

# Cisco Inter-network Operating System (IOS)

## A short guide for the NetAdmin

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Let's start out at the very beginning with the question:

### "What is a Command?"

The most important thing to understand is that all computers run on Magic. And that Commands are the Magic Words that make computers do things. And that a Router is merely a Computer in a box that does nothing but Route.

So what we are talking about here is the Magic Commands for Routing. And you are going to become the Magician!

***OF COURSE there is no Magic so lets see show things work in practice...***

Things to remember before delving into Cisco IOS:

### How Do we connect to the router?

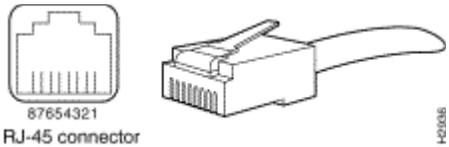
We connect to the router's Console or AUX port with a serial cable using a RJ45 connector (older models have DB9 or RS-232). In case we are trying to configure a modular router, the Console and the AUX are most probably on the Processor module.

To access a console we need Kermit and Minicom programs with the following settings:

#### VT100 Emulation

- **9600 Baud**
- **No Parity**
- **8 Data Bits**
- **1 Stop Bit**

### Console and AUX Connectors for Cisco Routers

Connector	Graphic
<a href="#">RJ-45</a>	

DB-25 DCE	 <p>Connector DB25 - DCE Cable end DB25 - DTE Console Cable Connection</p>
DB-25 DTE	 <p>Connector DB25 - DTE Cable end DB25 - DCE AUX Cable Connection</p>



## Main Parts for the processor module

### 1. ROM - Read Only Memory.

This is a form of permanent memory used by the Router to store:

- The "Power-On Self Test" that checks the Router on boot up.
- The "Bootstrap Startup Program" that gets the Router going.
- A very basic form of the Cisco IOS software.

(to change the ROM you have to remove and replace chips)

### 2. Flash Memory

An Electronically Erasable and Re-Programmable memory chip.

The "Flash" contains the full Operating System, or "Image".

This allows you to Upgrade the OS without removing chips.

### 3. NVRAM - Non-Volatile RAM

This stores your Router's "Startup Configuration File".

Similar to Flash memory, this retains data even when power is lost.

### 4. RAM - Random Access Memory

This is regular computer memory chips.

These are the working memory of the Router,

and provide Caching, Packet Buffering, and hold Routing Tables.

The RAM is also where the Running Operating System

lives when the Router is on.

RAM loses all its data when reset or powered off.

In addition and for small end routers we can have in the same module:

**Interfaces** - Where the Router meets the Outside World.

Basically your Router will have **Serial** interfaces, Which are mostly used to connect long-distance as in a WAN (Wide-Area Network).

You will also have LAN (Local-Area Network) Interfaces, such as **Ethernet, Token Ring, and FDDI** (Fiber Distributed Data Interface)

**If the router is modular, the Interfaces will be different cards or modules.**

## **Explanation of the Boot Up Process**

1. The "Power-On Self-Test" checks the Router Hardware. This includes the CPU (Central Processor Unit), memory, and interfaces.
2. The "**Bootstrap Program**", which is stored in ROM, runs itself
3. The "**Bootfield**" is read to find out the proper Operating System source.
4. The "**Operating System Image**" is loaded into RAM. (Random Access Memory)
5. The "**Configuration File**" saved in NVRAM is loaded into the RAM. The Configuration File is then executed one line at a time.
6. If no "Configuration File" is found in NVRAM, the Cisco IOS will offer you the chance to use the "**Initial Configuration Dialog**". This is a set of Questions for you to answer to do a basic configuration. The "Setup Dialog" will be one of the first things we see when you receive a **new router** or when the router's configuration is **lost or corrupted**.

## **On the router prompt**

If things go fine we should be able to see a "Router>" prompt which is purely informational. The Cisco IOS command-line interface is organized around the idea of modes (Unprivileged/Privileged) which determine what commands you can use. Each mode has a set of commands available in that mode, and some of these commands are **only** available in that mode.

**In any mode, typing a question mark will display a list of the commands available in that mode.**

**Router>?**

In addition, for any command we can get its options or completion using the question mark:

**Router>show ?**

**To configure a router you need to have a password for the Privileged EXEC mode using enable!**

Router> **enable**

**result:** Router#

now we are in a privileged mode and we can configure the router both in terms of security and in terms of actual functionality. To leave this mode we can type “disable” when we are in privileged mode.<sup>1</sup>

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

Mode of Operation	Usage	How to Enter the Mode	Prompt
User EXEC	Change terminal settings on a temporary basis, perform basic tests, and list system information.	First level accessed.	Router>
Privileged EXEC	System administration, set operating parameters.	From user EXEC mode, enter <b>enable password</b> command	Router#
Global Config	Modify configuration that affect the system as a whole.	From privileged EXEC, enter <b>configure terminal</b> .	Router(config)#
Interface Config	Modify the operation of an interface.	From global mode, enter <b>interface type number</b> .	Router(config-if)#
Setup	Create the initial configuration.	From privileged EXEC mode, enter command <b>setup</b> .	Prompted dialog

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<sup>1</sup>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.

## Steps for First Boot and Initial Setup:

For a freshly configured router we need to SETUP passwords to avoid any intrusions and problems:

There are **5 separate Passwords** you need to protect your Router.

- 1. Console - protects the Console Port (usually our primary entry)**
- 2. Auxiliary - protects the AUX Port (for your modem or another serial)**
- 3. TTY - Protects against un-authorized Telnet Port logons**
- 4. Enable - Guards the use of the Enable Mode Super-user status.**
- 5. Enable Secret - an Encrypted Secret form of the Above (better!)**

Setting up the router's passwords:

### 1. Console

Get into Privileged EXEC mode (for all configurations)

- a) Router> **enable**  
Router#

Get into Global Config mode through terminal (for all MANUAL configurations)

- b) Router# **configure terminal**  
Router(config)#
- c) Router(config)# **line console 0**  
d) Router(config-line)# **password (plaintext password here)**  
e) Router(config-line)#**end** (alternatively you can press Ctrl-Z)

### 2. Aux

We follow all the previous steps and we just change the line in step (c) to:

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

### 3. VTY Ports

VTY are rather a special case, since they are not real ports: You won't find a port on the back of your Router labeled VTY, these ports are mostly used for remote connections

Again we follow all the steps for the console and we only change **(c)**:

- d) Router(config)# **line vty 0 4** (for 5 lines, there might be more!)

**4. Enable password** (this password is stored as plain text in the configuration files and in memory and it **should be avoided**).

a) Router> **enable**

b) Router# **configure terminal**

c)Router(config)# **enable password *enable-plaintext-password***

**5. Enable Secret** (this password uses a one-way cryptographic secret password and it is stored as a hashed value and thus it is more secure).

a) Router> **enable**

b) Router# **configure terminal**

c)Router(config)# **enable secret *enable-secret-plaintext-password***

**\*WARNINGS\*:**

**DO NOT SET Enable Secret to be the same as the Enable – it won't work...**

**DO NOT leave enable mode until you check that you can login from AUX or VTY and use enable successfully!!!**

## **Displaying Modules & Configuration**

Router# **show ?** (gives a complete list)

Commonly used:

router>**show version**

router>**show memory**

router>**show processes**

router>**show stacks**

router>**show buffers**

router>**show flash**

router>**show interfaces**

router>**show protocols**

router>**show running-config**

router>**show startup-config**

## Core Router Configuration

### IP Address Configuration

Take the following steps to configure the IP address of an interface.

Step 1: Enter privileged EXEC mode:

**Router>enable password**

Step 2: Enter the configure terminal command to enter global configuration mode.

**Router#config terminal**

Step 3: Enter the interface type slot/port (for Cisco 7000 series) or interface type port (for Cisco 2500 series) to enter the interface configuration mode.

Example:

**Router (config)#interface ethernet 0/1**

Step 4: Enter the IP address and subnet mask of the interface using the ip address ipaddress subnetmask command. For example:

**Router (config-if)#ip address 192.168.10.1 255.255.255.0**

Step 5: Exit the configuration mode by pressing Ctrl-Z or using end

**Router(config-if)#end or [Ctrl-Z]**

### - Routing Protocol Configuration: **Routing Information Protocol (RIP)**

Step 1: Enter privileged EXEC mode:

**Router>enable (use your enable password)**

Step 2: Enter the configure terminal command to enter global configuration mode.

**Router#config terminal**

Step 3: Enter the router rip command

**Router(config)#router rip**

Step 4: Add the network number to use RIP and repeat this step for all the numbers.

**Router(config-router)#network network-number**

Example: **Router(config-router)#network 192.168.10.0**

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

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

### **Other useful commands:**

- Specify a RIP Version

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

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 only RIP version 1 and version 2 packets.

To control how packets received from an interface are processed, use one of the following commands:

Command

Purpose

**ip rip receive version 1**

Configure an interface to accept only RIP version 1 packets.

**ip rip receive version 2**

Configure an interface to accept only RIP version 2 packets

**ip rip receive version 1 2**

Configure an interface to accept only RIP version 1 or 2 packets.

• **Enable or Disable Split Horizon**

Use one of the following commands in interface configuration mode:

Command

Purpose

Enable split horizon: **ip split-horizon**

Disable split horizon: **no ip split-horizon**

- Routing Protocol Configuration: Open Shortest Path First (OSPF)

Step 1: Enter privileged EXEC mode:

**Router>enable password**

Step 2: Enter the configure terminal command to enter global configuration mode.

**Router#config terminal**

Step 3: Enter the router ospf command and follow by the process-id.

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

Pick the process-id which is not being used. To determine what ids are being used, issue the show process command.

**Router(config)#show process**

Step 4: Add the network number, mask and area-id

**Router(config-router)#network network-number mask area area-id**

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.

Example:

**Router(config-router)#network 192.168.10.0 255.255.255.0 area 0.0.0.0**  
**Repeat this step for all the network numbers.**

To turn off OSPF, use the following command.

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

Other useful commands

- 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:

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

- Routing Protocol Configuration: Interior Gateway Routing Protocol (IGRP)

- Create the IGRP Routing Process

To create the IGRP routing process, use the following required commands starting **in global configuration mode**:

Enable an IGRP routing process, which place you in router configuration mode.

Step 1: **Router(config)#router igrp <autonomous-system>**

Associate networks with an IGRP routing process.

Step 2: **Router(config-router)#network <network-number>**

- **Disable Holddown**

The holddown mechanism is used to help avoid routing loop in the network, but has the effect of increasing the topology convergence time.

To disable holddowns with IGRP, use the following command in router configuration mode. All devices in an IGRP autonomous system must be consistent in their use of holddowns.

Disable the IGRP holddown period:

**Router(config-router)# no metric holddown**

- **Enforce a Maximum Network Diameter**

Define a maximum diameter to the IGRP network. Routes whose hop counts exceed this diameter are not advertised. The default maximum diameter is 100 hops. The maximum diameter is 255 hops.

Use the following command in router configuration mode.

**Router(config-router)# metric maximum-hops hops**

Configure the maximum network diameter.

- **To turn off IGRP, use the following command.**

**Router(config)#no router igrp <autonomous-system>**

– Routing Protocol Configuration:Border Gateway Protocol (BGP)

- **Enable BGP Routing**

Use the following commands in global configuration mode:

Enable a BGP routing process, which places you in router configuration mode.

**Router(config)#router bgp <autonomous-system>**

network network-number [mask network-mask] [route-map route-map-name]

Flag a network as local to this autonomous system and enter it to the BGP table.

- Configure BGP Neighbors:

**Router(config-router)#neighbor {ip-address | peer-group-name} remote-as number**

Specify a BGP neighbor.

- Reset BGP Connections

Use either of the following commands in EXEC mode to reset BGP connections

Reset a particular BGP connection:

**Router#clear ip bgp address**

Reset all BGP connections:

**Router#clear ip bgp \***

- To turn off BGP, use the following command.

**Router(config)#no router bgp <autonomous-system>**