Security Configuration Guide: Unicast Reverse Path Forwarding, Cisco IOS XE 16 (NCS 4200 Series)

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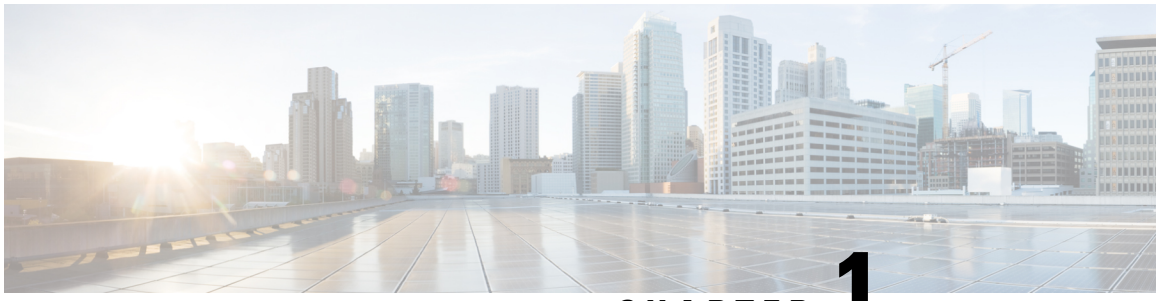
CONTENTS



CHAPTER 1

Unicast Reverse Path Forwarding Strict Mode

The Unicast Reverse Path Forwarding feature limits the malicious traffic on a network. This feature enables devices to verify the reachability of the source address in packets that are being forwarded and limit the appearance of spoofed or malformed addresses on a network. If the source IP address is not valid, Unicast Reverse Path Forwarding (RPF) discards the packet.

This module describes the Unicast Reverse Path Forwarding feature.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Prerequisites for Unicast Reverse Path Forwarding

- Unicast Reverse Path Forwarding (RPF) requires Cisco Express Forwarding to function properly on a device.
- Prior to configuring Unicast RPF, you must configure the following access control lists (ACLs):
  - Configure standard or extended ACL to mitigate the transmission of invalid IP addresses (by performing egress filtering). Configuring standard or extended ACLs permit only valid source addresses to leave your network and enter the Internet.

- Configure standard or extended ACL entries to drop (deny) packets that have invalid source IP addresses (by performing ingress filtering). Invalid source IP addresses include the following types:
  - Broadcast addresses (including multicast addresses)
  - Loopback addresses
  - Private addresses (RFC 1918, *Address Allocation for Private Internets*)
  - Reserved addresses
  - Source addresses that fall outside the range of valid addresses that are associated with the protected network

Restrictions for Unicast Reverse Path Forwarding

- Unicast RPF does not support access control list (ACL) templates.
- Unicast RPF is available only on images that support Cisco Express Forwarding.
- With multiple IPv4 interfaces under the same VRF, configuration of different modes of uRPF is not allowed on them. A single IPv4 uRPFmode is only allowed on all the IPv4 interfaces in this VRF.
- IPv4 uRPF with allow-self-ping option is *not* supported.
- If allow-default is enabled, it should be applied to all IPv4 uRPF enabled interfaces under that VRF.

The following basic restrictions apply to multihomed clients:

- Clients should not be multihomed on the same device because multihoming defeats the purpose of creating a redundant service for a client.
- Ensure that packets that flow up the link (out to the Internet) match the route advertised out of the link. Otherwise, Unicast RPF filters these packets as malformed packets.

Information About Unicast Reverse Path Forwarding

Overview of Unicast Reverse Path Forwarding

The Unicast Reverse Path Forwarding feature helps to mitigate problems that are caused by the introduction of malformed or forged (spoofed) IP source addresses into a network by discarding IP packets that lack verifiable IP source addresses. For example, a number of common types of denial-of-service (DoS) attacks, including Smurf and Tribal Flood Network (TFN), can take advantage of forged or rapidly changing source IP addresses to allow attackers to thwart efforts to locate or filter these attacks. For ISPs that provide public access, Unicast RPF deflects such attacks by forwarding only packets that have source addresses that are valid and consistent with the IP routing table, thereby protecting the network of the ISP, ISP customers, and the Internet.

Unicast RPF Operation

When Unicast RPF is enabled on an interface of a device, the device examines all packets received as input on that interface to ensure that the source address and source interface information appears in the routing table

and matches the interface on which packets are received. This ability to “look backwards” is available only when Cisco Express Forwarding is enabled on a device because the lookup relies on the presence of a Forwarding Information Base (FIB). Cisco Express Forwarding generates a FIB as part of its operation.

Note Unicast RPF is an input function and is applied only on the input interface of a device at the upstream end of a connection.

Unicast RPF does a reverse lookup in the Cisco Express Forwarding table to check if any packet received at the interface of a device arrives on the best return path (or return route) to the source of the packet. If the packet was received from one of the best reverse path routes, the packet is forwarded as normal. No reverse path route on the interface from which the packet was received can mean that the source address was modified. If Unicast RPF cannot find a reverse path for the packet, the packet is dropped.

Note With Unicast RPF, all equal-cost “best” return paths are considered valid. Unicast RPF supports multiple return paths, provided that each path is equal to the others in terms of the routing cost (such as number of hops, weights, and so on) and the route is available in the FIB. Unicast RPF also functions where Enhanced Interior Gateway Routing Protocol (EIGRP) variants are used.

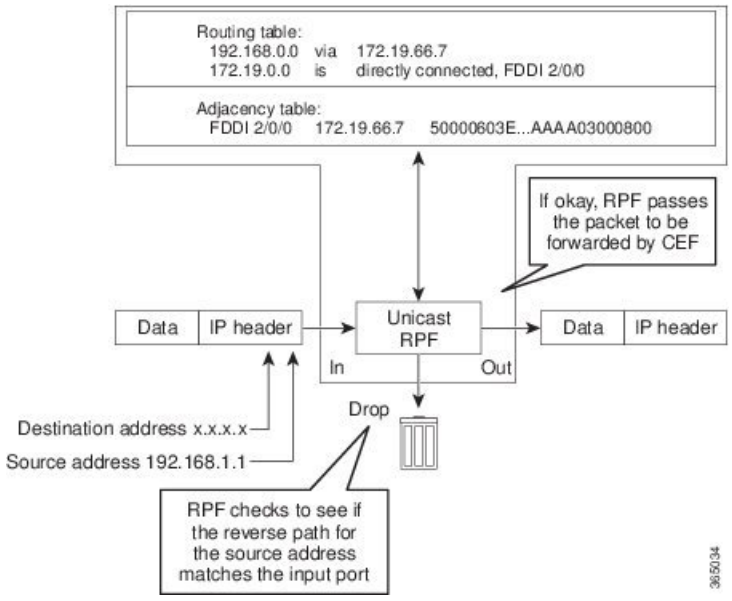
Before forwarding a packet that is received at the interface on which Unicast RPF and ACLs have been configured, Unicast RPF does the following checks:

1. If input ACLs are configured on the inbound interface.
2. If the packet has arrived on the best return path to the source by doing a reverse lookup in the FIB table.
3. Does a lookup of the Cisco Express Forwarding table for packet forwarding.
4. Checks output ACLs on the outbound interface.
5. Forwards the packet.

Unicast RPF illustration

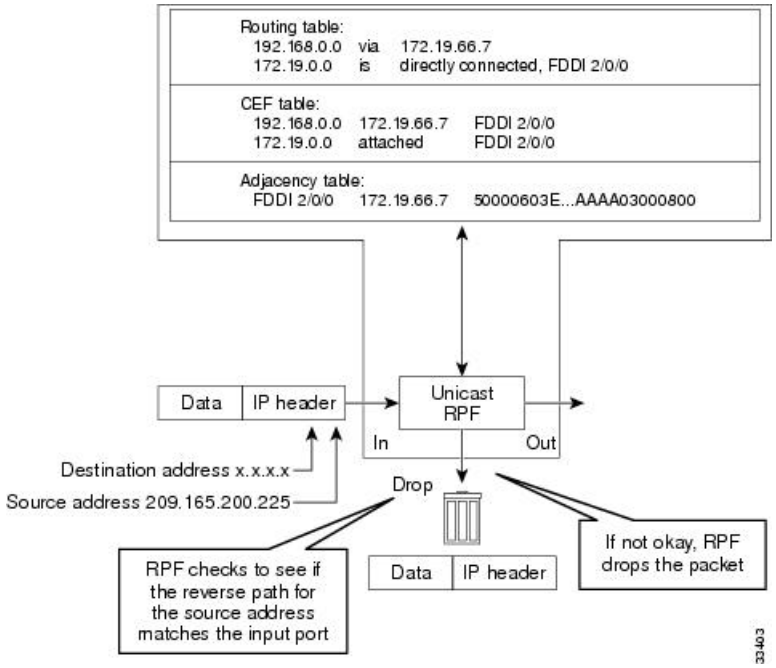
The figure below illustrates how Unicast RPF and CEF work together to validate IP source addresses by verifying packet return paths. In this example, a customer has sent a packet having a source address of 192.168.1.1 from interface FDDI 2/0/0. Unicast RPF checks the FIB to see if 192.168.1.1 has a path to FDDI 2/0/0. If there is a matching path, the packet is forwarded. If there is no matching path, the packet is dropped.

Figure 1: Unicast RPF Validating IP Source Addresses



The figure below illustrates how Unicast RPF drops packets that fail validation. In this example, a customer has sent a packet having a source address of 209.165.200.225, which is received at interface FDDI 2/0/0. Unicast RPF checks the FIB to see if 209.165.200.225 has a return path to FDDI 2/0/0. If there is a matching path, the packet is forwarded. In this case, there is no reverse entry in the routing table that routes the customer packet back to source address 209.165.200.225 on interface FDDI 2/0/0, and so the packet is dropped.

Figure 2: Unicast RPF Dropping Packets That Fail Verification



Rules for Implementing Unicast RPF

The following rules apply when implementing Unicast Reverse Path Forwarding (RPF):

- Packets must be received at an interface that has the best return path (route) to the packets' source. This process is called symmetric routing. A route in the Forwarding Information Base (FIB) must match the route to the receiving interface. Add a route in the FIB through dynamic or static routing or by using a network statement.
- IP source addresses at the receiving interface must match the routing entry for the interface.
- Unicast RPF is an input function and can be applied at the input interface of a device at the upstream end of a connection.

Network administrators can use Unicast RPF for their customers and also for their downstream network or ISP, even if the downstream network or ISP has other connections to the Internet.

Caution Using optional Border Gateway Protocol (BGP) attributes, such as weight and local preference, the best path back to source addresses can be modified. The best path modification will affect the operation of Unicast RPF.

The following sections provides information about the implementation of Unicast RPF:

Security Policy and Unicast RPF

When determining how to deploy Unicast Reverse Path Forwarding (RPF), consider the following points:

- Apply Unicast RPF at the downstream interface, away from the larger portion of the network, preferably at the edges of your network. The further you apply Unicast RPF, the finer the granularity you have in mitigating address spoofing and in identifying sources of spoofed addresses. For example, applying Unicast RPF on an aggregation device helps to mitigate attacks from many downstream networks or clients and is simple to administer, but Unicast RPF does not help in identifying the source of the attack. Applying Unicast RPF at the network access server helps to limit the scope of the attack and trace the source of the attack. However, deploying Unicast RPF across many sites adds to the administration cost of operating a network.
- When you deploy Unicast RPF on many entities on a network (for example, across the Internet, intranet, and extranet resources), you have better chances of mitigating large-scale network disruptions throughout the Internet community, and of tracing the source of an attack.
- Unicast RPF does not inspect IP packets that are encapsulated in tunnels, such as the generic routing encapsulation (GRE), Layer 2 Tunneling Protocol (L2TP), or Point-to-Point Tunneling Protocol (PPTP). Configure Unicast RPF on a home gateway so that Unicast RPF processes network traffic only after tunneling and encryption layers are stripped off from the packets.

Ingress and Egress Filtering Policy for Unicast RPF

Unicast Reverse Path Forwarding (RPF) can be more effective at mitigating spoofing attacks when combined with a policy of ingress and egress filtering by using access control lists (ACLs).

Ingress filtering applies filters to traffic that is received at a network interface from either internal or external networks. With ingress filtering, packets that arrive from other networks or the Internet and that have a source

address that matches a local network or private or broadcast addresses are dropped. For example, in ISP environments, ingress filtering can be applied to traffic that is received at a device from either a client (customer) or the Internet.

Egress filtering applies filters to the traffic that exits a network interface (the sending interface). By filtering packets on devices that connect your network to the Internet or to other networks, you can permit only packets with valid source IP addresses to leave your network.

For more information on network filtering, refer to RFC 2267, *Network Ingress Filtering: Defeating Denial of Service Attacks which employ IP Source Address Spoofing*.

Where to Use Unicast RPF

Unicast Reverse Path Forwarding (RPF) can be used in any "single-homed" environment where there is essentially only one access point out of the network, which means that there is only one upstream connection to the network. Networks having one access point offer the best example of symmetric routing, which means that the interface where a packet enters the network is also the best return path to the source of the IP packet. Unicast RPF is best used at the network perimeter for Internet, intranet, or extranet environments, or in ISP environments for customer network terminations.

The following sections describe two sample network environments in which Unicast RPF is implemented:

Enterprise Networks with a Single Connection to an ISP

In enterprise networks, you can use Unicast Reverse Path Forwarding (RPF) to filter traffic at the input interface (a process called ingress filtering) to protect from malformed packets that arrive from the Internet. Traditionally, local networks that have one connection to the Internet use access control lists (ACLs) at the receiving interface to prevent spoofed packets from entering their local network.

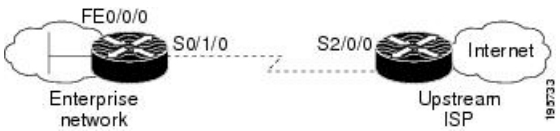
ACLs work well for single-homed customers. However, when ACLs are used as ingress filters, the following two commonly referenced limitations apply:

- Packet-per-second (PPS) performance at very high packet rates
- ACL maintenance (whenever there are new addresses added to the network)

Unicast RPF addresses both the limitations described above. With Unicast RPF, ingress filtering is done at Cisco Express Forwarding PPS rates. Because Unicast RPF uses the Forwarding Information Base (FIB), ACL maintenance is not required, and thus, the administration overhead of traditional ACLs is reduced. The following figure and example demonstrate how Unicast RPF is configured for ingress filtering.

The figure below illustrates an enterprise network that has a single link to an upstream ISP. In this example, Unicast RPF is applied at GigabitEthernet interface 1/0/2 on the enterprise device for protection from malformed packets arriving from the Internet. Unicast RPF is also applied at GigabitEthernet interface 1/0/2 on the ISP device for protection from malformed packets arriving from the enterprise network.

Figure 3: Enterprise Network Using Unicast RPF for Ingress Filtering



A typical configuration on an ISP device that uses the topography in the figure above would be as follows:

```
ip cef
interface loopback 0
```

```
  description Loopback interface on Gateway Device 2
  ip address 192.168.3.1 255.255.255.255
  no ip redirects
  no ip directed-broadcast
  no ip proxy-arp
!
interface GigabitEthernet 1/0/2
  description 128K HDLC link to ExampleCorp WT50314E  R5-0
  bandwidth 128
  ip unnumbered loopback 0
  ip verify unicast source reachable-via rx

  no ip redirects
  no ip directed-broadcast
  no ip proxy-arp
!
ip route 192.168.10.0 255.255.252.0 GigabitEthernet 1/0/2
```

The gateway device configuration of the enterprise network will be similar to the following:

```
ip cef
interface FastEthernet 0/0/0
 description ExampleCorp LAN
 ip address 192.168.10.1 255.255.252.0
 no ip redirects
 no ip directed-broadcast
 no ip proxy-arp
!
interface GigabitEthernet 1/0/2
 description 128K HDLC link to ExampleCorp Internet Inc WT50314E  C0
 bandwidth 128
 ip unnumbered FastEthernet 0/0/0
 ip verify unicast source reachable-via rx

 no ip redirects
 no ip directed-broadcast
 no ip proxy-arp
!
ip route 0.0.0.0 0.0.0.0 GigabitEthernet 1/0/2
```

Notice that Unicast RPF works with a single default route. There are no additional routes or routing protocols. Network 192.168.10.0/22 is a connected network. Hence, packets coming from the Internet with a source address in the network 192.168.10.0/22 will be dropped by Unicast RPF.

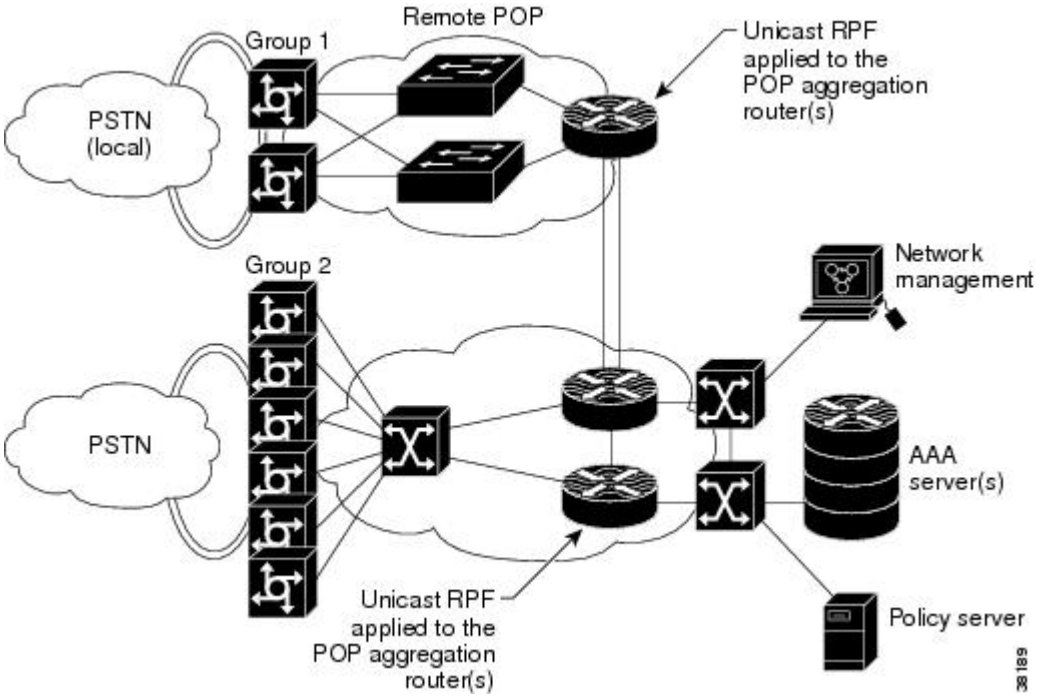
Applying Unicast RPF to Network Access Servers

If a network access server supports Cisco Express Forwarding, Unicast RPF will work on that network. A network access server (NAS) allows users to access a network by checking the credentials of the users accessing the network. Aggregation devices support Unicast RPF with single-homed clients. Unicast RPF works well on leased lines or on a digital subscriber line (DSL), ISDN, or public switched telephone network (PSTN) customer connections that are connected to the Internet. Dialup connections are a big source of denial of service (Dos) attacks that use forged IP addresses.

Aggregation devices need routing prefixes information (IP address block) for routing traffic. In the topology described below, aggregation devices do not have a full Internet routing table, and as a result, Unicast RPF uses the information configured or redistributed by the Interior Gateway Protocol (IGP) or Internal Border Gateway Protocol (IBGP) (based on how customer routes are added to the network) to route traffic. Unicast RPF is applied upstream on the customer dialup connection device that is on the receiving (input) interfaces of ISP aggregation devices.

The figure below illustrates how Unicast RPF is applied to aggregation and access devices for an ISP or point of presence (PoP) with ISP devices providing dialup connections.

Figure 4: Unicast RPF Applied to PSTN/ISDN Customer Connections



Routing Table Requirements

Unicast Reverse Path Forwarding (RPF) uses the routing information in Cisco Express Forwarding tables for routing traffic. The amount of routing information that must be available in Cisco Express Forwarding tables depends on the device where Unicast RPF is configured and the functions the device performs in the network. For example, in an ISP environment where a device is a leased-line aggregation device for customers, the information about static routes that are redistributed into the Interior Gateway Protocol (IGP) or Internal Border Gateway Protocol (IBGP) (depending on which technique is used in the network) is required in the routing table. Because Unicast RPF is configured on customer interfaces, only minimal routing information is required. If a single-homed ISP configures Unicast RPF on the gateway to the Internet, the full Internet routing table information is required by Unicast RPF to help protect the ISP from external denial of service (DoS) attacks that use addresses that are not in the Internet routing table.

Where Not to Use Unicast RPF

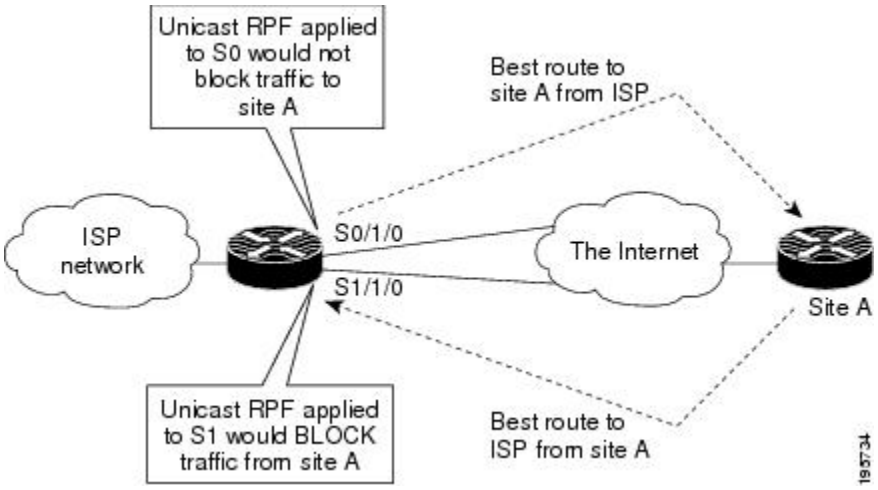
Do not use Unicast Reverse Path Forwarding (RPF) on interfaces that are internal to a network. Internal interfaces are likely to have routing asymmetry (see the figure below), which means that there can be multiple routes to the source of a packet. Unicast RPF is applied only where there is a natural or configured symmetry.

For example, devices at the edge of an ISP network are more likely to have symmetrical reverse paths than devices that are in the core of an ISP network. The best forwarding path to forward packets from devices that are at the core of an ISP network may not be the best forwarding path that is selected for packets that are returned to the device.

We recommend that you do not apply Unicast RPF where there is a chance of asymmetric routing, unless you configure access control lists (ACLs) to allow the device to accept incoming packets. ACLs permit the use of Unicast RPF when packets arrive through specific, less-optimal asymmetric input paths.

The figure below illustrates how Unicast RPF can block legitimate traffic in an asymmetric routing environment.

Figure 5: Unicast RPF Blocking Legitimate Traffic in an Asymmetric Routing Environment



Unicast RPF with BOOTP and DHCP

Unicast RPF allows packets with 0.0.0.0 as the source IP address and 255.255.255.255 as the destination IP address to pass through a network to enable Bootstrap Protocol (BOOTP) and DHCP functions to work properly when Unicast RPF is configured.

How to Configure Unicast Reverse Path Forwarding

Configuring Unicast RPF

Before you begin

To use Unicast Reverse Path Forwarding, you must configure a device for Cisco Express Forwarding switching or distributed Cisco Express Forwarding switching. If Cisco Express Forwarding is not enabled globally on a device, Unicast RPF will not work on that device. If Cisco Express Forwarding is running on a device, individual interfaces on the device can be configured with other switching modes. Unicast RPF is an input-side function that is enabled on an interface or subinterface that supports any type of encapsulation, and Unicast RPF operates on IP packets that are received by the device.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
	`Device> enable`	
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip cef distributed** **Example:** `Device(config)# ip cef distributed`	Enables Cisco Express Forwarding or distributed Cisco Express Forwarding on a device.
Step 4	**interface** *slot/subslot/port* **Example:** `Device(config)# interface GigabitEthernet 0/0`	Selects the input interface on which you want to apply Unicast Reverse Path Forwarding and enters interface configuration mode. • The interface that is configured is the receiving interface, which allows Unicast RPF to verify the best return path before forwarding a packet to the next destination.
Step 5	**ip verify unicast source reachable-via rx** Alternate Command: **ip verify unicast reverse-path** **Example:** `Device(config-if)# ip verify unicast source reachable-via rx`	Enables Unicast RPF on the interface.
Step 6	**no ip verify unicast source reachable-via rx** Alternate command: **no ip verify unicast reverse-path** **Example:** `Device(config-if)# no ip verify unicast source reachable-via rx`	(Optional) Disables Unicast RPF on the interface.
Step 7	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode.
Step 8	Repeat Step 4 for each interface on which you want to apply Unicast RPF and Step 5 for each interface on which you want to remove Unicast RPF.	—
Step 9	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and enters privileged EXEC mode.

	Command or Action	Purpose
Step 10	**show cef interface** [*type number*] **Example:** `Device# show cef interface`	Displays detailed Cisco Express Forwarding information for a specified interface or for all interfaces.
Step 11	**show platform hardware pp active asic statistics** |i rpf **Example:** `Device# show platform hardware pp active asic statistics|i Rpf`	Displays ASIC statistics on the Unicast RPF packet drops.

Example:

Note You cannot disable Cisco Express Forwarding in RSP3 Module.

The following is the sample output from the **show platform hardware pp active asic statistics|i Rpf** command:

```
Device#  show platform hardware pp active asic statistics|i Rpf

StatsIpv4UcastRpfFail           0x80C7
StatsIpv4McastRpfFail           0x0
StatsIpv6UcastRpfFail           0x0
StatsIpv6McastRpfFail           0x0
```

The following is the sample output from the **show cef interface gigabitEthernet** command to validate if Unicast RPF is enabled on the interface.

```
Device#show cef interface gigabitEthernet 0/0/0
GigabitEthernet0/0/0 is up (if_number 7)
  Corresponding hwidb fast_if_number 7
  Corresponding hwidb firstsw->if_number 7
  Internet address is 192.0.2.0/24
  ICMP redirects are always sent
  IP unicast RPF check is enabled
  Input features: uRPF                          ===> uRPF feature enabled
  IP policy routing is disabled
  BGP based policy accounting on input is disabled
  BGP based policy accounting on output is disabled
  Hardware idb is GigabitEthernet0/0/0
  Fast switching type 1, interface type 27
```

Configuration Examples for Unicast Reverse Path Forwarding

Example: Configuring Unicast RPF

```
Device# configure terminal
Device(config)# ip cef distributed
```

```
Device(config)# interface GigabitEthernet 1/0/2
Device(config-if)# description Connection to Upstream ISP
Device(config-if)# ip address 209.165.200.225 255.255.255.252
Device(config-if)# no ip redirects
Device(config-if)# no ip directed-broadcast
Device(config-if)# no ip proxy-arp
Device(config-if)# ip verify unicast source reachable-via rx
```

Additional References

Related Documents

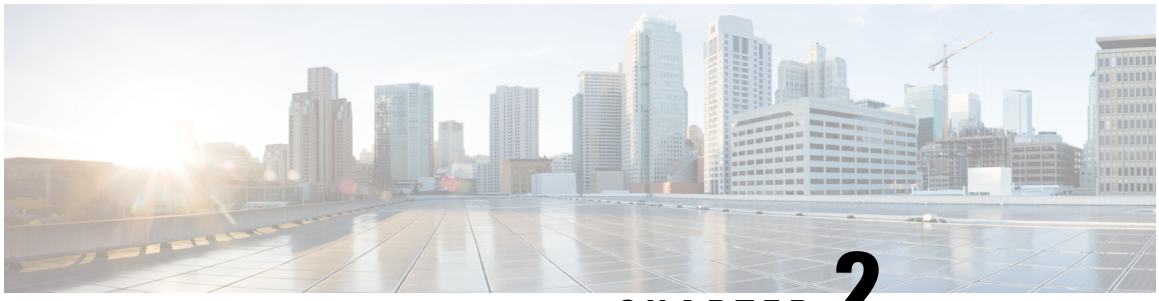
Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
Unicast RPF command descriptions	• Cisco IOS Security Command Reference: Commands A to C • Cisco IOS Security Command Reference: Commands D to L • Cisco IOS Security Command Reference: Commands M to R • Cisco IOS Security Command Reference: Commands S to Z
Cisco Express Forwarding commands	Cisco IOS IP Switching Command Reference

Standards & RFCs

Standard/RFC	Title
RFC 1918	*Address Allocation for Private Internets*
RFC 2267	*Network Ingress Filtering: Defeating Denial of Service Attacks which employ IP Source Address Spoofing*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html



CHAPTER 2

Unicast Reverse Path Forwarding Loose Mode

The Unicast Reverse Path Forwarding Loose Mode feature creates a new option for Unicast Reverse Path Forwarding (Unicast RPF), providing a scalable anti-spoofing mechanism suitable for use in multihome network scenarios. This mechanism is especially relevant for Internet Service Providers (ISPs), specifically on routers that have multiple links to multiple ISPs. In addition, Unicast RPF (strict or loose mode), when used in conjunction with a Border Gateway Protocol (BGP) "trigger," provides an excellent quick reaction mechanism that allows network traffic to be dropped on the basis of either the source or destination IP address, giving network administrators an efficient tool for mitigating denial of service (DoS) and distributed denial of service (DDoS) attacks.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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.

Prerequisites for Unicast RPF Loose Mode

To use Unicast RPF, you must enable Cisco Express Forwarding (CEF) switching or distributed CEF (dCEF) switching in the router. There is no need to configure the input interface for CEF switching. As long as CEF is running on the router, individual interfaces can be configured for other switching modes.

Information About Unicast RPF Loose Mode

Unicast RPF Background

A number of common types of DoS attacks take advantage of forged or rapidly changing source IP addresses, allowing attackers to thwart efforts by ISPs to locate or filter these attacks. Unicast RPF was originally created to help mitigate such attacks by providing an automated, scalable mechanism to implement the Internet Engineering Task Force (IETF) Best Common Practices 38/Request for Comments 2827 (BCP 38/RFC 2827) anti-spoofing filtering on the customer-to-ISP network edge. By taking advantage of the information stored in the Forwarding Information Base (FIB) that is created by the CEF switching process, Unicast RPF can determine whether IP packets are spoofed or malformed by matching the IP source address and ingress interface against the FIB entry that reaches "back" to this source (a so-called "reverse lookup"). Packets that are received from one of the best reverse path routes back out of the same interface are forwarded as normal. If there is no reverse path route on the same interface from which the packet was received, it might mean that the source address was modified, and the packet is dropped (by default).

This original implementation of Unicast RPF, known as "strict mode," required a match between the ingress interface and the reverse path FIB entry. With Unicast RPF, all equal-cost "best" return paths are considered valid, meaning that it works for cases in which multiple return paths exist, provided that each path is equal in routing cost to the others (number of hops, weights, and so on), and as long as the route is in the FIB. Unicast RPF also functions when Enhanced Interior Gateway Routing Protocol (EIGRP) variants are being used and unequal candidate paths back to the source IP address exist. The strict mode works well for customer-to-ISP network edge configurations that have symmetrical flows (including some multihomed configurations in which symmetrical flows can be enforced).

However, some customer-to-ISP network edges and nearly all ISP-to-ISP network edges use multihomed configurations in which routing asymmetry is typical. When traffic flows are asymmetrical, that is, those in which traffic from Network A to Network B would normally take a different path from traffic flowing from Network B to Network A, the Unicast RPF check will always fail the strict mode test. Because this type of asymmetric routing is common among ISPs and in the Internet core, the original implementation of Unicast RPF was not available for use by ISPs on their core routers and ISP-to-ISP links.

Over time and with an increase in DDoS attacks on the Internet, the functionality of Unicast RPF was reviewed as a tool that ISPs can use on the ISP-to-ISP network edge (an ISP router "peered" with another ISP router) to enable dynamic BGP, triggered null route. To provide this functionality, however, the mechanisms used with Unicast RPF had to be modified to permit its deployment on the ISP-to-ISP network edge so that asymmetrical routing is not an issue.

Loose Mode

To provide ISPs with a DDoS resistance tool on the ISP-to-ISP edge of a network, Unicast RPF was modified from its original strict mode implementation to check the source addresses of each ingress packet without regard for the specific interface on which it was received. This modification is known as "loose mode." Loose mode allows Unicast RPF to automatically detect and drop packets such as the following:

- IETF RFC 1918 source addresses
- Other Documenting Special Use Addresses (DUSA) that should not appear in the source
- Unallocated addresses that have not been allocated by the Regional Internet Registries (RIRs)

- Source addresses that are routed to a null interface on the router

Loose mode removes the match requirement on the specific ingress interface, allowing Unicast RPF to loose-check packets. This packet checking allows the "peering" router of an ISP having multiple links to multiple ISPs to check the source IP address of ingress packets to determine whether they exist in the FIB. If they exist, the packets are forwarded. If they do not exist in the FIB, the packets fail and are dropped. This checking increases resistance against DoS and DDoS attacks that use spoofed source addresses and unallocated IP addresses.

How to Configure Unicast RPF Loose Mode

Configuring Unicast RPF Loose Mode

To configure Unicast RPF loose mode, perform the following steps.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip cef** **Example:** `Router (config)# ip cef`	Enables CEF on the route processor card.
Step 4	**interface** *type slot / port-adapter / port* **Example:** `Router (config)# interface serial5/0/0`	Configures an interface type and enters interface configuration mode.
Step 5	**ip verify unicast source reachable-via any** **Example:** `Router (config-if)# ip verify unicast source reachable-via any`	Enables Unicast RPF using loose mode.

Troubleshooting Tips

CEF Not Enabled

If CEF is not enabled on your device and an attempt is made to deploy Unicast RPF, the following error message is generated:

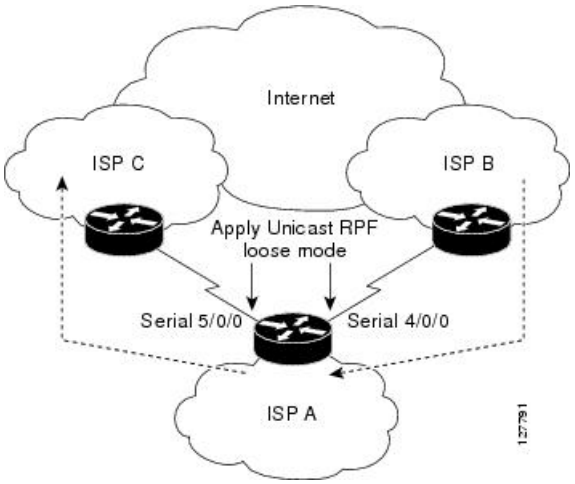
```
Router(config-if)# ip verify unicast source reachable-via any
% CEF not enabled. Enable first.
```

Configuration Examples for Unicast RPF Loose Mode

Example Configuring Unicast RPF Using Loose Mode

The following example (see the figure below) uses a simple dual-homed ISP to demonstrate the concept of Unicast RPF loose mode. The example illustrates an ISP (A) peering router that is connected to two different upstream ISPs (B and C) and shows that traffic flows into and out of ISP A may be asymmetric given this dual-homed configuration. Hence, provisions for asymmetrical flows (when outbound traffic goes out one link and returns via a different link) must be accounted for by the Unicast RPF deployment. In this case, it is appropriate to use the loose-mode configuration of Unicast RPF because this configuration alleviates the interface dependency of strict mode.

Figure 6: Unicast RPF Loose Mode




```
Device# configure terminal
Device(config)# ip cef distributed
Device(config)# interface gigabitEthernet 0/2/0
Device(config-if)# description Connection to Upstream ISP
Device(config-if)# ip address 209.165.200.225 255.255.255.252
Device(config-if)# no ip redirects
Device(config-if)# no ip directed-broadcast
Device(config-if)# no ip proxy-arp
Device(config-if)# ip verify unicast source reachable-via any
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Best practices using Unicast RPF	Internet Service Provider (ISP) Security Bootcamp/Best Practices--CPN-Summit-2004/Paris-Sept-04

Standards

Standards	Title
No new or modified standards are supported by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature.	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

RFCs	Title
No new or modified RFCs are supported by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html