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How to Configure Cisco 2600 Routers

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Purpose

Purpose of this document is to show how to use and configure Cisco 2600 Series routers. Mainly this document has been done for Laboratory work course (S-38.133) at Networking Laboratory at HUT. On laboratory course these Cisco's routers are used for IPv4 routing in small network.

This document includes configuring interfaces up and routing part, which has manual for RIP (Routing Information Protocol) and for OSPF (Open Shortest Path First). For other routing protocols among others BGP (Border Gateway Protocol) see for example Cisco's web site¹.

Chapter 3 is suited very good for example for PC routers running Zebra² (nowadays Quagga³) as routing daemon, because it has same commands as Cisco routers use.

Mainly this document is collection of Cisco's manuals ([1] – [2], [6] – [7]), which are modified for our laboratory course's use.

¹ www.cisco.com

² www.zebra.org

³ www.quagga.net

1 Cisco Inter-network Operating System (IOS)

1.1 Cisco IOS Operation Modes

The Cisco Software provides access to four different command modes. There are more commands, but in normal use they are not necessary. Each command mode provides a different group of related commands. For security purposes, the Cisco IOS software provides two levels of access to commands: user and privileged. The unprivileged user mode is called user EXEC mode. The privileged mode is called privileged EXEC mode and requires a password.

The following table, Table (1) describes four used modes, how to enter the modes and the resulting prompts. The prompt helps you identify which mode you are in and therefore which commands are available to you. In Fig. (1) these four operation modes are presented as a figure.

Table 1. Accessing and Exiting Command Modes.

Command Mode	Access Method	Prompt	Exit Method
User EXEC	Log in.	Router>	Use the logout command.
Privileged EXEC	From user EXEC mode, use the enable EXEC Command	Router#	To return to user EXEC mode, use the disable command
Global configuration	From privileged EXEC mode, use the configure terminal privileged EXEC command.	Router(config)#	To return to privileged EXEC mode from global configuration mode, use the exit or end command, or press Ctrl-Z .
Interface configuration	From global configuration mode, specify an interface using an interface (or router) command	Router(config-if)# Or Router(config-router)#	To return to global configuration mode use the exit command. To return to privileged EXEC mode, use the end command, or press Ctrl-Z .

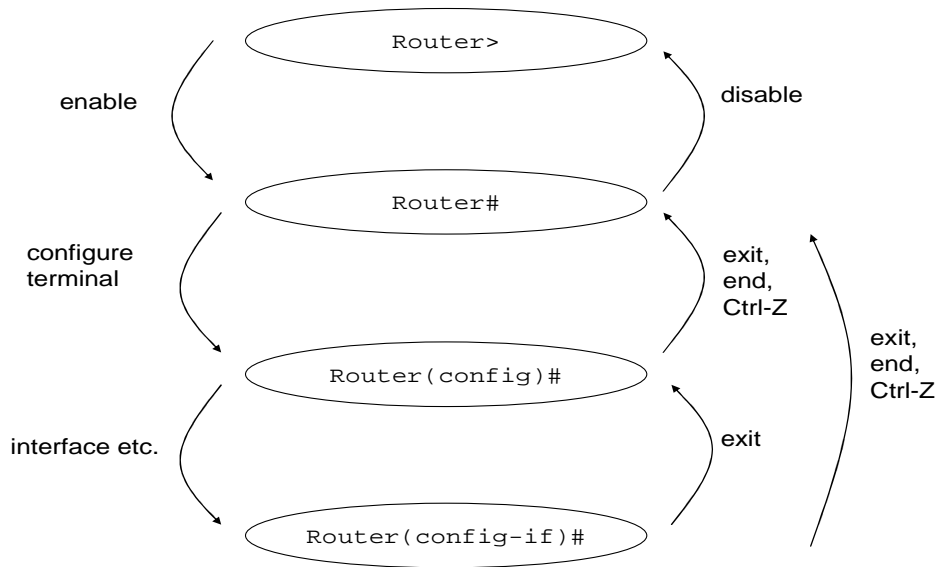


Figure 1. Four Cisco IOS Operation modes and their accesses and exits as a figure.

1.1.1 User EXEC Mode

When you are connected to the router, you are started in user EXEC mode. The user EXEC commands are a subset of the privileged EXEC commands.

1.1.2 Privileged EXEC Mode

Privileged commands include the following:

- Configure – Changes the software configuration.
- Debug – Display process and hardware event messages.
- Setup – Enter configuration information at the prompts.

Enter the command `disable` to exit from the privileged EXEC mode and return to user EXEC mode.

1.1.3 Configuration Mode

Configuration mode has a set of submodes that you use for modifying interface settings, routing protocol settings, line settings, and so forth. Use caution with configuration mode because all changes you enter take effect immediately.

To enter configuration mode, enter the command `configure terminal` and exit by pressing `Ctrl-Z`.

1.1.4 No Form

Almost every configuration command also has a `no` form. In general, use the `no` form to disable a feature or function. Use the command without the keyword `no` to re-enable a disabled feature or to enable a feature that is disabled by default. For example, IP

routing is enabled by default. To disable IP routing, enter the `no ip routing` command and enter `ip routing` to re-enable it.

1.2 Getting Help

In any command mode, you can get a list of available commands by entering a question mark (?).

```
Router>?
```

To obtain a list of command that begin with a particular character sequence, type in those characters followed immediately by the question mark (?).

```
Router#co?  
Configure connect copy
```

To list keywords or arguments, enter a question mark in place of a keyword or argument. Include a space before the question mark.

```
Router#configure ?  
memory      Configure from NV memory  
network     Configure from a TFTP network host  
terminal    Configure from the terminal
```

You can also abbreviate commands and keywords by entering just enough characters to make the command unique from other commands. For example, you can abbreviate the `show` command to `sh`.

1.3 Configuration Files

Any time you make changes to the router configuration, you must save the changes to memory because if you do not they will be lost if there is a system reload or power outage. There are two types of configuration files: the running (current operating) configuration and the startup configuration, which is loaded up in rebooting a router.

Use the following privileged mode commands to work with configuration files.

- **configure terminal** – modify the running configuration manually from the terminal.
- **show running-config** – display the running configuration.
- **show startup-config** – display the startup configuration.
- **copy running-config startup-config** – copy the running configuration to the startup configuration.
- **copy startup-config running-config** – copy the startup configuration to the running configuration.
- **erase startup-config** – erase the startup-configuration in NVRAM.
- **copy tftp running-config** – load a configuration file stored on a Trivial File Transfer Protocol (TFTP) server into the running configuration.
- **copy running-config tftp** – store the running configuration on a TFTP server.

1.4 Configuration System (Setup)

In privileged EXEC mode you can setup the whole system, for example setup network cards, put IP addresses, start simple RIP routing.

```
Router#setup
```

In Cisco routers interfaces are named as FastEthernet0/0 and FastEthernet0/1. Some of our lab routers also include serial cable interfaces. Numbering is same like above.

1.5 IP Address and Interface Configuration

If you don't like to put IP address like in 1.4 *Configuration System (Setup)*, you can put them with the following instructions.

In privileged EXEC mode give the next command:

```
Router#config terminal
```

Then enter the **interface** *type port* to enter the interface configuration mode.

```
Router(config)#interface FastEthernet0/0
```

Now you are in interface configuration mode and you can modify this chosen interface. Enter the IP address and subnet mask of the interface using **ip address** *ipaddress subnetmask* command.

```
Router(config-if)#ip address 10.12.0.1 255.255.255.252
```

In this mode you can give parameters like for example hello protocol interval in OSPF for an interface. Exit interface configuration mode by giving command Ctrl-Z.

2 Routing Protocol Configuration

2.1 Routing Information Protocol RIP

You can modify RIP routing by giving the next command in global configuration mode:

```
Router(config)#router rip
```

2.1.1 RIP Commands

Then in router configuration mode `Router(config-router)#` you can give the next listed commands:

- `address-family` Enter Address Family command mode
- `auto-summary` Enable automatic network number summarization
- `default` Set a command to its defaults
- `default-information` Control distribution of default information
- `default-metric` Set metric of redistributed routes
- `distance` Define an administrative distance
- `distribute-list` Filter networks in routing updates
- `exit` Exit from routing protocol configuration mode
- `flash-update-threshold` Specify flash update threshold in second
- `help` Description of the interactive help system
- `input-queue` Specify input queue depth
- `maximum-paths` Forward packets over multiple paths
- `neighbor` Specify a neighbor router
- `network` Enable routing on an IP network
- `no` Negate a command or set its defaults
- `offset-list` Add or subtract offset from IGRP or RIP metrics
- `output-delay` Interpacket delay for RIP updates
- `passive-interface` Suppress routing updates on an interface
- `redistribute` Redistribute information from another routing protocol
- `timers` Adjust routing timers
- `traffic-share` How to compute traffic share over alternate paths
- `validate-update-source` Perform sanity checks against source address of routing updates
- `version` Set routing protocol version

2.1.2 Specify a RIP Version

By default the software receives the both RIP version 1 and version 2 packets but send only version 1 packets. To control which RIP version an interface sends, use one of the following commands in interface configuration mode, shown in Table (2).

Table 2. RIP version commands in sending.

Command	Purpose
ip rip send version 1	Configure an interface to send only RIP version 1 packets.
ip rip send version 2	Configure an interface to send only RIP version 2 packets.
ip rip send version 1 2	Configure an interface to send RIP version 1 and 2 packets.

To control how packets received from an interface are processed, use one of commands shown in Table (3).

Table 3. RIP version commands in receiving.

Command	Purpose
ip rip receive version 1	Configure an interface to receive only RIP version 1 packets.
ip rip receive version 2	Configure an interface to receive only RIP version 2 packets.
ip rip receive version 1 2	Configure an interface to receive RIP version 1 and 2 packets.

2.1.3 No Form

To turn off any feature of RIP routing, for example to turn off neighbor 10.12.0.5 255.255.255.252, give the next command:

```
Router(config-router)#no neighbor 10.12.0.5 255.255.255.252
```

To turn off RIP, use the **no router rip** command:

```
Router(config)#no router rip
```

2.2 Open Shortest Path First OSPF

You can modify OSPF routing by giving the next command in global configuration mode:

```
Router(config)#router ospf process-id
```

Process-id is a number between 1 and 65535. Pick the process-id which is not being used. To determine which ids are being used, issue the show process command

```
Router#show ip ospf
```

2.2.1 OSPF Commands

Then in router configuration mode `Router(config-router)#` you can give the next listed commands:

- area OSPF area parameters
- auto-cost Calculate OSPF interface cost according to bandwidth
- capability Enable specific OSPF feature
- compatible OSPF compatibility list
- default Set a command to its defaults
- default-information Control distribution of default information
- default-metric Set metric of redistributed routes
- discard-route Enable or disable discard-route installation
- distance Define an administrative distance
- distribute-list Filter networks in routing updates
- domain-id OSPF domain-id
- domain-tag OSPF domain-tag
- exit Exit from routing protocol configuration mode
- help Description of the interactive help system
- ignore Do not complain about specific event
- log-adjacency-changes Log changes in adjacency state
- maximum-paths Forward packets over multiple paths
- neighbor Specify a neighbor router
- network Enable routing on an IP network
- no Negate a command or set its defaults
- passive-interface Suppress routing updates on an interface
- redistribute Redistribute information from another routing protocol
- router-id router-id for this OSPF process
- summary-address Configure IP address summaries
- timers Adjust routing timers
- traffic-share How to compute traffic share over alternate paths

The network-number identifies the network using OSPF. The mask tells which bits to use from the network-number, and the area-id is used for determining areas in an OSPF configuration. For example:

```
Router(config-router)#network 10.12.0.4 255.255.255.252 area 0
```

Area 0 is so called backbone network.

2.2.2 Router ID

Router ID is the tie-breaker for OSPF path selection. The path selection process uses a variety of metrics to select a route. If all other metrics (accessibility, administrative weight, local preference, etc.) are equal, OSPF determines the router ID using the following priority:

1. Use the address configured by the **ospf router-id** command
2. Use the address of the loopback 0 interface
3. Use the highest IP address of any interface
4. If no interface exists, set the router-ID to 0.0.0.0

If no OSPF router ID is explicitly configured, OSPF computes the router-ID based on the items 2, 3, and 4 and restarts OSPF (if the process is enabled and router-ID has changed). The **ospf router-id** command causes the OSPF process to restart using the new router-ID (if the processes are enabled and router-ID has changed).

Use in router configuration mode **ospf router-id ip-address** command to set the OSPF router ID for the system. Use the **no ospf router-id** to configure the OSPF router ID as the default value (address of the loopback 0 interface). Factory Default is Loopback 0 interface address.

```
Router(config-router)#router id 1.1.1.1
```

It is very recommend checking router's router ID by giving the next command

```
Router#show ip ospf
```

2.2.3 Virtual Link

A Virtual link can be built up for network shown in Figure (2) by

1. Defining Router IDs for the both ends.
2. Giving in router configuration mode the **area x virtual-link A.B.C.D**, where *x* is area ID in the both routers. For example in Router 1.1.1.1

```
Router(config-router)#area 1 virtual-link 2.2.2.2
```

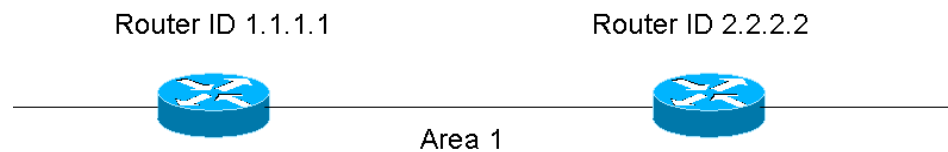


Figure 2. Configuration a Virtual link.

To ensure a virtual link is up, give the next command

```
Router#show ip ospf
```

2.2.4 Configure OSPF Interface Parameters

You are not required to alter any of these parameters, but some interface parameters must be consistent across all routers in an attached network. In interface configuration mode, specify any of the following commands show in Table (4).

Table 4. OSPF Interface Parameters.

Command	Purpose
<code>ip ospf cost <i>cost</i></code>	Explicitly specify the cost of sending a packet on an OSPF interface.
<code>ip ospf retransmit-interval <i>seconds</i></code>	Specify the number of seconds between link state advertisement retransmissions for adjacencies belonging to an OSPF interface.

<code>ip ospf transmit-delay <i>seconds</i></code>	Set the estimated number of seconds it takes to transmit a link state update packet on an OSPF interface.
<code>ip ospf priority <i>number</i></code>	Set router priority to help determine the OSPF designated router for a network.
<code>ip ospf hello-interval <i>seconds</i></code>	Specify the length of time, in seconds, between the hello packets that a router sends on an OSPF interface.
<code>ip ospf dead-interval <i>seconds</i></code>	Set the number of seconds that a router's hello packets must not have been seen before its neighbors declare the OSPF router down.
<code>ip ospf authentication-key <i>password</i></code>	Assign a specific password to be used by neighboring OSPF routers on a network segment that is using OSPF's simple password authentication.

2.2.5 Configure OSPF authentication

Cisco router supports message-digest hashing algorithm to guarantee the integrity of OSPF packets and authenticate between the routers. The key is set on interface by the following command

```
Router(config-if)#ip ospf message-digest-key key-id md5
encryption-type key
```

The key-id is an identifier and takes the value in the range of 1 through 255. The encryption type field refers to the type of encryption, where 0 means none and 7 means proprietary. The key is an alphanumeric password up to sixteen characters. Neighbor routers must use the same key identifier with the same key value.

After the key is configured, authentication must be enabled in global configuration mode

```
Router(config)#router ospf process-id
Router(config-router)#area area-id authentication message-
digest
```

2.2.6 No Form

To turn off any feature of OSPF routing, for example to turn off network 10.12.0.4 255.255.255.252 area 0, give the next command:

```
Router(config-router)#no network 10.12.0.4 255.255.255.252
area 0
```

To turn off RIP, use the **no router rip** command:

```
Router(config)#no router ospf process-id
```

2.3 RIP and OSPF Redistribution

2.3.1 RIP

If you like to redistribute routing information to OSPF, you have to tell RIP running router process-id of OSPF and default-metric value. For example

```
Router(config-router)#redistribute ospf process-id
```

And default-metric value:

```
Router(config-router)#default-metric value
```

Value is a positive integer.

2.3.2 OSPF

In OSPF you have to mention any default-metric value, just give the next command, if you like to transform routing information to RIP.

```
Router(config-router)#redistribute rip
```

In addition in classless addressing, you have to write subnets, like

```
Router(config-router)#redistribute rip subnets
```

2.3.3 Gateway

When you have a network with running a routing protocol and you like to connect it to another network running B routing protocol throughout one or more routers, you have to tell about border area router or gateway router with the following command. B network is generally much bigger and for example the Internet.

```
Router(config-router)#default-information originate
```

2.3.4 LAN

If a LAN is connected to a router as shown in Fig. 3., you have to tell about it to the router's routing protocol. Just write

```
Router(config-router)#redistribute connected
```

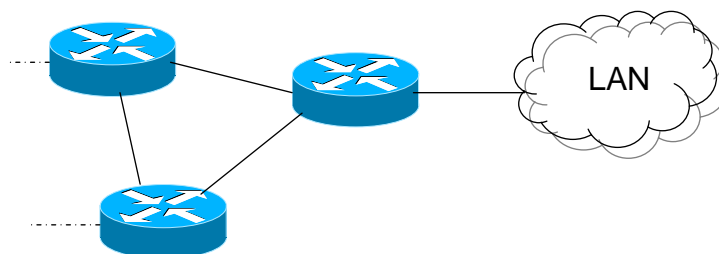


Figure 3. Redistributing to LAN

3 Configure CEF

Load balancing is based on a combination of source and destination packet information; it allows you to optimize resources by distributing traffic over multiple equal-cost connections for transferring data to a destination. You configure load balancing on outbound interfaces on a per-destination or per-packet basis.

3.1 Enable CEF

To enable CEF, use the following command in global configuration mode:

```
Router(config)# ip cef
```

3.2 Enable Per-Packet Load Balancing

Per-destination load balancing is enabled by default when you enable CEF. Typically, you would disable per-destination load balancing when you want to enable per-packet load balancing. To disable per-destination load balancing, use the following command in interface configuration mode:

```
Router (config-if) # no ip load-sharing per-destination
```

To enable per-packet load balancing, use the following command in interface configuration mode:

```
Router (config-if) # ip load-sharing per-packet
```

3.3 Enable Network Accounting for CEF

Hash bucket accounting to collect statistics is better to understand Cisco Express Forwarding patterns in your network. Use the following command to enable it:

```
Router (config) # ip cef accounting load-balance-hash
```

3.4 Verifying CEF

Use the use the following commands in privileged EXEC mode to view the path-to-bucket assignment result from the hash bucket accounting

```
Router# show ip cef {prefix} internal
```

References

- [1] Cisco: *Configuring RIP*
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