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CHAPTER 1

Introduction

The Cisco IR1101 Industrial Integrated Services Router is a next generation modular industrial router which has a Base module with additional Pluggable Modules that can be added. The Pluggable Module provides the flexibility of adding different interfaces to the IR1101 platform.

The IR1101 ISR also has an Expansion Module that adds key capabilities such as dual LTE Pluggables, mSATA SSD FRU, SFP, and Digital GPIO connections.

The IR1101 is the first IoT platform to run the Cisco IOS-XE operating system. IOS-XE is a Linux based OS that comes with many enhancements and more features compared to the classic IOS version.

The following figure shows the front panel of the IR1101 and highlights some of its capabilities:

*Figure 1: IR1101 Front Panel*
Table 1: Front Panel Descriptions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SFP GigE WAN Port (Combo port of #3 below)</td>
</tr>
<tr>
<td>2</td>
<td>Type A USB 2.0 Host Port</td>
</tr>
<tr>
<td>3</td>
<td>RJ45 GigE WAN Port (Combo port of #1 above)</td>
</tr>
<tr>
<td>4</td>
<td>Asynchronous Serial Port (DTE only)</td>
</tr>
<tr>
<td>5</td>
<td>RJ45 Fast Ethernet LAN Ports</td>
</tr>
<tr>
<td>6</td>
<td>Grounding Point (On side of device)</td>
</tr>
<tr>
<td>7</td>
<td>DC Power and Alarm Input</td>
</tr>
<tr>
<td>8</td>
<td>Type B Mini-USB Console Port</td>
</tr>
<tr>
<td>9</td>
<td>Reset Button</td>
</tr>
<tr>
<td>10</td>
<td>Pluggable Module Slot (ex. 4G/LTE module)</td>
</tr>
</tbody>
</table>

Cisco IRM-1100-SP Expansion Module

The Expansion Module comes in two types:

- IRM-1100-SPMI
- IRM-1100-SP

The following figure shows the front panel of the IRM-1100-SPMI and highlights some of its capabilities:
**Figure 2: IR-1100-SPMI Expansion Module Details**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1    | 4 GPIO + 1 Return (Digital I/O)  
*Note* Functionality is available on Cisco IOS-XE release 16.12.1 and above. |
| 2    | SFP Connector |
| 3    | Pluggable Module |
| 4    | mSATA SSD Slot |
| 5    | Digital I/O LEDs |

The IR-1100-SP Expansion Module is the same as the IR-1100-SPMI module, without the Digital I/O and mSATA components.

More Expansion Module information can be found in this chapter `m_expansion_module.ditamap#id_111605`.


This section of the guide also includes:

- Accessing the CLI Using a Router Console, on page 4
- Accessing the CLI from a Remote Console, on page 6
- CLI Session Management, on page 8
Accessing the CLI Using a Router Console

Cisco IR1101 routers have console port with only USB support. The console cable (Cisco P/N CAB-CONSOLE-USB, 6ft long) is not included and must be ordered.

The console port is a USB 2.0 mini USB Type B connector which is located on the front panel of the chassis. The default baud rate is 9600.

If your laptop or PC warns you that you do not have the proper drivers to communicate with the router, you can obtain them from your computers manufacturer, or go here: https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

On a device fresh from the factory, you are greeted with a System Configuration Dialog where you respond to basic configuration questions. If the router was ordered for the use of Cisco PnP connect services, in the case of centralized provisioning, the router skips the initial dialog. The following is an example:

--- System Configuration Dialog ---

Would you like to enter the initial configuration dialog? [yes/no]: yes

At any point you may enter a question mark '?' for help. Use ctrl-c to abort configuration dialog at any prompt. Default settings are in square brackets '[]'.

Basic management setup configures only enough connectivity for management of the system, extended setup will ask you to configure each interface on the system

Would you like to enter basic management setup? [yes/no]: yes

Configuring global parameters:

Enter host name [Router]: <your-host-name>

The enable secret is a password used to protect access to privileged EXEC and configuration modes. This password, after entered, becomes encrypted in the configuration.

Enter enable secret: <your-password>

The enable password is used when you do not specify an enable secret password, with some older software versions, and some boot images.

Enter enable password: <your-password>

The virtual terminal password is used to protect access to the router over a network interface.

Enter virtual terminal password: <your-password>

Setup account for accessing HTTP server? [yes]: <return>

Username [admin]: <your-username>
Password [cisco]: <your-password>

Password is UNENCRYPTED.

Configure SNMP Network Management? [no]: <return>

Current interface summary

Any interface listed with OK? value "NO" does not have a valid configuration

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP-Address</th>
<th>OK? Method</th>
<th>Status</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>GigabitEthernet0/0/0</td>
<td>unassigned</td>
<td>NO unset</td>
<td>up</td>
<td>up</td>
</tr>
<tr>
<td>FastEthernet0/0/0</td>
<td>unassigned</td>
<td>YES unset</td>
<td>down</td>
<td>down</td>
</tr>
</tbody>
</table>
Enter interface name used to connect to the management network from the above interface summary: **vlan1**

Configuring interface Vlan1:
- Configure IP on this interface? [no]: **yes**
  - IP address for this interface: **192.168.1.1**
  - Subnet mask for this interface [255.255.255.0] : **<return>**
  - Class C network is 192.168.1.0, 24 subnet bits; mask is /24

Would you like to configure DHCP? [yes/no]: **yes**
- Enter DHCP pool name: **wDHCPool**
- Enter DHCP network: **192.168.1.0**
- Enter DHCP netmask: **255.255.255.0**
- Enter Default router: **192.168.1.1**

The following configuration command script was created:

```bash
hostname <your-hostname>
enable secret 9 $9$Z6fl74fvoEdMgUSXYz8I4pnhbZpXab4819bzCng3u4Bc2kh1STsoLoHNes
enable password <your-enable-password>
line vty 0 4
password <your-password>
username <your-username> privilege 15 password <your-password>
no snmp-server

interface GigabitEthernet0/0/0
shutdown
no ip address

interface FastEthernet0/0/1

interface FastEthernet0/0/2

interface FastEthernet0/0/3

interface FastEthernet0/0/4

interface Vlan1
no shutdown
ip address 192.168.1.1 255.255.255.0
no mop enabled
ip dhcp pool wDHCPool
network 192.168.1.0 255.255.255.0
default-router 192.168.1.1

end
```

[0] Go to the IOS command prompt without saving this config.
[1] Return back to the setup without saving this config.
[2] Save this configuration to nvram and exit.
Enter your selection [2]: 2
Building configuration...

[OK]
Use the enabled mode 'configure' command to modify this configuration.

Press RETURN to get started! <return>

*Jul 27 21:35:24.369: %CRYPTO_ENGINE-5-KEY_ADDITION: A key named TP-self-signed-3211716068 has been generated or imported by crypto-engine
*Jul 27 21:35:24.372: %SSH-5-ENABLED: SSH 1.99 has been enabled
*Jul 27 21:35:24.448: %PKI-4-NOCONFIGAUTOSAVE: Configuration was modified. Issue "write memory" to save new IOS PKI configuration
*Jul 27 21:35:24.532: %CRYPTO_ENGINE-5-KEY_ADDITION: A key named TP-self-signed-3211716068.server has been generated or imported by crypto-engine

The device now has a basic configuration that you can build upon.

Using the Console Interface

**Step 1** Enter the following command:

Router > enable

**Step 2** (Go to Step 3 if the enable password has not been configured.) At the password prompt, enter your system password:

Password: enablepass

When your password is accepted, the privileged EXEC mode prompt is displayed.

Router#

You now have access to the CLI in privileged EXEC mode and you can enter the necessary commands to complete your desired tasks.

**Step 3** To exit the console session, enter the quit command:

Router# quit

Accessing the CLI from a Remote Console

The remote console of the IR1101 can be accessed through Telnet or the more secure SSH. Details on telnet access follow in this chapter. For details on SSH access see the SSH chapter located here: Configuring Secure Shell, on page 39

The following topics describe the procedure to access the CLI from a remote console:
Preparing to Connect to the Router Console Using Telnet


Configuring the diagnostic and wait banners is optional, but recommended. The banners are especially useful as indicators to users about the status of their Telnet or SSH attempts.

To access the router remotely using Telnet from a TCP/IP network, configure the router to support virtual terminal lines using the `line vty` global configuration command. Configure the virtual terminal lines to require users to log in and specify a password.

See the Cisco IOS Terminal Services Command Reference document for more information about the `line vty` global configuration command.

To prevent disabling login on a line, specify a password with the `password` command when you configure the `login` command.

If you are using authentication, authorization, and accounting (AAA), configure the `login authentication` command. To prevent disabling login on a line for AAA authentication when you configure a list with the login authentication command, you must also configure that list using the `aaa authentication login` global configuration command.

For more information about AAA services, see the Cisco IOS XE Security Configuration Guide: Secure Connectivity and the Cisco IOS Security Command Reference documents. For more information about the login line-configuration command, see the Cisco IOS Terminal Services Command Reference document.

In addition, before you make a Telnet connection to the router, you must have a valid hostname for the router or have an IP address configured on the router. For more information about the requirements for connecting to the router using Telnet, information about customizing your Telnet services, and using Telnet key sequences, see the Cisco IOS Configuration Fundamentals Configuration Guide.

Using Telnet to Access a Console Interface

**Step 1** From your terminal or PC, enter one of the following commands:

- `connect host [port] [keyword]`
- `telnet host [port] [keyword]`

Here, `host` is the router hostname or IP address, `port` is a decimal port number (23 is the default), and `keyword` is a supported keyword. For more information about these commands, see the Cisco IOS Terminal Services Command Reference document.

*Note* If you are using an access server, specify a valid port number, such as `telnet 172.20.52.40 2004`, in addition to the hostname or IP address.

The following example shows how to use the `telnet` command to connect to a router named `router`:

```
unix_host% telnet router
Trying 172.20.52.40...
Connected to 172.20.52.40.
Escape character is '^]'.
unix_host% connect
```

**Step 2** Enter your login password:
User Access Verification
Password: mypassword

Note If no password has been configured, press Return.

Step 3 From user EXEC mode, enter the enable command:
Router> enable

Step 4 At the password prompt, enter your system password:
Password: enablepass

Step 5 When the enable password is accepted, the privileged EXEC mode prompt is displayed:
Router#

Step 6 You now have access to the CLI in privileged EXEC mode and you can enter the necessary commands to complete your desired tasks.

Step 7 To exit the Telnet session, use the exit or logout command.
Router# logout

CLI Session Management

An inactivity timeout is configurable and can be enforced. Session locking provides protection from two users overwriting changes that the other has made. To prevent an internal process from using all the available capacity, some spare capacity is reserved for CLI session access. For example, this allows a user to remotely access a router.

Information About CLI Session Management

An inactivity timeout is configurable and can be enforced. Session locking provides protection from two users overwriting changes that each other has made. To prevent an internal process from using all the available capacity, some spare capacity is reserved for CLI session access. For example, this allows a user to remotely access the router.

Changing the CLI Session Timeout

Step 1 configure terminal
Enters global configuration mode

Step 2 line console 0

Step 3 session-timeout minutes
The value of minutes sets the amount of time that the CLI waits before timing out. Setting the CLI session timeout increases the security of a CLI session. Specify a value of 0 for minutes to disable session timeout.

Step 4 show line console 0
Verifies the value to which the session timeout has been set, which is shown as the value for "Idle Session".

## Locking a CLI Session

### Before you begin

To configure a temporary password on a CLI session, use the `lock` command in EXEC mode. Before you can use the `lock` command, you need to configure the line using the `lockable` command. In this example the line is configured as `lockable`, and then the `lock` command is used and a temporary password is assigned.

### Step 1

`Router# configure terminal`

Enters global configuration mode.

### Step 2

Enter the line upon which you want to be able to use the `lock` command.

`Router(config)# line console 0`

### Step 3

`Router(config)# lockable`

Enables the line to be locked.

### Step 4

`Router(config)# exit`

### Step 5

`Router# lock`

The system prompts you for a password, which you must enter twice.

Password: <password>
Again: <password>
Locked
Using Cisco IOS XE Software

If your installation will make use of Cisco SDWAN technology, it is important to note that the Cisco IOS-XE SDWAN image (cEdge) has different Command modes, (for example Config-transaction, commit...).

IR1101 SDWAN features are aligned on cEdge IOS-XE 16.12.1 ones. Some features may not be available on the IR1101, i.e. URL Filtering, IPS/IDS, and some IR1101 features may not be available from the SDWAN image.


This chapter contains the following sections:

- Understanding Command Modes, on page 11
- Keyboard Shortcuts, on page 13
- Using the no and default Forms of Commands, on page 14
- Using the History Buffer to Recall Commands, on page 14
- Managing Configuration Files, on page 15
- Saving Configuration Changes, on page 15
- Filtering Output from the show and more Commands, on page 15
- Finding Support Information for Platforms and Cisco Software Images, on page 16

Understanding Command Modes

The command modes available in Cisco IOS XE are the same as those available in traditional Cisco IOS. Use the CLI to access Cisco IOS XE software. Because the CLI is divided into many different modes, the commands available to you at any given time depend on the mode that you are currently in. Entering a question mark (?) at the CLI prompt allows you to obtain a list of commands available for each command mode.

When you log in to the CLI, you are in user EXEC mode. User EXEC mode contains only a limited subset of commands. To have access to all commands, you must enter privileged EXEC mode, normally by using a password. From privileged EXEC mode, you can issue any EXEC command—user or privileged mode—or you can enter global configuration mode. Most EXEC commands are one-time commands. For example, show commands show important status information, and clear commands clear counters or interfaces. The EXEC commands are not saved when the software reboots.

Configuration modes allow you to make changes to the running configuration. If you later save the running configuration to the startup configuration, these changed commands are stored when the software is rebooted. To enter specific configuration modes, you must start at global configuration mode. From global configuration
mode, you can enter interface configuration mode and a variety of other modes, such as protocol-specific modes.

ROM monitor mode is a separate mode used when the Cisco IOS XE software cannot load properly. If a valid software image is not found when the software boots or if the configuration file is corrupted at startup, the software might enter ROM monitor mode.

The following table describes how to access and exit various common command modes of the Cisco IOS XE software. It also shows examples of the prompts displayed for each mode.

**Table 2: Accessing and Exiting Command Modes**

<table>
<thead>
<tr>
<th>Command Mode</th>
<th>Access Method</th>
<th>Prompt</th>
<th>Exit Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>User EXEC</td>
<td>Log in.</td>
<td>Router&gt;</td>
<td>Use the <strong>logout</strong> command.</td>
</tr>
<tr>
<td>Privileged EXEC</td>
<td>From user EXEC mode, use the <strong>enable</strong> command.</td>
<td>Router#</td>
<td>To return to user EXEC mode, use the <strong>disable</strong> command.</td>
</tr>
<tr>
<td>Global configuration</td>
<td>From privileged EXEC mode, use the <strong>configure terminal</strong> command.</td>
<td>Router(config)#</td>
<td>To return to privileged EXEC mode from global configuration mode, use the <strong>exit</strong> or <strong>end</strong> command.</td>
</tr>
<tr>
<td>Interface configuration</td>
<td>From global configuration mode, specify an interface using an <strong>interface</strong> command.</td>
<td>Router(config-if)#</td>
<td>To return to global configuration mode, use the <strong>exit</strong> command. To return to privileged EXEC mode, use the <strong>end</strong> command.</td>
</tr>
</tbody>
</table>
IffailureoftheCiscoIOS processisthereasonfor enteringdiagnosticmode, theCiscoIOSproblem mustberesolvedandtherouter rebootedtogetout ofdiagnosticmode. Iftherouterisin diagnosticmodebecause ofatransport-map configuration,accessthe routerthroughanother portorbyusingamethod thatisconfiguredto connecttotheCiscoIOS CLI.

<table>
<thead>
<tr>
<th>Command Mode</th>
<th>Access Method</th>
<th>Prompt</th>
<th>Exit Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic</td>
<td>The router boots up or accesses diagnostic mode in the following scenarios:</td>
<td>Router(diag)#</td>
<td>If failure of the Cisco IOS process is the reason for entering diagnostic mode, the Cisco IOS problem must be resolved and the router rebooted to get out of diagnostic mode. If the router is in diagnostic mode because of a transport-map configuration, access the router through another port or by using a method that is configured to connect to the Cisco IOS CLI.</td>
</tr>
<tr>
<td></td>
<td>• In some cases, diagnostic mode will be reached when the Cisco IOS process or processes fail. In most scenarios, however, the router will reload.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A user-configured access policy is configured using the transport-map command that directs a user into diagnostic mode.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A break signal (Ctrl-C, Ctrl-Shift-6, or the send break command) is entered and the router is configured to go to diagnostic mode when the break signal is received.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROM monitor</td>
<td>From privileged EXEC mode, use the reload EXEC command. Press the Break key during the first 60 seconds while the system is booting.</td>
<td>rommon#&gt;</td>
<td>To exit ROM monitor mode, manually boot a valid image or perform a reset with autoboot set so that a valid image is loaded.</td>
</tr>
</tbody>
</table>

**Keyboard Shortcuts**

Commands are not case sensitive. You can abbreviate commands and parameters if the abbreviations contain enough letters to be different from any other currently available commands or parameters.

The following table lists the keyboard shortcuts for entering and editing commands.
### Table 3: Keyboard Shortcuts

<table>
<thead>
<tr>
<th>Key Name</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-B or the Left Arrow key$^1$</td>
<td>Move the cursor back one character.</td>
</tr>
<tr>
<td>Ctrl-F or the Right Arrow key$^1$</td>
<td>Move the cursor forward one character.</td>
</tr>
<tr>
<td>Ctrl-A</td>
<td>Move the cursor to the beginning of the command line.</td>
</tr>
<tr>
<td>Ctrl-E</td>
<td>Move the cursor to the end of the command line.</td>
</tr>
<tr>
<td>Esc B</td>
<td>Move the cursor back one word.</td>
</tr>
<tr>
<td>Esc F</td>
<td>Move the cursor forward one word.</td>
</tr>
</tbody>
</table>

### Using the no and default Forms of Commands

Almost every configuration command has a **no** form. In general, use the **no** form to disable a function. Use the command without the **no** keyword to re-enable a disabled function or to enable a function that is disabled by default. For example, IP routing is enabled by default. To disable IP routing, use the **no ip routing** command; to re-enable IP routing, use the **ip routing** command. The Cisco IOS software command reference publications provide the complete syntax for the configuration commands and describe what the **no** form of a command does.

Many CLI commands also have a **default** form. By issuing the `<command> default` command-name, you can configure the command to its default setting. The Cisco IOS software command reference publications describe the function from a **default** form of the command when the **default** form performs a different function than the plain and **no** forms of the command. To see what default commands are available on your system, enter `default ?` in the appropriate command mode.

### Using the History Buffer to Recall Commands

The history buffer stores the last 20 commands you entered. History substitution allows you to access these commands without retyping them, by using special abbreviated commands.

The following table lists the history substitution commands.

### Table 4: History Substitution Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-P or the Up Arrow key$^1$</td>
<td>Recalls commands in the history buffer, beginning with the most recent command. Repeat the key sequence to recall successively older commands.</td>
</tr>
<tr>
<td>Ctrl-N or the Down Arrow key$^1$</td>
<td>Returns to more recent commands in the history buffer after recalling commands with Ctrl-P or the Up Arrow key.</td>
</tr>
</tbody>
</table>
Managing Configuration Files

The startup configuration file is stored in the nvram: file system and the running configuration files are stored in the system: file system. This configuration file storage setup is also used on several other Cisco router platforms.

IOS XE provides encryption of the configuration file. Encryption is discussed in length in the IOS XE hardening device guide which can be found here: https://www.cisco.com/c/en/us/support/docs/ip/access-lists/13608-21.html

As a matter of routine maintenance on any Cisco router, users should back up the startup configuration file by copying the startup configuration file from NVRAM to one of the router’s other file systems and, additionally, to a network server. Backing up the startup configuration file provides an easy method of recovering the startup configuration file if the startup configuration file in NVRAM becomes unusable for any reason.

The `copy` command can be used to back up startup configuration files.

For more detailed information on managing configuration files, see the “Managing Configuration Files” section in the Cisco IOS XE Configuration Fundamentals Configuration Guide.

Saving Configuration Changes

Use the `copy running-config startup-config` command to save your configuration changes to the startup configuration so that the changes will not be lost if the software reloads or a power outage occurs. For example:

```
Router# copy running-config startup-config
Building configuration...
```

It may take a few minutes to save the configuration. After the configuration has been saved, the following output is displayed:

```
[OK]
Router#
```

This task saves the configuration to the NVRAM.

Filtering Output from the show and more Commands

You can search and filter the output of `show` and `more` commands. This functionality is useful if you need to sort through large amounts of output or if you want to exclude output that you need not see.

To use this functionality, enter a `show` or `more` command followed by the “pipe” character (`|`); one of the keywords `begin`, `include`, or `exclude`; and a regular expression on which you want to search or filter (the expression is case sensitive):
**show command | {append | begin | exclude | include | redirect | section | tee} regular-expression**

The output matches certain lines of information in the configuration file.

**Example**

In this example, a modifier of the `show interface` command (include protocol) is used to provide only the output lines in which the expression `protocol` is displayed:

```
Router# show interface | include protocol
GigabitEthernet0/0/0 is administratively down, line protocol is down (disabled)
0 unknown protocol drops
FastEthernet0/0/1 is down, line protocol is down (notconnect)
0 unknown protocol drops
FastEthernet0/0/2 is down, line protocol is down (notconnect)
0 unknown protocol drops
FastEthernet0/0/3 is down, line protocol is down (notconnect)
0 unknown protocol drops
FastEthernet0/0/4 is down, line protocol is down (notconnect)
0 unknown protocol drops
GigabitEthernet0/0/5 is up, line protocol is up (connected)
0 unknown protocol drops
Cellular0/1/0 is up, line protocol is up
0 unknown protocol drops
Cellular0/1/1 is administratively down, line protocol is down
0 unknown protocol drops
Cellular0/3/0 is up, line protocol is up
0 unknown protocol drops
Cellular0/3/1 is administratively down, line protocol is down
0 unknown protocol drops
Async0/2/0 is up, line protocol is down
0 unknown protocol drops
Vlan1 is up, line protocol is up , Autostate Enabled
0 unknown protocol drops
Vlan172 is up, line protocol is down , Autostate Enabled
0 unknown protocol drops
Vlan175 is down, line protocol is down , Autostate Enabled
0 unknown protocol drops
IRI101#
```

**Finding Support Information for Platforms and Cisco Software Images**

The Cisco IOS XE software is packaged in feature sets consisting of software images that support specific platforms.


The group of feature sets that are available for a specific platform depends on which Cisco software images are included in a release. To identify the set of software images available in a specific release or to find out if a feature is available in a given Cisco IOS XE software image, you can use Cisco Feature Navigator or see the https://www.cisco.com/c/en/us/support/ios-nx-os-software/ios-xe-16/products-release-notes-list.html.
Using Cisco Feature Navigator

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator is a tool that enables you to determine which Cisco IOS XE software images support a specific software release, feature set, or platform. To use the navigator tool, an account on Cisco.com is not required.

Getting Help

Entering a question mark (?) at the CLI prompt displays a list of commands available for each command mode. You can also get a list of keywords and arguments associated with any command by using the context-sensitive help feature.

To get help that is specific to a command mode, a command, a keyword, or an argument, use one of the following commands.

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>help</td>
<td>Provides a brief description of the help system in any command mode.</td>
</tr>
<tr>
<td>abbreviated-command-entry?</td>
<td>Provides a list of commands that begin with a particular character string.</td>
</tr>
<tr>
<td>Note</td>
<td>There is no space between the command and the question mark.</td>
</tr>
<tr>
<td>abbreviated-command-entry&lt;Tab&gt;</td>
<td>Completes a partial command name.</td>
</tr>
<tr>
<td>?</td>
<td>Lists all the commands that are available for a particular command mode.</td>
</tr>
<tr>
<td>command ?</td>
<td>Lists the keywords or arguments that you must enter next on the command line.</td>
</tr>
<tr>
<td>Note</td>
<td>There is a space between the command and the question mark.</td>
</tr>
</tbody>
</table>

Finding Command Options: Example

This section provides information about how to display the syntax for a command. The syntax can consist of optional or required keywords and arguments. To display keywords and arguments for a command, enter a question mark (?) at the configuration prompt or after entering a part of a command followed by a space. The Cisco IOS XE software displays a list and brief descriptions of the available keywords and arguments. For example, if you are in global configuration mode and want to see all the keywords and arguments for the arap command, you should type arap ?.

The <cr> symbol in command help output stands for carriage return. On older keyboards, the carriage return key is the Return key. On most modern keyboards, the carriage return key is the Enter key. The <cr> symbol at the end of command help output indicates that you have the option to press Enter to complete the command and that the arguments and keywords in the list preceding the <cr> symbol are optional. The <cr> symbol by
itself indicates that no more arguments or keywords are available, and that you must press **Enter** to complete the command.

The following table shows examples of using the question mark (\?) to assist you in entering commands.

### Table 5: Finding Command Options

<table>
<thead>
<tr>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
</table>
| Router> **enable**  
Password: <password>  
Router# | Enter the **enable** command and password to access privileged EXEC commands. You are in privileged EXEC mode when the prompt changes to a “#” from the “>”, for example, **Router> to Router#** |

| Router# **configure terminal**  
Enter configuration commands, one per line. End with CNTL/Z.  
Router(config)# | Enter the **configure terminal** privileged EXEC command to enter global configuration mode. You are in global configuration mode when the prompt changes to **Router (config)#** |

| Router(config)# **interface GigabitEthernet**  
<0-0> GigabitEthernet interface number  
Router(config)# **interface GigabitEthernet 0/1**  
<0-5> Port Adapter number  
Router (config)# **interface GigabitEthernet 0/0/1**  
<0-63> GigabitEthernet interface number  
Router (config)# **interface GigabitEthernet 0/0/0/1**  
.  
<0-71>  
Router(config-if)# | Enter interface configuration mode by specifying the interface that you want to configure, using the **interface GigabitEthernet** global configuration command.  
Enter ? to display what you must enter next on the command line.  
When the <cr> symbol is displayed, you can press **Enter** to complete the command.  
You are in interface configuration mode when the prompt changes to **Router(config-if)#** |
Enter \? to display a list of all the interface configuration commands available for the interface. This example shows only some of the available interface configuration commands.

<table>
<thead>
<tr>
<th>Command</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-if)# ?</td>
<td>Enter ? to display a list of all the interface configuration commands</td>
</tr>
<tr>
<td>Interface configuration</td>
<td>available for the interface. This example shows only some of the</td>
</tr>
<tr>
<td>commands:</td>
<td>available interface configuration commands.</td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>ip</td>
<td>Interface Internet</td>
</tr>
<tr>
<td>Protocol</td>
<td>config commands</td>
</tr>
<tr>
<td>keepalive</td>
<td>Enable keepalive</td>
</tr>
<tr>
<td>lan-name</td>
<td>LAN Name command</td>
</tr>
<tr>
<td>llc2</td>
<td>LLC2 Interface Subcommands</td>
</tr>
<tr>
<td>load-interval</td>
<td>Specify interval for load calculation for an interface</td>
</tr>
<tr>
<td>calculation</td>
<td></td>
</tr>
<tr>
<td>locaddr-priority</td>
<td>Assign a priority group</td>
</tr>
<tr>
<td>logging</td>
<td>Configure logging for</td>
</tr>
<tr>
<td>interface</td>
<td></td>
</tr>
<tr>
<td>loopback</td>
<td>Configure internal</td>
</tr>
<tr>
<td>loopback on an</td>
<td></td>
</tr>
<tr>
<td>mac-address</td>
<td>Manually set interface</td>
</tr>
<tr>
<td>MAC address</td>
<td></td>
</tr>
<tr>
<td>mls</td>
<td>mls router sub/interface</td>
</tr>
<tr>
<td>commands</td>
<td></td>
</tr>
<tr>
<td>mposa</td>
<td>MPOA interface</td>
</tr>
<tr>
<td>configuration commands</td>
<td></td>
</tr>
<tr>
<td>mtu</td>
<td>Set the interface</td>
</tr>
<tr>
<td>(MTU)</td>
<td>Maximum Transmission Unit</td>
</tr>
<tr>
<td>netbios</td>
<td>Use a defined NETBIOS or enable name-caching</td>
</tr>
<tr>
<td>access list</td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>Negate a command or set</td>
</tr>
<tr>
<td>its defaults</td>
<td></td>
</tr>
<tr>
<td>nrzi-encoding</td>
<td>Enable use of NRZI</td>
</tr>
<tr>
<td>encoding</td>
<td></td>
</tr>
<tr>
<td>ntp</td>
<td>Configure NTP</td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
</tr>
<tr>
<td>Router(config-if)#</td>
<td></td>
</tr>
<tr>
<td>Command</td>
<td>Comment</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Router(config-if)# ip ?</strong></td>
<td>Enter the command that you want to configure for the interface. This example uses the <code>ip</code> command. Enter <code>?</code> to display what you must enter next on the command line. This example shows only some of the available interface IP configuration commands.</td>
</tr>
</tbody>
</table>

**Interface IP configuration subcommands:**

- `access-group` 
  Specify access control for packets
- `accounting` 
  Enable IP accounting on this interface address
- `address` 
  Set the IP address of an interface authentication
- `authentication` 
  authentication subcommands bandwidth-percent
- `Set EIGRP bandwidth limit`
- `broadcast-address` 
  Set the broadcast address of an interface cgmp
- `Enable/disable CGMP`
directed-broadcast
- `Enable forwarding of directed broadcasts`
dvmrp
- `DVMRP interface commands`
- `hello-interval` 
  Configures IP-EIGRP hello interval
- `helper-address` 
  Specify a destination address for UDP broadcasts
- `hold-time` 
  Configures IP-EIGRP hold time

**Router(config-if)# ip**

**Router(config-if)# ip address ?**

- `A.B.C.D` 
  IP address
- `negotiated` 
  IP Address negotiated over ppp

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

**Router(config-if)# ip address 172.16.0.1 ?**

- `A.B.C.D` 
  IP address
- `172.16.0.1` 
  IP subnet mask

**Router(config-if)# ip address 172.16.0.1**

Enter the keyword or argument that you want to use. This example uses the 172.16.0.1 IP address. Enter `?` to display what you must enter next on the command line. In this example, you must enter an IP subnet mask.

`<cr>` is not displayed. Therefore, you must enter additional keywords or arguments to complete the command.
Enter the IP subnet mask. This example uses the 255.255.255.0 IP subnet mask.

Enter ? to display what you must enter next on the command line. In this example, you can enter the secondary keyword, or you can press Enter.

<cr> is displayed. Press Enter to complete the command, or enter another keyword.

Press Enter to complete the command.

Using Software Advisor

Cisco maintains the Software Advisor tool. See Tools and Resources. Use the Software Advisor tool to see if a feature is supported in a Cisco IOS XE release, to locate the software document for that feature, or to check the minimum software requirements of Cisco IOS XE software with the hardware installed on your router. You must be a registered user on Cisco.com to access this tool.

Using Software Release Notes

See the release notes for information about the following:

- Memory recommendations
- Open and resolved severity 1 and 2 caveats

Release notes are intended to be release-specific for the most current release, and the information provided in these documents may not be cumulative in providing information about features that first appeared in previous releases. For cumulative feature information, refer to the Cisco Feature Navigator at: http://www.cisco.com/go/cfn/.
Chapter 3

Basic Router Configuration

This chapter contains the following sections:

• IR1101 Interface Naming, on page 23
• Basic Configuration, on page 24
• Configuring Global Parameters, on page 28
• Configuring the Gigabit Ethernet Interface, on page 29
• Support for sub-interface on GigabitEthernet0/0/0, on page 30
• Configuring a Loopback Interface, on page 30
• Enabling Cisco Discovery Protocol, on page 32
• Configuring Command-Line Access, on page 32
• Configuring Static Routes, on page 34
• Configuring Dynamic Routes, on page 36
• Configuring the Serial Interface, on page 37

IR1101 Interface Naming

The supported hardware interfaces and their naming conventions are in the following table:

<table>
<thead>
<tr>
<th>Hardware Interface</th>
<th>Naming Convention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit Ethernet combo port</td>
<td>gigabitethernet 0/0/0</td>
</tr>
<tr>
<td>Gigabit Ethernet SFP port on Expansion Module</td>
<td>gigabitethernet 0/0/5</td>
</tr>
<tr>
<td>Fast Ethernet ports</td>
<td>fastethernet0/1-0/0/4</td>
</tr>
<tr>
<td>Cellular Interface</td>
<td>cellular 0/1/0 and cellular 0/1/1</td>
</tr>
<tr>
<td>Cellular Interface on Expansion Module</td>
<td>cellular 0/3/0 and 0/3/1</td>
</tr>
<tr>
<td>Asynchronous Serial Interface</td>
<td>asyne 0/2/0</td>
</tr>
<tr>
<td>USB</td>
<td>usbflash0:</td>
</tr>
<tr>
<td>mSATA</td>
<td>msata</td>
</tr>
<tr>
<td>IR1101 Base Unit Alarm input</td>
<td>alarm contact 0</td>
</tr>
</tbody>
</table>
Basic Configuration

The basic configuration is a result of the entries you made during the initial configuration dialog. This means the router has at least one interface set with an IP address to be reachable, either through WebUI or to allow the PnP process to work. Use the `show running-config` command to view the initial configuration, as shown in the following example:

```
Router# show running-config
Building configuration...

Current configuration : 8079 bytes
!
! Last configuration change at 17:33:19 GMT Tue Jun 25 2019
!
version 16.12
service timestamps debug datetime msec localtime show-timezone
service timestamps log datetime msec localtime show-timezone
service internal
service call-home
platform qfp utilization monitor load 80
no platform punt-keepalive disable-kernel-core
!
hostname IR1101
!
boot-start-marker
boot-end-marker
!
no aaa new-model
!
clock timezone GMT 0 0
call-home
!
! If contact email address in call-home is configured as sch-smart-licensing@cisco.com
! the email address configured in Cisco Smart License Portal will be used as contact email
! address to send SCH notifications.
!
contact-email-addr sch-smart-licensing@cisco.com
!
profile "CiscoTAC-1"
 active
destination transport-method http
 no destination transport-method email
!
!
ip name-server 171.70.168.183 198.224.173.135 8.8.8.8
no ip domain lookup
ip domain name cisco.com
!
login on-success log
ipv6 unicast-routing
!
chat-script lte "" "AT!CALL" TIMEOUT 20 "OK"
chat-script hspa-R7 "" "AT!SCACT=1,1" TIMEOUT 60 "OK"
!
crypto pki trustpoint SLA-TrustPoint
 enrollment pkcs12
 revocation-check crl
!
crypto pki trustpoint TP-self-signed-756885843
```
Basic Router Configuration

subject-name cn=IOS-Self-Signed-Certificate-756885843
revocation-check none

crypto pki certificate chain SLA-TrustPoint

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  certificate self-signed 01
  certificate ca 01
  revocation-check none
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
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  enrollment selfsigned
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  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

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  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

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  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
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  enrollment selfsigned

Certificate:
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  enrollment selfsigned
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  enrollment selfsigned

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  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

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  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
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  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

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  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned
  subject-name cn=IOS-Self-Signed-Certificate-756885843
  enrollment selfsigned

Certificate:
license udi pid IR1101-K9 sn FCW222700RS
diagnostic bootup level minimal
spanning-tree extend system-id
memory free low-watermark processor 50357
file prompt quiet
!
username cisco privilege 15 password 0 cisco
username lab password 0 lab123
!
redundancy
!
controller Cellular 0/1/0
  no lte firmware auto-sim
  lte modem link-recovery disable
controller Cellular 0/3/0

vlan internal allocation policy ascending
!
interface GigabitEthernet0/0/0
  no ip address
  shutdown
!
interface FastEthernet0/0/1
  switchport access vlan 192
  switchport mode access
!
interface FastEthernet0/0/2
  switchport access vlan 172
  switchport mode access
!
interface FastEthernet0/0/3
  switchport access vlan 172
!
interface FastEthernet0/0/4
  switchport mode access
!
interface GigabitEthernet0/0/5
!
interface Cellular0/1/0
  ip address negotiated
  load-interval 30
dialer in-band
dialer idle-timeout 0
dialer watch-group 1
ipv6 enable
pulse-time 1
ip virtual-reassembly
!
interface Cellular0/1/1
  no ip address
  shutdown
!
interface Cellular0/3/0
  ip address negotiated
dialer in-band
dialer idle-timeout 0
dialer watch-group 2
ipv6 enable
pulse-time 1
ip virtual-reassembly
!
interface Cellular0/3/1
no ip address
shutdown
!
interface Vlan1
ip address 192.168.10.15 255.255.255.0
!
interface Vlan172
ip address 172.27.167.121 255.255.255.128
!
interface Vlan175
ip address 175.1.1.1 255.255.255.0
!
interface Async0/2/0
no ip address
encapsulation scada
!
ip default-gateway 172.27.167.1
ip forward-protocol nd
!
ip http server
ip http authentication local
ip http secure-server
ip route 0.0.0.0 0.0.0.0 172.27.167.1
ip route 0.0.0.0 0.0.0.0 Cellular0/1/0
ip route 0.0.0.0 0.0.0.0 Cellular0/3/0 253
ip route 8.8.4.0 255.255.255.0 Cellular0/3/0
ip route 171.70.0.0 255.255.0.0 172.27.167.1
ip route 192.1.1.0 255.255.255.0 Cellular0/1/0
ip route 192.168.193.0 255.255.255.0 192.168.10.1
!
ip access-list standard 1
10 permit any
dialer watch-list 1 ip 5.6.7.8 255.255.255.255
dialer watch-list 1 delay route-check initial 60
dialer watch-list 1 delay connect 1
dialer watch-list 2 ip 5.6.7.8 255.255.255.255
dialer watch-list 2 delay route-check initial 60
dialer watch-list 2 delay connect 1
dialer-list 1 protocol ip permit
dialer-list 1 protocol ipv6 permit
ipv6 route ::/0 Cellular0/1/0
!
!
snmp-server community public RO
snmp-server community private RW
snmp-server host 171.70.127.43 version 2c public
snmp-server host 172.27.167.220 version 2c public
snmp-server manager
!
control-plane
!
line con 0
exec-timeout 0 0
stopbits 1
speed 115200
line 0/0/0
line 0/2/0
line vty 0 4
exec-timeout 0 0
Configuring Global Parameters

To configure global parameters for your router, follow these steps.

**SUMMARY STEPS**

1. configure terminal
2. hostname *name*
3. enable password *password*

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure terminal</td>
<td>Enters global configuration mode when using the console port. Use the following to connect to the router with a remote terminal:</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>telnet router-name or address</td>
</tr>
<tr>
<td></td>
<td>Router&gt; enable</td>
<td>Login: login-id</td>
</tr>
<tr>
<td></td>
<td>Router# configure terminal</td>
<td>Password: *********</td>
</tr>
<tr>
<td></td>
<td>Router(config)#</td>
<td>Router&gt; enable</td>
</tr>
<tr>
<td></td>
<td>Step 2</td>
<td>Specifies the name for the router.</td>
</tr>
<tr>
<td></td>
<td>hostname <em>name</em></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td>Router(config)# hostname Router</td>
</tr>
<tr>
<td></td>
<td>Step 3</td>
<td>Note In this form of the command, password is not encrypted. To encrypt the password use enable secret password as noted in the previously mentioned Device Hardening Guide.</td>
</tr>
</tbody>
</table>
Configuring the Gigabit Ethernet Interface

The default configuration for the Gigabit Ethernet Interface (GI0/0/0) on the IR1101 is Layer 3 (L3). It is possible to configure the interface as a Layer 2 (L2) interface. The Gigabit Ethernet Interface on the IR1101 is a combo port, which means it is a RJ45+SFP connector.

The Expansion Module also has an SFP port. The Gigabit Ethernet Interface (GI0/0/5) on the IRM-1100-SPMI is Layer 2 (L2) only. This means you can assign this port to any vlan (switchport acc vlan #) and use the SVI interface. You cannot assign an ip address directly under this port.

The correct connector must be selected, refer to the IR1101 Industrial Integrated Services Router Hardware Installation Guide here: https://www.cisco.com/c/en/us/td/docs/routers/access/1101/hardware/installation/guide/1101hwinst.html

To manually define the Gigabit Ethernet interface, follow these steps, beginning from global configuration mode.

SUMMARY STEPS

1. `interface GigabitEthernet slot/bay/port`
2. `ip address ip-address mask`
3. `ipv6 address ipv6-address/prefix`
4. `ipv6 unicast-routing`
5. `no shutdown`
6. `exit`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters the configuration mode for an interface on the router.</td>
</tr>
<tr>
<td><code>interface GigabitEthernet slot/bay/port</code></td>
<td>Example:</td>
</tr>
<tr>
<td><code>Router(config)# interface GigabitEthernet 0/0/0</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Sets the IP address and subnet mask for the specified interface. Use this Step if you are configuring an IPv4 address.</td>
</tr>
<tr>
<td><code>ip address ip-address mask</code></td>
<td>Example:</td>
</tr>
<tr>
<td><code>Router(config-if)# ip address 192.168.12.2 255.255.255.0</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Sets the IPv6 address and prefix for the specified interface. Use this step instead of Step 2, if you are configuring an IPv6 address. IPv6 unicast-routing needs to be set-up as well, see further information in the IPv6 Addressing and Basic Connectivity Configuration Guide located here: <a href="https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/ipv6_basic/configuration/xe-16-10/ip6b-xe-16-10-book/read-me-first.html">https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/ipv6_basic/configuration/xe-16-10/ip6b-xe-16-10-book/read-me-first.html</a></td>
</tr>
<tr>
<td><code>ipv6 address ipv6-address/prefix</code></td>
<td>Example:</td>
</tr>
<tr>
<td><code>Router(config-if)# ipv6 address 2001:db8::ffff:1/128</code></td>
<td></td>
</tr>
</tbody>
</table>
Support for sub-interface on GigabitEthernet0/0/0

Cisco IOS-XE release 16.11.1 and above supports sub-interfaces and dot1q configuration on the g0/0/0 interface. For example:

```
Router(config)# interface g0/0/0 ?
<1-4294967295> GigabitEthernet interface number
Router(config-subif)# encapsulation ?
dot1Q IEEE 802.1Q Virtual LAN
```

Configuring a Loopback Interface

Before you begin

The loopback interface acts as a placeholder for the static IP address and provides default routing information. To configure a loopback interface, follow these steps.

SUMMARY STEPS

1. `interface type number`
2. (Option 1) `ip address ip-address mask`
3. (Option 2) `ipv6 address ipv6-address/prefix`
4. `exit`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | **interface**  *type number*  
Example: 
Router(config)# **interface Loopback 0** | Enters configuration mode on the loopback interface. |
| **Step 2** | (Option 1) **ip address** *ip-address mask*  
Example: 
Router(config-if)# **ip address 10.108.1.1 255.255.255.0**  
(If you are configuring an IPv6 address, use the **ipv6 address** *ipv6-address/prefix* command described below. | Sets the IP address and subnet mask on the loopback interface. |
| **Step 3** | (Option 2) **ipv6 address** *ipv6-address/prefix*  
Example: 
Router(config-if)# **ipv6 address 2001:db8::ffff:1/128** | Sets the IPv6 address and prefix on the loopback interface. |
| **Step 4** | **exit**  
Example: 
Router(config-if)# **exit** | Exits configuration mode for the loopback interface and returns to global configuration mode. |

### Example

**Verifying Loopback Interface Configuration**

Enter the **show interface loopback** command. You should see an output similar to the following example:

```
Router# **show interface loopback 0**  
Loopback 0 is up, line protocol is up  
Hardware is Loopback  
Internet address is 192.0.2.0/16  
MTU 1514 bytes, BW 800000 Kbit, DLY 5000 usec,  
reliability 255/255, txload 1/255, rxload 1/255  
Encapsulation LOOPBACK, loopback not set  
Last input never, output never, output hang never  
Last clearing of "show interface" counters never  
Queueing strategy: fifo  
Output queue 0/0, input queue 0/0, 0 drops  
5 minute input rate 0 bits/sec, 0 packets/sec  
5 minute output rate 0 bits/sec, 0 packets/sec  
0 packets input, 0 bytes, 0 no buffer  
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles  
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort  
0 packets output, 0 bytes, 0 underruns  
0 output errors, 0 collisions, 0 interface resets  
o 0 output buffer failures, 0 output buffers swapped out
```
Alternatively, use the `ping` command to verify the loopback interface, as shown in the following example:

```
Router# ping 192.0.2.0
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.0.2.0, timeout is 2 seconds:
!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms
```

### Enabling Cisco Discovery Protocol

Cisco Discovery Protocol (CDP) is enabled by default on the router. It may be disabled if needed for security purposes.

For more information on using CDP, see Cisco Discovery Protocol Configuration Guide, Cisco IOS XE Release 3S.

### Configuring Command-Line Access

To configure parameters to control access to the router, follow these steps. Note: Transport input must be set as explained in the previous Telnet and SSH sections of the guide.

#### SUMMARY STEPS

1. `line [aux | console | tty | vty] line-number`
2. `password password`
3. `login`
4. `exec-timeout minutes [seconds]`
5. `exit`
6. `line [aux | console | tty | vty] line-number`
7. `password password`
8. `login`
9. `end`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td>`line [aux</td>
<td>console</td>
</tr>
<tr>
<td>Example: <code>Router(config)# line console 0</code></td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>2</td>
<td><code>password password</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# password 5dr4Hepw3</code></td>
</tr>
<tr>
<td>3</td>
<td><code>login</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# login</code></td>
</tr>
<tr>
<td>4</td>
<td><code>exec-timeout minutes [seconds]</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# exec-timeout 5 30</code></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)#</code></td>
</tr>
<tr>
<td>5</td>
<td><code>exit</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# exit</code></td>
</tr>
<tr>
<td>6</td>
<td>`line [aux</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config)# line vty 0 4</code></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)#</code></td>
</tr>
<tr>
<td>7</td>
<td><code>password password</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# password aldf2ad1</code></td>
</tr>
<tr>
<td>8</td>
<td><code>login</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# login</code></td>
</tr>
<tr>
<td>9</td>
<td><code>end</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>Router(config-line)# end</code></td>
</tr>
</tbody>
</table>
Example

The following configuration shows the command-line access commands. Note that transport input
none is the default, but if SSH is enabled this must be set to ssh.

You do not have to input the commands marked default. These commands appear automatically in
the configuration file that is generated when you use the show running-config command.

```
! line console 0
exec-timeout 10 0
password 4youreyesonly
login
transport input none (default)
stopbits 1 (default)
line vty 0 4
password secret
login
!
```

Configuring Static Routes

Static routes provide fixed routing paths through the network. They are manually configured on the router. If
the network topology changes, the static route must be updated with a new route. Static routes are private
routes unless they are redistributed by a routing protocol.

To configure static routes, follow these steps.

SUMMARY STEPS

1. (Option 1) ip route prefix mask {ip-address | interface-type interface-number [ip-address]}
2. (Option 2) ipv6 route prefix/mask {ipv6-address | interface-type interface-number [ipv6-address]}
3. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> (Option 1) ip route prefix mask {ip-address</td>
<td>interface-type interface-number [ip-address]}</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# ip route 192.10.2.3 255.255.0.0 10.10.10.2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> (Option 2) ipv6 route prefix/mask {ipv6-address</td>
<td>interface-type interface-number [ipv6-address]}</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# ipv6 route 2001:db8:2::/64</td>
<td></td>
</tr>
</tbody>
</table>
**Purpose**

<table>
<thead>
<tr>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 3 end</strong></td>
</tr>
</tbody>
</table>

**Example:**

```
Router(config)# end
```

Exits global configuration mode and enters privileged EXEC mode.

---

In the following configuration example, the static route sends out all IP packets with a destination IP address of 192.168.1.0 and a subnet mask of 255.255.255.0 on the Gigabit Ethernet interface to another device with an IP address of 10.10.10.2. Specifically, the packets are sent to the configured PVC.

You do not have to enter the command marked `default`. This command appears automatically in the configuration file generated when you use the `running-config` command.

```
! ip classless (default)
ip route 2001:db8:2::/64 2001:db8:3::0
```

**Verifying Configuration**

To verify that you have configured static routing correctly, enter the `show ip route` command (or `show ipv6 route` command) and look for static routes marked with the letter S.

When you use an IPv4 address, you should see verification output similar to the following:

```
Router# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/24 is subnetted, 1 subnets
 C 10.108.1.0 is directly connected, Loopback0
 S* 0.0.0.0/0 is directly connected, FastEthernet0
```

When you use an IPv6 address, you should see verification output similar to the following:

```
Router# show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS inter area, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DEC -

Destination

 C 2001:db8:3::/64 [0/0]
     via GigabitEthernet0/0/2, directly connected
 S 2001:db8:2::/64 [1/0]
     via 2001:db8:3::1
```

---

Cisco IR1101 Integrated Services Router Software Configuration Guide
Configuring Dynamic Routes

In dynamic routing, the network protocol adjusts the path automatically, based on network traffic or topology. Changes in dynamic routes are shared with other routers in the network.


Configuring Routing Information Protocol

To configure the RIP on a router, follow these steps.

SUMMARY STEPS

1. `router rip`
2. `version {1 | 2}`
3. `network ip-address`
4. `no auto-summary`
5. `end`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters router configuration mode, and enables RIP on the router.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config)# router rip</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Specifies use of RIP version 1 or 2.</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-router)# version 2</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Specifies a list of networks on which RIP is to be applied, using the address of the network of each directly connected network.</td>
</tr>
</tbody>
</table>
| Example: | Router(config-router)# network 192.168.1.1  
 Router(config-router)# network 10.10.7.1 |
| **Step 4** | Disables automatic summarization of subnet routes into network-level routes. This allows subprefix routing information to pass across classful network boundaries. |
| Example: | Router(config-router)# no auto-summary |
| **Step 5** | Exits router configuration mode, and enters privileged EXEC mode. |
| Example: | |
Example

Verifying Configuration

To verify that you have configured RIP correctly, enter the `show ip route` command and look for RIP routes marked with the letter R. You should see an output similar to the one shown in the following example:

```
Router# show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

10.0.0.0/24 is subnetted, 1 subnets
   C 10.108.1.0 is directly connected, Loopback0
   R 3.0.0.0/8 [120/1] via 2.2.2.1, 00:00:02, Ethernet0/0/0
```

Configuring Enhanced Interior Gateway Routing Protocol

The Enhanced Interior Gateway Routing Protocol (EIGRP) is an enhanced version of the Interior Gateway Routing Protocol (IGRP) developed by Cisco. The convergence properties and the operating efficiency of EIGRP have improved substantially over IGRP, and IGRP is now obsolete.

The convergence technology of EIGRP is based on an algorithm called the Diffusing Update Algorithm (DUAL). The algorithm guarantees loop-free operation at every instant throughout a route computation and allows all devices involved in a topology change to synchronize. Devices that are not affected by topology changes are not involved in recomputations.


Configuring the Serial Interface

This section describes configuring serial interface management.

The IR1101 supports asynchronous serial interface protocols used for SCADA, Raw Socket, or reverse Telnet. It has a single serial interface, designated async 0/2/0. The serial interface is DTE only.

Note

Specifying an Asynchronous Serial Interface

To specify an asynchronous serial interface and enter interface configuration mode, use one of the following commands in global configuration mode.

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config)# interface async 0/2/0</td>
<td>Enters interface configuration mode.</td>
</tr>
</tbody>
</table>

Specifying Asynchronous Serial Encapsulation

The asynchronous serial interfaces support the following serial encapsulation methods:

- Raw-TCP
- Raw-UDP
- SCADA
- Encapsulation Relay

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config-if)# encapsulation {raw-tcp</td>
<td>raw-udp</td>
</tr>
</tbody>
</table>

Encapsulation methods are set according to the type of protocol or application you configure in the Cisco IOS software.

The remaining encapsulation methods are defined in their respective books and chapters describing the protocols or applications.

Configuring the Serial Port

To configure the serial port perform the steps in the following example:

IR1101#sh run int async 0/2/0
Building configuration...
Current configuration : 62 bytes
!
interface Async0/2/0
no ip address
encapsulation raw-tcp
end
IR1101#show line

<table>
<thead>
<tr>
<th>Tty Line Typ</th>
<th>Tx/Rx</th>
<th>A Modem</th>
<th>Roty AccO</th>
<th>AccI</th>
<th>Uses</th>
<th>Noise</th>
<th>Overruns</th>
<th>Int</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 0 0 CTY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>-</td>
</tr>
<tr>
<td>0/2/0 50 TTY</td>
<td>9600/9600</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0/0</td>
</tr>
<tr>
<td>74 74 VTY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>0</td>
<td>0/0</td>
<td>-</td>
</tr>
<tr>
<td>75 75 VTY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0/0</td>
</tr>
<tr>
<td>76 76 VTY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>-</td>
</tr>
<tr>
<td>77 77 VTY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>-</td>
</tr>
<tr>
<td>78 78 VTY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>-</td>
</tr>
</tbody>
</table>

Line(s) not in async mode -or- with no hardware support:
1-49, 51-73, 79-726
Configuring Secure Shell

This section contains the following topics:

- Information About Secure Shell, on page 39
- How to Configure Secure Shell, on page 41
- Information about Secure Copy, on page 46
- Additional References, on page 48

Information About Secure Shell

Secure Shell (SSH) is a protocol that provides a secure, remote connection to a device. SSH provides more security for remote connections than Telnet does by providing strong encryption when a device is authenticated. This software release supports SSH Version 1 (SSHv1) and SSH Version 2 (SSHv2).

Prerequisites for Configuring Secure Shell

The following are the prerequisites for configuring the device for secure shell (SSH):

- For SSH to work, the switch needs an RSA public/private key pair.
- The Secure Shell (SSH) server requires an IPsec (Data Encryption Standard [DES] or 3DES) encryption software image; the SSH client requires an IPsec (DES or 3DES) encryption software image.
- Configure a hostname and host domain for your device by using the hostname and ip domain-name commands in global configuration mode. Use the hostname and ip domain-name commands in global configuration mode.

Restrictions for Configuring Secure Shell

The following are restrictions for configuring the IR1101 for secure shell.

- The router supports RSA authentication.
- SSH supports only the execution-shell application.
- The SSH server and the SSH client are supported only on Data Encryption Standard (DES) (56-bit) and 3DES (168-bit) data encryption software. In DES software images, DES is the only encryption algorithm available. In 3DES software images, both DES and 3DES encryption algorithms are available.

- This software release supports IP Security (IPSec).
- The IR1101 supports the Advanced Encryption Standard (AES) encryption algorithm with a 128-bit key, 192-bit key, or 256-bit key. However, symmetric cipher AES to encrypt the keys is not supported.
- The login banner is not supported in Secure Shell Version 1. It is supported in Secure Shell Version 2, which Cisco recommends due to its better security.
- The -l keyword and userid : {number} {ip-address} delimiter and arguments are mandatory when configuring the alternative method of Reverse SSH for console access.

SSH And Router Access

Secure Shell (SSH) is a protocol that provides a secure, remote connection to a device. SSH provides more security for remote connections than Telnet does by providing strong encryption when a device is authenticated. This software release supports SSH Version 1 (SSHv1) and SSH Version 2 (SSHv2). SSH functions the same in IPv6 as in IPv4. For IPv6, SSH supports IPv6 addresses and enables secure, encrypted connections with remote IPv6 nodes over an IPv6 transport.

SSH Servers, Integrated Clients, and Supported Versions

The Secure Shell (SSH) Integrated Client feature is an application that runs over the SSH protocol to provide device authentication and encryption. The SSH client enables a Cisco device to make a secure, encrypted connection to another Cisco device or to any other device running the SSH server. This connection provides functionality similar to that of an outbound Telnet connection except that the connection is encrypted. With authentication and encryption, the SSH client allows for secure communication over an unsecured network.

The SSH server and SSH integrated client are applications that run on the switch. The SSH server works with the SSH client supported in this release and with non-Cisco SSH clients. The SSH client works with publicly and commercially available SSH servers. The SSH client supports the ciphers of Data Encryption Standard (DES), 3DES, and password authentication.

Note: The SSH client functionality is available only when the SSH server is enabled.

User authentication is performed like that in the Telnet session to the device. SSH also supports the following user authentication methods:

- TACACS+
- RADIUS
- Local authentication and authorization
SSH Configuration Guidelines

Follow these guidelines when configuring the device as an SSH server or SSH client:

• An RSA key pair generated by a SSHv1 server can be used by an SSHv2 server, and the reverse.

• If you get CLI error messages after entering the `crypto key generate rsa` global configuration command, an RSA key pair has not been generated. Reconfigure the hostname and domain, and then enter the `crypto key generate rsa` command.

• When generating the RSA key pair, the message *No hostname specified* might appear. If it does, you must configure an IP hostname by using the `hostname` global configuration command.

• When generating the RSA key pair, the message *No domain specified* might appear. If it does, you must configure an IP domain name by using the `ip domain-name` global configuration command.

• When configuring the local authentication and authorization authentication method, make sure that AAA is disabled on the console.

Related Tasks

Setting Up the IR1101 to Run SSH, on page 41
Configuring the Router for Local Authentication and Authorization, on page 44

How to Configure Secure Shell

Setting Up the IR1101 to Run SSH

Follow the procedure given below to set up your device to run SSH:

Before you begin

Configure user authentication for local or remote access. This step is required. For more information, see Related Topics below.

SUMMARY STEPS

1. configure terminal
2. hostname hostname
3. ip domain-name domain_name
4. crypto key generate rsa
5. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>
# Configuring the SSH Server

Follow these steps to configure the SSH server:

**Note**

This procedure is only required if you are configuring the device as an SSH server.

## SUMMARY STEPS

1. configure terminal
2. ip ssh version [2]
3. ip ssh {timeout seconds | authentication-retries number}
4. Use one or both of the following:

## Table

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR1101# configure terminal</td>
<td>Configures a hostname and IP domain name for your device.</td>
</tr>
<tr>
<td><strong>Step 2</strong> hostname hostname</td>
<td>Configures a host domain for your device.</td>
</tr>
<tr>
<td>Example: IR1101(config)# hostname your_hostname</td>
<td></td>
</tr>
</tbody>
</table>
| **Step 3** ip domain-name domain_name | Enables the SSH server for local and remote authentication on the device and generates an RSA key pair. Generating an RSA key pair for the device automatically enables SSH.
We recommend that a minimum modulus size of 1024 bits.
When you generate RSA keys, you are prompted to enter a modulus length. A longer modulus length might be more secure, but it takes longer to generate and to use. |
| Example: IR1101(config)# ip domain-name your_domain_name | |
| **Step 4** crypto key generate rsa | Configures a host domain for your device. |
| Example: IR1101(config)# crypto key generate rsa | |
| **Step 5** end | Returns to privileged EXEC mode. |
| Example: IR1101(config)# end | |
### Configuring Secure Shell

#### Configuring the SSH Server

**Detailed Steps**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>IR1101# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>If you do not enter this command or do not specify a keyword, the SSH server selects the latest SSH version supported by the SSH client. For example, if the SSH client supports SSHv1 and SSHv2, the SSH server selects SSHv2.</td>
</tr>
<tr>
<td>IR1101(config)# ip ssh version 2</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> ip ssh {timeout seconds</td>
<td>authentication-retries number}</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>• Specify the time-out value in seconds; the default is 120 seconds. The range is 0 to 120 seconds. This parameter applies to the SSH negotiation phase. After the connection is established, the device uses the default time-out values of the CLI-based sessions.</td>
</tr>
<tr>
<td>IR1101(config)# ip ssh timeout 90</td>
<td>By default, up to five simultaneous, encrypted SSH connections for multiple CLI-based sessions over the network are available (session 0 to session 4). After the execution shell starts, the CLI-based session time-out value returns to the default of 10 minutes.</td>
</tr>
<tr>
<td>ip ssh authentication-retries 2</td>
<td>• Specify the number of times that a client can re-authenticate to the server. The default is 3; the range is 0 to 5.</td>
</tr>
<tr>
<td><strong>Step 4</strong> Use one or both of the following:</td>
<td>(Optional) Configures the virtual terminal line settings.</td>
</tr>
<tr>
<td>• line vty line_number [ending line number]</td>
<td>• Enters line configuration mode to configure the virtual terminal line settings. For the line_number and ending_line_number arguments, the range is from 0 to 15.</td>
</tr>
<tr>
<td>• transport input ssh</td>
<td>• Specifies that the device prevents non-SSH Telnet connections, limiting the device to only SSH connections.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>IR1101(config)# line vty 1 10</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>IR1101(config-line)# transport input ssh</td>
<td></td>
</tr>
</tbody>
</table>
Purpose or Command | Purpose
--- | ---
**Step 5** end | Exits line configuration mode and returns to privileged EXEC mode.
Example: IR1101(config-line)# end

### Monitoring the SSH Configuration and Status

This table displays the SSH server configuration and status.

*Table 6: Commands for Displaying the SSH Server Configuration and Status*

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show ip ssh</td>
<td>Shows the version and configuration information for the SSH server.</td>
</tr>
<tr>
<td>show ssh</td>
<td>Shows the status of the SSH server.</td>
</tr>
</tbody>
</table>

### Configuring the Router for Local Authentication and Authorization

You can configure AAA to operate without a server by setting the switch to implement AAA in local mode. The router then handles authentication and authorization. No accounting is available in this configuration.

Follow these steps to configure AAA to operate without a server by setting the router to implement AAA in local mode:

**SUMMARY STEPS**

1. configure terminal
2. aaa new-model
3. aaa authentication login default local
4. aaa authorization exec local
5. aaa authorization network local
6. username name privilege level password encryption-type password
7. end
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** configure terminal  
  Example:  
  IR1101# configure terminal | Enters global configuration mode. |
| **Step 2** aaa new-model  
  Example:  
  IR1101(config)# aaa new-model | Enables AAA |
| **Step 3** aaa authentication login default local  
  Example:  
  IR1101(config)# aaa authentication login default local | Sets the login authentication to use the local username database. The default keyword applies the local user database authentication to all ports. |
| **Step 4** aaa authorization exec local  
  Example:  
  IR1101(config-line)# aaa authorization exec local | Configures user AAA authorization, check the local database, and allow the user to run an EXEC shell. |
| **Step 5** aaa authorization network local  
  Example:  
  IR1101(config-line)# aaa authorization network local | Configures user AAA authorization for all network-related service requests. |
| **Step 6** username name privilege level password encryption-type password  
  Example:  
  IR1101(config-line)# username your_user_name privilege 1 password 7 secret567 | Enters the local database, and establishes a username-based authentication system. Repeat this command for each user.  
  a. For name, specify the user ID as one word. Spaces and quotation marks are not allowed.  
  b. (Optional) For level, specify the privilege level the user has after gaining access. The range is 0 to 15. Level 15 gives privileged EXEC mode access. Level 0 gives user EXEC mode access.  
  c. For encryption-type, enter 0 to specify that an unencrypted password follows. Enter 7 to specify that a hidden password follows.  
  d. For password, specify the password the user must enter to gain access to the switch. The password must be from |
Information about Secure Copy

The Secure Copy Protocol (SCP) feature provides a secure and authenticated method for copying router configuration or router image files. SCP relies on Secure Shell (SSH), an application and a protocol that provide a secure replacement for the Berkeley r-tools.

Prerequisites for Secure Copy

The following are the prerequisites for configuring the device for secure shell (SSH):

- Before enabling SCP, you must correctly configure SSH, authentication, and authorization on the switch.
- Because SCP relies on SSH for its secure transport, the router must have an RSA key pair.
- SCP relies on SSH for security.
- SCP requires that authentication, authorization, and accounting (AAA) authorization be configured so the router can determine whether the user has the correct privilege level.
- A user must have appropriate authorization to use SCP.
- A user who has appropriate authorization can use SCP to copy any file in the Cisco IOS File System (IFS) to and from a switch by using the `copy` command. An authorized administrator can also do this from a workstation.

Restrictions for Configuring Secure Copy

- Before enabling SCP, you must correctly configure SSH, authentication, and authorization on the router.
- When using SCP, you cannot enter the password into the `copy` command. You must enter the password when prompted.

Configuring Secure Copy

To configure the Cisco IR1101 for Secure Copy (SCP) server-side functionality, perform the following steps.
### SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `aaa new-model`
4. `aaa authentication login {default | list-name} method1 [ method2... ]`
5. `username name [privilege level] password encryption-type encrypted-password`
6. `ip scp server enable`
7. `exit`
8. `show running-config`
9. `debug ip scp`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>enables privileged EXEC mode.</td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device&gt; enable</td>
</tr>
<tr>
<td></td>
<td>• Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device# configure terminal</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>sets AAA authentication at login.</td>
</tr>
<tr>
<td>aaa new-model</td>
<td>Sets AAA authentication at login.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# aaa new-model</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>enables the AAA access control system.</td>
</tr>
<tr>
<td>aaa authentication login {default</td>
<td>list-name} method1 [ method2... ]</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# aaa authentication login default group tacacs+</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>establishes a username-based authentication system.</td>
</tr>
<tr>
<td>username name [privilege level] password encryption-type encrypted-password</td>
<td>Establishes a username-based authentication system.</td>
</tr>
<tr>
<td>Note</td>
<td>You may omit this step if a network-based authentication mechanism, such as TACACS+ or RADIUS, has been configured.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# username superuser privilege 2 password 0 superpassword</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>enables SCP server-side functionality.</td>
</tr>
<tr>
<td>ip scp server enable</td>
<td>Enables SCP server-side functionality.</td>
</tr>
<tr>
<td>Example:</td>
<td>Device(config)# ip scp server enable</td>
</tr>
</tbody>
</table>
### Command or Action

<table>
<thead>
<tr>
<th>Step 7</th>
<th>exit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device(config)# exit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 8</th>
<th>show running-config</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device# show running-config</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 9</th>
<th>debug ip scp</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td>Device# debug ip scp</td>
</tr>
</tbody>
</table>

#### Example

IR1101# copy scp <somefile> your_username@remotehost:/<some/remote/directory>

### Additional References

The following sections provide references related to the SSH feature.

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
</table>

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**Cisco IR1101 Integrated Services Router Software Configuration Guide**
New Features for Cisco IOS-XE 17.1.1

This section contains the following topics:

- Support for the X25 over TCP (XOT), on page 49
- Support for YANG Data Models (Call-home), on page 49
- Yang Data Model Support for Scada, on page 50
- Support for Model Driven support for GNMI Telemetry Dial-In, on page 50
- Option to Enable or Disable USB Access, on page 50
- Day 0 Web User Interface, on page 50

Support for the X25 over TCP (XOT)

X.25 is an ITU standard for packet switching Wide Area Network (WAN). This is used in the Telecommunication industry over serial interfaces that are replaced by IP Network. An X25 connection can be established by using a PAD connection similar to Telnet/SSH. The IR1101 router has only one asynchronous serial interface where features of X25 are not supported. However, we can communicate to the X25 edge devices using by using feature TCP over X25 (XOT). With XOT, we can directly establish a PAD connection to X25 edge devices. Also, we can assign default or customized profiles to the access-groups by changing various parameters of X25 packets.

For additional information about XOT for IOS-XE, see the following:

Wide-Area Networking Configuration Guide: X.25 and LAPB, Cisco IOS XE

Support for YANG Data Models (Call-home)

The YANG models supported for the call-home feature are similar to the earlier releases of Cisco-IOS-XE, and the same is supported on 17.1 release of IOS-XE on IR1101. The following references are available for earlier YANG models:

https://github.com/YangModels.yang/tree/master/vendor/cisco/xe/1651

For additional information about call-home for IOS-XE, see the following:

Software Activation Configuration Guide, Cisco IOS XE Release 3S
Yang Data Model Support for Scada

The Cisco IOS XE 17.1.1 introduces support for the Cisco IOS XE YANG model for the Scada System. Previous releases already provided Yang models in other areas.

https://github.com/YangModels/yang/tree/master/vendor/cisco/xe/1711

For configuration information, refer to Information About SCADA, on page 173

Support for Model Driven support for GNMI Telemetry Dial-In

Similar to YANG models, there is support on IOS-XE for open source models defined by Google and is referred as Google Network Management Interface (GNMI). Configurations of GNMI can be verified either with Secure or Insecure Mode.

• Secure Mode

Secure Mode establishes secure connection using OpenSSL certificates between client and server. It sends GNMI telemetry updates using open source gnmi_cli tool.

• Insecure Mode

Insecure Mode sends GNMI telemetry updates between client and server using open source pygnmi tool.

For additional information about GNMI Telemetry see the following reference:
Programmability Configuration Guide, Cisco IOS XE

Option to Enable or Disable USB Access

USB flash drives offer inexpensive and easy storage space for the routers to store the images, configuration files and other files. However, the USB port could be considered a potential security risk. Functionality was added to enable or disable the USB access. Details can be found at Option to Enable or Disable USB Access, on page 55

Day 0 Web User Interface

Effective with IOS-XE Release 17.1.1, the Day 0 Web User Interface (WebUI) will be supported on the IR1101. Day 0 WebUI is supported only on LAN ports. These are FastEthernet ports 0/0/1 – 0/0/4 on the IR1101. Connect either a Windows, Linux or Mac PC/Laptop to one of the LAN ports of the IR1101 and boot the router on Day 0. The PC/Laptop should be configured to obtain an IP address through DHCP. Details can be found at Day 0 Web User Interface, on page 79
Installing the Software

Installing the Software

Installing software on the router involves installing a consolidated package (bootable image). This consists of a bundle of subpackages (modular software units), with each subpackage controlling a different set of functions.

These are the two main methods to install the software:

• Managing and Configuring a Router to Run Using Consolidated Packages — This method allows for individual upgrade of subpackages and generally has reduced boot times compared to the method below. Use this method if you want to individually upgrade a module's software.

• Managing and Configuring a Router to Run Using Individual Packages — This simple method is similar to a typical Cisco router image installation and management that is supported across Cisco routers.

It is better to upgrade software in a planned period of maintenance when an interruption in service is acceptable. The router needs to be rebooted for a software upgrade to take effect.

Licensing

Cisco Software Licensing

Cisco software licensing consists of processes and components to activate Cisco IOS software feature sets by obtaining and validating Cisco software licenses.
You can enable licensed features and store license files in the bootflash of your router. Licenses pertain to consolidated packages, technology packages, or individual features.

The IR1101 uses Smart Licensing, which is discussed in detail in the next chapter.

The IR1101 does not support the Right to Use licenses, and supports only the Specific License Reservation (SLR)

### Consolidated Packages

To obtain software images for the router, go to: https://software.cisco.com/download/home/286319772/type/282046477/release/Gibraltar-16.11.1

---

**Note**

All of the IOS-XE feature set may not apply to the IR1101. Some features may not have been implemented yet, or are not appropriate for this platform.

An image-based license is used to help bring up all the subsystems that correspond to a license. This license is enforced only at boot time.

One of the following image-based licenses can be pre-installed on the IR1101 router:

- Network-Essentials
- Network-Advantage

---

**Note**


### Network-Essentials

The **Network-Essentials** technology package includes the baseline features. It also supports security features.

The **Network-Essentials_npe** technology package (npe = No Payload Encryption) includes all the features in the Network-Essentials technology package without the payload encryption functionality. This is to fulfill export restriction requirements. The Network-Essentials_npe is available only in the Network-Essentials_npe image. The difference in features between the Network-Essentials package and the Network-Essentials_npe package is therefore the set of payload encryption features such as IPsec and Secure VPN.

### Network-Advantage

The **Network-Advantage** technology package includes all crypto features.

The **Network-Advantage_npe** package (npe = No Payload Encryption) includes all the features in the **Network-Advantage** technology package without the payload-encryption functionality. This is to fulfill export restriction requirements. The **Network-Advantage_npe** package is available only in the **Network-Advantage_npe** image. The difference in features between the **Network-Advantage** package and the **Network-Advantage_npe** package is therefore the set of payload-encryption-enabling features such as IPsec and Secure VPN.
Related Documentation

For further information on software licenses, see Information About Smart Licensing, on page 59.

How to Install the Software for Cisco IOS XE

To install the software, use one of the following methods to use the software from a consolidated package or an individual package. Also see Overview section.

• Managing and Configuring a Router to Run Using a Consolidated Package section
• Managing and Configuring a Router to Run Using Individual Packages section
• Configuring a Router to Boot the Consolidated Package via TFTP Using the boot Command: Example section

Installing the Cisco IOS XE Release

When the device boots up with Cisco IOS XE image for the first time, the device checks the installed version of the ROMMON, and upgrades if the system is running an older version. During the upgrade, do not power cycle the device. The system automatically power cycles the device after the new ROMMON is installed. After the installation, the system will boot up with the Cisco IOS XE image as normal.

Note

When the device boots up for first time and if the device requires an upgrade, the entire boot process may take several minutes. This process will be longer than a normal boot due to the ROMMON upgrade.

The following example illustrates the boot process of a consolidated package:

Router# configure terminal
Router(config)# boot sys bootflash:ir1101-universalk9.16.10.01.SPA.bin
Router(config)# config-register 0x2102
Router(config)# exit
Router#
*Nov 7 00:07:06.784: %SYS-5-CONFIG_I: Configured from console by console
Router#
Router# show run | inc license
license udi pid IR1101-K9 sn FCW2150TH0F
license boot level network-advantage
Router# reload
/verify
Building configuration...

[OK]
*Nov 7 00:08:48.101: %SYS-2-PRIVCFG.ENCRYPT: Successfully encrypted private config file
*Nov 7 00:08:48.101: %SYS-2-PRIVCFG.ENCRYPT: Successfully encrypted private config file
*Nov 7 00:08:48.101: %SYS-2-PRIVCFG.ENCRYPT: Successfully encrypted private config file...
ROMMON Images

A ROMMON image is a software package used by ROM Monitor (ROMMON) software on a router. The software package is separate from the consolidated package normally used to boot the router.

An independent ROMMON image (software package) may occasionally be released and the router can be upgraded with the new ROMMON software. For detailed instructions, see the documentation that accompanies the ROMMON image.

A new version of the ROMMON image is not necessarily released at the same time as a consolidated package for a router.

File Systems

The following table provides a list of file systems that can be seen on the Cisco IR1101 router.

<table>
<thead>
<tr>
<th>File System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bootflash:</td>
<td>Boot flash memory file system.</td>
</tr>
<tr>
<td>File System</td>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>flash:</td>
<td>Alias to the boot flash memory file system above.</td>
</tr>
<tr>
<td>cns:</td>
<td>Cisco Networking Services file directory.</td>
</tr>
<tr>
<td>nvram:</td>
<td>Router NVRAM. You can copy the startup configuration to NVRAM or from NVRAM.</td>
</tr>
<tr>
<td>obfl:</td>
<td>File system for Onboard Failure Logging (OBFL) files.</td>
</tr>
<tr>
<td>system:</td>
<td>System memory file system, which includes the running configuration.</td>
</tr>
<tr>
<td>tar:</td>
<td>Archive file system.</td>
</tr>
<tr>
<td>tmpsys:</td>
<td>Temporary system files file system.</td>
</tr>
<tr>
<td>usbflash0:</td>
<td>The Universal Serial Bus (USB) flash drive file systems. <strong>Note</strong>: The USB flash drive file system is visible only if a USB drive is installed in the usb port.</td>
</tr>
</tbody>
</table>

Use the `?` help option if you find a file system that is not listed in the table above.

## Option to Enable or Disable USB Access

USB flash drives offer inexpensive and easy storage space for the routers to store the images, configuration files and other files.

**Note**: The IR1101 supports ext2 and vfat file systems for USB flash drives.

The IR1101 supports hot plug/unplug of USB flash drives. To access the USB flash drive, insert the device into Router's USB interface. Once the USB is recognized, an alert message is seen on the console:

Aug 1 11:08:53.198 PDT: %IOSD_INFRA-6-IFS_DEVICE_OIR: Device usbflash0 added

After this message is seen, the USB flash drive is accessible. Users can access the USB contents using the `dir usbflash0:` command:

```
Device#dir usbflash0:
Directory of usbflash0:/
5 drwx 512 Aug 23 2019 10:42:18 -07:00 System Volume Information
6 -rwx 35 Aug 27 2019 17:40:38 -07:00 test.txt
206472192 bytes total (206470144 bytes free)
Device#
```

Contents can be copied to and from the USB flash drive using the `copy` command. Once the copy is complete, a log message showing number of bytes copied is displayed.

```
Device#copy flash:test.txt usbflash0:
Destination filename [test.txt]? <Enter>
Copy in progress...C
35 bytes copied in 0.020 secs (1750 bytes/sec)
Device#
```
While hot plug/unplug of a USB flash drive is supported, the functionality comes with security vulnerabilities. To prevent users from copying sensitive information to the USB flash drive, USB enable/disable functionality has been added.

By default, the USB flash drive is enabled. If a user wishes to disable USB, they can do so using the disable command:

```
Device# config terminal
Device(config)# platform usb disable
Device(config)# end
```

Once the USB flash drive has been disabled, the file system is not shown on the Device and syslog messages will not be displayed when the USB is inserted. Users will not be able to access the contents of the USB.

For example:

```
Device# dir usbflash0:
% Invalid input detected at '^' marker.
Device#
```

The USB is enabled by issuing a `no` with the disable command:

```
Device# config terminal
Device(config)# no platform usb disable
Device(config)# end
```

The USB status can be displayed using the following command:

```
Device# show platform usb status
USB enabled
Device#
```

The USB port could be considered a potential security risk. If you wish to disable the USB port, use these steps:

```
Configure terminal
platform usb disable
exit
show platform usb
```

**Autogenerated File Directories and Files**

This section discusses the autogenerated files and directories that can be created, and how the files in these directories can be managed.
Table 8: Autogenerated Files

<table>
<thead>
<tr>
<th>File or Directory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>crashinfo files</td>
<td>Crashinfo files may appear in the bootflash: filesystem. These files provide descriptive information of a crash and may be useful for tuning or troubleshooting purposes. However, the files are not part of router operations, and can be erased without impacting the functioning of the router.</td>
</tr>
<tr>
<td>core directory</td>
<td>The storage area for .core files. If this directory is erased, it will automatically regenerate itself at bootup. The .core files in this directory can be erased without impacting any router functionality, but the directory itself should not be erased.</td>
</tr>
<tr>
<td>managed directory</td>
<td>This directory is created on bootup if a system check is performed. Its appearance is completely normal and does not indicate any issues with the router.</td>
</tr>
<tr>
<td>tracelogs directory</td>
<td>The storage area for trace files. Trace files are useful for troubleshooting. If the Cisco IOS process fails, for instance, users or troubleshooting personnel can access trace files using diagnostic mode to gather information related to the Cisco IOS failure. Trace files, however, are not a part of router operations, and can be erased without impacting the router's performance.</td>
</tr>
</tbody>
</table>

Important Notes About Autogenerated Directories

Important information about autogenerated directories include:

- Autogenerated files on the bootflash: directory should not be deleted, renamed, moved, or altered in any way unless directed by Cisco customer support.

  **Note**
  
  Altering autogenerating files on the bootflash: may have unpredictable consequences for system performance.

- Crashinfo files and files in the core and tracelogs directory can be deleted.

Flash Storage

Subpackages are installed to local media storage, such as flash. For flash storage, use the `dir bootflash:` command to list the file names.

  **Note**

  Flash storage is required for successful operation of a router.
LED Indicators

For information on LEDs on the router, see "LED Indicators" in the "Product Overview" section of the Hardware Installation Guide for the Cisco IR1101 Industrial Integrated Services Router.

To monitor the LED status of the system, the alarm and interface ports, the show LED command line is supported in IOS mode.

Router# show LED
SYSTEM LED : Green
Custom LED : Off
VPN LED : Off
ALARM LED : Off

GigabitEthernet0/0/0 LED : Off
FastEthernet0/0/1 LED : Off
FastEthernet0/0/2 LED : Off
FastEthernet0/0/3 LED : Off
FastEthernet0/0/4 LED : Off
GigabitEthernet0/0/5 LED : On

EM Module digital I/O 1 LED : Off
EM Module digital I/O 2 LED : Off
EM Module digital I/O 3 LED : Off
EM Module digital I/O 4 LED : Off

*System LTE Pluggable*
LTE module Enable LED : Green
LTE module SIM 0 LED : Green
LTE module SIM 1 LED : Off
LTE module GPS LED : Off
LTE module RSSI 0 LED : On
LTE module RSSI 1 LED : On
LTE module RSSI 2 LED : On
LTE module RSSI 3 LED : On

*EM Module LTE Pluggable*
LTE module Enable LED : Green
LTE module SIM 0 LED : Green
LTE module SIM 1 LED : Off
LTE module GPS LED : Off
LTE module RSSI 0 LED : On
LTE module RSSI 1 LED : On
LTE module RSSI 2 LED : On
LTE module RSSI 3 LED : On
Router#

Related Documentation

For further information on software licenses, see the Smart Licensing Chapter.

For further information on obtaining and installing feature licenses, see Configuring the Cisco IOS Software Activation Feature.
Prerequisites for Smart Licensing

- You must have a Cisco username and password to login into Cisco Smart Software Manager.
- You must accept the Smart Software Licensing Agreement on Cisco Smart Software Manager to register devices.

- Information About Smart Licensing, on page 59
- Overview of Cisco Smart Software Manager, on page 60
- Deployment Options for IR1101 Licensing, on page 60
- Specific License Reservation, on page 60
- To Register a Device in Cisco Smart Software Manager, on page 61
- Renewing Smart Licensing Registration, on page 61
- Enabling Specific License Reservation and Generating a Request Code, on page 62
- Reserving a License in Cisco Smart Software Manager, on page 63
- Registering Device with Specific License Reservation, on page 67
- Monitoring Smart Licensing Configuration, on page 68
- Example: Registering Smart Licensing Enabled Device, on page 69
- IR1101 Licensing for Cisco IOS-XE, on page 69
- Smart Licensing Support for Evaluation Expired Syslog after 365 Days, on page 76
- Licensing Event History Logging, on page 77

Information About Smart Licensing

Smart Licensing is a cloud-based, software license management solution that allows you to manage and track the status of your license, hardware and software usage trends. Smart Licensing also enables you to automate time-consuming, manual licensing tasks. Smart Licensing helps simplify three core functions:

- Purchasing: The software that you have installed in your network can automatically self-register themselves, without using traditional licenses like Product Activation Keys (PAKs), CSL, Honor Based License (HBL) or Right-to-Use (RTU).

- Management: You can automatically track activations against your license entitlements. Additionally, there is no need to install the license file on every node. You can create license pools (logical grouping of licenses) to reflect your organization structure. Smart Licensing offers you Cisco Smart Software Manager, a centralized portal that enables you to manage all your Cisco software licenses from one centralized website.
Overview of Cisco Smart Software Manager

Cisco Smart Software Manager enables you to manage all of your Cisco Smart software licenses from one centralized website. With Cisco Smart Software Manager, you organize and view your licenses in groups called virtual accounts (collections of licenses and product instances). Use the Cisco Smart Software Manager to do the following tasks:

• Create, manage or view virtual accounts.
• Create and manage Product Instance Registration Tokens.
• Transfer licenses between virtual accounts or view licenses.
• Transfer, remove or view product instances.
• Run reports against your virtual accounts.
• Modify your email notification settings.
• View overall account information.

The Cisco Smart Software Manager Help describes the procedures for carrying out these tasks. You can access the Cisco Smart Software Manager on https://software.cisco.com/#, by clicking Smart Software Licensing link under License tab. Login using the username and password provided by Cisco.

Note
Use Chrome 32.0, Firefox 25.0 or Safari 6.0.5 web browsers to access the Cisco Smart Software Manager. Also, ensure that Javascript 1.5 or a later version is enabled in your browser.

Deployment Options for IR1101 Licensing

The only supported licensing deployment for IR1101 is Specific License Reservation.

Specific License Reservation

Specific License Reservation (SLR) allows devices, in highly secure networks, to be associated with smart licenses without connecting to Cisco Smart Software Manager. Excess Licenses can be reserved in Cisco Smart Software Manager and associated with devices with their unique device information (UDI).

Note
Pre-authorization is required from Cisco to enable Specific License Reservation.
Specific License Reservations provides limited or no functionality to certain Smart Licensing features such as transfer of licenses between products, license usage, asset management e.t.c

**To Register a Device in Cisco Smart Software Manager**

To register a device with token in Cisco Smart Software Manager, perform this procedure:

**SUMMARY STEPS**

1. **enable**
2. **license smart register** *token_ID*

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enable</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>device&gt;</code> <code>enable</code></td>
<td></td>
</tr>
<tr>
<td><strong>License smart register</strong> <em>token_ID</em></td>
<td>Registers the device with the back-end server. Registration of the device changes the License Authorization Status from Eval Mode to Authorized shown in “show license summary”.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>device#</code> <code>license smart register idtoken</code> NmElYzg0OWMMyMj4</td>
<td></td>
</tr>
</tbody>
</table>

**Renewing Smart Licensing Registration**

In general, your registration is automatically renewed every 30 days. Use this option to make an on-demand manual update of your registration. Thus, instead of waiting 30 days for the next registration renewal cycle, you can issue this command to instantly find out the status of your license.

To renew smart licensing registration, perform this procedure:

**SUMMARY STEPS**

1. **enable**
2. **license smart renew** {auth | id}

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enable</strong></td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>device&gt;</code> <code>enable</code></td>
<td></td>
</tr>
</tbody>
</table>
Enabling Specific License Reservation and Generating a Request Code

To enable Specific License Reservation and to generate a request code, perform this procedure:

SUMMARY STEPS
1. enable
2. configure terminal
3. license smart reservation
4. exit
5. license smart reservation request local
6. license smart reservation install \{auth-code | file <filename>\}
7. license smart reservation cancel

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>device# enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2** configure terminal | Enters global configuration mode. |
| Example:                      | |
| device# configure terminal    | |

| **Step 3** license smart reservation | Enables Specific License Reservation. Use the no form of this command to disable Specific License Reservation. |
| Example:                            | |

Note
Authorization periods are renewed by the Smart Licensing system every 30 days. As long as the license is in an 'Authorized' or 'Out-of-compliance' (OOC), the authorization period is renewed. Grace period starts when an authorization period expires. During the grace period or when the grace period is in the 'Expired' state, the system continues to try renew the authorization period. If a retry is successful, a new authorization period starts.

Renew your ID or authorization with Cisco Smart Licensing. If ID certification renewal fails, then the product instance goes to an unidentified state and starts consuming the evaluation period.

Example:

Step 2 goes to an unidentified state and starts consuming the evaluation period.

device# license smart renew auth Tue Apr 22 09:12:37.086 PST

Authorization period sarerenewedbytheSmartLicensingsystemevery30days.Aslongasthe licenseisinan'Authorized'or 'Out-of-compliance' (OOC), the authorization period is renewed. Grace period starts when an authorization period expires. During the grace period or when the grace period is in the 'Expired' state, the system continues to try renew the authorization period. If a retry is successful, a new authorization period starts.

PurposeCommand or Action

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong> license smart renew {auth</td>
<td>id }</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>device# license smart renew auth Tue Apr 22 09:12:37.086 PST</td>
<td></td>
</tr>
</tbody>
</table>

Note
Authorization periods are renewed by the Smart Licensing system every 30 days. As long as the license is in an 'Authorized' or 'Out-of-compliance' (OOC), the authorization period is renewed. Grace period starts when an authorization period expires. During the grace period or when the grace period is in the 'Expired' state, the system continues to try renew the authorization period. If a retry is successful, a new authorization period starts.

Enabling Specific License Reservation and Generating a Request Code

To enable Specific License Reservation and to generate a request code, perform this procedure:

SUMMARY STEPS
1. enable
2. configure terminal
3. license smart reservation
4. exit
5. license smart reservation request local
6. license smart reservation install \{auth-code | file <filename>\}
7. license smart reservation cancel

DETAILED STEPS

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<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>device# enable</td>
<td></td>
</tr>
</tbody>
</table>

| **Step 2** configure terminal | Enters global configuration mode. |
| Example:                      | |
| device# configure terminal    | |

| **Step 3** license smart reservation | Enables Specific License Reservation. Use the no form of this command to disable Specific License Reservation. |
| Example:                            | |
### Prerequisites for Smart Licensing

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>device(config)# license smart reservation</code></td>
<td>Exits configuration mode, and returns the device to global configuration mode.</td>
</tr>
</tbody>
</table>

#### Step 4

**exit**

**Example:**

```
device(config)# exit
```

#### Step 5

**license smart reservation request local**

**Example:**

```
device# license smart reservation request local
```

Generates a request code to be entered in the Cisco Smart Software Manager. The request code can be generated for the following:

- **all** - Generates a request code for all connected devices.
- **local** - Generates a request code for the active device.
- **universal** - Generates a universal request code. This mode of request is deprecated and will not be supported for further releases.

#### Step 6

**license smart reservation install**

`[auth-code | file <filename>]`

**Example:**

```
device# license smart reservation install
```

To install the authorization code which is generated by the CSSM server, with the given request code generated via the command "license smart reservation request local":

#### Step 7

**license smart reservation cancel**

**Example:**

```
device# license smart reservation cancel
```

This command is used to cancel the reservation request made via the command "license smart reservation request local", and transition back to an unregistered state.

---

**Reserving a License in Cisco Smart Software Manager**

#### Step 1

Login to Cisco Smart Software Manager at [https://software.cisco.com/](https://software.cisco.com/).

#### Step 2

Select **Smart Software Licensing** then the **Inventory** tab.
You must log in to the portal using a Cisco provided username and password.

**Step 3**  From the Virtual Account sub-page, select the Licenses tab and click on the License Reservation button as shown in the following image.

**Figure 4: Smart Software Licensing**

**Step 4**  On the Smart License Reservation page, enter the request code generated by the device from the `license smart reservation request local` command. Hit the Enter key then click on the Next button.
**Figure 5: Enter Request Code**

**Step 5**
Enable the **Reserve a Specific License** checkbox. For the required license, enter the number in the Quantity to Reserve field (normally 1 for a device). In the following example, we enter “1” for Cisco IR1101 Network Advantage and “1” for Cisco IR1101 Network Essentials”. Then click the **Next** button.

**Figure 6: Select Licenses**

**Step 6**
The **Review and Confirm** tab is displayed. Make sure that you have the correct licenses reserved. When done, click the **Generate Authorization Code** button.
Step 7  Once the authorization code is generated, click either the **Download as File** or the **Copy to Clipboard** button for use in the `license smart reservation install [auth-code] [file <filename>])` command.
Registering Device with Specific License Reservation

To register device with specific license reservation, perform this procedure:

**SUMMARY STEPS**

1. enable
2. license smart reservation install auth-code | auth-code-file

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>enable</td>
<td>Enables privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>Enter your password if prompted.</td>
</tr>
<tr>
<td>device&gt; enable</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>license smart reservation install auth-code</td>
<td>auth-code-file</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>device&gt; license smart reservation install file bootflash:network-advantage_auth_code.txt</td>
<td></td>
</tr>
</tbody>
</table>
Monitoring Smart Licensing Configuration

Use the privileged EXEC commands in the following table to monitor your PIM snooping configurations.

Table 9: Commands to Monitor Smart Licensing Configuration

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show license status</td>
<td>Displays the compliance status of Smart Licensing. Following are the possible status:</td>
</tr>
<tr>
<td></td>
<td>• Enabled: Indicates that Smart Licensing is enabled.</td>
</tr>
<tr>
<td></td>
<td>Waiting: Indicates the initial state after your device has made a license entitlement request. The device establishes communication with</td>
</tr>
<tr>
<td></td>
<td>Cisco and successfully registers itself with the Cisco license manager.</td>
</tr>
<tr>
<td></td>
<td>Authorized: Indicates that your device is able to communicate with the Cisco license manager, and is authorised to initiate requests for</td>
</tr>
<tr>
<td></td>
<td>license entitlements.</td>
</tr>
<tr>
<td></td>
<td>Out-Of-Compliance: Indicates that one or more of your licenses are out-of-compliance. You must buy additional licenses.</td>
</tr>
<tr>
<td></td>
<td>Eval Period: Indicates that Smart Licensing is consuming the evaluation period. You must register the device with the Cisco Licensing</td>
</tr>
<tr>
<td></td>
<td>manager, else your license expires.</td>
</tr>
<tr>
<td></td>
<td>Grace Period: Indicates that connectivity to the Cisco license manager is lost. You must try restore connectivity to renew the authorization</td>
</tr>
<tr>
<td></td>
<td>period.</td>
</tr>
<tr>
<td></td>
<td>Disabled: Indicates that Smart Licensing is disabled.</td>
</tr>
<tr>
<td></td>
<td>Invalid: Indicates that Cisco does not recognize the entitlement tag as it is not in the database.</td>
</tr>
<tr>
<td>show license all</td>
<td>Displays all entitlements in use. It can also be used to check if Smart Licensing is enabled. Additionally, it shows associated licensing</td>
</tr>
<tr>
<td></td>
<td>certificates, compliance status, UDI, and other details.</td>
</tr>
<tr>
<td>show license tech support</td>
<td>Displays the output of the license commands.</td>
</tr>
<tr>
<td>show license usage</td>
<td>Displays the license usage information.</td>
</tr>
</tbody>
</table>
Example: Registering Smart Licensing Enabled Device

Device> enable
Device# license smart register idtoken NmElYzg0OOWMyM34
license smart register: Registration process is in progress. Please check the syslog for the registration status and result.

IR1101 Licensing for Cisco IOS-XE

With IOS-XE release 16.10.1 and above, the IR1101 supports boot level licenses Network-Essentials and Network-Advantage. Both of these licenses are available in the universalk9 and universalk9_npe images. With release 16.10.1 and above, Network-Advantage is a superset of Network-Essentials, so the license are mutually exclusive and Network-Essentials will be the default license level. Displaying the license consumption and boot level configuration will have either Network-Essentials or Network-Advantage but not both at the same time.

There are two important things to consider with licensing the IR1101:

If you have performed a write erase, or used the reset button, you will need to add the license.

IR1101# config term
IR1101# license smart reservation

If you perform a factory reset all, this will erase the license with no way to recover it unless you get the authorization file from the smart account.

The following shows an example of the different licensing:

IR1101# show license summary
Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
Status: REGISTERED - SPECIFIC LICENSE RESERVATION
Export-Controlled Functionality: Allowed

License Authorization:
Status: AUTHORIZED - RESERVED

License Usage:
License Entitlement tag Count Status
------------------------------------------------------------------------------------------
Cisco IR1101 Network... (IR1101_Network_Advantage) 1 AUTHORIZED

IR1101# show license status
Smart Licensing is ENABLED

Utility:
Status: DISABLED
License Reservation is ENABLED

Data Privacy:
Sending Hostname: yes
Callhome hostname privacy: DISABLED
Smart Licensing hostname privacy: DISABLED
Version privacy: DISABLED

Transport:
Type: Callhome

Registration:
Status: REGISTERED - SPECIFIC LICENSE RESERVATION
Export-Controlled Functionality: Allowed
Initial Registration: SUCCEEDED on Nov 07 02:04:55 2018 UTC

License Authorization:
Status: AUTHORIZED - RESERVED on Nov 07 02:04:55 2018 UTC

Export Authorization Key:
Last return status: SUCCEEDED on Nov 07 02:04:55 2018 UTC
Features Authorized:
none

# IR1101# show license all
Smart Licensing Status

Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
Status: REGISTERED - SPECIFIC LICENSE RESERVATION
Export-Controlled Functionality: Allowed
Initial Registration: SUCCEEDED on Nov 07 02:04:55 2018 UTC

License Authorization:
Status: AUTHORIZED - RESERVED on Nov 07 02:04:55 2018 UTC

Export Authorization Key:
Last return status: SUCCEEDED on Nov 07 02:04:55 2018 UTC
Features Authorized:
none

Utility:
Status: DISABLED

Data Privacy:
Sending Hostname: yes
Callhome hostname privacy: DISABLED
Smart Licensing hostname privacy: DISABLED
Version privacy: DISABLED

Transport:
Type: Callhome

License Usage

Cisco IR1101 Network Advantage (IR1101_Network_Advantage):
Description: Cisco Network Advantage Smart License for Cisco IR1101
Industrial Integrated Services Router
Count: 1
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED
Reservation:
Reservation status: SPECIFIC INSTALLED
Total reserved count: 1

Product Information
---------------------
UDI: PID:IR1101-K9,SN:FCW2150TH0F

Agent Version
-------------
Smart Agent for Licensing: 4.5.5_rel/56
Component Versions: SA:(1_3_dev)1.0.15, SI:(dev22)1.2.1, CH:(rel5)1.0.3, PK:(dev18)1.0.3

Reservation Info
----------------
License reservation: ENABLED

Overall status:
Active: PID:IR1101-K9,SN:FCW2150TH0F
Reservation status: SPECIFIC INSTALLED on Nov 07 02:04:55 2018 UTC
Export-Controlled Functionality: Allowed
Last Confirmation code: 9765d8c5

Specified license reservation:
Cisco IR1101 Network Advantage (IR1101_Network_Advantage):
Description: Cisco Network Advantage Smart License for Cisco IR1101 Industrial Integrated Services Router
Total reserved count: 1
Term information:
Active: PID:IR1101-K9,SN:FCW2150TH0F
License type: TERM
Start Date: 2018-JUN-13 UTC
End Date: 2018-DEC-10 UTC
Term Count: 1

IR1101# show license tech support
Smart Licensing Tech Support info
Smart Licensing Status
---------------------------
Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
Status: REGISTERED - SPECIFIC LICENSE RESERVATION
Export-Controlled Functionality: Allowed
Initial Registration: SUCCEEDED on Nov 07 02:04:55 2018 UTC

License Authorization:
Status: AUTHORIZED - RESERVED on Nov 07 02:04:55 2018 UTC

Export Authorization Key:
Last return status: SUCCEEDED on Nov 07 02:04:55 2018 UTC
Features Authorized:
<none>

Utility:
Status: DISABLED

Data Privacy:
Sending Hostname: yes
Callhome hostname privacy: DISABLED
Smart Licensing hostname privacy: DISABLED
Version privacy: DISABLED

Transport:
Type: Callhome

Evaluation Period:
Evaluation Mode: EXPIRED
Evaluation Period Remaining: Expired on Nov 05 08:27:16 2018 UTC

License Usage
------------------
Handle: 1
License: Cisco IR1101 Network Advantage
Entitlement tag:
regid.2018-04.com.cisco.IR1101_Network_Advantage,1.0_d2087fd8-364a-4ef3-bbaf-66111de3684b
Description: Cisco Network Advantage Smart License for Cisco IR1101 Industrial Integrated Services Router
Count: 1
Version: 1.0
Status: AUTHORIZED(3)
Status time: Nov 07 02:04:55 2018 UTC
Request Time: Nov 06 23:22:13 2018 UTC
Export status: NOT RESTRICTED

Product Information
-------------------
UDI: PID:IR1101-K9,SN:PCW2150TH0F

Agent Version
--------------
Smart Agent for Licensing: 4.5.5_rel/56
Component Versions: SA:(1_3_dev)1.0.15, SI:(dev22)1.2.1, CH:(rel5)1.0.3, PK:(dev18)1.0.3

Upcoming Scheduled Jobs
------------------------
Current time: Nov 07 02:10:15 2018 UTC
Daily: Nov 07 23:22:16 2018 UTC (21 hours, 12 minutes, 1 seconds remaining)
Init Flag Check: Not Available
Reservation request in progress warning: Not Available
Reservation configuration mismatch between nodes in HA mode: Nov 14 02:05:24 2018 UTC (6 days, 23 hours, 55 minutes, 9 seconds remaining)

License Certificates
---------------------
Production Cert: True
Not registered. No certificates installed

HA Info
-------
RP Role: Active
Chassis Role: Active
Behavior Role: Active
RMF: True
CF: True
CF State: Stateless
Message Flow Allowed: True

Reservation Info
----------------
License reservation: ENABLED

Overall status:
Prerequisites for Smart Licensing

IR1101 Licensing for Cisco IOS-XE

Active: PID:IR1101-K9, SN: FCW2150TH0F
Reservation status: SPECIFIC INSTALLED on Nov 07 02:04:55 2018 UTC
Export-Controlled Functionality: Allowed
Request code: <none>
Last return code: <none>
Last Confirmation code: 9765d8c5
Reservation authorization code:

Specified license reservations:
Cisco IR1101 Network Advantage (IR1101_Network_Advantage):
  Description: Cisco Network Advantage Smart License for Cisco IR1101 Industrial Integrated Services Router
  Total reserved count: 1
  Term information:
    Active: PID:IR1101-K9, SN: FCW2150TH0F
    License type: TERM
    Start Date: 2018-JUN-13 UTC
    End Date: 2018-DEC-10 UTC
    Term Count: 1
    Subscription ID: <none>

Other Info
---------
Software ID: regid.2018-04.com.cisco.IR1101,1.0_e40b8e7c-fd51-418c-a981-a49697dd08f5
Agent State: authorized
TS enable: True
Transport: Callhome
Locale: en_US.UTF-8
Debug flags: 0x7
Privacy Send Hostname: True
Privacy Send IP: True
Build type:: Production
sizeof(char) : 1
sizeof(int) : 4
sizeof(long) : 4
sizeof(char *) : 8
sizeof(time_t) : 4
sizeof(size_t) : 8
Endian: Big
Write Erase Occurred: False
XOS version: 0.12.0.0
Config Persist Received: True
Message Version: 1.3
connect_info.name: <empty>
connect_info.version: <empty>
connect_info.additional: <empty>
connect_info.prod: False
connect_info.capabilities: <empty>
agent.capabilities: UTILITY, DLC, AppHA, MULTITIER, EXPORT_2
SmartAgentCmReTrySend: True
SmartAgentCmClient: True
SmartAgentClientName: UnifiedClient
builtInEncryption: True
enableOnInit: True
routingReadyByEvent: True
systemInitByEvent: True
enableByDefault: False
conversionAutomatic: True
show license usage
License Authorization:
  Status: EVAL MODE
  Evaluation Period Remaining: 29 days, 13 hours, 48 minutes, 12 seconds

(IR1101_Network_Advantage):
  Description:
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Reservation:
  Reservation status: NOT INSTALLED

(IR1101_Network_Essentials):
  Description:
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Reservation:
  Reservation status: NOT INSTALLED

show license reservation
License reservation: ENABLED

Overall status:
Active: PID:IR1101-K9,SN:FCW2150TH0F
Reservation status: SPECIFIC INSTALLED on Nov 07 02:04:55 2018 UTC
Export-Controlled Functionality: Allowed
Last Confirmation code: 9765d8c5

Specified license reservations:
Cisco IR1101 Network Advantage (IR1101_Network_Advantage):
Description: Cisco Network Advantage Smart License for Cisco IR1101 Industrial Integrated Services Router
Total reserved count: 1
Term information:
  Active: PID:IR1101-K9,SN:FCW2150TH0F
  License type: TERM
  Start Date: 2018-JUN-13 UTC
  End Date: 2018-DEC-10 UTC
  Term Count: 1
#
show version
Cisco IOS-XE software, Copyright (c) 2005-2019 by cisco Systems, Inc. All rights reserved. Certain components of Cisco IOS-XE software are licensed under the GNU General Public License ("GPL") Version 2.0. The software code licensed under GPL Version 2.0 is free software that comes with ABSOLUTELY NO WARRANTY. You can redistribute and/or modify such GPL code under the terms of GPL Version 2.0. For more details, see the documentation or "License Notice" file accompanying the IOS-XE software, or the applicable URL provided on the flyer accompanying the IOS-XE software.

Technology Package License Information:

<table>
<thead>
<tr>
<th>Technology-package</th>
<th>Type</th>
<th>Technology-package</th>
<th>Next reboot</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-essentials</td>
<td>Smart License</td>
<td></td>
<td>network-essentials</td>
</tr>
</tbody>
</table>

Smart Licensing Status: UNREGISTERED/EVAL EXPIRED

cisco IR1101-K9 (ARM64) processor (revision 1.2 GHz) with 708327K/6147K bytes of memory.
Processor board ID FCW222700KS
3 Virtual Ethernet interfaces
4 FastEthernet interfaces
2 Gigabit Ethernet interfaces
1 Serial interface
1 terminal line
Smart Licensing Support for Evaluation Expired Syslog after 365 Days

For the 16.11.1 release, evaluation expired syslog messages will be displayed after 365 days, and it is enabled by default. Customers will not see the evaluation period syslog messages for one year. There are no CLI or show command changes.

This feature changes only when the evaluation syslog messages are sent if the product instance is not registered, for example, the license usage is in Evaluation Mode. The actual 90-day evaluation period will not change. The only change is when these evaluation period syslog messages are sent, which is one year from the date the license has actually expired.

This one-year period will include the 90-day evaluation period, such that after the evaluation period expires, the smart agent will not send the evaluation mode syslog messages for another 275 calendar days.

The 90-day evaluation period will still trigger the following events:

• After 90 days of usage the evaluation period will expire.
  • The `show usage` and `show status` CLI commands will show that the evaluation period has expired.

The following three evaluation period syslog messages are at issue. With the previous 90-day evaluation period, these are sent only if the product instance is not registered. However, with the evaluation expired syslog after 365-days in effect, none of these messages are logged in the syslog.

**%SMART_LIC-3-EVAL_EXPIRED**

• Evaluation period just expired.
• Sent at the time the evaluation period expires

**%SMART_LIC-4-EVAL_WILL_EXPIRE_WARNING**

• Evaluation period will expire soon.
• Currently sent prior to expiration on the following schedule.
  • 60 days before.
  • 30 days before.
  • Every week in the last month
  • Every day in the last week
  • Every hour on the last day.
The evaluation period expired in the past.
Sent once per week after the expiration. Includes the timestamp of the expiration.

Licensing Event History Logging

This feature will always be on for continuous logging of events, and available across a reboot. These logs will be independent of btrace, and will contain:

- Boot log
- Registration & Renewal log
- Authorization log
- The regular log will contain all of the information.

This event history logging would be present across all the subsystems like smart agent, smart licensing infrastructure and platforms.

To display the licensing event history log, execute the `show license eventlog` CLI.

Sample output from the CLI:

```
Router# show license eventlog
**** Event Log ****
2019-01-15 19:06:59.454 UTC SAEVT_INIT_START version="4.6.3_rel/58"
2019-01-15 19:06:59.455 UTC SAEVT_INIT_CRYPTO success="False" error="Crypto Initialization has not been completed"
2019-01-15 19:06:59.455 UTC SAEVT_HA_EVENT eventType="SmartAgentEvtHArmfRegister"
2019-01-15 19:06:59.525 UTC SAEVT_EXPORT_FLAG exportAllowed="False"
2019-01-15 19:06:59.596 UTC SAEVT_LICENSE_USAGE count="1" type="total" entitlementTag="regid.2018-04.com.cisco.IR1101_Network_Essentials,1.0_95814bcc-8788-4546-9dc1-524953f68cbc"
2019-01-15 19:07:00.954 UTC SAEVT_READY
2019-01-15 19:07:00.955 UTC SAEVT_ENABLED
2019-01-15 19:07:00.955 UTC SAEVT_HA_EVENT eventType="SmartAgentEvtHArmfInitialize"
2019-01-15 19:07:03.925 UTC SAEVT_HA_CHASSIS_ROLE udi="PID:IR1101-K9,SN:FCW2213TH01"
2019-01-15 19:07:03.925 UTC SAEVT_HA_EVENT eventType="SmartAgentEvtHAchkptRegister"
2019-01-15 19:07:04.267 UTC SAEVT_INIT_ROUTING_READY
2019-01-15 19:07:07.437 UTC SAEVT_HA_ROLE udi="PID:IR1101-K9,SN:FCW2213TH01" haRole="Active"
2019-01-15 19:07:07.439 UTC SAEVT_HA_ROLE udi="PID:IR1101-K9,SN:FCW2213TH01" haRole="Active"
2019-01-15 19:07:07.489 UTC SAEVT_HA_CHASSIS_ROLE udi="PID:IR1101-K9,SN:FCW2213TH01" haRole="Active"
2019-01-15 19:07:07.489 UTC SAEVT_HA_ROLE udi="PID:IR1101-K9,SN:FCW2213TH01" haRole="Active"
2019-01-15 19:07:07.615 UTC SAEVT_INIT_CONFIG_READ_BEGIN
2019-01-15 19:07:12.110 UTC SAEVT_Hostname_CHANGE
2019-01-15 19:07:12.284 UTC SAEVT_INIT_CONFIG_READ_DONE
2019-01-15 19:07:12.614 UTC SAEVT_INIT_SYSTEM_INIT
2019-01-15 19:07:13.616 UTC SAEVT_INIT_CRYPTO success="False" error="Crypto Initialization has not been completed"
2019-01-15 19:07:43.615 UTC SAEVT_INIT_CRYPTO success="True"
2019-01-15 19:07:43.615 UTC SAEVT_EXPORT_FLAG exportAllowed="False"
2019-01-15 19:07:43.615 UTC SAEVT_INIT_COMPLETE
```
Licensing Event History Logging

Prerequisites for Smart Licensing
Web User Interface (WebUI)

This section contains the following topics:

- Day 0 Web User Interface, on page 79

Day 0 Web User Interface

Note: A Day 0 configuration is defined as a device that is fresh out of the box with no startup-configuration.

Effective with IOS-XE Release 17.1.1, the Day 0 Web User Interface (WebUI) will be supported on the IR1101. Day 0 WebUI is supported only on LAN ports. These are FastEthernet ports 0/0/1 – 0/0/4 on the IR1101. Connect either a Windows, Linux or Mac PC/Laptop to one of the LAN ports of the IR1101 and boot the router on Day 0. The PC/Laptop should be configured to obtain an IP address through DHCP.

Once the router boots up in Day 0, the PC/Laptop will acquire IP address in 192.168.1.x network and can access WebUI using the IP address of 192.168.1.1 with any browser. After the configuration is applied through the WebUI, the router will display the message "Day 0 config done. Stopping autoinstall".

Note: Issue a write memory command once the configuration is applied through the WebUI.

Configuration Notes

The following are limitations to the Day 0 feature:

- The WebUI is not supported on the GigabitEthernet 0/0/0 port. It is only supported on the LAN ports 0/0/1 – 0/0/4.
- Plug and Play (PNP) cannot be used if router is being used to configure using Day 0 WebUI as PNP will be aborted once the configuration is applied through Day 0 WebUI.
- Starting from release 17.1.2, an explicit write memory is not needed once config is applied through WebUI.

Configuring Your Computer to Connect to the Router

The following section provides guidance for configuring your computer to properly interface with the IR1101.
You can access the application from a client web browser. Ensure that the following web client requirements are met:

- **Hardware**—A Mac (OS version 10.9.5) or Windows (OS version 10) laptop or desktop compatible with one of the following tested and supported browsers:
  - Google Chrome 59 or later
  - Mozilla Firefox 54 or later
  - Apple Safari 10 or later
  - Microsoft Edge browser

- **Display resolution**—We recommend that you set the screen resolution to 1280 x 800 or higher.

### Windows Users

Navigate to **Registry Edit -> HKEY_LOCAL_MACHINE -> SYSTEM -> CurrentControlSet -> Services 'TCP/IP -> Interfaces** Add a binary file and name it DhcpClientIdentifier then modify the data as 7765627569 (See #1) in Figure 9: Registry Editor, on page 80.

![Figure 9: Registry Editor](image)

Make sure the interface that you have connected is the interface where this file is added. There will be many other interfaces so sometimes it becomes difficult to identify the interface. An easy way to find out is to configure a dummy IP address on interface that is connected and just try to see which Interface acquires that IP address in the registry edit.

### Mac Users

Navigate to **System Preference -> Network** and then select the interface which is connected. Click **advanced**. Under advanced, Select **Configure IPv4**. Beside Configure IPv4 select **Using DHCP** (See #1 in Figure 10: Mac Interface Configuration, on page 81.) Beside DHCP Client ID enter **webui** (See #2 in Figure 10: Mac Interface Configuration, on page 81.)

Click **OK**.
Linux Users

Navigate to **Edit Connections**. Select the Interface and go to **IPv4 settings**. While in this window, configure the following:

- Ip address acquire method as Automatic (DHCP) - (See #1 in Figure 11: Editing Wired Connection in UBUNTU, on page 82.)
- DHCP Client ID as webui (See #2 in Figure 11: Editing Wired Connection in UBUNTU, on page 82.)
Configuring the WebUI through the Browser

The following steps guide you through the process of using the browser on your PC/laptop to configure the WebUI.

**SUMMARY STEPS**

1. Open your browser and enter 192.168.1.1 in the address bar. The Login Screen appears. Enter the Username `webui` and the Password `cisco`. Then click **Log In**.
2. The Welcome Screen appears. Select Advanced Mode or Basic Mode. Basic Mode allows for configuring Basic settings, LAN, and a Primary WAN. Advanced Mode allows you to configure an additional Backup WAN, AVC, as well as additional settings. For the purposes of this guide, Basic Mode is used. Select **Basic Mode**, then click **Go To Account Creation Page**.
3. The Create New Account Screen appears. Create a new Login Name and Password to access the WebUI. Click **Create and Launch Wizard**.
4. The Basic Settings Screen appears. Provide a Router Name (hostname), Domain Name, Time Zone and Date & Time Mode. Click **LAN SETTINGS**.
5. The LAN Configuration Screen appears. Enter the `webui_dhcp Pool Name`, VLAN interface IP address, and select the interface that is connected to your laptop from the list of available interfaces. Click **PRIMARY WAN SETTINGS**.
6. The PRIMARY WAN SETTINGS Screen appears. Configure the WAN interface by selecting the WAN Type and Interface from the available options. Next enter your DNS IP address information and select Enable/Disable NAT. Click **Day 0 Config Summary**.

7. The Review Summary Screen appears. Verify your entries before applying the configuration.

8. (Optional) You can click on **CLI Preview** to see the Configuration that is being applied to the router. Close the CLI Preview and if you are ready, Click **Submit**.

9. After clicking on Submit, a dialog box will appear which informs you that the configuration has been applied successfully. The new WebUI ip address is also presented.

10. If you have web connectivity, the device will try to connect. It is recommended that you close the browser session and move to the newly configured WebUI ip address.

**DETAILED STEPS**

**Step 1** Open your browser and enter 192.168.1.1 in the address bar. The Login Screen appears. Enter the Username **webui** and the Password **cisco**. Then click **Log In**.

*Figure 12: Login Screen*

**Step 2** The Welcome Screen appears. Select Advanced Mode or Basic Mode. Basic Mode allows for configuring Basic settings, LAN, and a Primary WAN. Advanced Mode allows you to configure an additional Backup WAN, AVC, as well as additional settings. For the purposes of this guide, Basic Mode is used. Select **Basic Mode**, then click **Go To Account Creation Page**.
Configuring the WebUI through the Browser

Figure 13: Welcome Screen

This device is detected as a factory-fresh device. To begin, create a new user account and launch the setup wizard to bring up the device quickly.

READ THE INSTRUCTIONS BELOW BEFORE YOU BEGIN

- Ensure that you have all the required information from your service provider to complete the configuration.
- If you are configuring a non-3G/4G WAN connection, ensure that the physical WAN cable connection with the service provider is installed correctly.
- If 3G/4G is configured as WAN, ensure that the Subscriber Information Module (SIM) is inserted properly in the router slot.
- By default, the wizard enables some recommended configurations. We recommend that you keep these defaults unless you have a reason to change them.
- This wizard helps you to bring up your WAN/LAN connectivity quickly. You can change the configuration and configure advanced features after the wizard completes successfully.
- As a best practice, when you use WebUI to configure a device, do not delete or modify the configuration directly by logging into the device. Changing the configuration method could lead to errors.

Example:

Step 3

The Create New Account Screen appears. Create a new Login Name and Password to access the WebUI. Click Create and Launch Wizard.

Figure 14: Create New Account Screen

Step 4

The Basic Settings Screen appears. Provide a Router Name (hostname), Domain Name, Time Zone and Date & Time Mode. Click LAN SETTINGS.
Step 5  
The LAN Configuration Screen appears. Enter the webui_dhcp Pool Name, VLAN interface IP address, and select the interface that is connected to your laptop from the list of available interfaces. Click PRIMARY WAN SETTINGS.

Step 6  
The PRIMARY WAN SETTINGS Screen appears. Configure the WAN interface by selecting the WAN Type and Interface from the available options. Next enter your DNS IP address information and select Enable/Disable NAT. Click Day 0 Config Summary.
**Step 7**

The Review Summary Screen appears. Verify your entries before applying the configuration.

**Step 8**

(Optional) You can click on **CLI Preview** to see the Configuration that is being applied to the router. Close the CLI Preview and if you are ready, Click **Submit**.
Step 9

After clicking on Submit, a dialog box will appear which informs you that the configuration has been applied successfully. The new WebUI IP address is also presented.

Step 10

If you have web connectivity, the device will try to connect. It is recommended that you close the browser session and move to the newly configured WebUI IP address.
Figure 21: Test VLAN Connection Screen

Web User Interface (WebUI)

Configuring the WebUI through the Browser
Configuring Ethernet Switch Ports

This chapter contains the following sections:

- Configuring VLANs, on page 89
- VLAN Trunking Protocol (VTP), on page 90
- Configuring 802.1x Authentication, on page 91
- Configuring Spanning Tree Protocol, on page 92
- Configuring MAC Address Table Manipulation, on page 93
- Configuring Switch Port Analyzer, on page 94
- Configuring IGMP Snooping, on page 95

Configuring VLANs

A VLAN is a switched network that is logically segmented by function, project team, or application, without regard to the physical locations of the users. VLANs have the same attributes as physical LANs, but you can group end stations even if they are not physically located on the same LAN segment. Any switch port can belong to a VLAN, and unicast, broadcast, and multicast packets are forwarded and flooded only to end stations in the VLAN. Each VLAN is considered a logical network, and packets destined for stations that do not belong to the VLAN must be forwarded through a router.

On the IR1101, all the Fast Ethernet ports are set up in vlan1, which does not need to be created. The default for the Gigabit Ethernet port (gi0/0/0) is Layer 3. If needed, the Gigabit Ethernet port (gi0/0/0) could be set up as Layer 2 and added into vlan1.

Note

For example:

```
# config terminal
interface gi0/0/0
switchport
exit
```

The following is an example of a vlan configuration:

```
IR1101# show vlan
VLAN Name Status Ports
----- --------------- -------------------------------
1 default active Fa0/0/1, Fa0/0/2, Fa0/0/3, Fa0/0/4
```

On the Expansion Module, GigabiEthernet 0/0/5 is in VLAN 1 by default, and is an SFP.
VLAN Trunking Protocol (VTP)

VTP is a Layer 2 messaging protocol that maintains VLAN configuration consistency by managing the addition, deletion, and renaming of VLANs on a network-wide basis. VTP minimizes misconfigurations and configuration inconsistencies that can cause several problems, such as duplicate VLAN names, incorrect VLAN-type specifications, and security violations.

Before you create VLANs, you must decide whether to use VTP in your network. Using VTP, you can make configuration changes centrally on one or more switches and have those changes automatically communicated to all the other switches in the network. Without VTP, you cannot send information about VLANs to other switches. VTP is designed to work in an environment where updates are made on a single switch and are sent through VTP to other switches in the domain. It does not work well in a situation where multiple updates to the VLAN database occur simultaneously on switches in the same domain, which would result in an inconsistency in the VLAN database.

Further information about configuring VTP can be found here: http://www.cisco.com/c/en/us/td/docs/routers/access/interfaces/software/feature/guide/geshwic_cfg.html#wp1046901
IEEE 802.1x port-based authentication defines a client-server-based access control and authentication protocol to prevent unauthorized clients from connecting to a LAN through publicly accessible ports. The authentication server authenticates each client connected to a switch port before allowing access to any switch or LAN services. Until the client is authenticated, IEEE 802.1x access control allows only Extensible Authentication Protocol over LAN (EAPOL), Cisco Discovery Protocol (CDP), and Spanning Tree Protocol (STP) traffic through the port to which the client is connected. After authentication, normal traffic passes through the port.

With IEEE 802.1x authentication, the devices in the network have specific roles:

- **Supplicant**—Device (workstation) that requests access to the LAN and switch services and responds to requests from the router. The workstation must be running IEEE 802.1x-compliant client software such as that offered in the Microsoft Windows XP operating system. (The supplicant is sometimes called the client.)

- **Authentication server**—Device that performs the actual authentication of the supplicant. The authentication server validates the identity of the supplicant and notifies the router whether or not the supplicant is authorized to access the LAN and switch services. The Network Access Device transparently passes the authentication messages between the supplicant and the authentication server, and the authentication process is carried out between the supplicant and the authentication server. The particular EAP method used will be decided between the supplicant and the authentication server (RADIUS server). The RADIUS security system with EAP extensions is available in Cisco Secure Access Control Server Version 3.0 or later. RADIUS operates in a client and server model in which secure authentication information is exchanged between the RADIUS server and one or more RADIUS clients.

- **Authenticator**—Router that controls the physical access to the network based on the authentication status of the supplicant. The router acts as an intermediary between the supplicant and the authentication server, requesting identity information from the supplicant, verifying that information with the authentication server, and relaying a response to the supplicant. The router includes the RADIUS client, which is responsible for encapsulating and decapsulating the EAP frames and interacting with the authentication server.

For detailed information on how to configure 802.1x port-based authentication, see the following link:


Example: Enabling IEEE 802.1x and AAA on a Switch Port

This example shows how to configure an IR1101 router as 802.1x authenticator:

```
Router> enable
Router# configure terminal
Router(config)# dot1x system-auth-control
Router(config)# aaa new-model
Router(config)# aaa authentication dot1x default group radius
Router(config)# interface FastEthernet 0/0/1
Router(config-if)# switchport mode access
Router(config-if)# access-session port-control auto
Router(config-if)# dot1x pae authenticator
Router(config-if)# access-session closed
Router(config-if)# access-session host-mode single-host
Router(config-if)# end
```
Configuring Spanning Tree Protocol

Spanning Tree Protocol (STP) is a Layer 2 link management protocol that provides path redundancy while preventing loops in the network. For a Layer 2 Ethernet network to function properly, only one active path can exist between any two stations. Multiple active paths among end stations cause loops in the network. If a loop exists in the network, end stations might receive duplicate messages. Switches might also learn end-station MAC addresses on multiple Layer 2 interfaces. These conditions result in an unstable network. Spanning-tree operation is transparent to end stations, which cannot detect whether they are connected to a single LAN segment or a switched LAN of multiple segments.

The STP uses a spanning-tree algorithm to select one switch of a redundantly connected network as the root of the spanning tree. The algorithm calculates the best loop-free path through a switched Layer 2 network by assigning a role to each port based on the role of the port in the active topology:

- **Root**—A forwarding port elected for the spanning-tree topology
- **Designated**—A forwarding port elected for every switched LAN segment
- **Alternate**—A blocked port providing an alternate path to the root bridge in the spanning tree
- **Backup**—A blocked port in a loopback configuration

The switch that has all of its ports as the designated role or as the backup role is the root switch. The switch that has at least one of its ports in the designated role is called the designated switch. Spanning tree forces redundant data paths into a standby (blocked) state. If a network segment in the spanning tree fails and a redundant path exists, the spanning-tree algorithm recalculates the spanning-tree topology and activates the standby path. Switches send and receive spanning-tree frames, called bridge protocol data units (BPDUs), at regular intervals. The switches do not forward these frames but use them to construct a loop-free path. BPDUs contain information about the sending switch and its ports, including switch and MAC addresses, switch priority, port priority, and path cost. Spanning tree uses this information to elect the root switch and root port for the switched network and the root port and designated port for each switched segment.

When two ports on a switch are part of a loop, the spanning-tree port priority and path cost settings control which port is put in the forwarding state and which is put in the blocking state. The spanning-tree port priority value represents the location of a port in the network topology and how well it is located to pass traffic. The path cost value represents the media speed.

For detailed configuration information on STP see the following link:


Example: Spanning Tree Configuration

The following example shows configuring spanning-tree port priority of a Gigabit Ethernet interface. If a loop occurs, spanning tree uses the port priority when selecting an interface to put in the forwarding state.

```
Router# configure terminal
Router(config)# interface FastEthernet 0/0/1
Router(config-if)# spanning-tree vlan 1 port-priority 64
Router(config-if)# end
```

The following example shows how to change the spanning-tree port cost of a Gigabit Ethernet interface. If a loop occurs, spanning tree uses cost when selecting an interface to put in the forwarding state.
The following examples show configuring VLAN settings:

```
Router# configure terminal
Router(config)# interface FastEthernet 0/0/1
Router(config-if)# spanning-tree cost 18
Router(config-if)# end
```

The following example shows configuring the bridge priority of VLAN 10 to 33792:

```
Router# configure terminal
Router(config)# spanning-tree vlan 10 priority 33792
Router(config)# end
```

The following example shows configuring the hello time for VLAN 10 being configured to 7 seconds. The hello time is the interval between the generation of configuration messages by the root switch.

```
Router# configure terminal
Router(config)# spanning-tree vlan 10 hello-time 7
Router(config)# end
```

The following example shows configuring forward delay time. The forward delay is the number of seconds an interface waits before changing from its spanning-tree learning and listening states to the forwarding state.

```
Router# configure terminal
Router(config)# spanning-tree vlan 10 forward-time 21
Router(config)# end
```

The following example shows configuring maximum age interval for the spanning tree. The maximum-aging time is the number of seconds a switch waits without receiving spanning-tree configuration messages before attempting a reconfiguration.

```
Router# configure terminal
Router(config)# spanning-tree vlan 20 max-age 36
Router(config)# end
```

The following example shows the switch being configured as the root bridge for VLAN 10, with a network diameter of 4.

```
Router# configure terminal
Router(config)# spanning-tree vlan 10 root primary diameter 4
Router(config)# exit
```

---

### Configuring MAC Address Table Manipulation

The MAC address table contains address information that the switch uses to forward traffic between ports. All MAC addresses in the address table are associated with one or more ports. The address table includes these types of addresses:

- Dynamic address: a source MAC address that the switch learns and then drops when it is not in use. You can use the aging time setting to define how long the switch retains unseen addresses in the table.
- Static address: a manually entered unicast address that does not age and that is not lost when the switch resets.

The address table lists the destination MAC address, the associated VLAN ID, and port associated with the address and the type (static or dynamic).

See the "Example: MAC Address Table Manipulation" for sample configurations for enabling secure MAC address, creating a state entry, set the maximum number of secure MAC addresses and set the aging time.
For detailed configuration information on MAC address table manipulation see the following link:

Example: MAC Address Table Manipulation

The following example shows creating a static entry in the MAC address table.

```
Router# configure terminal
Router(config)# mac address-table static 0002.0003.0004 interface FastEthernet 0/0/1 vlan 3
Router(config)# end
```

The following example shows setting the aging timer.

```
Router# configure terminal
Router(config)# mac address-table aging-time 300
Router(config)# end
```

## Configuring Switch Port Analyzer

The Cisco IR1101 supports local SPAN only, and up to one SPAN session. You can analyze network traffic passing through ports by using SPAN to send a copy of the traffic to another port on the switch or on another switch that has been connected to a network analyzer or other monitoring or security device. SPAN copies (or mirrors) traffic received or sent (or both) on source ports to a destination port for analysis. SPAN does not affect the switching of network traffic on the source ports. You must dedicate the destination port for SPAN use. Except for traffic that is required for the SPAN or RSPAN session, destination ports do not receive or forward traffic.

Only traffic that enters or leaves source ports or traffic that enters or leaves source can be monitored by using SPAN; traffic routed to a source cannot be monitored. For example, if incoming traffic is being monitored, traffic that gets routed from another source cannot be monitored; however, traffic that is received on the source and routed to another can be monitored.

For detailed information on how to configure a switched port analyzer (SPAN) session, see the following web link:


Example: SPAN Configuration

The following example shows how to configure a SPAN session to monitor bidirectional traffic from a Gigabit Ethernet source interface:

```
Router# configure terminal
Router(config)# monitor session 1 source FastEthernet 0/0/1
Router(config)# end
```

The following example shows how to configure a gigabit ethernet interface as the destination for a SPAN session:

```
Router# configure terminal
Router(config)# monitor session 1 destination FastEthernet 0/0/1
Router(config)# end
```

The following example shows how to remove gigabit ethernet as a SPAN source for SPAN session 1:
Configuring IGMP Snooping

IGMP snooping constrains the flooding of multicast traffic by dynamically configuring Layer 2 interfaces so that multicast traffic is forwarded to only those interfaces associated with IP multicast devices. As the name implies, IGMP snooping requires the LAN switch to snoop on the IGMP transmissions between the host and the router and to keep track of multicast groups and member ports. When the switch receives an IGMP report from a host for a particular multicast group, the switch adds the host port number to the forwarding table entry; when it receives an IGMP Leave Group message from a host, it removes the host port from the table entry. It also periodically deletes entries if it does not receive IGMP membership reports from the multicast clients.

The multicast router sends out periodic general queries to all VLANs. All hosts interested in this multicast traffic send join requests and are added to the forwarding table entry.

Use the `ip igmp snooping enable` command to configure IGMP Snooping on the IR1101.

By default, IGMP snooping is globally enabled in the IR1101.

MLD snooping is also supported on the IR1101, and further information can be found in this documentation set: https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst3850/software/release/16-1/configuration_guide/b_161_consolidated_3850_cg/b_161_consolidated_3850_cg_chapter_01100.html
CHAPTER 10

Cisco 4G LTE-Advanced Configuration

This section contains the following topics:

- Cisco Fourth-Generation LTE Advanced on the Cisco IR1101 Series Integrated Services Router, on page 97

Cisco Fourth-Generation LTE Advanced on the Cisco IR1101 Series Integrated Services Router


The IR1101 offers LTE support through the use of Pluggable Modules. You can find a list of the supported Pluggable Modules in the IR1101 Industrial Integrated Services Router Hardware Installation Guide.

Cisco LTE Pluggable Module support the following 4G/3G modes:

- **4G LTE**—4G LTE mobile specification provides multi-megabit bandwidth, more efficient radio network, latency reduction, and improved mobility. LTE solutions target new cellular networks. These networks initially support up to 100 Mb/s peak rates in the downlink and up to 50 Mb/s peak rates in the uplink. The throughput of these networks is higher than the existing 3G networks.

- **3G Evolution High-Speed Packet Access (HSPA/HSPA+)**—HSPA is a UMTS-based 3G network. It supports High-Speed Downlink Packet Access (HSDPA) and High-Speed Uplink Packet Access (HSUPA) data for improved download and upload speeds. Evolution High-Speed Packet Access (HSPA+) supports Multiple Input/Multiple Output (MIMO) antenna capability.

- **3G Evolution-Data Optimized (EVDO or DOrA) Mode**—EVDO is a 3G telecommunications standard for the wireless transmission of data through radio signals, typically for broadband Internet access. DOrA refers to EVDO Rev-A. EVDO uses multiplexing techniques including Code Division Multiple Access (CDMA), as well as Time Division Multiple Access (TDMA), to maximize both individual users' throughput and the overall system throughput.

It is important to understand the architecture of the IR1101 series and the relationship between Modems, SIMs, Interface and Controller. The following table helps to illustrate these relationships.

<table>
<thead>
<tr>
<th>Router</th>
<th>Controller</th>
<th>SIM</th>
<th>Modem SubSlot</th>
<th>PDN Interface</th>
<th>Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR1101</td>
<td>0/1/0</td>
<td>0/1</td>
<td>0/1</td>
<td>Cellular 0/1/0/1</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table: IR1101 Integrated Services Router Software Configuration Guide
### Prerequisites for Configuring Cisco 4G LTE Advanced

- If the signal is not good at the router, use the Cisco offered antenna accessories and extension cables to place the antenna away from router in a better coverage area. Please refer to the RSSI/SNT values as displayed through `show cellular 0/1/0 all` or the LED of the pluggable modem.
- You must have 4G LTE network coverage where your router is physically placed. For a complete list of supported carriers.
- You must subscribe to a service plan with a wireless service provider and obtain a Subscriber Identity Module (SIM) card. Only micro SIM is supported.
- You must install the SIM card before configuring the 4G LTE or router.
- The standalone antenna that supports GPS capabilities must be installed for the GPS feature to work.

### Restrictions for Configuring Cisco 4G LTE Advanced

- Currently, cellular networks support only user initiated bearer establishment.
- Due to the shared nature of wireless communications, the experienced throughput varies depending on the number of active users or congestion in a given network.
- Cellular bandwidth is asymmetric with the downlink data rate being greater than the uplink data rate.
- Cellular networks have higher latency compared to wired networks. Latency rates depend on the technology and carrier. Latency also depends on the signal conditions and can be higher because of network congestion.
- CDMA-EVDO, CDMA-1xRTT, and GPRS technology modes are not supported.
- Any restrictions that are part of the terms of service from your carrier.
- SMS—Only one text message up to 160 characters to one recipient at a time is supported. Larger texts are automatically truncated to the proper size before being sent.
- It is strongly recommended that you configure SNMP V3 with authentication/privacy.
Features not Supported in 4G LTE Advanced

The following features are not supported on Cisco 4G LTE Advanced on the IR1101, when compared to Classic IOS:

- TTY support or Line
- Chat script/dialer string
- DM log output to USB flash is not supported.

4G LTE-Advanced LEDs

LED status can be obtained through the show led CLI, or visually on the pluggable modem card. The following is an example of the show led CLI:

```sh
IR1101#show led
SYSTEM LED : Green
Custom LED : Off
VPN LED : Off
ALARM LED : Off
GigabitEthernet0/0/0 LED : Off
FastEthernet0/0/1 LED : Off
FastEthernet0/0/2 LED : Off
FastEthernet0/0/3 LED : Off
FastEthernet0/0/4 LED : Off
GigabitEthernet0/0/5 LED : On
EM Module digital I/O 1 LED : Off
EM Module digital I/O 2 LED : Off
EM Module digital I/O 3 LED : Off
EM Module digital I/O 4 LED : Off
*System LTE Pluggable*
LTE module Enable LED : Green
LTE module SIM 0 LED : Green
LTE module SIM 1 LED : Off
LTE module GPS LED : Off
LTE module RSSI 0 LED : On
LTE module RSSI 1 LED : On
LTE module RSSI 2 LED : On
LTE module RSSI 3 LED : On
*EM Module LTE Pluggable*
LTE module Enable LED : Green
LTE module SIM 0 LED : Green
LTE module SIM 1 LED : Off
LTE module GPS LED : Off
LTE module RSSI 0 LED : On
LTE module RSSI 1 LED : On
LTE module RSSI 2 LED : On
LTE module RSSI 3 LED : On
```

The following table describes the LED behavior in 4G LTE-Advanced.
Table 10: 4G LTE-Advanced LED Indicators

<table>
<thead>
<tr>
<th>LED</th>
<th>Color/Bar and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTE SIM(0) &amp; SIM(1)</td>
<td>Green (Solid) Modem up, SIM installed and active</td>
</tr>
<tr>
<td></td>
<td>Off                                        No SIM is present</td>
</tr>
<tr>
<td></td>
<td>Amber (Solid) Modem up, SIM installed but not active</td>
</tr>
<tr>
<td>EN</td>
<td>Off                                        Pluggable is powered off.</td>
</tr>
<tr>
<td></td>
<td>Amber (Solid) Module power is on, but the module is not functioning correctly.</td>
</tr>
<tr>
<td></td>
<td>Green (Solid) Module power is on</td>
</tr>
<tr>
<td>RSSI - Uses Bars for LED Indication</td>
<td>Four Bar High RSSI &gt;= -69dBm</td>
</tr>
<tr>
<td></td>
<td>Three Bar Medium RSSI, -89dBm &lt;&gt; -70dBm</td>
</tr>
<tr>
<td></td>
<td>Two Bar Low RSSI, -99dBm &lt;&gt; -90dBm</td>
</tr>
<tr>
<td></td>
<td>One Bar RSSI &lt;= -100dBm</td>
</tr>
<tr>
<td></td>
<td>0 or No Bar No Service</td>
</tr>
<tr>
<td>GPS</td>
<td>Green (Solid) GPS coordinates are obtained.</td>
</tr>
<tr>
<td></td>
<td>Off                                        GPS is disabled, GPS is enabled without GPS mode and NMEA configuration, or GPS is acquiring</td>
</tr>
</tbody>
</table>

Cisco 4G LTE-Advanced Features

Cisco 4G LTE-Advanced supports the following major features:

- Global Navigation Satellite System (GNSS) (requires a GNSS compliant antenna) and National Marine Electronics Association (NMEA) streaming.
- Short Message Service (SMS)
- 3G/4G Simple Network Management Protocol (SNMP) MIB
- SIM lock and unlock capabilities
- Dual SIM (Only SIM slot 0 is functional on the P-LTE-VZ pluggable)
- Auto SIM
- NeMo
- Mobile Network IPv6
• Public Land Mobile Network (PLMN) selection
• IPv6
• Multiple PDN
• LTE Link Recovery

4G GNSS and NMEA

Active GNSS is supported on the SubMiniature version A (SMA) port. Active GNSS antenna is supported only in the standalone mode. An Active GNSS antenna includes a built-in Low-Noise Amplifier that provides sufficient gain to overcome coaxial cable losses while providing the proper signal level to the GNSS receiver. Active GNSS antennae require power from the GNSS receiver SMA port to operate.

National Marine Electronics Association (NMEA) streams GNSS data either from a 4G LTE through a virtual COM port and a TCP/IP Ethernet connection to any marine device (such as a Windows-based PC) that runs a commercially available GNSS-based application.

The following GNSS and NMEA features are supported on the Cisco 4G LTE-Advanced:
• GNSS standalone mode (satellite-based GNSS)
• Cisco IOS-XE CLI display coordinates.
• External application displays router map location
• Objects in the CISCO-WAN-3G-MIB supports GNSS and NMEA features
• The Cisco 4G LTE-Advanced only support NMEA over IP and uses show commands in the platform

Note
Assisted GNSS mode is not supported.

Example: Connecting to a Server Hosting a GPS Application

You can feed the NMEA data to a remote server that hosts the GPS application. The server can be connected to the router either directly using an Ethernet cable or through a LAN or WAN network. If the application supports serial port, run a serial port emulation program to create a virtual serial port over the LAN or WAN connection.

Note
Microsoft Streets & Trips is a licensed software that you can download from the Microsoft website.

To connect a Cisco 4G LTE-Advanced through IP to a PC running Microsoft Streets & Trips, perform the following steps:
1. Connect the PC to the router using an Ethernet cable.
2. Ensure that the PC and router can ping.
3. Launch the serial port redirector on the PC.
4. Create a virtual serial port that connects to the NMEA port on the router.

5. Launch Microsoft Streets & Trips on your PC.

6. Select the GPS Menu.

7. Click Start Tracking.

8. If you have acquired a location fix from the `show cellular 0/1/0 gps` command output on the router, the current location is plotted on the graph, and a reddish brown dotted cursor with a circle around it is seen on the map.

---

**Note**

If you have not acquired a location fix, the Microsoft application times out and disconnects.

---

### Dual SIM Card

**Note**

The P-LTE-VZ pluggable which supports Verizon is a single SIM.

SIM card primary slot is selected when router boots up or when NIM reloads. The default slot is 0. If SIM card is not present in the primary slot, select the alternative slot if SIM card is present.

```plaintext
controller cellular 0/1/0
lte sim primary slot <slot#>
```

If the active SIM card loses connectivity to the network a failover to the alternative SIM card slot occurs.

By default the failover timer is 3 minutes. The failover timer can be set from 3 to 7 minutes.

```plaintext
controller cellular 0/1/0
lte failovertimer <3-7>
```

You can also manually switch the SIM slot via the command line interface.

```plaintext
cellular 0/1/0 lte sim activate slot <0-1>
```

### Auto SIM

The Auto SIM feature detects the SIM and loads the corresponding firmware. For example, if an AT&T SIM is detected, the modem loads the AT&T firmware.

When Auto-SIM is enabled, it is said to be in Auto-SIM mode and when disabled, it is known as Manual mode. In Auto-SIM mode, the modem selects the right carrier firmware from the list of firmware's available. When in manual mode, you can select the firmware manually. Modem resets every time you make a config change from Auto-SIM enabled to disabled or vice-versa.

The P-LTE-US and P-LTE-GB pluggable modules on the IR1101 support Auto SIM.

**Note**

Auto SIM is always enabled by default.
Enable Auto SIM

SUMMARY STEPS

1. configure terminal
2. cellular slots/sub-slots/interface lte firmware-activate firmware-index

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> cellular slots/sub-slots/interface lte firmware-activate firmware-index</td>
<td>Activates the firmware index.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>For the 4G LTE Advanced, the unit argument identifies the slot, subslot, and the interface separated by slashes (0/1/0).</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config)# cellular 0/1/0 lte firmware-activate 1</td>
<td></td>
</tr>
</tbody>
</table>

Example: List the firmware when Auto-SIM is Enabled

```
Device# show cellular 0/1/0

<table>
<thead>
<tr>
<th>firmware</th>
<th>Idx Carrier</th>
<th>FwVersion</th>
<th>PriVersion</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATT</td>
<td>02.28.00.00</td>
<td>002.035_000</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>GENERIC</td>
<td>02.28.00.00</td>
<td>002.035_000</td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td>ROGERS</td>
<td>02.28.00.00</td>
<td>001.012_000</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>SPRINT</td>
<td>02.14.03.02</td>
<td>002.012_000</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>VERIZON</td>
<td>02.28.00.00</td>
<td>002.042_000</td>
<td>Inactive</td>
<td></td>
</tr>
</tbody>
</table>
```

Firmware Activation mode = AUTO

Disable Auto SIM

SUMMARY STEPS

1. configure terminal
2. controller cellular slots/sub-slots/interface
3. no lte firmware auto-sim

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
</tbody>
</table>
Example: List the firmware when Auto-SIM is Disabled

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>controller cellular slots/sub-slots/interface</td>
<td>Specifies the controller interface.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config)# controller cellular 0/1/0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>no lte firmware auto-sim</td>
<td>Disable auto SIM.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config-if)# no lte firmware auto-sim</td>
<td></td>
</tr>
</tbody>
</table>

Example: List the firmware when Auto-SIM is Disabled

```
Device# show cellular 0/1/0 firmware
Idx  Carrier    FWVersion  PriVersion  Status
 1    ATT        02.28.00.00 002.035_000  Active
 2    GENERIC    02.28.00.00 002.035_000  Inactive
 3    ROGERS     02.28.00.00 001.012_000  Inactive
 4    SPRINT     02.14.03.02 002.012_000  Inactive
 5    VERIZON    02.28.00.00 002.042_000  Inactive
```

Firmware Activation mode = Manual

**Using a SIM Card**

Cisco 4G LTE-Advanced needs an active SIM card provided by a service provider. The SIM cards are usually provided in an unlocked state so that it can be used without a Personal Identification Number (PIN). If the SIM is unlocked, it can be inserted into a 4G LTE-Advanced and used without an authorization code.

The SIM can be initially locked with a PIN code (4 to 8 digits long) defined by the service provider. Contact your service provider for the PIN code.

The SIM-Lock feature allows a SIM to be locked or unlocked with a PIN code so that it is used only in an authorized device. Perform the SIM lock and unlock procedures using the Cisco IOS CLI through a console or Telnet/SSH to the ISR.

After the SIM is locked, it cannot initiate a call unless authentication is done using the same PIN. Authentication is done automatically by Cisco IOS through configuration of the PIN. This mandatory configuration for automatic SIM authentication is done using the Cisco IOS CLI as part of the router startup configuration.

After the Cisco IOS configuration is in place, the ISR can initiate an LTE connection. The ISR uses the configured PIN to authenticate prior to the LTE connection. If the Cisco IOS PIN configuration is missing or if the PIN is incorrect, the SIM authentication will fail and the connection will not be initiated.

If the locked SIM is moved to a different ISR or to another device, or if the 4G LTE-Advanced in which the locked SIM resides is moved to a different 4G LTE-Advanced slot in the same ISR, the ISR configuration should be changed. The configuration is associated with the cellular controller that is specific to an ISR 4G LTE-Advanced slot number. This will ensure that the SIM card will not be used in any unauthorized device, or, if there are multiple 4G LTE-Advanced in a single ISR, that the appropriate PIN is applied to each 4G LTE-Advanced SIM. An authentication command (with the same PIN used to lock the SIM) must be defined on the new device or on the new cellular controller slot to successfully initiate the LTE connection.
The following procedures are used to configure a SIM:

⚠️ Caution
It is very important to use the correct PIN after it is configured. The SIM card will be blocked if the wrong PIN is entered three consecutive times on a locked SIM during authentication or when trying to unlock a locked SIM. You can unlock a blocked SIM card using the PUK code. Contact your service provider for the PUK code. Use the cellular <slot> lte sim unblock <PUK code> <new PIN code> command to unblock the SIM.

Changing the PIN

Ensure to enter the correct PIN, the SIM card gets blocked if the wrong PIN is entered three consecutive times.

SUMMARY STEPS

1. cellular interface lte sim change-pin current-pin new-pin

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> cellular interface lte sim change-pin current-pin new-pin</td>
<td>Locks or unlocks the SIM card using a PIN code.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# cellular 0/1/0 lte sim lock 1111 1234</td>
<td></td>
</tr>
</tbody>
</table>

Note
- Locks or unlocks the SIM card using a PIN code.
- pin—A code (4 to 8 digits long) provided by your service provider to lock or unlock the SIM card.
- SIM should be in locked state when the PIN is being changed.

Locking and Unlocking a SIM Card Using a PIN

Perform this task to lock or unlock a SIM card given by your service provider. Make sure you enter the correct PIN, the SIM card gets blocked if the wrong PIN is entered three consecutive times.

Procedure

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> cellular unit lte sim {lock</td>
<td>unlock} pin</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# cellular 0/1/0 lte sim lock 1111</td>
<td></td>
</tr>
</tbody>
</table>

Note
- pin—A code (4 to 8 digits long) provided by your service provider to lock or unlock the SIM card.

Configure CHV1 for Unencrypted Levels

Use either of these commands:

- lte sim authenticate 0 pin

or

- lte sim authenticate 0 pin slot {0 | 1}
### Configure CHV1 for Unencrypted Level 7

To configure an encrypted PIN, the scrambled value of the PIN must be obtained. To get the scrambled Level 7 PIN and to configure the SIM CHV1 code for verification using this encrypted PIN, enter the following commands in the EXEC mode. When obtaining the encrypted PIN for a SIM, a username and password are created by configuring password encryption, defining the username and associated password, copying the resulting scrambled password, and using this scrambled password in the SIM authentication command.

**Note**

After the scrambled PIN has been obtained and used in SIM authentication, the username created can be deleted from the Cisco IOS configuration. A SIM should be locked for SIM authentication to work.

### Procedure

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> controller cellular  interface</td>
<td>Enters the cellular controller configuration mode or</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# controller cellular 0/1/0</td>
<td></td>
</tr>
<tr>
<td>lte sim authenticate 7 1111 slot 0</td>
<td></td>
</tr>
</tbody>
</table>

---

### Procedure

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> service password-encryption</td>
<td>Enables password encryption.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router (config)# service password-encryption</td>
<td></td>
</tr>
</tbody>
</table>

**Note**

Creates username and password.

name - specifies the username. *pin*—A 4 to 8 digits PIN code.

<table>
<thead>
<tr>
<th><strong>Step 2</strong> username privilege var password pin</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router (config)# username SIM privilege 0 password 1111</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 3</strong> do show run</th>
<th>i name</th>
<th>Shows the username configuration line with the encrypted level 7 PIN for the username created in Step 3 (user “SIM” in the example shown). Copy the scrambled password for use in Step 6 (as the PIN).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Router(config)# do show run</td>
<td>i SIM</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 4</strong> username privilege 0 password pin</th>
<th>Enters the cellular controller configuration mode.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# controller cellular 0/1/0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Step 5</strong> lte sim authenticate 7 pin OR lte sim authenticate 7 pin</th>
<th>Authenticates the SIM CHV1 code by using the encrypted keyword 7 and the scrambled PIN from Step 4. The PIN is sent to the modem for authentication with each subsequent LTE connection. If authentication passes based on the</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
<td></td>
</tr>
</tbody>
</table>

---

**Cisco IR1101 Integrated Services Router Software Configuration Guide**
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>Device(config-controller)# lte sim authenticate 7 055A575E70</code></td>
<td>configured PIN, the data call is allowed. If authentication fails, the modem does not initiate the data call.</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The slot keyword and its options are available only on platforms that supports Dual-SIM feature.</td>
</tr>
</tbody>
</table>

### Step 6

- **exit**
- **Example:**
  
  `Router(config-controller)# exit`

(Optional) Exits the cellular controller configuration mode.

### Step 7

- **no username name**
- **Example:**
  
  `Router(config-controller)# no username SIM`

(Optional) Removes the username and password created in Step 3.

### Step 8

- **no service password-encryption name**
- **Example:**
  
  `Router(config-controller)# no service password-encryption`

(Optional) Removes the username and password created in Step 3.

---

### Short Message Service (SMS) Capabilities

Cisco 4G LTE-Advanced support receiving, transmitting, archiving, and deleting of SMS messages. This support includes the ability to view up to 25 received texts, and archive more messages in a custom file location. SMS is supported on multiple carriers. Cisco 4G LTE-Advanced also have the capability to revert from LTE SMS to 3G technology if necessary.

A sending device behind a Cisco 4G LTE-Advanced transmits an SMS text message over the 4G cellular link through cellular towers until it the message reaches the recipient’s router, which then notifies the recipient device, such as a cell phone. The receiving device uses the same process to return a reply to the sending device. The following figure describes the flow from a mobile device to a sending device. For SMS transmission to work, end users must have a text-capable device, and optionally, a text plan. If end users do not have a text plan, standard SMS rates apply to their text transmissions.
Data Account Provisioning

One or more modem data profiles can be created to provision a modem on a 4G LTE SKU. An active wireless account with a service provider with one or more (dual) SIM cards must be installed. The modem data profile is pre-configured on the modem.

The following tasks are used to verify the signal strength and service availability of the modem and to create, modify, and delete modem data profiles:

IP Multimedia Subsystem Profiles

IP Multimedia Subsystem (IMS) profiles establish a session, and are a part of the modem configuration and are stored in the modem's NVRAM. An IMS network is an access-independent and standard-based IP connectivity service that enables different types of multimedia services to end users using common Internet-based protocols.

Configuring Cisco 4G LTE Advanced

For 4G-LTE-Advanced, the numbering on the IR1101 for slot 0, module 0, and port 0 is 0/1/0 for all commands on the base unit. On the Expansion Module, the numbering for slot 0, module 0, and port 0 is 0/3/0 for all commands.
4G modems in the Expansion Module will support the same feature set, including GPS, as supported by the same modem in the Base Module.

Verifying Modem Signal Strength and Service Availability

For the 4G LTE Advanced, the `unit` argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

**Procedure**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td><strong>show cellular unit network</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Router# show cellular 0/1/0 network</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td><strong>show cellular unit radio</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Router# show cellular 0/1/0 radio</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td>The RSSI should be better than –90 dBm for steady and reliable connection.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td><strong>show cellular unit profile</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Router# show cellular 0/1/0 profile</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td><strong>show cellular unit security</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Router# show cellular 0/1/0 security</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td><strong>show cellular unit all</strong></td>
</tr>
<tr>
<td>Example:</td>
<td>Router# show cellular 0/1/0 all</td>
</tr>
</tbody>
</table>

Guidelines for Creating, Modifying, or Deleting Modem Data Profiles

Customized profiles (Access Point Name(APN) in mobile networks) can be created and used on Cisco 4G LTE Advanced SKU’s. Maximum number of profiles that can be created are 16.

Cisco SKU’s shipping with specific carrier provisioning file (Can be found in Carrier label under "show cellular <slot> hardware"), default profiles are already populated and can be deployed readily.

In all other cases where profile configurations are not available, separate profiles should be created with required parameters.

You can create multiple profiles on Cisco 4G LTE Advanced. The following are the default internet profile numbers for the modems:
Profile Number Modem

<table>
<thead>
<tr>
<th>Modem</th>
<th>Profile Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP7607 (Global)</td>
<td>Profile 1</td>
</tr>
<tr>
<td>WP7601 (Verizon)</td>
<td>Both Profile 1 and Profile 3</td>
</tr>
<tr>
<td>WP7603 (AT&amp;T or other SPs)</td>
<td>Profile 1</td>
</tr>
</tbody>
</table>

Follow these guidelines when you configure a data profile using EXEC mode or Config mode:

- You do not have to make any profile-related changes if your modem comes with a data profile, for instance, AT&T, Sprint and Verizon.
- If any profile parameter changes are required for a connection type, the changes will likely be carried out in the default profiles.
- To configure different profile types and use them for a different connection, you can create separate profiles with different parameters (for instance, APN names). Note that only one profile is active at a given time.
- Use the `show cellular <unit> profile` command to view the data profile. An asterisk(*) symbol is displayed against the data profile. Double asterisk(**) symbol is displayed against the attach profile.
- The data profile is used to set up a data call. If you want to use a different profile, that profile needs to be made the default one. Use the `lte sim data-profile number` command to change the default profile under `controller cellular 0/1/0`.

Creating, Modifying, or Deleting Data Profiles Using EXEC Mode

Customized profiles (Access Point Name(APN) in mobile networks) can be created and used on Cisco 4G LTE Advanced SKU's. Maximum number of profiles that can be created are 16.

Cisco SKU's shipping with specific carrier provisioning file (can be found in carrier label under `show cellular slot hardware`), default profiles are already populated and can be deployed readily.

**Note**

For the 4G LTE Advanced, the `unit` argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

**Procedure**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>`cellular unit lte profile [create</td>
<td>delete] profile-number [apn [authentication [username password [bearer-type]]]]`</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td><code>Router# cellular 0/1/0 lte profile create 2 apn.com pap username pwd ipv4</code></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The <code>profile-number</code> argument specifies the profile number created for the modem.</td>
</tr>
<tr>
<td></td>
<td>• (Optional) The <code>apn</code> argument specifies an Access Point Name (APN). An APN is provided by your service provider. Only a single APN can be specified for a single profile.</td>
</tr>
<tr>
<td></td>
<td>• (Optional) The <code>authentication</code> parameter specifies the authentication type used. Acceptable parameters are <code>chap</code>, <code>none</code> (no authentication), <code>pap</code>, and <code>pap_chap</code> (PAP or CHAP authentication).</td>
</tr>
</tbody>
</table>
Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• (Optional) The <em>username</em> and <em>password</em> arguments are given by a service provider. These are mandatory when an authentication type other than <em>none</em> is used.</td>
</tr>
<tr>
<td></td>
<td>• (Optional) The <em>PDN</em> type parameter specifies the type of packet data session established with mobile network using this profile. Acceptable parameters are: <em>ipv4 ipv6</em> and <em>ipv4v6</em> (IPv4 and IPv6).</td>
</tr>
</tbody>
</table>

The *show cellular slot* profile displays configured profile list.

**Note** Single asterisk(*) displayed against data profile. Double asterisk(**) displayed against attached profile.

---

**Example**

```
router# show cellular 0/1/0 profile
Profile 1 = INACTIVE **
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzwims
Authentication = None

Profile 2 = INACTIVE
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzwadmin
Authentication = None

Profile 3 = ACTIVE*
---------
PDP Type = IPv4v6
PDP address = 100.119.136.44
PDP IPv6 address = 2600:1010:B00E:1E11:192D:3E20:199B:3A70/64 Scope: Global
Access Point Name (APN) = VZWINTERNET
Authentication = None
Primary DNS address = 198.224.173.135
Secondary DNS address = 198.224.174.135
Primary DNS IPv6 address = 2001:4888:68:FF00:608:D:0:0
Secondary DNS IPv6 address = 2001:4888:61:FF00:604:D:0:0

Profile 4 = INACTIVE
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzwapp
Authentication = None

Profile 5 = INACTIVE
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzw800
Authentication = None

Profile 6 = INACTIVE
---------
```

---
PDP Type = IPv4v6
Access Point Name (APN) = CISCO.GW4.VZWENTP
Authentication = None

* - Default profile
** - LTE attach profile

#show cellular 0/3/0 profile
Profile 1 = INACTIVE **
--------
PDP Type = IPv4v6
Access Point Name (APN) = vzwims
Authentication = None

Profile 2 = INACTIVE
--------
PDP Type = IPv4v6
Access Point Name (APN) = vzwadmin
Authentication = None

Profile 3 = ACTIVE*
--------
PDP Type = IPv4v6
PDP address = 100.86.69.19
Access Point Name (APN) = VZWINTERNET
Authentication = None
Primary DNS address = 198.224.173.135
Secondary DNS address = 198.224.174.135
Primary DNS IPv6 address = 2001:4888:68:FF00:608:D:0:0
Secondary DNS IPv6 address = 2001:4888:61:FF00:604:D:0:0

Profile 4 = INACTIVE
--------
PDP Type = IPv4v6
Access Point Name (APN) = vzwapp
Authentication = None

Profile 5 = INACTIVE
--------
PDP Type = IPv4v6
Access Point Name (APN) = vzw800
Authentication = None

Profile 6 = INACTIVE
--------
PDP Type = IPv4v6
Access Point Name (APN) = vzwclass6
Authentication = None

* - Default profile
** - LTE attach profile

Configured default profile for active SIM 0 is profile 3.

---

Note

If data and attach profile bindings need modification, use the controller cellular slot.

router(config-controller)# lte sim data-profile 3 attach-profile 2 slot unit
Device# show cellular 0/1/0 profile
Profile 1 = INACTIVE
--------------------------------------------------
PDP Type = IPv4v6
Access Point Name (APN) = test
Authentication = None

Profile 2 = INACTIVE **
---------
PDP Type = IPv4
Access Point Name (APN) = internet
Authentication = PAP or CHAP
Username = user@solution.com
Password = cisco

Profile 3 = INACTIVE*
---------
PDP Type = IPv4v6
Access Point Name (APN) = basic
Authentication = None

* - Default profile
** - LTE attach profile
Configured default profile for active SIM 0 is profile 2.

Configuration Examples

The following example shows how to change a default profile on 4G LTE Advanced:

router(config-controller)# lte sim data-profile 2 attach-profile 1 slot unit

The following example shows the output of the show cellular command for Verizon network service:

router# show cellular 0/1/0 profile
Profile 1 = INACTIVE **
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzwms
Authentication = None

Profile 2 = INACTIVE
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzwadmin
Authentication = None

Profile 3 = ACTIVE*
---------
PDP Type = IPv4v6
PDP address = 100.119.136.44
PDP IPv6 address = 2600:1010:B00E:1E11:192D:3E20:199B:3A70/64 Scope: Global
Access Point Name (APN) = VZWINTERNET
Authentication = None
Primary DNS address = 198.224.173.135
Secondary DNS address = 198.224.174.135
Primary DNS IPv6 address = 2001:4888:68:FF00:608:D:0:0
Secondary DNS IPv6 address = 2001:4888:61:FF00:604:D:0:0

Profile 4 = INACTIVE
---------
PDP Type = IPv4v6
Access Point Name (APN) = vzwapp
Configuring a SIM for Data Calls

Locking and Unlocking a SIM Card Using a PIN Code

Perform this task to lock or unlock a SIM card given by your service provider.

The SIM card gets blocked if the wrong PIN is entered three consecutive times. Make sure you enter the correct PIN the SIM is configured with. If your SIM card gets blocked, contact your service provider for a PUK code. Using the PUK code, you can unblock the SIM card.

For the 4G LTE Advanced, the unit argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

**Procedure**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>cellular unit lte sim {lock</td>
<td>unlock} pin</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# cellular 0/1/0 lte sim lock 1111</td>
<td>• pin—A code (4 to 8 digits long) provided by your carrier to lock or unlock the SIM card.</td>
</tr>
</tbody>
</table>

Changing the PIN Code

Perform this task to change the PIN code of a SIM.

For the 4G LTE Advanced, the unit argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

**Procedure**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>cellular unit lte sim change-pin pin new-pin</td>
<td>Changes the assigned PIN code. SIM should be in locked state when the PIN is being changed.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# cellular 0/1/0 lte sim change-pin 1111 1234</td>
<td></td>
</tr>
</tbody>
</table>
Verifying the Security Information of a Modem

Perform this task to verify the security information of a modem.

Note

For the 4G LTE Advanced, the **unit** argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

<table>
<thead>
<tr>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command or Action</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
</tr>
<tr>
<td>Example:</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Configuring Automatic Authentication for a Locked SIM

An unencrypted PIN can be configured to activate the Card Holder Verification (CHV1) code that authenticates a modem.

The SIM card gets blocked if the wrong PIN is entered three consecutive times. Make sure you enter the correct PIN the SIM is configured with. If your SIM card gets blocked, contact your service provider for a PUK code.

Follow these procedures when using an unencrypted Level 0 PIN to configure CHV1. For instructions on how to configure CHV1 using an encrypted Level 7 PIN, see the Configuring an Encrypted PIN for a SIM, on page 116.

A SIM should be locked for SIM authentication to work. To verify the SIM’s status, use the **show cellular unit security** command.

For the 4G LTE Advanced, the **unit** argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

<table>
<thead>
<tr>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command or Action</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
</tr>
<tr>
<td>Example:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
</tr>
<tr>
<td>Example:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

### Configuring an Encrypted PIN for a SIM

To configure an encrypted PIN, the scrambled value of the PIN must be obtained. To get the scrambled Level 7 PIN and to configure the SIM CHV1 code for verification using this encrypted PIN, enter the following commands in the EXEC mode.

---

**Note** When obtaining the encrypted PIN for a SIM, a username and password are created by configuring password encryption, defining the username and associated password, copying the resulting scrambled password, and using this scrambled password in the SIM authentication command. After the scrambled PIN has been obtained and used in SIM authentication, the username created can be deleted from the Cisco IOS configuration.

---

**Note** A SIM should be locked for SIM authentication to work. To verify the SIM’s status, use the `show cellular <unit> security` command.

---

**Note** For the 4G LTE SKU, the *unit* argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

### SUMMARY STEPS

1. `configure terminal`
2. `service password-encryption`
3. `username name privilege 0 password pin`
4. `do show run | i name`
5. `controller cellular unit`
6. `lte sim authenticate {0 | 7} pin`
7. `exit`
8. `no username name`
9. `no service password-encryption`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1**

**configure terminal**

**Example:**

Router# configure terminal

| **Step 2**

**service password-encryption**

**Example:**

Router(config)# service password-encryption

| **Step 3**

**username** *name* **privilege** 0 **password** *pin*

**Example:**

Router(config)# username SIM privilege 0 password 1111

*name*—Specifies the username.

*pin*—Specifies the four- to eight-digit PIN code.

| **Step 4**

**do show run** | **i** *name*

**Example:**

Router(config)# do show run | i SIM

| **Step 5**

**controller cellular** *unit*

**Example:**

Router(config)# controller cellular 0/1/0

| **Step 6**

**Ite sim authenticate** \{0 | 7\} *pin*

| **Step 7**

**exit**

**Example:**

Router(config-controller)# exit

| **Step 8**

**no username** *name*

**Example:**

Router(config)# no username SIM

| **Step 9**

**no service password-encryption**

**Example:**

(Optional) Exitsthe cellular controller configuration mode.

(Optional) Removes the username and password created in Step 3.

(Optional) Disablesthe password encryption.
Applying a Modem Profile in a SIM Configuration

SUMMARY STEPS

1. configure terminal
2. controller cellular unit
3. lte sim data-profile number attach-profile number

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters the global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> controller cellular unit</td>
<td>Enters the cellular controller configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> lte sim data-profile number attach-profile number</td>
<td>Applies the configured profile number to the SIM and its slot number. The default (primary) slot is 0.</td>
</tr>
<tr>
<td></td>
<td>The attach profile is the profile used by the modem to attach to the LTE network.</td>
</tr>
<tr>
<td></td>
<td>The data profile is the profile used to send and receive data over the cellular network.</td>
</tr>
</tbody>
</table>

Data Call Setup

To set up a data call, use the following procedures:

Configuring the Cellular Interface

To configure the cellular interface, enter the following commands starting in EXEC mode.

For the 4G LTE Advanced, the unit argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

If a tunnel interface is configured with ip unnumbered cellular 0/1/0, it is necessary to configure the actual static IP address under the cellular interface, in place of ip address negotiated.

SUMMARY STEPS

1. configure terminal
2. interface cellular unit
### Detailed Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><code>interface cellular unit</code></td>
<td>Specifies the cellular interface.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config)# interface cellular 0/1/0</code></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td><code>ip address negotiated</code></td>
<td>Specifies that the IP address for a particular interface is dynamically obtained.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-if)# ip address negotiated</code></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td><code>dialer in-band</code></td>
<td>Enables DDR and configures the specified serial interface to use in-band dialing.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-if)# dialer in-band</code></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td><code>dialer watch-group group-number</code></td>
<td>Specifies the number of the dialer access group to which the specific interface belongs.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-if)# dialer watch-group 1</code></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td><code>exit</code></td>
<td>Enters the global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config-if)# exit</code></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>`ip route network-number network-mask {ip-address</td>
<td>interface} [administrative distance] [name name]`</td>
</tr>
<tr>
<td></td>
<td>Example: <code>Router(config)# ip route 209.165.200.225 255.255.255.224 cellular 0/1/0</code></td>
<td><strong>Note</strong> A higher administrative distance should be configured for the route through the backup interface so that it is used only when the primary interface is down.</td>
</tr>
</tbody>
</table>
Configure Cellular Interface with dialer watch-group

To configure the cellular interface with dialer watch-group, enter the following commands starting in EXEC mode.

**Note**
For the 4G LTE Advanced, the *unit* argument identifies the router slot, module slot, and port separated by slashes (0/1/0).

**SUMMARY STEPS**

1. configure terminal
2. interface cellular *unit*
3. ip address negotiated
4. dialer in-band
5. ip address negotiated
6. dialer idle-timeout *seconds*
7. dialer watch-group *group-number*
8. exit
9. dialer-list dialer-group protocol protocol-name {permit | deny | list access-list-number | access-group}
10. access-list access-list-number permit ip-source-address
11. dialer watch-list watch-group number ip ip mask
12. dialer watch-list watch-group number delay route-check initial *time in seconds*
13. dialer watch-list watch-group number delay connected *seconds*

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Specifies the cellular interface.</td>
</tr>
<tr>
<td>interface cellular <em>unit</em></td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# interface cellular 0/1/0</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>3</td>
<td>ip address negotiated</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# ip address negotiated</td>
</tr>
<tr>
<td>4</td>
<td>dialer in-band</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# dialer in-band</td>
</tr>
<tr>
<td>5</td>
<td>ip address negotiated</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# ip address negotiated</td>
</tr>
<tr>
<td>6</td>
<td>dialer idle-timeout seconds</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# dialer idle-timeout 30</td>
</tr>
<tr>
<td>7</td>
<td>dialer watch-group group-number</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# dialer watch-group 1</td>
</tr>
<tr>
<td>8</td>
<td>exit</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config-if)# exit</td>
</tr>
<tr>
<td>9</td>
<td>dialer-list dialer-group protocol protocol-name {permit</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config)# dialer-list 1 protocol ip list 1</td>
</tr>
<tr>
<td>10</td>
<td>access-list access-list-number permit ip-source-address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config)# access-list 1 permit any</td>
</tr>
<tr>
<td>11</td>
<td>dialer watch-list watch-group number ip ip mask</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Router(config)# dialer watch-list 1 ip 5.6.7.8 255.255.255.255</td>
</tr>
</tbody>
</table>
### Enabling 4G GPS and NMEA Data Streaming

GPS NMEA data streaming to external NMEA 2.0-compliant GPS plotter applications can be enabled on Cisco 4G LTE Advanced.

**Note**  
For a 4G LTE-Advanced, the `unit` argument identifies the router slot, module slot, and the port, and is separated by slashes (0/1/0).

### SUMMARY STEPS

1. configure terminal
2. controller cellular `unit`
3. lte gps enable
4. lte gps mode standalone
5. lte gps nmea {ip | udp [source address][destination address][destination port] }
6. end
7. test cellular `unit` modem-power-cycle
8. show cellular `unit` gps
9. show cellular `unit` gps detail

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>configure terminal</td>
<td>Enters the configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>controller cellular <code>unit</code></td>
<td>Enters the controller cellular configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td>Router(config)# controller cellular 0/1/0</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td><code>lte gps enable</code></td>
<td>(Optional) GPS is enabled by default. Use this command to enable the GPS feature if GPS has been disabled for any reason.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>Router(config-controller)# lte gps enable</code></td>
<td></td>
</tr>
</tbody>
</table>

| **Step 4**       | Enables the standalone GPS mode. |
| `lte gps mode standalone` | |
| **Example:**     |         |
| `Router(config-controller)# lte gps mode standalone` |         |

| **Step 5**       | Enables NMEA. Cisco 4G LTE Advanced support only IP NMEA. Therefore, the IP interface and serial interface options are unavailable. |
| `lte gps nmea {ip | udp [source address][destination address][destination port] }` | |
| **Example:**     |         |
| `Router(config-controller)# lte gps nmea ip` |         |
| or               |         |
| `Router(config-controller)# lte gps nmea` |         |

| **Step 6**       | Exits the controller configuration mode and returns to the privileged EXEC mode. |
| `end`            | |
| **Example:**     |         |
| `Router(config-controller)# end` |         |

| **Step 7**       | GPS can take effect only after modem power cycle. |
| `test cellular unit modem-power-cycle` | |
| **Example:**     |         |
| `Router# test cellular 0/1/0 modem-power-cycle` |         |

| **Step 8**       | Displays a summary of the following GPS data: |
| `show cellular unit gps` |         |
| **Example:**     |         |
| `Router# show cellular 0/1/0 gps` |         |
| GPS Feature = enabled | |
| GPS Mode Configured = standalone | |
| GPS Port Selected = Dedicated GPS port | |
| GPS Status = GPS coordinates acquired | |
| Last Location Fix Error = Offline [0x0] | |
| Latitude = 37 Deg 25 Min 4.8915 Sec North | |
| Longitude = 121 Deg 55 Min 8.5627 Sec West | |
| Timestamp (GMT) = Wed Nov 7 21:54:18 2018 | |
| Fix type index = 0, Height = 8 m | |
| Satellite Info | |
| ---------------- | |
| Satellite #1, elevation 45, azimuth 303, SNR 20 * | |
| Satellite #3, elevation 15, azimuth 296, SNR 21 | |
| Satellite #8, elevation 9, azimuth 227, SNR 27 * | |
| Satellite #11, elevation 41, azimuth 270, SNR 27 * | |
| Satellite #18, elevation 64, azimuth 258, SNR 29 * | |
| Satellite #22, elevation 35, azimuth 303, SNR 22 * | |
| Satellite #31, elevation 51, azimuth 140, SNR 24 * | |
| Satellite #32, elevation 46, azimuth 43, SNR 22 * | |
### Configuring 4G SMS Messaging

**Note**

For an 4G LTE Advanced, the `unit` argument identifies the router slot, module slot, and the port, and is separated by slashes (0/1/0).

### SUMMARY STEPS

1. `configure terminal`
2. `controller cellular unit`
3. `lte sms archive path FTP-URL`
4. `cellular unit lte sms view { all | ID | summary }
5. `end`
6. `show cellular unit sms`
7. `cellular unit lte sms send number`
8. `cellular unit lte sms delete [ all | id ]`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters the configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> controller cellular unit</td>
<td>Enters the controller cellular configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# controller cellular 0/1/0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong> lte sms archive path FTP-URL</td>
<td>Specifies an FTP server folder path to send all the incoming and outgoing SMS messages. After the folder path is identified, it is appended automatically with outbox and inbox folders for the path to which SMS messages are sent and received, for example:</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-controller)# lte sms archive path</td>
<td></td>
</tr>
<tr>
<td>ftp://username:password@172.25.211.175/SMS-LTE</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> cellular unit lte sms view { all</td>
<td>ID</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# cellular 0/1/0 lte sms view summary</td>
<td></td>
</tr>
<tr>
<td>ID FROM YY/MM/DD HR:MN:SC SIZE CONTENT</td>
<td></td>
</tr>
<tr>
<td>0 4442235525 12/05/29 10:50:13 137 Your entry last</td>
<td></td>
</tr>
<tr>
<td>month has...</td>
<td></td>
</tr>
<tr>
<td>2 5553337777 13/08/01 10:24:56 5 First</td>
<td></td>
</tr>
<tr>
<td>3 5553337777 13/08/01 10:25:02 6 Second</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> end</td>
<td>Exits the configuration mode and returns to the privileged EXEC mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# end</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> show cellular unit sms</td>
<td>Displays all the information in the text messages sent and received. Message information includes text messages sent successfully, received, archived, and messages pending to be sent. LTE-specific information on errors in case of a FAILED attempt may also be displayed.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router#show cellular 0/1/0 sms</td>
<td></td>
</tr>
<tr>
<td>Incoming Message Information</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>SMS stored in modem - 20</td>
<td></td>
</tr>
<tr>
<td>SMS archived since booting up - 0</td>
<td></td>
</tr>
<tr>
<td>Total SMS deleted since booting up - 0</td>
<td></td>
</tr>
<tr>
<td>Storage records allocated - 25</td>
<td></td>
</tr>
<tr>
<td>Storage records used - 20</td>
<td></td>
</tr>
<tr>
<td>Number of callbacks triggered by SMS - 0</td>
<td></td>
</tr>
<tr>
<td>Number of successful archive since booting up - 0</td>
<td></td>
</tr>
<tr>
<td>Number of failed archive since booting up - 0</td>
<td></td>
</tr>
<tr>
<td>Outgoing Message Information</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Total SMS send successfully - 0</td>
<td></td>
</tr>
<tr>
<td>Total SMS send failure - 0</td>
<td></td>
</tr>
</tbody>
</table>
Configuring Modem DM Log Collection

Diagnostic Monitor (DM) Log is a modem's feature that captures data transactions between the modem and the network over the radio frequency interface. This feature is a useful tool for troubleshooting 3G and 4G data connectivity or performance issues.

Once a DM log file is captured, diagnostic software tools, such as Sierra Wireless SwiLog and Qualcomm QXDM, can be used to decode the DM log file to understand the issues. A member of Cisco TAC can help with decoding the DM log files.

To configure DM log collection, enter the following commands, starting in privileged EXEC mode.

Procedure

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enters global configuration mode.</td>
<td></td>
</tr>
<tr>
<td>Step 1 configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td>Step 2 controller cellular slot</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# controller cellular slot</td>
<td></td>
</tr>
</tbody>
</table>

Note

- 10-digit or 11-digit (phone) numbers are the proper numerical format for sending a text. For example, #123456789 or 1#123456789. Seven digits are not supported.

Example:

Step 7

`cellular unit lte sms send number`

Example:

Router# cellular 0/1/0 lte sms send 15554443333 <sms text>

(Optional) Deletes one message ID or all of the stored messages from memory.

Example:

Step 8

`cellular unit lte sms delete [ all | id ]`

Example:

Router# cellular 0/1/0 lte sms delete [ all | id ]
### Purpose
Command or Action

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router(config)# controller cellular 0/1/0</td>
<td>Configures DM logging for LTE modem.</td>
</tr>
</tbody>
</table>

#### Step 3

**lte modem dm-log**

- **autostop**—Automatically stops DM log capturing based on:
  - **link-down**—cellular interface link down event
  - **timer**—amount of time in minutes
- **enable**—Starts DM log capturing.
- **filesize**—Specifies the maximum log file size, in MB for each DM log file before creating another DM log file. Range is from 1 to 64. Default is 20.
- **filter**—Specifies the DM log filter to use from the following locations:
  - **bootflash:**
  - **flash:**
  - **Note** Bootflash and flash are the only valid locationst to store the DM log filter file.
  - **Note** If the DM log filter file is not specified, the generic filter file, which comes with the router will be used.
  - **Note** The DM log filter file needs to be in .sqf format.
- **rotation**—Enables continuous DM log capturing by replacing the oldest DM log files with the latest.
- **size**—Specifies the maximum total size in MB of all DM log files that can be allowed in the bootflash or flash before modem stops capturing DM log files. If rotation is enabled, the oldest DM files is replaced with the latest DM file to meet this size configuration.

**Example:**

Router(config-controller)# lte modem dm-log enable

**Example:**

Router(config-controller)# lte modem dm-log

### Step 4

**end**

**Example:**

Router(config-controller)# end

### Step 5

**show cellular**

**Example:**

Router# show cellular 0/1/0 logs dm-log
Integrated DM logging is on

**Example:**

(Optional) Displays DM log configuration and statistics.
<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>output path = Utility Flash</td>
<td></td>
</tr>
<tr>
<td>filter = MC74xx generic - v11026_Generic_GSM_WCDMA_LTE_IP-no-data-packets.sqf</td>
<td></td>
</tr>
<tr>
<td>maximum log size = 0</td>
<td></td>
</tr>
<tr>
<td>maximum file size = 0</td>
<td></td>
</tr>
<tr>
<td>log rotation = disabled</td>
<td></td>
</tr>
<tr>
<td>33 packets sent to the modem, 4663 bytes, 0 errors</td>
<td></td>
</tr>
<tr>
<td>28521 packets received from the modem, 13500758 bytes, 0 input drops</td>
<td></td>
</tr>
<tr>
<td>28521 packets stored in utility flash, 13500758 bytes</td>
<td></td>
</tr>
<tr>
<td>current file size = 13500758</td>
<td></td>
</tr>
<tr>
<td>current log size = 13500758</td>
<td></td>
</tr>
<tr>
<td>total log size = 13500758</td>
<td></td>
</tr>
<tr>
<td>Utility Flash DM log files = (1) files</td>
<td></td>
</tr>
</tbody>
</table>

**Example**

The following example shows how to:

- Specifies the maximum size of all DM log files that can be stored in bootflash or flash to 512 MB
- Specifies the maximum size of each DM log file to 32 MB
- Uses MC7xxx_GPS_Log.sqf DM log filter in the flash
- Enable rotation
- Enables DM log capturing

```
Router(config-controller)# controller cell 0/1/0
Router(config-controller)# lte modem dm-log filesize 512
```

The following example shows how to specify the filter file for LTE:

```
Router(config-controller)# controller cell 0/1/0
Router(config-controller)# lte modem dm-log logfile flash:MC7xxx_GPS_Log.sqf
```

The following example shows how to enable DM log rotation for LTE:

```
Router(config-controller)# controller cell 0/1/0
Router(config-controller)# lte modem dm-log rotation
```

The following example shows how to specify the maximum log size for LTE:

```
Router(config-controller)# controller cell 0/1/0
Router(config-controller)# lte modem dm-log enable
```

The following example shows how to enable DM log rotation for LTE:

```
Router(config-controller)# controller cell 0/1/0
Router(config-controller)# end
```

The following example shows how to specify the maximum log size for LTE:

```
Router(config-controller)# controller cell 0/1/0
Router(config-controller)# lte modem dm-log size 1024
```

The following example shows what was configured on the router for DM log feature:
Router#show running-config | section controller
controller Cellular 0/1/0
lte modem dm-log filter flash:MC7xxx_GPS_Log.sqf
lte modem dm-log size 512
lte modem dm-log filesize 32
lte modem dm-log rotation
lte modem dm-log enable
lte modem dm-log size 1024

The following displays DM log configuration and statistics

Router#show cellular 0/1/0 logs dm-log
Integrated DM logging is on
output path = Utility Flash
filter = flash:MC7xxx_GPS_Log.sqf
maximum log size = 536870912
maximum file size = 33554432
log rotation = enabled
32 packets sent to the modem, 3879 bytes, 0 errors
158324 packets received from the modem, 75971279 bytes, 0 input drops
158324 packets stored in utility flash, 75971279 bytes

current file size = 8863042
current log size = 75971279
total log size = 75971279
Utility Flash DM log files = (3) files
end

The following shows the DM log files created:

Router#dir flash:dmlog*
Directory of bootflash:/dmlog*

Directory of bootflash:/

27 -rw- 33554069 Jun 7 2018 18:08:46 -08:00 dmlog-slot2-20180607-180628.bin
28 -rw- 33554168 Jun 7 2018 18:11:25 -08:00 dmlog-slot2-20180607-180846.bin
29 -rw- 14188544 Jun 7 2018 18:12:37 -08:00 dmlog-slot2-20180607-181125.bin

2885718016 bytes total (521891840 bytes free)

lte modem dm-log size 1024

The following shows hot to disable/stop DM log capturing:

Router(config)#controller cellular 0/1/0
Router(config-controller)#no lte modem dm-log enable
Router(config-controller)#end

### Enabling Modem Crashdump Collection

Modem crashdump collection is useful in debugging firmware crash. To collect crash data, the modem has to be pre-configured so that it will stay in memdump mode after a crash. Memdump mode is a special boot-and-hold mode for the memdump utility to collect crash data.

To enable modem crashdump collection, perform the following steps.

---

**Note**

The integrated modem crashdump collection feature is supported only on 3G HSPA and 4G LTE Advanced based SKUs.
### Before you begin

The device will need to be in boot-and-hold mode.

Router# conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# controller cel 0/1/0
Router(config-controller)# lte modem crash-action?
boot-and-hold Remain in crash state

Router(config-controller)# lte modem crash-action boot-and-hold

This ensures that whenever the router crashes, it will stay in that state and will not try to recover. By default the crash-action is reset which means the modem will reset and try to recover itself whenever it crashes. The above boot-and-hold command is used to keep the modem in a crashed state so that you can capture crashdump using the following command:

Router# test cell-cwan 0/1/0 modem-crashdump?
off Disable Modem firmware crash dump
on Enable Modem firmware crash dump

Router# test cell-cwan 0/1/0 modem-crashdump on

This will capture the crashdump and store it in flash.

### Procedure

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enables or disables modem crashdump collection.</td>
</tr>
<tr>
<td>test { cell-cwan } unit modem-crashdump { on location</td>
<td>off }</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Enables crashdump log collection.</td>
</tr>
<tr>
<td>Router# test cell-host 0/1/0 modem-crashdump on local_uf</td>
<td>• cell-host</td>
</tr>
<tr>
<td></td>
<td>— Keyword for fixed platform.</td>
</tr>
<tr>
<td></td>
<td>• cell-cwan</td>
</tr>
<tr>
<td></td>
<td>— Keyword for LTE on a modular inside platform.</td>
</tr>
<tr>
<td></td>
<td>• unit</td>
</tr>
<tr>
<td></td>
<td>— For LTE module, this is the router slot, module slot, and port separated by slashes (for example, 0/1/0). For fixed platform, this is the number 0.</td>
</tr>
<tr>
<td></td>
<td>• on</td>
</tr>
<tr>
<td></td>
<td>Enables crashdump log collection.</td>
</tr>
<tr>
<td></td>
<td>• location</td>
</tr>
<tr>
<td></td>
<td>— Specifies the destination URL where the modem crashdump logs will be stored.</td>
</tr>
<tr>
<td></td>
<td>• off</td>
</tr>
<tr>
<td></td>
<td>— Disables crashdump log collection.</td>
</tr>
</tbody>
</table>
Displaying Modem Log Error and Dump Information

As part of the 3G serviceability enhancement, commands strings (at!err and at!gcdump) can be sent to the modem using Cisco IOS CLI rather than setting up a reverse telnet session to the cellular modem to obtain log error and dump information.

To obtain log error and dump information, perform the following steps.

**Note**

The modem log error and dump collection feature is supported only on 3G SKUs.

**Procedure**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> show cellular unit log error</td>
<td>Shows modem log error and dump information.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# show cellular 0/1/0 log error</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> test cellular unit modem-error-clear</td>
<td>(Optional) Clears out the error and dump registers. By default, error and dump registers are not cleared out after a read. This command changes the operation so that registers are cleared once they are read. As a result, the AT command strings are changed to “at!errclr=–1” for CDMA and “at!err=0” for GSM modems.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# test cellular 0/1/0 modem-error-clear</td>
<td></td>
</tr>
</tbody>
</table>

Verifying the 4G LTE Advanced Router Information

You can verify the configuration by using the following show commands:

**show version**

Router#show version
Cisco IOS XE Software, Version BLD_V1612_THROTTLE_LATEST_20190604_050228_V16_12_0_134
Cisco IOS Software [Gibraltar], ISR Software (ARMV8EL_LINUX_IOSD-UNIVERSALK9-M), Experimental
Version 16.12.20190604:055159
[v1612_throttle-/nobackup/mcpre/BLD-BLD_V1612_THROTTLE_LATEST_20190604_050228 226]
Copyright (c) 1986-2019 by Cisco Systems, Inc.
Compiled Tue 04-Jun-19 16:24 by mcpre

Cisco IOS-XE software, Copyright (c) 2005-2019 by cisco Systems, Inc.
All rights reserved. Certain components of Cisco IOS-XE software are licensed under the GNU General Public License ("GPL") Version 2.0. The software code licensed under GPL Version 2.0 is free software that comes with ABSOLUTELY NO WARRANTY. You can redistribute and/or modify such GPL code under the terms of GPL Version 2.0. For more details, see the documentation or "License Notice" file accompanying the IOS-XE software, or the applicable URL provided on the flyer accompanying the IOS-XE software.

ROM: IOS-XE ROMMON
IR1101 uptime is 5 minutes
Uptime for this control processor is 6 minutes
System returned to ROM by Power-on at 17:11:39 GMT Tue Jun 25 2019
System image file is "usbflash0:ir1101-universal-k9.BLD_V1612_THROTTLE_LATEST_20190604_050228_V16_12_0_134.SSA.bin"
Last reload reason: Power-on

This product contains cryptographic features and is subject to United States and local country laws governing import, export, transfer and use. Delivery of Cisco cryptographic products does not imply third-party authority to import, export, distribute or use encryption. Importers, exporters, distributors and users are responsible for compliance with U.S. and local country laws. By using this product you agree to comply with applicable laws and regulations. If you are unable to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at: http://www.cisco.com/wl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to export@cisco.com.

Technology Package License Information:

<table>
<thead>
<tr>
<th>Technology-package</th>
<th>Current Type</th>
<th>Technology-package</th>
<th>Next reboot</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-essentials</td>
<td>Smart License</td>
<td>network-essentials</td>
<td></td>
</tr>
</tbody>
</table>

Smart Licensing Status: UNREGISTERED/EVAL EXPIRED

cisco IR1101-K9 (ARM64) processor (revision 1.2 GHz) with 708327K/6147K bytes of memory.
Processor board ID FCW222700KS
3 Virtual Ethernet interfaces
4 FastEthernet interfaces
2 Gigabit Ethernet interfaces
1 Serial interface
1 terminal line
4 Cellular interfaces
32768K bytes of non-volatile configuration memory.
4038072K bytes of physical memory.

--More--
2766848K bytes of Bootflash at bootflash:
15350496K bytes of USB Flash at usbflash0:
0K bytes of WebUI ODM Files at webui:

Configuration register is 0x1820

show platform

router# sh platform
Chassis type: IR1101-K9

<table>
<thead>
<tr>
<th>Slot</th>
<th>Type</th>
<th>State</th>
<th>Insert time (ago)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>IR1101-K9</td>
<td>ok</td>
<td>1w1d</td>
</tr>
<tr>
<td>0/0</td>
<td>IR1101-ES-5</td>
<td>ok</td>
<td>1w1d</td>
</tr>
<tr>
<td>0/1</td>
<td>P-LTE-GB</td>
<td>ok</td>
<td>1w1d</td>
</tr>
</tbody>
</table>
show interfaces

router#sh interface cellular 0/1/0
Cellular0/1/0 is up, line protocol is up
    Hardware is LTE Adv CAT6 - Europe/North America Multimode LTE/DC-HSPA+/HSPA+/HSPA/UMTS/
    Internet address is 10.14.162.11/32
    MTU 1500 bytes, BW 50000 Kbit/sec, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
    Encapsulation HDLC, loopback not set
    Keepalive not supported
    DTR is pulsed for 1 seconds on reset
    Last input never, output 00:00:42, output hang never
    Last clearing of "show interface" counters never
    Queuing strategy: fifo
    Output queue: 0/40 (size/max)
    5 minute input rate 0 bits/sec, 0 packets/sec
    5 minute output rate 0 bits/sec, 0 packets/sec
    5 packets input, 460 bytes, 0 no buffer
    Received 0 broadcasts (0 IP multicasts)
    0 runs, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    21 packets output, 1692 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 unknown protocol drops
    0 output buffer failures, 0 output buffers swapped out
    0 carrier transitions

show inventory

router# show inventory
+--------------------------------------------------------------------------------------------------------------------------------+
INFO: Please use "show license UDI" to get serial number for licensing.
+--------------------------------------------------------------------------------------------------------------------------------+
NAME: "Chassis", DESCR: "IR1101 Base Chassis"
PID: IR1101-K9 , VID: V00 , SN: FCW222700KS

NAME: "Module 0 - Mother Board", DESCR: "Cisco IR1101 motherboard"
PID: IR1101-K9 , VID: V00 , SN: FOC22224U22

NAME: "module subslot 0/0", DESCR: "IR1101-ES-6S"
PID: IR1101-ES-6S , VID: V01 , SN:

NAME: "subslot 0/0 transceiver 5", DESCR: "100BASE FX-GE"
PID: GLC-FE-100FX-RGD , VID: V02 , SN: FMS153304G4

NAME: "module subslot 0/1", DESCR: "P-LTEA-LA Module"
PID: P-LTEA-LA , VID: V01 , SN: FOC22287JNR

NAME: "Modem on Cellular0/1/0", DESCR: "Sierra Wireless EM7430"
PID: EM7430 , VID: 1.0 , SN: 355813070162356

NAME: "module subslot 0/3", DESCR: "P-LTEA-EA Module"
PID: P-LTEA-EA , VID: V01 , SN: FOC22170JA9

NAME: "Modem on Cellular0/3/0", DESCR: "Sierra Wireless EM7455"
Configuring Cellular Modem Link Recovery

The cellular modem link recovery feature is disabled by default and it is recommended to enable the link recovery feature.

---

Note

No manual operations or automated scripts interacting with 4G modems may be possible until and unless the modems have come fully in-service. Modems may take approximately 4 minutes after platform bootup and CLI available to be able to allow full interaction and establish IP connectivity. A typical modem power-cycle may also take approximately 4 minutes before any interaction is possible. Modems are in-service after the console displays “%CELLWAN-2-MODEM_RADIO: Cellular0/x/0 Modem radio has been turned on” – where x is the modem slot number.

To enable or disable the cellular modem link recovery feature, if required, perform the following steps:

---

**SUMMARY STEPS**

1. configure terminal
2. controller cellular unit
3. {lte} modem link-recovery disable | no lte | modem link-recovery disable
4. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>configure terminal</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Enters cellular controller configuration mode.</td>
</tr>
<tr>
<td>controller cellular unit</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config)# controller cellular 0/1/0</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Enables or disables the cellular modem link recovery feature.</td>
</tr>
<tr>
<td>{lte} modem link-recovery disable</td>
<td></td>
</tr>
<tr>
<td>no lte</td>
<td>modem link-recovery disable</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router(config-controller)# lte modem link-recovery disable</td>
<td></td>
</tr>
</tbody>
</table>
There are four configurable parameters to adjust the behavior of cellular link recovery. The default values optimized for the best performance of the feature and changing it is not recommended unless advised by Cisco.

The following table explains the link recovery parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rssi onset-threshold</td>
<td>This parameter defines the RSSI value below which the link recovery feature triggers additional scrutiny to look for potential issues and take action if needed. The range of this parameter can be set from -90 dBm to -125 dBm. The recommended and default value is -110 dBm.</td>
</tr>
</tbody>
</table>
### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>monitor-timer</td>
<td>This parameter determines how often link recovery looks for potential issues. The default value for this parameter is 20 seconds meaning that link recovery feature will be triggered every 20 seconds and look at certain parameters to determine if there is a potential issue. You can configure the monitor-timer range between 20 to 60 seconds. Increasing the monitor timer value above 20 seconds will increase the response time of the feature.</td>
</tr>
<tr>
<td>wait-timer and debounce-count</td>
<td>The wait-timer parameter is used in conjunction with the debounce-count parameter to perform more frequent, additional checks, once the link recovery feature has identified a potential issue that needs to be recovered from, with a modem power-cycle. The default value for wait-timer is 10 seconds and the default value for debounce-count is 6. With this setting, once link recovery has identified an inoperative modem state, it performs additional checks every 10 seconds, up to 6 times, to determine if the issue has been resolved without a modem power-cycle. Reducing the debounce-count and the wait-timer makes faster link recovery, while reducing them may increase the time for recovery. The configurable range for wait-timer is 5-60 seconds. The configurable range for debounce-count is 6-20 seconds.</td>
</tr>
</tbody>
</table>

### Verifying the Cellular Modem Link Recovery Configuration

To determine if the cellular modem link recovery is enabled, use the `show controller cellularunit` command. In this example, the cellular modem link recovery feature related information is highlighted.

Router# show controller cellular 0/1/0 Interface Cellular0/1/0
LTE Module = Multimode LTE/DC-HSPA+/HSPA+/HSPA/UMTS/EDGE/GPRS unit 2

Cellular Modem Configuration
---------------------------------------------
Modem is recognized as valid
Power save mode is OFF
manufacture id = 0x00001199 product id = 0x000068C0
Sierra Wireless unknown modem
Modem Uplink Speed = 50000 kbit.
Modem Downlink Speed = 300000 kbit.

GPS Feature = enabled
GPS Status = NMEA Disabled
GPS Mode = not configured

Cellular Dual SIM details:
---------------------------------------------
SIM 0 is present
SIM 1 is not present
SIM 0 is active SIM
Module Reload Statistics
----------------------------------
Soft OIR reloads = 0
Hard OIR reloads = 0
----------------------------------

Modem Management Statistics
----------------------------------
Modem resets = 1
Modem timeouts = 0
Link recovery is ON

Registration check is ON
RSSI threshold value is -110 dBm
Monitor Timer value is 20 seconds
Wait Timer value is 10 seconds
Debounce Count value is 6

Link recovery count is 0

When the cellular modem link recovery occurs and modem is power cycled, you can see the %CELLWAN-2-MODEM_DOWN message on the console logs and additionally there is a %CELLWAN-2-LINK_RECOVERY message which indicates that action has been taken by the cellular modem link recovery feature.

Whenever the cellular modem link recovery has occurred, it updates the Modem timeouts counter under the Modem Management Statistics section of the show controller cellular unit command output. Modem parameters at the last timeout section has information that helps to identify the cause of the issue that triggered link recovery.

In the following example log, the messages, modem time out counter, and modem parameters at the last time out are highlighted.

*Jul 19 17:15:18.980 PDT: %CELLWAN-2-LINK_RECOVERY: Cellular0/1/0: Cellular Modem has been power cycled

Device#show controller Cellular 0/1/0
Interface Cellular0/1/0
LTE Module - Multimode LTE/DC-HSPA+/HSPA+/HSPA/UMTS/EDGE/GPRS unit 2

Cellular Modem Configuration
----------------------------------
Modem is recognized as valid
Power save mode is OFF
manufacture id = 0x00001199 product id = 0x000068C0
Sierra Wireless unknown modem
Modem Uplink Speed = 50000 kbit.
Modem Downlink Speed = 300000 kbit.

GPS Feature = enabled
GPS Status = NMEA Disabled
GPS Mode = not configured

Cellular Dual SIM details:
----------------------------------
SIM 0 is present
SIM 1 is not present
SIM 0 is active SIM

Module Reload Statistics
----------------------------------
Soft OIR reloads = 0
Hard OIR reloads = 0
Configuration Examples for 3G and 4G Serviceability Enhancement

Example: Sample Output for the show cellular logs dm-log Command

The following shows a sample output of the show cellular logs dm-log command:

```
Router# show cellular 0/1/0 logs dm-log
Integrated DM logging is on
filter = generic
maximum log size = 67108864
maximum file size = 20971520
log rotation = disabled
7 packets sent to the modem, 3232 bytes, 0 errors
75 packets received from the modem, 57123 bytes, 0 input drops
75 packets stored in file system, 57123 bytes, 0 errors, 0 aborts
2 max rcv queue size
current file size = 57123
current log size = 57123
total log size = 57123
DM log files: (1 files)
```

Example: Sample Output for the show cellular logs modem-crashdump Command

The following shows a sample output of the show cellular logs modem-crashdump command:

```
Router# show cellular 0/1/0 logs modem-crashdump
Modem crashdump logging: off
Progress = 100%
Last known State = Getting memory chunks
Total consecutive NAKs = 0
Number of retries = 0
Memory Region Info:
1: Full SDRAM [Base:0x0, Length:0x2000000]
2: MDSP RAM A region [Base:0x91000000, Length:0x8000]
3: MDSP RAM B region [Base:0x91200000, Length:0x8000]
4: MDSP RAM C region [Base:0x91400000, Length:0x8000]
```
Configuration Examples for 4G LTE Advanced

Configuration examples follow based upon the following hardware shown in the two examples.

Router# show inventory

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++ INFO: Please use "show license UDI" to get serial number for licensing. +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

NAME: "Chassis", DESC: "IR1101 Base Chassis"
PID: IR1101-K9, VID: V00, SN: FCW222700KS

NAME: "Module 0 - Mother Board", DESC: "Cisco IR1101 motherboard"
PID: IR1101-K9, VID: V00, SN: FOC22224U22

NAME: "module subslot 0/0", DESC: "IR1101-ES-6s"
PID: IR1101-ES-6S, VID: V01, SN:

NAME: "subslot 0/0 transceiver 5", DESC: "100BASE FX-GE"
PID: GLC-FE-100FX-RGD, VID: V02, SN: FNS153304G4

NAME: "module subslot 0/1", DESC: "P-LTEA-LA Module"
PID: P-LTEA-LA, VID: V01, SN: FOC22287JNR

NAME: "Modem on Cellular0/1/0", DESC: "Sierra Wireless EM7430"
PID: EM7430, VID: 1.0, SN: 355813070162356

NAME: "module subslot 0/3", DESC: "P-LTEA-EA Module"
PID: P-LTEA-EA, VID: V01, SN: FOC22170JA9

NAME: "Modem on Cellular0/3/0", DESC: "Sierra Wireless EM7455"
PID: EM7455, VID: 1.0, SN: 356129070235970

NAME: "Module 2 - Expansion Module", DESC: "IR1100 expansion module with Pluggable slot and SFP"
PID: IRM-1100-SP, VID: V00, SN: FCW23050014

NAME: "Module 3 - FP F0", DESC: "Cisco IR1101 Forwarding Processor"
PID: IR1101-K9, VID: V00, SN: FOC22224U22

Router# show ip interface brief

Interface IP-Address OK? Method Status Protocol
GigabitEthernet0/0/0 unassigned YES NVRAM administratively down down
FastEthernet0/0/1 unassigned YES unset down down
FastEthernet0/0/2 unassigned YES unset down down
FastEthernet0/0/3 unassigned YES unset down down
GigabitEthernet0/0/5 unassigned YES unet up up
Cellular0/1/0 192.1.1.21 YES IPCP up up
Cellular0/1/1 unassigned YES NVRAM administratively down down
Cellular0/3/0 100.86.69.19 YES IPCP up up
Cellular0/3/1 unassigned YES unset administratively down down
Async0/2/0 unassigned YES unet up up
Example: Basic Cellular Interface Configuration: Cisco 4G LTE Advanced

The following example shows a dual LTE scenario configuration showing working cellular configuration for both 0/1/0 and 0/3/0 with appropriate routes and dialer watch-group.

```
show run
Building configuration...

Current configuration : 8079 bytes
!
! Last configuration change at 17:33:19 GMT Tue Jun 25 2019
!
version 16.12
service timestamps debug datetime msec localtime show-timezone
service timestamps log datetime msec localtime show-timezone
service internal
service call-home
platform qfp utilization monitor load 80
no platform punt-keepalive disable-kernel-core
!
hostname IR1101
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
!
clock timezone GMT 0 0
call-home
! If contact email address in call-home is configured as sch-smart-licensing@cisco.com
! the email address configured in Cisco Smart License Portal will be used as contact email
! address to send SCH notifications.
contact-email-addr sch-smart-licensing@cisco.com
profile "CiscoTAC-1"
active
destination transport-method http
no destination transport-method email
!
ip name-server 171.70.168.183 198.224.173.135 8.8.8.8
no ip domain lookup
ip domain name cisco.com
!
login on-success log
ipv6 unicast-routing
!
chat-script lte "" "AT!CALL" TIMEOUT 20 "OK"
chat-script hspa-R7 "" "AT!SCACT=1,1" TIMEOUT 60 "OK"
!
crypto pki trustpoint SLA-TrustPoint
   enrollment pkcs12
   revocation-check crl
!
crypto pki trustpoint TP-self-signed-756885843
   enrollment selfsigned
   subject-name cn=IOS-Self-Signed-Certificate-756885843
   revocation-check none
   rsakeypair TP-self-signed-756885843
```
Cisco 4G LTE-Advanced Configuration
Example: Basic Cellular Interface Configuration: Cisco 4G LTE Advanced

!
!
crypto pki certificate chain SLA-TrustPoint
certificate ca 01
30820321 30820209 A0030201 02020101 300D0609 2A864886
32310E30 0C060355 040A1305 43697363 6F312030 1E060355
6F204C69 63656E73 696E6720 526F6F74 20434130 1E170D31
3834375A 170D3338 30353330 31393438 34375A30 32310E30
43697363 6F312030 1E060355 04031317 43697363 6F204C69
526F6F74 20434130 82012230 0D06092A 864886F7 0D010101
82010A02 82010100 A6BCBD96 131E05F7 145EA72C 2CD686E6
CBB4C798 212AA147 C655D8D7 9471380D 8711441E 1AAF071A
1C394D78 462EF239 C659F715 B98C0A59 5BBB5CBD 0CFEBEA3
4AA4E80D DB6FD1C9 60B1FD18 FFC69C96 6FA68957 A2617DE7
7390A3EB 2B5436AD C847A2C5 DAB553EB 69A9A535 58E9F3E3
68E69491 20F320E7 948E71D7 AE3BCC84 F10684C7 4BC8E00F
C7479096 B4CB2D62 EA2F505D C7B062A4 6811D95B E8250FC4
C55F0D76 61F9A4CD 3D992327 A8BB03BD 4E6D7069 7CBADF8B
DFC7C6CF 04DD7FD1 02030100 01A34230 40300E06 03551D0F
06300F06 03551D13 0101FF04 05300301 01FF301D 0603551D
4B3D31E5 1B3E6A17 606AF333 3D3B4C73 E8300D06 092A8648
03820101 00507F24 D3932A66 86025D9F E838AE5C 6D4DF6B0
604EDCDE FF4FED2B 77FC460E CD636FDB DD44681E 3A5673AB
D98987BF E40CBD9E 1AECA0C2 2189BB5C 8FA85686 CD98B646
467A3DF4 4D565700 6ADF0F0D CF835015 3C04FF7C 21E878AC
7CA7B7E6 C1AF74F6 152E99B7 B1FCF9BB E973DE7F 5BDDEB86
5FB0DA06 B92AFE7F 494E8A9E 07B85737 F3A58BE1 1A48A229
80DDCD16 D6BACECA EEBC7CF9 8428787B 35202CDC 60E4616A
418616A9 4093E049 4D10AB75 27E86F73 932E35B5 8862FDAE
D697DF7F 28
quit
crypto pki certificate chain TP-self-signed-756885843
certificate self-signed 01
3082032E 30820216 A0030201 02020101 300D0609 2A864886
30312E30 2C060355 04031325 494F532D 53656C66 2D536967
69666963 6174652D 37353638 38353834 33301E17 0D313930
385A170D 33303031 30313030 30303030 5A303031 2E302C06
532D5365 6C662D53 69676E65 642D4365 72746966 69636174
38343330 82012230 0D06092A 864886F7 0D010101 05000382
82010100 D2F61742 3B651909 95856431 9BC2CCB7 D4B04861
8BF2ABD9 5C3A597D 2EE0112C ECA615AA D0297F9E 071B6B5D
2352EEC9 EE70742E 46EFBAFC A03744D8 A22E4DA3 AAF919CC
C04DA5B9 028DD3EC 992493A6 EA864ED6 354CB3F4 094D3EBF
E458712D 841A43CD 709D4D9E 72A9DE3E F935A688 59B6F278
7B97582A 64E511A6 D81735FF 117CE399 4C2A2973 F5FD407D
882E0749 ACE5BD44 32634790 3607ADEA 9F319343 4CA76B0D
E38119E2 8B34F7AC 090C0450 03166B42 8C7C9EA7 5132687F
889F02BB 02030100 01A35330 51300F06 03551D13 0101FF04
0603551D 23041830 16801405 77954127 36509205 7025CF4E
1D060355 1D0E0416 04140577 95412736 50920570 25CF4E84
06092A86 4886F70D 01010505 00038201 01004147 49C6A0A9
22955E06 AF192FA6 868D5556 959ACF05 398F3907 DFE3148B
DC23E8D7 A47DB4AE D6CB6665 BCAE7F39 24D010F0 DB8F0E70
1346D540 47BB7E89 2BB1BE4D 16990318 A4612CC5 C7CC9376
4D950D99 3CC0C65B 0A98859A 3B81E324 BAB34EDF 64CA8C38
F71F8D5E D3B7A962 3D0FDE44 012AC034 D0E7F75A DB1BF12A
A588DCDA 8272CE33 36ABC57A BFF52980 5FFC7C34 4D4307BB
27C61E89 0EC1C6AA 6AB3F73B EF8450FD 782DFC63 038F6A27
C8064523 EBB93FF5 8B98B546 44F853E9 0E04
quit
!
license udi pid IR1101-K9 sn FCW222700KS
diagnostic bootup level minimal
!

F70D0101
04031317
33303533
0C060355
63656E73
05000382
17222EA1
9CAE6388
700A8BF7
104FDC5F
C0BD23CF
539BA42B
5D5D5FB8
DF5F4368
0101FF04
0E041604
86F70D01
49631C78
9093D3B1
5575B146
11BA9CD2
C71E3B49
C37C1E69
B623CDBD
0275156F

0B050030
43697363
30313934
040A1305
696E6720
010F0030
F1EFF64D
8A38E520
D8F256EE
EA2956AC
58BD7188
42C68BB7
8F27D191
95135E44
04030201
1449DC85
010B0500
240DA905
6C9E3D8B
8DFC66A8
55A9232C
1765308B
39F08678
230E3AFB
719BB2F0

F70D0101
6E65642D
35333130
03550403
652D3735
010F0030
DD6E0924
9B831332
0A7929A7
5307CAA3
65B59EE0
BCEB62A6
B1DE6A1C
E1F7BF6E
05300301
84B5D4A2
B5D4A2A3
56F5BD4D
0E2CFC12
5E7C3F73
7DF1A1F4
184DC796
CF23E2F5
AC0C0F18
456CA32B

05050030
43657274
30303530
1325494F
36383835
82010A02
4C3E6A51
021E61F4
3BDB3B17
192B5759
6B72469E
FD7C6B08
AD144548
B065CD4E
01FF301F
A3D53730
D537300D
4892AEE0
20BEEA05
25AB1783
C09C0051
47DDD9DD
6A4FDA14
AA783B9D
D3FEDB97

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spanning-tree extend system-id
memory free low-watermark processor 50357
file prompt quiet
username cisco privilege 15 password 0 cisco
username lab password 0 lab123
!
redundancy
!
controller Cellular 0/1/0
no lte firmware auto-sim
lte modem link-recovery disable
!
controller Cellular 0/3/0
!
vlan internal allocation policy ascending
!
interface GigabitEthernet0/0/0
no ip address
shutdown
!
interface FastEthernet0/0/1
switchport access vlan 192
switchport mode access
!
interface FastEthernet0/0/2
switchport access vlan 172
switchport mode access
!
interface FastEthernet0/0/3
switchport access vlan 172
!
interface FastEthernet0/0/4
switchport mode access
!
interface GigabitEthernet0/0/5
!
interface Cellular0/1/0
ip address negotiated
load-interval 30
dialer in-band
dialer idle-timeout 0
dialer watch-group 1
ipv6 enable
pulse-time 1
ip virtual-reassembly
!
interface Cellular0/1/1
no ip address
shutdown
!
interface Cellular0/3/0
ip address negotiated
dialer in-band
dialer idle-timeout 0
dialer watch-group 2
ipv6 enable
pulse-time 1
ip virtual-reassembly
!
interface Cellular0/3/1
no ip address
shutdown

interface Vlan1
  ip address 192.168.10.15 255.255.255.0
!
interface Vlan172
  ip address 172.27.167.121 255.255.255.128
!
interface Vlan175
  ip address 175.1.1.1 255.255.255.0
!
interface Async0/2/0
  no ip address
  encapsulation scada
!
ip default-gateway 172.27.167.1
ip forward-protocol nd
!
ip http server
ip http authentication local
ip http secure-server
ip route 0.0.0.0 0.0.0.0 172.27.167.1
ip route 0.0.0.0 0.0.0.0 Cellular0/1/0
ip route 0.0.0.0 0.0.0.0 Cellular0/3/0 253
ip route 8.8.4.0 255.255.255.0 Cellular0/3/0
ip route 171.70.0.0 255.255.0.0 172.27.167.1
ip route 192.1.1.0 255.255.255.0 Cellular0/1/0
ip route 192.168.193.0 255.255.255.0 192.168.10.1
!
ip access-list standard 1
  10 permit any
dialer watch-list 1 ip 5.6.7.8 255.255.255.255
dialer watch-list 1 delay route-check initial 60
dialer watch-list 1 delay connect 1
dialer watch-list 2 ip 5.6.7.8 255.255.255.255
dialer watch-list 2 delay route-check initial 60
dialer watch-list 2 delay connect 1
dialer-list 1 protocol ip permit
dialer-list 1 protocol ipv6 permit
ipv6 route ::/0 Cellular0/1/0
!
!
!
!
!
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Configuration Examples for Cisco 4G LTE Advanced

The following example shows how to configure Cisco 4G LTE Advanced:

```
!
! Last configuration change at 19:14:26 UTC Fri Oct 19 2018
!
version 16.10
service timestamps debug datetime msec
service timestamps log datetime msec
service internal
service call-home
platform qfp utilization monitor load 80
no platform punt-keepalive disable-kernel-core
no platform punt-keepalive settings
!
hostname IR1101
!
boot-start-marker
boot system flash ir1101-universalk9.16.10.SSA.bin
boot-end-marker
!
!
no aaa new-model
!
call-home
! If contact email address in call-home is configured as sch-smart-licensing@cisco.com
! the email address configured in Cisco Smart License Portal will be used as contact email
```
address to send SCH notifications.
contact-email-addr sch-smart-licensing@cisco.com
profile "CiscoTAC-1"
active
destination transport-method http
no destination transport-method email

ip admission watch-list expiry-time 0
!
login on-success log
!
crypto pki trustpoint TP-self-signed-2240381033
enrollment selfsigned
subject-name cn=IOS-Self-Signed-Certificate-2240381033
revocation-check none
rsakeypair TP-self-signed-2240381033

crypto pki trustpoint SLA-TrustPoint
enrollment pkcs12
revocation-check crl
!
quit

crypto pki certificate chain TP-self-signed-2240381033
certificate self-signed 01
30820330 30820218 A0030201 02020101 300D6009 2A864886 F70D0101 05050030
31312F20 D06D539 49F53S2D 5365C66 2D536967 6E65642D 43657274
696666963 6714652D 32323430 33383130 3333301E 170D3138 30737311 32323035
3531A17 03330330 30303030 053A3031 3232030 06050034 31326429
4F5352D3 5656C662 5369676E 65642D43 65726966 66696361 74652D32 32343033
38313303 33382021 22300D06 092A8648 86F70D01 01010500 0382010F 05302031
0A028201 01000C58 6E6D3D1D 23941CF C7FE4E28 C5BB3156 029E3121 371AB009
BE4BF667 47E4252B F5922BD4 8C4F7F2 390FEFBE 7C8C2034 63EA879E 691B796C
363032BB 206886D2 774D131C 970A1A3C 530A88BB 5ABBB05 5F59951E 613B6E4E
EC608F11 E92D43A8 3C306FBA 76CD2FF5 2BA3FE66 FD49C40F 29BB8755 ADBB989E
C91F97CE 8C6C287E CAA29350 35A520B9 7D0B436C 20480476 67160C6C 1F0D128B
902676E5 6398BC80 120F9F7 62995271 88D12026 178F9DBD FDC9F210 8379598F
109B52A7 5BC87C1C 5C706526 40441431 1CC66D9 6AF7CD5 D46040B5 502CBC62
8222C80A 52570945 CAFAA996 88782852 05F45E80 79F2E9D 4185DDA4 993E0CB5
D4770CB7 C6360203 01000043 53305130 6F003501 3D301001 FF004530 003011FF
301F6063 5D1D2304 18301680 142B79CA 98BEF61F 3EC23015 E30E120C 0C474C6C
E1301206 03551D0E 04160014 2878CAEB 89EF613E C2301583 E0FE120C D4746C61
300D0609 2A864886 F70D0101 05050003 82010100 9E1269A8 349CEF9D E2801B79
4F52F1ED 44F8E434 62EA6432 F0297977 F68885D0 9942E0F8 FFC2F3G3 A03FA7A0
EEF0521B BF9A7FEA 516D3827 7D85417E CBDE865F 9C7B3E76 542AB69 0465FD4F
3406A83F 6C609CFB 4D56C46B 9C9A95C0 5EA5E099 8921220 8B6412D0 972FBF9
2181B847 E1EA4D6 A52B216A D2AEE76 986C116 0932EFE4 9A86F62D F394C361
A70D4A98 94942B80 52CAD033 7636DCCA E6F687C2 28E1015B F3805D7A 898548E9
FA2F11E7 0E60853 E0CCDB86 B134A2CF 20046280 F9088830 516F6A1 719D19E9
110ACD3 8D772A6B 0BA4573F 76D3364A 594246E9 3EC2301A 2D344B52 9F7588E8
E050B27E 01BC2E1C 7375F6F3 5584E740 BE2A54DE
quit
crypto pki certificate chain SLA-TrustPoint
certificate ca 01
30820321 30820209 A0030201 02020101 300D6009 2A864886 F70D0101 0B050030
323103E0 C060355 040A1305 43697363 6F312030 1E060355 04031317 43697363
6F204C69 6365E7E7 696E6720 5266F74 20434130 1E170D31 3303533 3013934
3834375A 170D3338 3033330 31393438 34375A30 32310E30 0C060355 040A1305
43697363 6F312030 1E060355 04031317 43697363 6F204C69 6365E7E7 696E6720
5266F74 20434130 82012230 0D06092A 864886F7 0D010101 00000382 010F0030
82010A02 82010100 A8BC0B96 113E05F7 145EA72C 2CD68E6E 17222E5C 5EEFF64A
CBB4C79 212AA147 C655D8D7 9471380D 8711441E 1AAF071A 9CAE6388 8A38E520
license udi pid IR1101-K9 sn FCW2227XXXX
license boot level network-advantage
license smart transport callhome
diagnostic bootup level minimal
spanning-tree mode rapid-pvst
spanning-tree extend system-id
memory free low-watermark processor 50290
redundancy
controller Cellular 0/1/0
  lte sim data-profile 3 attach-profile 1 slot 0
  no lte firmware auto-sim
  lte gps mode standalone
  lte modem link-recovery disable
controller Cellular 0/3/0
  no lte firmware auto-sim
  lte gps mode standalone
  lte modem link-recovery disable

vlan internal allocation policy ascending

interface GigabitEthernet0/0/0
  ip address 175.1.1.1 255.255.255.0
interface FastEthernet0/0/1
  shutdown
interface FastEthernet0/0/2
  shutdown
interface FastEthernet0/0/3
  shutdown
interface FastEthernet0/0/4
  switchport access vlan 168
  switchport mode access
interface GigabitEthernet0/0/5
interface Cellular0/1/0
  ip address negotiated
  load-interval 30
dialer in-band
dialer idle-timeout 0
dialer watch-group 1
ipv6 enable
pulse-time 1
ip virtual-reassembly
!
interface Cellular0/1/1
no ip address
shutdown
!
interface Vlan1
no ip address
!
interface Vlan168
  ip address 192.168.10.22 255.255.255.0
!
interface Async0/2/0
no ip address
  encapsulation slip
!
  ip default-gateway 172.27.138.129
  ip forward-protocol nd
  !
ip http server
  ip http authentication local
  ip http secure-server
ip route 0.0.0.0 0.0.0.0 Cellular0/1/0
ip route 172.27.0.0 255.255.0.0 172.27.138.129
!
access-list 1 permit any
access-list 2 permit any
dialer watch-list 1 ip 5.6.7.8 255.255.255.255
dialer watch-list 1 delay route-check initial 60
dialer watch-list 1 delay connect 1
dialer-list 1 protocol ip permit
dialer-list 1 protocol ipv6 permit
dialer-list 2 protocol ip permit
dialer-list 2 protocol ipv6 permit
ipv6 route ::/0 Cellular0/1/0
!
control-plane
!
line con 0
  exec-timeout 0 0
  transport input none
  stopbits 1
  speed 115200
line 0/2/0
line vty 0 4
  password cisco
  login
  transport input all
  transport output all
!
end
Cellular Back-off

Cellular Backoff is a feature introduced in IOS which addresses the concerns about Cisco LTE router not performing backoff in error handling. When PDP Context activation is failing, modems may receive from a cellular service provider. As a result, when some specific error codes (for example: 29, 33) are received by the modem from a cellular network, the router’s IOS incrementally adds interval in sending PDP Context Activation requests and any IP traffic such as not to load service provider network with requests that are known to IOS as failing. Once PDP Context is established and IP traffic is successful, the Cellular Backoff is removed for normal operation.

This back-off implementation will be a generic design and will NOT be specific to a particular service provider. There will be NO IOS CLI command to disable this new feature either.

Example: GRE Tunnel over Cellular Interface Configuration

The following example shows how to configure the static IP address when a GRE tunnel interface is configured with `ip address unnumbered cellular interface`:

```
interface Tunnel2
 ip unnumbered <internal LAN interface GE0/0 etc.>
tunnel source Cellular0/1/0
tunnel destination a.b.c.d
interface Cellular0/1/0
 ip address negotiated
 no ip mroute-cache
dialer in-band
dialer-group 1
```

Note: The GRE tunnel configuration is supported only if the service providers provide a public IP address on the LTE interface.

Note: For service providers using a private IP address, the point-to-point static GRE tunnel cannot be set up with a private IP address at one end and a public IP address on the other end.

Example: 4G LTE Advanced as Backup with NAT and IPSec

The following example shows how to configure the 4G LTE Advanced on the router as backup with NAT and IPSec:

The receive and transmit speeds cannot be configured. The actual throughput depends on the cellular network service.

For service providers using a private IP address, use the `crypto ipsec transform-set esp` command (that is, `esp-aes esp-sha256-hmac...`).

```
ip dhcp excluded-address 10.4.0.254
 !
ip dhcp pool lan-pool
  network 10.4.0.0 255.255.0.0
dns-server 10.4.0.254
default-router 10.4.0.254
```

---

**Cisco IR1101 Integrated Services Router Software Configuration Guide**

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crypto isakmp policy 1
  encr 3des
  authentication pre-share
crypto isakmp key address a.b.c.d
!
!
crypto ipsec transform-set ah-sha-hmac esp-3des
!
crypto map gsm1 10 ipsec-isakmp
  set peer a.b.c.d
  set transform-set
  match address 103
!
interface Gi 0/0/0
  no ip address
  ip virtual-reassembly
  load-interval 30
  no atm ilmi-keepalive
  dsl operating-mode auto
!
backup interface Cellular0/1/0
  ip address negotiated
  ip mtu 1492
  ip nat outside
  ip virtual-reassembly
  encapsulation ppp
  load-interval 30
  dialer pool 2
  dialer-group 2
  ppp authentication chap callin
  ppp chap hostname cisco@dsl.com
  ppp chap password 0 cisco
  ppp ipcp dns request
  crypto map gsm1
  ip nat outside
  ip virtual-reassembly
  no snmp trap link-status
  pvc 0/35
    pppoe-client dial-pool-number 2
    !
!
interface Cellular0/1/0
  ip address negotiated
  ip nat outside
  ip virtual-reassembly
  no ip mroutecache
  dialer in-band
  dialer idle-timeout 0
  dialer watch-group 1
  crypto map gsm1
!
interface Vlan1
  description used as default gateway address for DHCP clients
  ip address 10.4.0.254 255.255.0.0
  ip nat inside
  ip virtual-reassembly
!
ip local policy route-map track-primary-if
ip route 0.0.0.0 0.0.0.0 Dialer2 track 234
ip route 0.0.0.0 0.0.0.0 Cellular0/3/0 254
!
ip nat inside source route-map nat2cell interface Cellular0/1/0 overload
ip nat inside source route-map nat2dsl overload
!
ip sla 1
  icmp-echo 2.2.2.2 source
timeout 1000
  frequency 2
ip sla schedule 1 life forever start-time now
access-list 1 permit any
access-list 101 deny ip 10.4.0.0 0.0.255.255 10.0.0.0 0.255.255.255
access-list 101 permit ip 10.4.0.0 0.0.255.255 any
access-list 102 permit icmp any host 2.2.2.2
access-list 103 permit ip 10.4.0.0 0.0.255.255 10.0.0.0 0.255.255.255
dialer-list 1 protocol ip list 1
dialer-list 2 protocol ip permit
!
route-map track-primary-if permit 10
  match ip address 102
!
route-map nat2dsl permit 10
  match ip address 101
!
route-map nat2cell permit 10
  match ip address 101
  match interface Cellular0/1/0
!
exec-timeout 0 0
login
modem InOut

Example: SIM Configuration

Locking the SIM Card

The following example shows how to lock the SIM. The italicized text in this configuration example is used to indicate comments and are not be seen when a normal console output is viewed.

Router# sh cellular 0/1/0 security
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3
Router# !! SIM is in unlocked state.
Router# cellular 0/1/0 lte sim lock 1111
!!!WARNING: SIM will be locked with pin=1111(4).
Do not enter new PIN to lock SIM. Enter PIN that the SIM is configured with.
Call will be disconnected!!!
Are you sure you want to proceed?[confirm]
Router#
Apr 26 19:35:28.339: %CELLWAN-2-MODEM_DOWN: Modem in NIM slot 0/2 is DOWN
Apr 26 19:35:59.967: %CELLWAN-2-MODEM_UP: Modem in NIM slot 0/2 is now UP
Router# sh cellular 0/1/0 security
Card Holder Verification (CHV1) = Enabled
SIM Status = Locked
SIM User Operation Required = Enter CHV1
Number of CHV1 Retries remaining = 3
Router# !! SIM is in locked state.
Unlocking the SIM Card

The following example shows how to unlock the SIM. The italicized text throughout this configuration example is used to indicate comments and will not be seen when a normal console output is viewed.

Router# `sh cellular 0/1/0 security`
Card Holder Verification (CHV1) = Enabled
SIM Status = Locked
SIM User Operation Required = Enter CHV1
Number of CHV1 Retries remaining = 3
Router# !! SIM is in locked state.!
Router# cellular 0/1/0 lte sim unlock 1111
!!!WARNING: SIM will be unlocked with pin=1111(4).
Do not enter new PIN to unlock SIM. Enter PIN that the SIM is configured with.
Call will be disconnected!!!
Are you sure you want to proceed?[confirm]
Router#
Router# `sh cellular 0/1/0 security`
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3
Router# !! SIM is in unlocked state.!

Automatic SIM Authentication

The following example shows how to configure automatic SIM authentication. The italicized text throughout this configuration example is used to indicate comments and will not be seen when a normal console output is viewed.

Router# `show cellular 0/1/0 security`
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3
Router# !! SIM is in unlocked state.!
Router# cellular 0/1/0 lte sim lock 1111
!!!WARNING: SIM will be locked with pin=1111(4).
Do not enter new PIN to lock SIM. Enter PIN that the SIM is configured with.
Call will be disconnected!!!
Are you sure you want to proceed?[confirm]
Router#
Router# `sh cellular 0/1/0 security`
Card Holder Verification (CHV1) = Enabled
SIM Status = Locked
SIM User Operation Required = Enter CHV1
Number of CHV1 Retries remaining = 3
Router# !! SIM is in locked state. SIM needs to be in locked state for SIM authentication to work.!
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# controller cellular 0/1/0
Router(config-controller)# lte sim authenticate 0 1111
CHV1 configured and sent to modem for verification
Router(config-controller)# end
Router#
Apr 26 21:23:50.571: %SYS-5-CONFIG_I: Configured from console by console
Router#
Router# `sh cellular 0/1/0 security`
Card Holder Verification (CHV1) = Enabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3

Router#!! SIM is now in locked state but it can be used for connectivity since authentication is good. Authentication can be saved in the router configuration so that when you boot up! the router with the same locked SIM, connection can be established with the correct!
Cisco IOS configuration.

Changing the PIN Code

The following example shows how to change the assigned PIN code. The italicized text throughout this configuration example is used to indicate comments and will not be seen when a normal console output is viewed.

Router# sh cellular 0/1/0 security
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3

Router#!! SIM is in unlocked state.!(Router#
Router# cellular 0/1/0 lte sim lock 1111
!!!WARNING: SIM will be locked with pin=1111(4).
Do not enter new PIN to lock SIM. Enter PIN that the SIM is configured with.
Call will be disconnected!!!
Are you sure you want to proceed?[confirm]
Router#

Apr 26 21:58:11.903: %CELLWAN-2-MODEM_DOWN: Modem in NIM slot 0/2 is DOWN
Apr 26 21:58:43.775: %CELLWAN-2-MODEM_UP: Modem in NIM slot 0/2 is now UP

Router# sh cellular 0/1/0 security
Card Holder Verification (CHV1) = Enabled
SIM Status = Locked
SIM User Operation Required = Enter CHV1
Number of CHV1 Retries remaining = 3

Router#!! SIM is in locked state. SIM needs to be in locked state to change its PIN.!(Router#
Router# cellular 0/1/0 lte sim change-pin 1111 0000
!!!WARNING: SIM PIN will be changed from:1111(4) to:0000(4)
Call will be disconnected. If old PIN is entered incorrectly in 3 attempt(s), SIM will be blocked!!!
Are you sure you want to proceed?[confirm]
Resetting modem, please wait...
CHV1 code change has been completed. Please enter the new PIN in controller configuration for verification
Router#

Apr 26 21:58:16.735: %CELLWAN-2-MODEM_DOWN: Modem in NIM slot 0/2 is DOWN
Apr 26 21:59:48.387: %CELLWAN-2-MODEM_UP: Modem in NIM slot 0/2 is now UP

Router#

Router# sh cellular 0/1/0 security
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3

Router#!! SIM stays in locked state, as expected, but with new PIN.!(Router# cellular 0/1/0
lte sim unlock 0000
!!!WARNING: SIM will be unlocked with pin=0000(4).
Do not enter new PIN to unlock SIM. Enter PIN that the SIM is configured with.
Call will be disconnected!!!
Are you sure you want to proceed?[confirm]
Router#

Router# show cellular 0/1/0 security
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3

Router#!! Unlock with new PIN is successful. Hence, changing PIN was successful.

Configuring an Encrypted PIN

The following example shows how to configure automatic SIM authentication using an encrypted PIN. The italicized text throughout this configuration example is used to indicate comments and will not be seen when a normal console output is viewed.

Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.

Router(config)# service password-encryption
Router(config)# username SIM privilege 0 password 1111
Router(config)# do sh run | i SIM
username SIM privilege 0 password 7 055A575E70.!! Copy the encrypted level 7 PIN. Use this scrambled PIN in the SIM authentication command.

Router(config)# controller cellular 0/1/0
Router(config-controller)# lte sim authenticate 7 055A575E70
CHV1 configured and sent to modem for verification
Router(config-controller)# exit
Router(config)# no username SIM
Router(config)# end
May 14 20:20:52.603: %SYS-5-CONFIG_I: Configured from console by console

Upgrading the Modem Firmware

The IR1101 uses Sierra Wireless modems that are supported on Cisco 4G LTE Advanced. The firmware for the modem is upgradeable using Cisco IOS commands. The firmware is typically a Crossword Express (cwe) file and can be downloaded from the wireless software download page on Cisco.com. For some modems, such as the EM74XX series, the file type is an *.spk file.

Prior to performing the cellular modem firmware upgrade, make sure of the following:

- The "microcode reload ..." command is issued only from router's base directory.
- The modem firmware directory must contain the following:
  - Only the *.spk file
  - Only the *.cwe file
  - Only the *.nvu file
  - Only a matching pair of *.cwe and *.nvu files for the exact same version
- The modem firmware directory MUST NOT contain any other files

Firmware upgrade is supported on utility flash.

Use only Cisco certified firmware. Using a firmware version not certified by Cisco may impact the wireless service provider network adversely.

Do not disconnect power or switch the router off during the firmware upgrade process. This may result in permanent modem failure.
Firmwaredowngradeisnotsupported.

Note
NotallIR1101cellularinterfacescansupport2G(onlyP-LTE-GB),andmaynotsupport3G(P-LTE-VZ).

Note

Youcandeterminewhichradiobandsaresupportedbyusingthethefollowingcommand:

```
IR1101#showcellu0/1/0radio band
```

LTE bands supported by modem:
- Bands 1 3 7 8 20 28.
LTE band Preference settings for the active sim(slot 0):
- Bands 1 3 7 8 20 28.

Non-LTE bands supported by modem:
Index:
72 - GSM DCS band (1800)
73 - GSM Extended GSM (E-GSM) band (900)
87 - WCDMA (Europe, Japan, and China) 2100 band
114 - WCDMA Europe and Japan 900 band

Non-LTE band Preference settings for the active sim(slot 0):
Index:
72 - GSM DCS band (1800)
73 - GSM Extended GSM (E-GSM) band (900)
87 - WCDMA (Europe, Japan, and China) 2100 band
114 - WCDMA Europe and Japan 900 band

Band index reference list:
Indices 1-64 correspond to LTE bands 1-64.
Indices 65-128 correspond to Non-LTE bands.

IR1101#

Upgrading the Modem Firmware Manually With CLI

**SUMMARY STEPS**

2. On the Cisco Wireless WAN software page, go to Products -> Cisco Interfaces and Modules -> Cisco High-Speed WAN interface Cards and select your product from the list of available cards.
3. Select and download the appropriate firmware.
4. terminal monitor
5. `microcode reload cellular` pa-bay slot modem-provision `[flash:<firmware_directory_name>]`
6. `show cellular 0/1/0 hardware`
## DETAILED STEPS

<table>
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<th>Step</th>
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<tr>
<td>Step 1</td>
<td>Go to the Cisco Wireless WAN software download website at: <a href="http://software.cisco.com/download/navigator.html">http://software.cisco.com/download/navigator.html</a></td>
<td>Provides access to Cisco Wireless WAN software downloads page to select the firmware for Cisco 4G.</td>
<td>This website is only available to registered Cisco.com users.</td>
</tr>
<tr>
<td>Step 2</td>
<td>On the Cisco Wireless WAN software page, go to Products -&gt; Cisco Interfaces and Modules -&gt; Cisco High-Speed WAN interface Cards and select your product from the list of available cards.</td>
<td>Select your product for firmware upgrade.</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>Select and download the appropriate firmware.</td>
<td>Download the modem firmware file to flash memory on the router.</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>terminal monitor Example: Router# terminal monitor</td>
<td>Enables the logging console in privileged EXEC mode.</td>
<td></td>
</tr>
</tbody>
</table>
| Step 5 | microcode reload cellular pa-bay slot modem-provision [flash:<firmware_directory_name>] Example: Router# microcode reload cellular 0 slot modem-provision bootflash:<firmware_directory> | Initiates the firmware upgrade process. For the IR1101 Base, the firmware upgrade would use microcode reload cellular 0 1 ... For the IR1101 Expansion Module, the firmware upgrade would use microcode reload cellular 0 3 ... | Modem firmware upgrade may take 10-15 mins from issuing the microcode reload command to the modem coming up. The router console will display ‘FW_UPGRADE: Firmware upgrade success....’ message to indicate the firmware upgrade completed. The modem will reset itself and may take an additional 5 minutes to be up in-service.  
  - pa-bay—Use 0 for 4G LTE Advanced.  
  - slot—For 4G LTE Advanced, slot number, 0 to 3, where the 4G LTE Advanced is plugged in.  
  - For remote download, you can transfer this using the wireless link from Cisco.com onto flash. |
| Step 6 | show cellular 0/1/0 hardware                                                       | Verifies the cellular modem type, model, carrier, firmware, PRI, SKU, IMEI and other modem details. |                                           |

### Manual Modem Firmware Upgrade: Example

```
Router# sh cellu 0/1/0 hardware
Modem Firmware Version = SWI9X30C_02.20.03.00
Modem Firmware built = 2016/06/30 10:54:05
```
Hardware Version = 1.0
Device Model ID: EM7455
International Mobile Subscriber Identity (IMSI) = <imsi>
International Mobile Equipment Identity (IMEI) = <imei>
Integrated Circuit Card ID (ICCID) = <iccid>
Mobile Subscriber Integrated Services Digital Network-Number (MSISDN) =
Modem Status = Modem Online
Current Modem Temperature = 44 deg C
PRI SKU ID = 1102526, PRI version = 002.020_000, Carrier = AT&T
OEM PRI version = 006
Router#cd fw_22_vzw
Router#dir
Directory of bootflash:/fw_22_vzw/
227586 -rw- 64389490 Jun 30 2000 10:21:29 +00:00 74XX_02.20.03.22.cwe
227587 -rw- 16951 Jun 30 2000 10:22:10 +00:00
7455_02.20.03.22_Verizon_002.026_000.nvu
6816092160 bytes total (5965422592 bytes free)
Router#cd
Router#microcode reload cellular 0 2 modem-provision bootflash:/fw_22_vzw/
Reload microcode? [confirm]
Log status of firmware download in router flash?[confirm]
Firmware download status will be logged in bootflash:fwlogfile
Microcode Reload Process launched for cwan slot/bay =0/2; hw type=0x102download option = 0

Router#Success !! send FW Upgrade command to card

*******************************************************************************
The interface will be Shut Down for Firmware Upgrade
This will terminate any active data connections.
*******************************************************************************

Modem will be upgraded!
Upgrade process will take up to 15 minutes. During this time the modem will be unusable.
Please do not remove power or reload the router during the upgrade process.
*******************************************************************************
*Jul 6 10:19:34.701: %LINK-5-CHANGED: Interface Cellular0/1/0, changed state to administratively down
*Jul 6 10:19:34.701: %LINK-5-CHANGED: Interface Cellular0/2/1, changed state to administratively down
*******************************************************************************
FIRMWARE INFO BEFORE UPGRADE:
Modem Device ID: EM7455 MODEM F/W Boot Version: SWI9X30C_02.20.03.00
Modem F/W App Version: SWI9X30C_02.20.03.00 Modem SKU ID: 1102526
Modem Package Identifier: Modem Carrier String: 4
Modem PRI Ver: 000.006 Modem Carrier Name: ATT
Modem Carrier Revision: 002.020_000
*******************************************************************************
FW_UPGRADE: Modem needs CWE, PRI
*Jul 6 10:19:57.978: %CELLWAN-2-MODEM_DOWN: Modem in NIM slot 0/2 is DOWN
FW_UPGRADE: Upgrade begin at Thu Jul 6 10:20:01 2000
FW_UPGRADE: Firmware upgrade success.....
FW_UPGRADE: Waiting for modem to become online
*******************************************************************************
FIRMWARE INFO AFTER UPGRADE:
Modem Device ID: EM7455 MODEM F/W Boot Version: SWI9X30C_02.20.03.22
Modem F/W App Version: SWI9X30C_02.20.03.22 Modem SKU ID: 1102526
Modem Package Identifier: Modem Carrier String: 5
Modem PRI Ver: 000.006 Modem Carrier Name: VERIZON
Modem Carrier Revision: 002.026_000
-----------------------------------
F/W Upgrade: Firmware Upgrade has Completed Successfully
*Jul 6 10:21:55.275: %CELLWAN-2-MODEM_RADIO: Cellular0/1/0 Modem radio has been turned on
*Jul 6 10:21:57.276: %LINK-3-UPDOWN: Interface Cellular0/1/0, changed state to down
Router# sh cellu 0/1/0 hardware
Modem Firmware Version = SWI9X30C_02.20.03.22
Modem Hardware built = 2016/10/11 16:03:14
Hardware Version = 1.0
Device Model ID: EM7455
International Mobile Subscriber Identity (IMSI) =<imsi>
International Mobile Equipment Identity (IMEI) = <imei>
Integrated Circuit Card ID (ICCID) = <iccid>
Mobile Subscriber Integrated Services Digital Network-Number (MSISDN) = <msisdn>
Modem Status = Modem Online
Current Modem Temperature = 0 deg C
PRI SKU ID = 1102526, PRI version = 002.026_000, Carrier = Verizon
OEM PRI version = 006

Configuring dm-log to Utility Flash: Example

```
Router(config)#controller cellular 0/1/0
Router(config-controller)#lte modem dm-log enable
Router(config-controller)#
*May 8 17:57:09.905: %SYS-5-CONFIG_I: Configured from console by console
Router#
Router# show cellular 0/1/0 log dm-log
Integrated DM logging is off
Output path = bootflash:
Filter Type = Default
Filter Name = v11026_Generic_GSM_WCDMA LTE IP-no-data-packets.sqf
Maximum log size = 0 MB
Maximum file size = 0 MB
Log rotation = Disabled

IR1101# show cellular 0/1/0 log dm-log details
Integrated DM logging is off
Output path = bootflash:
Filter Type = Default
Filter Name = v11026_Generic_GSM_WCDMA LTE IP-no-data-packets.sqf
Maximum log size = 0 MB
Maximum file size = 0 MB
Log rotation = Disabled

0 Packets sent to the modem, 0 Bytes, 0 Errors
0 Packets received from the modem, 0 Bytes, 0 Input drops
0 Packets stored in file system, 0 Bytes, 0 Errors, 0 Aborts
0 Max rcv queue size

Current file size = 0 MB
Current log size = 0 MB
Total log size = 0 MB
IR1101#```

SNMP MIBs

A MIB (Management Information Base) is a database of the objects that can be managed on a device. The managed objects, or variables, can be set or read to provide information on the network devices and interfaces.
You can find complete information on MIBS and the MIB locator here: https://mibs.cloudapps.cisco.com/ITDIT/MIBS/servlet/index

It is recommended that you configure SNMP V3 with authentication/privacy when implementing SNMP SET operation.


The following Simple Management Network Protocol (SNMP) MIbs are supported on Cisco 4G LTE Advanced:

- IF-MIB
- ENTITY-MIB
- CISCO-WAN-3G-MIB
- CISCO-WAN-CELL-EXT-MIB

For the CISCO-WAN-3G-MIB, the following tables and sub-tables are supported for 3G and LTE technologies:

- ciscoWan3gMIB(661)
- ciscoWan3gMIBNotifs(0)
- ciscoWan3gMIBObjects(1)
- c3gWanCommonTable(1)
- c3gWanGsm(3)
- c3gGsmIdentityTable(1)
- c3gGsmNetworkTable(2)
- c3gGsmPdpProfile(3)
- c3gGsmPdpProfileTable(1)
- c3gGsmPacketSessionTable(2)
- c3gGsmRadio(4)
- c3gGsmRadioTable(1)
- c3gGsmSecurity(5)
- c3gGsmSecurityTable(1)

For the CISCO-WAN-CELL-EXT-MIB, the following tables and sub-tables are supported for LTE technology only:

- ciscoWanCellExtMIB(817)
- ciscoWanCellExtMIBNotifs(0)
- ciscoWanCellExtMIBobjects(1)
- ciscoWanCellExtLte(1)
You can download the MIBs from the Cisco MIB Locator at http://www.cisco.com/go/mibs.

**SNMP 4G LTE Advanced Configuration: Example**

The following example describes how to configure 3G 4G MIB trap on the router:

```
controller Cellular 0/1/0
lte event rssi onset mib-trap All-lte
lte event rssi onset threshold -100
lte event rssi abate mib-trap All-lte
lte event rssi abate threshold -90
lte event temperature onset mib-trap
lte event temperature onset threshold 55
lte event temperature abate mib-trap
lte event temperature abate threshold 50
lte event modem-state mib-trap all
lte event service mib-trap
lte event network mib-trap
lte event connection-status mib-trap All-lte
lte event rsrp onset mib-trap All-lte
lte event rsrp onset threshold -85
lte event rsrp abate mib-trap All-lte
lte event rsrp abate threshold -80
lte event rsrq onset mib-trap All-lte
lte event rsrq onset threshold -8
lte event rsrq abate mib-trap All-lte
lte event rsrq abate threshold -6
```

The following example describes how to configure SNMP capability on the router:

```
snmp-server group neomobilityTeam v3 auth notify 3gView
snmp-server view 3gView ciscoWan3gMIB included
snmp-server community neomobility-test RW snmp-server community public RW
snmp-server enable traps c3g
snmp server enable traps LTE
snmp-server host 172.19.153.53 neomobility c3g snmp-server host 172.19.152.77 public c3g
snmp-server host 172.19.152.77 public udp-port 6059
```

The following example describes how to configure an external host device to communicate with the router through SNMP:

```
setenv SR_MGR_CONF_DIR /users/<userid>/mibtest
setenv SR_UTIL_COMMUNITY neomobility-test
setenv SR_UTIL_SNMP_VERSION -v2c
setenv SR_TRAP_TEST_PORT 6059
```

**Troubleshooting**

This section provides the essential information and resources available for troubleshooting the Cisco 4G LTE Advanced feature.

**Verifying Data Call Setup**

To verify the data call setup, follow these steps:
1. After you create a modem data profile using the cellular profile create command and configuring DDR on the cellular interface, send a ping from the router to a host across the wireless network.

2. If the ping fails, debug the failure by using the following debug and show commands:
   3. debug chat
   4. debug modem
   5. debug dialer
   6. show cellular all
   7. show controller cell/0/1/0
   8. show interface cellular
   9. show running-config
   10. show ip route
   11. show platform
   12. Save the output from these commands and contact your system administrator.

Checking Signal Strength

If the Received Signal Strength Indication (RSSI) level is very low (for example, if it is less than –110 dBm), follow these steps:

**SUMMARY STEPS**

1. Ensure at least one antenna is connected to the 'MAIN' RF port on the 4G module. Preferably both MAIN and DIV RF ports should be connected to antenna for better RF signal. Check to ensure the antenna are threaded and tightened.

2. If you are using a remote antenna, move the antenna cradle and check if the RSSI has improved.

3. Contact your wireless service provider to verify if there is service availability in your area.

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Ensure at least one antenna is connected to the 'MAIN' RF port on the 4G module. Preferably both MAIN and DIV RF ports should be connected to antenna for better RF signal. Check to ensure the antenna are threaded and tightened.</td>
</tr>
<tr>
<td>Step 2</td>
<td>If you are using a remote antenna, move the antenna cradle and check if the RSSI has improved.</td>
</tr>
<tr>
<td>Step 3</td>
<td>Contact your wireless service provider to verify if there is service availability in your area.</td>
</tr>
</tbody>
</table>
Verifying Service Availability

The following is a sample output for the `show cellular all` command for a scenario where the antenna is disconnected and a modem data profile has not been created.

Router# show cellular 0/1/0 all
Hardware Information
====================
Modem Firmware Version = SWI9X07Y_02.18.05.00
Device Model ID = WP7603
International Mobile Subscriber Identity (IMSI) = 001012345678901
International Mobile Equipment Identity (IMEI) = 359528080002501
Integrated Circuit Card ID (ICCID) = 89860000502000180722
Mobile Subscriber Integrated Services
Digital Network-Number (MSISDN) =
Factory Serial Number (FSN) = U3734285450506
Modem Status = Modem Online
Current Modem Temperature = 49 deg C
PRI SKU ID = 1103507, PRI version = 002.041_002, Carrier = GENERIC
OEM PRI version = 002.000

Profile Information
-------------------
Profile 1 = ACTIVE* **
--------
PDP Type = IPv4v6
PDP address = 192.1.1.21
PDP IPv6 address = FC01:ABAB:CDCD:EF0:7DC4:256:B64F:22F8/64 Scope: Global
Access Point Name (APN) = broadband
Authentication = None
Primary DNS address = 192.1.1.2
Primary DNS IPv6 address = FC01:CAFE:0:0:0:0:1
Secondary DNS IPv6 address = 0:0:0:0:0:0:0:0

* = Default profile
** = LTE attach profile

Configured default profile for active SIM 0 is profile 1.

Data Connection Information
---------------------------
Profile 1, Packet Session Status = ACTIVE
Cellular0/1/0:
Data Packets Transmitted = 31546 , Received = 57008
Data Transmitted = 5049096 bytes, Received = 7702570 bytes
IP address = 192.1.1.21
IPV6 address = FC01:ABAB:CDCD:EF0:7DC4:256:B64F:22F8/64 Scope = Global
Primary DNS address = 192.1.1.2
Primary DNS IPv6 address = FC01:CAFE:0:0:0:0:1
Secondary DNS IPv6 address = 0:0:0:0:0:0:0:0
Profile 2, Packet Session Status = INACTIVE
Profile 3, Packet Session Status = INACTIVE
Profile 4, Packet Session Status = INACTIVE
Profile 5, Packet Session Status = INACTIVE
Profile 6, Packet Session Status = INACTIVE
Profile 7, Packet Session Status = INACTIVE
Profile 8, Packet Session Status = INACTIVE
Profile 9, Packet Session Status = INACTIVE
Profile 10, Packet Session Status = INACTIVE
Profile 11, Packet Session Status = INACTIVE
Profile 12, Packet Session Status = INACTIVE
Profile 13, Packet Session Status = INACTIVE
Profile 14, Packet Session Status = INACTIVE
Profile 15, Packet Session Status = INACTIVE
Profile 16, Packet Session Status = INACTIVE

Network Information
----------------------
Current System Time = Thu Jan 10 8:31:28 1980
Current Service Status = Normal
Current Service = Packet switched
Current Roaming Status = Home
Network Selection Mode = Automatic
Network = Test PLMN 1-1
Mobile Country Code (MCC) = 1
Mobile Network Code (MNC) = 1
Packet switch domain (PS) state = Attached
Registration state (EMM) = Registered
EMM Sub State = Normal Service
Tracking Area Code (TAC) = 1
Cell ID = 256
Negotiated network MTU = 1500

Radio Information
-------------------
Radio power mode = online
LTE Rx Channel Number = 2175
LTE Tx Channel Number = 20175
LTE Band = 4
LTE Bandwidth = 20 MHz
Current RSSI = -68 dBm
Current RSRP = -102 dBm
Current RSRQ = -13 dB
Current SNR = 19.4 dB
Physical Cell Id = 0
Number of nearby cells = 1
Idx PCI (Physical Cell Id)

1 0

Radio Access Technology (RAT) Preference = AUTO
Radio Access Technology (RAT) Selected = LTE

LTE bands supported by modem:
- Bands 2 4 5 12.
LTE band Preference settings for the active sim(slot 0):
- Bands 2 4 5 12.

Non-LTE bands supported by modem:
Index:
88 - WCDMA US PCS 1900 band
90 - WCDMA US 1700 band
91 - WCDMA US 850 band
Non-LTE band Preference settings for the active sim(slot 0):
Index:
88 - WCDMA US PCS 1900 band
90 - WCDMA US 1700 band
91 - WCDMA US 850 band

Band index reference list:
Indices 1-64 correspond to LTE bands 1-64.
Indices 65-128 correspond to Non-LTE bands.

Modem Security Information
-------------------------------
Active SIM = 0
SIM switchover attempts = 0
Card Holder Verification (CHV1) = Disabled
SIM Status = OK
SIM User Operation Required = None
Number of CHV1 Retries remaining = 3

Cellular Firmware List
-------------------------------
<table>
<thead>
<tr>
<th>Idx</th>
<th>Carrier</th>
<th>FwVersion</th>
<th>PriVersion</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ATT</td>
<td>02.18.04.00</td>
<td>002.039_000</td>
<td>Inactive</td>
</tr>
<tr>
<td>2</td>
<td>GENERIC</td>
<td>02.18.05.00</td>
<td>002.041_002</td>
<td>Active</td>
</tr>
<tr>
<td>3</td>
<td>VERIZON</td>
<td>02.17.01.00</td>
<td>002.036_000</td>
<td>Inactive</td>
</tr>
</tbody>
</table>

Firmware Activation mode = MANUAL

FOTA Information
-------------------
FOTA server poll timer (mins) = Disable
FOTA server connection retry value = 0
FOTA status = Please re-configure FOTA poll timer

GPS Information
-------------------
GPS Feature = enabled
GPS Mode Configured = not configured
GPS Status = NMEA Disabled

SMS Information
-------------------
Incoming Message Information
-------------------------------
SMS stored in modem = 7
SMS archived since booting up = 0
Total SMS deleted since booting up = 0
Storage records allocated = 25
Storage records used = 7
Number of callbacks triggered by SMS = 0
Number of successful archive since booting up = 0
Number of failed archive since booting up = 0

Outgoing Message Information
-------------------------------
Total SMS sent successfully = 0
Total SMS send failure = 0
Number of outgoing SMS pending = 0
Number of successful archive since booting up = 0
Number of failed archive since booting up = 0
Last Outgoing SMS Status = SUCCESS
Copy-to-SIM Status = 0x0
Send-to-Network Status = 0x0
Report-Outgoing-Message-Number:
Reference Number = 0
Result Code = 0x0
Diag Code = 0x0 0x0 0x0 0x0 0x0

SMS Archive URL =

Cisco IR1101 Integrated Services Router Software Configuration Guide
Modem Crashdump Information
----------------------------------
Modem crashdump logging = off

Successful Call Setup

The following is a sample output when a call is set up. It shows a received IP address from the network. Call setup is successful and data path is open.

dump cellular 0/1/0 messages callcontrol

Modem Troubleshooting Using Integrated Modem DM Logging

As part of the 3G and 4G serviceability enhancement in Cisco IOS, DM log collection has been integrated into Cisco IOS, eliminating the need for an external PC and simplifying the DM log collection process. The lte modem dm-log command can be used in controller cellular configuration mode to configure integrated DM logging to monitor traffic on the modem. See the Cisco 3G and 4G Serviceability Enhancement User Guide for more information on configuring Integrated DM Logging parameters.

Modem Settings for North America and Carriers Operating on 700 MHz Band

For LTE-EA deployments in North America and for carriers operating in the 700 MHz band, the following changes to the modem settings are required to prevent long network attach times.

The output of show cellular 0/1/0 all command shows the following:

- Current RSSI is –125 dBm
- LTE Technology Preference = No preference specified (AUTO)

The following sections explain useful commands for changing modem settings:

Changing Modem Settings

To change the modem settings to force the modem to scan different technologies, use the following Cisco IOS command:

Router# cellular 0/1/0 lte technology ?
auto Automatic LTE Technology Selection
lte LTE
umts UMTS

Electronic Serial Number (ESN)

The ESN number is located directly on the modem label in hexadecimal notation. It can also be retrieved using the Cisco IOS CLI using the show cellular slot/port/module hardware command.

The sample output below shows the ESN number:

Hardware Information
----------------------
Electronic Serial Number (ESN) = 0x603c9854 [09603971156]
Electronic Serial Number (ESN) = <specific ESN in hexadecimal> [specific ESN in decimal]
This chapter contains the following sections:

- Cellular IPv6 Address, on page 165
- Configuring a Deterministic IPv6 Host Address, on page 169

### Cellular IPv6 Address

IPv6 addresses are represented as a series of 16-bit hexadecimal fields separated by colons (:) in the format: x:x:x:x:x:x:x. Following are two examples of the same IPv6 address:

- 2001:CDBA::3257:9652 (zeros can be omitted)

IPv6 addresses commonly contain successive hexadecimal fields of zeros. Two colons (::) may be used to compress successive hexadecimal fields of zeros at the beginning, middle, or end of an IPv6 address (the colons represent successive hexadecimal fields of zeros). The table below lists compressed IPv6 address formats.

An IPv6 address prefix, in the format ipv6-prefix/prefix-length, can be used to represent bit-wise contiguous blocks of the entire address space. The ipv6-prefix must be in the form documented in RFC 2373 where the address is specified in hexadecimal using 16-bit values between colons. The prefix length is a decimal value that indicates how many of the high-order contiguous bits of the address comprise the prefix (the network portion of the address). For example, 2001:cdca::3257:9652/64 is a valid IPv6 prefix.

### IPv6 Unicast Routing

An IPv6 unicast address is an identifier for a single interface, on a single node. A packet that is sent to a unicast address is delivered to the interface identified by that address.

The IR1101 supports the following address types:

#### Link-Local Address

A link-local address is an IPv6 unicast address that can be automatically configured on any interface using the link-local prefix FE80::/10 (1111 1110 10) and the interface identifier in the modified EUI-64 format. An link-local address is automatically configured on the cellular interface when an IPv6 address is enabled.
After the data call is established, the link-local address on the cellular interface is updated with the host generated link-local address that consists of the link-local prefix FF80::/10 (1111 1110 10) and the auto-generated interface identifier from the USB hardware address. The figure below shows the structure of a link-local address.

**Global Address**

A global IPv6 unicast address is defined by a global routing prefix, a subnet ID, and an interface ID. The routing prefix is obtained from the PGW. The Interface Identifier is automatically generated from the USB hardware address using the interface identifier in the modified EUI-64 format. The USB hardware address changes after the router reloads.

**Configuring Cellular IPv6 Address**

To configure the cellular IPv6 address, perform these steps:

**SUMMARY STEPS**

1. configure terminal
2. ipv6 unicast-routing
3. interface cellular <slot/port/interface>
4. description <text>
5. ipv6 address <options>
6. load-interval <seconds>
7. dialer in-band
8. dialer idle-timeout <seconds>
9. dialer watch-group <group number>
10. ipv6 enable
11. pulse time <seconds>
12. ip virtual-reassembly
13. no shutdown
14. exit
15. access-list 1 permit any
16. dialer watch-list 1 <ipaddress> < mask>
17. dialer watch-list 1 delay route-check initial 60
18. dialer watch-list 1 delay connect 1
19. dialer-list 1 protocol ip permit
20. dialer-list 1 protocol ipv6 permit
21. ipv6 route <destination ipv6 prefix> / <destination mask> [forwarding router address | interface | other options]
22. end

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure terminal</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Router# configure terminal</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>ipv6 unicast-routing</td>
</tr>
<tr>
<td>Example:</td>
<td>Router# ipv6 unicast-routing</td>
</tr>
<tr>
<td>Enables IPv6 routing globally on the router.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>interface cellular &lt;slot/port/interface&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config)# interface cellular 0/1/0</td>
</tr>
<tr>
<td>Specifies the cellular interface. The IR1101 has the primary Cellular interface as 0/1/0.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>description &lt;text&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# description text</td>
</tr>
<tr>
<td>Provides a description for the cellular interface, if desired.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>ipv6 address &lt;options&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# ipv6 address negotiated</td>
</tr>
<tr>
<td>Specifies that the IP address for a particular interface is dynamically obtained.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>load-interval &lt;seconds&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# load-interval 30</td>
</tr>
<tr>
<td>Specifies the length of time for which data is used to compute load statistics.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>dialer in-band</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# dialer in-band</td>
</tr>
<tr>
<td>Enables DDR and configures the specified serial interface to use in-band dialing.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>dialer idle-timeout &lt;seconds&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# dialer idle-timeout 0</td>
</tr>
<tr>
<td>Specifies the dialer idle timeout period.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>dialer watch-group &lt;group number&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# dialer watch-group 1</td>
</tr>
<tr>
<td>Specifies the number of the dialer access group to which the specific interface belongs.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>ipv6 enable</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# ipv6 enable</td>
</tr>
<tr>
<td>Enables IPv6.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>pulse time &lt;seconds&gt;</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# pulse-time 1</td>
</tr>
<tr>
<td>Define pulse time</td>
<td></td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>ip virtual-reassembly</td>
</tr>
<tr>
<td>Example:</td>
<td>Router(config-if)# ip virtual-reassembly</td>
</tr>
<tr>
<td>Enable Virtual Fragment Reassembly (default is ‘in’ only).</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
</tr>
<tr>
<td>13</td>
<td><code>no shutdown</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>no shutdown</code></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-if)#no shutdown</code></td>
</tr>
<tr>
<td>14</td>
<td><code>exit</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>exit</code></td>
</tr>
<tr>
<td></td>
<td><code>Router(config-if)#exit</code></td>
</tr>
<tr>
<td>15</td>
<td><code>access-list 1 permit any</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>access-list 1 permit any</code></td>
</tr>
<tr>
<td></td>
<td><code>Router(config)#access-list 1 permit any</code></td>
</tr>
<tr>
<td>16</td>
<td><code>dialer watch-list 1 &lt;ipaddress&gt; &lt;mask&gt;</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>dialer watch-list 1 ip 5.6.7.8 255.255.255.255</code></td>
</tr>
<tr>
<td>17</td>
<td><code>dialer watch-list 1 delay route-check initial 60</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>dialer watch-list 1 delay route-check initial 60</code></td>
</tr>
<tr>
<td>18</td>
<td><code>dialer watch-list 1 delay connect 1</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>dialer watch-list 1 delay connect 1</code></td>
</tr>
<tr>
<td>19</td>
<td><code>dialer-list 1 protocol ip permit</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>dialer-list 1 protocol ip permit</code></td>
</tr>
<tr>
<td>20</td>
<td><code>dialer-list 1 protocol ipv6 permit</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>dialer-list 1 protocol ipv6 permit</code></td>
</tr>
<tr>
<td>21</td>
<td>`ipv6 route &lt;destination ipv6 prefix&gt; / &lt;destination mask&gt; [forwarding router address</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>ipv6 route ::/0 Cellular0/1/0</code></td>
</tr>
<tr>
<td>22</td>
<td><code>end</code></td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td><code>end</code></td>
</tr>
<tr>
<td></td>
<td><code>Router(config)#end</code></td>
</tr>
</tbody>
</table>
Examples

The following example shows the Cellular IPv6 configuration:

```
lte sim data-profile 1 attach-profile 1 slot 0
lte sim data-profile 1 attach-profile 1 slot 1
lte interface 0 64 1111:2222:3333:0001
lte gps mode standalone
lte modem dm-log size 2
lte modem dm-log filesize 1
lte modem dm-log rotation
lte modem link-recovery disable
!
interface Loopback0
  ip address 1.1.1.1 255.255.255.255
!
interface Cellular0/1/0
  description Cell-to-CMW
  ip address negotiated
  load-interval 30
  dialer in-band
  dialer idle-timeout 0
  dialer watch-group 1
  ipv6 enable
  pulse-time 1
  ip virtual-reassembly
!
interface Cellular0/1/1
  no ip address
  shutdown
!
... ip route 0.0.0.0 0.0.0.0 Cellular0/1/0
ipv6 route ::/0 Cellular0/1/0
...
!
access-list 1 permit any
dialer watch-list 1 ip 5.6.7.8 255.255.255.255
dialer watch-list 1 delay route-check initial 60
dialer watch-list 1 delay connect 1
dialer-list 1 protocol ip permit
dialer-list 1 protocol ipv6 permit
!
```

Configuring a Deterministic IPv6 Host Address

Deterministic IPv6 addresses allow a user to configure a static, user-specified IPv6 address host portion for the interface. While IPv6 address network and subnet parts may be assigned by the ISP, the host part remains unchanged using this configuration. This allows devices to have known, pre-determined IPv6 addresses in their network.

To configure the deterministic IPv6 host address, perform these steps:
### SUMMARY STEPS

1. `config terminal`
2. `ipv6 unicast-routing`
3. `interface Cellular <slot/port/interface>`
4. `enable ipv6`
5. `ipv6 address autoconfig`
6. `no shut`
7. `controller cellular <controller slot/port adapter/port>`
8. `lte interface <interface number> <address length 48-80> <deterministic address suffix>`
9. `end`
10. `clear int cellular 0/1/0`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| **Step 1** | `config terminal`  
   Example:  
   Router# configure terminal | Enters global configuration mode. |
| **Step 2** | `ipv6 unicast-routing`  
   Example:  
   Router(config)# ipv6 unicast-routing | Enable IPv6 routing. |
| **Step 3** | `interface Cellular <slot/port/interface>`  
   Example:  
   Router(config)# interface Cellular 0/1/0 | Specifies the cellular interface. |
| **Step 4** | `enable ipv6`  
   Example:  
   Router(config-if)# enable ipv6 | Enables IPv6. |
| **Step 5** | `ipv6 address autoconfig`  
   Example:  
   Router(config-if)# ipv6 address autoconfig | Enables automatic configuration of IPv6 addresses using stateless autoconfiguration on an interface and enables IPv6 processing on the interface. |
| **Step 6** | `no shut`  
   Example:  
   Router(config-if)# no shut | Shutdown Interface. |
| **Step 7** | `controller cellular <controller slot/port adapter/port>`  
   Example:  
   Router(config)# controller cellular 0/1/0 | Configure the controller. |
### Configuring Deterministic IPv6 Host Address

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 8</td>
<td><strong>lte interface</strong> <code>&lt;interface number&gt;</code> <code>&lt;address length 48-80&gt;</code> <code>&lt;deterministic address suffix&gt;</code></td>
<td>Specify in controller config the deterministic IPv6 address for cellular interface.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router(config)# lte interface 0 64 1111:2222:3333:1234</td>
<td></td>
</tr>
<tr>
<td>Step 9</td>
<td><strong>end</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# end</td>
<td></td>
</tr>
<tr>
<td>Step 10</td>
<td><strong>clear int cellular 0/1/0</strong></td>
<td>Clears the cellular interface and forces the cellular interface to reacquire IP address.</td>
</tr>
<tr>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Router# clear int cellular 0/1/0</td>
<td></td>
</tr>
</tbody>
</table>

### Example

The following example shows the configuration:

```plaintext
controller Cellular 0/1/0
lte sim data-profile 1 attach-profile 1 slot 0
lte sim data-profile 1 attach-profile 1 slot 1
no lte firmware auto-sim
lte interface 0 64 1111:2222:3333:0001
lte gps mode standalone
lte modem dm-log size 2
lte modem dm-log filesize 1
lte modem dm-log rotation
lte modem link-recovery disable
!
!
interface Loopback0
  ip address 1.1.1.1 255.255.255.255
!
interface Cellular0/1/0
  description Cell-to-CMW
  ip address negotiated
  load-interval 30
dialer in-band
dialer idle-timeout 0
dialer watch-group 1
dialer-group 1
ipv6 enable
pulse-time 1
ip virtual-reassembly
!
interface Cellular0/1/1
  no ip address
  shutdown
!
!
  ip route 0.0.0.0 0.0.0.0 Cellular0/1/0
  ipv6 route ::/0 Cellular0/1/0
```
!  
access-list 1 permit any  
dialer watch-list 1 ip 5.6.7.0 255.255.255.255  
dialer watch-list 1 delay route-check initial 60  
dialer watch-list 1 delay connect 1  
dialer-list 1 protocol ip permit  
dialer-list 1 protocol ipv6 permit  
!  
...
Information About SCADA

SCADA refers to a control and management system employed in industries such as water management, electric power, and manufacturing. A SCADA system collects data from various types of equipment within the system and forwards that information back to a Control Center for analysis. Generally, individuals located at the Control Center monitor the activity on the SCADA system and intervene when necessary.

The Remote Terminal Unit (RTU) acts as the primary control system within a SCADA system. RTUs are configured to control specific functions within the SCADA system, which can be modified as necessary through a user interface.

On the IR1101, line is 0/2/0 same as the Async interface.

Role of the IR1101

In the network, the Control Center always serves as the master in the network when communicating with the IR1101. The IR1101 serves as a proxy master station for the Control Center when it communicates with the RTU.

The IR1101 provides protocol translation to serve as a SCADA gateway to do the following:

- Receive data from RTUs and relay configuration commands from the Control Center to RTUs.
- Receive configuration commands from the Control Center and relay RTU data to the Control Center
- Terminate incoming requests from the Control Center, when an RTU is offline.

The IR1101 performs Protocol Translation for the following protocols:

- IEC 60870 T101 to/from IEC 60870 T104.
- DNP3 serial to DNP3 IP
Key Terms

The following terms are relevant when you configure the T101 and T104 protocol stacks on the IR1101:

- **Channel**—A channel is configured on each IR1101 serial port interface to provide a connection to a single RTU for each IP connection to a remote Control Center. Each connection transports a single T101 (RTU) or T104 (Control Center) protocol stack.
- **Link Address**—Refers to the device or station address.
- **Link Mode (Balanced and Unbalanced)**—Refers to the modes of data transfer.
  - An Unbalanced setting refers to a data transfer initiated from the master.
  - A Balanced setting can refer to either a master or slave initiated data transfer.
- **Sector**—Refers to a single RTU within a remote site.
- **Sessions**—Represents a single connection to a remote site.

The following terms are relevant when you configure the DNP3 protocol stacks on the IR1101:

- **Channel**—A channel is configured on the IR1101 serial port interface to provide a connection to a single RTU for each IP connection to a remote Control Center. Each connection transports a single DNP3 serial (RTU) or DNP3 IP (Control Center) protocol stack.
- **Link Address**—Refers to the device or station address.
- **Sessions**—Represents a single connection to a remote site.

Protocol Translation Application

In *Figure 23: Routers Within a SCADA System*, on page 175 the IR1101 (installed within a secondary substation of the Utility Network) employs Protocol Translation to provide secure, end-to-end connectivity between Control Centers and RTUs within a SCADA System.

The IR1101 connects to the RTU (slave) through a RS232 connection. To protect the traffic when forwarded over public infrastructures (for example, cellular), the IR1101 forwards SCADA data from the RTU to the Control Center in the SCADA system through an IPSec tunnel (FlexVPN site-to-site or hub and spoke). The IPSec tunnel protects all traffic between the IR1101 and the Head-end aggregation router. SCADA traffic can be inspected through an IPS device positioned in the path of the SCADA traffic before it is forwarded to the proper Control Center.
Prerequisites

RTUs must be configured and operating in the network.

For each RTU that connects to the IR1101, you will need the following information for T101/T104:

- Channel information
  - Channel name
  - Connection type: serial
  - Link transmission procedure setting: unbalanced or balanced
  - Address field of the link (number expressed in octets)

- Session information
  - Session name
  - Size of common address of Application Service Data Unit (ASDU) (number expressed in octets)
  - Cause of transmission (COT) size (number expressed in octets)
  - Information object address (IOA) size (number expressed in octets)

- Sector information
  - Sector name
  - ASDU address, (number expressed in octets)

For each RTU that connects to the IR1101, you will need the following information for DNP3:

- Channel information
  - Channel name
  - Connection type: serial
Guidelines and Limitations

Each channel supports only one session.
Each sessions supports only one sector.

Default Settings

<table>
<thead>
<tr>
<th>T101/T104 Parameters</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role for T101</td>
<td>Master</td>
</tr>
<tr>
<td>Role for T104</td>
<td>Slave</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DNP3 Parameters</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsolicited Response (DNP3-serial)</td>
<td>Not Enabled</td>
</tr>
<tr>
<td>Send Unsolicited Message (DNP3-IP)</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

Configuring Protocol Translation

This section includes the following topics:

Note
Before making any configuration changes to a IR1101 operating with Protocol Translation, please review the section on Starting and Stopping the Protocol Translation Engine, on page 191.

Enabling the IR1101 Serial Port and SCADA Encapsulation

Before you can enable and configure Protocol Translation on the IR1101, you must first enable the serial port on the IR1101 and enable SCADA encapsulation on that port.

Before you begin
Determine availability of serial port on the IR1101.

SUMMARY STEPS

1. configure terminal
2. interface async slot/port/interface
3. no shutdown
4. encapsulation scada

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>configure terminal</td>
<td>Enters the global configuration mode.</td>
</tr>
</tbody>
</table>
| 2.   | interface async slot/port/interface | Enters the interface command mode for the async slot/port/interface.  
`slot`—value of 0  
`port`—value of 2  
`interface`—value of 0 |
| 3.   | no shutdown       | Brings up the port, administratively. |
| 4.   | encapsulation scada | Enables encapsulation on the serial port for protocol translation and other SCADA protocols. |

**EXAMPLE**

This example shows how to enable serial port 0/2/0 and how to enable encapsulation on that interface to support SCADA protocols.

```
router# configure terminal
router(config)# interface async 0/2/0
router (config-if)# no shutdown
router (config-if)# encapsulation scada
```

**Configuring T101 and T104 Protocol Stacks**

You can configure T101 and T104 protocol stacks, which allow end-to-end communication between Control Centers (T104) and RTUs (T101) within a SCADA system.

- Configuring the T101 Protocol Stack, on page 177
- Configuring the T104 Protocol Stack, on page 180
- Starting and Stopping the Protocol Translation Engine, on page 191

**Prerequisites**

Ensure that you have gathered all the required configuration information.

Enable the serial port and SCADA encapsulation.

**Configuring the T101 Protocol Stack**

Configure the channel, session, and sector parameters for the T101 protocol stack.

**SUMMARY STEPS**

1. configure terminal
2. scada-gw protocol t101
3. `channel channel_name`
4. `role master`
5. `link-mode {balanced | unbalanced}`
6. `link-addr-size {none | one | two}`
7. `bind-to-interface async slot/port/interface`
8. `exit`
9. `session session_name`
10. `attach-to-channel channel_name`
11. `common-addr-size {one | two | three}`
12. `cot size {one | two | three}`
13. `info-obj-addr-size {one | two | three}`
14. `link-addr-size {one | two | three}`
15. `link-addr link_address`
16. `exit`
17. `sector sector_name`
18. `attach-to-session session_name`
19. `asdu-addr asdu_address`
20. `exit`
21. `exit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> scada-gw protocol t101</td>
<td>Enters the configuration mode for the T101 protocol.</td>
</tr>
<tr>
<td><strong>Step 3</strong> channel <code>channel_name</code></td>
<td>Enters the channel configuration mode for the T101 protocol.</td>
</tr>
<tr>
<td></td>
<td><code>channel_name</code> – Identifies the channel on which the serial port of the IR1101 communicates to the RTU.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> When the entered channel name does not already exist, the router creates a new channel.</td>
</tr>
<tr>
<td></td>
<td>Entering the no form of this command deletes an existing channel. However, all sessions must be deleted before you can delete a channel.</td>
</tr>
<tr>
<td><strong>Step 4</strong> role master</td>
<td>Assigns the master role to the T101 protocol channel (default).</td>
</tr>
<tr>
<td><strong>Step 5</strong> link-mode `{balanced</td>
<td>unbalanced}`</td>
</tr>
<tr>
<td></td>
<td>unbalanced – Refers to a data transfer initiated from the master.</td>
</tr>
<tr>
<td></td>
<td>balanced – Refers to either a master or slave data transfer.</td>
</tr>
<tr>
<td><strong>Step 6</strong> link-addr-size `{none</td>
<td>one</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td><strong>bind-to-interface async slot/port/interface</strong></td>
</tr>
<tr>
<td></td>
<td>Defines the IR1101 serial interface on which the system sends its T101 protocol traffic.</td>
</tr>
<tr>
<td></td>
<td><em>slot</em> – Value of 0</td>
</tr>
<tr>
<td></td>
<td><em>port</em> – Value of 2</td>
</tr>
<tr>
<td></td>
<td><em>interface</em> – Value of 0</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td></td>
<td>Ends configuration of the channel and exits the channel configuration mode. Saves all settings.</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td><strong>session session_name</strong></td>
</tr>
<tr>
<td></td>
<td>Enters the session configuration mode and assigns a name to the session.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td><strong>attach-to-channel channel_name</strong></td>
</tr>
<tr>
<td></td>
<td>Attaches the session to the channel.</td>
</tr>
<tr>
<td></td>
<td>Enter the same channel name that you entered in <strong>Step 3</strong>.</td>
</tr>
<tr>
<td></td>
<td><em>channel_name</em> – Identifies the channel.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td>**common-addr-size {one</td>
</tr>
<tr>
<td></td>
<td>Defines the common address size in octets.</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td>**cot size {one</td>
</tr>
<tr>
<td></td>
<td>Defines the cause of transmission such as spontaneous or cyclic data schemes in octets.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td>**info-obj-addr-size {one</td>
</tr>
<tr>
<td></td>
<td>Defines the information object element address size in octets.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td>**link-addr-size {one</td>
</tr>
<tr>
<td></td>
<td>Defines the link address size in octets.</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td><strong>link-addr link_address</strong></td>
</tr>
<tr>
<td></td>
<td>Refers to the link address of the RTU.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> The link address entered here must match the value set on the RTU to which the serial port connects.</td>
</tr>
<tr>
<td></td>
<td><em>link_address</em> – Range of 0-65535.</td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td></td>
<td>Exits the session configuration mode.</td>
</tr>
<tr>
<td><strong>Step 17</strong></td>
<td><strong>sector sector_name</strong></td>
</tr>
<tr>
<td></td>
<td>Enters the sector configuration mode and assigns a name to the sector for the RTU.</td>
</tr>
<tr>
<td></td>
<td><em>sector_name</em> – Identifies the sector.</td>
</tr>
<tr>
<td><strong>Step 18</strong></td>
<td><strong>attach-to-session session_name</strong></td>
</tr>
<tr>
<td></td>
<td>Attaches the RTU sector to the session.</td>
</tr>
<tr>
<td></td>
<td>Enter the same session name that you entered in <strong>Step 9</strong>.</td>
</tr>
<tr>
<td></td>
<td><em>session_name</em> – Identifies the session.</td>
</tr>
<tr>
<td><strong>Step 19</strong></td>
<td><strong>asdu-addr asdu_address</strong></td>
</tr>
<tr>
<td></td>
<td>Refers to the ASDU structure address of the RTU.</td>
</tr>
<tr>
<td><strong>Step 20</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td></td>
<td>Exits the sector configuration mode.</td>
</tr>
<tr>
<td><strong>Step 21</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td></td>
<td>Exits the protocol configuration mode.</td>
</tr>
</tbody>
</table>
This example shows how to configure the parameters for the T101 protocol stack for RTU_10.

```
router# configure terminal
router(config)# scada-gw protocol t101
router(config-t101)# channel rtu_channel
router(config-t101-channel)# role master
router(config-t101-channel)# link-mode unbalanced
router(config-t101-channel)# link-addr-size one
router(config-t101-channel)# bind-to-interface async 0/2/0
router(config-t101-channel)# exit
router(config-t101)# session rtu_session
router(config-t101-session)# attach-to-channel rtu_channel
router(config-t101-session)# common-addr-size two
router(config-t101-session)# cot-size one
router(config-t101-session)# info-obj-addr-size two
router(config-t101-session)# link-addr 3
router(config-t101-session)# exit
router(config-t101)# sector rtu_sector
router(config-t101-sector)# attach-to-session rtu_session
router(config-t101-sector)# asdu-addr 3
router(config-t101-sector)# exit
router(config-t101)# exit
router(config)#
```

Configuring the T104 Protocol Stack

Follow the steps below for each Control Center that you want to connect to over a T104 protocol.

**Before you begin**

Ensure that you have gathered all the required configuration information. (See Prerequisites, on page 175)

Enable the serial port and SCADA encapsulation. (See Enabling the IR1101 Serial Port and SCADA Encapsulation, on page 176)

**SUMMARY STEPS**

1. configure terminal
2. scada-gw protocol t104
3. channel channel_name
4. k-value value
5. w-value value
6. t0-timeout value
7. t1-timeout value
8. t2-timeout value
9. t3-timeout value
10. tcp-connection {0|1} local-port {port_number | default} remote-ip {A.B.C.D | A.B.C.D/LEN | any} [vrf WORD]
11. exit
12. session session_name
13. attach-to-channel channel_name
14. `cot size {one | two | three}`

15. `exit`

16. `sector sector_name`

17. `attach-to-session session_name`

18. `asdu-addr asdu_address`

19. `map-to-sector sector_name`

20. Return to Step 1.

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> scada-gw protocol t104</td>
<td>Enters the configuration mode for the T104 protocol.</td>
</tr>
<tr>
<td><strong>Step 3</strong> channel channel_name</td>
<td>Enters the channel configuration mode for the T104 protocol.</td>
</tr>
<tr>
<td><code>channel_name</code> – Identifies the channel on which the router communicates with the Control Center.</td>
<td></td>
</tr>
<tr>
<td><strong>Note</strong> When the entered channel name does not already exist, the router creates a new channel.</td>
<td></td>
</tr>
<tr>
<td>Entering the <code>no</code> form of this command deletes an existing channel. However, all sessions must be deleted before you can delete a channel.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> k-value value</td>
<td>Sets the maximum number of outstanding Application Protocol Data Units (APDUs) for the channel.</td>
</tr>
<tr>
<td><strong>Note</strong> An APDU incorporates the ASDU and a control header.</td>
<td></td>
</tr>
<tr>
<td><code>value</code> – Range of values from 1 to 32767. Default value is 12 APDUs.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> w-value value</td>
<td>Sets the maximum number of APDUs for the channel.</td>
</tr>
<tr>
<td><code>value</code> – Range of values from 1 to 32767. Default value is 8 APDUs.</td>
<td></td>
</tr>
<tr>
<td><strong>Step 6</strong> t0-timeout value</td>
<td>Defines the t0-timeout value for connection establishment of the T104 channel.</td>
</tr>
<tr>
<td><strong>Step 7</strong> t1-timeout value</td>
<td>Defines the t1-timeout value for send or test APDUs on the T104 channel.</td>
</tr>
<tr>
<td><strong>Step 8</strong> t2-timeout value</td>
<td>Defines the t2-timeout value for acknowledgements when the router receives no data message.</td>
</tr>
<tr>
<td><strong>Note</strong> The t2 value must always be set to a lower value than the t1 value on the T104 channel.</td>
<td></td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td><strong>t3-timeout</strong> value</td>
</tr>
<tr>
<td></td>
<td>Defines the t3-timeout value for sending s-frames in case of a long idle state on the T104 channel.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong> The t3 value must always be set to a higher value than the t1 value on the T104 channel.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td><strong>tcp-connection</strong> {0</td>
</tr>
<tr>
<td></td>
<td>In a configuration where there are redundant Control Centers, sets the connection value for the secondary Control Center as defined on the primary Control Center.</td>
</tr>
<tr>
<td></td>
<td>port-number – value between 2000 and 65535.</td>
</tr>
<tr>
<td></td>
<td>default – value of 2404.</td>
</tr>
<tr>
<td></td>
<td>A.B.C.D – single host.</td>
</tr>
<tr>
<td></td>
<td>A.B.C.D/nn – subnet A.B.C.D/LEN.</td>
</tr>
<tr>
<td></td>
<td>any – any remote hosts 0.0.0.0/0.</td>
</tr>
<tr>
<td></td>
<td>WORD – VRF name.</td>
</tr>
<tr>
<td><strong>Step 11</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td></td>
<td>Exits the channel configuration mode.</td>
</tr>
<tr>
<td><strong>Step 12</strong></td>
<td><strong>session</strong> session_name</td>
</tr>
<tr>
<td></td>
<td>Enters the session configuration mode and assigns a name to the session.</td>
</tr>
<tr>
<td></td>
<td>session_name – Use the same name that you assigned to the channel in Step 3.</td>
</tr>
<tr>
<td><strong>Step 13</strong></td>
<td><strong>attach-to-channel</strong> channel_name</td>
</tr>
<tr>
<td></td>
<td>Defines the name of the channel that transports the session traffic.</td>
</tr>
<tr>
<td><strong>Step 14</strong></td>
<td><strong>cot size</strong> {one</td>
</tr>
<tr>
<td></td>
<td>Defines the cause of transmission (cot), such as spontaneous or cyclic data schemes in octets.</td>
</tr>
<tr>
<td><strong>Step 15</strong></td>
<td><strong>exit</strong></td>
</tr>
<tr>
<td></td>
<td>Exits the session configuration mode.</td>
</tr>
<tr>
<td><strong>Step 16</strong></td>
<td><strong>sector</strong> sector_name</td>
</tr>
<tr>
<td></td>
<td>Enters the sector configuration mode and assigns a name to the sector for the Control Center.</td>
</tr>
<tr>
<td><strong>Step 17</strong></td>
<td><strong>attach-to-session</strong> session_name</td>
</tr>
<tr>
<td></td>
<td>Attaches the Control Center sector to the channel.</td>
</tr>
<tr>
<td></td>
<td>session_name – Use the same name that you assigned to the channel in Step 3.</td>
</tr>
<tr>
<td><strong>Step 18</strong></td>
<td><strong>asdu-addr</strong> asdu_address</td>
</tr>
<tr>
<td></td>
<td>Refers to the ASDU structure address. Value entered here must match the ASDU value on the RTU.</td>
</tr>
<tr>
<td></td>
<td>asdu_address – asdu_address – Value of 1 or 2.</td>
</tr>
<tr>
<td><strong>Step 19</strong></td>
<td><strong>map-to-sector</strong> sector_name</td>
</tr>
<tr>
<td></td>
<td>Maps the Control Center (T104) sector to the RTU (T101) sector.</td>
</tr>
<tr>
<td><strong>Step 20</strong></td>
<td>Return to Step 1.</td>
</tr>
<tr>
<td></td>
<td>Repeat all steps in this section for each Control Center active in the network.</td>
</tr>
</tbody>
</table>
This example shows how to configure the parameters for the T104 protocol stack on Control Center 1 and Control Center 2, both of which are configured as masters, and how to map the T104 sector to the T101 sector.

To configure Control Center 1 (cc_master1), enter the following commands.

```plaintext
router# configure terminal
router(config)# scada-gw protocol t104
router(config-t104)# channel cc_master1
router(config-t104-channel)# k-value 12
router(config-t104-channel)# w-value 8
router(config-t104-channel)# t0-timeout 30
router(config-t104-channel)# t1-timeout 15
router(config-t104-channel)# t2-timeout 10
router(config-t104-channel)# t3-timeout 30
router(config-t104-channel)# tcp-connection 0 local-port 2050 remote-ip 209.165.200.225
router(config-t104-channel)# tcp-connection 1 local-port 2051 remote-ip 209.165.201.25
router(config-t104-channel)# exit
router(config-t104)# session cc_master1
router(config-t104-session)# attach-to-channel cc_master1
router(config-t104-session)# cot-size two
router(config-t104-session)# exit
router(config-t104)# sector cc_master1-sector
router(config-t104-sector)# attach-to-session cc_master1
router(config-t104-sector)# asdu-adr 3
router(config-t104-sector)# map-to-sector rtu_sector
router(config-t104)# exit
router(config-t104)# exit
router(config)#
```

To configure Control Center 2 (cc_master2), enter the following commands.

```plaintext
router(config)# scada-gw protocol t104
router(config-t104)# channel cc_master2
router(config-t104-channel)# k-value 12
router(config-t104-channel)# w-value 8
router(config-t104-channel)# t0-timeout 30
router(config-t104-channel)# t1-timeout 15
router(config-t104-channel)# t2-timeout 10
router(config-t104-channel)# t3-timeout 30
router(config-t104-channel)# tcp-connection 0 local-port 2060 remote-ip 209.165.201.237
router(config-t104-channel)# tcp-connection 1 local-port 2061 remote-ip 209.165.200.27
router(config-t104-channel)# exit
router(config-t104)# session cc_master2
router(config-t104-session)# attach-to-channel cc_master2
router(config-t104-session)# cot-size two
router(config-t104-session)# exit
router(config-t104)# sector cc_master2-sector
router(config-t104-sector)# attach-to-session cc_master2
router(config-t104-sector)# asdu-adr 3
router(config-t104-sector)# map-to-sector rtu_sector
router(config-t104-sector)# exit
router(config-t104)# exit
router(config)#
```
The following example shows how to configure the serial port interface for T101 connection, configure T101 and T104 protocol stacks, and starts the Protocol Translation Engine on the IR1101.

```
router# configure terminal
router(config)# interface async 0/2/0
router (config-if)# no shutdown
router (config-if)# encapsulation scada
router (config-if)# exit
router(config)# scada-gw protocol t101
router(config-t101)# channel rtu_channel
router(config-t101-channel)# role master
router(config-t101-channel)# link-mode unbalanced
router(config-t101-channel)# link-addr-size one
router(config-t101-channel)# bind-to-interface async 0/2/0
router(config-t101-channel)# exit
router(config-t101)# session rtu_session
router(config-t101-session)# attach-to-channel rtu_channel
router(config-t101-session)# common-addr-size two
router(config-t101-session)# cot-size one
router(config-t101-session)# info-obj-addr-size two
router(config-t101-session)# link-addr 3
router(config-t101-session)# exit
router(config-t101)# sector rtu_sector
router(config-t101-sector)# attach-to-session rtu_session
router(config-t101-sector)# asdu-addr 3
router(config-t101-sector)# exit
router(config-t101)# exit
router(config)# scada-gw protocol t104
router(config-t104)# channel cc_master1
router(config-t104-channel)# k-value 12
router(config-t104-channel)# w-value 8
router(config-t104-channel)# t0-timeout 30
router(config-t104-channel)# t1-timeout 15
router(config-t104-channel)# t2-timeout 10
router(config-t104-channel)# t3-timeout 30
router(config-t104-channel)# tcp-connection 0 local-port 2050 remote-ip any
router(config-t104-channel)# tcp-connection 1 local-port 2051 remote-ip any
router(config-t104-channel)# exit
router(config-t104)# session cc_master1
router(config-t104-session)# attach-to-channel cc_master1
router(config-t104-session)# cot-size two
router(config-t104-session)# exit
router(config-t104)# sector cc_master1-sector
router(config-t104-sector)# attach-to-session cc_master1
router(config-t104-sector)# asdu-addr 3
router(config-t104-sector)# map-to-sector rtu_sector
router(config-t104)# exit
router(config-t104)# session cc_master2
router(config-t104-session)# attach-to-channel cc_master2
router(config-t104-session)# cot-size two
router(config-t104-session)# exit
router(config-t104)# sector cc_master2-sector
router(config-t104-sector)# attach-to-session cc_master2
router(config-t104-sector)# asdu-addr 3
router(config-t104-sector)# map-to-sector rtu_sector
```
router(config-t104-sector)# exit
router(config-t104)# exit
router(config)# scada-gw enable

This example configures end-to-end communication between Control Centers and RTUs within a SCADA system using the DNP3 protocol stacks and starts the Protocol Translation Engine on the IR1101:

router# configure terminal
router(config)# interface async 0/2/0
router (config-if)# no shutdown
router (config-if)# encapsulation scada
router (config-if)# exit
router(config)# scada-gw protocol dnp3-serial
router(config-dnp3s)# channel rtu_channel
router(config-dnp3s-channel)# bind-to-interface async 0/2/0
router(config-dnp3s-channel)# link-addr source 3
router(config-dnp3s-channel)# unsolicited-response enable
router(config-dnp3s-channel)# exit
router(config-dnp3s)# session rtu_session
router(config-dnp3s-session)# attach-to-channel rtu_channel
router(config-dnp3s-session)# link-addr dest 3
router(config-dnp3s-session)# exit
router(config-dnp3s)# exit
router(config)# scada-gw protocol dnp3-ip
router(config-dnp3n)# channel cc_channel
router(config-dnp3n-channel)# link-addr dest 3
router(config-dnp3n-channel)# top-connection local-port default remote-ip any
router(config-dnp3n-channel)# exit
router(config-dnp3n)# session cc_session
router(config-dnp3n-session)# attach-to-channel cc_channel
router(config-dnp3n-session)# link-addr source 3
router(config-dnp3n-session)# map-to-session rtu_session
router(config-dnp3n)# exit
router(config)# exit
router(config)# scada-gw enable

**Yang Data Model Support for Scada**

The Cisco IOS XE 17.1.1 introduces support for the Cisco IOS XE YANG model for the Scada System. Previous releases already provided Yang models in other areas.

[https://github.com/YangModels/yang/tree/master/vendor/cisco/xe/17111](https://github.com/YangModels/yang/tree/master/vendor/cisco/xe/17111)

**Scada Yang Models**

There are two feature modules available for Scada that belong to the main Cisco-IOS-XE-native model:

- **Cisco-IOS-XE-scada-gw.yang**

  This module contains a collection of YANG definitions for Scada Gateway Configuration commands.

- **Cisco-IOS-XE-scada-gw-oper.yang**

  This module contains a collection of YANG definitions for Scada Gateway operational data.

There are 8 dependent modules (also belonging to the main Cisco-IOS-XE-native model), that should be imported for the Scada models to work. The following section shows the Scada Yang Models list, configuration CLI commands, and the dependent modules that each feature module covers.
Cisco-IOS-XE-scada-gw

This module has the following corresponding Cli commands:

```
(config)# scada-gw protocol t101
(config-t101)# channel <channel-name>
(config-t101)# bind-to-interface <interface-name>
(config-t101)# link-mode <link-mode>
(config-t101)# link-addr-size <size>
(config-t101)# day-of-week <enable>
(config-t101)# session <session_name>
(config-t101)# attach-to-channel <channel-name>
(config-t101)# cot-size <size>
(config-t101)# common-addr-size <size>
(config-t101)# info-obj-addr-size <size>
(config-t101)# link-addr <addr>
(config-t101)# request <request>
(config-t101)# sector <sector_name>
(config-t101)# attach-to-session <session_name>
(config-t101)# asdu-addr <addr>
(config-t101)# request <request>
(config)# scada-gw protocol t104
(config-t104)# channel <channel-name>
(config-t104)# tcp connection
(config-t104)# to-timeout <value>
(config-t104)# t1-timeout <value>
(config-t104)# t2-timeout <value>
(config-t104)# t3-timeout <value>
(config-t104)# k-value <value>
(config-t104)# w-value <value>
(config-t101)# day-of-week <enable>
(config-t101)# send-ei <enable>
(config-t104)# session <session_name>
(config-t104)# attach-to-channel
```
<channel_name>
(config-t104)# sector
<sector_name>
(config-t104)# attach-to-session
<session-name>
config-t104)# map-to-sector
<sector-name>
(config) scada-gw enable

The Cisco-IOS-XE-scada-gw module has the following dependent modules:

- Cisco-IOS-XE-native
- Cisco-IOS-XE-features
- ietf-inet-types
- Cisco-IOS-XE-interfaces
- Cisco-IOS-XE-ip
- Cisco-IOS-XE-vlan
- ietf-yang-types @ (any revision)
- cisco-semver

Cisco-IOS-XE-scada-gw-oper

This module has the following corresponding Cli commands:

```
# show scada statistics
# show scada tcp
```

The Cisco-IOS-XE-scada-gw-oper module has the following dependent modules:

- Cisco-IOS-XE-native
- Cisco-IOS-XE-features
- ietf-inet-types
- Cisco-IOS-XE-interfaces
- Cisco-IOS-XE-ip
- Cisco-IOS-XE-vlan
- ietf-yang-types @ (any revision)
- cisco-semver

Configuring the DNP3 Protocol Stacks

You can configure the DNP3 serial and DNP3 IP protocol stacks, which allow end-to-end communication between Control Centers and RTUs within a SCADA system.

Configuring DNP3 Serial

Configure the channel and session parameters for the DNP serial communication with an RTU.

**SUMMARY STEPS**

1. configure terminal
2. scada-gw protocol dnp3-serial
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>2</td>
<td>scada-gw protocol dnp3-serial</td>
<td>Enters configuration mode for the DNP3 serial protocol.</td>
</tr>
</tbody>
</table>
| 3    | channel channel_name | Enters channel configuration mode for the DNP3 serial protocol.  

*channel_name* – Identifies the channel on which the router serial port communicates to the RTU.  

Note: When the entered channel name does not already exist, the router creates a new channel  

Entering the *no* form of this command deletes an existing channel. However, all sessions must be deleted before you can delete a channel. |
| 4    | bind-to-interface async0/2/0 | Defines the router async interface on which the system sends its DNP3 protocol traffic. |
| 5    | link-addr source source_address | Refers to the link address of the master.  

*source_address* – Range of values from 1 to 65535. |
| 6    | unsolicited-response enable | (Optional) Allows unsolicited responses.  

Entering the *no* form of this command disables unsolicited responses.  

The default is disabled. |
| 7    | exit | Ends configuration of the channel and exits channel configuration mode. Saves all settings. |
| 8    | session session_name | Enters session configuration mode and assigns a name to the session.  

Note: When the entered session name does not already exist, the router creates a new session. |
### Command or Action | Purpose
--- | ---
Step 9 **attach-to-channel channel_name** | Entering the no form of this command deletes an existing session. Attaches the session to the channel. Note: Enter the same channel name that you entered in Step 3 above
channel_name — Identifies the channel.

### Step 10 **link-addr dest destination_address**
Refers to the link address of the slave.
destination_address — Range of values from 1 to 65535.

### Step 11 **exit**
Exits session configuration mode.

### Step 12 **exit**
Exits protocol configuration mode.

---

#### EXAMPLE

This example shows how to configure the parameters for the DPN3-serial protocol stack:

```
router# configure terminal
router(config)# scada-gw protocol dnp3-serial
router(config-dnp3s)# channel rtu_channel
router(config-dnp3s-channel)# bind-to-interface async 0/2/0
router(config-dnp3s-channel)# link-addr source 3
router(config-dnp3s-channel)# unsolicited-response enable
router(config-dnp3s-channel)# exit
router(config-dnp3s)# session rtu_session
router(config-dnp3s-session)# attach-to-channel rtu_channel
router(config-dnp3s-session)# link-addr dest 3
router(config-dnp3s-session)# exit
router(config-dnp3s)# exit
router(config)#
```

#### Configuring DNP3 IP

Follow the steps below for the Control Center that you want to connect to over DNP3 IP. For redundancy, you can create multiple connections that share the same session configuration under the same session.

#### SUMMARY STEPS

1. configure terminal
2. scada-gw protocol dnp3-ip
3. channel channel_name
4. link-addr dest destination_address
5. send-unsolicited-msg enable
6. tcp-connection local-port [default | local_port] remote-ip [any | remote_ip | remote_subnet]
7. exit
8. session session_name
9. attach-to-channel channel_name
**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td>2</td>
<td>scada-gw protocol dnp3-ip</td>
<td>Enters configuration mode for the DNP-IP protocol.</td>
</tr>
<tr>
<td>3</td>
<td>channel channel_name</td>
<td>Enters channel configuration mode for the DNP-IP protocol.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>channel_name</em> – Identifies the channel on which the router communicates with the Control Center.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: When the entered channel name does not already exist, the router creates a new channel.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Entering the no form of this command deletes an existing channel. However, all sessions must be deleted before you can delete a channel.</td>
</tr>
<tr>
<td>4</td>
<td>link-addr dest destination_address</td>
<td>Refers to the link address of the master.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>destination_address</em> – Range of values from 1 to 65535.</td>
</tr>
<tr>
<td>5</td>
<td>send-unsolicited-msg enable</td>
<td>(Optional) Allow unsolicited messages.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The default is enabled.</td>
</tr>
<tr>
<td>6</td>
<td>tcp-connection local-port [default</td>
<td>local_port]</td>
</tr>
<tr>
<td></td>
<td>remote-ip [any</td>
<td>remote_ip</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• local_port – Range of values from 2000 to 65535.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• any – Any remote hosts 0.0.0.0/0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• remote_ip – Single host: A.B.C.D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• remote_subnet – Subnet: A.B.C.D/LEN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If remote_subnet is specified, when two channels have the same local ports, the remote subnets cannot overlap each other.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: Every &lt;local-port, remote-ip&gt; must be unique per channel. If remote_subnet is specified, when two channels have the same local ports, the remote subnets cannot overlap each other.</td>
</tr>
<tr>
<td>7</td>
<td>exit</td>
<td>Exits channel configuration mode.</td>
</tr>
<tr>
<td>8</td>
<td>session session_name</td>
<td>Enters session configuration mode and assigns a name to the session.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Note: When the entered session name does not already exist, the router creates a new session.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Entering the no form of this command deletes an existing session.</td>
<td></td>
</tr>
</tbody>
</table>
| Step 9 attach-to-channel channel_name | Attaches the session to the channel.  
Enter the same channel name that you entered in Step 3.  
channel_name – Identifies the channel. |   |
| Step 10 link-addr source source_address | Refers to the link address of the slave.  
source_address – Value of 1-65535. |   |
| Step 11 map-to-session session_name | Maps the dnp3-ip session to an existing dnp3-serial session.  
Note: One dnp3-ip session can be mapped to only one dnp3-serial session. |   |
| Step 12 exit | Exits session configuration mode. |   |
| Step 13 exit | Exits protocol configuration mode. |   |

**EXAMPLE**

This example shows how to configure the DNP3 IP parameters:

```plaintext
router# configure terminal
router(config)# scada-gw protocol dnp3-ip
router(config-dnp3n)# channel cc_channel
router(config-dnp3n-channel)# link-addr dest 3
router(config-dnp3n-channel)# tcp-connection local-port default remote-ip any
router(config-dnp3n-channel)# exit
router(config-dnp3n)# session cc_session
router(config-dnp3n-session)# attach-to-channel cc_channel
router(config-dnp3n-session)# link-addr source 4
router(config-dnp3n-session)# map-to-session rtu_session
router(config-dnp3n)# exit
router(config)# exit
```

**Starting and Stopping the Protocol Translation Engine**

You must start the Protocol Translation Engine to use Protocol Translation on the IR1101.

**Starting**–After enabling SCADA encapsulation on the IR1101 serial port and configuring the T101 and T104 protocols on the IR1101, you can start the Protocol Translation Engine.

**Stopping**–Before you can make any configuration changes to Protocol Translation on the IR1101 with an active Protocol Translation Engine, you must stop the engine.
Before you begin

Before starting the Protocol Translation Engine on the router for the first time, make sure you complete the following items:

- Enabling the IR1101 Serial Port and SCADA Encapsulation, on page 176
- Configuring T101 and T104 Protocol Stacks, on page 177

SUMMARY STEPS

1. configure terminal
2. [no] scada-gw enable

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 2 [no] scada-gw enable</td>
<td>Starts (scada-gw enable) or stops (no scada-gw enable) the Protocol Translation Engine on the IR1101.</td>
</tr>
</tbody>
</table>

EXAMPLE

To start the protocol translation engine on the router, enter the following commands:

```
router# configure terminal
router(config)# scada-gw enable
```

To stop the protocol translation engine on the router, enter the following commands:

```
router# configure terminal
router(config)# no scada-gw enable
```

Verifying Configuration

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>show running-config</td>
<td>Shows the configuration of the router including active features and their settings.</td>
</tr>
<tr>
<td>show scada database</td>
<td>Displays details on the SCADA database.</td>
</tr>
<tr>
<td>show scada statistics</td>
<td>Shows statistics for the SCADA gateway, including the number of messages sent and received, timeouts, and errors.</td>
</tr>
<tr>
<td>show scada tcp</td>
<td>Displays TCP connections associated with the SCADA gateway.</td>
</tr>
</tbody>
</table>

This example shows the output from the show scada tcp and show scada statistics commands:
router# show scada tcp
DNP3 network channel [test]: 4 max simultaneous connections
conn: local-ip: 3.3.3.21 local-port 20000 remote-ip 3.3.3.15 data-socket 1
Total:
1 current client connections
0 total closed connections
router# show scada statistics
DNP3 network Channel [test]:
5 messages sent, 2 messages received
0 timeouts, 0 aborts, 0 rejections
2 protocol errors, 2 link errors, 0 address errors
DNP3 serial Channel [test]:
152 messages sent, 152 messages received
1 timeouts, 0 aborts, 0 rejections
0 protocol errors, 0 link errors, 0 address errors

Debug Commands

This section lists some debug commands that are helpful when troubleshooting.

Table 12: SCADA DNP3-IP Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada dnp3n application</td>
<td>DNP3-IP application trace</td>
</tr>
<tr>
<td>debug scada dnp3n datalink</td>
<td>DNP3-IP datalink trace</td>
</tr>
<tr>
<td>debug scada dnp3n event</td>
<td>DNP3-IP event trace</td>
</tr>
<tr>
<td>debug scada dnp3n physical</td>
<td>DNP3-IP physical trace</td>
</tr>
<tr>
<td>debug scada dnp3n transport</td>
<td>DNP3-IP transport trace</td>
</tr>
</tbody>
</table>

Table 13: SCADA DNP3-Serial Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada dnp3s application</td>
<td>DNP3-Serial application trace</td>
</tr>
<tr>
<td>debug scada dnp3s datalink</td>
<td>DNP3-Serial datalink trace</td>
</tr>
<tr>
<td>debug scada dnp3s event</td>
<td>DNP3-Serial event trace</td>
</tr>
<tr>
<td>debug scada dnp3s physical</td>
<td>DNP3-Serial physical trace</td>
</tr>
<tr>
<td>debug scada dnp3s transport</td>
<td>DNP3-Serial transport trace</td>
</tr>
</tbody>
</table>

Table 14: SCADA Driver Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada driver event</td>
<td>Driver event trace</td>
</tr>
</tbody>
</table>
### Table 15: SCADA Function Level Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada driver packet</td>
<td>Driver packet trace</td>
</tr>
</tbody>
</table>

### Table 16: SCADA Protocol Layer Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada function config</td>
<td>Configuration trace</td>
</tr>
<tr>
<td>debug scada function control</td>
<td>Control trace</td>
</tr>
<tr>
<td>debug scada function file</td>
<td>File trace</td>
</tr>
<tr>
<td>debug scada function freeze</td>
<td>Freeze trace</td>
</tr>
<tr>
<td>debug scada function physical</td>
<td>Physical trace</td>
</tr>
<tr>
<td>debug scada function poll</td>
<td>Poll trace</td>
</tr>
<tr>
<td>debug scada function stack</td>
<td>Stack trace</td>
</tr>
<tr>
<td>debug scada function umode</td>
<td>Umode trace</td>
</tr>
</tbody>
</table>

### Table 17: SCADA T101 Trace Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada t101 application</td>
<td>T101 application trace</td>
</tr>
<tr>
<td>debug scada t101 datalink</td>
<td>T101 datalink trace</td>
</tr>
<tr>
<td>debug scada t101 event</td>
<td>T101 event trace</td>
</tr>
<tr>
<td>debug scada t101 physical</td>
<td>T101 physical trace</td>
</tr>
<tr>
<td>debug scada t101 transport</td>
<td>T101 transport trace</td>
</tr>
</tbody>
</table>

### Table 18: SCADA T104 Trace Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada t104 application</td>
<td>T104 application trace</td>
</tr>
</tbody>
</table>
### Table 19: SCADA Protocol TCP Level Debug Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>debug scada t104 datalink</td>
<td>T104 datalink trace</td>
</tr>
<tr>
<td>debug scada t104 event</td>
<td>T104 event trace</td>
</tr>
<tr>
<td>debug scada t104 physical</td>
<td>T104 physical trace</td>
</tr>
<tr>
<td>debug scada t104 transport</td>
<td>T104 transport trace</td>
</tr>
</tbody>
</table>
Raw Socket Transport

This section contains the following topics:

- Raw Socket Transport, on page 197

Raw Socket Transport

Raw Socket Transport transports streams of characters from one serial interface to another over an IP network for utility applications.

This document describes Raw Socket Transport for the IR1101 and provides a reference section describing the Raw Socket Transport commands.

This document includes the following sections:

Information About Raw Socket Transport

Raw Socket is a method for transporting serial data through an IP network. The feature can be used to transport Supervisory Control and Data Acquisition (SCADA) data from Remote Terminal Units (RTUs). This method is an alternative to the Block Serial Tunnel (BSTUN) protocol.

Raw Socket Transport supports TCP or UDP as the transport protocol. An interface can be configured to use either protocol but not both at the same time. TCP transport is suitable for applications such as control applications that require acknowledged and sequenced delivery of data. For latency-sensitive applications such as line SEL relays, UDP transport provides faster transport of serial data than TCP.

Raw Socket Transport supports the following for the asynchronous serial interface:

- TCP as the transport protocol, with built-in auto TCP connection retry mechanism.
- Up to 32 TCP sessions.
- Interface configuration as a server, client, or a combination of both.
- One server interface, but multiple clients.
- VRF-awareness, which enables the router to send Raw Socket Transport traffic to a server host connected through a Virtual Private Network (VPN) Virtual Routing and Forwarding (VRF) interface.

This section includes the following topics:
TCP Transport

TCP Raw Socket transport uses a client-server model. At most one server and multiple clients can be configured on a single asynchronous serial line. In client mode, the IR1101 can initiate up to 32 TCP sessions to Raw Socket servers, which can be other IR1101 routers or third-party devices.

Figure 1 shows a sample Raw Socket TCP configuration. In this example, serial data is transferred between RTUs and a utility management system across an IP network that includes several IR1101 routers. One IR1101 router (Router 1) acts as a Raw Socket server, listening for TCP connection requests from the other IR1101 routers (Router 2 and Router 3), which are configured as Raw Socket clients.

A Raw Socket client receives streams of serial data from the RTUs and accumulates this data in its buffer, then places the data into packets, based on user-specified packetization criteria. The Raw Socket client initiates a TCP connection with the Raw Socket server and sends the packetized data across the IP network to the Raw Socket server, which retrieves the serial data from the packets and sends it to the serial interface, and on to the utility management system.

Note

When you configure the serial link interface on the router as a server, the interface’s peer is the serial link interface on the client router and vice versa.

UDP Transport

UDP transport uses a peer-to-peer model. Multiple UDP connections can be configured on an asynchronous serial line.

Figure 2 shows a sample Raw Socket UDP configuration. In this example, serial data is transferred between RTUs and a utility management system across an IP network that includes two routers (Router 1 which is an IR1101 and Router 2 which is an IR807) that are configured as Raw Socket UDP peers.

In this example, the Raw Socket UDP peer receives streams of serial data from the RTUs and accumulates this data in its buffer, then places the data into packets, based on user-specified packetization criteria. The Raw Socket UDP peer sends the packetized data across the IP network to the Raw Socket peer at the other end, which retrieves the serial data from the packets and sends it to the serial interface, and on to the utility management system.
Serial Data Processing

When the default serial protocol, Asynchronous Communication Protocol, is used, the streams of serial data received by a Raw Socket peer can be packetized based on the following criteria:

- **Packet length**—You can specify a packet length that triggers the IR1101 to transmit the serial data to the peer. Once the IR1101 collects this much data in its buffer, it packetizes the accumulated data and forwards it to the Raw Socket peer.

- **Packet-timer value**—The packet timer specifies the amount of time the IR1101 waits to receive the next character in a stream. If a character is not received by the time the packet timer expires, the data the IR1101 has accumulated in its buffer is packetized and forwarded to the Raw Socket peer.

- **Special character**—You can specify a character that will trigger the IR1101 to packetize the data accumulated in its buffer and send it to the Raw Socket peer. When the special character (for example, a CR/LF) is received, the IR1101 packetizes the accumulated data and sends it to the Raw Socket peer.

See the “Configuring Common Raw Socket Line Options” procedure on page 6 for information about configuring the processing options.

VRF-Aware Raw Socket

The VRF-aware Raw Socket Transport feature enables you to isolate Raw Socket traffic using a VRF for efficient management and control of serial data. After configuring a VRF, you can associate the serial interface configured for Raw Socket Transport with the VRF. See the Raw Socket VRF, on page 208 for a configuration example.

Prerequisites

Determine how you want Raw Socket traffic transported in your network, including the network devices and interfaces to use, how the router packetizes the serial data, and whether to use VRF.

Guidelines and Limitations

Typically, UDP traffic is blocked by firewalls in the network. If the network has such firewalls, make sure to configure pinholes to allow the raw socket UDP traffic.
Default Settings

<table>
<thead>
<tr>
<th>Feature</th>
<th>Default Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Socket Transport</td>
<td>Disabled.</td>
</tr>
<tr>
<td>Packet length</td>
<td>No packet length is configured.</td>
</tr>
<tr>
<td>Serial Protocol</td>
<td>Asynchronous Communication Protocol</td>
</tr>
<tr>
<td>Packet timeout</td>
<td>15 ms.</td>
</tr>
<tr>
<td>Special character</td>
<td>No special character is configured.</td>
</tr>
<tr>
<td>Raw Socket mode</td>
<td>Best-effort mode is off, not supported on the IR1101.</td>
</tr>
<tr>
<td>TCP idle timeout</td>
<td>5 minutes.</td>
</tr>
</tbody>
</table>

Configuring Raw Socket Transport

This section includes the following topics:

Enabling Raw Socket Transport on the Serial Interface

To enable Raw Socket Transport on the IR1101 router, you must first enable an asynchronous serial port and enable Raw Socket TCP or UDP encapsulation for that port.

Before you begin

Determine availability of the serial port on the IR1101.

SUMMARY STEPS

1. configure terminal
2. interface async0/slot/port
3. no ip address
4. Do one of the following:
   * encapsulation raw-tcp
   * encapsulation raw-udp

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Step 2 interface async0/slot/port</td>
<td>Enters the interface command mode for the async slot/port.</td>
</tr>
<tr>
<td>Step 3 no ip address</td>
<td>Disables IP processing on the interface.</td>
</tr>
</tbody>
</table>
### Command or Action | Purpose
--- | ---
**Step 4** | Do one of the following:  
• encapsulation raw-tcp  
• encapsulation raw-udp  
| Enables Raw Socket TCP encapsulation or UDP encapsulation for the serial port.  

### EXAMPLE
This example shows how to enable serial port 0/2/0 and how to enable Raw Socket TCP encapsulation on that port.

```
router# configure terminal
router(config)# interface async0/2/0
router(config-if)# no ip address
router(config-if)# encapsulation raw-tcp
router(config-if)# exit
```

### Configuring Common Raw Socket Line Options
You can configure options common to all connections on a line. The common options apply to both TCP and UDP.

#### Before you begin
Enable Raw Socket Transport as described in Enabling Raw Socket Transport on the Serial Interface, on page 200.

### SUMMARY STEPS
1. configure terminal  
2. line 0/slot/port  
3. raw-socket packet-length *length*  
4. raw-socket packet-timer *timeout*  
5. raw-socket spec-char *ascii_char*

### DETAILED STEPS

| Command or Action | Purpose |
--- | --- |
**Step 1** | configure terminal  
| Enters global configuration mode.  
|  
**Step 2** | line 0/slot/port  
| Enters line command mode for the serial slot/port.  
|  
**Step 3** | raw-socket packet-length *length*  
| Specifies the packet size that triggers the IR1101 to transmit the data to the peer. When the IR1101 accumulates this much data in its buffer, it packetizes the data and forwards it to the Raw Socket peer.  
*length*—2 to 1400 bytes.  
| By default, the packet-length trigger is disabled.  

---

*Cisco IR1101 Integrated Services Router Software Configuration Guide*
### Purpose

**Command or Action**  
**Step 4** raw-socket packet-timer *timeout*  
**Step 5** raw-socket spec-char *ascii_char*

### Purpose

**Command or Action**  
**Step 4** raw-socket packet-timer *timeout*  
Specifies the maximum time in milliseconds the IR1101 waits to receive the next character in a stream. If a character is not received by the time the packet-timer expires, the accumulated data is packetized and forwarded to the Raw Socket peer.

*timeout* — 3 to 1000 ms.
The default is 15 ms.

**Step 5** raw-socket spec-char *ascii_char*  
Specifies a character that will trigger the IR1101 to packetize the data accumulated in its buffer and send it to the Raw Socket peer.

*ascii_char* — 0 to 255.
By default, the special character trigger is disabled.

### What to do next

Use the **no** form of these commands to return to the default values.

### EXAMPLE

```bash
router# configure terminal
router(config)# line 0/2/0
router(config-line)# raw-socket packet-length 32
router(config-line)# raw-socket packet-timer 500
router(config-line)# raw-socket special-char 3
```

### Configuring Raw Socket TCP

After enabling Raw Socket TCP encapsulation, you configure the TCP server and/or clients.

#### Configuring the Raw Socket TCP Server

**Before you begin**

Enable a serial port and Raw Socket TCP encapsulation for that port, as described in Enabling Raw Socket Transport on the Serial Interface, on page 200.

**SUMMARY STEPS**

1. **configure terminal**
2. **line 0/slot/port**
3. **raw-socket tcp server port [ip_address ]**
4. **raw-socket tcp idle-timeout session_timeout**

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
</tbody>
</table>
### Purpose

<table>
<thead>
<tr>
<th>Command or Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 2</strong> line 0/slot/port</td>
</tr>
<tr>
<td><strong>Step 3</strong> raw-socket tcp server port [ip_address]</td>
</tr>
<tr>
<td><strong>Step 4</strong> raw-socket tcp idle-timeout session_timeout</td>
</tr>
</tbody>
</table>

### Purpose

**Step 2**

Enters line command mode for the serial slot/port.

**Step 3**

Starts the Raw Socket Transport TCP server for an asynchronous line interface. In Raw Socket server mode, the IR1101 listens for incoming connection requests from Raw Socket clients.

- **port** – Port number the server listens on.
- **ip_address** – (Optional) Local IP address on which the server listens for connection requests.

**Step 4**

Sets the Raw Socket Transport TCP session timeout for the asynchronous line interface. If no data is transferred between the client and server over this interval, then the TCP session closes. The client then automatically attempts to reestablish the TCP session with the server.

- **session_timeout** – Currently configured session idle timeout in minutes. The default is 5 minutes.

### What to do next

To remove a Raw Socket TCP server, use the **no raw-socket tcp server** command.

### EXAMPLE

This example shows how to configure a Raw Socket TCP server for an asynchronous serial line. The TCP server listens for TCP client connection requests on local port 4000 and local IP address 10.0.0.1. If no data is exchanged between the Raw Socket TCP server and one of the TCP clients for 10 minutes, then the TCP session closes, and the Raw Socket client attempts to reestablish the session with the Raw Socket server.

```
router# configure terminal
router(config)# line 0/2/0
router(config-line)# raw-socket tcp server 4000 10.0.0.1
router(config-line)# raw-socket tcp idle-timeout 10
router(config-line)# exit
```

### Configuring the Raw Socket TCP Client

#### Before you begin

Enable a serial port and Raw Socket TCP encapsulation for that port, as described in [Enabling Raw Socket Transport on the Serial Interface](#), on page 200.  

### SUMMARY STEPS

1. **configure terminal**
2. **line 0/slot/port**
3. **raw-socket tcp client dest_ip_address dest_port [local_ip_address ] [local_port ]**
4. **raw-socket tcp idle-timeout session_timeout**
5. **raw-socket tcp keepalive interval**

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>line 0/slot/port</td>
<td>Enters line command mode for the serial slot/port.</td>
</tr>
</tbody>
</table>
| **Step 3** | raw-socket tcp client dest_ip_address dest_port [local_ip_address ] [local_port ] | Specifies settings for Raw Socket Transport TCP client sessions.  
  *dest_ip_address* – Destination IP address of the remote Raw Socket server.  
  *dest_port* – Destination port number to use for the TCP connection to the remote server.  
  *local_ip_address* – (Optional) Local IP address that the client can also bind to.  
  *local_port* – (Optional) Local port number that the client can also bind to. |
| **Step 4** | raw-socket tcp idle-timeout session_timeout | Sets the Raw Socket Transport TCP session timeout for the asynchronous line interface. If no data is transferred between the client and server over this interval, then the TCP session is closed. The client then automatically attempts to reestablish the TCP session with the server.  
  This timeout setting applies to all Raw Socket Transport TCP sessions under this particular line.  
  *session_timeout* – Currently configured session idle timeout in minutes. The default is 5 minutes. |
| **Step 5** | raw-socket tcp keepalive interval | Sets the Raw Socket Transport TCP session keepalive interval for the asynchronous line interface. The router sends keepalive messages based on the configured interval. You may need to configure this interval, for example, when sending raw TCP traffic over a cellular interface.  
  *interval* – Currently configured keepalive interval in seconds. Range is 1-864000 seconds. The default is 1 second. |

### What to do next

To remove a Raw Socket TCP client, use the **no raw-socket tcp client** command.
This example shows how to configure a Raw Socket TCP client for an asynchronous serial line. The IR1101 (router), serving as a Raw Socket client, initiates TCP sessions with a Raw Socket server and forwards packetized serial data to it. The router collects streams of serial data in its buffer; when it accumulates 827 bytes in its buffer, the router packetizes the data and forwards it to the Raw Socket server. If the router and the Raw Socket server do not exchange any data for 10 minutes, then the TCP session with the Raw Socket server closes, and the router attempts to reestablish the session with the Raw Socket server.

```
router# configure terminal
router(config)# line 0/2/0
router(config-line)# raw-socket tcp client 10.0.0.1 4000
router(config-line)# raw-socket packet-length 827
router(config-line)# raw-socket tcp idle-timeout 10
router(config-line)# exit
router(config)#
```

**Configuring a Raw Socket UDP Peer-to-Peer Connection**

After enabling Raw Socket UDP encapsulation and the common line options, you configure the Raw Socket UDP peer-to-peer connection. The local port on one end of the connection should be the destination port on the other end.

**Before you begin**

Enable a serial port and Raw Socket UDP encapsulation for that port, as described in Enabling Raw Socket Transport on the Serial Interface, on page 200.

**SUMMARY STEPS**

1. configure terminal
2. line 0/slot/port
3. raw-socket udp connection dest_ip_address dest_port local_port [local_ip_address ]

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 configure terminal</td>
<td>Enters configuration mode.</td>
</tr>
<tr>
<td>Step 2 line 0/slot/port</td>
<td>Enters line command mode for the serial slot/port.</td>
</tr>
</tbody>
</table>
| Step 3 raw-socket udp connection dest_ip_address dest_port local_port [local_ip_address ] | Specifies settings for Raw Socket Transport UDP connections.  
  dest_ip_address – Destination IP address to use for the UDP connection.  
  dest_port – Destination port number to use for the UDP connection.  
  local_port – Local port number for the UDP connection.  
  local_ip_address – (Optional) Local IP address for the UDP connection. |
What to do next

To remove a Raw Socket UDP connection, use the `no raw-socket udp connection` command.

**EXAMPLE**

This example shows how to configure a Raw Socket UDP connection between router A (local IP address 192.168.0.8) and router B (local IP address 192.168.0.2).

**Router A**

```
router# configure terminal
router(config)# line 0/2/0
router(config-line)# raw-socket udp connection 192.168.0.2 5000 7000
router(config-line)# exit
router(config)#
```

**Router B**

```
router# configure terminal
router(config)# line 0/2/0
router(config-line)# raw-socket udp connection 192.168.0.8 7000 5000
router(config-line)# exit
router(config)#
```

**Verifying Configuration**

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>show running-config</code></td>
<td>Shows the configuration of the IR1101, including those features that are active and their settings.</td>
</tr>
<tr>
<td><code>show raw-socket tcp detail</code></td>
<td>Displays information about Raw Socket Transport TCP activity.</td>
</tr>
<tr>
<td><code>show raw-socket tcp sessions</code></td>
<td>Displays information about Raw Socket Transport TCP sessions.</td>
</tr>
<tr>
<td><code>show raw-socket tcp statistics</code></td>
<td>Displays Raw Socket Transport TCP statistics for each asynchronous serial line.</td>
</tr>
<tr>
<td><code>show raw-socket udp detail</code></td>
<td>Displays information about Raw Socket Transport UDP activity.</td>
</tr>
<tr>
<td><code>show raw-socket udp sessions</code></td>
<td>Displays information about Raw Socket Transport UDP sessions.</td>
</tr>
<tr>
<td><code>show raw-socket udp statistics</code></td>
<td>Displays Raw Socket Transport UDP statistics for each asynchronous serial line.</td>
</tr>
<tr>
<td><code>clear raw-socket statistics</code></td>
<td>Clears Raw Socket Transport statistics for a specific TTY interface or for all asynchronous serial lines.</td>
</tr>
</tbody>
</table>

**Configuration Example**

The following sections include Raw Socket Transport configuration examples:
**Raw Socket TCP**

The following example shows a Raw Socket Transport configuration in which an IR1101 router (Router 1) acts as the server, and another IR809 (Router 2) acts as the client.

The following table displays the configuration of the server and client IR1101s highlighted in Figure 3:

<table>
<thead>
<tr>
<th>IR1101 Server Configuration</th>
<th>IR807 Client Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>interface async0/2/0</td>
<td>interface async0</td>
</tr>
<tr>
<td>no ip address</td>
<td>no ip address</td>
</tr>
<tr>
<td>encapsulation raw-tcp</td>
<td>encapsulation raw-tcp</td>
</tr>
<tr>
<td>!</td>
<td>!</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>line 0/2/0</td>
<td>line 1</td>
</tr>
<tr>
<td>raw-socket tcp server 5000 10.0.0.1</td>
<td>raw-socket tcp client 10.0.0.1 5000 10.0.0.2 9000</td>
</tr>
<tr>
<td>raw-socket packet-timer 3</td>
<td>raw-socket packet-length 32</td>
</tr>
<tr>
<td>raw-socket tcp idle-timeout 5</td>
<td>raw-socket tcp idle-timeout 5</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Raw Socket UDP**

This example shows the configuration for a Raw Socket UDP connection between two IR1101 routers:

**From Router1**

```
interface GigabitEthernet0/1
ip address 192.168.0.8 255.255.255.0
duplex auto
speed auto
interface async0/2/0
no ip address
encapsulation raw-udp
line 0/2/0
raw-socket udp connection 192.168.0.2 2 2
```
From Router2

interface GigabitEthernet0/1
ip address 192.168.0.2 255.255.255.0
load-interval 60
duplex auto
speed auto
no keepalive

interface async0/2/0
no ip address
encapsulation raw-udp
line 0/2/0
raw-socket udp connection 192.168.0.8 2 2

Raw Socket VRF

The following example shows a Raw Socket VRF configuration in which two routers, configured for Raw Socket Transport, connect through a VRF. Router1 is an IR1101, serves as the Raw Socket TCP server, and Router2 is an IR807 serves as the Raw Socket TCP client.

Following are the configurations of Router1 and Router2 as shown in Figure 4:

Router1 Configuration

Defining VRF on the router:

vrf definition router1
rd 100:1
route-target export 100:3
route-target import 100:3

interface GigabitEthernet0/0
vrf forwarding router1
ip address 100.100.100.2 255.255.255.0
duplex auto
speed auto

Applying raw-tcp on the serial interface:

interface async0/2/0
vrf forwarding router1
ip address 192.168.0.8 255.255.255.0
duplex auto
speed auto
raw-socket udp connection 192.168.0.8 2 2
interface async0/2/0
  vrf forwarding router1
  no ip address
  encapsulation raw-tcp

Applying raw-tcp on the line:

line 0/2/0
  raw-socket tcp server 5000 4.4.4.4

Router2 Configuration

Defining VRF on the router:

vrf definition router1
  rd 100:1
  route-target export 100:3
  route-target import 100:3
!
  address-family ipv4
  exit-address-family

Applying VRF configuration on the interface:

interface GigabitEthernet0/0
  vrf forwarding router1
  ip address 100.100.100.1 255.255.255.0
  duplex auto
  speed auto

Applying raw-tcp on the serial interface:

interface async0
  vrf forwarding router1
  no ip address
  encapsulation raw-tcp

Applying raw-tcp on line:

line 1
  raw-socket tcp client 4.4.4.4 5000
Expansion Module

This section contains the following topics:

- Expansion Module Overview, on page 211
- mSATA Overview, on page 212
- Digital IO, on page 215
- New Cellular Pluggable Modules, on page 218
- SFP Support, on page 219

Expansion Module Overview

The IR1101 ISR has an Expansion Module that adds key capabilities such as dual LTE Pluggables, mSATA SSD FRU, SFP, and Digital GPIO connections.

The Expansion Module comes in two types:

- IRM-1100-SPMI
- IRM-1100-SP

Warning

It is important to note that just like the Base IR1101, Online Insertion and Removal (OIR) is not supported on The Expansion Module. If the 4G module (or mSATA) is inserted or pulled out while the device is powered up, it may damage the module.

The following figure shows the front panel of the IRM-1100-SPMI and highlights some of its capabilities:
**mSATA Overview**

IOx/Guest-OS legacy systems on which end users can host applications, typically came with a disk storage of 4GB to store user data. Functionality has been added allowing for a Cisco supported Pluggable mSATA SSD PID to add 50 GB of available storage. Support for a 100 GB mSATA SSD has the following limitations:

- There is no support for the `show inventory` command.
- Supports 55GB (IOx allocation for applications and packages alike), 32B (IOS allocation for storage can be viewed in ‘dir msata’ on IOS).
It is important to note that Online Insertion and Removal (OIR) is not supported. If the mSATA SSD is inserted or pulled out while the device is powered up, it may damage the module.

Warning

As with any IoT platform, for IOx, use the Fog Director, Local Manager, or app-hosting CLI's to install applications and access the new mSATA disk storage provided.

Note

50 GB mSATA Partitioning

IOS-XE divides the mSATA SSD into 2 partitions. One for IOS-XE and the other for IOx. The percentage of usage is:

- IOS: 33.33%
- IOx: 66.66%

Using these percentages, the space allocation breaks down as follows:

50GB mSATA:

- IOS: 16.51 GB
- IOx: 31.43 GB

Using the mSATA SSD

Functionality-wise, there are no configuration and troubleshooting differences to the end-user in IOS or IOx, with or without mSATA. The system simply recognizes the additional storage. There are some CLI commands that will show information that pertains to the mSATA storage. Examples are show inventory, and show platform msata.

Router#show inventory
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
INFO: Please use "show license UDI" to get serial number for licensing.
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

Router#show platform hardware msata lifetime
SSD Lifetime Remaining: 99% -> 99% of the net disk read/write lifetime is remaining

Router#show platform hardware msata status
SSD is present

Router#show platform hardware msata
SSD Lifetime remaining(%): 99

Display the mSATA Partitioning:

Display mSATA partition 1 in IOS-XE:

Router#dir msata:
Directory of msata:/
11 drwx 16384 Jun 4 2019 17:59:45 +00:00 lost+found
33820622848 bytes total (32052379648 bytes free)
Copy contents to and from mSATA partition:

```
Router#copy bootflash: msata:
Source filename [ ] ? sparrow-uefi-rommon.SSA
Destination filename [sparrow-uefi-rommon.SSA]?
Copy in progress...CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
2097152 bytes copied in 0.164 secs (12787512 bytes/sec)
```

Display disk space allocated by mSATA to IOx:

```
Router#show app-hosting resource
CPU:
Quota: 1000(Units)
Available: 1000(Units)
Memory:
Quota: 862(MB)
Available: 862(MB)
Storage space:
Total: 58313(MB)
Available: 58313(MB)
```

**Displaying the Wear Leveling Data for the mSATA SSD**

IOx Local Manager/ Fog Director can now display the wear leveling data for the mSATA SSD on the IR1101. In the IOx Local Manager, it is observed by selecting **System > Storage**.

From the IOS command line, you can monitor the lifetime using the `show platform hardware msata` command.

```
Router#show platform hardware msata lifetime
SSD Lifetime remaining(%): 98
```

After a router reload, it will take a few minutes (approximately 5) before this data will be populated again.

When the SSD lifetime reduces to 15% and 5% of the lifetime limit, errors start getting reported in syslog.

For example:

*Jan 30 19:03:00.257: %IOX-4-IOX_SSD_LIFETIME_WARN: SSD Lifetime remaining in module:15

**MIB support for mSATA Wear Ratio and Usage**

mSATA functionality was added to the router to add extra storage for IOx apps. The following table shows the router with the OID:

<table>
<thead>
<tr>
<th>SKU</th>
<th>OID</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR1100-SSD-100G</td>
<td>1.3.6.1.4.1.9.12.3.1.9.96.176</td>
</tr>
</tbody>
</table>

As part of this enhancement, SNMP support has been added for the following mSATA parameters on the router:

- lifetime remaining (wear leveling)
- memory usage for the mSATA SSD
The `show platform hardware msata` command gives information about this MIB.

Related documentation:


https://developer.cisco.com/docs/iox/

**Example: Actual OID and output of SNMP get/walk on OID**

```plaintext
<OID> = STRING: "Lifetime Remaining: 99%, Usage: 30%"
```

**Feature Details**

The following conditions must be met before performing SNMP requests on the Router:

- An active mSATA module must be configured in the router.
- The Integrator must have incorporated the supported pluggable mSATA into their design.
- Verify this using the `show platform hardware msata` CLI.

**Feature Assumptions**

- After a router reload it will take approximately 5 minutes before mSATA data will be populated again. Only SNMP get is allowed on the OID and is marked as read-only. Setting its value will not be allowed.
- Configurations to enable SNMP on the router are necessary for fetching MIB value.

**Digital IO**

The IR1101 has two different Expansion Modules, the IRM-1100-SP and IRM-1100-SPMI. The IRM-1100-SPMI comes with a Digital I/O connector which has 4 GPIO connections plus 1 Return connection. Both Dry and Wet contacts up to 60Volts.

- Dry contact is isolated from a voltage source (or “No Volt”), with an embedded relay function (NPN transistor), usually used to indicate an event. For example: open/close, alarm.
- Wet contact is a contact with external power (+3.3V to +60V, max 150mA of current allowed at high voltage) applied, usually used to energize something. For example: solenoid, light.

Digital IO is similar to the ALARM IN and ALARM OUT supported on the IR800 series routers. The differences are that on the IR800 series, ALARM IN is a dedicated input, the ALARM OUT is a dedicated output. With Digital IO, it can be input or output. ALARM OUT includes a relay to provide the Normally Open (NO) or Normally Close (NC) terminals. Digital IO does not include a relay.

There are no traps for alarms on the GPIO.

More information on the Digital IO hardware capabilities can be found in the **IR1101 Industrial Integrated Services Router Hardware Installation Guide**.

**Configuration Commands**

You can set the alarm severity to critical, major, minor, or none. The severity is included in the alarm message when the alarm is triggered.
To configure and show alarms on the IR1101, use the Command Line Interface (CLI).

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>alarm contact</td>
<td>Enables the alarm contact number.</td>
</tr>
<tr>
<td>contact-number enable</td>
<td>Enter a contact number (0-4) that you are configuring.</td>
</tr>
<tr>
<td></td>
<td>• The description string is up to 80 alphanumeric characters in length</td>
</tr>
<tr>
<td></td>
<td>and is included in any generated system messages.</td>
</tr>
<tr>
<td></td>
<td>• For application, select dry (default) or wet. Only applicable for</td>
</tr>
<tr>
<td></td>
<td>Digital I/O ports 1-4.</td>
</tr>
<tr>
<td></td>
<td>• enable is for enabling the alarm port. A no alarm contact</td>
</tr>
<tr>
<td></td>
<td>contact-number x will disable the alarm port.</td>
</tr>
<tr>
<td></td>
<td>• The output is either 1 for High or 0 for Low. Only application for</td>
</tr>
<tr>
<td></td>
<td>Digital I/O ports 1-4.</td>
</tr>
<tr>
<td></td>
<td>• For severity, enter critical, major, minor or none. If you do not</td>
</tr>
<tr>
<td></td>
<td>configure a severity, the default is minor.</td>
</tr>
<tr>
<td></td>
<td>• For threshold, select a value between 1600-2700. The default value</td>
</tr>
<tr>
<td></td>
<td>is 1600 mv.</td>
</tr>
<tr>
<td></td>
<td>• For trigger, enter open or closed. If you do not configure a trigger,</td>
</tr>
<tr>
<td></td>
<td>the alarm is triggered when the circuit is closed.</td>
</tr>
<tr>
<td>alarm contact</td>
<td>Configure an alarm.</td>
</tr>
<tr>
<td>{contact-number</td>
<td>&lt;0-4&gt; Alarm contact number (0: Alarm port, 1-4: Digital I/O)</td>
</tr>
<tr>
<td>{application {dry</td>
<td></td>
</tr>
<tr>
<td>wet}</td>
<td>description</td>
</tr>
<tr>
<td>end</td>
<td>Returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>show alarm</td>
<td>Shows the configured alarm contacts.</td>
</tr>
<tr>
<td>copy running-config</td>
<td>(Optional) Saves your entries in the configuration file.</td>
</tr>
<tr>
<td>startup-config</td>
<td></td>
</tr>
</tbody>
</table>

Verify alarm contacts using the CLI:

```
Router(config)#alarm contact ?
<0-4> Alarm contact number (0: Alarm port, 1-4: Digital I/O)
```

### Configuration Examples

#### Configure an alarm.

```
ir1101#conf term
Enter configuration commands, one per line. End with CNTL/Z.
ir1101(config)#alarm contact 1 description
```

Cisco IR1101 Integrated Services Router Software Configuration Guide
Your Descriptive Text Here

ir1101(config)# alarm contact 1 severity critical

ir1101(config)# alarm contact 1 trigger closed

ir1101#

**To show the alarm status:**

ir1101# show alarm
Alarm contact 0:
Enabled: Yes
Status: Not Asserted
Application: Dry
Description: test
Severity: Critical
Trigger: Open
Threshold: 2000

**Example of an alarm being generated:**

ir1101# !
*Nov 27 14:54:52.573: %IR1101_ALARM_CONTACT-0-EXTERNAL_ALARM_CONTACT_ASSERT: External alarm asserted, Severity: Critical

**To show the alarm status during an event:**

ir1101# show alarm
ALARM CONTACT
Enabled: Yes
Status: Asserted
Application: Dry
Description: test
Severity: Critical
Trigger: Open
Threshold: 2000
Digital I/O 1:
Enabled: No
Status: Not Asserted
Application: Dry
Description: External digital I/O port 1
Severity: Minor
Trigger: Closed
Threshold: 1600
Digital I/O 2:
Enabled: No
Status: Not Asserted
Application: Dry
Description: External digital I/O port 2
Severity: Minor
Trigger: Closed
Threshold: 1600
Digital I/O 3:
Enabled: No
Status: Not Asserted
Application: Dry
Description: External digital I/O port 3
Severity: Minor
Trigger: Closed
Threshold: 1600
Digital I/O 4:
Enabled: Yes
Status: Not Asserted
Description: External digital I/O port 4
Mode: Output
Router#

Example of an alarm being cleared:

ir1101# !
*Nov 27 14:55:02.573: %IR1101_ALARM_CONTACT-0-EXTERNAL_ALARM>Contact_CLEAR: External alarm cleared
ir1101#

New Cellular Pluggable Modules

Release 16.12.1 supports new pluggable modules/modems. The IR1101 with an Expansion Module supports DUAL LTE (Active/Active), DUAL SIM and DUAL Radio.

- Dual LTE (active/active or active/backup) is supported on the IR1101 equipped with an expansion module and two LTE pluggable interfaces. One on the base unit, the other on the expansion module.
- With DUAL SIM, the two SIMs operate in active/backup mode on the single LTE pluggable module.
  With DUAL Radio the two LTE pluggable modules operate in active/active mode with each of the two SIMs assigned to a specific cellular radio on the DUAL Radio.

See the following table for details on the new SKUs.

<table>
<thead>
<tr>
<th>SKU ID</th>
<th>Modem Used</th>
<th>Description</th>
<th>Technology Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-LTE-GB</td>
<td>WP7607-G</td>
<td>Europe Dual Micro SIM</td>
<td>LTE CAT4: B3, B5, B8, B20, B28 HSPA+: B1, B5, B8 EDGE: 900/1800</td>
</tr>
</tbody>
</table>
## SFP Support

The SFP interface on the Expansion Module operates differently than on the Base unit. The SFP interface on the IR1101 base module is part of the combo port (SFP/RJ45) for GigabitEthernet0/0/0. It may be configured as Layer-3 (default) or Layer-2 interface.

The SFP interface on the Expansion Module is only an SFP interface. It is named GigabitEthernet0/0/5, and is a Layer-2 interface. For Layer-3 feature set, it must be assigned to a VLAN interface.

Details about the SFP Interface can be displayed using the `show interfaces transceiver detail` CLI, for example:

```plaintext
Router#show interfaces transceiver detail
IDPROM for transceiver Gigabitethernet0/0/0:
Description = SFP or SFP+ optics (type 3)
Transceiver Type: = GE T (26)
Product Identifier (PID) = ABCU-5710RZ-CS4
Vendor Revision =
Serial Number (SN) = AGM151124J4
Vendor Name = CISCO-AVAGO
Vendor OUI (IEEE company ID) = 00.17.6A (5994)
CLEI code =
Cisco part number =
Device State = Enabled.
```
Date code (yy/mm/dd) = 11/03/21
Connector type = Unknown.
Encoding = 8B10B (1)
Nominal bitrate = GE (1300 Mbits/s)
Minimum bit rate as % of nominal bit rate = not specified
Maximum bit rate as % of nominal bit rate = not specified

Socket Verification

SFP IDPROM Page 0xA0:
000: 03 04 00 08 00 00 00 00 00 00
010: 00 01 00 00 00 00 00 00 64 00
020: 43 49 53 43 4F 2D 41 56 41 47
030: 4F 20 20 20 20 20 17 6A
040: 41 42 43 55 2D 35 37 31 30 52
050: 5A 2D 43 53 34 20 20 20 20 20
060: 41 OC C1 15 00 10 00 00 41 47
070: 4D 31 35 31 31 32 34 4A 34 20
080: 20 20 20 20 31 30 33 32 31
090: 20 20 00 00 99 00 00 06 17
100: C5 44 22 B7 DE 02 63 0F 59 73
110: 64 EC A5 37 19 00 00 00 00 00
120: FF FF FF FF FF FF FF FF FF FF
130: FF FF FF FF FF FF FF FF FF FF
140: FF FF FF FF FF FF FF FF FF FF
150: FF FF FF FF FF FF FF FF FF FF
160: FF FF FF FF FF FF FF FF FF FF
170: FF FF FF FF FF FF FF FF FF FF
180: FF FF FF FF FF FF FF FF FF FF
190: FF FF FF FF FF FF FF FF FF FF
200: FF FF FF FF FF FF FF FF FF FF
210: FF FF FF FF FF FF FF FF FF FF
220: FF FF FF FF

SFP IDPROM Page 0xA2:
000: 00 00 00 00 00 00 00 00 00 00
010: 00 00 00 00 00 00 00 00 00 00
020: 00 00 00 00 00 00 00 00 00 00
030: 00 00 00 00 00 00 00 00 00 00
040: 00 00 00 00 00 00 00 00 00 00
050: 00 00 00 00 00 00 00 00 00 00
060: 00 00 00 00 00 00 00 00 00 00
070: 00 00 00 00 00 00 00 00 00 00
080: 00 00 00 00 00 00 00 00 00 00
090: 00 00 00 00 00 00 00 00 00 00
100: 00 00 00 00 00 00 00 00 00 00
110: 00 00 00 00 00 00 00 00 00 00
120: 00 00 00 00 00 00 00 00 00 00
130: 00 00 00 00 00 00 00 00 00 00
140: 00 00 00 00 00 00 00 00 00 00
150: 00 00 00 00 00 00 00 00 00 00
160: 00 00 00 00 00 00 00 00 00 00
170: 00 00 00 00 00 00 00 00 00 00
180: 00 00 00 00 00 00 00 00 00 00
190: 00 00 00 00 00 00 00 00 00 00
200: 00 00 00 00 00 00 00 00 00 00
210: 00 00 00 00 00 00 00 00 00 00
220: 00 00 00 00 00 00 00 00 00 00
230: 00 00 00 00 00 00 00 00 00 00
240: 00 00 00 00 00 00 00 00 00 00
250: 00 00 00 00 00 00 00 00 00 00

Link reach for 9u fiber (km)
- SX(550/270m) (0)
  1xFC-MM(500/300m) (0)
  2xFC-MM(300/150m) (0)
### Link reach for 9μ fiber (m)

- ESCON-MM(2km) (0)
- SX(550/270m) (0)
- 1xFC-MM(500/300m) (0)
- 2xFC-MM(300/150m) (0)
- ESCON-MM(2km) (0)

### Link reach for 50μ fiber (m)

- SR(2km) (0)
- IR-1(15km) (0)
- IR-2(40km) (0)
- LR-1(40km) (0)
- LR-2(80km) (0)
- LR-3(80km) (0)
- DX(40km) (0)
- HX(40km) (0)
- ZX(80km) (0)
- VX(100km) (0)
- 1xFC, 2xFC-SM(10km) (0)
- ESCON-SM(20km) (0)

### Link reach for 62.5μ fiber (m)

- SR(2km) (0)
- IR-1(15km) (0)
- IR-2(40km) (0)
- LR-1(40km) (0)
- LR-2(80km) (0)
- LR-3(80km) (0)
- DX(40km) (0)
- HX(40km) (0)
- ZX(80km) (0)
- VX(100km) (0)
- 1xFC, 2xFC-SM(10km) (0)
- ESCON-SM(20km) (0)

- Nominal laser wavelength = 16652 nm.
- DWDM wavelength fraction = 16652.193 nm.
- Supported options = Tx disable

You can find all of the supported SFP Interfaces in the [IR1101 Industrial Integrated Services Router Hardware Installation Guide](#).
CHAPTER 15

System Messages

This chapter contains the following sections:

- Information About Process Management, on page 223
- How to Find Error Message Details, on page 223

Information About Process Management

You can access system messages by logging into the console through Telnet protocol and monitoring your system components remotely from any workstation that supports the Telnet protocol.

Starting and monitoring software is referred to as process management. The process management infrastructure for a router is platform independent, and error messages are consistent across platforms running on Cisco IOS XE. You do not have to be directly involved in process management, but we recommend that you read the system messages that refer to process failures and other issues.

How to Find Error Message Details

To show further details about a process management or a syslog error message, enter the error message into the Error Message Decoder tool at: https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi.

For example, enter the message %PMAN-0-PROCESS_NOTIFICATION into the tool to view an explanation of the error message and the recommended action to be taken.

The following are examples of the description and the recommended action displayed by the Error Message Decoder tool for some of the error messages.

<table>
<thead>
<tr>
<th>Error Message</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>%PMAN-0-PROCESS_NOTIFICATION</td>
<td>The process lifecycle notification component failed because [chars]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The process lifecycle notification component failed, preventing proper detection of a process start and stop. This problem is likely the result of a software defect in the software subpackage.

Note the time of the message and investigate the kernel error message logs to learn more about the problem and see if it is correctable. If the problem cannot be corrected or the logs are not helpful, copy the error message exactly as it appears on the console along with the output of the `show tech-support` command and provide the gathered information to a Cisco technical support representative.

**Error Message:** `%PMAN-0-PROCFAILCRIT` A critical process [chars] has failed (rc [dec])

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A process important to the functioning of the router has failed.</td>
<td>Note the time of the message and investigate the error message logs to learn more about the problem. If the problem persists, copy the message exactly as it appears on the console or in the system log. Research and attempt to resolve the issue using the tools and utilities provided at: <a href="http://www.cisco.com/tac">http://www.cisco.com/tac</a>. With some messages, these tools and utilities will supply clarifying information. Search for resolved software issues using the Bug Search Tool at: <a href="http://www.cisco.com/cisco/psn/bssprt/bss">http://www.cisco.com/cisco/psn/bssprt/bss</a>. If you still require assistance, open a case with the Technical Assistance Center at: <a href="http://tools.cisco.com/ServiceRequestTool/create/">http://tools.cisco.com/ServiceRequestTool/create/</a>, or contact your Cisco technical support representative and provide the representative with the information you have gathered. Attach the following information to your case in nonzipped, plain-text (.txt) format: the output of the <code>show logging</code> and <code>show tech-support</code> commands and your pertinent troubleshooting logs.</td>
</tr>
</tbody>
</table>

**Error Message:** `%PMAN-3-PROCFAILOPT` An optional process [chars] has failed (rc [dec])

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A process important to the functioning of the router has failed.</td>
<td>Note the time of the message and investigate the error message logs to learn more about the problem. If the problem persists, copy the message exactly as it appears on the console or in the system log. Research and attempt to resolve the issue using the tools and utilities provided at: <a href="http://www.cisco.com/tac">http://www.cisco.com/tac</a>. With some messages, these tools and utilities will supply clarifying information. Search for resolved software issues using the Bug Search Tool at: <a href="http://www.cisco.com/cisco/psn/bssprt/bss">http://www.cisco.com/cisco/psn/bssprt/bss</a>. If you still require assistance, open a case with the Technical Assistance Center at: <a href="http://tools.cisco.com/ServiceRequestTool/create/">http://tools.cisco.com/ServiceRequestTool/create/</a>, or contact your Cisco technical support representative and provide the representative with the information you have gathered. Attach the following information to your case in nonzipped, plain-text (.txt) format: the output of the <code>show logging</code> and <code>show tech-support</code> commands and your pertinent troubleshooting logs.</td>
</tr>
</tbody>
</table>
A process that does not affect the forwarding of traffic has failed.

Note the time of the message and investigate the kernel error message logs to learn more about the problem. Although traffic will still be forwarded after receiving this message, certain functions on the router may be disabled because of this message and the error should be investigated. If the logs are not helpful or indicate a problem you cannot correct, copy the message exactly as it appears on the console or in the system log. Research and attempt to resolve the issue using the tools and utilities provided at http://www.cisco.com/tac. With some messages, these tools and utilities will supply clarifying information.

Search for resolved software issues using the Bug Search Tool at:
http://www.cisco.com/cisco/psn/bssprt/bss. If you still require assistance, open a case with the Technical Assistance Center at:
http://tools.cisco.com/ServiceRequestTool/create/, or contact your Cisco technical support representative and provide the representative with the information you have gathered. Attach the following information to your case in nonzipped, plain-text (.txt) format: the output of the `show logging` and `show tech-support` commands and your pertinent troubleshooting logs.

<table>
<thead>
<tr>
<th>Error Message</th>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
</table>
| %PMAN-3-PROCFAIL The process [chars] has failed (rc [dec]) | The process has failed as the result of an error. | This message will appear with other messages related to the process. Check the other messages to determine the reason for the failures and see if corrective action can be taken. If the problem persists, copy the message exactly as it appears on the console or in the system log. Research and attempt to resolve the issue using the tools and utilities provided at:
http://www.cisco.com/tac. With some messages, these tools and utilities will supply clarifying information. Search for resolved software issues using the Bug Search Tool at:
http://www.cisco.com/cisco/psn/bssprt/bss. If you still require assistance, open a case with the Technical Assistance Center at:
http://tools.cisco.com/ServiceRequestTool/create/, or contact your Cisco technical support representative and provide the representative with the information you have gathered. Attach the following information to your case in nonzipped, plain-text (.txt) format: the output of the `show logging` and `show tech-support` commands and your pertinent troubleshooting logs. |
### Error Message: %PMAN-3-PROCFAIL_IGNORE

**Explanation:** A process failure is being ignored due to the user-configured debug settings.

**Recommended Action:** If this behavior is desired and the debug settings are set according to a user's preference, no action is needed. If the appearance of this message is viewed as a problem, change the debug settings. The router is not expected to behave normally with this debug setting. Functionalities such as SSO switchover, router reloads, FRU resets, and so on will be affected. This setting should only be used in a debug scenario. It is not normal to run the router with this setting.

### Error Message: %PMAN-3-PROCHOLDDOWN

**Explanation:** The process [chars] has been held down (rc [dec])

**Recommended Action:** This message will appear with other messages related to the process. Check the other messages to determine the reason for the failures and see if corrective action can be taken. If the problem persists, copy the message exactly as it appears on the console or in the system log. Research and attempt to resolve the issue using the tools and utilities provided at: [http://www.cisco.com/tac](http://www.cisco.com/tac). With some messages, these tools and utilities will supply clarifying information. Search for resolved software issues using the Bug Search Tool at: [http://www.cisco.com/cisco/psn/bssprt/bss](http://www.cisco.com/cisco/psn/bssprt/bss). If you still require assistance, open a case with the Technical Assistance Center at: [http://tools.cisco.com/ServiceRequestTool/create/](http://tools.cisco.com/ServiceRequestTool/create/), or contact your Cisco technical support representative and provide the representative with the information you have gathered. Attach the following information to your case in nonzipped, plain-text (.txt) format: the output of the `show logging` and `show tech-support` commands and your pertinent troubleshooting logs.

### Error Message: %PMAN-3-RELOAD_RP_SB_NOT_READY

**Explanation:** The route processor is being reloaded because there is no ready standby instance.

**Recommended Action:** Ensure that the reload is not due to an error condition.

### Error Message: %PMAN-3-RELOAD_RP

**Explanation:** Reloading: [chars]

**Recommended Action:**

---

**Cisco IR1101 Integrated Services Router Software Configuration Guide**
The RP is being reloaded.

**Error Message:** %PMAN-3-RELOAD_SYSTEM : Reloading: [chars]

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The system is being reloaded.</td>
<td>Ensure that the reload is not due to an error condition. If it is due to an error condition, collect information requested by the other log messages.</td>
</tr>
</tbody>
</table>

The system is being reloaded.

**Error Message:** %PMAN-3-PROC_BAD_EXECUTABLE : Bad executable or permission problem with process [chars]

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The executable file used for the process is bad or has permission problem.</td>
<td>Ensure that the named executable is replaced with the correct executable.</td>
</tr>
</tbody>
</table>

**Error Message:** %PMAN-3-PROC_BAD_COMMAND: Non-existent executable or bad library used for process <process name>

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The executable file used for the process is missing, or a dependent library is bad.</td>
<td>Ensure that the named executable is present and the dependent libraries are good.</td>
</tr>
</tbody>
</table>

**Error Message:** %PMAN-3-PROC_EMPTY_EXEC_FILE : Empty executable used for process [chars]

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The executable file used for the process is empty.</td>
<td>Ensure that the named executable is non-zero in size.</td>
</tr>
</tbody>
</table>

**Error Message:** %PMAN-5-EXITACTION : Process manager is exiting: [chars]

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The process manager is exiting.</td>
<td>Ensure that the process manager is not exiting due to an error condition. If it is due to an error condition, collect information requested by the other log messages.</td>
</tr>
</tbody>
</table>

**Error Message:** %PMAN-6-PROC_SHUT : The process [chars] has shutdown

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The process has gracefully shut down.</td>
<td>No user action is necessary. This message is provided for informational purposes only.</td>
</tr>
</tbody>
</table>

**Error Message:** %PMAN-6-PROC_START : The process [chars] has started
The process has launched and is operating properly. No user action is necessary. This message is provided for informational purposes only.

**Error Message:** %PMAN-6-PROCSTATELESS : The process [chars] is restarting stateless

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The process has requested a stateless restart.</td>
<td>No user action is necessary. This message is provided for informational purposes only.</td>
</tr>
</tbody>
</table>
Environmental Monitoring

This chapter contains the following sections:

- Environmental Monitoring, on page 229
- Environmental Monitoring and Reporting Functions, on page 229
- Environmental Monitoring Functions, on page 230
- Environmental Reporting Functions, on page 231
- Additional References, on page 237

Environmental Monitoring

The router provides a robust environment-monitoring system with several sensors that monitor the system temperatures. The following are some of the key functions of the environmental monitoring system:

- Monitoring temperature of CPUs and Motherboard
- Recording abnormal events and generating notifications
- Monitoring Simple Network Management Protocol (SNMP) traps
- Generating and collecting Onboard Failure Logging (OBFL) data
- Sending call home event notifications
- Logging system error messages
- Displaying present settings and status

Environmental Monitoring and Reporting Functions

Monitoring and reporting functions allow you to maintain normal system operation by identifying and resolving adverse conditions prior to loss of operation.

- Environmental Monitoring Functions, on page 230
- Environmental Reporting Functions, on page 231
Environmental Monitoring Functions

Environmental monitoring functions use sensors to monitor the temperature of the cooling air as it moves through the chassis.

The router is expected to meet the following environmental operating conditions:

- **Non-operating Temperature:** -40°F to 158°F (-40°C to 70°C)
- **Non-operating Humidity:** 5 to 95% relative humidity (non-condensing)
- **Operating Temperature:**
  - -40° to 140°F (-40° to 60°C) in a sealed NEMA cabinet with no airflow
  - -40° to 158°F (-40° to 70°C) in a vented cabinet with 40 lfm of air
  - -40° to 167°F (-40° to 75°C) in a forced air enclosure with 200 lfm of air
- **Operating Humidity:** 10% to 95% relative humidity (non-condensing)
- **Operating Altitude:** -500 to 5,000 feet. Derate max operating temperature 1.5°C per 1000 feet.

The following table displays the levels of status conditions used by the environmental monitoring system.

<table>
<thead>
<tr>
<th>Status Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>All monitored parameters are within normal tolerance.</td>
</tr>
<tr>
<td>Warning</td>
<td>The system has exceeded a specified threshold. The system continues to operate, but operator action is recommended to bring the system back to a normal state.</td>
</tr>
<tr>
<td>Critical</td>
<td>An out-of-tolerance temperature or voltage condition exists. Although the system continues to operate, it is approaching shutdown. Immediate operator action is required.</td>
</tr>
</tbody>
</table>

The environmental monitoring system sends system messages to the console, for example, when the conditions described here are met:

**Temperature and Voltage Exceed Max/Min Thresholds**

The following example shows the warning messages indicating the maximum and minimum thresholds of the temperature or voltage:

Warnings:

```
For all the temperature sensors (name starting with "Temp:"), above,
the critical warning threshold is 100C (100C and higher)
the warning threshold is 80C (range from 80C to 99C)
the low warning threshold is 1C (range from -inf to 1C).

For all voltage sensors (names starting with "V:"),
the high warning threshold starts at that voltage +10%. (voltage + 10% is warning)
the low warning threshold starts at the voltage -10%. (voltage - 10% is warning)
```
Environmental Reporting Functions

You can retrieve and display environmental status reports using the following commands:

Can someone provide me the output of a full Sparrow/Snowfinch device?

- `show diag all eeprom`
- `show environment`
- `show environment all`
- `show inventory`
- `show platform`
- `show platform diag`
- `show platform software status control-processor`
- `show diag slot R0 eeprom detail`
- `show version`
- `show power`

These commands show the current values of parameters such as temperature and voltage.

The environmental monitoring system updates the values of these parameters every 60 seconds. Brief examples of these commands are shown below:

**show diag all eeprom: Example**

Router# `show diag all eeprom`

MIDPLANE EEPROM data:

Product Identifier (PID) : IR1101-K9
Version Identifier (VID) : V00
PCB Serial Number : FOC21482ZQF
PCB Serial Number : FOC214822CK
PCB Serial Number : FOC21482SY7
Top Assy. Part Number : 68-6479-01
Top Assy. Revision : 13
Hardware Revision : 0.2
Asset ID :
CLEI Code : UNASSIGNED
Power/Fan Module P0 EEPROM data is not initialized
Power/Fan Module P1 EEPROM data is not initialized

Slot R0 EEPROM data:

Product Identifier (PID) : IR1101-K9
Version Identifier (VID) : V00
PCB Serial Number : FOC21482ZQF
PCB Serial Number : FOC214822CK
PCB Serial Number : FOC21482SY7
Top Assy. Part Number : 68-6479-01
Top Assy. Revision : 13
Hardware Revision : 0.2
CLEI Code : UNASSIGNED
Environmental Reporting Functions

Slot F0 EEPROM data:

Product Identifier (PID) : IR1101-K9
Version Identifier (VID) : V00
PCB Serial Number : FOC21482ZQF
PCB Serial Number : FOC214822CK
PCB Serial Number : FOC21482SY7
Top Assy. Part Number : 68-6479-01
Top Assy. Revision : 13
Hardware Revision : 0.2
CLEI Code : UNASSIGNED

Slot 0 EEPROM data:

Product Identifier (PID) : IR1101-K9
Version Identifier (VID) : V00
PCB Serial Number : FOC21482ZQF
PCB Serial Number : FOC214822CK
PCB Serial Number : FOC21482SY7
Top Assy. Part Number : 68-6479-01
Top Assy. Revision : 13
Hardware Revision : 0.2
CLEI Code : UNASSIGNED

SPA EEPROM data for subslot 0/0:

Product Identifier (PID) : IR1101-ES-5
Version Identifier (VID) : V01
PCB Serial Number :
Top Assy. Part Number : 68-2236-01
Top Assy. Revision : A0
Hardware Revision : 2.2
CLEI Code : CNUIAHSAAA
SPA EEPROM data for subslot 0/1 is not available
SPA EEPROM data for subslot 0/2 is not available
SPA EEPROM data for subslot 0/3 is not available
SPA EEPROM data for subslot 0/4 is not available
SPA EEPROM data for subslot 0/5 is not available

Router#

show environment: Example

Router# show environment
Number of Critical alarms: 0
Number of Major alarms: 0
Number of Minor alarms: 0
Slot Sensor Current State Reading Threshold(Minor,Major,Critical,Shutdown)
------------------------------------------------------------------------------------------
R0 Temp: LM75BXXX Normal 43 Celsius (75,80,90,na)(Celsius)

Router#
show environment all: Example

Router# show environment all
Sensor List: Environmental Monitoring
Sensor Location State Reading
Temp: LM75BXXX R0 Normal 48 Celsius

show inventory: Example

Router# show inventory
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
INFO: Please use "show license UDI" to get serial number for licensing.
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
NAME: "Chassis", DESCR: "IR1101 Base Chassis"
PID: IR1101-K9 , VID: V00 , SN: FCW21327H0Z
NAME: "Module 0 - Mother Board", DESCR: "Cisco IR1101 motherboard"
PID: IR1101-K9 , VID: , SN:
NAME: "module subslot 0/0", DESCR: "IR1101-ES-5"
PID: IR1101-ES-5 , VID: V01 , SN:
NAME: "Subslot 0/0 transceiver 0", DESCR: "GE SX"
PID: GLC-SX-MM-RGD , VID: V01 , SN: FNS16370HL4
NAME: "module subslot 0/1", DESCR: "P-LTE-US Module"
PID: P-LTE-US , VID: V01 , SN: FOC21333R92
NAME: "Modem 0 on Cellular0/1/0", DESCR: "Sierra Wireless WP7603"
PID: WP7603 , VID: 10000, SN: 359528080000794

show platform: Example

Router# show platform
Chassis type: IR1101-K9
Slot Type State Insert time (ago)
--------- ------------------- --------------------- -----------------
0 IR1101-K9 ok 01:52:41
0/0 IR1101-ES-5 ok 01:51:35
R0 IR1101-K9 ok, active 01:52:41
F0 IR1101-K9 init, active 01:52:41
Router#

show platform diag: Example

Router# show platform diag
Chassis type: IR1101-K9
Slot: 0, IR1101-K9
Running state : ok
Internal state : online
show platform software status control-processor: Example

Router# show platform software status control-processor
RP0: online, statistics updated 9 seconds ago
Load Average: healthy
  1-Min: 0.32, status: healthy, under 5.00
  5-Min: 0.33, status: healthy, under 5.00
  15-Min: 0.35, status: healthy, under 5.00
Memory (kb): healthy
  Total: 3959840
  Used: 2894588 (73%), status: healthy
  Free: 1065252 (27%)
  Committed: 2435656 (62%), under 90%
Per-core Statistics
  CPU0: CPU Utilization (percentage of time spent)
    User: 0.50, System: 0.91, Nice: 0.00, Idle: 98.07
    IRQ: 0.40, SIRQ: 0.10, IOWait: 0.00
  CPU1: CPU Utilization (percentage of time spent)
    User: 0.81, System: 0.30, Nice: 0.00, Idle: 98.48
    IRQ: 0.20, SIRQ: 0.20, IOWait: 0.00

Router#
CPU2: CPU Utilization (percentage of time spent)
User: 0.81, System: 2.65, Nice: 0.00, Idle: 95.41
IRQ: 1.12, SIRQ: 0.00, IOwait: 0.00

CPU3: CPU Utilization (percentage of time spent)
User: 7.66, System: 17.05, Nice: 0.00, Idle: 70.58
IRQ: 4.59, SIRQ: 0.10, IOwait: 0.00

Router#

**show diag slot R0 eeprom detail: Example**

Router# show diag slot R0 eeprom detail

Slot R0 EEPROM data:

EEPROM version : 4
Compatible Type : 0xFF
Controller Type : 3457
Hardware Revision : 0.2
PCB Part Number : 73-18820-03
Board Revision : 02
Deviation Number : 0
Fab Version : 02
PCB Serial Number : FOC22106KKH
Top Assy. Part Number : 68-6479-03
Top Assy. Revision : 04
Chassis Serial Number : FCW2213TH07
Deviation Number : 0
RMA Test History : 00
RMA Number : 0-0-0-0
RMA History : 00
Product Identifier (PID) : IR1101-K9
Version Identifier (VID) : V00
CLEI Code : UNASSIGNED
Manufacturing Test Data : 00 00 00 00 00 00 00 00
Field Diagnostics Data : 00 00 00 00 00 00 00 00
Chassis MAC Address : 682c.7b4d.7880
MAC Address block size : 128
Asset ID :
Asset Alias :
PCB Part Number : 73-18821-03
Board Revision : 03
Deviation Number : 0
Fab Version : 02
PCB Serial Number : FOC22106KHD
PCB Part Number : 73-19117-02
Board Revision : 02
Deviation Number : 0
Fab Version : 01
PCB Serial Number : FOC22106KJ9
Asset ID :
Router#

**show version: Example**

Router# show version
Cisco IOS XE Software, Version 16.10.01
Cisco IOS Software [Gibraltar], ISR Software (ARMV8EL_LINUX_IOSD-UNIVERSALK9-M), Version 16.10.1prd7, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2018 by Cisco Systems, Inc.
Compiled Wed 31-Oct-18 23:27 by mcpre

Cisco IOS-XE software, Copyright (c) 2005-2018 by cisco Systems, Inc.
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ROM: IOS-XE ROMMON

Router uptime is 1 hour, 53 minutes
Uptime for this control processor is 1 hour, 54 minutes
System returned to ROM by reload
System image file is "usb0:ir1101-universalk9.16.10.01prd7.SPA.bin"
Last reload reason: Reload Command

This product contains cryptographic features and is subject to United States and local country laws governing import, export, transfer and use. Delivery of Cisco cryptographic products does not imply third-party authority to import, export, distribute or use encryption. Importers, exporters, distributors and users are responsible for compliance with U.S. and local country laws. By using this product you agree to comply with applicable laws and regulations. If you are unable to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at: http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to export@cisco.com.

Technology Package License Information:

-----------------------------------------------
Technology-package Technology-package
Current Type Next reboot
-----------------------------------------------
network-advantage Smart License network-advantage

Smart Licensing Status: UNREGISTERED/EVAL EXPIRED

cisco IR1101-K9 (ARM64) processor (revision 1.2 GHz) with 711867K/6147K bytes of memory.
Processor board ID FCW2150TH0F
1 Virtual Ethernet interface
4 FastEthernet interfaces
1 Gigabit Ethernet interface
1 Serial interface
1 terminal line
32768K bytes of non-volatile configuration memory.
4038072K bytes of physical memory.
show power: Example

Router# show power
Main PSU:
Total Power Consumed: 8.16 Watts
Router#

Additional References

The following sections provide references related to the power efficiency management feature.

MIBs

<table>
<thead>
<tr>
<th>MIBs</th>
<th>MIBs Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO-ENTITY-FRU-CONTROL-MIB</td>
<td>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use the Cisco MIB Locator at: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>.</td>
</tr>
</tbody>
</table>

Technical Assistance

<table>
<thead>
<tr>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</td>
<td><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></td>
</tr>
</tbody>
</table>
IOx Application Hosting

This section contains the following topics:

- Application Hosting, on page 239

Application Hosting

A hosted application is a software as a service solution, and it can be run remotely using commands. Application hosting gives administrators a platform for leveraging their own tools and utilities.

This module describes the Application Hosting feature and how to enable it.

Information About Application Hosting

Need for Application Hosting

The move to virtual environments has given rise to the need to build applications that are reusable, portable, and scalable. Application hosting gives administrators a platform for leveraging their own tools and utilities. An application, hosted on a network device, can serve a variety of purposes. This ranges from automation, configuration management monitoring, and integration with existing tool chains.

Cisco devices support third-party off-the-shelf applications built using Linux tool chains. Users can run custom applications cross-compiled with the software development kit that Cisco provides.

IIoX Overview

IIoX is a Cisco-developed end-to-end application framework that provides application hosting capabilities for different application types on Cisco network platforms.

IIoX architecture for the IR1101 is different compared to other Cisco platforms that use the hypervisor approach. In other platforms, IIoX runs as a virtual machine. IIoX is running as a process on the IR1101.

Cisco Application Hosting Overview

The IR1101 enables the user to deploy the application using the app-hosting CLIs. These app-hosting CLIs are not available on the other older platforms. There are additional ways to deploy the applications using the Local Manager and Fog Director.

Application hosting provides the following services:
• Launches designated applications in containers.
• Checks available resources (memory, CPU, and storage), and allocates and manages them.
• Provides support for console logging.
• Provides access to services via REST APIs.
• Provides a CLI endpoint.
• Provides an application hosting infrastructure referred to as Cisco Application Framework (CAF).
• Helps in the setup of platform-specific networking (packet-path) via VirtualPortGroup and management interfaces.

The container is referred to as the virtualization environment provided to run the guest application on the host operating system. The Cisco IOS-XE virtualization services provide manageability and networking models for running guest applications. The virtualization infrastructure allows the administrator to define a logical interface that specifies the connectivity between the host and the guest. IOx maps the logical interface into the Virtual Network Interface Card (vNIC) that the guest application uses.

Applications to be deployed in the containers are packaged as TAR files. The configuration that is specific to these applications is also packaged as part of the TAR file.

The management interface on the device connects the application hosting network to the IOS management interface. The Layer 3 interface of the application receives the Layer 2 bridged traffic from the IOS management interface. The management interface connects through the management bridge to the container/application interface. The IP address of the application must be on the same subnet as the management interface IP address.

IOXMAN

IOXMAN is a process that establishes a tracing infrastructure to provide logging or tracing services for guest applications, except Libvirt, that emulates serial devices. IOXMAN is based on the lifecycle of the guest application to enable and disable the tracing service, to send logging data to IOS syslog, to save tracing data to IOx tracelog, and to maintain IOx tracelog for each guest application.

Application Hosting on the IR1101 Industrial Integrated Services Router

This section describes the application-hosting characteristics specific to the IR1101 Industrial Integrated Services Router.

Note

The IR1101 CPU is not based on x86 architecture like other Routers. Therefore, this requires the application to comply with the ARM 64-bits architecture.

Application hosting can be achieved using the app-hosting cli's as well using the Local Manager and Fog Director. Application hosting using Local Manager is done through the WebUI. In order to deploy the applications using Local Manager, WebUI should be enabled and then login to the Local Manager.
1. From the WebUI, click on Configuration > Services > IOx

2. Login using the username and password configured.

3. Follow the steps for the application lifecycle in the Cisco IOx Local Manager Reference Guide using this link: [https://www.cisco.com/c/en/us/td/docs/routers/access/800/software/guides/iox/lm/reference-guide/1-7/b_iox_lm_ref_guide_1_7/b_iox_lm_ref_guide_1_7_chapter_011.html](https://www.cisco.com/c/en/us/td/docs/routers/access/800/software/guides/iox/lm/reference-guide/1-7/b_iox_lm_ref_guide_1_7/b_iox_lm_ref_guide_1_7_chapter_011.html)

   The next section explains the deployment of an application using the app-hosting cli's.

**VirtualPortGroup**

The VirtualPortGroup is a software construct on Cisco IOS that maps to a Linux bridge IP address. As such, the VirtualPortGroup represents the switch virtual interface (SVI) of the Linux container. Each bridge can contain multiple interfaces; each mapping to a different container. Each container can also have multiple interfaces.

VirtualPortGroup interfaces are configured by using the interface virtualportgroup command. Once these interfaces are created, IP address and other resources are allocated.

The VirtualPortGroup interface connects the application hosting network to the IOS routing domain. The Layer 3 interface of the application receives routed traffic from IOS. The VirtualPortGroup interface connects through the SVC Bridge to the container/application interface.

The following graphic helps to understand the relationship between the VirtualPortGroup and other interfaces, as it is different than the IR8x9 routers.
vNIC

For the container life cycle management, the Layer 3 routing model that supports one container per internal logical interface is used. This means that a virtual Ethernet pair is created for each application; and one interface of this pair, called vNIC is part of the application container. The other interface, called vpgX is part of the host system.

NIC is the standard Ethernet interface inside the container that connects to the platform dataplane for the sending and receiving of packets. IOx is responsible for the gateway (VirtualPortGroup interface), IP address, and unique MAC address assignment for each vNIC in the container.

The vNIC inside the container/application are considered as standard Ethernet interfaces.

How to Configure Application Hosting

Enabling IOx

Perform this task to enable access to the IOx Local Manager. The IOx Local Manager provides a web-based user interface that you can use to manage, administer, monitor, and troubleshoot apps on the host system, and to perform a variety of related activities.
In the steps that follow, IP HTTP commands do not enable IOX, but allow the user to access the WebUI to connect the IOX Local Manager.

SUMMARY STEPS

1. enable
2. configure terminal
3. iox
4. ip http server
5. ip http secure-server
6. username name privilege level password {0 | 7 | user-password }encrypted-password
7. end

DETAILED STEPS

<table>
<thead>
<tr>
<th>Steps</th>
<th>Command</th>
<th>Purpose</th>
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<tbody>
<tr>
<td>1.</td>
<td>enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
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<td>2.</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
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<td>Example:</td>
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<td>3.</td>
<td>iox</td>
<td>Enables IOX</td>
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<td>4.</td>
<td>ip http server</td>
<td>Enables the HTTP server on your IP or IPv6 system.</td>
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<td>Example:</td>
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<td>5.</td>
<td>ip http secure-server</td>
<td>Enables a secure HTTP (HTTPS) server.</td>
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<td>Example:</td>
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</table>
### Configuring a VirtualPortGroup to a Layer 3 Data Port

Multiple Layer 3 data ports can be routed to one or more VirtualPortGroups or containers. VirtualPortGroups and Layer 3 data ports must be on different subnets.

Enable the `ip routing` command to allow external routing on the Layer 3 data-port.

**SUMMARY STEPS**

1. `enable`
2. `configure terminal`
3. `ip routing`
4. `interface type number`
5. `no switchport`
6. `ip address ip-address mask`
7. `exit`
8. `interface type number`
9. `ip address ip-address mask`
10. `end`
## DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| 1.   | `enable` | Enables privileged EXEC mode. Enter your password if prompted.  
Example:  
Device>enable |
| 2.   | `configure terminal` | Enters global configuration mode.  
Example:  
Device#configure terminal |
| 3.   | `ip routing` | Enables IP routing. The `ip routing` command must be enabled to allow external routing on Layer 3 data ports.  
Example:  
Device(config)#ip routing |
| 4.   | `interface type number` | Configures an interface and enters interface configuration mode.  
Example:  
Device(config)#interface gigabitethernet 0/0/0 |
| 5.   | `no switchport` | Places the interface in Layer 3 mode, and makes it operate more like a router interface rather than a switch port.  
Example:  
Device(config-if)#no switchport |
| 6.   | `ip address ip-address mask` | Configures an IP address for the interface.  
Example:  
Device(config-if)#ip address 10.1.1.1 255.255.255.0 |
| 7.   | `exit` | Exits interface configuration mode and returns to global configuration mode.  
Example:  
Device(config-if)#exit |
| 8.   | `interface type number` | Configures an interface and enters interface configuration mode.  
Example:  
Device(config)#interface virtualportgroup 0 |
### Configuring a VirtualPortGroup to a Layer 3 Data Port

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td><code>ip address ip-address mask</code>&lt;br&gt;Example: <code>Device(config-if)#ip address 192.168.0.1 255.255.255.0</code></td>
<td>Configures an IP address for the interface.</td>
</tr>
<tr>
<td>10.</td>
<td><code>end</code>&lt;br&gt;Example: <code>Device(config-if)#end</code></td>
<td>Exits interface configuration mode and returns to privileged EXEC mode.</td>
</tr>
<tr>
<td>11.</td>
<td><code>configure terminal</code>&lt;br&gt;Enter configuration commands, one per line. End with CNTL/Z.&lt;br&gt;Example: <code>Device#configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>12.</td>
<td><code>app-hosting appid app1</code>&lt;br&gt;Example: <code>Device(config)#app-hosting appid app1</code></td>
<td>Configures the application and enters the application configuration mode.</td>
</tr>
<tr>
<td>13.</td>
<td><code>app-vnic gateway0 virtualportgroup 0 guest-interface 0</code>&lt;br&gt;Example: <code>Device(config-app-hosting)#app-vnic gateway0 virtualportgroup 0 guest-interface 0</code></td>
<td>Configures the application interface and the gateway of the application.</td>
</tr>
<tr>
<td>14.</td>
<td><code>guest-ipaddress 192.168.0.2 netmask 255.255.255.0</code>&lt;br&gt;Example: <code>Device(config-app-hosting-gateway0)#guest-ipaddress 192.168.0.2 netmask 255.255.255.0</code></td>
<td>Configures the application Ethernet interface ip address.</td>
</tr>
</tbody>
</table>
Installing and Uninstalling Apps

SUMMARY STEPS

1. enable
2. app-hosting install appid application-name package package-path
3. app-hosting activate appid application-name
4. app-hosting start appid application-name
5. app-hosting stop appid application-name
6. app-hosting deactivate appid application-name
7. app-hosting uninstall appid application-name

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
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<td></td>
<td>Example:</td>
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<tr>
<td></td>
<td>Device#enable</td>
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<tr>
<td>2.</td>
<td>app-hosting install appid application-name package package-path</td>
<td>Installs an app from the specified location. The app can be installed from any local storage location such as, flash, bootflash, and usbfash0.</td>
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<td>Example:</td>
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<td></td>
<td>Device#app-hosting install appid lxc_app package flash:/my_iox_app.tar</td>
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<tr>
<td>Step</td>
<td>Command</td>
<td>Purpose</td>
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<tr>
<td>3.</td>
<td><code>app-hosting activate appid application-name</code></td>
<td>Activates the application. This command validates all application resource requests, and if all resources are available the application is activated; if not, the activation fails.</td>
</tr>
<tr>
<td>4.</td>
<td><code>app-hosting start appid application-name</code></td>
<td>Starts the application. Application start-up scripts are activated.</td>
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<td>5.</td>
<td><code>app-hosting stop appid application-name</code></td>
<td>Stops the application.</td>
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<tr>
<td>6.</td>
<td><code>app-hosting deactivate appid application-name</code></td>
<td>Deactivates all resources allocated for the application.</td>
</tr>
<tr>
<td>7.</td>
<td><code>app-hosting uninstall appid application-name</code></td>
<td>Uninstalls the application. Uninstalls all packaging and images stored. All changes and updates to the application are also removed.</td>
</tr>
</tbody>
</table>

**Overriding the App Resource Configuration**

Resource changes will take effect only after the `app-hosting activate` command is configured.

**SUMMARY STEPS**
1. `enable`  
2. `configure terminal`  
3. `app-hosting appid name`  
4. `app-resource profile name`  
5. `cpu unit`
### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
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<td>Example:</td>
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<td></td>
<td>Device&gt;enable</td>
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<tr>
<td>2.</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
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<td>Example:</td>
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<tr>
<td></td>
<td>Device#configure terminal</td>
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<tr>
<td>3.</td>
<td>app-hosting appid name</td>
<td>Enables application hosting and enters application hosting configuration mode.</td>
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<td>Example:</td>
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<td></td>
<td>Device(config)#app-hosting appid app1</td>
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<tr>
<td>4.</td>
<td>app-resource profile name</td>
<td>Configures the custom application resource profile, and enters custom application resource profile configuration mode. Only the custom profile name is supported.</td>
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<td>Example:</td>
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<td>Device(config-app-hosting)#app-resource profile custom</td>
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<td>5.</td>
<td>cpu unit</td>
<td>Changes the default CPU allocation for the application. Resource values are application-specific, and any adjustment to these values must ensure that the application can run reliably with the changes.</td>
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<td>Example:</td>
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<td>Device(config-app-resource-profile-custom)#cpu 800</td>
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<td>6.</td>
<td>memory memory</td>
<td>Changes the default memory allocation.</td>
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<td>Example:</td>
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<td>Device(config-app-resource-profile-custom)#memory 512</td>
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</tbody>
</table>
Verifying the Application Hosting Configuration

SUMMARY STEPS
1. enable
2. show iox-service
3. show app-hosting detail
4. show app-hosting list

DETAILED STEPS
1. enable
   Enables privileged EXEC mode. Enter your password if prompted.
   Example:
   
   Device>enable

2. show iox-service
   Displays the status of all IOx services
   Example:
   
   Device# show iox-service
   IOx Infrastructure Summary:
   ------------------------------------------
   IOx service (CAF) 1.8.0.2 : Running
   IOx service (HA) : Not Supported
   IOx service (IOxman) : Running
   Libvirtd 1.3.4 : Running
   Device#

3. show app-hosting detail
   Displays detailed information about the application.
   Example:
Device# show app-hosting detail
App id : app1
Owner : iox
State : RUNNING
Application
   Type : lxc
   Name : nt08-stress
   Version : 0.1
   Description : Stress Testing Application
   Path : usbflash0: my_iox_app.tar
Activated profile name : custom
Resource reservation
   Memory : 64 MB
   Disk : 2 MB
   CPU : 500 units
Attached devices
   Type       Name       Alias
   -----------------------------
   serial/shell  iox_console_shell  serial0
   serial/aux    iox_console_aux    serial1
   serial/syslog iox_syslog         serial2
   serial/trace  iox_trace          serial3

Network interfaces
   ---------------------------------------
   eth0:
   MAC address : 52:54:dd:fa:25:ee

4. show app-hosting list

Displays the list of applications and their status.

Example:

Device# show app-hosting list
App id    State
--------------------------------------
app1      RUNNING

Configuration Examples for Application Hosting

See the following examples:

Example: Enabling IOx

Device> enable
Device# configure terminal
Device(config)# iox
Device(config)# ip http server
Device(config)# ip http secure-server
Device(config)# username cisco privilege 15 password 0 cisco
Device(config)# end

Example: Configuring a VirtualPortGroup to a Layer 3 Data Port

Device> enable
Device# configure terminal
Device(config)# ip routing
Example: Installing and Uninstalling Apps

Device(config)# interface gigabitethernet 0/0/0
Device(config-if)# no switchport
Device(config-if)# ip address 10.1.1.1 255.255.255.0
Device(config-if)# exit
Device(config)# interface virtualportgroup 0
Device(config-if)# ip address 192.168.0.1 255.255.255.0
Device(config-if)# end

Device> enable
Device# app-hosting install appid app1 package flash:my_iox_app.tar
Device# app-hosting activate appid app1
Device# app-hosting start appid app1
Device# app-hosting stop appid app1
Device# app-hosting deactivate appid app1
Device# app-hosting uninstall appid app1

Example: Overriding the App Resource Configuration

Device# configure terminal
Device(config)# app-hosting appid app1
Device(config-app-hosting)# app-resource profile custom
Device(config-app-resource-profile-custom)# cpu 800
Device(config-app-resource-profile-custom)# memory 512
Device(config-app-resource-profile-custom)# vcpu 2
Device(config-app-resource-profile-custom)# end
Serial Relay Service

This chapter contains the following:

- Serial Relay Service, on page 253

Serial Relay Service

Serial Relay service on the IR1101 enables IOx apps to communicate with the Async Serial port (/dev/ttyS1 under IOS-XE). The configuration of Serial Relay service is similar to that of the IR800.

Data Paths

On the IR1101, IOS-XE has complete control over the data path and control path of the Async Serial port. This aspect is essential to other encapsulations supported on the Async port such as PPP, raw-socket, SCADA, etc. The IOx app is never allowed to exercise full control over the device. All data and configurations are passed through IOS-XE before going to the device. Instead of exposing the actual Serial port to IOx apps, the Serial relay service creates a software emulated serial tty device enumerated as /dev/ttyTun0 (shown below). The pair of devices /dev/ttyTun0 and /dev/ttyTun1 represent a data tunnel whose primary function is to act as a pass-through gateway during any data transfer. /dev/ttyTun1 is open by IOS-XE and all the ingress/egress data from IOS to the app uses this device during data transfer. Line 0/0/0 is used to communicate with /dev/ttyTun1. Serial relay service should be configured beforehand to allow the connection between two lines.
Data Paths:

1. When the IOx app sends a character to /dev/ttyTun0, the tunnel driver automatically pushes the data to /dev/ttyTun1.
2. IOS reads the data which it then passes to the Serial relay service.
3. The Serial relay service retrieves information about the other end of the relay service (Line 0/2/0 in this case) and forwards the data to the Line's buffer.
4. The line driver actively pushes the data into the actual serial device (/dev/ttyS1) based on buffer availability.
5. The reverse path functions the same with the roles of /dev/ttyS1 and /dev/tun0 reversed.

Control Path:

1. When the IOx app performs TCGETS ioctl call on /dev/ttyTun0, the tunnel driver uses /dev/cttyTun to send request to the CTTY handler service running in IOS.
2. CTTY handler service and the kernel driver use a client-server architecture to communicate configuration objects.
3. Upon receiving the request about TCGETS from /dev/cttyTun, the CTTY handler examines the request and requests Line driver to populate the required data into control data structures.
4. Upon receiving the control data structures, CTTY handler sends out a response to /dev/cttyTun which eventually goes back to /dev/ttyTun0.
5. /dev/ttyTun0 passes the control data to IOx app as requested.
6. Similar path can be extrapolated for TCSETS where the CTTY handler requests the Line driver to update the settings of the underneath /dev/ttyS1 driver.
7. Line driver of Line 0/2/0 and driver config on /dev/ttyTun0 are always in sync with each other. Any configuration changes such as baud rate modification is transparently propagated to the Line driver without any additional configuration overhead. This emulates the propagation feature of Serial relay on the IR800 series where the virtual serial port can configure the parameters of the real serial port.
Configuration Commands

IR1101# configure terminal
IR1101(config)# interface async 0/2/0
IR1101(config-if)# encapsulation relay-line
IR1101(config-if)# exit
IR1101(config)# relay line 0/2/0 0/0/0
IR1101(config)# exit
IR1101#
Cisco SD-WAN Support

This chapter contains the following:

- Cisco SD-WAN Support, on page 257

Cisco SD-WAN Support

Cisco SD-WAN is a cloud-first architecture that separates data and control planes, managed through the Cisco vManage console. You can quickly establish an SD-WAN overlay fabric to connect data centers, branches, campuses, and co-location facilities to improve network speed, security, and efficiency.

Cisco SD-WAN Overview

Cisco SDWAN adopts a cloud based solution, it consists of vOrchestrator, vManage, vSmart and vEdge.

- vOrchestrator is responsible for launching all controllers VMs in the cloud.
- vManage is the management plane for the overall SDWAN solution. It uses netconf/YANG to talk to vEdge devices.
- vSmart is the control plane for the overall SDWAN solution. It talks to the vEdge device, acts as the route reflector, key reflector, and policy engine.
- vEdge is the data plane of the overall SDWAN solution. The IR1101 platform talks to vSmart, vManage, as part of the SDWAN network.

The follow diagram shows the high level architecture of SDWAN:
Frequently Asked Questions

**Question:** What is the minimum cEdge software version supporting SDWAN on the IR1101?

**Answer:** The minimum cEdge software version supporting SDWAN on the IR1101 is IOS-XE 16.12.1, the ir1101-ucmk9-XX image.

**Question:** What is the minimum SDWAN controller software version supporting the IR1101?

**Answer:** The minimum SDWAN controller software version supporting the IR1101 is 19.2.

**Question:** Where can I find SDWAN documentation?

**Answer:** Cisco SDWAN documentation is available from
https://sdwan-docs.cisco.com/Product_Documentation/Software_Features

**Question:** Can I use 2 LTE pluggables with SDWAN?

**Answer:** Cisco IOS-XE SDWAN version 16.12.1 does not support 2 LTE pluggable interfaces. Both the Base or Expansion Module can support 4G module, but still only one 4G module, in current May 2019 vManage and IOS XE 16.12.1 releases.

**Question:** Can I convert an IR1101 IOS-XE to a cEdge IR1101?

**Answer:** For migration from Cisco IOS-XE to cEdge image, please refer to

**Question:** Is IOx supported when running a cEdge image?

**Answer:** IOx is not supported on the IR1101 SDWAN 16.12.1 version.

All of the technical documentation for Cisco SD-WAN can be found here:
CHAPTER 20

ROM Monitor Overview

- ROM Monitor Overview and Basic Procedures, on page 261

ROM Monitor Overview and Basic Procedures

This chapter provides an overview of ROM Monitor concepts and operations. This chapter includes the following main topics:

ROM Monitor Overview

The ROM Monitor is a bootstrap program that initializes the hardware and boots the Cisco IOS XE software when you power on or reload a router. When you connect a terminal to the router that is in ROM Monitor mode, the ROM Monitor (rommon 1>) prompt is displayed.

During normal operation, users do not use ROM Monitor mode. ROM Monitor mode is used only in special circumstances, such as reinstalling the entire software set, resetting the router password, or specifying a configuration file to use at startup.

The ROM Monitor software is known by many names. It is sometimes called ROMMON because of the CLI prompt in ROM Monitor mode. The ROM Monitor software is also called the boot software, boot image, or boot helper. Although it is distributed with routers that use the Cisco IOS XE software, ROM Monitor is a separate program from the Cisco IOS XE software. During normal startup, the ROM Monitor initializes the router, and then control passes to the Cisco IOS XE software. After the Cisco IOS XE software takes over, the ROM Monitor is no longer in use.

Environmental Variables and the Configuration Register

Two primary connections exist between ROM Monitor and the Cisco IOS XE software: the ROM Monitor environment variables and the configuration register.

The ROM Monitor environment variables define the location of the Cisco IOS XE software and describe how to load it. After the ROM Monitor has initialized the router, it uses the environment variables to locate and load the Cisco IOS XE software.

The configuration register is a software setting that controls how a router starts up. One of the primary uses of the configuration register is to control whether the router starts in ROM Monitor mode or Administration EXEC mode. The configuration register is set in either ROM Monitor mode or Administration EXEC mode as needed. Typically, you set the configuration register using the Cisco IOS XE software prompt when you
need to use ROM Monitor mode. When the maintenance in ROM Monitor mode is complete, you change the configuration register so the router reboots with the Cisco IOS XE software.

**Accessing ROM Monitor Mode with a Terminal Connection**

When the router is in ROM Monitor mode, you can access the ROM Monitor software only from a terminal connected directly to the console port of the card. Because the Cisco IOS XE software (EXEC mode) is not operating, nonmanagement interfaces are not accessible. Basically, all Cisco IOS XE software resources are unavailable. The hardware is available, but no configuration exists to make use of the hardware.

**Network Management Access and ROM Monitor Mode**

It is important to remember that ROM Monitor mode is a router mode, not a mode within the Cisco IOS XE software. It is best to remember that ROM Monitor software and the Cisco IOS XE software are two separate programs that run on the same router. At any given time, the router runs only one of these programs.

One area that can be confusing when using ROM Monitor and the Cisco IOS XE software is the area that defines the IP configuration for the Management Ethernet interface. Most users are comfortable with configuring the Management Ethernet interface in the Cisco IOS XE software. When the router is in ROM Monitor mode, however, the router does not run the Cisco IOS XE software, so that Management Ethernet interface configuration is not available.

When you want to access other devices, such as a TFTP server, while in ROM Monitor mode on the router, you must configure the ROM Monitor variables with IP access information.

---

**Note**

TFTP access variables are currently not supported on the IR1101 platform.

---

**Access ROM Monitor Mode**

The following sections describe how to enter the ROMMON mode, and contains the following sections:

**Checking the Current ROMMON Version**

To display the version of ROMmon running on a router, use the `show rom-monitor` command. To show all variables that are set in ROMmon, use `show romvar`.

```
Router#show rom-monitor r0
System Bootstrap, Version 1.2, RELEASE SOFTWARE
Copyright (c) 1994-2018 by cisco Systems, Inc.

Router# show romvar
ROMMON variables:
    PS1 = rommon ! >
    MCP_STARTUP_TRACEFLAGS = 00000000:00000000
    LICENSE_SUITE =
    RET_2_RTS =
    Diagnostic = 1
    THRPUT =
    USER_BOOT_PARAM = DEBUG_CONF=/bootflash/debug.conf
    EULA_ACCEPTED = TRUE
    BOOT_WDOG = DISABLE
    LICENSE_BOOT_LEVEL =
    BOOT = bootflash:sparrow_crashkernel.bin,1;
```
If your configuration register was set to hex value 0x0 or 0x1820, reload operation will bring you to the ROMmon mode command prompt (rommon 1>). Invoking the set command at the prompt (rommon 1> set) will display the same information as "show romvar" above in IOS/XE exec mode.

```
rommon 1 > set
PS1=rommon ! >
```

**Commonly Used ROM Monitor Commands**

The following table summarizes the commands commonly used in ROM Monitor. For specific instructions on using these commands, refer to the relevant procedure in this document.

<table>
<thead>
<tr>
<th>ROMMON Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>boot image</td>
<td>Manually boots a Cisco IOS XE software image.</td>
</tr>
<tr>
<td>boot image –o config-file-path</td>
<td>Manually boots the Cisco IOS XE software with a temporary alternative administration configuration file.</td>
</tr>
<tr>
<td>confreg</td>
<td>Changes the config-register setting.</td>
</tr>
<tr>
<td>dev</td>
<td>Displays the available local storage devices.</td>
</tr>
<tr>
<td>dir</td>
<td>Displays the files on a storage device.</td>
</tr>
<tr>
<td>reset</td>
<td>Resets the node.</td>
</tr>
<tr>
<td>set</td>
<td>Displays the currently set ROM Monitor environmental settings.</td>
</tr>
<tr>
<td>sync</td>
<td>Saves the new ROM Monitor environmental settings.</td>
</tr>
<tr>
<td>unset</td>
<td>Removes an environmental variable setting.</td>
</tr>
</tbody>
</table>
Examples

The following example shows what appears when you enter the ? command on a router:

```plaintext
rommon 1 > ?
alias set and display aliases command
boot boot up an external process
confreg configuration register utility
dev list the device table
dir list files in file system
help monitor builtin command help
history monitor command history
meminfo main memory information
repeat repeat a monitor command
reset system reset
set display the monitor variables
showmon display currently selected ROM monitor
sync write monitor environment to NVRAM
token display board's unique token identifier
unalias unset an alias
unset unset a monitor variable
```

Changing the ROM Monitor Prompt

You can change the prompt in ROM Monitor mode by using the PS1= command as shown in the following example:

```
rommon 8 > PS1="IR1101 rommon ! > 
IR1101 rommon 9 >
```

Changing the prompt is useful if you are working with multiple routers in ROM Monitor at the same time. This example specifies that the prompt should be “IR1101 rommon “, followed by the line number, and then followed by “ > “ by the line number.

Displaying the Configuration Register Setting

To display the current configuration register setting, enter the confreg command without parameters as follows:

```
rommon > confreg
```

Configuration Summary

(Virtual Configuration Register: )

enabled are:
[ 0 ] break/abort has effect
[ 1 ] console baud: 9600

boot:...... the ROM Monitor
do you wish to change the configuration? y/n [n]:

The configuration register setting is labeled Virtual Configuration Register. Enter the no command to avoid changing the configuration register setting.

Environment Variable Settings

The ROM Monitor environment variables define the attributes of the ROM Monitor. Environmental variables are entered like commands and are always followed by the equal sign (=). Environment variable settings are entered in capital letters, followed by a definition. For example:
IP_ADDRESS=10.0.0.2

Under normal operating conditions, you do not need to modify these variables. They are cleared or set only when you need to make changes to the way ROM Monitor operates.

This section includes the following topics:

**Frequently Used Environmental Variables**

The following table shows the main ROM Monitor environmental variables. For instructions on how to use these variables, see the relevant instructions in this document. The IR1101 boot loader does not support netboot, so any setting like environment variables IP_ADDRESS, IP_SUBNET_MASK, DEFAULT_GATEWAY, TFTP_SERVER, TFTP_FILE are not used.

<table>
<thead>
<tr>
<th>Environmental variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOOT=path/file</td>
<td>Identifies the boot software for a node. This variable is usually set automatically when the router boots.</td>
</tr>
</tbody>
</table>

**Displaying Environment Variable Settings**

To display the current environment variable settings, enter the `set` command:

```
rommon 1 > showmon
System Bootstrap, Version 1.3(REL), RELEASE SOFTWARE
Copyright (c) 1994-2018 by cisco Systems, Inc.
IR1101-K9 platform with 4188160 Kbytes of main memory
MCU Version - Bootloader: 4, App: 4
MCU is in application mode.
```

**Entering Environment Variable Settings**

Environment variable settings are entered in capital letters, followed by a definition. The following example shows the environmental variables that can be configured in ROMmon mode:

```
rommon 1 > confreg 0x0
rommon 1> BOOT_WDOG = DISABLE
rommon 1> BOOT = IR1101-K9_image_name
```

**Saving Environment Variable Settings**

To save the current environment variable settings, enter the `sync` command:

```
rommon > sync
```

**Note**

Environmental values that are not saved with the `sync` command are discarded whenever the system is reset or booted.
Exiting ROM Monitor Mode

To exit ROM Monitor mode, you must change the configuration register and reset the router.

SUMMARY STEPS

1. confreg
2. Respond to each prompt as instructed.
3. reset

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
</tr>
<tr>
<td>confreg</td>
<td>Initiates the configuration register configuration prompts.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>rommon 1&gt; confreg</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
</tr>
<tr>
<td>Respond to each prompt as instructed.</td>
<td>See the example that follows this procedure for more information.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td></td>
</tr>
<tr>
<td>reset</td>
<td>Resets and initializes the router.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>rommon 2&gt; reset</td>
<td></td>
</tr>
</tbody>
</table>

Configuration Example

rommon 3 > confreg

Configuration Summary
(Virtual Configuration Register: 0x0)
enabled are:
[ 0 ] break/abort has effect
[ 1 ] console baud: 9600
boot: ...... the ROM Monitor
do you wish to change the configuration? y/n [n]: y
enable "diagnostic mode"? y/n [n]:
enable "use net in IP bcast address"? y/n [n]:
enable "load rom after netboot fails"? y/n [n]:
enable "use all zero broadcast"? y/n [n]:
disable "break/abort has effect"? y/n [n]:
enable "ignore system config info"? y/n [n]:
change console baud rate? y/n [n]:
change the boot characteristics? y/n [n]:

Configuration Summary
(Virtual Configuration Register: 0x0)
enabled are:
[ 0 ] break/abort has effect
[ 1 ] console baud: 9600
boot: ...... the ROM Monitor
do you wish to change the configuration? y/n [n]:

Cisco IR1101 Integrated Services Router Software Configuration Guide
Upgrading the ROMmon for a Router

ROMmon upgrade on the IR1101-K9 router is automatically done when the image is booted. The latest version of the ROMmon is bundled with the IOSXE image. An algorithm detects if the current running version is older than the bundled version, if so, it is automatically upgraded. If the current running version is equal to the bundled version no upgrade is executed. For every successful upgrade, the router is automatically rebooted in order for the new version to get loaded and executed.

SUMMARY STEPS

1. (Optional) Run the `show rom-monitor slot` command on the router to see the current release numbers of ROMmon on the hardware. See the Checking the Current ROMMON Version, on page 262 for information about interpreting the output of the command that you run.

2. If autoboot has not been enabled by using the `config-register 0x2102` command, run the `boot filesystem:/file-location` command at the ROMmon prompt to boot the Cisco IOSXE image, where `filesystem:/file-location` is the path to the consolidated package file. The ROMmon upgrade is not permanent for any piece of hardware until the Cisco IOSXE image is booted.

3. Run the `enable` command at the user prompt to enter the privileged EXEC mode after the boot is complete.

4. Run the `show rom-monitor slot` command to verify whether the ROMmon has been upgraded.

DETAILED STEPS

**Step 1** (Optional) Run the `show rom-monitor slot` command on the router to see the current release numbers of ROMmon on the hardware. See the Checking the Current ROMMON Version, on page 262 for information about interpreting the output of the command that you run.

**Step 2** If autoboot has not been enabled by using the `config-register 0x2102` command, run the `boot filesystem:/file-location` command at the ROMmon prompt to boot the Cisco IOSXE image, where `filesystem:/file-location` is the path to the consolidated package file. The ROMmon upgrade is not permanent for any piece of hardware until the Cisco IOSXE image is booted.

**Step 3** Run the `enable` command at the user prompt to enter the privileged EXEC mode after the boot is complete.

**Step 4** Run the `show rom-monitor slot` command to verify whether the ROMmon has been upgraded.
WAN Monitoring

This chapter contains the following topics:

- Information About WANMon, on page 269
- Prerequisites, on page 270
- Guidelines and Limitations, on page 270
- Configuring WANMon, on page 270
- Verifying WANMon Configuration, on page 272
- Configuration Examples, on page 273

Information About WANMon

WANMon is a flexible solution to address the WAN link recovery requirements for the following products and interfaces:

- Physical networks: 4G LTE and Ethernet (WAN port)
- Virtual links: Non-crypto map based IPSec tunnels (either legacy or FlexVPN); that is, any IPSec tunnel you configure as an interface.

You enable WANMon to monitor your WAN links and initiate link recovery actions on receipt of link failure triggers.

Built-in Recovery Actions

The following are the three levels of built-in recovery processes specific to the link type:

<table>
<thead>
<tr>
<th>Link Type</th>
<th>Recovery Actions</th>
<th>Level 1 (Active)</th>
<th>Level 2 (Last-Resort)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4G LTE</td>
<td>Clear interface, and then shut/no-shut</td>
<td>Module reload</td>
<td>System reload</td>
</tr>
<tr>
<td>Ethernet</td>
<td>Clear interface, and then shut/no-shut</td>
<td>No action taken</td>
<td>System reload</td>
</tr>
<tr>
<td>Tunnel</td>
<td>Shut/no-shut</td>
<td>No action taken</td>
<td>System reload</td>
</tr>
</tbody>
</table>
Each level has two time-based thresholds based on which built-in recovery actions are taken. The following are the default settings for each level:

- **threshold** is the wait time in minutes after receipt of a link failure trigger to initiate the recovery action as set in the specified level.
- **mintime** is the frequency to perform the recovery action if the link remains down.

The built-in values are:

<table>
<thead>
<tr>
<th>Level</th>
<th>threshold</th>
<th>mintime</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>10 min</td>
<td>10 min</td>
<td>Triggers Level 0 actions 10 minutes after the link went down. Repeat no more than every 10 minutes.</td>
</tr>
<tr>
<td>Level 1</td>
<td>60 min</td>
<td>60 min</td>
<td>Triggers Level 1 actions 10 minutes after the link went down. Repeat no more than every 60 minutes.</td>
</tr>
<tr>
<td>Level 2</td>
<td>480 min</td>
<td>60 min</td>
<td>Triggers Level 2 actions 480 minutes after the link went down. Repeat no more than every 60 minutes.</td>
</tr>
</tbody>
</table>

**Note**

If threshold values are specified as 0, no recovery actions are taken for that level. You can use this to avoid system reload (the built-in Level 2 recovery action) on receipt of a link failure trigger where other WAN links may be operational.

**Prerequisites**

Ensure that the WANMon module is available. The WANMon module is included in the IOS-XE image as the `tm_wanmon.tcl` policy file.

**Guidelines and Limitations**

- WANMon automatically performs IP address checking (no user configuration) as required for cellular interfaces.
- For all other interfaces, WANMon never performs IP address checking.
- WANMon indirectly triggers user-specified actions by generating an application event that link resetter applets monitor.
- If your network is live, ensure that you understand the potential impact of any command.

**Configuring WANMon**

You can enable WANMon on the router and assign WANMon support to specific interfaces. Optionally, you can override the built-in recovery actions, define custom recovery links, and define an event manager.
environment policy to set the track object value and disable IP address checking. WANMon is disabled by default.

**SUMMARY STEPS**

1. event manager policy `tm_wanmon.tcl` authorization bypass
2. event manager environment `wanmon_if_list` `<instance>` `{interface name {ipsla `<instance>`}}`
3. event manager environment `wanmon_if_lists` `{interface name {recovery Level0 `<Level1` Level2`}}`
4. publish-event sub-system 798 type 2000 `arg1` `<interface name>` `arg2` `<level>`
5. `{stub `<track-stub-id`>`}
6. event manager environment `wanmon_if_lists` `{interface name > {checkip `<instance>`}}`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> event manager policy <code>tm_wanmon.tcl</code> authorization bypass</td>
<td>Enables the WANMon link recovery module. Use <code>authorization bypass</code> to avoid authorization for CLIs invoked by this policy.</td>
</tr>
<tr>
<td><strong>Step 2</strong> event manager environment <code>wanmon_if_list</code> <code>&lt;instance&gt;</code> <code>{interface name {ipsla </code>&lt;instance&gt;<code>}}</code></td>
<td>Configures WANMon for the interfaces in your WAN, and indicates that this is an interface configuration command. <strong>Note</strong> Any environment variable with the prefix <code>wanmon_if_list</code> constitutes an interface configuration. Multiple interfaces are allowed by specifying an instance. Be sure to specify the full interface name (for example, <code>cellular0/1/0</code> or <code>cellular0/3/0</code>). You can set the IP SLA icmp-echo trigger, if desired. Multiple IP SLA triggers are allowed by specifying an instance. <strong>Note</strong> WANMon only looks at the status of the SLA ID. Even though <code>icmp-echo</code> is most common, if needed any other type of SLA probe (for example, <code>udp-echo</code>) can be used instead.</td>
</tr>
<tr>
<td><strong>Step 3</strong> event manager environment <code>wanmon_if_lists</code> <code>{interface name {recovery Level0 </code>&lt;Level1<code> Level2</code>}}`</td>
<td>(Optional) Overrides the built-in thresholds.</td>
</tr>
<tr>
<td><strong>Step 4</strong> publish-event sub-system 798 type 2000 <code>arg1</code> <code>&lt;interface name&gt;</code> <code>arg2</code> <code>&lt;level&gt;</code></td>
<td>(Optional) Configures custom recovery actions using link resetter applets. <code>&lt;interface&gt;</code> is the full interface name (for example, <code>cellular0/1/0</code> or <code>cellular0/3/0</code>). <code>&lt;level&gt;</code> is 0, 1, or 2 to match the desired link recovery action.</td>
</tr>
<tr>
<td><strong>Step 5</strong> <code>{stub </code>&lt;track-stub-id&gt;<code>}</code></td>
<td>(Optional) Allows an event manager environment policy to set the track object value. WANMon can set a...</td>
</tr>
</tbody>
</table>
Verifying WANMon Configuration

Use the following steps to verify your WANMon configuration.

SUMMARY STEPS

1. show event manager policy registered
2. show event manager environment
### Configuration Examples

The following examples are provided:

**WANMon Cellular Interface Configuration Example**

```plaintext
track 1 ip sla 1
ip sla 1
  icmp-echo 172.27.166.250
timeout 6000
  frequency 300
ip sla schedule 1 life forever start-time now
event manager environment wanmon_if_list {cellular0/1/0 {ipsla 1}}
event manager policy tm_wanmon.tcl authorization bypass
```

**Multiple WAN Link Monitoring Example**

```plaintext
track 1 ip sla 1
track 21 stub-object
ip sla 1
  icmp-echo 172.27.166.250
timeout 6000
  frequency 300
ip sla schedule 1 life forever start-time now
track 2 ip sla 2
track 22 stub-object
ip sla 2
  icmp-echo 10.27.16.25
timeout 6000
  frequency 300
ip sla schedule 2 life forever start-time now
event manager environment wanmon_if_list1 {cellular0/1/0 {ipsla 1} {stub 21}}
event manager policy tm_wanmon.tcl authorization bypass
```
Process Health Monitoring

This chapter describes how to manage and monitor the health of various components of your router. It contains the following sections:

- Monitoring Control Plane Resources, on page 275
- Monitoring Hardware Using Alarms, on page 281

Monitoring Control Plane Resources

The following sections explain the details of memory and CPU monitoring from the perspective of the Cisco IOS process and the overall control plane:

- Avoiding Problems Through Regular Monitoring, on page 275
- Cisco IOS Process Resources, on page 275
- Overall Control Plane Resources, on page 279

Avoiding Problems Through Regular Monitoring

Processes should provide monitoring and notification of their status/health to ensure correct operation. When a process fails, a syslog error message is displayed and either the process is restarted or the router is rebooted. A syslog error message is displayed when a monitor detects that a process is stuck or has crashed. If the process can be restarted, it is restarted; else, the router is restarted.

Monitoring system resources enables you to detect potential problems before they occur, thus avoiding outages. It also establishes a baseline for a normal system load. You can use this information as a basis for comparison, when you upgrade hardware or software to see if the upgrade has affected resource usage.

Cisco IOS Process Resources

You can view CPU utilization statistics on active processes and see the amount of memory being used in these processes using the `show memory` command and the `show process cpu` command. These commands provide a representation of memory and CPU utilization from the perspective of only the Cisco IOS process; they do not include information for resources on the entire platform. When the `show memory` command is used in a system with 4 GB RAM running a single Cisco IOS process, the following memory usage is displayed:
Router# show memory
Tracekey : 1#3e0077971693714bd2b0bc347d77489
Address Bytes Prev Next Ref PrevF NextF what Alloc PC

<table>
<thead>
<tr>
<th>Processor</th>
<th>7F68ECD010</th>
<th>728952276</th>
<th>281540188</th>
<th>447412088</th>
<th>445683380</th>
<th>234766720</th>
</tr>
</thead>
<tbody>
<tr>
<td>lsmpi_io</td>
<td>7F6852A1A8</td>
<td>6295128</td>
<td>6294304</td>
<td>824</td>
<td>824</td>
<td>412</td>
</tr>
</tbody>
</table>

Dynamic heap limit(MB) 200 Use(MB) 0

Processor memory
Address Bytes Prev Next Ref PrevF NextF what Alloc PC

<table>
<thead>
<tr>
<th>Processor</th>
<th>7F68ECD010</th>
<th>0000000568</th>
<th>00000000</th>
<th>7F68ECD2A0</th>
<th>001</th>
<th>Managed Chunk Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>7F68ECD2A0</td>
<td>000032776</td>
<td>00000000</td>
<td>7F68ED5300</td>
<td>001</td>
<td><em>Init</em> :400000+60E37C4</td>
</tr>
<tr>
<td>lsmpi_io</td>
<td>7F6852A1A8</td>
<td>6295128</td>
<td>6294304</td>
<td>824</td>
<td>824</td>
<td>412</td>
</tr>
</tbody>
</table>

Cisco IR1101 Integrated Services Router Software Configuration Guide
The `show process cpu` command displays Cisco IOS CPU utilization average:

```
Router# show process cpu
CPU utilization for five seconds: 0%/0%; one minute: 0%; five minutes: 0%
PID Runtime(ms) Invoked uSecs 5Sec 1Min 5Min TTY Process
1 0 17 0 0.00% 0.00% 0.00% 0 Chunk Manager
2 552 1205 458 0.00% 0.00% 0.00% 0 Load Meter
3 0 1 0 0.00% 0.00% 0.00% 0 PKI Trustpool
4 0 1 0.00% 0.00% 0.00% 0 Retransmission o
5 0 1 0.00% 0.00% 0.00% 0 IPC ISSU Dispatc
6 36 132769 0.00% 0.00% 0.00% 0 RF Slave Main Th
7 0 1 0.00% 0.00% 0.00% 0 EDDRI_MAIN
8 0 1 0.00% 0.00% 0.00% 0 RO Notify Timers
9 4052 920 4404 0.23% 0.09% 0.06% 0 Check heaps
10 1210118 0.00% 0.00% 0.00% 0 Pool Manager
11 0 1 0.00% 0.00% 0.00% 0 DiscardQ Backgro
12 0 2 0.00% 0.00% 0.00% 0 Timers
13 0 163 0.00% 0.00% 0.00% 0 WATCH_AFS
14 0 2 0.00% 0.00% 0.00% 0 ATM AutoVC Perio
15 0 2 0.00% 0.00% 0.00% 0 ATM VC Auto Crea
16 76 3024 25 0.00% 0.00% 0.00% 0 IOSXE heartbeat
17 0 13 0.00% 0.00% 0.00% 0 DB Lock Manager
18 0 1 0.00% 0.00% 0.00% 0 DB Notification
19 0 1 0.00% 0.00% 0.00% 0 IPC Apps Task
20 0 1 0.00% 0.00% 0.00% 0 ifIndex Receive
21 361210 29 0.00% 0.00% 0.00% 0 IPC Event Notifi
22 725904 12 0.00% 0.00% 0.00% 0 IPC Mcast Pendin
23 0 1 0.00% 0.00% 0.00% 0 Platform appsess
24 0 101 0.00% 0.00% 0.00% 0 IPC Dynamic Cach
25 161210 13 0.00% 0.00% 0.00% 0 IPC Service MonC
26 0 1 0.00% 0.00% 0.00% 0 IPC Zone Manager
27 645904 10 0.00% 0.00% 0.00% 0 IPC Periodic Tim
28 765904 12 0.00% 0.00% 0.00% 0 IPC Deferred Por
29 0 1 0.00% 0.00% 0.00% 0 IPC Process leve
30 0 1 0.00% 0.00% 0.00% 0 IPC Seat Manager
31 8346 23 0.00% 0.00% 0.00% 0 IPC Check Queue
32 0 1 0.00% 0.00% 0.00% 0 IPC Seat RX Cont
33 0 1 0.00% 0.00% 0.00% 0 IPC Seat TX Cont
34 48606 79 0.00% 0.00% 0.00% 0 IPC Keep Alive M
35 281210 23 0.00% 0.00% 0.00% 0 IPC Loadometer
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37 0 1 0.00% 0.00% 0.00% 0 SENSOR-MGR event
38 4606 6 0.00% 0.00% 0.00% 0 Compute SRP rate
39 0 1 0.00% 0.00% 0.00% 0 MEMLEAK PROCESS
40 0 1 0.00% 0.00% 0.00% 0 ARP Input
41 1126331 17 0.00% 0.00% 0.00% 0 ARP Background
42 0 2 0.00% 0.00% 0.00% 0 ATM Idle Timer
43 0 1 0.00% 0.00% 0.00% 0 ATM ASYNCC Proc
44 0 1 0.00% 0.00% 0.00% 0 CEF MIB API
--More--
```

```
show process cpu platform sorted
CPU utilization for five seconds: 11%, one minute: 12%, five minutes: 12%
```
Core 0: CPU utilization for five seconds: 1%, one minute: 3%, five minutes: 3%
Core 1: CPU utilization for five seconds: 1%, one minute: 3%, five minutes: 3%
Core 2: CPU utilization for five seconds: 1%, one minute: 1%, five minutes: 1%
Core 3: CPU utilization for five seconds: 42%, one minute: 42%, five minutes: 42%

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Cisco IR1101 Integrated Services Router Software Configuration Guide
Overall Control Plane Resources

Control plane memory and CPU utilization on each control processor allows you to keep a tab on the overall control plane resources. You can use the `show platform software status control-processor brief` command (summary view) or the `show platform software status control-processor` command (detailed view) to view control plane memory and CPU utilization information.

All control processors should show status, Healthy. Other possible status values are Warning and Critical. Warning indicates that the router is operational, but that the operating level should be reviewed. Critical implies that the router is nearing failure.

If you see a Warning or Critical status, take the following actions:

- Reduce the static and dynamic loads on the system by reducing the number of elements in the configuration or by limiting the capacity for dynamic services.
- Reduce the number of routes and adjacencies, limit the number of ACLs and other rules, reduce the number of VLANs, and so on.

The following sections describe the fields in the `show platform software status control-processor` command output.

**Load Average**

Load average represents the process queue or process contention for CPU resources. For example, on a single-core processor, an instantaneous load of 7 would mean that seven processes are ready to run, one of which is currently running. On a dual-core processor, a load of 7 would mean that seven processes are ready to run, two of which are currently running.

**Memory Utilization**

Memory utilization is represented by the following fields:

- Total—Total system memory
- Used—Consumed memory
- Free—Available memory
- Committed—Virtual memory committed to processes

**CPU Utilization**

CPU utilization is an indication of the percentage of time the CPU is busy, and is represented by the following fields:

- CPU—Allocated processor
- User—Non-Linux kernel processes
- System—Linux kernel process
- Nice—Low-priority processes
- Idle—Percentage of time the CPU was inactive
- IRQ—Interrupts
• SIRQ—System Interrupts
• IOwait—Percentage of time CPU was waiting for I/O

**Example: show platform software status control-processor Command**

The following are some examples of using the `show platform software status control-processor` command:

```
Router# show platform software status control-processor
RP0: online, statistics updated 4 seconds ago
Load Average: healthy
1-Min: 0.29, status: healthy, under 5.00
5-Min: 0.51, status: healthy, under 5.00
15-Min: 0.54, status: healthy, under 5.00
Memory (kb): healthy
Total: 4038072
Used: 2872136 (71%), status: healthy
Free: 1165936 (29%)
Committed: 2347228 (58%), under 90%
Per-core Statistics
CPU0: CPU Utilization (percentage of time spent)
  User: 1.00, System: 0.70, Nice: 0.00, Idle: 97.88
  IRQ: 0.30, SIRQ: 0.10, IOwait: 0.00
CPU1: CPU Utilization (percentage of time spent)
  User: 0.70, System: 0.30, Nice: 0.00, Idle: 98.48
  IRQ: 0.30, SIRQ: 0.20, IOwait: 0.00
CPU2: CPU Utilization (percentage of time spent)
  User: 0.20, System: 1.11, Nice: 0.00, Idle: 97.87
  IRQ: 0.40, SIRQ: 0.00, IOwait: 0.00
CPU3: CPU Utilization (percentage of time spent)
  User: 8.23, System: 24.37, Nice: 0.00, Idle: 58.00
  IRQ: 9.26, SIRQ: 0.11, IOwait: 0.00

Router# show platform software status control-processor brief
Load Average
Slot Status 1-Min 5-Min 15-Min
RP0 Healthy 0.28 0.46 0.52
Memory (kB)
Slot Status Total Used (Pct) Free (Pct) Committed (Pct)
RP0 Healthy 4038072 2872136 (71%) 1165936 (29%) 2347228 (58%)
CPU Utilization
Slot CPU User System Nice Idle IRQ SIRQ IOwait
RP0 0 0.70 0.20 0.00 98.58 0.30 0.20 0.00
  1 1.10 0.90 0.00 97.59 0.30 0.10 0.00
  2 0.40 1.31 0.00 97.87 0.40 0.00 0.00
  3 8.00 26.55 0.00 56.33 8.99 0.11 0.00
```
Monitoring Hardware Using Alarms

Router Design and Monitoring Hardware

The router sends alarm notifications when problems are detected, allowing you to monitor the network remotely. You do not need to use `show` commands to poll devices on a routine basis; however, you can perform onsite monitoring if you choose.

BootFlash Disk Monitoring

The bootflash disk must have enough free space to store two core dumps. This condition is monitored, and if the bootflash disk is too small to store two core dumps, a syslog alarm is generated, as shown in the following example:

```
Oct 6 14:10:56.292: %FLASH_CHECK-3-DISK_QUOTA: R0/0: flash_check: Flash disk quota exceeded [free space is 1429020 kB] - Please clean up files on bootflash.
```

Approaches for Monitoring Hardware Alarms

Viewing the Console or Syslog for Alarm Messages

The network administrator can monitor alarm messages by reviewing alarm messages sent to the system console or to a system message log (syslog).

Enabling the logging alarm Command

The `logging alarm` command must be enabled for the system to send alarm messages to a logging device, such as the console or a syslog. This command is not enabled by default.

You can specify the severity level of the alarms to be logged. All the alarms at and above the specified threshold generate alarm messages. For example, the following command sends only critical alarm messages to logging devices:

```
Router(config)# logging alarm critical
```

If alarm severity is not specified, alarm messages for all severity levels are sent to logging devices.

Network Management System Alerts a Network Administrator when an Alarm is Reported Through SNMP

The SNMP is an application-layer protocol that provides a standardized framework and a common language used for monitoring and managing devices in a network.

SNMP provides notification of faults, alarms, and conditions that might affect services. It allows a network administrator to access router information through a network management system (NMS) instead of reviewing logs, polling devices, or reviewing log reports.

To use SNMP to get alarm notification, use the following MIBs:
Network Management System Alerts a Network Administrator when an Alarm is Reported Through SNMP

- ENTITY-MIB, RFC4133 (required for the CISCO-ENTITY-ALARM-MIB, ENTITY-STATE-MIB and CISCO-ENTITY-SENSOR-MIB to work)
- CISCO-ENTITY-ALARM-MIB
- ENTITY-STATE-MIB
- CISCO-ENTITY-SENSOR-MIB (for transceiver environmental alarm information, which is not provided through the CISCO-ENTITY-ALARM-MIB)
CHAPTER 23

Troubleshooting

This section describes the troubleshooting scenarios.

Before troubleshooting a software problem, you must connect a PC to the router via the console port. With a connected PC, you can view status messages from the router and enter commands to troubleshoot a problem.

You can also remotely access the interface by using Telnet. The Telnet option assumes that the interface is up and running.

- Understanding Diagnostic Mode, on page 283
- Before Contacting Cisco or Your Reseller, on page 284
- show interfaces Troubleshooting Command, on page 284
- Software Upgrade Methods, on page 284
- Change the Configuration Register, on page 285
- Recovering a Lost Password, on page 288

Understanding Diagnostic Mode

The router boots up or accesses diagnostic mode in the following scenarios:

- The IOS process or processes fail, in some scenarios. In other scenarios, the system resets when the IOS process or processes fail.
- A user-configured access policy was configured using the transport-map command that directs the user into the diagnostic mode.
- A send break signal (Ctrl-C or Ctrl-Shift-6) was entered while accessing the router, and the router was configured to enter diagnostic mode when a break signal was sent.

In the diagnostic mode, a subset of the commands that are available in user EXEC mode are made available to the users. Among other things, these commands can be used to:

- Inspect various states on the router, including the IOS state.
- Replace or roll back the configuration.
- Provide methods of restarting the IOS or other processes.
- Reboot hardware, such as the entire router, a module, or possibly other hardware components.
- Transfer files into or off of the router using remote access methods such as FTP, TFTP, and SCP.
The diagnostic mode provides a more comprehensive user interface for troubleshooting than previous routers, which relied on limited access methods during failures, such as ROMMON, to diagnose and troubleshoot Cisco IOS problems. The diagnostic mode commands can work when the Cisco IOS process is not working properly. These commands are also available in privileged EXEC mode on the router when the router is working normally.

Before Contacting Cisco or Your Reseller

If you cannot locate the source of a problem, contact your local reseller for advice. Before you call, you should have the following information ready:

- Chassis type and serial number
- Maintenance agreement or warranty information
- Type of software and version number
- Date you received the hardware
- Brief description of the problem
- Brief description of the steps you have taken to isolate the problem

show interfaces Troubleshooting Command

Use the `show interfaces` command to display the status of all physical ports and logical interfaces on the router. `#unique_360 unique_360_Connect_42_tab_1055127` describes messages in the command output.

The IR1101 supports the following interfaces:

- GigabitEthernet 0/0/0
- Cellular 0/1/0
- FastEthernet 0/0/1 to 0/0/4
- Async 0/2/0

Software Upgrade Methods

Several methods are available for upgrading software on the Cisco IR1101 Routers, including:

- Copy the new software image to flash memory over LAN or WAN when the existing Cisco IOS software image is in use.
- Copy the new software image to flash memory over the LAN while the boot image (ROM monitor) is operating.
- Copy the new software image over the console port while in ROM monitor mode.
- From ROM monitor mode, boot the router from a software image that is loaded on a TFTP server. To use this method, the TFTP server must be on the same LAN as the router.
Change the Configuration Register

To change a configuration register, follow these steps:

**SUMMARY STEPS**

1. Connect a PC to the CONSOLE port on the router.
2. At the privileged EXEC prompt (router_name #), enter the `show version` command to display the existing configuration register value (shown in bold at the bottom of this output example):
3. Record the setting of the configuration register.
4. To enable the break setting (indicated by the value of bit 8 in the configuration register), enter the `config-register 0x01` command from privileged EXEC mode.

**DETAILED STEPS**

**Step 1** Connect a PC to the CONSOLE port on the router.
**Step 2** At the privileged EXEC prompt (router_name #), enter the `show version` command to display the existing configuration register value (shown in bold at the bottom of this output example):

**Example:**

Router# show version
Cisco IOS XE Software, Version 16.10.01
Cisco IOS Software [Gibraltar], ISR Software (ARMV8EL_LINUX_IOSD-UNIVERSALK9-M), Version 16.10.1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2018 by Cisco Systems, Inc.
Compiled Fri 09-Nov-18 18:08 by mcpre

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ROM: IOS-XE ROMMON

Router uptime is 14 hours, 36 minutes
Uptime for this control processor is 14 hours, 37 minutes
System returned to ROM by reload
System restarted at 08:47:04 GMT Mon Nov 12 2018
System image file is "bootflash:ir1101-universalk9.16.10.01.SPA.bin"
Last reload reason: Reload Command

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Technology Package License Information:

<table>
<thead>
<tr>
<th>Technology-package</th>
<th>Type</th>
<th>Technology-package</th>
</tr>
</thead>
<tbody>
<tr>
<td>network-essentials</td>
<td>Smart License</td>
<td>network-essentials</td>
</tr>
</tbody>
</table>

Smart Licensing Status: UNREGISTERED/EVAL MODE

cisco IR1101-K9 (ARM64) processor (revision 1.2 GHz) with 711861K/6147K bytes of memory.
Processor board ID FCW222700MY
3 Virtual Ethernet interfaces
4 FastEthernet interfaces
1 Gigabit Ethernet interface
1 Serial interface
1 terminal line
2 Cellular interfaces
32768K bytes of non-volatile configuration memory.
4038072K bytes of physical memory.
3110864K bytes of Bootflash at bootflash:/
OK bytes of WebUI ODM Files at webui:.

Configuration register is 0x1821

Router#

Step 3
Record the setting of the configuration register.

Step 4
To enable the break setting (indicated by the value of bit 8 in the configuration register), enter the `config-register 0x01` command from privileged EXEC mode.

• Break enabled—Bit 8 is set to 0.
• Break disabled (default setting)—Bit 8 is set to 1.

Configuring the Configuration Register for Autoboot

Note
Altering the configuration register is only for advanced troubleshooting and should only be done with guidance from Cisco support.
The configuration register can be used to change router behavior. This includes controlling how the router boots. Set the configuration register to 0x0 to boot into ROM, by using one of the following commands:

- In Cisco IOS configuration mode, use the `config-reg 0x0` command.
- From the ROMMON prompt, use the `confreg 0x0` command.

Note: Setting the configuration register to 0x2102 will set the router to autoboott the Cisco IOS XE software.

## Reset the Router

To reset the router, follow these steps:

### SUMMARY STEPS

1. If break is disabled, turn the router off (O), wait 5 seconds, and turn it on (I) again. Within 60 seconds, press the Break key. The terminal displays the ROM monitor prompt.
2. Press break. The terminal displays the following prompt:
3. Enter `confreg 0x142` to reset the configuration register:
4. Initialize the router by entering the `reset` command:
5. Enter `no` in response to the prompts until the following message is displayed:
6. Press Return. The following prompt appears:
7. Enter the enable command to enter enable mode. Configuration changes can be made only in enable mode:
8. Enter the `show startup-config` command to display an enable password in the configuration file:

### DETAILED STEPS

#### Step 1
If break is disabled, turn the router off (O), wait 5 seconds, and turn it on (I) again. Within 60 seconds, press the Break key. The terminal displays the ROM monitor prompt.

Note: Some terminal keyboards have a key labeled Break. If your keyboard does not have a Break key, see the documentation that came with the terminal for instructions on how to send a break.

#### Step 2
Press break. The terminal displays the following prompt:

Example:

```
rommon 2>
```

#### Step 3
Enter `confreg 0x142` to reset the configuration register:

Example:

```
rommon 2> confreg 0x142
```

#### Step 4
Initialize the router by entering the `reset` command:

Example:
The router cycles its power, and the configuration register is set to 0x142. The router uses the boot ROM system image, indicated by the system configuration dialog:

Example:

--- System Configuration Dialog ---

Step 5 Enter no in response to the prompts until the following message is displayed:

Example:

Press RETURN to get started!

Step 6 Press Return. The following prompt appears:

Example:

Router>

Step 7 Enter the enable command to enter enable mode. Configuration changes can be made only in enable mode:

Example:

Router> enable

The prompt changes to the privileged EXEC prompt:

Example:

Router#

Step 8 Enter the show startup-config command to display an enable password in the configuration file:

Example:

Router# show startup-config

---

**What to do next**

If you are recovering an enable password, do not perform the steps in the Reset the Password and Save Your Changes section. Instead, complete the password recovery process by performing the steps in the Reset the Configuration Register Value section.

If you are recovering an enable secret password, it is not displayed in the show startup-config command output. Complete the password recovery process by performing the steps in the Reset the Password and Save Your Changes section.

---

**Recovering a Lost Password**

To recover a lost enable or lost enable-secret password, refer to the following sections:

1. Change the Configuration Register
2. Reset the Router

3. Reset the Password and Save your Changes (for lost enable secret passwords only)

4. Reset the Configuration Register Value.

5. If you have performed a write erase, or used the reset button, you will need to add the license.

   IR1101#config term
   IR1101#license smart reservation

---

**Note**
Recovering a lost password is only possible when you are connected to the router through the console port. These procedures cannot be performed through a Telnet session.

---

**Tip**
See the “Hot Tips” section on Cisco.com for additional information on replacing enable secret passwords.

---

**Reset the Password and Save Your Changes**

To reset your password and save the changes, follow these steps:

**SUMMARY STEPS**

1. Enter the `configure terminal` command to enter global configuration mode:

   **Example:**

   

   

   Router# configure terminal

2. Enter the `enable secret` command to reset the enable secret password in the router:

   **Example:**

   

   

   Router(config)# enable secret

   password

3. Enter `exit` to exit global configuration mode:

   **Example:**

   

   

   Router(config)# exit

4. Save your configuration changes:

   **Example:**

   

   

   

---
Reset the Configuration Register Value

To reset the configuration register value after you have recovered or reconfigured a password, follow these steps:

**SUMMARY STEPS**

1. Enter the `configure terminal` command to enter global configuration mode:
2. Enter the `configure register` command and the original configuration register value that you recorded.
3. Enter `exit` to exit configuration mode:
4. Reboot the router, and enter the recovered password.

**DETAILED STEPS**

Step 1
Enter the `configure terminal` command to enter global configuration mode:

**Example:**

```
Router# configure terminal
```

Step 2
Enter the `configure register` command and the original configuration register value that you recorded.

**Example:**

```
Router(config)# config-reg value
```

Step 3
Enter `exit` to exit configuration mode:

**Example:**

```
Router(config)# exit
```

**Note**
To return to the configuration being used before you recovered the lost enable password, do not save the configuration changes before rebooting the router.

Step 4
Reboot the router, and enter the recovered password.

---

**Configuring a Console Port Transport Map**

This task describes how to configure a transport map for a console port interface on the router.
SUMMARY STEPS

1. enable
2. configure terminal
3. transport-map type console transport-map-name
4. connection wait [allow [interruptible] | none [disconnect]]
5. (Optional) banner [diagnostic | wait] banner-message
6. exit
7. transport type console console-line-number input transport-map-name

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 enable</td>
<td>Enables privileged EXEC mode. Enter your password if prompted.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>Router&gt; enable</td>
<td></td>
</tr>
</tbody>
</table>

| Step 2 configure terminal | Enters global configuration mode. |
| Example:                  |         |
| Router# configure terminal|         |

| Step 3 transport-map type console transport-map-name | Creates and names a transport map for handling console connections, and enters transport map configuration mode. |
| Example:                                              |         |
| Router(config)# transport-map type console consolehandler|         |

| Step 4 connection wait [allow [interruptible] | none [disconnect]] | Specifies how a console connection will be handled using this transport map. |
| Example:                                           |         |
| Router(config-tmap)# connection wait none         |         |

- allow interruptible—The console connection waits for a Cisco IOS VTY line to become available, and also allows users to enter diagnostic mode by interrupting a console connection that is waiting for a Cisco IOS VTY line to become available. This is the default setting.

- none—The console connection immediately enters diagnostic mode.

| Step 5 (Optional) banner [diagnostic | wait] banner-message | (Optional) Creates a banner message that will be seen by users entering diagnostic mode or waiting for the Cisco IOS VTY line because of the console transport map configuration. |
| Example: |         |
| Router(config-tmap)# banner diagnostic X |         |
| Enter TEXT message. End with the character 'X'. |         |
### Command or Action

---Welcome to Diagnostic Mode---

X

Router(config-tmap)#

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>diagnostic</strong>—Creates a banner message seen by users directed to diagnostic mode because of the console transport map configuration.</td>
</tr>
<tr>
<td><strong>Note</strong> Users can interrupt a waiting connection by entering Ctrl-C or Ctrl-Shift-6.</td>
</tr>
<tr>
<td>• <strong>wait</strong>—Creates a banner message seen by users waiting for Cisco IOS VTY to become available.</td>
</tr>
<tr>
<td>• <strong>banner-message</strong>—Banner message, which begins and ends with the same delimiting character.</td>
</tr>
</tbody>
</table>

### Step 6

**exit**

**Example:**

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

**Exit** transport map configuration mode to re-enter global configuration mode.

### Step 7

**transport type console console-line-number input transport-map-name**

**Example:**

Router(config)# **transport type console 0 input consolehandler**

Applies the settings defined in the transport map to the console interface.

The **transport-map-name** for this command must match the **transport-map-name** defined in the **transport-map type console** command.

### Examples

The following example shows how to create a transport map to set console port access policies and attach to console port 0:

```
Router(config)# **transport-map type console consolehandler**
Router(config-tmap)# **connection wait allow interruptible**
Router(config-tmap)# **banner diagnostic X**
Enter TEXT message. End with the character 'X'.
---Welcome to diagnostic mode---

X
Router(config-tmap)# **banner wait X**
Enter TEXT message. End with the character 'X'.
Waiting for IOS vty line
X
Router(config-tmap)# **exit**
Router(config)# **transport type console 0 input consolehandler**
```

### Viewing Console Port, SSH, and Telnet Handling Configurations

Use the following commands to view console port, SSH, and Telnet handling configurations:

- **show transport-map**
- **show platform software configuration access policy**
Use the `show transport-map` command to view transport map configurations.

```
show transport-map [all | name transport-map-name | type [console]]
```

This command can be used either in user EXEC mode or privileged EXEC mode.

**Example**

The following example shows transport maps that are configured on the router: console port (`consolehandler`):

```
Router# show transport-map all
Transport Map:
  Name: consolehandler Type: Console Transport

  Connection:
  Wait option: Wait Allow Interruptable Wait banner:

  Waiting for the IOS CLI bshell banner:
  Welcome to Diagnostic Mode

Router# show transport-map type console
Transport Map:
  Name: consolehandler

  Type: Console Transport

  Connection:
  Wait option: Wait Allow Interruptable Wait banner:

  Waiting for the IOS CLI Bshell banner:
  Welcome to Diagnostic Mode

Router# show transport-map type persistent ssh
Transport Map:
  Name: consolehandler Type: Console Transport

  Connection:
  Wait option: Wait Allow Interruptable Wait banner:

  Waiting for the IOS CLI Bshell banner:
  Welcome to Diagnostic Mode
```

Use the `show platform software configuration access policy` command to view the current configurations for handling the incoming console port, SSH, and Telnet connections. The output of this command provides the current wait policy for each type of connection (Telnet, SSH, and console), as well as information on the currently configured banners.

Unlike the `show transport-map` command, the `show platform software configuration access policy` command is available in diagnostic mode so that it can be entered in scenarios where you need transport map configuration information, but cannot access the Cisco IOS CLI.
Example

The following example shows the `show platform software configuration access policy` command.

```
Router# show platform software configuration access policy
The current access-policies
Method : telnet
Rule : wait with interrupt Shell banner:
Welcome to Diagnostic Mode

Wait banner :
Waiting for IOS Process

Method : ssh Rule : wait Shell banner: Wait banner :

Method : console
Rule : wait with interrupt Shell banner:
Wait banner :
```

Using the factory reset Commands

The `factory reset` commands are used to remove all the customer specific data on a router/switch that has been added. The data can be configuration, log files, boot variables, core files, and so on.

The `factory-reset all` command erases the bootflash, nvram, rommon variables, licenses, and logs.

```
Router# factory-reset all
The factory reset operation is irreversible for all operations. Are you sure? [confirm]
*Enter*


***Return to ROMMON Prompt*