



Configuring Routing Information Protocol

Routing Information Protocol (RIP) is a commonly used routing protocol in small to medium TCP/IP networks. It is a stable protocol that uses a distance-vector algorithm to calculate routes.

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Prerequisites for RIP

You must configure **ip routing** command before you configure RIP.

Restrictions for RIP

Routing Information Protocol (RIP) uses hop count as the metric to rate the value of different routes. The hop count is the number of devices that can be traversed in a route. A directly connected network has a metric of zero; an unreachable network has a metric of 16. This limited metric range makes RIP unsuitable for large networks.



Note

If RIP configuration does not have a network statement covering a specific interface, we recommend that you do not configure RIP under that interface. If RIP is configured on such an interface, the redistribution of route(s) from another routing protocol into RIP, received through that interface, does not work.

Information About Configuring RIP

RIP Overview

The Routing Information Protocol (RIP) uses broadcast UDP data packets to exchange routing information. Cisco software sends routing information updates every 30 seconds, which is termed advertising. If a device does not receive an update from another device for 180 seconds or more, the receiving device marks the routes served by the nonupdating device as unusable. If there is still no update after 240 seconds, the device removes all routing table entries for the nonupdating device.

A device that is running RIP can receive a default network via an update from another device that is running RIP, or the device can source the default network using RIP. In both cases, the default network is advertised through RIP to other RIP neighbors.

The Cisco implementation of RIP Version 2 (RIPv2) supports plain text and message digest algorithm 5 (MD5) authentication, route summarization, classless interdomain routing (CIDR), and variable-length subnet masks (VLSMs).

RIP Routing Updates

The Routing Information Protocol (RIP) sends routing-update messages at regular intervals and when the network topology changes. When a device receives a RIP routing update that includes changes to an entry, the device updates its routing table to reflect the new route. The metric value for the path is increased by 1, and the sender is indicated as the next hop. RIP devices maintain only the best route (the route with the lowest metric value) to a destination. After updating its routing table, the device immediately begins transmitting RIP routing updates to inform other network devices of the change. These updates are sent independently of the regularly scheduled updates that RIP devices send.

RIP Routing Metric

The Routing Information Protocol (RIP) uses a single routing metric to measure the distance between the source and the destination network. Each hop in a path from the source to the destination is assigned a hop-count value, which is typically 1. When a device receives a routing update that contains a new or changed destination network entry, the device adds 1 to the metric value indicated in the update and enters the network in the routing table. The IP address of the sender is used as the next hop. If an interface network is not specified in the routing table, it will not be advertised in any RIP update.

Authentication in RIP

The Cisco implementation of the Routing Information Protocol (RIP) Version 2 (RIPv2) supports authentication, key management, route summarization, classless interdomain routing (CIDR), and variable-length subnet masks (VLSMs).

By default, the software receives RIP Version 1 (RIPv1) and RIPv2 packets, but sends only RIPv1 packets. You can configure the software to receive and send only RIPv1 packets. Alternatively, you can configure the software to receive and send only RIPv2 packets. To override the default behavior, you can configure the RIP version that an interface sends. Similarly, you can also control how packets received from an interface are processed.

RIPv1 does not support authentication. If you are sending and receiving RIPv2 packets, you can enable RIPv2 authentication on an interface.

The key chain determines the set of keys that can be used on the interface. Authentication, including default authentication, is performed on that interface only if a key chain is configured. For more information on key chains and their configuration, see the “Managing Authentication Keys” section in the “Configuring IP Routing Protocol-Independent Features” chapter in the *Cisco IOS IP Routing: Protocol-Independent Configuration Guide*.

Cisco supports two modes of authentication on an interface on which RIPv2 is enabled: plain-text authentication and message digest algorithm 5 (MD5) authentication. Plain-text authentication is the default authentication in every RIPv2 packet.



Note Do not use plain text authentication in RIPv2 packets for security purposes, because the unencrypted authentication key is sent in every RIPv2 packet. Use plain-text authentication when security is not an issue; for example, you can use plain-text authentication to ensure that misconfigured hosts do not participate in routing.

Exchange of Routing Information

Routing Information Protocol (RIP) is normally a broadcast protocol, and for RIPv2 routing updates to reach nonbroadcast networks, you must configure the Cisco software to permit this exchange of routing information.

To control the set of interfaces with which you want to exchange routing updates, you can disable the sending of routing updates on specified interfaces by configuring the **passive-interface** router configuration command.

You can use an offset list to increase increasing incoming and outgoing metrics to routes learned via RIPv2. Optionally, you can limit the offset list with either an access list or an interface.

Routing protocols use several timers that determine variables such as the frequency of routing updates, the length of time before a route becomes invalid, and other parameters. You can adjust these timers to tune routing protocol performance to better suit your internetwork needs. You can make the following timer adjustments:

- The rate (time, in seconds, between updates) at which routing updates are sent
- The interval of time, in seconds, after which a route is declared invalid
- The interval, in seconds, during which routing information about better paths is suppressed
- The amount of time, in seconds, that must pass before a route is removed from the routing table
- The amount of time for which routing updates will be postponed

You can adjust the IP routing support in the Cisco software to enable faster convergence of various IP routing algorithms, and hence, cause quicker fallback to redundant devices. The total effect is to minimize disruptions to end users of the network in situations where quick recovery is essential

In addition, an address family can have timers that explicitly apply to that address family (or Virtual Routing and Forwarding [VRF] instance). The **timers-basic** command must be specified for an address family or the system defaults for the **timers-basic** command are used regardless of the timer that is configured for RIPv2 routing. The VRF does not inherit the timer values from the base RIPv2 configuration. The VRF will always use the system default timers unless the timers are explicitly changed using the **timers-basic** command.

RIP Route Summarization

Summarizing routes in RIP Version 2 improves scalability and efficiency in large networks. Summarizing IP addresses means that there is no entry for child routes (routes that are created for any combination of the individual IP addresses contained within a summary address) in the RIP routing table, reducing the size of the table and allowing the router to handle more routes.

Summary IP address functions more efficiently than multiple individually advertised IP routes for the following reasons:

- The summarized routes in the RIP database are processed first.
- Any associated child routes that are included in a summarized route are skipped as RIP looks through the routing database, reducing the processing time required. Cisco routers can summarize routes in two ways:
- Automatically, by summarizing subprefixes to the classful network boundary when crossing classful network boundaries (automatic summary).



Note Automatic summary is enabled by default.

- As specifically configured, advertising a summarized local IP address pool on the specified interface (on a network access server) so that the address pool can be provided to dialup clients.

When RIP determines that a summary address is required in the RIP database, a summary entry is created in the RIP routing database. As long as there are child routes for a summary address, the address remains in the routing database. When the last child route is removed, the summary entry also is removed from the database. This method of handling database entries reduces the number of entries in the database because each child route is not listed in an entry, and the aggregate entry itself is removed when there are no longer any valid child routes for it.

RIP Version 2 route summarization requires that the lowest metric of the "best route" of an aggregated entry, or the lowest metric of all current child routes, be advertised. The best metric for aggregated summarized routes is calculated at route initialization or when there are metric modifications of specific routes at advertisement time, and not at the time the aggregated routes are advertised.

The **ip summary-address rip router** configuration command causes the router to summarize a given set of routes learned via RIP Version 2 or redistributed into RIP Version 2. Host routes are especially applicable for summarization.

See the "[Route Summarization Example, on page 23](#)" section at the end of this chapter for examples of using split horizon.

You can verify which routes are summarized for an interface using the **show ip protocols EXEC** command. You can check summary address entries in the RIP database. These entries will appear in the database only if relevant child routes are being summarized. To display summary address entries in the RIP routing database entries if there are relevant routes being summarized based upon a summary address, use the **show ip rip database** command in EXEC mode. When the last child route for a summary address becomes invalid, the summary address is also removed from the routing table.

Split Horizon Mechanism

Normally, devices that are connected to broadcast-type IP networks and that use distance-vector routing protocols employ the split horizon mechanism to reduce the possibility of routing loops. The split horizon mechanism blocks information about routes from being advertised by a device out of any interface from which that information originated. This behavior usually optimizes communications among multiple devices, particularly when links are broken. However, with nonbroadcast networks, such as Frame Relay and the Switched Multimegabit Digital System (SMDS), situations can arise for which this behavior is less than ideal. In such situations, you may want to disable split horizon with the Routing Information Protocol (RIP).

If an interface is configured with secondary IP addresses and split horizon is enabled, updates might not be sourced by the secondary address. If split horizon is enabled, one routing update is sourced per network number.

Split horizon is not disabled by default for interfaces using any of the X.25 encapsulations. For all other encapsulations, split horizon is enabled by default.

Interpacket Delay for RIP Updates

By default, the software adds no delay between packets in a multiple-packet RIP update being sent. If you have a high-end router sending to a low-speed router, you might want to add such interpacket delay to RIP updates, in the range of 8 to 50 milliseconds.

RIP Optimization over WAN Circuits

Devices are used on connection-oriented networks to allow potential connectivity to many remote destinations. Circuits on the WAN are established on demand and are relinquished when the traffic subsides. Depending on the application, the connection between any two sites for user data could be short and relatively infrequent.

Source IP Addresses of RIP Routing Updates

By default, the Cisco software validates the source IP address of incoming Routing Information Protocol (RIP) routing updates. If the source address is not valid, the software discards the routing update. You must disable this functionality if you want to receive updates from a device that is not part of this network. However, disabling this functionality is not recommended under normal circumstances.

Neighbor Router Authentication

You can prevent your router from receiving fraudulent route updates by configuring neighbor router authentication. When configured, neighbor authentication occurs whenever routing updates are exchanged between neighbor routers. This authentication ensures that a router receives reliable routing information from a trusted source.

Without neighbor authentication, unauthorized or deliberately malicious routing updates could compromise the security of your network traffic. A security compromise could occur if an unfriendly party diverts or analyzes your network traffic. For example, an unauthorized router could send a fictitious routing update to convince your router to send traffic to an incorrect destination. This diverted traffic could be analyzed to learn confidential information about your organization or merely used to disrupt your organization's ability to effectively communicate using the network. Neighbor authentication prevents any such fraudulent route updates from being received by your router.

When neighbor authentication has been configured on a router, the router authenticates the source of each routing update packet that it receives. This is accomplished by the exchange of an authenticating key (sometimes referred to as a password) that is known to both the sending and the receiving router.

There are two types of neighbor authentication used: plain text authentication and Message Digest Algorithm Version 5 (MD5) authentication. Both forms work in the same way, with the exception that MD5 sends a "message digest" instead of the authenticating key itself. The message digest is created using the key and a message, but the key itself is not sent, preventing it from being read while it is being transmitted. Plain text authentication sends the authenticating key itself over the wire.



Note Note that plain text authentication is not recommended for use as part of your security strategy. Its primary use is to avoid accidental changes to the routing infrastructure. Using MD5 authentication, however, is a recommended security practice.

In plain text authentication, each participating neighbor router must share an authenticating key. This key is specified at each router during configuration. Multiple keys can be specified with some protocols; each key must then be identified by a key number.

In general, when a routing update is sent, the following authentication sequence occurs:

1. A router sends a routing update with a key and the corresponding key number to the neighbor router. In protocols that can have only one key, the key number is always zero. The receiving (neighbor) router checks the received key against the same key stored in its own memory.
2. If the two keys match, the receiving router accepts the routing update packet. If the two keys do not match, the routing update packet is rejected.

MD5 authentication works similarly to plain text authentication, except that the key is never sent over the wire. Instead, the router uses the MD5 algorithm to produce a "message digest" of the key (also called a "hash"). The message digest is then sent instead of the key itself. This ensures that nobody can eavesdrop on the line and learn keys during transmission.

Another form of neighbor router authentication is to configure key management using key chains. When you configure a key chain, you specify a series of keys with lifetimes, and the Cisco IOS software rotates through each of these keys. This decreases the likelihood that keys will be compromised. To find complete configuration information for key chains, refer to the "Managing Authentication Keys" section in the Configuring IP Routing Protocol-Independent Features module of the Cisco IOS IP Routing: Protocol-Independent Configuration Guide.

IP-RIP Delay Start Overview

The IP-RIP Delay Start feature is used on Cisco devices to delay the initiation of Routing Information Protocol Version 2 (RIPv2) neighbor sessions until the network connectivity between the neighbor devices is fully operational, thereby ensuring that the sequence number of the first message digest algorithm 5 (MD5) packet that the device sends to the non-Cisco neighbor device is 0. The default behavior for a device configured to establish RIPv2 neighbor sessions with a neighbor device using MD5 authentication is to start sending MD5 packets when the physical interface is up.

The IP-RIP Delay Start feature is often used when a Cisco device is configured to establish a RIPv2 neighbor relationship using MD5 authentication with a non-Cisco device over a Frame Relay network. When RIPv2 neighbors are connected over Frame Relay, it is possible for the serial interface connected to the Frame Relay network to be up while the underlying Frame Relay circuits are not yet ready to transmit and receive data.

When a serial interface is up and the Frame Relay circuits are not yet operational, any MD5 packets that the device attempts to transmit over the serial interface are dropped. When MD5 packets are dropped because the Frame Relay circuits over which the packets need to be transmitted are not yet operational, the sequence number of the first MD5 packet received by the neighbor device after the Frame Relay circuits become active will be greater than 0. Some non-Cisco devices will not allow an MD5-authenticated RIPv2 neighbor session to start when the sequence number of the first MD5 packet received from the other device is greater than 0.

The differences in vendor implementations of MD5 authentication for RIPv2 are probably a result of the ambiguity of the relevant RFC (RFC 2082) with respect to packet loss. RFC 2082 suggests that devices should be ready to accept either a sequence number of 0 or a sequence number higher than the last sequence number received. For more information about MD5 message reception for RIPv2, see section 3.2.2 of RFC 2082 at the following url: <http://www.ietf.org/rfc/rfc2082.txt>.

The IP-RIP Delay Start feature is supported over other interface types such as Fast Ethernet and Gigabit Ethernet.

Cisco devices allow an MD5-authenticated RIPv2 neighbor session to start when the sequence number of the first MD5 packet received from the other device is greater than 0. If you are using only Cisco devices in your network, you do not need to use the IP-RIP Delay Start feature.

Offset-list

An offset list is the mechanism for increasing incoming and outgoing metrics to routes learned via RIP. This is done to provide a local mechanism for increasing the value of routing metrics. Optionally, you can limit the offset list with either an access list or an interface.

Timers

Routing protocols use several timers that determine such variables as the frequency of routing updates, the length of time before a route becomes invalid, and other parameters. You can adjust these timers to tune routing protocol performance to better suit your internetwork needs. You can make the following timer adjustments:

- The rate (time in seconds between updates) at which routing updates are sent
- The interval of time (in seconds) after which a route is declared invalid
- The interval (in seconds) during which routing information regarding better paths is suppressed
- The amount of time (in seconds) that must pass before a route is removed from the routing table
- The amount of time for which routing updates will be postponed

It also is possible to tune the IP routing support in the software to enable faster convergence of the various IP routing algorithms, and, hence, quicker fallback to redundant routers. The total effect is to minimize disruptions to end users of the network in situations where quick recovery is essential.

How to Configure RIP

Enabling RIP and Configuring RIP Parameters

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router rip**
4. **network** *ip-address*
5. **neighbor** *ip-address*
6. **offset-list** [*access-list-number* | *access-list-name*] {**in** | **out**} *offset* [*interface-type interface-number*]
7. **timers basic** *update invalid holddown flush* [*sleeptime*]
8. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	router rip Example: Device(config)# router rip	Enables a RIP routing process and enters router configuration mode.
Step 4	network <i>ip-address</i> Example: Device(config-router)# network 10.1.1.0	Associates a network with a RIP routing process.
Step 5	neighbor <i>ip-address</i> Example: Device(config-router)# neighbor 10.1.1.2	Defines a neighboring device with which to exchange routing information.

	Command or Action	Purpose
Step 6	offset-list <i>[access-list-number access-list-name] {in out} offset [interface-type interface-number]</i> Example: <pre>Device(config-router)# offset-list 98 in 1 Ethernet 1/0</pre>	(Optional) Applies an offset list to routing metrics.
Step 7	timers basic <i>update invalid holddown flush [sleep-time]</i> Example: <pre>Device(config-router)# timers basic 1 2 3 4</pre>	(Optional) Adjusts routing protocol timers.
Step 8	end Example: <pre>Device(config-router)# end</pre>	Exits router configuration mode and returns to privileged EXEC mode.

Specifying a RIP Version and Enabling Authentication

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router rip**
4. **version {1 | 2}**
5. **exit**
6. **interface** *type number*
7. **ip rip send version [1] [2]**
8. **ip rip receive version [1] [2]**
9. **ip rip authentication key-chain** *name-of-chain*
10. **ip rip authentication mode {text | md5}**
11. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	router rip Example: Device(config)# router rip	Enters router configuration mode.
Step 4	version {1 2} Example: Device(config-router)# version 2	Enables the Cisco software to send only RIP Version 2 (RIPv2) packets.
Step 5	exit Example: Device(config-router)# exit	Exits the router configuration mode and enters the global configuration mode.
Step 6	interface type number Example: Device(config)# interface Ethernet 3/0	Specifies an interface and enters interface configuration mode.
Step 7	ip rip send version [1] [2] Example: Device(config-if)# ip rip send version 2	Configures an interface to send only RIPv2 packets.
Step 8	ip rip receive version [1] [2] Example: Device(config-if)# ip rip receive version 2	Configures an interface to accept only RIPv2 packets.
Step 9	ip rip authentication key-chain name-of-chain Example: Device(config-if)# ip rip authentication key-chain chainname	Enables RIP authentication.
Step 10	ip rip authentication mode {text md5} Example: Device(config-if)# ip rip authentication mode md5	Configures the interface to use message digest algorithm 5 (MD5) authentication (or let it default to plain-text authentication).

	Command or Action	Purpose
Step 11	end Example: Device(config-if) # end	Exits interface configuration mode and returns to privileged EXEC mode.

Summarizing RIP Routes

RIP Version 2 supports automatic route summarization by default. The software summarizes subprefixes to the classful network boundary when classful network boundaries are crossed. If you have disconnected subnets, disable automatic route summarization to advertise the subnets. When route summarization is disabled, the software sends subnet and host routing information across classful network boundaries. To disable automatic summarization, use the **no auto-summary** command in router configuration mode.



Note Supernet advertisement (advertising any network prefix less than its classful major network) is not allowed in RIP route summarization, other than advertising a supernet learned in the routing tables. Supernets learned on any interface that is subject to configuration are still learned. For example, the following summarization is invalid: (invalid supernet summarization)

```
Router(config)# interface Ethernet 1
Router(config-if)# ip summary-address rip 10.0.0.0 252.0.0.0
.
.
>
```

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip summary-address rip** *ip-address network-mask*
5. **exit**
6. **router rip**
7. **no auto-summary**
8. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example:	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

	Command or Action	Purpose
	Router> enable	
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface type number Example: Router(config)# interface Ethernet 3/0	Enters the interface configuration mode.
Step 4	ip summary-address rip ip-address network-mask Example: Router(config-if)# ip summary-address rip 10.2.0.0 255.255.0.0	Specifies the IP address and network mask that identify the routes to be summarized.
Step 5	exit Example: Router(config-if)# exit	Exits the interface configuration mode.
Step 6	router rip Example: Router(config)# router rip	Enters the router configuration mode.
Step 7	no auto-summary Example: Router(config-router)# no auto-summary	Used in router configuration mode, disables automatic summarization.
Step 8	end Example: Router(config-router)# end	Exits router configuration mode and returns to privileged EXEC mode.

Enabling or Disabling Split Horizon

To enable or disable split horizon, use the following commands in interface configuration mode, as needed.

SUMMARY STEPS

1. enable
2. configure terminal
3. interface type number

4. **ip split-horizon**
5. **no ip split-horizon**
6. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: <pre>Router(config)# interface Ethernet 3/0</pre>	Enters interface configuration mode.
Step 4	ip split-horizon Example: <pre>Router(config-if)# ip split-horizon</pre>	Enables split horizon.
Step 5	no ip split-horizon Example: <pre>Router(config-if)# no ip split-horizon</pre>	Disables split horizon.
Step 6	end Example: <pre>Router(config-if)# end</pre>	Exits interface configuration mode and returns to privileged EXEC mode.

Disabling the Validation of Source IP Addresses

Perform this task to disable the default function that validates the source IP addresses of incoming routing updates.



Note Split horizon for Frame Relay and SMDS encapsulation is disabled by default. Split horizon is not disabled by default for interfaces using any of the X.25 encapsulations. For all other encapsulations, split horizon is enabled by default.

In general, changing the state of the default is not recommended unless you are certain that your application requires making a change in order to advertise routes properly. Remember that if split horizon is disabled on a serial interface (and that interface is attached to a packet-switched network), you *must* disable split horizon for all routers in any relevant multicast groups on that network.



Note Summarized network will not be advertised when split horizon is enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip split-horizon**
5. **exit**
6. **router rip**
7. **no validate-update-source**
8. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: <pre>Router(config)# interface Ethernet 3/0</pre>	Enters interface configuration mode.

	Command or Action	Purpose
Step 4	ip split-horizon Example: Router(config-if)# ip split-horizon	Enables split horizon.
Step 5	exit Example: Router(config-if)# exit	Exits interface configuration mode.
Step 6	router rip Example: Router(config)# router rip	Enters router configuration mode.
Step 7	no validate-update-source Example: Router(config-router)# no validate-update-source	Disables the validation of the source IP address of incoming RIP routing updates.
Step 8	end Example: Router(config-router)# end	Exits router configuration mode and returns to privileged EXEC mode.

Configuring Interpacket Delay

Perform this to configure interpacket delay.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **exit**
5. **router rip**
6. **output-delay** *milliseconds*
7. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: Router> enable	<ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface type number Example: Router(config)# interface Ethernet 3/0	Enters interface configuration mode.
Step 4	exit Example: Router(config-if)# exit	Exits interface configuration mode.
Step 5	router rip Example: Router(config)# router rip	Enters router configuration mode.
Step 6	output-delay milliseconds Example: Router(config-router)# output-delay 8	Configures interpacket delay for outbound RIP updates.
Step 7	end Example: Router(config-router)# end	Exits router configuration mode and returns to privileged EXEC mode.

Optimizing RIP over WAN

There are two problems when RIP is not optimized:

- Periodic broadcasting by RIP generally prevents WAN circuits from being closed.
- Even on fixed, point-to-point links, the overhead of periodic RIP transmissions could seriously interrupt normal data transfer because of the quantity of information that passes through the line every 30 seconds.

To overcome these limitations, triggered extensions to RIP cause RIP to send information on the WAN only when there has been an update to the routing database. Periodic update packets are suppressed over the interface on which this feature is enabled. RIP routing traffic is reduced on point-to-point, serial interfaces. Therefore, you can save money on an on-demand circuit for which you are charged for usage. Triggered extensions to RIP partially support RFC 2091, *Triggered Extensions to RIP to Support Demand Circuits*.

Perform the following task to enable triggered extensions to RIP and to display the contents of the RIP private database.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface serial** *controller-number*
4. **ip rip triggered**
5. **end**
6. **show ip rip database** [*prefix mask*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	interface serial <i>controller-number</i> Example: <pre>Router(config)# interface serial3/0</pre>	Configures a serial interface.
Step 4	ip rip triggered Example: <pre>Router(config-if)# ip rip triggered</pre>	Enables triggered extensions to RIP.
Step 5	end Example: <pre>Router(config-if)# end</pre>	Returns to privileged EXEC mode.
Step 6	show ip rip database [<i>prefix mask</i>] Example: <pre>Router# show ip rip database</pre>	Displays the contents of the RIP private database.

Configuring IP-RIP Delay Start for Routers Connected by a Frame Relay Network

The tasks in this section explain how to configure a router to use the IP-RIP Delay Start feature on a Frame Relay interface.

**Timesaver**

Cisco routers allow an MD5-authenticated RIPv2 neighbor session to start when the sequence number of the first MD5 packet received from the other router is greater than 0. If you are using only Cisco routers in your network, you do not need to use the IP-RIP Delay Start feature.

Prerequisites

Your router must be running Cisco IOS Release 12.4(12) or a later release.

**Note**

The IP-RIP Delay Start feature is supported over other interface types such as Fast Ethernet and Gigabit Ethernet. If your Cisco router cannot establish RIPv2 neighbor sessions using MD5 authentication with a non-Cisco device, the IP-RIP Delay Start feature might resolve the problem.

Restrictions

The IP-RIP Delay Start feature is required only when your Cisco router is configured to establish a RIPv2 neighbor relationship with a non-Cisco device and you want to use MD5 neighbor authentication.

Configuring RIPv2

This required task configures RIPv2 on the router.

This task provides instructions for only one of the many possible permutations for configuring RIPv2 on your router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router rip**
4. **network** *ip-network*
5. **version** {1 | 2}
6. **[no] auto-summary**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.
	Example:	<ul style="list-style-type: none">• Enter your password if prompted.

	Command or Action	Purpose
	<code>Router> enable</code>	
Step 2	configure terminal Example: <code>Router# configure terminal</code>	Enters global configuration mode.
Step 3	router rip Example: <code>Router(config)# router rip</code>	Enables a RIP routing process, which places you in router configuration mode.
Step 4	network ip-network Example: <code>Router(config-router)# network 192.168.0.0</code>	Associates a network with a RIP routing process.
Step 5	version {1 2} Example: <code>Router (config-router)# version 2</code>	Configures the software to receive and send only RIP Version 1 or only RIP Version 2 packets.
Step 6	[no] auto-summary Example: <code>Router(config-router)# no auto-summary</code>	Disables or restores the default behavior of automatic summarization of subnet routes into network-level routes.

Configuring Frame Relay on a Serial Subinterface

This required task configures a serial subinterface for Frame Relay.



Note This task provides instructions for only one of the many possible permutations for configuring Frame Relay on a subinterface. For more information about and instructions for configuring Frame Relay, see the Configuring Frame Relay part of the *Cisco IOS Wide-Area Networking Configuration Guide* .

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface type number**
4. **no ip address**
5. **encapsulation frame-relay [mfr number | ietf]**
6. **frame-relay lmi-type {cisco | ansi | q933a}**
7. **exit**

8. `interface type number/subinterface-number {point-to-point | multipoint}`
9. `frame-relay interface-dlci dlci [ietf | cisco]`

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	interface type number Example: <pre>Router(config)# interface serial3/0</pre>	Specifies an interface and enters interface configuration mode.
Step 4	no ip address Example: <pre>Router(config-if)# no ip address</pre>	Removes a previously configured IP address from the interface.
Step 5	encapsulation frame-relay [mfr number ietf] Example: <pre>Router(config-if)# encapsulation frame-relay ietf</pre>	Specifies the type of Frame Relay encapsulation for the interface.
Step 6	frame-relay lmi-type {cisco ansi q933a} Example: <pre>Router(config-if)# frame-relay lmi-type ansi</pre>	Specifies the type of Frame Relay local management interface (LMI) for the interface.
Step 7	exit Example: <pre>Router(config-if)# exit</pre>	Exits interface configuration mode.
Step 8	interface type number/subinterface-number {point-to-point multipoint} Example:	Specifies a subinterface and the connection type for the subinterface and enters subinterface configuration mode.

	Command or Action	Purpose
	Router(config)# interface serial3/0.1 point-to-point	
Step 9	frame-relay interface-dlci <i>dlci</i> [ietf cisco] Example: Router(config-subif)# frame-relay interface-dlci 100 ietf	Assigns a data-link connection identifier (DLCI) to a Frame Relay subinterface.

Configuring IP with MD5 Authentication for RIPv2 and IP-RIP Delay on a Frame Relay Subinterface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **key chain** *name-of-chain*
4. **key** *number*
5. **key-string** *string*
6. **exit**
7. **exit**
8. **interface** *type number*
9. **no cdp enable**
10. **ip address** *ip-address subnet-mask*
11. **ip rip authentication mode** {**text** | **md5**}
12. **ip rip authentication key-chain** *name-of-chain*
13. **ip rip initial-delay** *delay*
14. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	key chain <i>name-of-chain</i> Example: <pre>Device(config)# key chain rip-md5</pre>	Specifies the name of a key chain and enters key chain configuration mode.
Step 4	key number Example: <pre>Device(config-keychain)# key 123456</pre>	Specifies the key identifier and enters key chain key configuration mode. The range is from 0 to 2147483647.
Step 5	key-string string Example: <pre>Device(config-keychain-key)# key-string abcde</pre>	Configures the key string.
Step 6	exit Example: <pre>Device(config-keychain-key)# exit</pre>	Exits key chain key configuration mode.
Step 7	exit Example: <pre>Device(config-keychain)# exit</pre>	Exits key chain configuration mode.
Step 8	interface type number Example: <pre>Device(config)# interface serial 3/0.1</pre>	Specifies a subinterface and enters subinterface configuration mode.
Step 9	no cdp enable Example: <pre>Device(config-subif)# no cdp enable</pre>	Disables Cisco Discovery Protocol options on the interface. Note Cisco Discovery Protocol is not supported by non-Cisco devices; and the IP-RIP Delay Start feature is required only when you are connecting to a non-Cisco device. Therefore, you should disable Cisco Discovery Protocol on any interfaces on which you want to configure the IP-RIP Delay Start feature.
Step 10	ip address ip-address subnet-mask Example: <pre>Device(config-subif)# ip address 172.16.10.1 255.255.255.0</pre>	Configures an IP address for the Frame Relay subinterface.
Step 11	ip rip authentication mode {text md5} Example:	Specifies the mode for RIPv2 authentication.

	Command or Action	Purpose
	Device(config-subif)# ip rip authentication mode md5	
Step 12	ip rip authentication key-chain <i>name-of-chain</i> Example: Device (config-subif)# ip rip authentication key-chain rip-md5	Specifies a previously configured key chain for Routing Information Protocol Version (RIPv2) message digest algorithm 5 (MD5) authentication.
Step 13	ip rip initial-delay <i>delay</i> Example: Device(config-subif)# ip rip initial-delay 45	Configures the IP-RIP Delay Start feature on the interface. The device will delay sending the first MD5 authentication packet to the RIPv2 neighbor for the number of seconds specified by the <i>delay</i> argument. The range is from 0 to 1800.
Step 14	end Example: Device(config-subif)# end	Exits the subinterface configuration mode and returns to privileged EXEC mode.

Configuration Examples for RIP

Route Summarization Example

The following example shows how the **ip summary-address riprouter** configuration command can be used to configure summarization on an interface. In this example, the subnets 10.1.3.0/25, 10.1.3.128/25, 10.2.1.0/24, 10.2.2.0/24, 10.1.2.0/24 and 10.1.1.0/24 can be summarized as shown below while sending the updates over an interface.

```
Router(config)#interface GigabitEthernet 0/2
Router(config-if)#ip summary-address rip 10.1.0.0 255.255.0.0
Router(config-if)#ip summary-address rip 10.2.0.0 255.255.0.0
Router(config-if)#ip summary-address rip 10.3.0.0 255.255.0.0
```

Split Horizon Examples

Two examples of configuring split horizon are provided.

Example 1

The following configuration shows a simple example of disabling split horizon on a serial link. In this example, the serial link is connected to an X.25 network.

```
Router(config)# interface Serial 0
Router(config-if)# encapsulation x25
```

```
Router(config-if) # no ip split-horizon
```

Example 2

In the next example, the figure below illustrates a typical situation in which the **no ip split-horizon** interface configuration command would be useful. This figure depicts two IP subnets that are both accessible via a serial interface on Router C (connected to a Frame Relay network). In this example, the serial interface on Router C accommodates one of the subnets via the assignment of a secondary IP address.

The Ethernet interfaces for Router A, Router B, and Router C (connected to IP networks 10.13.50.0, 10.155.120.0, and 10.20.40.0, respectively) all have split horizon enabled by default, while the serial interfaces connected to networks 172.16.1.0 and 192.168.1.0 all have split horizon disabled with the **no ip split-horizon** command. The figure below shows the topology and interfaces.

In this example, split horizon is disabled on all serial interfaces. Split horizon must be disabled on Router C in order for network 172.16.0.0 to be advertised into network 192.168.0.0 and vice versa. These subnets overlap at Router C, interface S0. If split horizon were enabled on serial interface S0, it would not advertise a route back into the Frame Relay network for either of these networks.

Configuration for Router A

```
interface ethernet 1
 ip address 10.13.50.1
!
interface serial 1
 ip address 172.16.2.2
 encapsulation frame-relay
 no ip split-horizon
```

Configuration for Router B

```
interface ethernet 2
 ip address 10.155.120.1
!
interface serial 2
 ip address 192.168.1.2
 encapsulation frame-relay
 no ip split-horizon
```

Configuration for Router C

```
interface ethernet 0
 ip address 10.20.40.1
!
interface serial 0
 ip address 172.16.1.1
 ip address 192.168.1.1 secondary
 encapsulation frame-relay
 no ip split-horizon
```

Address Family Timers Example

The following example shows how to adjust individual address family timers. Note that the address family "notusingtimers" will use the system defaults of 30, 180, 180, and 240 even though timer values of 5, 10, 15,

and 20 are used under the general RIP configuration. Address family timers are not inherited from the general RIP configuration.

```
Router(config)# router rip
Router(config-router)# version 2
Router(config-router)# timers basic 5 10 15 20
Router(config-router)# redistribute connected
Router(config-router)# network 5.0.0.0
Router(config-router)# default-metric 10
Router(config-router)# no auto-summary
Router(config-router)#
Router(config-router)# address-family ipv4 vrf abc
Router(config-router-af)# timers basic 10 20 20 20
Router(config-router-af)# redistribute connected
Router(config-router-af)# network 10.0.0.0
Router(config-router-af)# default-metric 5
Router(config-router-af)# no auto-summary
Router(config-router-af)# version 2
Router(config-router-af)# exit-address-family
Router(config-router)#
Router(config-router)# address-family ipv4 vrf xyz
Router(config-router-af)# timers basic 20 40 60 80
Router(config-router-af)# redistribute connected
Router(config-router-af)# network 20.0.0.0
Router(config-router-af)# default-metric 2
Router(config-router-af)# no auto-summary
Router(config-router-af)# version 2
Router(config-router-af)# exit-address-family
Router(config-router)#
Router(config-router)# address-family ipv4 vrf notusingtimers

Router(config-router-af)# redistribute connected
Router(config-router-af)# network 20.0.0.0
Router(config-router-af)# default-metric 2
Router(config-router-af)# no auto-summary
Router(config-router-af)# version 2
Router(config-router-af)# exit-address-family
Router(config-router)#
```

Example: IP-RIP Delay Start on a Frame Relay Interface

Additional References

The following sections provide references related to configuring Routing Information Protocol.

Related Documents

Related Topic	Document Title
Protocol-independent features, filtering RIP information, key management (available in RIP Version 2), and VLSM	<i>Configuring IP Routing Protocol-Independent Features</i>
IPv6 Routing: RIP for IPv6	<i>Cisco IOS IP Routing: RIP Configuration Guide</i>

Related Topic	Document Title
RIP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	<i>Cisco IOS IP Routing: RIP Command Reference</i>
Configuring Frame Relay	<i>Cisco IOS Wide-Area Networking Configuration Guide</i>

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported and support for existing MIBs has not been modified.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 1058	<i>Routing Information Protocol</i>
RFC 2082	RIP-2 MD5 Authentication
RFC 2091	<i>Triggered Extensions to RIP to Support Demand Circuits</i>
RFC 2453	RIP version 2

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>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.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Configuring RIP

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Configuring Routing Information Protocol

Feature Name	Releases	Feature Information
IP-RIP Delay Start	12.4(12), 15.0(1)M, 12.2(33)SRE, 15.0(1)SY	<p>The IP-RIP Delay Start feature is used on Cisco routers to delay the initiation of RIPv2 neighbor sessions until the network connectivity between the neighbor routers is fully operational, thereby ensuring that the sequence number of the first MD5 packet that the router sends to the non-Cisco neighbor router is 0. The default behavior for a router configured to establish RIPv2 neighbor sessions with a neighbor router using MD5 authentication is to start sending MD5 packets when the physical interface is up.</p> <p>The following commands were introduced or modified: ip rip initial-delay.</p>

Feature Name	Releases	Feature Information
IP Summary Address for RIPv2	12.0(7)T 12.1(3)T 12.1(14) 12.2(2)T 12.2(27)SBB 15.0(1)M 12.2(33)SRE 15.0S	<p>The IP Summary Address for RIPv2 feature introduced the ability to summarize routes. Summarizing routes in RIP Version 2 improves scalability and efficiency in large networks. Summarizing IP addresses means that there is no entry for child routes (routes that are created for any combination of the individual IP addresses contained within a summary address) in the RIP routing table, reducing the size of the table and allowing the router to handle more routes.</p> <p>The following commands were introduced or modified by this feature: ip summary-address rip.</p>
Routing Information Protocol	12.2(27)SBB 15.0(1)M 12.2(33)SRE 15.0S	<p>Routing Information Protocol (RIP) is a commonly used routing protocol in small to medium TCP/IP networks. It is a stable protocol that uses a distance-vector algorithm to calculate routes.</p>
Triggered RIP	12.0(1)T 15.0(1)M 12.2(33)SRE 15.0S	<p>Triggered RIP was introduced to overcome constant RIP updates over expensive circuit-based WAN links. Triggered extensions to RIP cause RIP to send information on the WAN only when there has been an update to the routing database. Periodic update packets are suppressed over the interface on which this feature is enabled. RIP routing traffic is reduced on point-to-point, serial interfaces.</p> <p>The following commands were introduced or modified: ip rip triggered, show ip rip database.</p>

Glossary

address family --A group of network protocols that share a common format of network address. Address families are defined by RFC 1700.

IS-IS --Intermediate System-to-Intermediate System. OSI link-state hierarchical routing protocol based on DECnet Phase V routing, where routers exchange routing information based on a single metric, to determine network topology.

RIP --Routing Information Protocol. RIP is a dynamic routing protocol used in local and wide area networks.

VRF --VPN routing and forwarding instance. A VRF consists of an IP routing table, a derived forwarding table, a set of interfaces that use the forwarding table, and a set of rules and routing protocols that determine what goes into the forwarding table. In general, a VRF includes the routing information that defines a customer VPN site that is attached to a PE router.