

# Router Management

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# Components of Router

- Bootstrap
- POST (power-on self test)
- ROM monitor
- Mini-IOS

# Components of Router..

- RAM
- ROM
- Flash memory
- NVRAM
- Configuration register

# Bootstrap

- Stored in the microcode of the ROM
- Bootstrap is used to bring a router up during initialization.
- It will boot the router and then load the IOS.

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# POST

Stored in the microcode of the ROM

POST is used to check the basic functionality of the router hardware and determines which interfaces are present

# ROM monitor

Stored in the microcode of the ROM

ROM monitor is used for manufacturing testing and troubleshooting.

# Mini-IOS

Mini-IOS is a small IOS in ROM that can be used to bring up an interface and load a Cisco IOS from flash memory



# RAM

Used to hold packet buffers, routing tables, and also the software and data structures that allow the router to function.

Running-config is stored in RAM, and the IOS can also be run from RAM in some routers

# ROM

Used to start and maintain the router

# Flash memory

Used on the router to hold the Cisco IOS.

Flash memory is not erased when the router is reloaded

# NVRAM

Used to hold the router and switch configuration.

NVRAM is not erased when the router or switch is reloaded.

# Configuration register

Used to control how the router boots up.

# Router Boot Sequence

1. The router performs a POST
2. The bootstrap looks for and loads the Cisco IOS software
3. The IOS software looks for a valid configuration file stored in NVRAM.

If a startup-config file is in NVRAM, the router will load and run this file. The router is now operational.

If a startup-config file is not in NVRAM, the router will start the setup mode configuration upon bootup.

# Managing Configuration Registers

The 16 bits of the configuration register are read 15–0, from left to right.

The default configuration setting on Cisco routers is 0x2102. This means that bits 13, 8, and 1 are on



Configuration Register	2							1			0			2		
Bit number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0

# Software Configuration Meanings

0–3	0x0000–0x000F Boot field
6	0x0040 Ignore NVRAM contents.
7	0x0080 OEM bit enabled.
8	0x0100 Break disabled.
10	0x0400 IP broadcast with all zeros.

# Software Configuration Meanings

- 11–12 0x0800–0x1000 Console line speed.
- 13 0x2000 Boot default ROM software if network boot fails.
- 14 0x4000 IP broadcasts do not have net numbers.
- 15 0x8000 Enable diagnostic messages and ignore NVM contents.

# The Boot Field (0-3)

- 00 ROM monitor mode
- 01 Boot image from ROM
- 02–F Specifies a default boot file name in NVRAM

# Checking the Current Configuration Register

You can see the current value of the configuration register by using the **show version** command

Router#**sh version**

Cisco Internetwork Operating System Software  
IOS (tm) C2600 Software (C2600-I-M), Version  
12.0(3)T3, RELEASE SOFTWARE (fc1)

[output cut]

Configuration register is 0x2102

# Changing the Configuration Register

You can change the configuration register value to modify how the router boots and runs, as follows:

- Force the system into the ROM monitor mode
- Select a boot source and default boot filename
- Enable or disable the Break function
- Control broadcast addresses
- Set the console terminal baud rate
- Load operating software from ROM
- Enable booting from a TFTP (Trivial File Transfer Protocol) server



You can change the configuration register by using the **config-register** command.

Following commands makes the router to boot from ROM monitor mode

# Ex

```
Router(config)#config-register 0x0101
```

```
Router(config)#^Z
```

```
Router#sh ver
```

```
[cut]
```

```
Configuration register is 0x2102
```

```
(will be 0x0101 at next reload)
```

Any change to the configuration register will not take effect until the router is reloaded

# Recovering Passwords

If you are locked out of a router because you forgot the password, you can change the configuration register to help you recover

Bit 6 in the configuration register is used to tell the router whether to use the contents of NVRAM to load a router configuration.

The default configuration register value for bit 6 is 0x2102, which means that bit 6 is off.

With the default setting, the router will look for and load a router configuration stored in NVRAM (startup-config)

To recover a password, you need to turn on bit 6, which will tell the router to ignore the NVRAM contents.

The configuration register value after turn on bit 6 becomes 0x2142.

# steps to password recovery

1. Boot the router and interrupt the boot sequence by performing a break (control+break)
2. Change the configuration register value to 0x2142 and turn on bit 6
3. Reload the router.
4. Enter privileged mode.



# steps to password recovery

5. Copy the **startup-config** file to **running-config**.
6. Change the password.
7. Reset the configuration register to the default value, 0x2102.
8. Reload the router.

# Interrupting the Router Boot Sequence

Your first step is to boot the router and perform a break.

Typically, you perform a break by pressing the Ctrl+Break key combination

# Ex

System Bootstrap, Version 11.3(2)XA4,  
RELEASE SOFTWARE

(fc1)

Copyright (c) 1999 by cisco Systems, Inc.

TAC:Home:SW:IOS:Specials for info

PC = 0xfff0a530, Vector = 0x500, SP =  
0x680127b0

C2600 platform with 32768 Kbytes of main  
memory

PC = 0xfff0a530, Vector = 0x500, SP =  
0x680127b0

# Changing the Configuration Register on Cisco 2600 Series

**rommon 1 > confreg 0x2142**

# Resetting the router

At this point, you need to reset the router, by typing **reset**

The router will reload and ask if you want to use setup mode (because no startup-config is used).

Answer No to entering setup mode, press Enter to go into user mode, and then type **enable** to go into privileged mode

You need to enter the user mode and privileged mode passwords in a router.

Copy the **running-config** to **startup-config** file by

**#copy running-config startup-config**

or

**#copy run start**

# Resetting the Configuration Register

After you are finished changing passwords, set the configuration register back to the default value

**#config-register 0x2102**



# Setting the Passwords

- There are five passwords used to secure Cisco routers.
- The first two passwords are used to set your enable password, which is used to secure privileged mode.
- This will prompt a user for a password when the command **enable** is used.

- The other three are used to configure a password when user mode is accessed either through the console port, the auxiliary port, or Telnet.

# Enable Passwords

- You set the enable passwords from global configuration mode.

## ***Router(config)#enable ?***

Last-resort - Define enable action if no TACACS servers respond

Password - Assign the privileged level password

Secret - Assign the privileged level secret

Use-tacacs - Use TACACS to check enable passwords

- **Password** is used to set the enable password on older, pre-10.3 systems.
- **Secret** is used in new devices and stores password in encrypted mode

- Secret Is the newer, encrypted password.
- Overrides the enable password if set.

# usage

- **Router(config)#enable password bhat1**
- **Router(config)#enable secret bhat2**

- User-mode passwords are assigned by using the **line** command



## ***Router(config)#line ?***

<0-4> First Line number

Aux Auxiliary line

Console Primary terminal line

Vty Virtual terminal

- Aux Is used to set the user-mode password for the auxiliary port
- Console Is used to set a console user-mode password.
- Vty Is used to set a Telnet password on the router.

# configure the auxiliary password

**Router(config)#line aux ?**

<0-0> First Line number

**Router(config)#line aux 0**

**Router(config-line)#login**

**Router(config-line)#password bhat1**

# configure the console password

**Router(config)#line console ?**

<0-0> First Line number

**Router(config)#line console 0**

**Router(config-line)#login**

**Router(config-line)#password bhat2**

# Telnet Password

**Router(config-line)#line vty 0 ?**

<1-197>Last Line Number

**Router(config-line)#line vty 0 197**

**Router(config-line)#login**

**Router(config-line)#password bhat3**

- You can tell the router to allow Telnet connections without a password by using the **no login** command
- **Router(config-line)#line vty 0 197**
- **Router(config-line)#no login**

# Encrypting Your Passwords

- Only the enable **secret** encrypts the password by default.
- You need to manually configure the user-mode enable passwords

- Notice that you can see all the passwords except the enable secret when performing a **show running-config** or **sh run** on a router.



Router#**sh run**

[output cut]

!

enable secret 5

\$1\$rFbM\$8.aXocHg6yHrM/zzeNkAT.

enable password bhat1

!

[output cut]

line con 0

password bhat2

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- To manually encrypt your passwords, use the **service password-encryption** command

# example

Router#**config t**

Enter configuration commands, one per line. End with

CNTL/Z.

Router(config)#**service password-encryption**

Router(config)#**enable password bhat1**

Router(config)#**line vty 0 197**

Router(config-line)#**login**

Router(config-line)#**password bhat2**

Router(config-line)#**line con 0**

Router(config-line)#**login**

Router(config-line)#**password bhat3**

Router(config-line)#**line aux 0**

Router(config-line)#**login**

Router(config-line)#**password bhat4**

Router(config-line)#**exit**

Router(config)#**no service password-encryption**

Router(config)#**^Z**

# Check encryption

```
Router#sh run
```

```
Building configuration...
```

```
[output cut]
```

```
!
```

```
enable secret 5
```

```
$1$rFbM$8.aXocHg6yHrM/zzeNkAT.
```

```
enable password 7 0835434A0D
```

```
!
```

```
[output cut]
```

The **exec-timeout** command sets the timeout for the console session

**Router(config)#line con 0**

**Router(config-line)#exec-timeout 5 0**

**Router(config)#line con 0**

**Router(config-line)#exec-timeout ?**

**<0-35791> Timeout in minutes**

**Router(config-line)#exec-timeout 0 ?**

**<0-2147483> Timeout in seconds**

**<cr>**

**Router(config-line)#exec-timeout 0 0**



# Setting the Router Clock

**Router#clock set ?**

hh:mm:ss Current Time

**Router#clock set 10:30:10 ?**

**<1-31> Day of the month**

MONTH Month of the year

**Router#clock set 10:30:10 28 ?**

MONTH Month of the year

**Router#clock set 10:30:10 28 may ?**

**<1993-2035> Year**

**Router#clock set 10:30:10 28 may 2000 ?**

**<cr>**

Router#

# Router Interfaces

- Interface configuration is one of the most important configurations of the router.

- Some of the configurations used to configure an interface are Network layer addresses, media type, bandwidth, and other administrator commands

- following command shows a 2522 router with 10 serial interfaces, which are labeled 0 through 9

**Router(config)#int serial ?**

<0-9> Serial interface number

- At this point you must choose the interface you want to configure.
- Once you do that, you will be in interface configuration for that interface.

Router(config)#**int serial ?**

<0-9> Serial interface number

Router(config)#**int serial 5**

Router(config)-if)#

Router(config)#**int ethernet ?**

<0-0> Ethernet interface number

Router(config)#**int ethernet 0**

Router(config-if)#

- To configure an interface, you always use the interface type number sequence.
- However, the 2600, 3600, 4000, and 7000 series routers use a physical slot in the router and a port number on the module plugged into that slot.



- For example, on a 2600 router, the configuration would be interface type slot/port:

on a 2600 router

Router(config)#**int fastethernet?**

<0-1> FastEthernet interface number

Router(config)#**int fastethernet 0**

% Incomplete command.

on a 2600 router..

Router(config)#**int fastethernet 0?**

/

Router(config)#**int fastethernet 0/?**

<0-1> FastEthernet interface

- Notice that you cannot type  
**int fastethernet 0.**
- You must type the full command,  
**int fastethernet 0/0.**
- You can type  
**int fa 0/0**

- To set the type of connector used, use the command **media-type**

Router(config)#**int fa 0/0**

Router(config-if)#**media-type ?**

100BaseX    Use RJ45 for -TX; SC FO for -FX

MII        Use MII connector

- However, this is typically auto-detected

# Bringing Up an Interface

- You can turn off an interface with interface command **shutdown**
- Turn it on with the **no shutdown** command.

- If an interface is shut down, it will display administratively down when using the **show interface** command
- The **show running-config** command will show the interface as shut down.
- All interfaces are shut down by default.



**Router#sh int e0**

Ethernet0 is administratively down, line protocol is  
down

[output cut]

Router(config)#**int e0**

Router(config-if)#**no shutdown**

Router(config-if)#**^Z**

00:57:08: %LINK-3-UPDOWN: Interface Ethernet0,  
changed state to up

00:57:09: %LINEPROTO-5-UPDOWN: Line protocol  
on Interface Ethernet0, changed state to up

Router#**sh int e0**

Ethernet0 is up, line protocol is up

# Configuring an IP Address on an Interface

- To configure IP addresses on an interface, use the **ip address** command

Router(config)#**int e0**

Router(config-if)#**ip address 172.16.10.2  
255.255.255.0**

Router(config-if)#**no shut**

- To add a secondary IP address, use the **secondary** command

```
Router(config-if)#ip address 172.16.20.2  
255.255.255.0 secondary
```

```
Router(config-if)#^Z
```

- You can verify both addresses are configured on the interface with the ***show running-config*** command(***sh run***)

Router#**sh run**

Building configuration...

Current configuration:

[output cut]

!

interface Ethernet0

ip address 172.16.20.2 255.255.255.0 secondary

ip address 172.16.10.2 255.255.255.0



# Serial Interface Commands

- Cisco routers, by default, are all DTE devices.
- To act as a DCE device, we need to set clock rate and bandwidth using **clock rate** command & **bandwidth** command.

Router(config)#**int s0**

Router(config-if)#**clock rate ?**

Speed (bits per second)

1200

2400

4800

9600

19200

38400

56000

64000

Router(config-if)#**clock rate 64000**

%Error: This command applies only to DCE  
interfaces

Router(config-if)#**int s1**

Router(config-if)#**clock rate 64000**

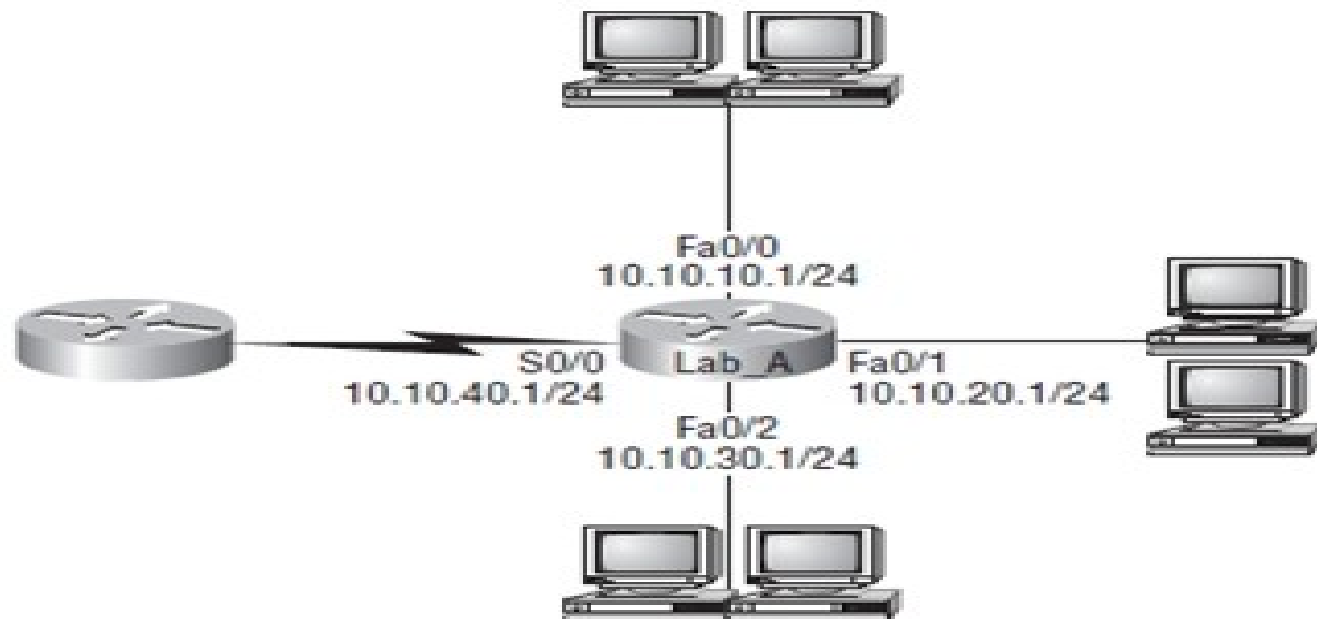
- Every Cisco router ships with a default serial link bandwidth of a T1, or 1.544Mbps.
- The bandwidth of a serial link is used by routing protocols such as IGRP, EIGRP, and OSPF

Router(config-if)#**bandwidth ?**

<1-100000000> Bandwidth in kilobits

Router(config-if)#**bandwidth 64**

- Notice that the clock rate command is in bits per second and bandwidth command is configured in kilobits..



Lab\_A# **sh ip route**

[output cut]

Gateway of last resort is not set

C 10.10.10.0/24 is directly connected, FastEthernet0/0

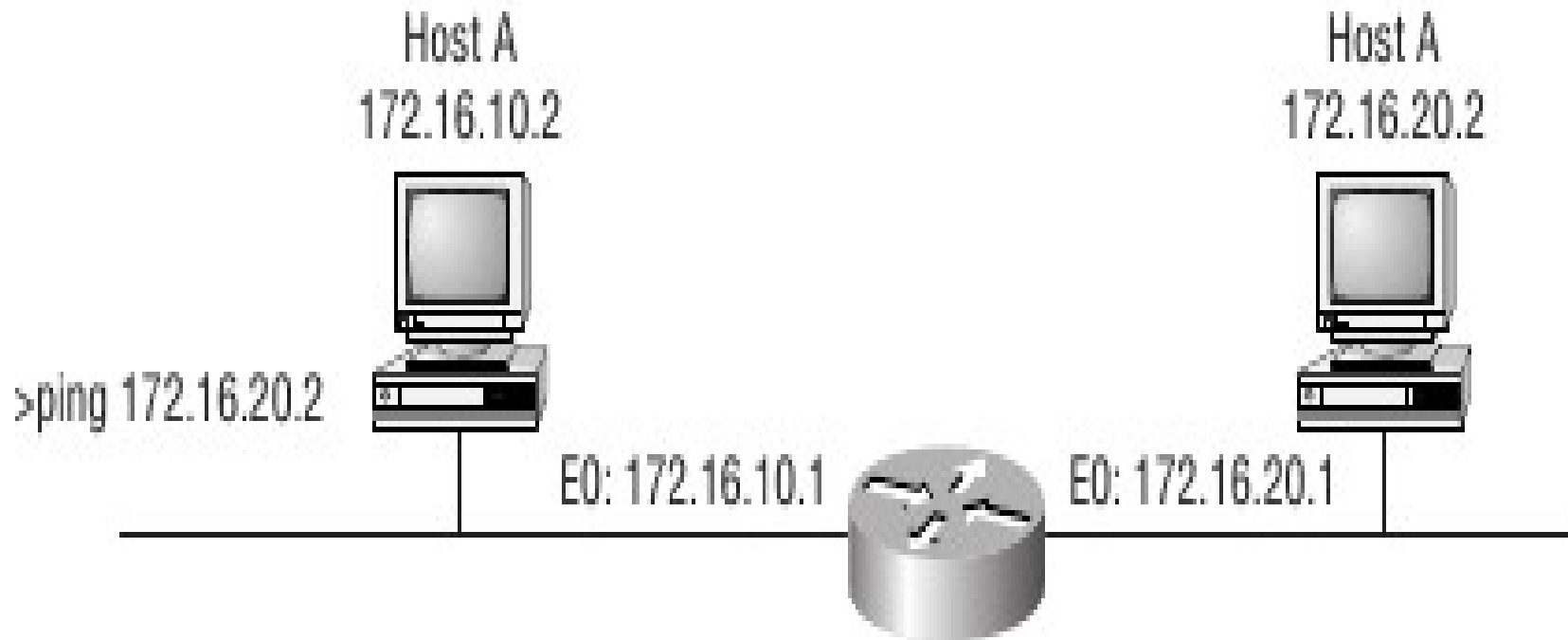
C 10.10.20.0/24 is directly connected, FastEthernet0/1

C 10.10.30.0/24 is directly connected, FastEthernet0/2

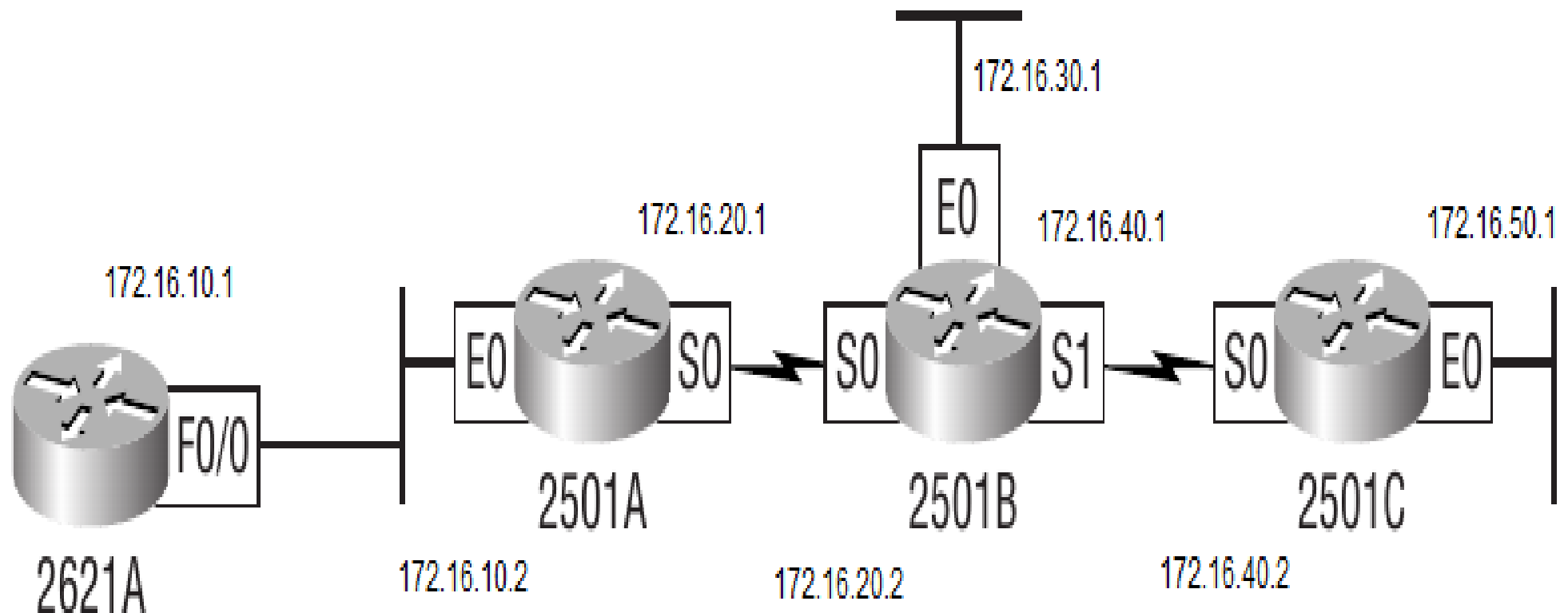
C 10.10.40.0/24 is directly connected, Serial 0/0



# Routing with 2 Hosts & 1 Router



# IP Routing in a Larger Network



# 2621A Configuration

```
Router> en
```

```
Router#config t
```

```
Router (config)#hostname 2621A
```

```
2621A(Config)#interface fa0/0
```

```
2621A(Config-if)#ip address 172.16.10.1  
255.255.255.0
```

```
2621A(Config-if)#no shut
```

- To view the IP routing tables created on a Cisco router, use the privileged mode command **show ip route**.

2621A#sh ip route

Codes: C - connected, S - static, I - IGRP, R - RIP,  
M -mobile, B – BGP D - EIGRP, EX - EIGRP  
external, O – OSPF

C 172.16.10.0 is directly connected,  
FastEthernet0/0

# 2501A Configuration

```
Router#config t
```

```
Router(config)#hostname 2501A
```

```
2501A(config)#int e0
```

```
2501A(config-if)#ip address 172.16.10.2  
255.255.255.0
```

```
2501A(config-if)#no shut
```

2501A(config-if)#int s0

2501A(config-if)#ip address 172.16.20.1  
255.255.255.0

2501A(config-if)#no shut

```
2501A#sh ip route
```

```
C 172.16.20.0 is directly connected, Serial0
```

```
C 172.16.10.0 is directly connected, Ethernet0
```



# 2501B Configuration

```
Router#config t
```

```
Router(config)#hostname 2501B
```

```
2501B(config)#int e0
```

```
2501B(config-if)#ip address 172.16.30.1  
255.255.255.0
```

```
2501B(config-if)#no shut
```

# 2501B Configuration..

2501B(config-if)#int s0

2501B(config-if)#ip address 172.16.20.2  
255.255.255.0

2501B(config-if)#clock rate 64000

2501B(config-if)#no shut

2501B#sh ip route

C 172.16.40.0 is directly connected, Serial1

C 172.16.30.0 is directly connected, Ethernet0

C 172.16.20.0 is directly connected, Serial0

# 2501C Configuration

```
Router(config)#hostname 2501C
```

```
2501C(config)#int e0
```

```
2501C(config-if)#ip address 172.16.50.1  
255.255.255.0
```

```
2501C(config-if)#no shut
```

2501C(config-if)#int s0

2501C(config-if)#ip address 172.16.40.2  
255.255.255.0

2501C(config-if)#no shut

```
2501C#sh ip route
```

```
C 172.16.50.0 is directly connected, Ethernet0
```

```
C 172.16.40.0 is directly connected, Serial0
```

# Backing Up Cisco IOS

Before you upgrade or restore a Cisco IOS, you should copy the existing file to a TFTP host as a backup in case the new image does not work.

# Backing Up Cisco IOS

You need to check the amount of flash memory, copy the Cisco IOS from flash memory to a TFTP host, and then copy the IOS from a TFTP host to flash memory.



# Verifying Flash Memory

Before you attempt to upgrade the Cisco IOS on your router with a new IOS file, you should verify that your flash memory has enough room to hold the new image.

# Verifying Flash Memory..

You can verify the amount of flash memory and the file or files being stored in flash memory by using the **show flash** command (**sh flash**)

# Ex

**Router#sh flash**

System flash directory:

File	Length	Name/status
------	--------	-------------

1	8121000	c2500-js-l.112-18.bin
---	---------	-----------------------

[8121064 bytes used, 8656152 available,  
16777216 total]

16384K bytes of processor board System flash  
(Read ONLY)

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c2500-js-l.112-18.bin is the ios file

c2500 is the platform

j indicates that the file is an enterprise image.

s indicates the file contains extended capabilities.

l indicates that the file can be moved from flash memory

11.2-18 is the revision number

To back up the Cisco IOS to a TFTP host, you use the command **copy flash tftp**

This is a straight forward command that requires only the source filename and the IP address of the TFTP host

# Ex

**Router#copy flash tftp**

System flash directory:

File Length

Name/status

1 8121000 c2500-js-l.112-18.bin

[8121064 bytes used, 8656152 available,  
16777216 total]

Address or name of remote host

[255.255.255.255]?

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# Ex

**192.168.0.120**

Source file name? **c2500-js-l.112-18.bin**

Destination file name [c2500-js-l.112-18.bin]?  
(press  
enter)

Verifying checksum for 'c2500-js-l.112-18.bin')file  
#1)...OK

Copy '/c2500-js-l.112-18' from Flash to server  
as '/c2500-js-l.112-18'? **[yes/no]y**

# Ex

Router#copy flash tftp

System flash directory:

File Length	Name/status
-------------	-------------

18121000	c2500-js-l.112-18.bin
----------	-----------------------

[8121064 bytes used, 8656152 available,  
16777216 total]

Address or name of remote host  
[255.255.255.255]?

192.168.0.120

Source file name? c2500-js-l.112-18.bin

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# Restoring or Upgrading the Cisco Router IOS

You may need to restore the Cisco IOS to flash memory to replace an original file that has been damaged or to upgrade the IOS.

You can download the file from a TFTP host to flash memory by using the **copy tftp flash** command

This command requires the IP address of the TFTP host and the name of the file you want to download to flash memory

Copying the IOS from the TFTP host to flash memory requires a router reboot.

# Ex

**Router#copy tftp flash**

\*\*\*\* NOTICE \*\*\*\*

Flash load helper v1.0

This process will accept the copy options and then terminate the current system image to use the ROM based image for the copy.

Routing functionality will not be available during that time.

If you are logged in via telnet, this connection will terminate.

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Users with console access can see the results of

System flash directory:

File Length Name/status

1 8121000 /c2500-js-l.112-18

[8121064 bytes used, 8656152 available,  
16777216 total]

Address or name of remote host [**192.168.0.120**]?  
(press enter)

Source file name? **c2500-js56i-l.120-9.bin**

Destination file name [c2500-js56i-l.120-9.bin]?  
(press enter)

Accessing file 'c2500-js56i-l.120-9.bin' on  
192.168.0.120...

Loading c2500-js56i-

Erase flash device before writing? [confirm] (press enter)

Flash contains files. Are you sure you want to erase? [confirm] (press enter)

System configuration has been modified. Save? [yes/no]: **y**

Building configuration...

[OK] Copy 'c2500-js56i-l.120-9.bin' from server as 'c2500-js56i-l.120-9.bin' into Flash WITH erase?



The file must be in your TFTP host's default directory.

# Backing Up and Restoring the Cisco Configuration

Any changes that you make to the router configuration are stored in the running-config file.

If you do not perform a **copy run start** command, that change will be gone if the router reboots or gets powered down.

You may want to make another backup of the configuration information as an extra precaution, in case the router or switch completely dies, or for documentation.

To copy the router's configuration from a router to a TFTP host, you can use command.

**copy running-config tftp**

or

**copy starting-config tftp**

**Router#copy run tftp**

Address or name of remote host []?

**192.168.0.120**

Destination filename [router-config]? todd1-config

!!

487 bytes copied in 12.236 secs (40 bytes/sec)

Router#

# Restoring the Cisco Router Configuration

If you have changed your router's running-config and want to restore the configuration to the version in startup-config

**#>copy startup-config running-config**

If you copied the router's configuration to a TFTP host as a second backup, you can restore the configuration using command

**#>copy tftp running-config**

**Or**

**#>copy tftp startup-config**

# Ex

**Router#copy tftp run**

Address or name of remote host []?

**192.168.0.120**

Source filename []? **todd1-config**

Destination filename [running-config]? (press enter)

Accessing tftp://192.168.0.120/todd1-config...

Loading todd1-config from 192.168.0.120 (via Ethernet0):



# Erasing the Configuration

To delete the startup-config file on a Cisco router, use the command

**#>erase startup-config**

**Router#erase startup-config**

Erasing the nvram filesystem will remove all files!

Continue? [confirm](press enter)

[OK]

Erase of nvram: complete

Router#

# Assignments