Router Configuration

Router User Interface Modes

The Cisco command-line interface (CLI) uses a hierarchical structure. This structure requires entry into different modes to accomplish particular tasks.

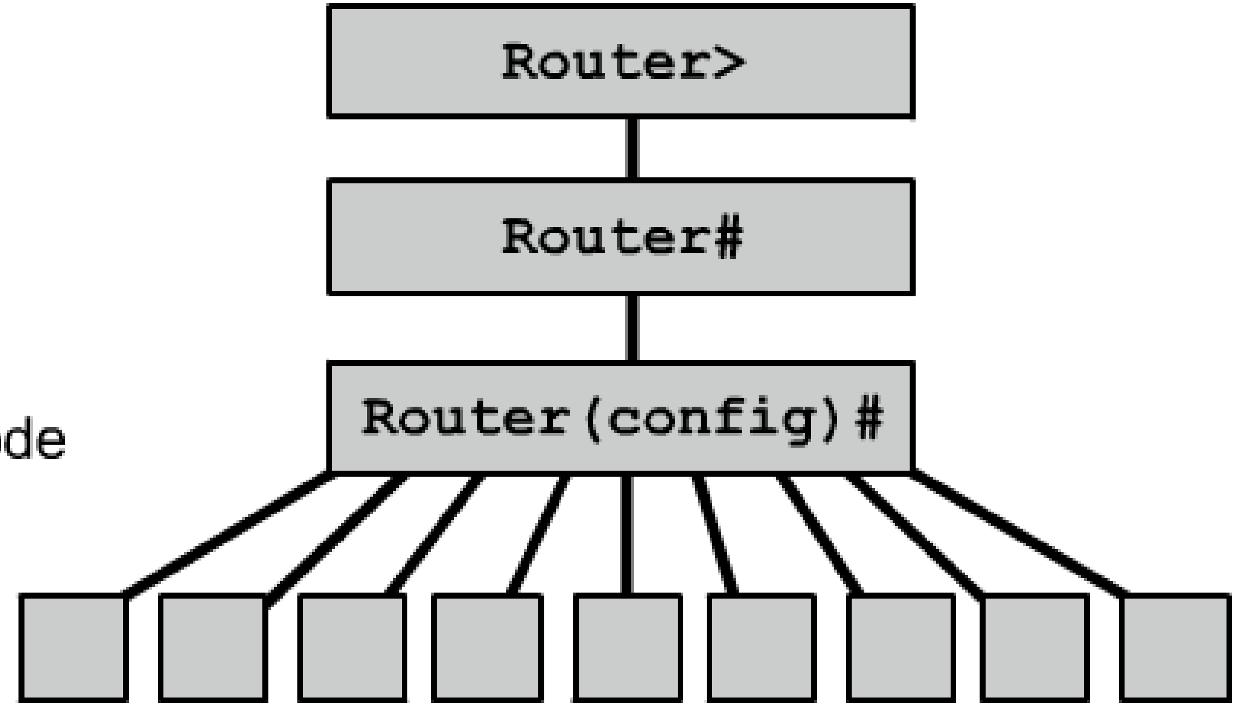
Each configuration mode is indicated with a distinctive prompt and allows only commands that are appropriate for that mode.

As a security feature the Cisco IOS software separates sessions into two access levels, user EXEC mode and privileged EXEC mode. The privileged EXEC mode is also known as enable mode.

EXEC Mode	Prompt	Typical Use
User	GAD>	check the router status
Privileged	GAD#	accessing the router configuration modes

Overview of Router Modes

- User EXEC mode
- Privileged EXEC mode
- Global configuration mode
- Specific configuration modes



Router Modes

Router

```
Router con0 is now available.

Press RETURN to get started.

User Access Verification
Password:
Router>                          User-Mode Prompt
Router>enable
Password:
Router#                          Privileged-Mode Prompt
Router#disable
Router>
Router>exit
```

User Mode Commands

Router

```
Cisco>?
Exec commands:
access-enable      Create a temporary Access-List
                   entry
access-profile     Apply user-profile to interface
access-template    Create a temporary Access-List
                   entry
archive            manage archive files
bfe                For manual emergency modes
                   setting
cd                 Change current directory
clear              Reset functions
clock              Manage the system clock
configure          Enter configuration mode
connect            Open a terminal connection
copy               Copy from one file to another
--More--
```

Privileged Mode Commands

Router

```
Cisco#?
Exec commands:
  access-enable    Create a temporary Access-List
                   entry
  access-profile   Apply user-profile to interface
  access-template  Create a temporary Access-List
                   entry
  archive          manage archive files
  bfe              For manual emergency modes
                   setting
  cd               Change current directory
  clear            Reset functions
  clock            Manage the system clock
  configure        Enter configuration mode
  connect          Open a terminal connection
  copy             Copy from one file to another
  debug            Debugging functions (see also
                   'undebug')
  delete           Delete a file
  dir              List files on a filesystem
  disable          Turn off privileged commands
  disconnect       Disconnect an existing network
                   connection
  elog             Event-logging control commands
  enable           Turn on privileged commands
  erase            Erase a filesystem
  exit             Exit from the EXEC
  help             Description of the interactive
                   help system
 --More--
```

NOTE: There are many more commands available in privileged mode.

Specific Configuration Modes

Configuration Mode	Prompt
Interface	`Router(config-if)#`
Subinterface	`Router(config-subif)#`
Controller	`Router(config-controller)#`
Map-list	`Router(config-map-list)#`
Map-class	`Router(config-map-class)#`
Line	`Router(config-line)#`
Router	`Router(config-router)#`
IPX-router	`Router(config-ipx-router)#`
Route-map	`Router(config-route-map)#`

CLI Command Modes

All command-line interface (CLI) configuration changes to a Cisco router are made from the global configuration mode. Other more specific modes are entered depending upon the configuration change that is required.

Global configuration mode commands are used in a router to apply configuration statements that affect the system as a whole.

The following command moves the router into global configuration mode

```
Router#configure terminal          (or config t)
Router(config)#
```

When specific configuration modes are entered, the router prompt changes to indicate the current configuration mode.

Typing **exit** from one of these specific configuration modes will return the router to global configuration mode. Pressing **Ctrl-Z**

Configuring a Router’s Name

A router should be given a unique name as one of the first configuration tasks.

This task is accomplished in global configuration mode using the following commands:

```
Router(config)#hostname Tokyo
Tokyo(config)#
```

As soon as the **Enter** key is pressed, the prompt changes from the default host name (Router) to the newly configured host name (which is Tokyo in the example above).

Setting the Clock with Help

Router

```
Cisco#cl?
clear  clock
Cisco#clock
% Incomplete command.
Cisco#clock ?
  set  Set the time and date
Cisco#clock set
% Incomplete command.
Cisco#clock set ?
  hh:mm:ss  Current Time
Cisco#clock set 19:50:00
% Incomplete command.
Cisco#clock set 19:50:00 ?
  <1-31>  Day of the month
  MONTH   Month of the year
Cisco#clock set 19:50:00 14 7
                            ^
% Invalid input detected at '^' marker.
Cisco#clock set 19:50:00 14 July
% Incomplete command.
Cisco#clock set 19:50:00 14 July ?
  <1993-2035>  Year
Cisco#clock set 19:50:00 14 July 2003
Cisco#
```

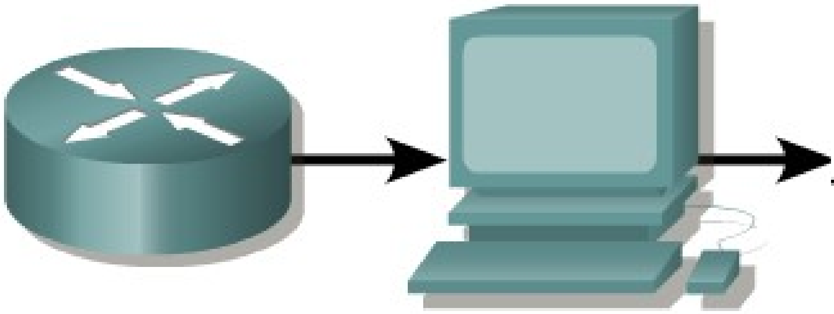
Message Of The Day (MOTD)

A message-of-the-day (MOTD) banner can be displayed on all connected terminals.

Enter global configuration mode by using the command **config t**

Enter the command
banner motd # The message of the day goes here #.

Save changes by issuing the command **copy run start**



```
Tokyo(config)#banner motd #
You have entered a secure
system, authorized access
ONLY! #
```

Configuring a Console Password

Passwords restrict access to routers.
Passwords should always be configured for virtual terminal lines and the console line.

Passwords are also used to control access to privileged EXEC mode so that only authorized users may make changes to the configuration file.

The following commands are used to set an optional but recommended password on the console line:

```
Router(config)#line console 0
Router(config-line)#password <password>
Router(config-line)#login
```

Configuring a Modem Password

If configuring a router via a modem you are most likely connected to the aux port.

The method for configuring the aux port is very similar to configuring the console port.

```
Router(config)#line aux 0
Router(config-line)#password <password>
Router(config-line)#login
```

Configuring Interfaces

An interface needs an IP Address and a Subnet Mask to be configured.
All interfaces are "shutdown" by default.
The DCE end of a serial interface needs a clock rate.

```
Router#config t
Router(config)#interface serial 0/1
Router(config-if)#ip address 200.100.50.75 255.255.255.240
Router(config-if)#clock rate 56000
```

(required for serial DCE only)

```
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#int f0/0
Router(config-if)#ip address 150.100.50.25 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#exit
Router#
```

On older routers, Serial 0/1 would be just Serial 1 and f0/0 would be e0.
s = serial e = Ethernet f = fast Ethernet

Configuring a Telnet Password

A password must be set on one or more of the virtual terminal (VTY) lines for users to gain remote access to the router using Telnet.

Typically Cisco routers support five VTY lines numbered 0 through 4.

The following commands are used to set the same password on all of the VTY lines:

```
Router(config)#line vty 0 4
Router(config-line)#password <password>
Router(config-line)#login
```

Examining the show Commands

There are many **show** commands that can be used to examine the contents of files in the router and for troubleshooting. In both privileged EXEC and user EXEC modes, the command **show ?** provides a list of available **show** commands. The list is considerably longer in privileged EXEC mode than it is in user EXEC mode.

show interfaces – Displays all the statistics for all the interfaces on the router.
show int s0/1 – Displays statistics for interface Serial 0/1
show controllers serial – Displays information-specific to the interface hardware
show clock – Shows the time set in the router
show hosts – Displays a cached list of host names and addresses
show users – Displays all users who are connected to the router
show history – Displays a history of commands that have been entered
show flash – Displays info about flash memory and what IOS files are stored there
show version – Displays info about the router and the IOS that is running in RAM
show ARP – Displays the ARP table of the router
show start – Displays the saved configuration located in NVRAM
show run – Displays the configuration currently running in RAM

The copy run tftp Command

Router

```
Router#copy running-config tftp

Remote host []? 131.108.2.155

Name of configuration file to write[tokyo-config]?tokyo.2

Write file tokyo.2 to 131.108.2.155? [confirm] y

Writing tokyo.2 !!!!!! [OK]
```

The copy tftp run Command

Router

```
Router#copy tftp running-config

Host or network configuration file [host]?

IP address of remote host [255.255.255.255]? 131.108.2.155

Name of configuration file [Router-config]? tokyo.2

Configure using tokyo.2 from 131.108.2.155? [confirm] y

Booting tokyo.2 from 131.108.2.155:!! [OK-874/16000 bytes]

tokyo#
```

Ethernet Fundamentals

Ethernet Overview

Ethernet is now the dominant LAN technology in the world.

Ethernet is not one technology but a family of LAN technologies.

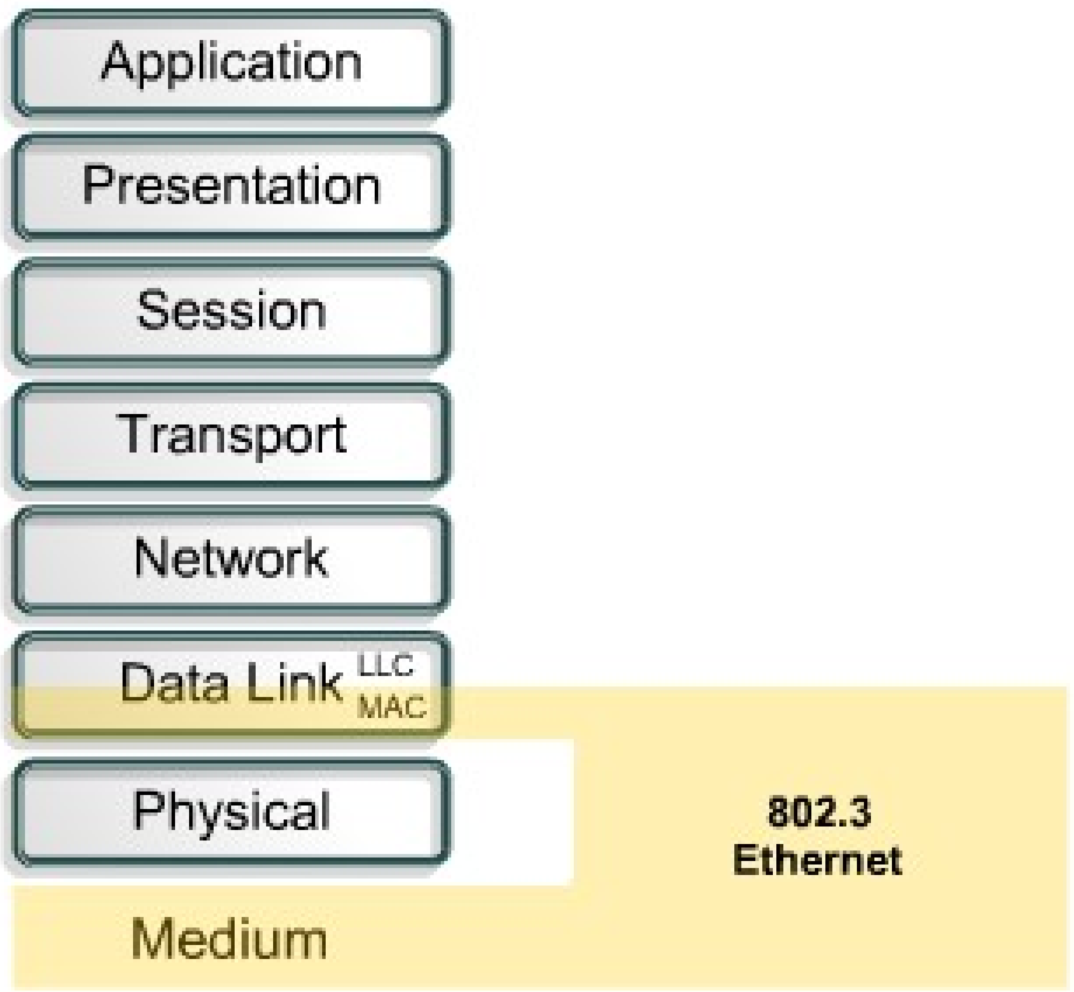
All LANs must deal with the basic issue of how individual stations (nodes) are named, and Ethernet is no exception.

Ethernet specifications support different media, bandwidths, and other Layer 1 and 2 variations.

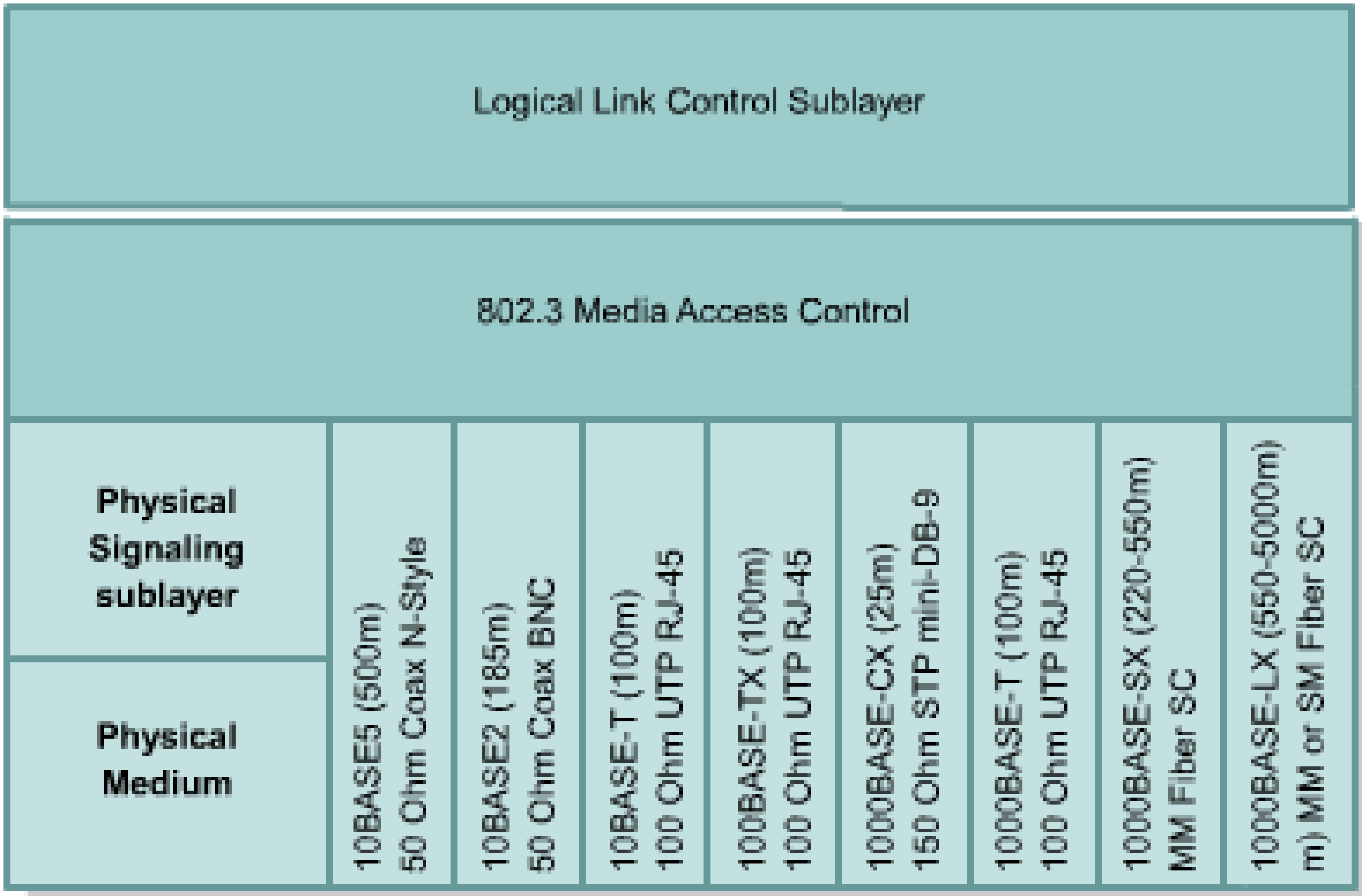
However, the basic frame format and addressing scheme

Ethernet and the OSI Model

Ethernet operates in two areas of the OSI model, the lower half of the data link layer, known as the MAC sublayer and the physical layer



Ethernet Technologies Mapped to the OSI Model



Layer 2 Framing

Framing is the Layer 2 encapsulation process.

A frame is the Layer 2 protocol data unit.

The frame format diagram shows different groupings of bits (fields) that perform other functions.

Field Names				
A	B	C	D	E
Start Frame Field	Address Field	Type/Length Field	Data Field	FCS Field

Ethernet and IEEE Frame Formats are Very Similar

IEEE 802.3

7	1	6	6	2	46 to 1500	4
Preamble	Start of Frame Delimeter	Destination Address	Source Address	Length/ Type	802.2 Header and Data	Frame Check Sequence

Ethernet

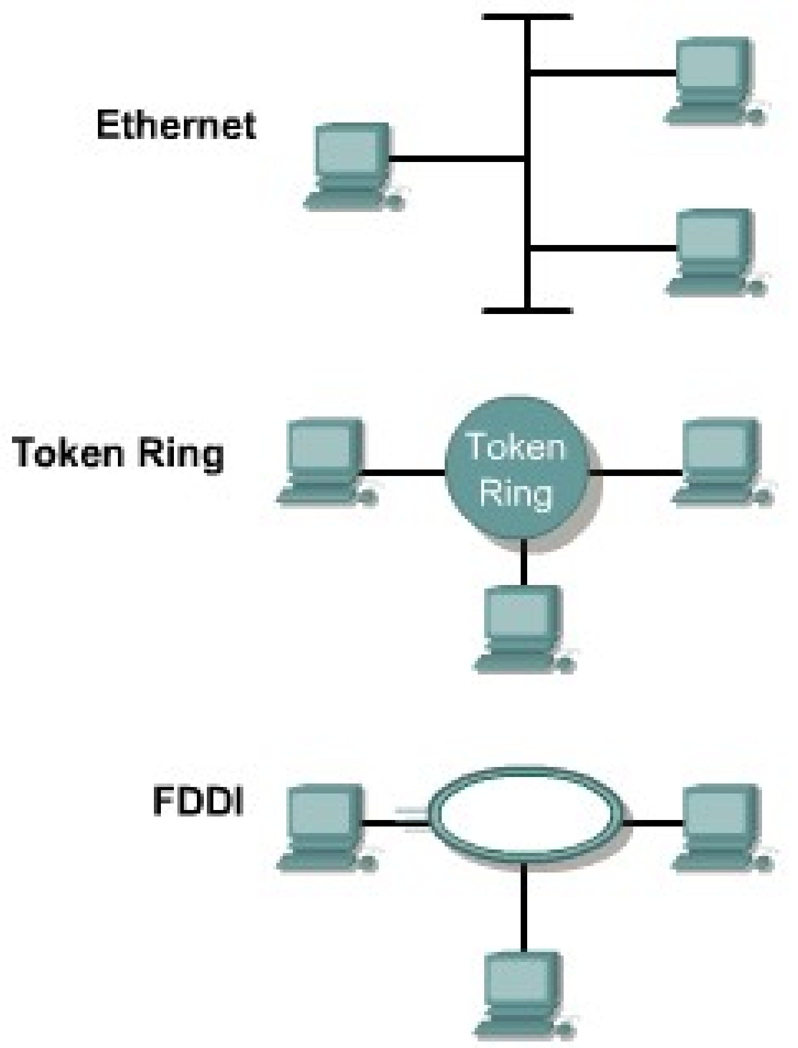
8	6	6	2	46 to 1500	4
Preamble	Destination Address	Source Address	Type	Data	Frame Check Sequence

3 Common Layer 2 Technologies

Ethernet
Uses CSMA/CD logical bus topology (information flow is on a linear bus) physical star or extended star (wired as a star)

Token Ring
logical ring topology (information flow is controlled in a ring) and a physical star topology (in other words, it is wired as a star)

FDDI
logical ring topology (information flow is controlled in a ring) and physical dual-ring topology(wired as a dual-ring)



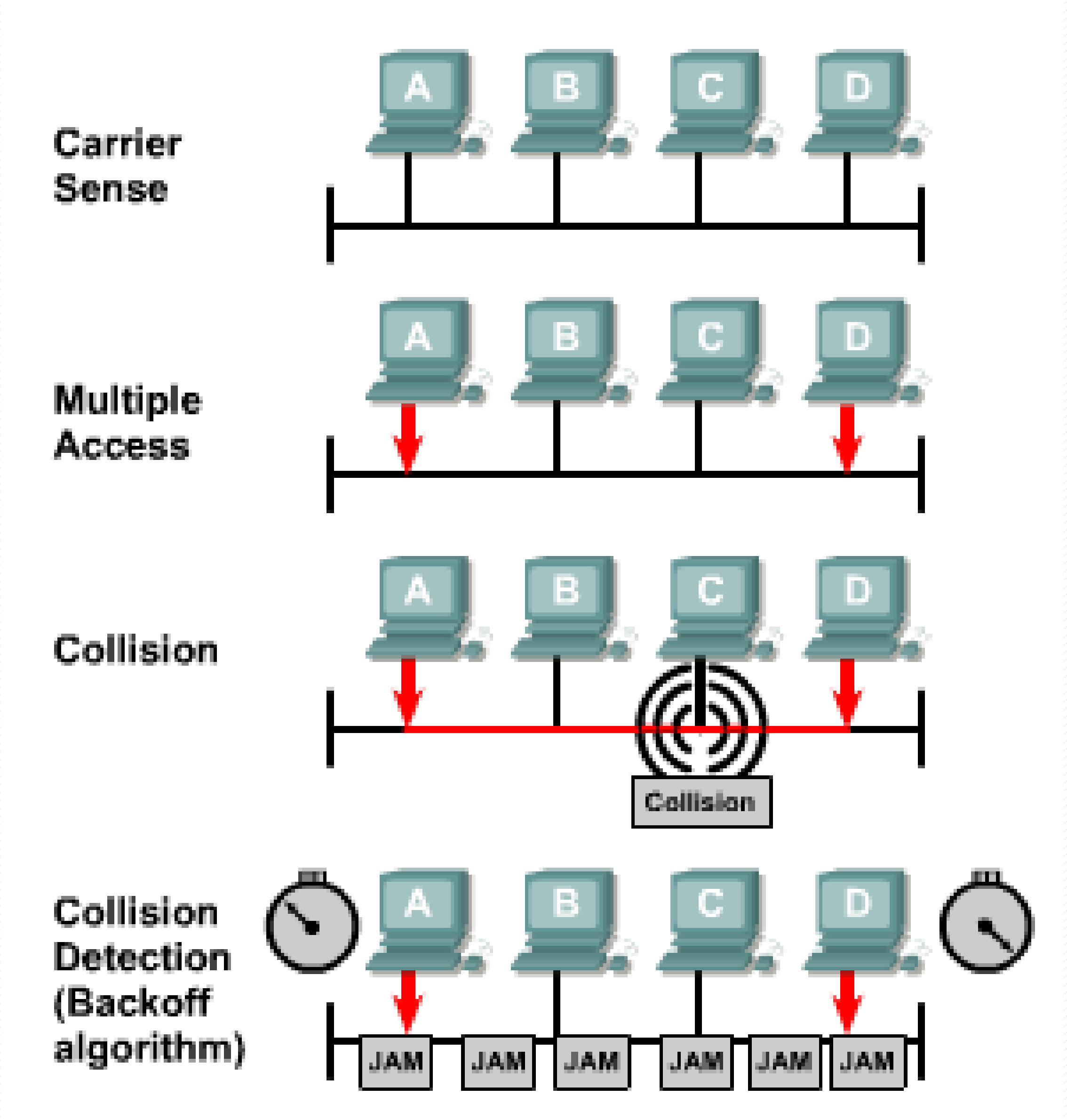
Collision Domains

To move data between one Ethernet station and another, the data often passes through a repeater.

All other stations in the same collision domain see traffic that passes through a repeater.

A collision domain is then a shared resource. Problems originating in one part of the collision domain will usually impact the entire collision domain.

CSMA/CD Graphic



Backoff

After a collision occurs and all stations allow the cable to become idle (each waits the full interframe spacing), then the stations that collided must wait an additional and potentially progressively longer period of time before attempting to retransmit the collided frame.

The waiting period is intentionally designed to be random so that two stations do not delay for the same amount of time before retransmitting, which would result in more collisions.

Advanced IP Addressing

Hierarchical Addressing Using Variable-Length Subnet Masks

Prefix Length and Network Mask

Fourth Octet

64	01000000
65	01000001
66	01000010
67	01000011
68	01000100
69	01000101
70	01000110
71	01000111
72	01001000
73	01001001
74	01001010
75	01001011
76	01001100
77	01001101
78	01001110
79	01001111

Range of Addresses: 192.168.1.64 through 192.168.1.79

- **Have the first 28 bits in common, which is represented by a /28 prefix length**
- **28 bits in common can also be represented in dotted decimal as 255.255.255.240**

Binary ones in the network mask represent network bits in the accompanying IP address; binary zeros represent host bits

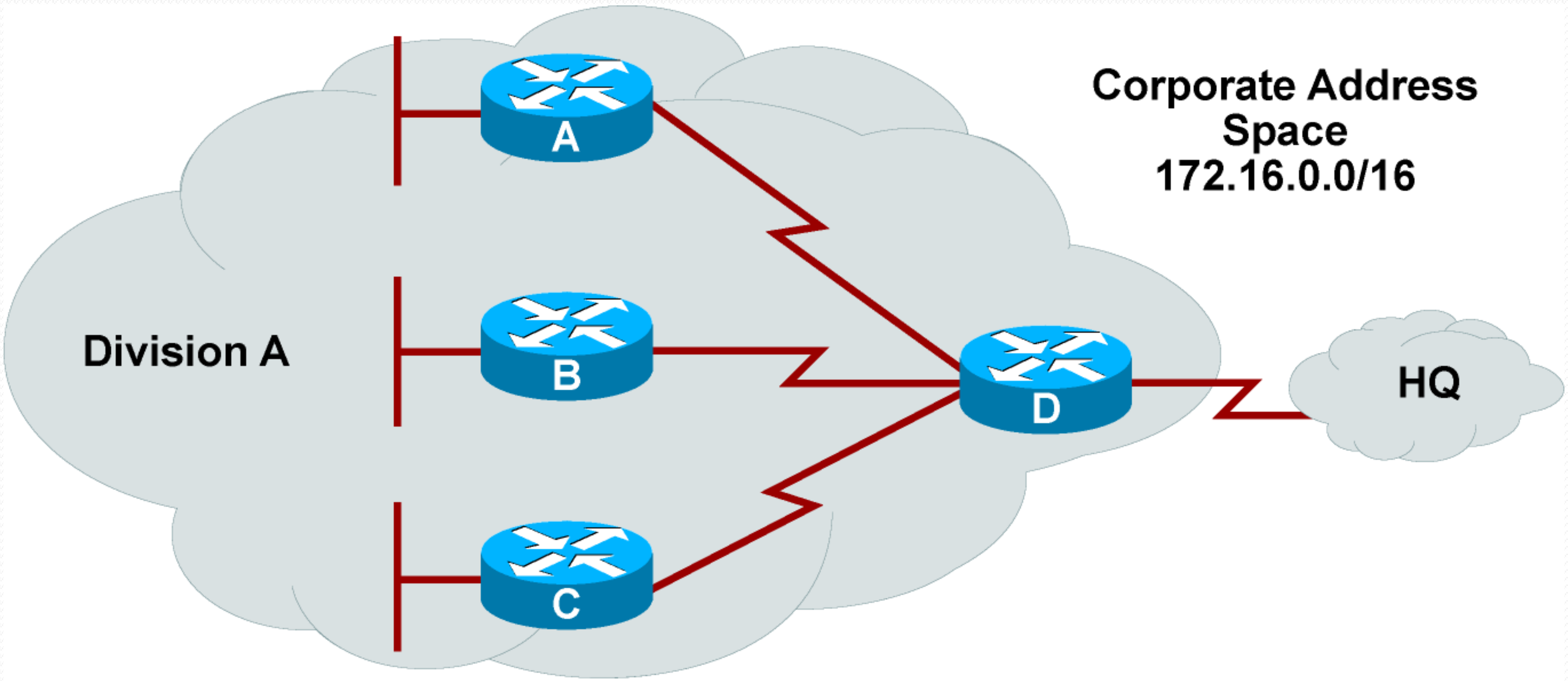
11000000.10101000.00000001.0100*xxxx*   IP Address

11111111.11111111.11111111.11110000   Network Mask

In the IP network number that accompanies the network mask, when the host bits of the IP network number are:

- **All binary zeros – that address is the bottom of the address range**
- **All binary ones – that address is the top of the address range**

Implementing VLSM



A corporation is using 172.16.0.0 /16 for its address space.
172.16.12.0 /22 has been assigned to Division A.
Range of addresses: 172.16.12.0 to 171.16.15.255.

Range Of Addresses for VLSM

Subnetted Address: 172.16.12.0 /22	
Dotted Decimal Notation	**Binary Notation**
172.16.11.0	10101100. 00010000.00001011.00000000
(Text omitted for continuation of bit/number pattern)	
172.16.12.0	10101100. 00010000.00001100.00000000
172.16.12.1	10101100. 00010000.00001100.00000001
172.16.12.255	10101100. 00010000.00001100.11111111
172.16.13.0	10101100. 00010000.00001101.00000000
172.16.13.1	10101100. 00010000.00001101.00000001
172.16.13.255	10101100. 00010000.00001101.11111111
172.16.14.0	10101100. 00010000.00001110.00000000
172.16.14.1	10101100. 00010000.00001110.00000001
172.16.14.255	10101100. 00010000.00001110.11111111
172.16.15.0	10101100. 00010000.00001111.00000000
172.16.15.1	10101100. 00010000.00001111.00000001
172.16.15.255	10101100. 00010000.00001111.11111111
(Text omitted for continuation of bit/number pattern)	
172.16.16.0	10101100. 00010000.00010000.00000000

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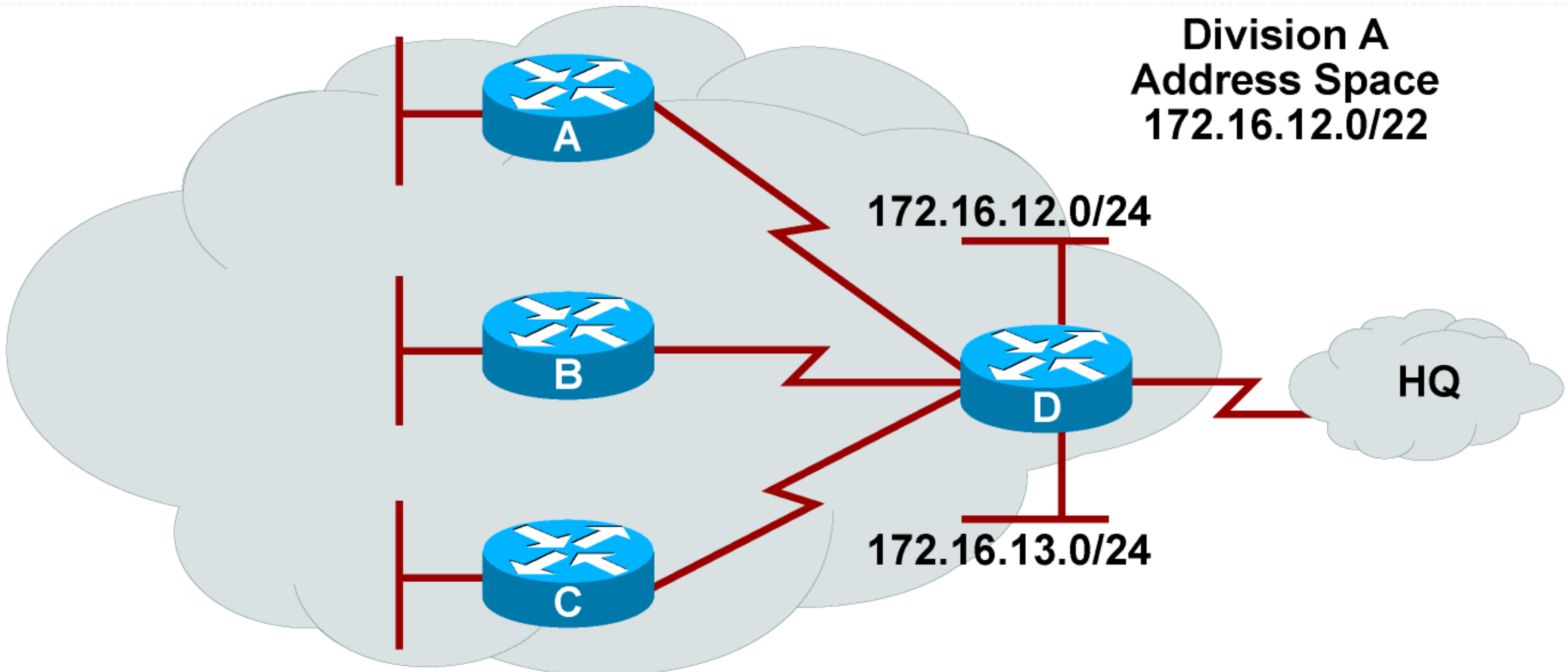
Breakdown Address Space for Largest Subnet



Router D has two VLANs with 200 users each
Subnet the address range into largest block of addresses needed for the division

172.16.12.0 /24	Range: 172.16.12.0 to 172.16.12.255
172.16.13.0 /24	Range: 172.16.13.0 to 172.16.13.255
172.16.14.0 /24	Range: 172.16.14.0 to 172.16.14.255
172.16.15.0 /24	Range: 172.16.15.0 to 172.16.15.255

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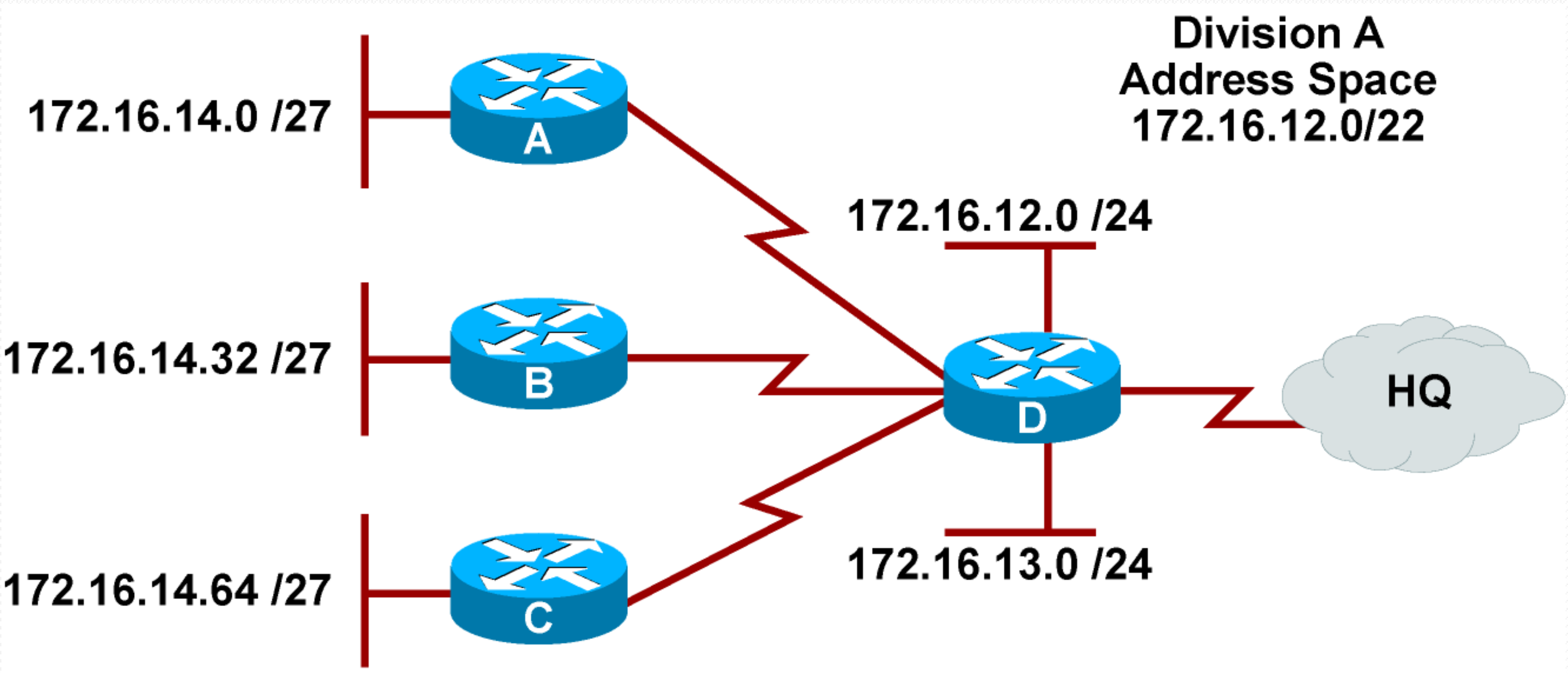
for Ethernets at Remote Sites



Networks 172.16.14.0 /24 and 172.16.15.0 /24 remain after the first round of subnetting.

Next largest blocks are 24-port switches at remote sites.

172.16.14.0 /24 is subnetted into blocks of 32 addresses.

172.16.14.00 /27	172.16.14.128 /27
172.16.14.32 /27	172.16.14.160 /27
172.16.14.64 /27	172.16.14.192 /27
172.16.14.96 /27	172.16.14.224 /27

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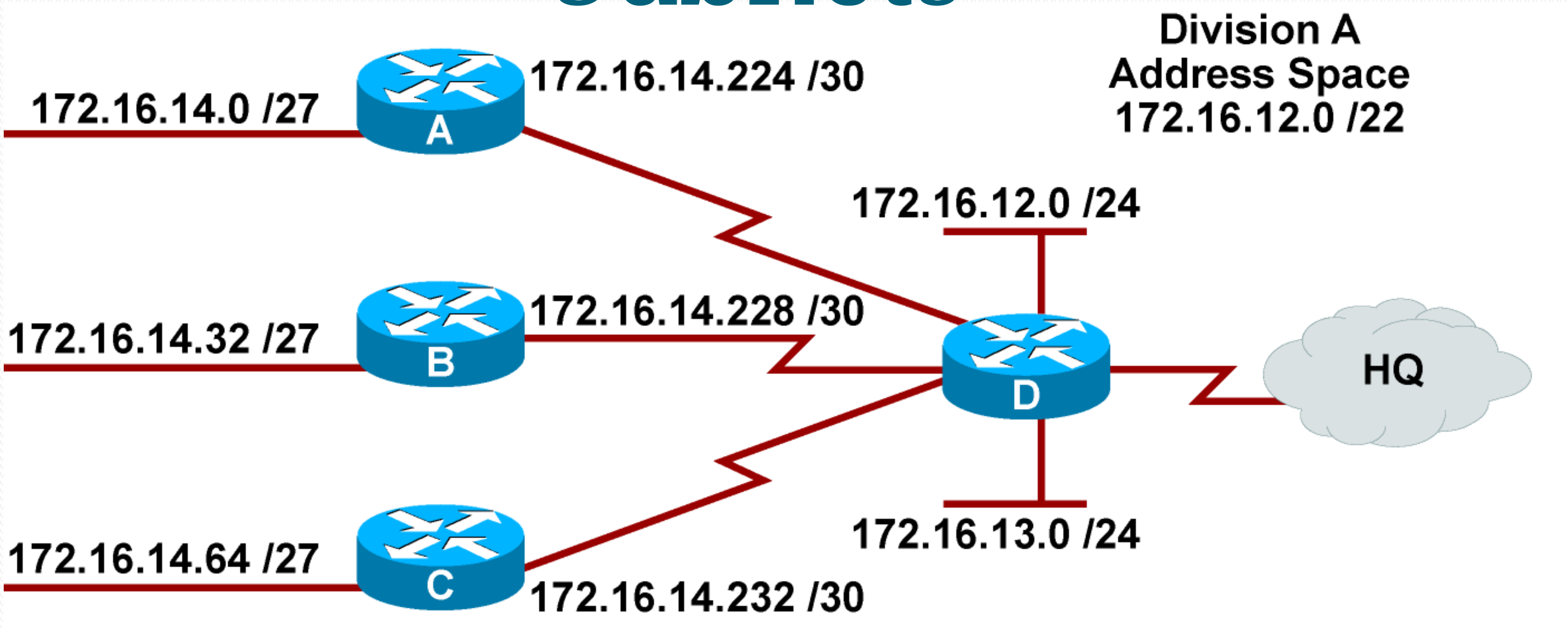
Address Space for Serial Subnets



Networks 172.16.14.0 /24 have the following subnets left over:

172.16.14.96 /27
172.16.14.128 /27
172.16.14.160 /27
172.16.14.192 /27
172.16.14.224 /27

Next largest blocks are the three serial links to each remote site.
Each site needs a block of four addresses.

172.16.14.224 /27 is subnetted to /30.

172.16.14.224 /30
172.16.14.228 /30
172.16.14.232 /30

Calculating VLSM: Binary

VLSM Addresses for /24 for 172.16.12.0 – 172.16.15.255 :						
172.16.12.0	10101100. 00010000.000011	00	.00000000			VLAN 1
172.16.13.0	10101100. 00010000.000011	01	.00000000			VLAN 2
172.16.14.0	10101100. 00010000.000011	10	.00000000			Nodes
172.16.15.0	10101100. 00010000.000011	11	.00000000			Not used
VLSM Addresses for /27 for 172.16.14.0 – 172.16.14.255:						
172.16.14.0	10101100. 00010000.000011	10	.000		00000	Nodes Site A
172.16.14.32	10101100. 00010000.000011	10	.001		00000	Nodes Site B
172.16.14.64	10101100. 00010000.000011	10	.010		00000	Nodes Site C
VLSM Addresses for /30 for 172.16.14.224 – 172.16.14.255:						
172.16.14.224	10101100. 00010000.000011	10	.111	000	00	A-D Serial
172.16.14.228	10101100. 00010000.000011	10	.111	001	00	B-D Serial
172.16.14.232	10101100. 00010000.000011	10	.111	010	00	C-D Serial
172.16.14.236	10101100. 00010000.000011	10	.111	011	00	Not used
172.16.14.240	10101100. 00010000.000011	10	.111	100	00	Not used
172.16.14.244	10101100. 00010000.000011	10	.111	101	00	Not used
172.16.14.248	10101100. 00010000.000011	10	.111	110	00	Not used
172.16.14.252	10101100. 00010000.000011	10	.111	111	00	Not used

Original Prefix

Mask (VLAN) Mask 2 (Nodes) Mask 3 (Serial Links)

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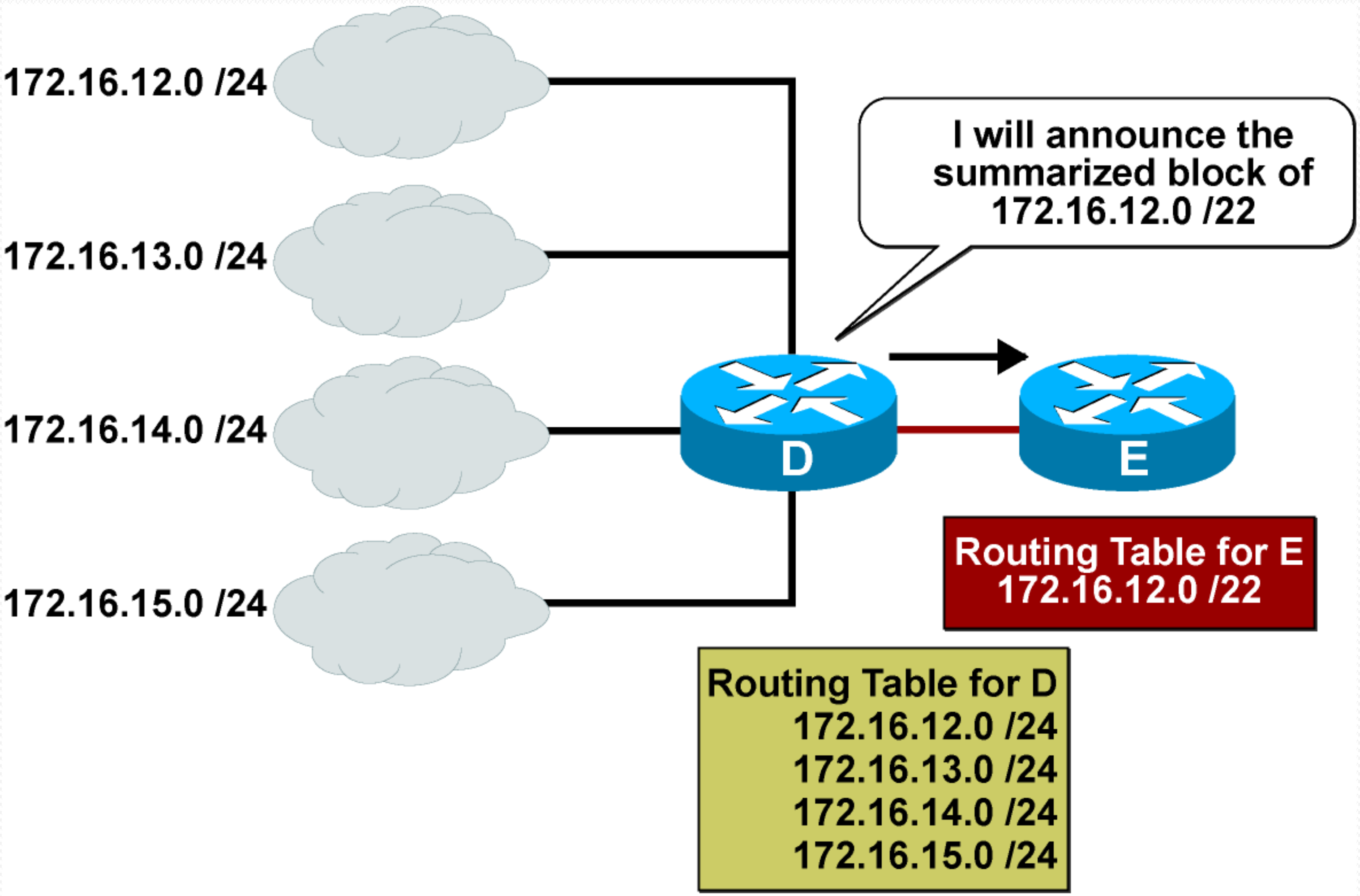
Route Summarization and Classless Interdomain Routing

What Is Route Summarization?



Routing protocols can summarize addresses of several networks into one address range.

Summarizing Within an Octet

Common Bits = 22 Summary: 172.16.12.0 /22		Noncommon Bits = 10
172.16.11.0	10101100. 00010000.000010	11.00000000
172.16.12.0	10101100. 00010000.000011	00.00000000
172.16.13.0	10101100. 00010000.000011	01.00000000
172.16.14.0	10101100. 00010000.000011	10.00000000
172.16.15.0	10101100. 00010000.000011	11.00000000
172.16.15.255	10101100. 00010000.000011	11.11111111
172.16.16.0	10101100. 00010000.000100	00.00000000

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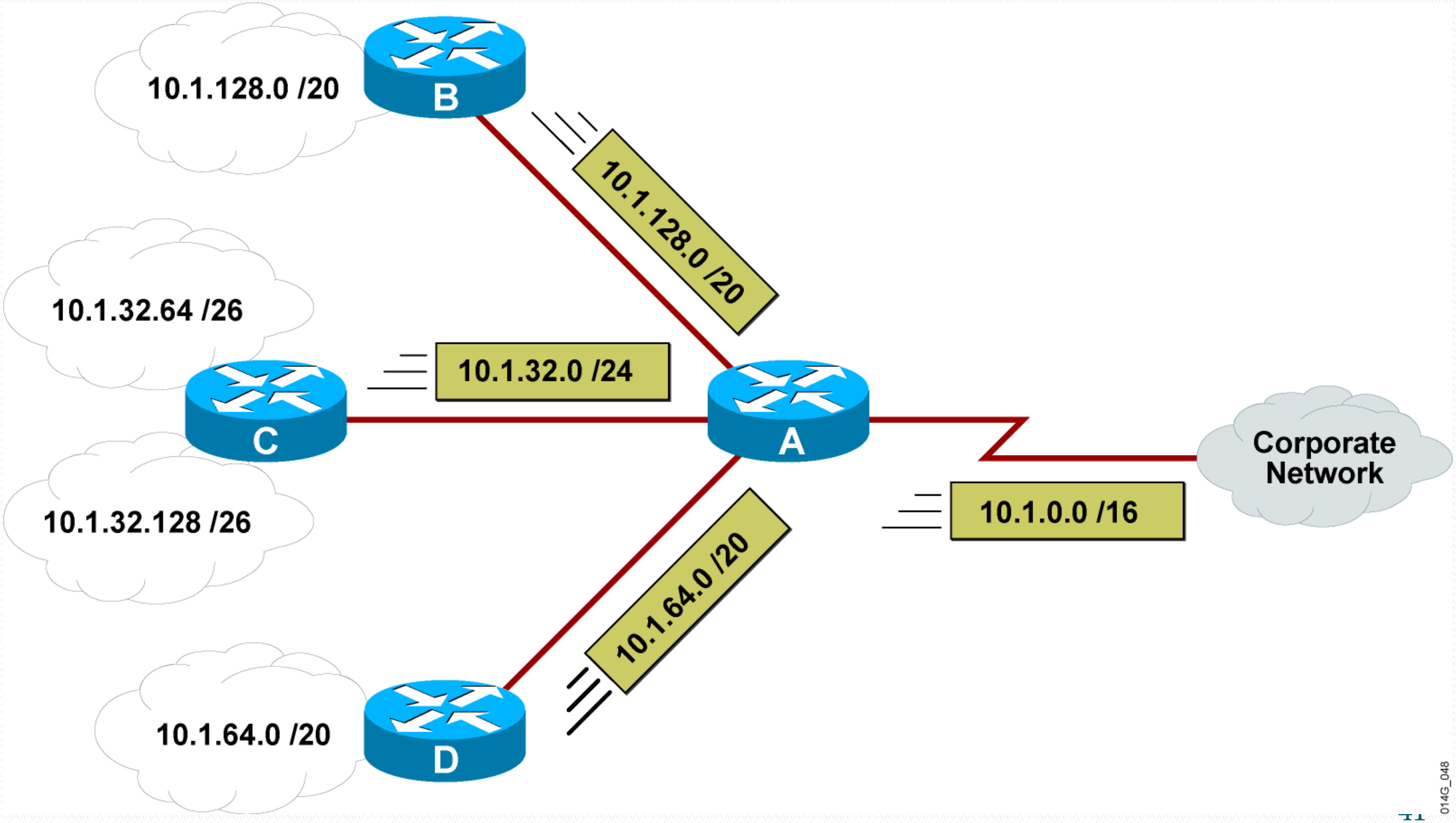
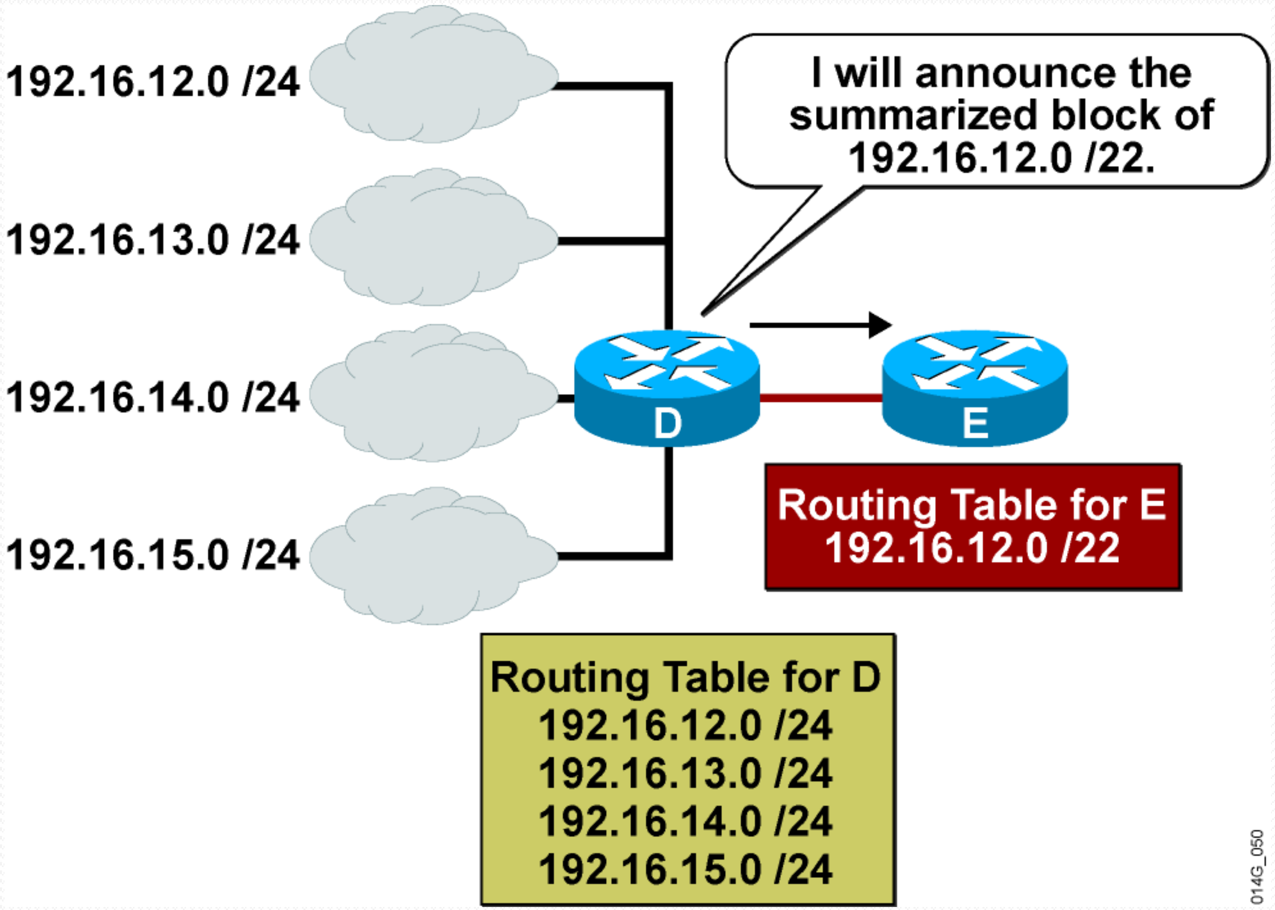
Summarizing Addresses in a VLSM-Designed Network



Classless Interdomain Routing

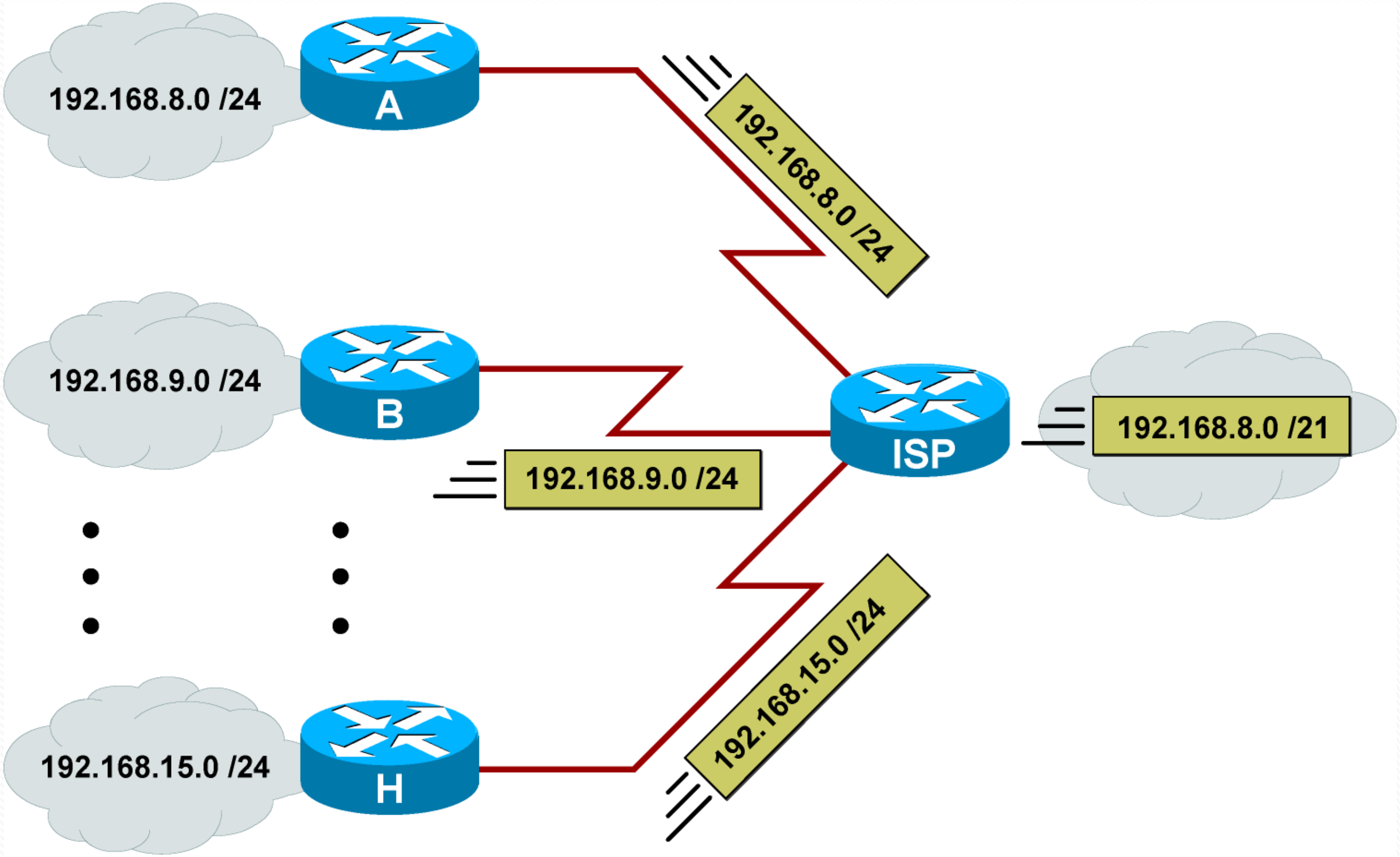
- CIDR is a mechanism developed to alleviate exhaustion of addresses and reduce routing table size.
- Block addresses can be summarized into single entries without regard to the classful boundary of the network number.
- Summarized blocks are installed in routing tables.

What Is CIDR?



- **Addresses are the same as in the route summarization figure, except that**
  Class B network 172 has been replaced by Class C network 192.

CIDR Example



Networks 192.168.8.0 /24 through 192.168.15.0 /24 are summarized by the ISP in one advertisement: 192.168.8.0 /21.