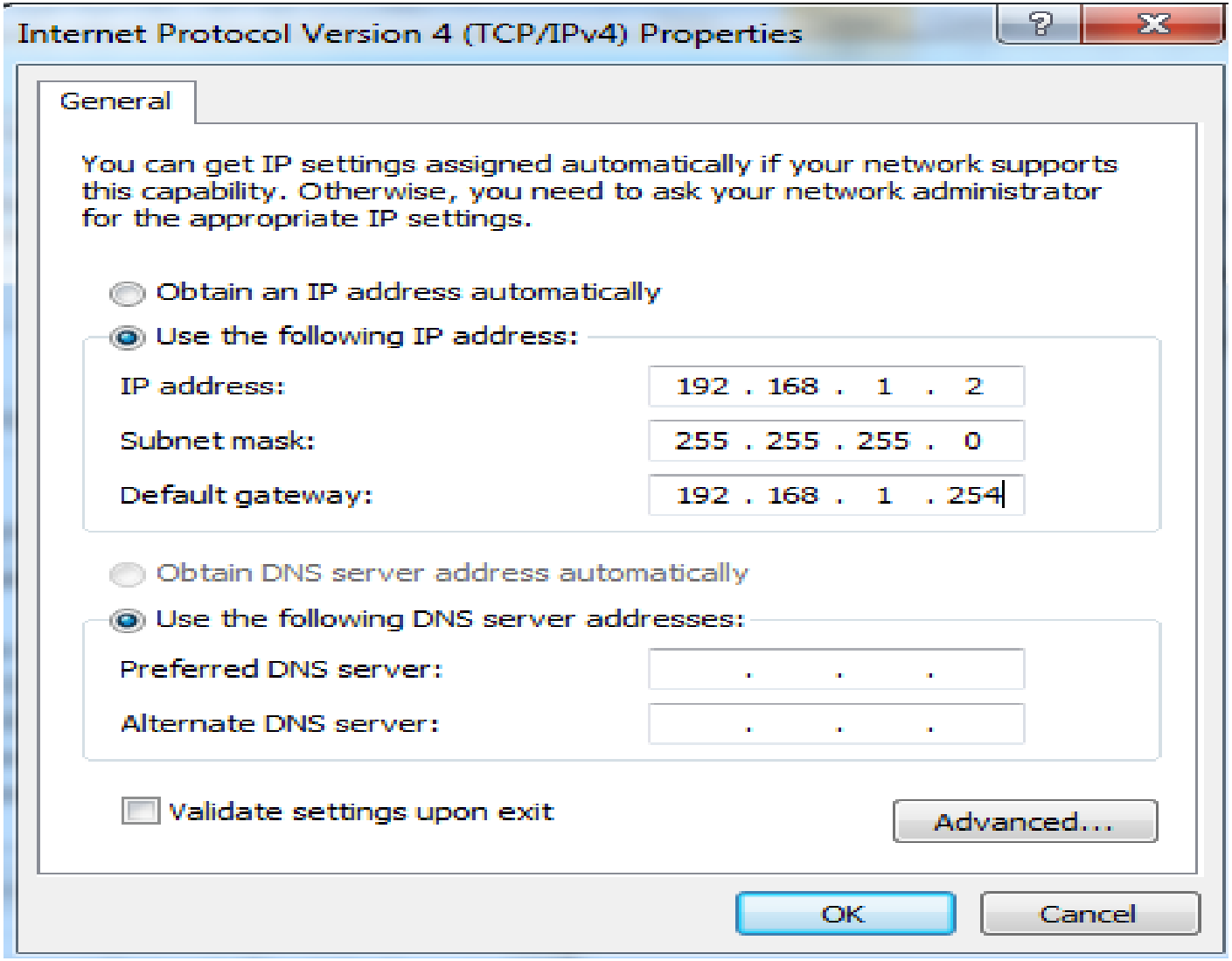
A gateway - the way out of our network

Confirming the Gateway Settings

```
C:\>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :
     ① IP Address. . . . . . . . . . . . : 192.168.1.2
     ② Subnet Mask . . . . . . . . . . . : 255.255.255.0
     ③ Default Gateway . . . . . . . . . : 192.168.1.254
```

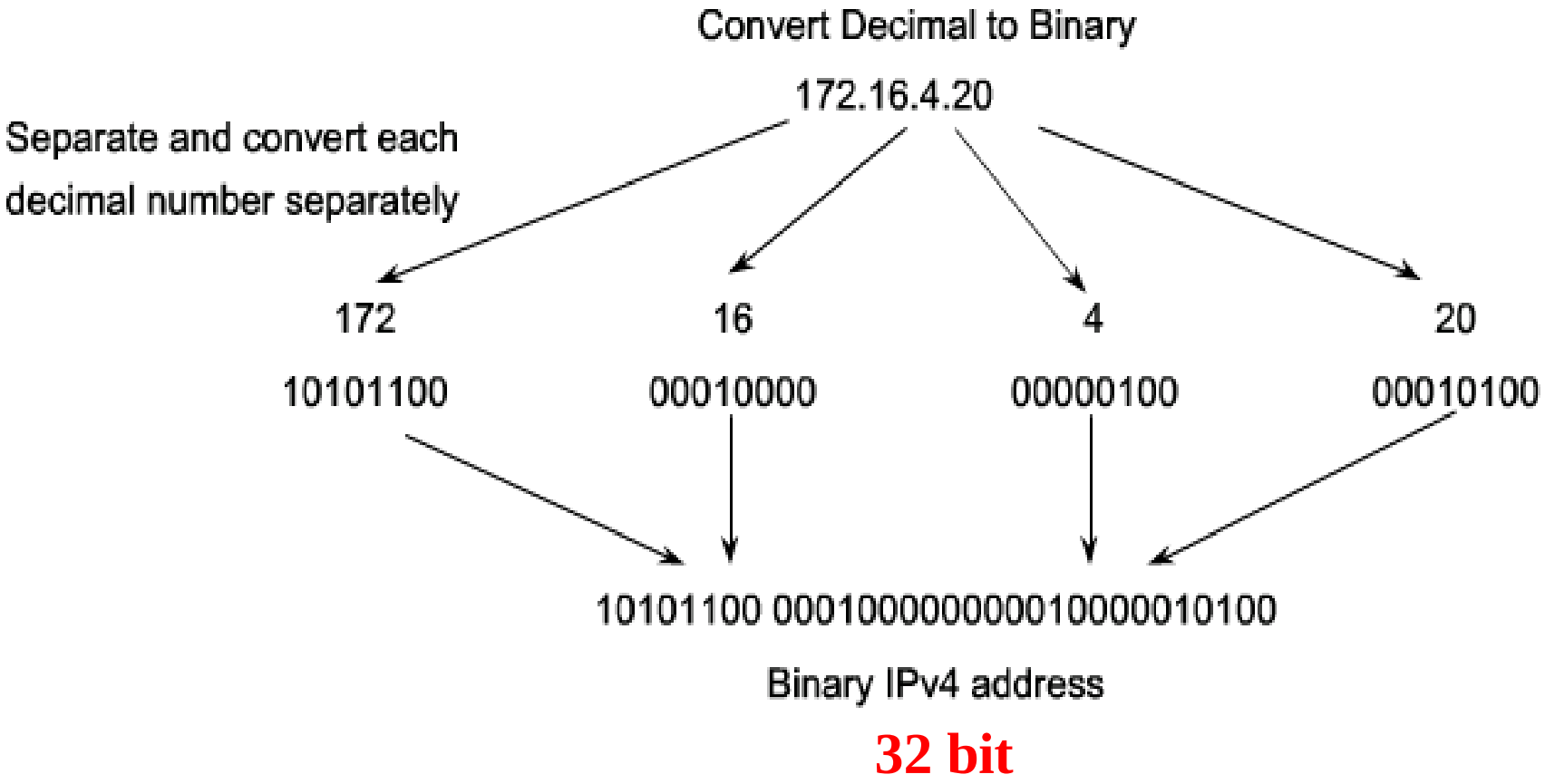
IP address for this host computer

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

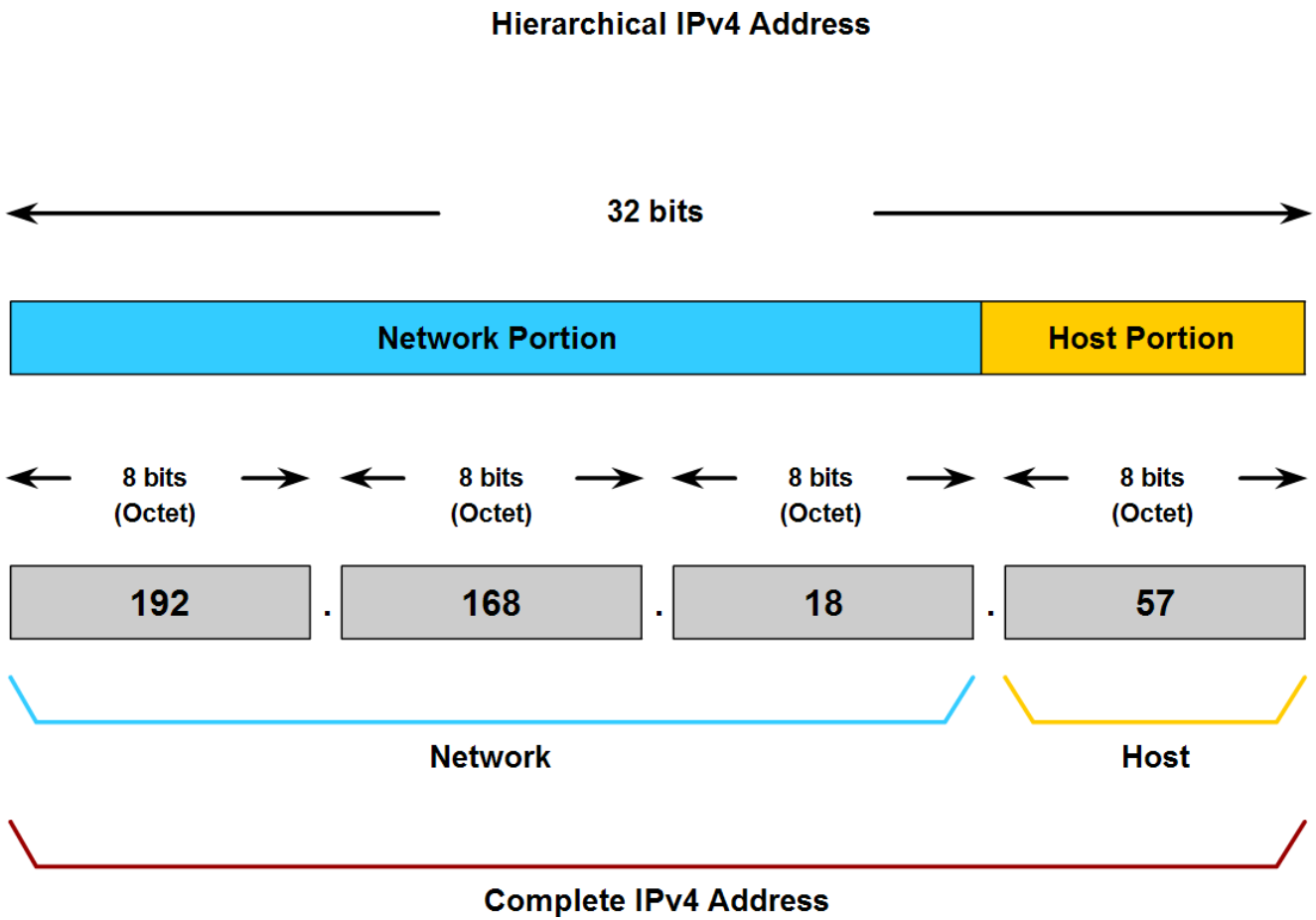
Binary & Decimal Numbering System



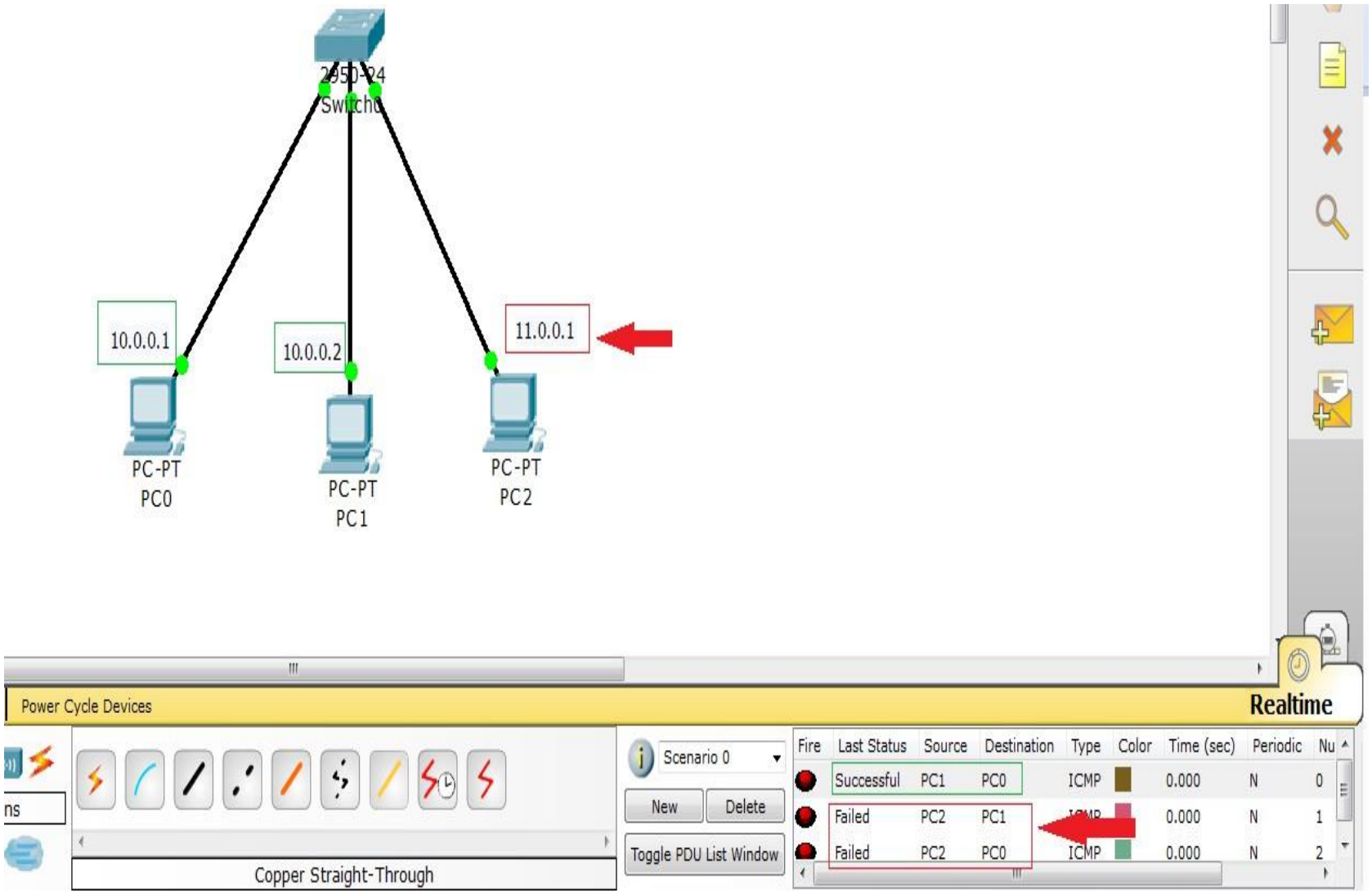
© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Dividing the networks - networks from networks

- Describe the purpose of further subdividing networks into smaller networks

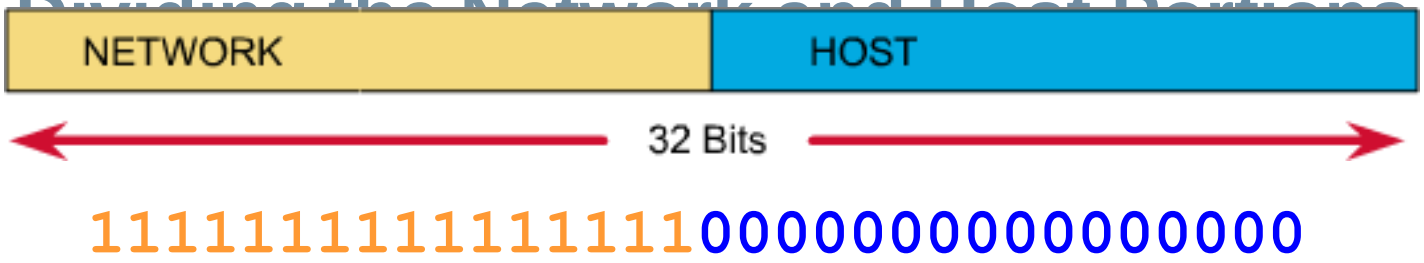


© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

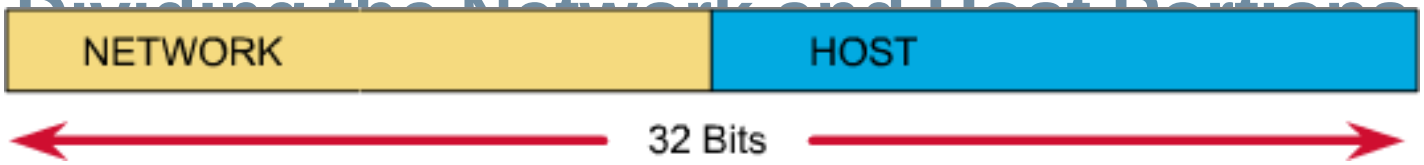
Dividing the Network and Host Portions



- **Subnet Mask**
  - Used to define the:
    - Network portion
    - Host portion
  - 32 bits
  - Contiguous set of 1's followed by a contiguous set of 0's
    - 1's: Network portion
    - 0's: Host portion

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Dividing the Network and Host Portions



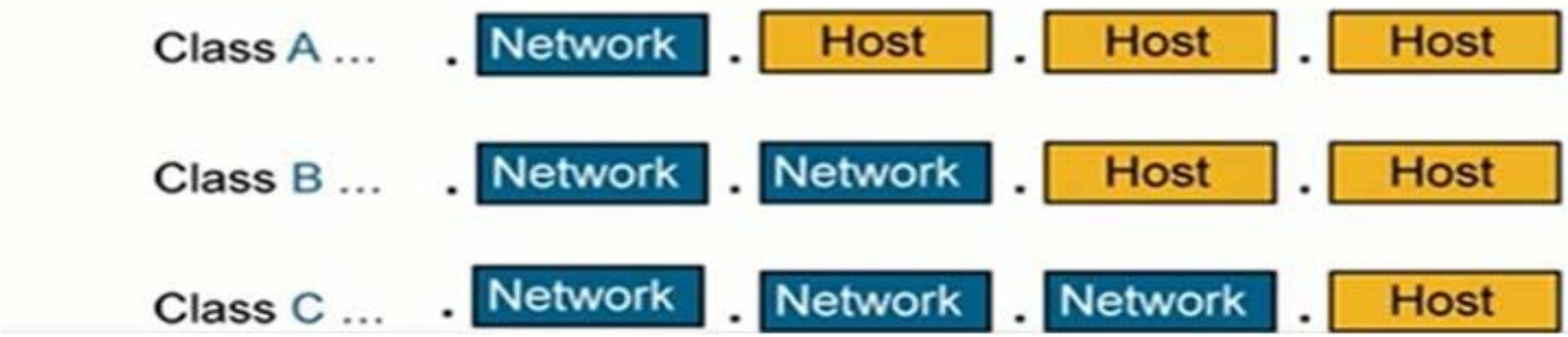

```
11111111.11111111.00000000.00000000

Dotted decimal:  255   .   255   .    0   .   0

Slash notation: /16
```

- Expressed as:
  - Dotted decimal
    - Ex: 255.255.0.0
  - Slash notation or prefix length
    - /16 (the number of one bits)

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

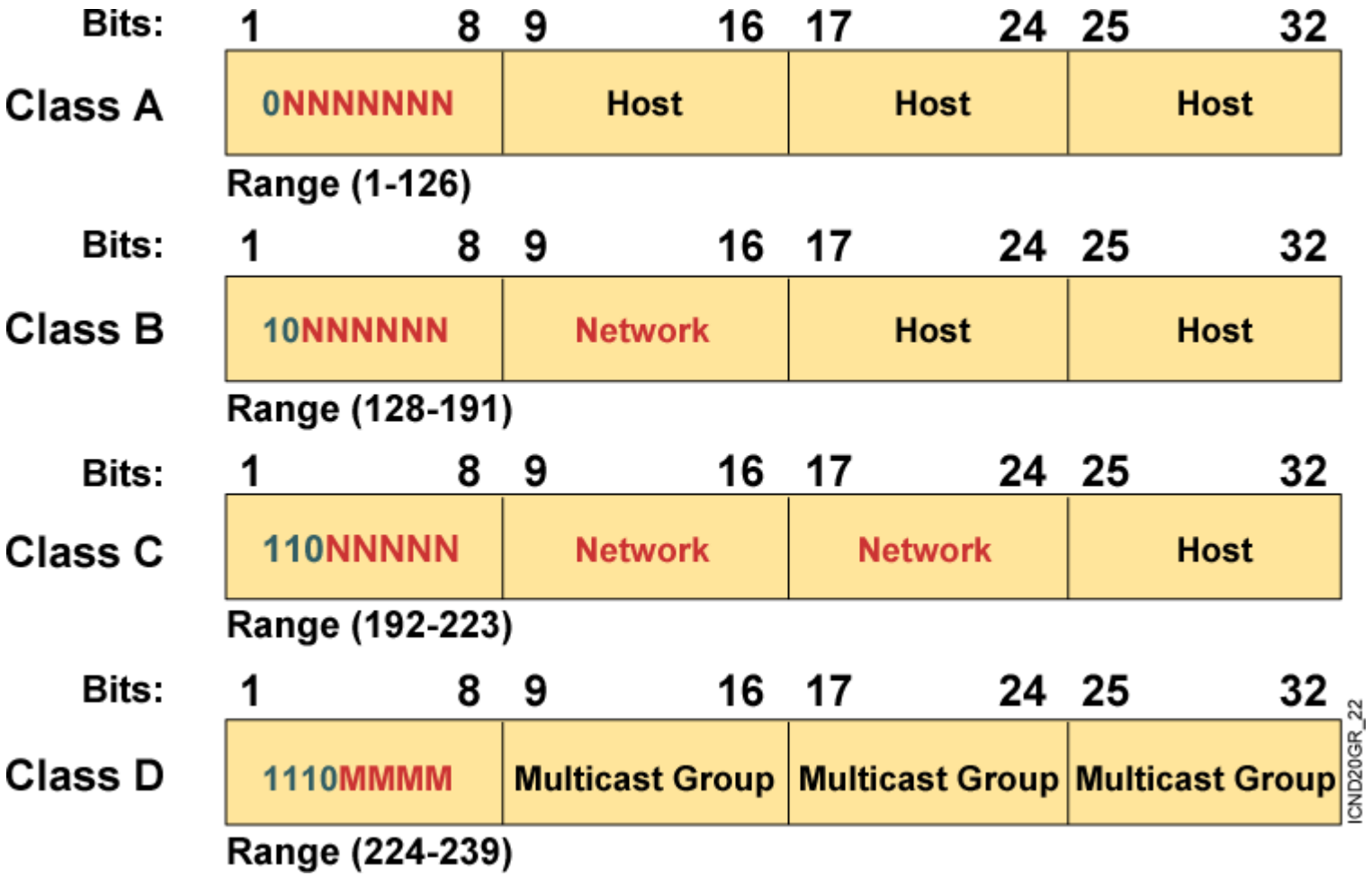
IP Address Classes (Classful IP Addressing)

Class A	1 to 126	Mask	255.0.0.0
Class B	128 to 191	Mask	255.255.0.0
Class C	192 to 223	Mask	255.255.255.0
Class D	---- 224 to 239 ----		Multicast
Class E	------- For Research		



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

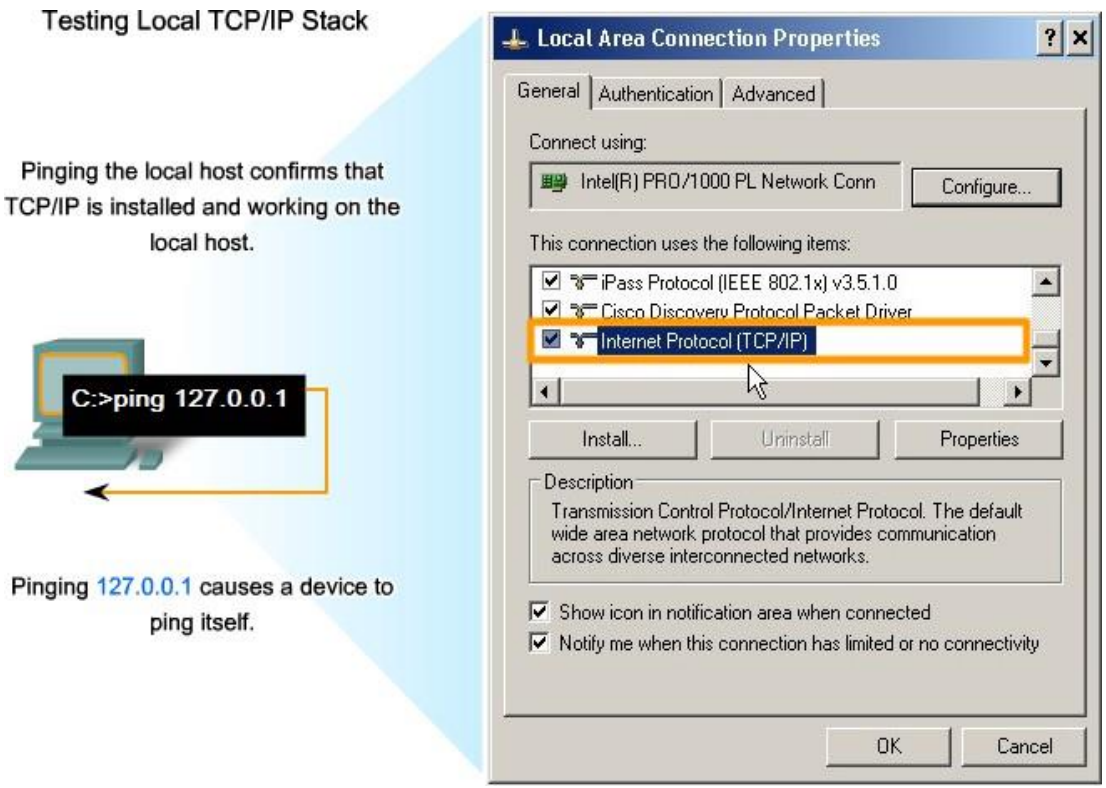
IP Address Classes



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Test a connectivity

- IP must be Unique
- IP 127.0.0.1 : Reserved for loopback



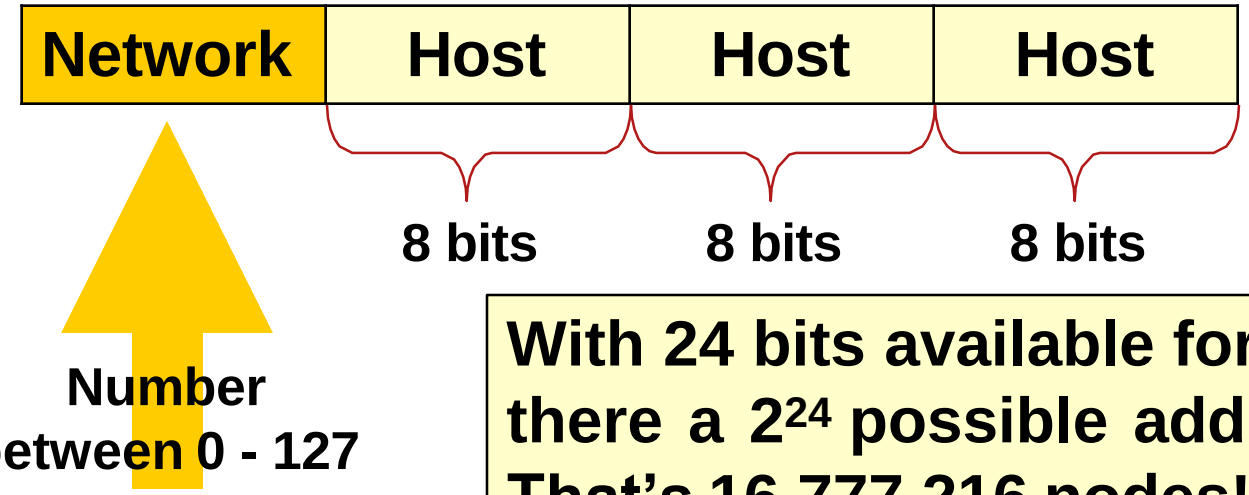
NIC's (Network Interface Cards)

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Default Mask: 255.0.0.0 (/8)

Class A addresses

First octet is between 0 – 127, begins with 0



With 24 bits available for hosts, there a 2^{24} possible addresses. That's 16,777,216 nodes!

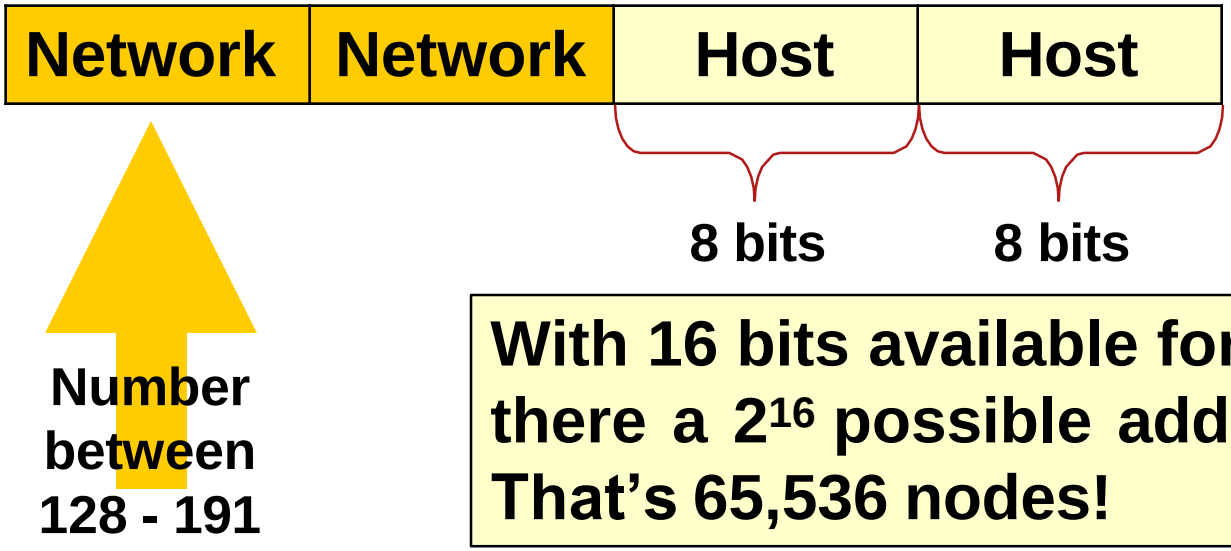
- No of network = 2^7= 128
  - There are 126 class A addresses.
    - 0 and 127 have special meaning and are not used.
- No of host = 2^{24}-2 = 16,777,214 host addresses, one for network address and one for broadcast address.
- Only large organizations such as the military, government agencies, universities, and large corporations have class A addresses.
- For example ISPs have 24.0.0.0 and 63.0.0.0

© 2007 Cisco Systems, Inc. All rights reserved. Cisco Public

Default Mask: 255.255.0.0 (/16)

Class B addresses

First octet is between 128 – 191, begins with 10



With 16 bits available for hosts, there a 2^{16} possible addresses. That's 65,536 nodes!

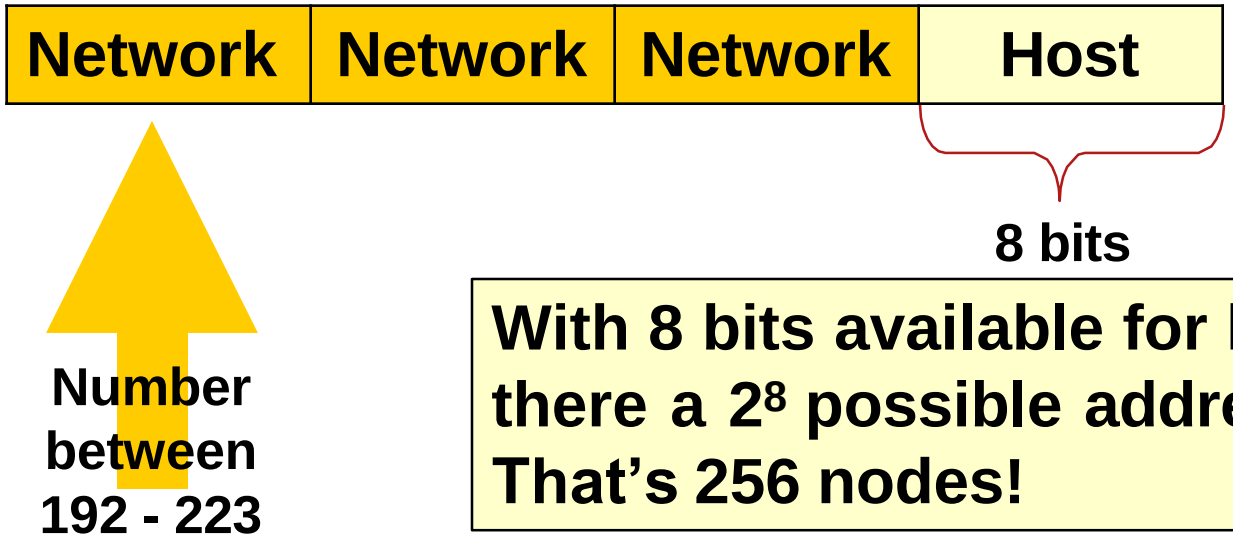
- No of network = 2^{14} =16,384
- No of host = 2^{16} -2 =65,534 host addresses, one for network address and one for broadcast address.
- Class B addresses are assigned to large organizations including corporations (such as Cisco, government agencies, and school districts).

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Default Mask: 255.255.255.0 (/24)

Class C addresses

First octet is between 192 – 223, begins with 110



With 8 bits available for hosts, there a 2^8 possible addresses. That's 256 nodes!

- No of network = 2^{21} =2,097,152
- No of host = 2^8-2 =254 host addresses, one for network address and one for broadcast address.

© 2007 Cisco Systems, Inc. All rights reserved.

IP Address Classes

Address Class	RANGE	Default Subnet Mask
A	1.0.0.0 to 126.255.255.255	255.0.0.0
B	128.0.0.0 to 191.255.255.255	255.255.0.0
C	192.0.0.0 to 223.255.255.255	255.255.255.0
D	224.0.0.0 to 239.255.255.255	Reserved for Multicasting
E	240.0.0.0 to 254.255.255.255	Experimental

Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback testing.

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

IP address types

- **IP address could be one of three categories**
  - ✓ Network address
  - ✓ Host address
  - ✓ Broadcast address

© 2007 Cisco Systems, Inc. All rights reserved.

Network / Broadcast Addresses

- **Network address :**
  the first IP address in it which all host part bits = 0
- **Broadcast address:**
  the last IP address in the network which all host part bits = 1

- other addresses are host addresses = $2^{\text{no.of host bits}} - 2$
-Here are some examples:

Class	Network Address	Broadcast Address
A	12.0.0.0	12.255.255.255
B	172.16.0.0	172.16.255.255
C	192.168.1.0	192.168.1.255

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Are You the Host or the Network?

- Network address: This is the designation used in routing to send packets to a remote network—for example, 10.0.0.0, 172.16.0.0, and 192.168.10.0.
- Broadcast address: The address used by applications and hosts to send information to all nodes on a network is called the broadcast address.
- Each Network is assigned a network address & every device or interface (such as a router port) on the network is assigned a host address
- A host address cannot be designated by all zeros or all ones.
- These are special addresses that are reserved for special purposes

© 2007 Cisco Systems, Inc. All rights reserved.

Types of Addresses

Network Addresses have all 0's in the host portion.

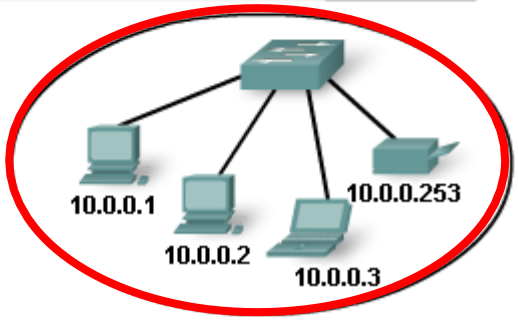
Network Address

Broadcast Address

Host Address

Roll over to learn more.

	Network		Host
10	0	0	0
00001010	00000000	00000000	00000000
10	0	0	255
00001010	00000000	00000000	11111111
10	0	0	1
00001010	00000000	00000000	00000001



- **Network address** - The address by which we refer to the network
- **Broadcast address** - A special address used to send data to all hosts in the network
- **Host addresses** - The addresses assigned to the end devices in the network

© 2007 Cisco Systems, Inc. All rights reserved. Cisco Public

Types of Addresses

Broadcast Addresses have all 1's in the host portion.

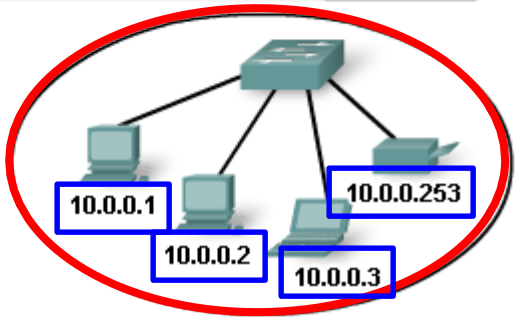
Network Address

Broadcast Address

Host Address

Roll over to learn more.

Network			Host
10	0	0	0
00001010	00000000	00000000	00000000
10	0	0	255
00001010	00000000	00000000	11111111
10	0	0	1
00001010	00000000	00000000	00000001



- **Network address** - The address by which we refer to the network
- **Broadcast address** - A special address used to send data to all hosts in the network
- **Host addresses** - The addresses assigned to the end devices in the network

© 2007 Cisco Systems, Inc. All rights reserved. Cisco Public

Types of Addresses

Host Addresses can not have all 0's or all 1's in the host portion.

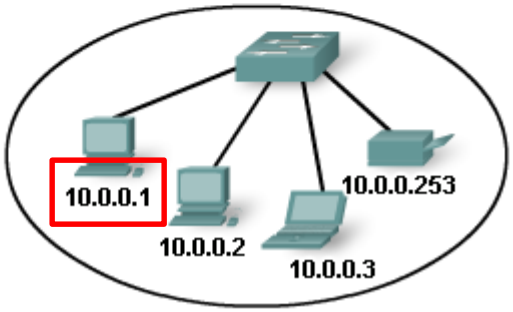
Network Address

Broadcast Address

Host Address

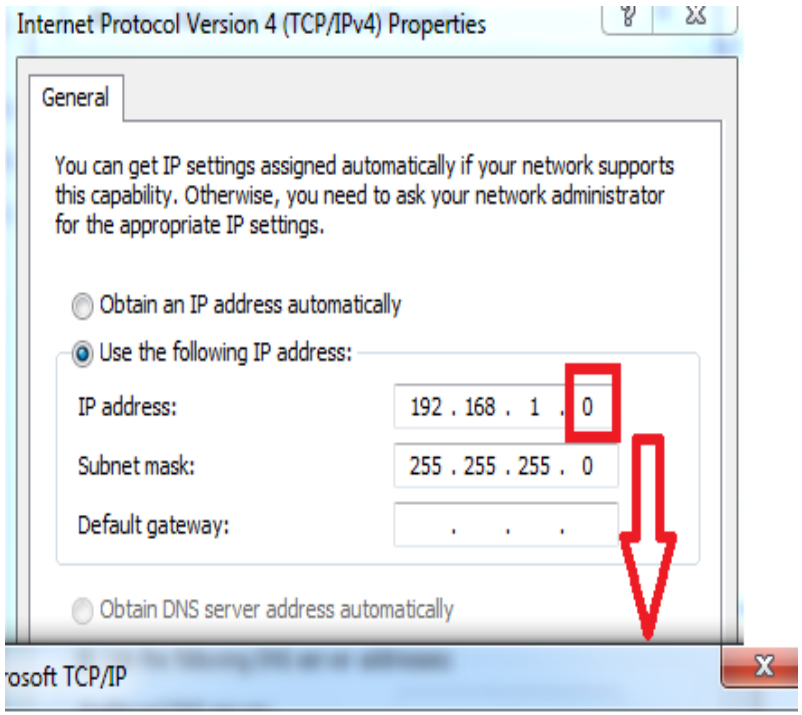
Roll over to learn more.

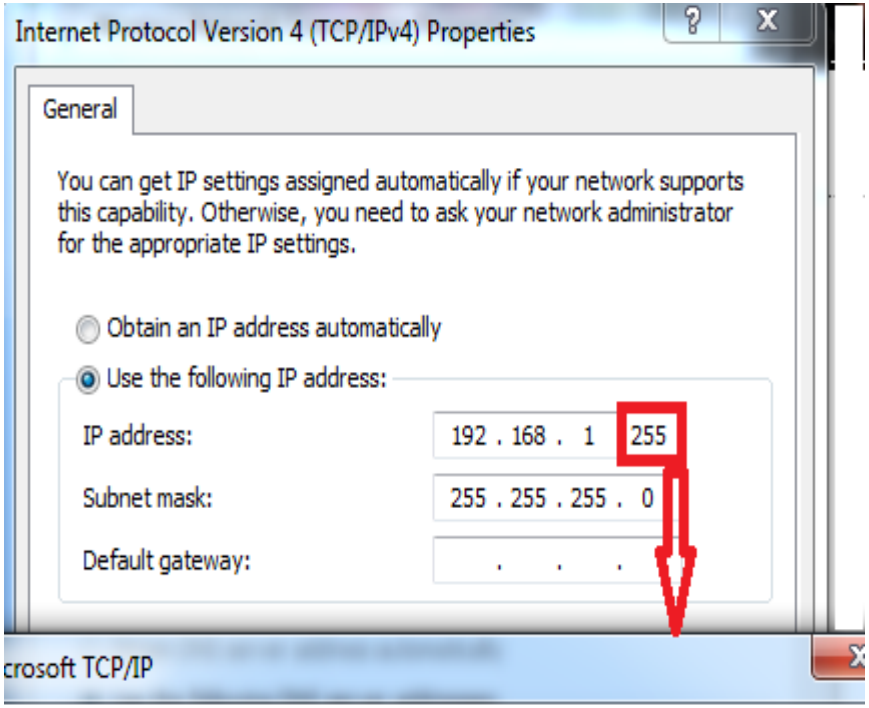
	Network		Host
10	0	0	0
00001010	00000000	00000000	00000000
10	0	0	255
00001010	00000000	00000000	11111111
10	0	0	1
00001010	00000000	00000000	00000001



- **Network address** - The address by which we refer to the network
- **Broadcast address** - A special address used to send data to all hosts in the network
- **Host addresses** - The addresses assigned to the end devices in the network

© 2007 Cisco Systems, Inc. All rights reserved. Cisco Public





The combination of IP address and subnet mask is invalid. All of the bits in the host address portion of the IP address are set to 0. Please enter a valid combination of IP address and subnet mask.

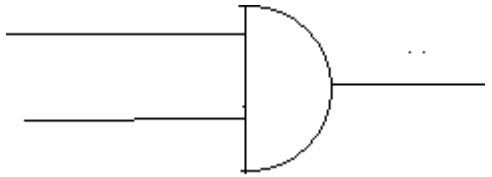
OK

The combination of IP address and subnet mask is invalid. All of the bits in the host address portion of the IP address are set to 1. Please enter a valid combination of IP address and subnet mask.

OK

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

10.15.13.2 172.16.2.160 200.50.40.5



X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

1*X=X

0*X=0

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Subnet mask

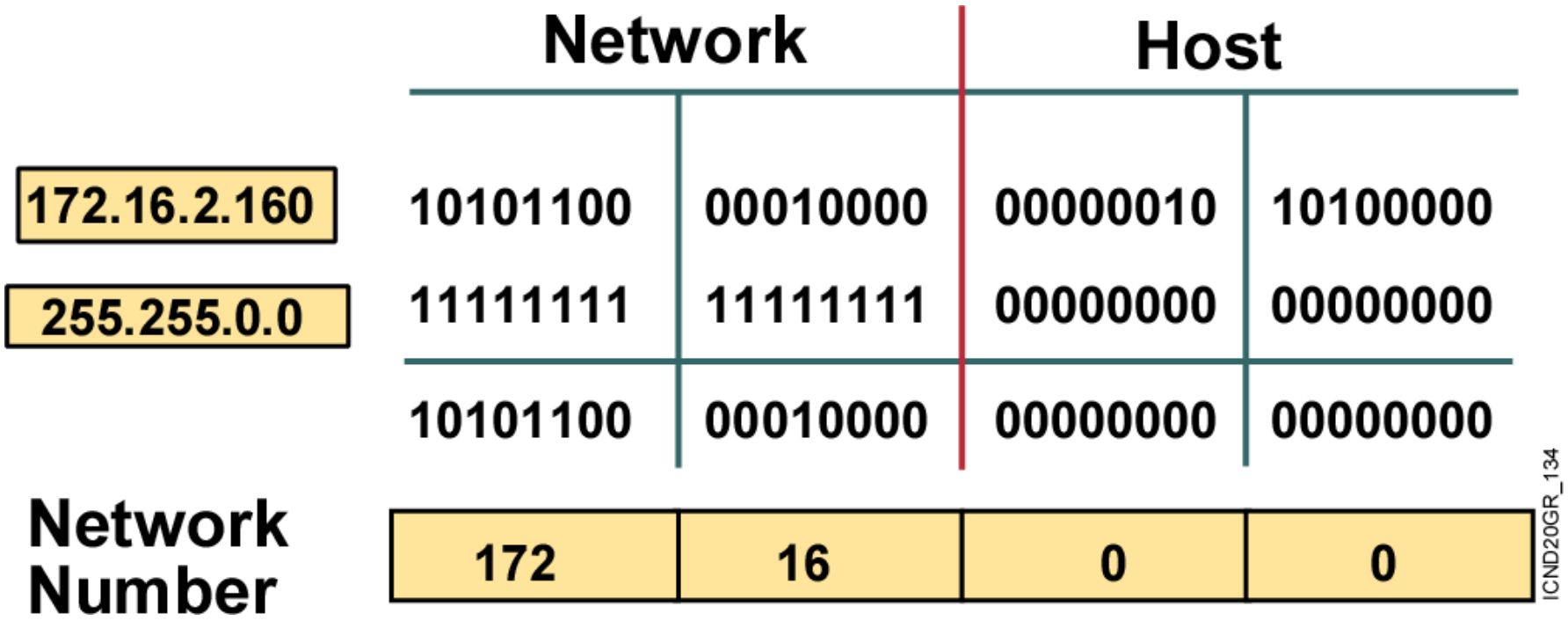
Applying the Subnet Mask

A device with address 192.0.0.1 belongs to network 192.0.0.0

	High order bits Prefix /16		Low order bits	
	192 .	0 .	0 .	1
Host Address	11000000	00000000	00000000	00000001
	255	255	0	0
Subnet Mask	11111111	11111111	00000000	00000000
Network Address	11000000	00000000	00000000	00000000
Network	192 .	0 .	0 .	0

© 2007 Cisco Systems, Inc. All rights reserved. Cisco Public

Default subnet



© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

Default subnet

10. 15.13.2
255.0. 0. 0
---
10. 0. 0. 0

172.16 . 2.160
255.255.0 .0

172.16.0.0

200. 50 . 40 .5
255.255.255.0

200.50. 40 . 0

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

IP Address Classes Exercise

Address	Class	Network	Host
10.2.1.1			
128.63.2.100			
201.222.5.64			
192.6.141.2			
130.113.64.16			
256.241.201.10			

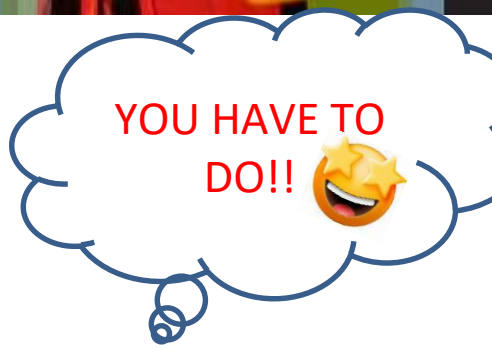
© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

IP Address Classes Exercise Answers

Address	Class	Network	Host
10.2.1.1	A	10.0.0.0	0.2.1.1
128.63.2.100	B	128.63.0.0	0.0.2.100
201.222.5.64	C	201.222.5.0	0.0.0.64
192.6.141.2	C	192.6.141.0	0.0.0.2
130.113.64.16	B	130.113.0.0	0.0.64.16
256.241.201.10	Nonexistent		

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public

TASK:



Fill in the information…

1. 192.168.1.3 Class _____ Default Mask:_____

Network: _____ Broadcast: _____

Hosts: _____ through _____

2. 1.12.100.31 Class _____ Default Mask:_____

Network: _____ Broadcast: _____

Hosts: _____ through _____

3. 172.30.77.5 Class _____ Default Mask:_____

Network: _____ Broadcast: _____

Hosts: _____ through _____

© 2007 Cisco Systems, Inc. All rights reserved.

© 2007 Cisco Systems, Inc. All rights reserved.
Cisco Public