Setting Up OER Network Components

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This module describes the concepts and tasks to help you set up the network components required for an Optimized Edge Routing (OER)-managed network. OER network components are described and configuration tasks are provided to help you configure a master controller (MC) and one or more border routers (BRs) that enable communication between these two software components.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see 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 at the end of this document.

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 Setting Up OER Network Components

- Before setting up OER network components, you should be familiar with the Cisco IOS Optimized Edge Routing Overview module.
- Cisco Express Forwarding (CEF) must be enabled on all participating routers.

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- Either routing protocol peering must be established on your network or static routing must be configured before setting up OER network components.

If you have configured internal Border Gateway Protocol (iBGP) on the border routers, BGP peering must be either established and consistently applied throughout your network or redistributed into the Interior Gateway Protocol (IGP).

If an IGP is deployed in your network, static route redistribution must be configured with the **redistribute** command. IGP or static routing should also be applied consistently throughout an OER-managed network; the border router should have a consistent view of the network.

Restrictions for Setting Up OER Network Components

- OER supports only IP security (IPsec), Generic Routing Encapsulation (GRE) Virtual Private Networks (VPNs) or Dynamic Multipoint VPNs (DMVPNs) only. No other VPN types are supported.
- When two or more border routers are deployed in an OER-managed network, the next hop on each border router, as installed in the Routing Information Base (RIB), cannot be an address from the same subnet as the next hop on the other border router.
- Interfaces that are configured to be under OER control can also carry multicast traffic. However, if the source of the multicast traffic comes from outside of the OER-managed network and inbound multicast traffic is carried over OER-managed exit links, the source multicast address should be excluded from OER control.
- Internet exchange points where a border router can communicate with several service providers over the same broadcast media are not supported.
- Token Ring interfaces are not supported by OER and cannot be configured as OER-managed interfaces. It may be possible to load a Token Ring interface configuration under certain conditions. However, the Token Ring interface will not become active and the border router will not function if the Token Ring interface is the only external interface on the border router.

Performance Routing DMVPN mGre Support

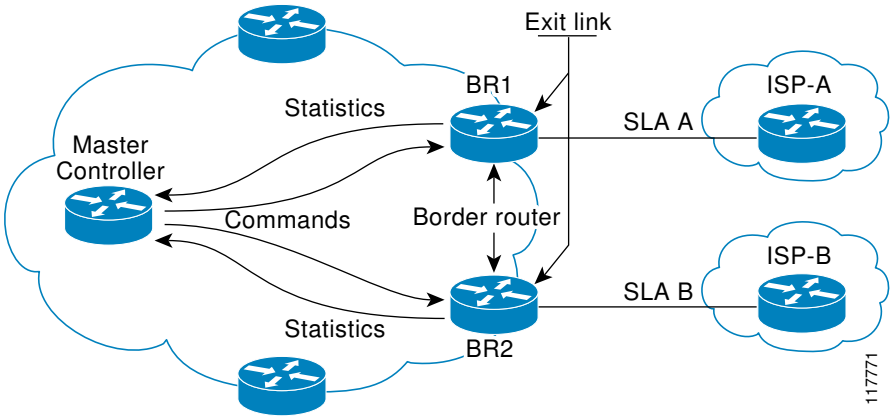
- Performance Routing (PfR) does not support split tunneling.
- PfR supports hub-to-spoke links only. Spoke-to-spoke links are not supported.
- PfR is supported on DMVPN Multipoint GRE (mGRE) deployments. Any multipoint interface deployment that has multiple next hops for the same destination IP address is not supported (for example, Ethernet).

Information About Setting Up OER Network Components

OER-Managed Network

The figure below shows an OER-managed network. This network contains a master controller and two border routers. OER is configured on Cisco routers using the Cisco IOS command-line interface (CLI). OER deployment has two primary components: a master controller and one or more border routers. The master controller is the intelligent decision maker, while the border routers are enterprise edge routers with exit interfaces at the network edge. Border routers are either used to access the Internet or used as WAN exit links. OER communication between the master controller and the border routers is carried separately from routing protocol traffic. This communication is protected by Message Digest 5 (MD5) authentication. Each border router has both an external interface, which is connected, for example, to an ISP by a WAN link, and an internal interface that is reachable by the master controller.

Figure 1 OER-Managed Network



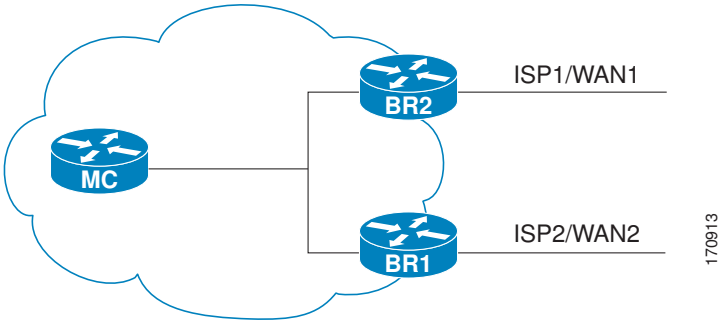
External interfaces are used to forward outbound traffic from the network and as the source for active monitoring. Internal interfaces are used for OER communication and for passive monitoring. In Cisco IOS Release 12.4(9)T, the ability to monitor and control inbound traffic was introduced. At least one external and one internal interface must be configured on each border router. At least two external interfaces are required in an OER-managed network. A local interface is configured on the border router for communication with the master controller.

OER Master Controller

The master controller is a single router that coordinates all OER functions within an OER-managed network. A Cisco router can be configured either to run a standalone master controller process or to

perform other functions, such as routing or running a border router process. The figure below shows an example of a standalone router configured as a master controller.

Figure 2 Master Controller Example



The master controller maintains communication and authenticates the sessions with the border routers. Outbound traffic flows are monitored by the border routers using active or passive monitoring, and the data is collected in a central policy database residing on the router configured as the master controller. Then the master controller applies default or user-defined policies to alter routing to optimize prefixes and exit links. OER administration and control is centralized on the master controller, which makes all policy decisions and controls the border routers. The master controller does not have to be in the traffic forwarding path, but it must be reachable by the border routers. The master controller can support up to 10 border routers and up to 20 OER-managed external interfaces.

Central Policy Database

The master controller continuously monitors the network and maintains a central policy database in which collected statistical information is stored. The master controller compares long-term and short-term measurements. The long-term measurements are collected every 60 minutes. Short-term measurements are collected every 5 minutes. The master controller analyzes these statistics to determine which routes have the lowest delay, highest outbound throughput, relative or absolute packet loss, relative or absolute link cost, and prefix reachability to analyze and optimize the performance of monitored prefixes and to distribute the load from overutilized exit links to underutilized exit links. The locations of the exit links on the border routers are shown in the figure above.

Tip We recommend that the master controller be physically close to the border routers to minimize communication response time in OER-managed networks. If traffic is to be routed between border routers, the border routers also should be physically close each other to minimize the number of hops.

Border Routers in an OER-Managed Network

The border router is an enterprise edge router with one or more exit links to another participating network, such as an Internet Service Provider (ISP), and is the site where all policy decisions and changes to routing in the network are enforced. The border router participates in prefix monitoring and route optimization by first reporting prefix and exit link measurements to the master controller and then by enforcing policy changes received from the master controller. The border router enforces policy changes by injecting a preferred route to alter routing in the network. The border router is deployed on the edge of the network, so the border router must be in the forwarding path. A border router process can be enabled on the same router as a master controller process.

Policy Enforcement Point

The border router is the policy enforcement point. Default or user-defined policies are configured on the master controller to set the performance level for prefixes and exit links. The master controller automatically alters routing in the OER-managed network, as necessary, by sending control commands to the border routers to inject a preferred route. The preferred route is advertised or redistributed through the internal network. The preferred route alters default routing behavior so that out-of-policy prefixes are moved from overutilized exit links to underutilized exit links, bringing prefixes and exit links in-policy, thus optimizing the overall performance of the enterprise network.

Tip We recommend that if traffic is to be routed between border routers, the border routers should be physically close to each other to minimize the number of hops. The master controller also should be physically close to the border routers to minimize communication response time in OER-managed networks.

OER Border Router Support for Cisco Catalyst 6500 Series Switches

In Cisco IOS Release 12.2(33)SXH support for using a Cisco Catalyst 6500 series switch as an OER border router was introduced. Only border router functionality is included in the Cisco IOS Release 12.2(33)SXH images; no master controller configuration is available. The master controller that communicates with the Cisco Catalyst 6500 series switch being used as a border router must be a router running Cisco IOS Release 12.4(6)T or a later release.

The OER master controller software has been modified to handle the limited functionality supported by the Cisco Catalyst 6500 border routers. Using the Route Processor (RP), the Catalyst 6500 border routers can capture throughput statistics only for a traffic class compared to the delay, loss, unreachability, and throughput statistics collected by non-Catalyst 6500 border routers. A master controller will automatically detect the limited capabilities of the Catalyst 6500 border routers and will downgrade other border routers to capture only the throughput statistics for traffic classes. By ignoring other types of statistics, the master controller is presented with a uniform view of the border router functionality.

If one of the border router is identified as a Catalyst 6500 border router, then the master controller starts periodic active probing of the all the traffic classes under OER control and ignores the passive performance statistics. Active probing results received for each traffic class are evaluated against the policies configured for that traffic class.

For more details about profiling and monitoring modifications introduced to support the Cisco Catalyst 6500 series switch as an OER border router, see the Measuring the Traffic Class Performance and Link Utilization Using OER module and the Using OER to Profile the Traffic Classes module.

OER-Managed Network Interfaces

An OER-managed network must have at least two egress interfaces that can carry outbound traffic and that can be configured as external interfaces. These interfaces should connect to an ISP or WAN link (Frame-Relay, ATM) at the network edge. The router must also have one interface (reachable by the internal network) that can be configured as an internal interface for passive monitoring. There are three interface configurations required to deploy OER:

- *External interfaces* are configured as OER-managed exit links to forward traffic. The physical external interface is enabled on the border router. The external interface is configured as an OER external interface on the master controller. The master controller actively monitors prefix and exit link performance on these interfaces. Each border router must have at least one external interface, and a minimum of two external interfaces are required in an OER-managed network.

- *Internal interfaces* are used only for passive performance monitoring with NetFlow. No explicit NetFlow configuration is required. The internal interface is an active border router interface that connects to the internal network. The internal interface is configured as an OER-internal interface on the master controller. At least one internal interface must be configured on each border router.
- *Local interfaces* are used only for master controller and border router communication. A single interface must be configured as a local interface on each border router. The local interface is identified as the source interface for communication with the master controller.

Tip If a master controller and border router process are enabled on the same router, a loopback interface should be configured as the local interface.

The following interface types can be configured as external and internal interfaces:

- ATM
- Basic Rate Interface (BRI)
- CTunnel
- Dialer
- Ethernet
- Fast Ethernet
- Gigabit Ethernet
- High-Speed Serial Interface (HSSI)
- Loopback (supported in Cisco IOS 15.0(1)M and later releases)
- Multilink (Supported in Cisco IOS Release 12.4(5), 12.4(4)T, and later releases)
- Multilink Frame Relay (MFR) (Supported in Cisco IOS Release 12.4(5), 12.4(4)T, and later releases)
- Null
- Packet-over-SONET (POS)
- Port Channel
- Serial
- Tunnel
- VLAN

The following interface types can be configured as local interfaces:

- Async
- Bridge Group Virtual Interface (BVI)
- Code division multiple access Internet exchange (CDMA-Ix)
- CTunnel
- Dialer
- Ethernet
- Group-Async
- Loopback
- Multilink
- Multilink Frame Relay (MFR)
- Null
- Serial
- Tunnel
- Virtual host interface (Vif)
- Virtual-PPP

- Virtual-Template
- Virtual-TokenRing

Note A virtual-TokenRing interface can be configured as a local interface. However, Token Ring interfaces are not supported and cannot be configured as external, internal, or local interfaces.

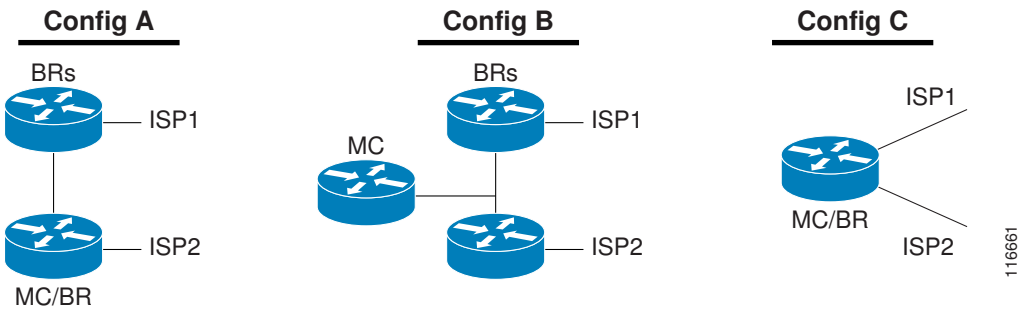
Note PfR does not support Ethernet interfaces that are Layer 2 only, for example, Ethernet switched interfaces.

OER Deployment Scenarios

OER can be deployed in an enterprise network, remote office network, or small office home office (SOHO) network using one of the following three configurations shown in the figure below:

- Configuration A shows a network with two edge routers configured as BRs. The border router that peers with ISP2 is also configured to run a master controller process. This configuration is suitable for a small or medium network with multiple edge routers, each of which provides an exit link to a separate external network.
- Configuration B shows two border routers and a master controller, each running on a separate router. This configuration is suitable for small, medium, and large networks. In this configuration, the master controller process is run on a separate Cisco router. This router performs no routing or forwarding functions, although routing and forwarding functions are not prohibited.
- Configuration C shows a single router that is configured to run a master controller and border router process. This configuration is suitable for a small network with a single router, such as a remote office or home network.

Figure 3 OER Deployment Scenarios



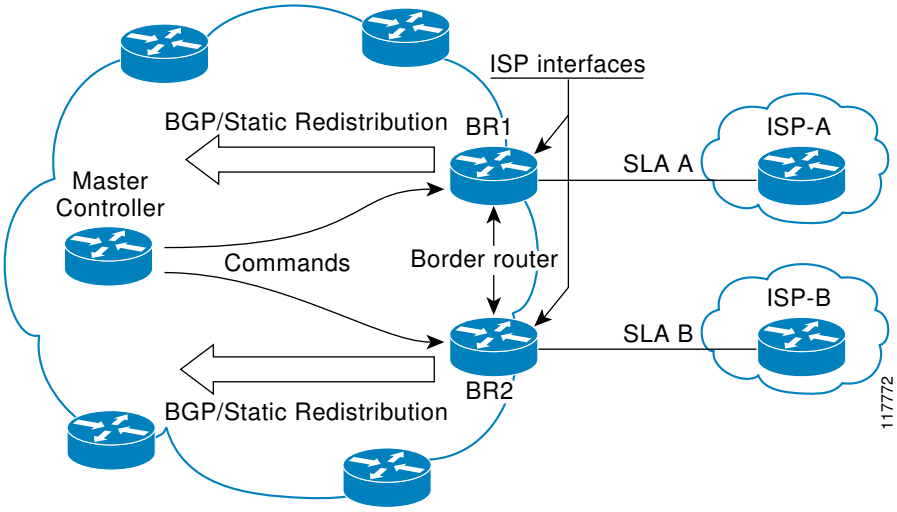
In each deployment scenario, a single master controller is deployed. The master controller does not have to be in the traffic forwarding path but must be reachable by the border routers. A master controller process can be enabled on router that is also configured to run a border router process. The master controller can support up to 10 border routers and up to 20 OER-managed external interfaces. At least one border router process and two external interfaces are required in an OER-managed network.

Note A Cisco router that is configured to run both a master controller and border router process will use more memory than a router that is configured to run only a border router process. This memory impact should be considered when selecting a router for dual operation.

Routing Control Using OER

The figure below shows an OER-managed network. The master controller alters IPv4 routing behavior inside of the OER-managed network to optimize traffic class and exit link performance. OER uses a command and response protocol to manage all communication between the border router and the master controller. The border routers are enterprise edge routers. Routing protocol peering or static routing is established between the border routers and internal peers. The border routers advertise a default route to internal peers through BGP peering, static routing, or route redistribution into an IGP. The master controller alters routing behavior in the OER-managed network by sending control commands to the border routers to inject a preferred route into the internal network.

Figure 4 OER Controls Default Routing Behavior Through Peering or Redistribution



When the master controller determines the best exit for a traffic class prefix, it sends a route control command to the border router with the best exit. The border router searches for a parent route for the monitored prefix. The BGP routing table is searched before the static routing table. The parent route can be a default route for the monitored prefix. If a parent route is found that includes the prefix (the parent route prefix may be equivalent or less specific than the original prefix) and points to the desired exit link by either the route to its next hop or by a direct reference to the interface, a preferred route is injected into the internal network from the border router. OER injects the preferred route where the first parent is found. The preferred route can be an injected BGP route or an injected static route. The preferred route is learned by internal peers, which in turn recalculate their routing tables, causing the monitored prefix to be moved to the preferred exit link. The preferred route is advertised only to the internal network, not to external peers.

Border Router Peering with the Internal Network

The master controller alters default routing behavior in the OER-managed network by injecting preferred routes into the routing tables of the border routers. The border routers peer with other routers in the internal

network through BGP peering, BGP or static route redistribution into an IGP, or static routing. The border routers advertise the preferred route to internal peers.

The border routers should be close to one another in terms of hops and throughput and should have a consistent view of the network; routing should be configured consistently across all border routers. The master controller verifies that a monitored prefix has a parent route with a valid next hop before it commands the border routers to alter routing. The border router will not inject a route where one does not already exist. This behavior is designed to prevent traffic from being lost because of an invalid next hop.

Note When two or more border routers are deployed in an OER-managed network, the next hop on each border router, as installed in the RIB, cannot be an IP address from the same subnet.

BGP Peering with OER

Standard iBGP peering can be established between the border routers and other internal peers. External BGP (eBGP) peering or a default route is configured to the ISP. In an iBGP network, the local preference attribute is used to set the preference for injected routes. Local preference is a discretionary attribute that is used to apply the degree of preference to a route during BGP best-path selection. This attribute is exchanged only between iBGP peers and is not advertised outside of the OER-managed network or to eBGP peers. The prefix with the highest local preference value is locally advertised as the preferred path to the destination. OER applies a local preference value of 5000 to injected routes by default. A local preference value from 1 to 65535 can be configured.

Note If a local preference value of 5000 or higher has been configured for default BGP routing, you should configure a higher local preference value in OER using the **mode** command in OER master controller configuration mode.

Note In Cisco IOS Release 12.4(6)T and prior releases, the IP address for each eBGP peering session must be reachable from the border router via a connected route. Peering sessions established through loopback interfaces or with the **neighbor ebgp-multihop** command are not supported. In Cisco IOS Release 12.4(9)T and 12.2(33)SRB, the **neighbor ebgp-multihop** command is supported.

BGP Redistribution into an IGP

BGP redistribution can be used if the border routers are configured to run BGP (for ISP peering for example) and the internal peers are configured to run another routing protocol (such as Enhanced Interior Gateway Routing Protocol [EIGRP], Open Shortest Path First [OSPF] or Routing Information Protocol [RIP]). The border routers can advertise a single, default route or full routing tables to the internal network. If you use BGP to redistribute more than a default route into an IGP, we recommend that you use IP prefix-list and route-map statements to limit the number of redistributed prefixes (BGP routing tables can be very large).

Static Routing and Static Route Redistribution into an IGP

Static routing or static route redistribution can be configured in the internal network. OER alters routing for this type of network by injecting temporary static routes. The temporary static route replaces the parent static route. OER will not inject a temporary static route where a parent static route does not exist. OER applies a default tag value of 5000 to identify the injected static route. In a network where only static

routing is configured, no redistribution configuration is required. In a network where an IGP is deployed and BGP is not run on the border routers, static routes to border router exit interfaces must be configured, and these static routes must be redistributed into the IGP.

Caution Caution must be applied when redistributing OER static routes into an IGP. The routes injected by OER may be more specific than routes in the IGP, and it will appear as if the OER border router is originating these routes. To avoid routing loops, the redistributed OER static routes should never be advertised over a WAN by an OER border router or any other router. Route filtering and stub network configuration can be used to prevent advertising the OER static routes. If the OER static routes are redistributed to routers terminating the OER external interfaces, routing loops may occur.

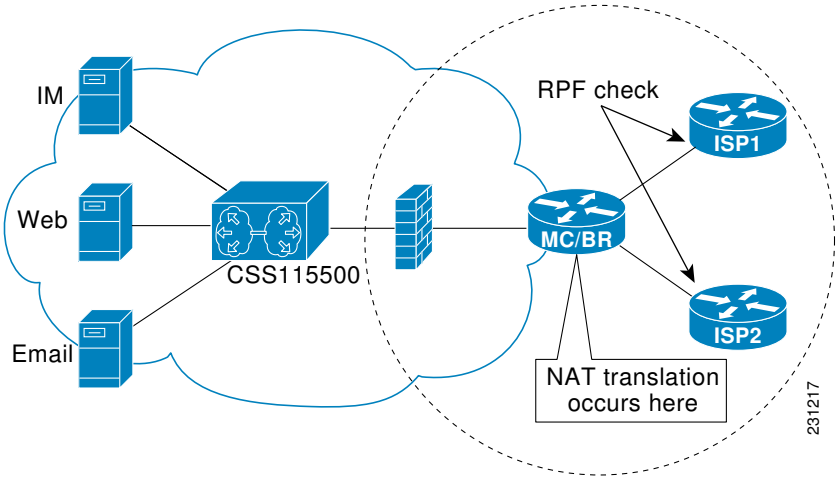
Split Prefixes Injected into the Routing Table

When configured to control a subset of a larger network, the master controller will add an appropriate route or split prefix to the existing routing table, as necessary. A split prefix is a more specific route that is derived from a less specific parent prefix. For example, if a /24 prefix is configured to be optimized, but only a /16 route is installed to the routing table, the master controller will inject a /24 prefix using the attributes of the /16 prefix. Any subset of the less-specific prefix can be derived, including a single host route. Split prefixes are processed only inside the OER-managed network and are not advertised to external networks. If BGP is deployed in the OER-managed network, the master controller will inject a more specific BGP route. If BGP is not deployed, the master controller will inject a more specific temporary static route.

OER and NAT

When Cisco IOS OER and NAT functionality are configured on the same router and OER controls the routing for a traffic class using static routing, some applications may fail to operate due to dropped packets. This dropping of packets behavior is seen when static routing is used to connect to multiple ISPs from the same router, OER uses static routing to control the traffic class routing, and one or more of the ISPs use Unicast Reverse Path Forwarding (Unicast RPF) filtering for security reasons. Packets are dropped at the ingress router performing Unicast RPF because OER changes the route for an outgoing packet for a traffic class from one exit interface to another after the NAT translation from a private IP address to a public IP address is performed. When the packet is transmitted, Unicast RPF filtering at the ingress router (for example, an ISP router) will show a different source IP address from the source IP address pool assigned by NAT, and the packet is dropped. For example, the figure below shows how OER works with NAT.

Figure 5 OER with NAT



The NAT translation occurs at the router that is connected to the internal network, and this router can be a border router or a combined master controller and border router. If OER changes routes to optimize traffic class performance and to perform load balancing, traffic from the border router in the figure above that was routed through the interface to ISP1 may be rerouted through the interface to ISP2 after the traffic performance is measured and policy thresholds are applied. The RPF check occurs at the ISP routers and any packets that are now routed through ISP2 will fail the RPF check at the ingress router for ISP2 because the IP address of the source interface has changed.

The solution involves a minimal configuration change with a new keyword, **oer**, that has been added to the **ip nat inside source** command. When the **oer** keyword is configured, new NAT translations are given the source IP address of the interface that OER has selected for the packet and OER forces existing flows to be routed through the interface for which the NAT translation was created. For example, OER is configured to manage traffic on a border router with two interfaces, InterfaceA to ISP1 and InterfaceB to ISP2 in the figure above. OER is first configured to control a traffic class representing Web traffic and the NAT translation for this traffic already exists with the source IP address in the packets set to InterfaceA. OER measures the traffic performance and determines that InterfaceB is currently the best exit for traffic flows, but OER does not change the existing flow. When OER is then configured to learn and measure a traffic class representing e-mail traffic, and the e-mail traffic starts, the NAT translation is done for InterfaceB. The OER static routing NAT solution is a single box solution and configurations with interfaces on multiple routers using NAT and managed by OER are not supported. Network configurations using NAT and devices such as PIX firewalls that do not run Cisco IOS software are not supported.

For details about configuring the OER static routing NAT solution, see the Configuring OER to Control Traffic with Static Routing in Networks Using NAT task.

OER Application Interface

In Cisco IOS Release 12.4(15)T support for an OER application interface was introduced. The OER application interface defines the mode of communication and messaging between applications and the network for the purpose of optimizing the traffic associated with the applications. A provider is defined as an entity outside the network in which the router configured as an OER master controller exists, for example, an ISP, or a branch office of the same company. The provider has one or more host devices running one or more applications that use the OER application interface to communicate with an OER master controller. A provider must be registered with an OER master controller before an application on a host device can interface with OER. Host devices in the provider network running an application that communicates with OER must also be configured at an OER master controller with an IP address and key chain password.

After registration, a host device in the provider network can initiate a session with an OER master controller. When a provider application initiates a session with an OER master controller, a session identifier (ID) number is allocated to the session. After a session is established, the application can send a request for reports containing performance numbers for traffic classes, dynamically create policies to influence the existing traffic classes, or specify new traffic class criteria.

The application interface can be used by Cisco partners to develop applications. An example of application developed by a partner is OER Manager by Fluke Networks. OER Manager is a complete graphical-user interface (GUI) interface for the Optimized Edge Routing technology. It provides detailed reporting on traffic class performance and OER behavior as well as easy-to-use configuration of OER traffic classes and policies. For more details about OER Manager, go to http://www.flukenetworks.com.

The OER application interface permits a maximum of five concurrent sessions, and keepalives are used to check that the session between the host application device and the OER master controller is still active. If the session is dropped, all policies created in the session are dropped. An application may negotiate an ability for the session to persist in the case of a temporary outage.

Application Interface Priority

The OER application interface has three main levels of priority to help resolve conflicts with requests coming from providers, host devices, and policies. In the table below the three priority levels are shown with the scope of the priority, whether the priority level can be configured on the master controller, the range and default values, if applicable.

When multiple providers are registered with OER, an optional priority value can be specified to give OER the ability to order requests coming in from multiple providers. Host devices in a provider network can also be assigned a priority. The lower the priority value, the higher the priority. If you configure a priority, each provider must be assigned a different priority number. If you try to assign the same priority number to two different providers, an error message is displayed on the console. Host devices must also be configured with different priority numbers if a priority is configured. If a priority has not been configured for the provider or host device, the priority is set to the default value of 65535, which is the lowest priority.

Table 1 Application Interface Priority Level Table

Priority Name	Scope	Mandatory In Application Interface Message	Configure on MC	Default Value	Range
Provider priority	Network wide	No	Yes	65535	1 to 65535
Host priority	Provider Level	No	Yes	65535	1 to 65535
Policy	Host Level	Yes	No	N/A	1 to 65535

The application administrator assigns a priority to all applications. This priority is conveyed to the Network in terms of a policy priority. The lower the application priority number, the higher the priority of the application. Policy priority is handled using the policy sequence number. A policy sequence number--see the table below--is a 64 bit number calculated by placing provider priority in bytes 1 and 2, host priority in bytes 3 and 4, policy priority in bytes 5 and 6 and Session ID in bytes 7 and 8. The policy sequence number is calculated by the OER master controller. An example policy sequence number is 18446744069421203465, representing a provider priority value of 65535, a host priority of 65535, a policy priority of 101, and a session ID of 9.

Use the **show oer master policy** command to view the policy sequence number. The lower the sequence number, the higher the priority for the policy.

Table 2 Formulation of a Policy Sequence Number

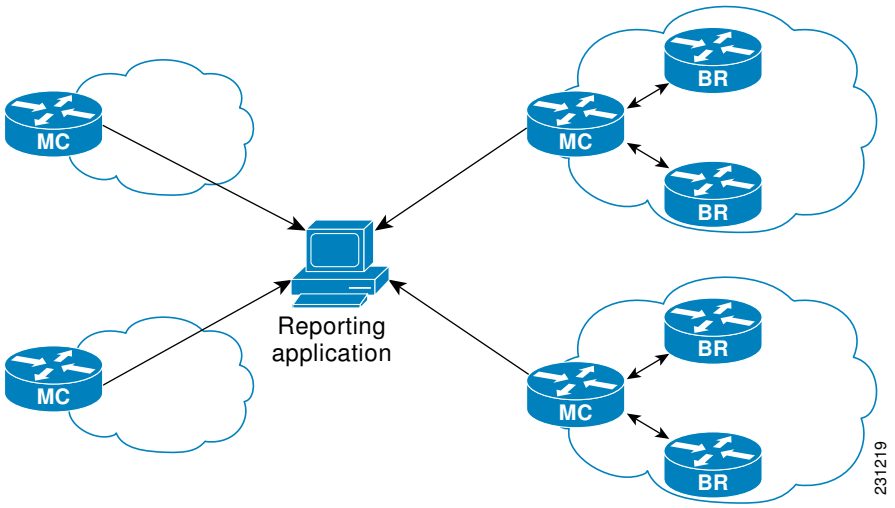
Bits 0-7	**Bits 8-15**	**Bits 16-23**	**Bits 24-31**
Provider Priority		Host Priority	
Bits 32-39	**Bits 40-48**	**Bits 49-56**	**Bits 57-64**
Policy Priority		Session ID	

In the situation where an application tries to create two policies with same policy priority; the second policy creation attempt will fail.

OER Application Interface Reporting Deployment

An application communicating through an OER application interface can request performance reports from OER and use the report information to create graphs and charts of the information. The figure below shows a diagram of an example reporting model. In this example, the topology contains multiple sites using OER within the site. Each site has a master controller but the company wants to review reports about activities in each site such as overall inter-site traffic activity, voice and video traffic activity, and data center access reports. An OER application interface solution is implemented with a reporting application--see the figure below--that resides in a central location. The reporting application is registered at each OER master controller and the application initiates a session with each master controller and requests traffic class performance information. The master controller at each site exports information to the application, which consolidates the information and displays graphs and charts. Reports can be requested at specified intervals to keep the information on the reporting application updated.

Figure 6 OER Application Interface Reporting Model



At each site the master controller can monitor provider activity. Several Cisco IOS command-line interface (CLI) commands allow you to view provider information including details about dynamic policies created by the application. Reporting can also be implemented for a single site.

In summary, the OER application interface provides an automated method for networks to be aware of applications and provides application-aware performance routing.

OER Logging and Reporting

Cisco IOS OER supports standard syslog functions. The notice level of syslog is enabled by default. System logging is enabled and configured in Cisco IOS software under global configuration mode. The **logging**command in OER master controller or OER border router configuration mode is used only to enable or disable system logging under OER. OER system logging supports the following message types:

- Error Messages--These messages indicate OER operational failures and communication problems that can impact normal OER operation.
- Debug Messages--These messages are used to monitor detailed OER operations to diagnose operational or software problems.
- Notification Messages--These messages indicate that OER is performing a normal operation.
- Warning Messages--These messages indicate that OER is functioning properly but an event outside of OER may be impacting normal OER operation.

To modify system, terminal, destination, and other system global logging parameters, use the logging commands in global configuration mode. For more information about global system logging configuration, see to the Troubleshooting, Logging, and Fault Management section of the *Cisco IOS Network Management Configuration Guide*.

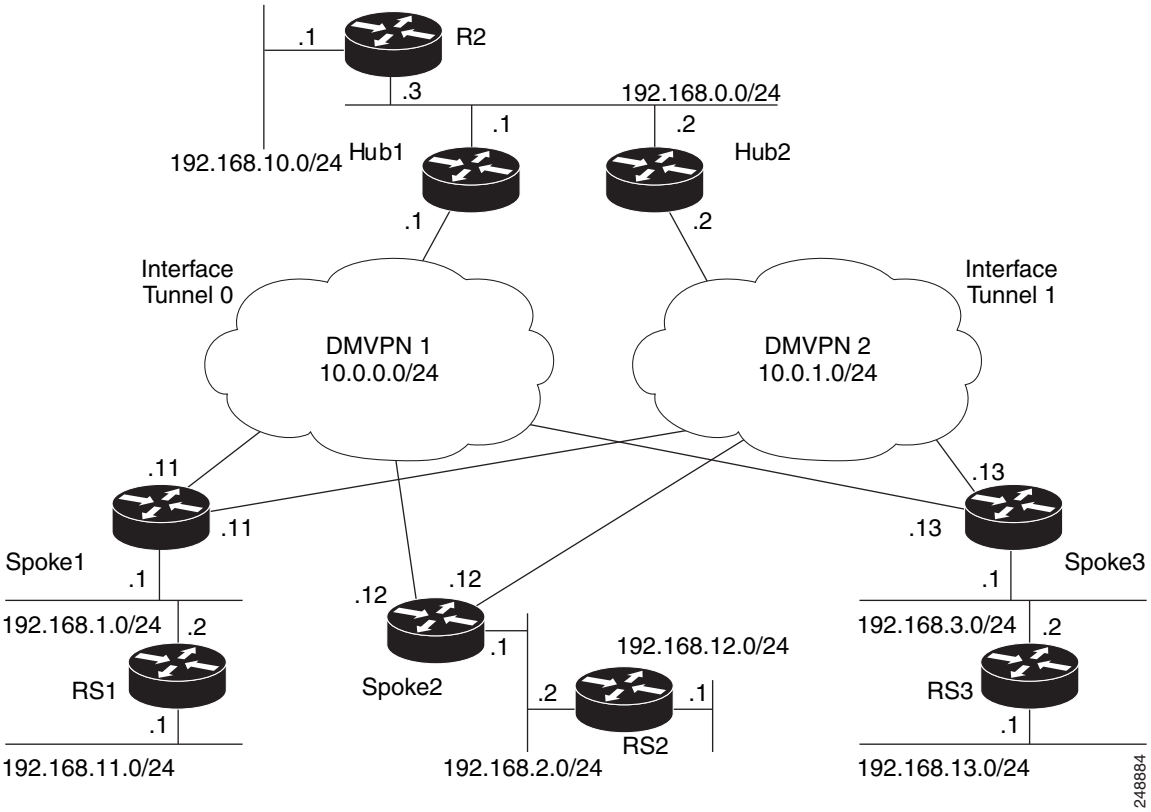
Performance Routing DMVPN mGRE Support

Cisco IOS software supports Performance Routing (PfR) on mGRE interfaces in Dynamic Multipoint VPN (DMVPN) topologies. In DMVPN topologies the mGRE interface works as a one-to-many interface and allows the dynamic creation of tunnels for each connected branch.

The diagram below shows a typical dual DMVPN topology. The head office (R2) has one hub (hub1) that connects to the remote site spokes using one of the DMVPN networks (DMVPN 1 or DMVPN 2) or the MPLS-GETVPN network.

Remote site 1 (RS1) has spokes 1 and 2 that connect to the hub using the DMVPN1 and DMVPN2 networks. Remote site 2 (RS2) has spoke 3 and connects to the hub using DMVPN1 network only. This means that there is no redundancy at RS2 and any performance optimization is performed between the hub and RS2 only. Remote site 3 (RS3) has spoke 3 that connects to the hub using the DMVPN2 network and the MPLS-GETVPN network.

Figure 7 PfR Dual DMVPN Topology



When PfR is configured on the network, the system can perform these functions:

- Control and measure the performance of PfR traffic-classes on mGRE interfaces.

- Support load balancing for traffic over multipoint interfaces that are configured as PfR external interfaces. For example, in topologies with two DMVPN clouds PfR can be configured to load balance the traffic across the two tunnel interfaces to ensure that network performance is maintained.
- Reroute traffic from or to a multipoint interface for better performance. For example, PfR policies can be configured to select the best path to a spoke and the best path from the spoke to the hub.
- Provide a back-up connection if the primary connection fails. For example, in a topology with one MPLS-GETVPN and one DMVPN connection, the MPLS-GETVPN could act as a primary connection and PfR could be configured to use the DMVPN connection if the primary connection fails.

How to Set Up OER Network Components

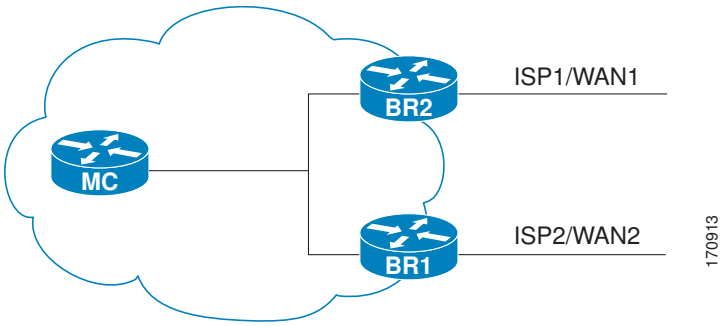
To set up an OER-managed network you must configure routing protocol peering or redistribution between border routers and peer routers in order for OER to control routing. Perform the first two tasks to set up the OER master controller and OER border routers. After performing these required tasks, the other tasks are optional and depend on the existing routing configuration in your network. For example, if only static routing is configured in your network, no optional configuration tasks are necessary for initial OER configuration.

- Setting Up the OER Master Controller, page 15
- Setting Up an OER Border Router, page 21
- Configuring OER to Control Traffic with Static Routing in Networks Using NAT, page 25
- Configuring iBGP Peering on the Border Routers Managed by OER, page 30
- Redistributing BGP Routes into an IGP in an OER-Managed Network, page 32
- Redistributing Static Routes into an IGP in an OER-Managed Network, page 35
- Redistributing Static Routes into EIGRP in an OER-Managed Network, page 38
- Registering an Application Interface Provider and Configuring Host Devices, page 42
- Displaying Information about Application Interface Provider Activity, page 44

Setting Up the OER Master Controller

Perform this task to set up the OER master controller to manage an OER-managed network. This task must be performed on the router designated as the OER master controller. For an example network configuration of a master router and two border routers, see the figure below. Communication is first established between the master controller and the border routers with key-chain authentication being configured to protect the communication session between the master controller and the border routers. Internal and external border router interfaces are also specified.

Figure 8 Master Controller and Border Router Diagram



Key Chain Authentication for OER

Communication between the master controller and the border router is protected by key-chain authentication. The authentication key must be configured on both the master controller and the border router before communication can be established. The key-chain configuration is defined in global configuration mode on both the master controller and the border router before key-chain authentication is enabled for master controller-to-border router communication. For more information about key management in Cisco IOS software, see the Managing Authentication Keys section of the Configuring IP Routing Protocol-Independent Features chapter in the *Cisco IOS IP Routing Protocols Configuration Guide*.

Master Controller Process Disablement

To disable a master controller and completely remove the process configuration from the running configuration, use the **no oer master**command in global configuration mode.

To temporarily disable a master controller, use the **shutdown** command in OER master controller configuration mode. Entering the **shutdown** command stops an active master controller process but does not remove any configuration parameters. The **shutdown** command is displayed in the running configuration file when enabled.

Manual Port Configuration

Communication between the master controller and border router is automatically carried over port 3949 when connectivity is established. Port 3949 is registered with the Internet Assigned Numbers Authority (IANA) for OER communication. Support for port 3949 was introduced in Cisco IOS Release 12.3(11)T and 12.2(33)SRB. Manual port number configuration is required only if you are running Cisco IOS Release 12.3(8)T or if you need to configure OER communication to use a dynamic port number.

Interfaces must be defined and reachable by the master controller and the border router before an OER-managed network can be configured.

Note Token Ring interfaces are not supported by OER and cannot be configured as OER-managed interfaces. It may be possible to load a Token Ring interface configuration under certain conditions. However, the Token Ring interface will not become active, and the border router will not function if the Token Ring interface is the only external interface on the border router.

Tip We recommend that the master controller be physically close to the border routers to minimize communication response time in OER-managed networks. If traffic is to be routed between border routers, the border routers also should be physically close each other to minimize the number of hops.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **key chain** *name-of-chain*
4. **key** *key-id*
5. **key-string** *text*
6. **exit**
7. **exit**
8. Repeat Step 3 through Step 7 with appropriate changes to configure key chain authentication for each border router.
9. **oer master**
10. **port** *port-number*
11. **logging**
12. **border** *ip-address* [**key-chain** *key-chain-name*]
13. **interface** *type number* **external**
14. **exit**
15. **interface** *type number* **internal**
16. **exit**
17. Repeat Step 12 through Step 16 with appropriate changes to establish communication with each border router.
18. **keepalive** *timer*
19. **end**
20. **show running-config**

DETAILED STEPS

	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.

	Command or Action	Purpose
Step 3	**key chain** *name-of-chain* **Example:** `Router(config)# key chain border1_OER`	Enables key-chain authentication and enters key-chain configuration mode. • Key-chain authentication protects the communication session between the master controller and the border router. The key ID and key string must match in order for communication to be established. • In this example, a key chain is created for use with border router 1.
Step 4	**key** *key-id* **Example:** `Router(config-keychain)# key 1`	Identifies an authentication key on a key chain. • The key ID must match the key ID configured on the border router.
Step 5	**key-string** *text* **Example:** `Router(config-keychain-key)# key-string b1`	Specifies the authentication string for the key and enters key-chain key configuration mode. • The authentication string must match the authentication string configured on the border router. • Any encryption level can be configured. • In this example, a key string is created for use with border router 1.
Step 6	**exit** **Example:** `Router(config-keychain-key)# exit`	Exits key-chain key configuration mode and returns to key-chain configuration mode.
Step 7	**exit** **Example:** `Router(config-keychain)# exit`	Exits key-chain configuration mode and returns to global configuration mode.
Step 8	Repeat Step 3 through Step 7 with appropriate changes to configure key chain authentication for each border router.	--
Step 9	**oer master** **Example:** `Router(config)# oer master`	Enters OER master controller configuration mode to configure a router as a master controller. • A master controller and border router process can be enabled on the same router (for example, in a network that has a single router with two exit links to different service providers). **Note** Only the syntax used in this context is displayed. For more details, see the *Cisco IOS Optimized Edge Routing Command Reference*.

	Command or Action	Purpose
Step 10	**port** *port-number* **Example:** `Router(config-oer-mc)# port 65534`	(Optional) Configures a dynamic port for communication between the master controller and border router. • Communication cannot be established until the same port number has been configured on both the master controller and the border router. **Note** Manual port number configuration is required to establish OER communication only when running Cisco IOS Release 12.3(8)T.
Step 11	**logging** **Example:** `Router(config-oer-mc)# logging`	Enables syslog messages for a master controller or border router process. • The notice level of syslog messages is enabled by default.
Step 12	**border** *ip-address* [**key-chain** *key-chain-name*] **Example:** `Router(config-oer-mc)# border 10.1.1.2 key-chain border1_OER`	Enters OER-managed border router configuration mode to establish communication with a border router. • An IP address is configured to identify the border router. • At least one border router must be specified to create an OER-managed network. A maximum of ten border routers can be controlled by a single master controller. • The value for the *key-chain-name* argument must match the key-chain name configured in Step 3. **Note** The **key-chain** keyword and *key-chain-name* argument must be entered when a border router is initially configured. However, this keyword is optional when reconfiguring an existing border router.
Step 13	**interface** *type number* **external** **Example:** `Router(config-oer-mc-br)# interface Ethernet 1/0 external`	Configures a border router interface as an OER-managed external interface. • External interfaces are used to forward traffic and for active monitoring. • A minimum of two external border router interfaces are required in an OER-managed network. At least one external interface must be configured on each border router. A maximum of 20 external interfaces can be controlled by single master controller. **Tip** Configuring an interface as an OER-managed external interface on a router enters OER border exit interface configuration mode. In this mode, you can configure maximum link utilization or cost-based optimization for the interface. **Note** Entering the **interface** command without the **external** or **internal** keyword places the router in global configuration mode and not OER border exit configuration mode. The **no** form of this command should be applied carefully so that active interfaces are not removed from the router configuration.

	Command or Action	Purpose
Step 14	**exit** **Example:** `Router(config-oer-mc-br-if)# exit`	Exits OER-managed border exit interface configuration mode and returns to OER-managed border router configuration mode.
Step 15	**interface** *type number* **internal** **Example:** `Router(config-oer-mc-br)# interface Ethernet 0/0 internal`	Configures a border router interface as an OER controlled internal interface. • Internal interfaces are used for passive monitoring only. Internal interfaces do not forward traffic. • At least one internal interface must be configured on each border router. **Note** Support to configure a VLAN interface as an internal interface was introduced in Cisco IOS Release 12.3(14)T and 12.2(33)SRB.
Step 16	**exit** **Example:** `Router(config-oer-mc-br)# exit`	Exits OER-managed border router configuration mode and returns to OER master controller configuration mode.
Step 17	Repeat Step 12 through Step 16 with appropriate changes to establish communication with each border router.	--
Step 18	**keepalive** *timer* **Example:** `Router(config-oer-mc)# keepalive 10`	(Optional) Configures the length of time that an OER master controller will maintain connectivity with an OER border router after no keepalive packets have been received. • The example sets the keepalive timer to 10 seconds. The default keepalive timer is 60 seconds.
Step 19	**end** **Example:** `Router(config-oer-mc-learn)# end`	Exits OER Top Talker and Top Delay learning configuration mode and returns to privileged EXEC mode.
Step 20	**show running-config** **Example:** `Router# show running-config`	(Optional) Displays the running configuration to verify the configuration entered in this task.

Examples

The following partial output shows the section of the running configuration file that contains the OER master controller configuration from this task. A second border router was also identified.

```
Router# show running-config
!
key chain border1_OER
 key 1
  key-string b1
key chain border2_OER
 key 1
  key-string b2
oer master
 port 65534
 keepalive 10
 logging
 !
 border 10.1.1.2 key-chain border1_OER
  interface Ethernet0/0 internal
  interface Ethernet1/0 external
 !
 border 10.1.1.3 key-chain border2_OER
  interface Ethernet0/0 internal
  interface Ethernet1/0 external
.
.
.
```

Setting Up an OER Border Router

Perform this task to set up an OER border router. This task must be performed at each border router in your OER-managed network. For an example network configuration of a master router and two border routers, see the Setting Up an OER Border Router section. Communication is first established between the border router and the master controller with key-chain authentication being configured to protect the communication session between the border router and the master controller. A local interface is configured as the source for communication with the master controller, and external interfaces are configured as OER-managed exit links.

- Interface Configuration in an OER-Managed Network, page 21
- Disabling a Border Router Process, page 22
- What to Do Next, page 25

Interface Configuration in an OER-Managed Network

- Each border router must have at least one external interface that is either used to connect to an ISP or is used as an external WAN link. A minimum of two external interfaces are required in an OER-managed network.
- Each border router must have at least one internal interface. Internal interfaces are used for only passive performance monitoring with NetFlow. Internal interfaces are not used to forward traffic.
- Each border router must have at least one local interface. Local interfaces are used only for master controller and border router communication. A single interface must be configured as a local interface on each border router.

Tip If a master controller and border router process is enabled on the same router, a loopback interface should be configured as the local interface.

Disabling a Border Router Process

To disable a border router and completely remove the process configuration from the running configuration, use the **no oer border** command in global configuration mode.

To temporarily disable a border router process, use the **shutdown** command in OER border router configuration mode. Entering the **shutdown** command stops an active border router process but does not remove any configuration parameters. The **shutdown** command is displayed in the running configuration file when enabled.

Perform the task Setting Up the OER Master Controller to set up the master controller and define the interfaces and establish communication with the border routers.

Tip We recommend that the border routers be physically close to one another to minimize the number of hops. The master controller also should be physically close to the border routers to minimize communication response time in OER-managed networks.

Note

- Internet exchange points where a border router can communicate with several service providers over the same broadcast media are not supported.
- When two or more border routers are deployed in an OER-managed network, the next hop to an external network on each border router, as installed in the RIB, cannot be an IP address from the same subnet.
- In Cisco IOS Release 12.2(33)SXH support for using a Cisco Catalyst 6500 series switch as an OER border router was introduced. Only border router functionality is included in the Cisco IOS Release 12.2(33)SXH images; no master controller configuration is available. The master controller that communicates with the Cisco Catalyst 6500 series switch being used as a border router must be a router running Cisco IOS Release 12.4(6)T or a later release.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **key chain** *name-of-chain*
4. **key** *key-id*
5. **key-string** *text*
6. **exit**
7. **exit**
8. **oer border**
9. **port** *port-number*
10. **local** *type number*
11. **master** *ip-address* **key-chain** *key-chain-name*
12. **end**

DETAILED STEPS

	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	**key chain** *name-of-chain* **Example:** `Router(config)# key chain border1_OER`	Enables key-chain authentication and enters key-chain configuration mode. • Key-chain authentication protects the communication session between both the master controller and the border router. The key ID and key string must match in order for communication to be established.
Step 4	**key** *key-id* **Example:** `Router(config-keychain)# key 1`	Identifies an authentication key on a key chain and enters key-chain key configuration mode. • The key ID must match the key ID configured on the master controller.

	Command or Action	Purpose
Step 5	**key-string** *text* **Example:** `Router(config-keychain-key)# key-string b1`	Specifies the authentication string for the key. • The authentication string must match the authentication string configured on the master controller. • Any level of encryption can be configured.
Step 6	**exit** **Example:** `Router(config-keychain-key)# exit`	Exits key-chain key configuration mode and returns to key-chain configuration mode.
Step 7	**exit** **Example:** `Router(config-keychain)# exit`	Exits key-chain configuration mode and returns to global configuration mode.
Step 8	**oer border** **Example:** `Router(config)# oer border`	Enters OER border router configuration mode to configure a router as a border router. • The border router must be in the forwarding path and contain at least one external and internal interface. **Note** Only the syntax used in this context is displayed. For more details, see the *Cisco IOS Optimized Edge Routing Command Reference*.
Step 9	**port** *port-number* **Example:** `Router(config-oer-br)# port 65534`	(Optional) Configures a dynamic port for communication between an OER master controller and border router. • Communication cannot be established until the same port number has been configured on both the border router and the master controller. **Note** Manual port number configuration is required to establish OER communication only when running Cisco IOS Release 12.3(8)T.
Step 10	**local** *type number* **Example:** `Router(config-oer-br)# local Ethernet 0/0`	Identifies a local interface on an OER border router as the source for communication with an OER master controller. • A local interface must be defined. **Tip** A loopback should be configured when a single router is configured to run both a master controller and border router process.

	Command or Action	Purpose
Step 11	**master** *ip-address* **key-chain** *key-chain-name* **Example:** `Router(config-oer-br)# master 10.1.1.1 key-chain border1_OER`	Enters OER-managed border router configuration mode to establish communication with a master controller. • An IP address is used to identify the master controller. • The value for the key-chain-name argument must match the key-chain name configured in Step 3.
Step 12	**end** **Example:** `Router(config-oer-br)# end`	Exits OER Top Talker and Top Delay learning configuration mode and returns to privileged EXEC mode.

What to Do Next

If your network is configured to use only static routing, no additional configuration is required. The OER-managed network should be operational, as long as valid static routes that point to external interfaces on the border routers are configured. You can proceed to the Where to Go Next section at the end of this document for information about further OER customization.

Otherwise, routing protocol peering or static redistribution must be configured between the border routers and other routers in the OER-managed network.

The master controller implements policy changes by altering IP routing behavior in the OER-managed network. If iBGP peering is enabled on the border routers, the master controller will inject iBGP routes into routing tables on the border routers. To configure iBGP peering on the border routers managed by OER, proceed to the Configuring iBGP Peering on the Border Routers Managed by OER task.

If BGP is configured on the border routers and another IGP is deployed in the internal network, proceed to the Redistributing BGP Routes into an IGP in an OER-Managed Network task for more information about configuring redistribution from BGP into the IGP.

If BGP is not configured in the internal network, then static routes to the border exits must be configured and the static routes must be redistributed into the IGP. For more information, see the Redistributing Static Routes into an IGP in an OER-Managed Network task.

If you need to configure static redistribution into EIGRP, see the Redistributing Static Routes into EIGRP in an OER-Managed Network task for more information.

Configuring OER to Control Traffic with Static Routing in Networks Using NAT

Perform this task to allow OER to control traffic with static routing in a network using NAT. This task allows OER to optimize traffic classes while permitting your internal users access to the internet.

When Cisco IOS OER and NAT functionality are configured on the same router and OER controls the routing for a traffic class using static routing, some applications may fail to operate due to dropped packets. This dropping of packets behavior is seen when static routing is used to connect to multiple ISPs from the

same router, OER uses static routing to control the traffic class routing, and one or more of the ISPs use Unicast Reverse Path Forwarding (Unicast RPF) filtering for security reasons.

In this task, the **oer** keyword is used with the **ip nat inside source** command. When the **oer** keyword is configured, new NAT translations are given the source IP address of the interface that OER has selected for the packet and OER forces existing flows to be routed through the interface where the NAT translation was created. This task uses a single IP address but an IP address pool can also be configured. For a configuration example using an IP address pool, see Configuring OER to Control Traffic with Static Routing in Networks Using NAT Example.

Note The OER static routing NAT solution is a single box solution and configurations with interfaces on multiple routers using NAT and managed by OER are not supported.

For more details about configuring NAT, see the Configuring NAT for IP Address Conservation chapter of the *Cisco IOS IP Addressing Services Configuration Guide* .

- NAT, page 26
- Inside Global Addresses Overloading, page 26
- What to Do Next, page 29

NAT

NAT enables private IP internetworks that use nonregistered IP addresses to connect to the Internet. NAT operates on a router, usually connecting two networks together, and translates the private (not globally unique) address in the internal network into legal addresses before packets are forwarded onto another network. NAT can be configured to advertise only one address for the entire network to the outside world. This ability provides additional security, effectively hiding the entire internal network behind that one address.

NAT is also used at the Enterprise edge to allow internal users access to the Internet and to allow Internet access to internal devices such as mail servers.

Inside Global Addresses Overloading

You can conserve addresses in the inside global address pool by allowing the router to use one global address for many local addresses. When this overloading is configured, the router maintains enough information from higher-level protocols (for example, TCP or UDP port numbers) to translate the global address back to the correct local address. When multiple local addresses map to one global address, the TCP or UDP port numbers of each inside host distinguish between the local addresses.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **access-list** *access-list-number* {**permit** | **deny**} *ip-address*mask
4. **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
5. **match ip address** {**access-list** *access-list-name*| **prefix-list** *prefix-list-name*}
6. **match interface** *interface-type interface-number* [*...interface-type interface-number*]
7. **exit**
8. Repeat Step 4 through Step 7 for more route map configurations, as required.
9. **ip nat inside source** {**list** {*access-list-number*| *access-list-name*} | **route-map** *map-name*} {**interface** *type number*| **pool** *name*} [**mapping-id** *map-id* | **overload**| **reversible**| **vrf** *vrf-name*][**oer**]
10. **interface** *type number*
11. **ip address** *ip-address mask*
12. **ip nat inside**
13. **exit**
14. **interface** *type number*
15. **ip address** *ip-address mask*
16. **ip nat outside**

DETAILED STEPS

	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	**access-list** *access-list-number* {**permit**	**deny**} *ip-address*mask **Example:** `Router(config)# access-list 1 permit 10.1.0.0 0.0.255.255`	Defines a standard access list permitting the IP addresses that are to be translated. • The access list must permit only those addresses that are to be translated. (Remember that there is an implicit “deny all” at the end of each access list.) An access list that is too permissive can lead to unpredictable results.

	Command or Action	Purpose
Step 4	**route-map** *map-tag* [**permit** | **deny**] [*sequence-number*] **Example:** `Router(config)# route-map isp-1 permit 10`	Enters route-map configuration mode to configure a route map. • The example creates a route map named BGP.
Step 5	**match ip address** {**access-list** *access-list-name*| **prefix-list** *prefix-list-name*} **Example:** `Router(config-route-map)# match ip address access-list 1`	Creates an access list or prefix list match clause entry in a route map to identify traffic to be translated by NAT. • The example references the access list created in Step 3 that specifies the 10.1.0.0 0.0.255.255. prefix as match criteria.
Step 6	**match interface** *interface-type interface-number* [*...interface-type interface-number*] **Example:** `Router(config-route-map)# match interface serial 1/0`	Creates a match clause in a route map to distribute any routes that match out one of the interfaces specified. • The example creates a match clause to distribute routes that pass the match clause in Step 5 through serial interface 1/0.
Step 7	**exit** **Example:** `Router(config-route-map)# exit`	Exits route-map configuration mode and returns to global configuration mode.
Step 8	Repeat Step 4 through Step 7 for more route map configurations, as required.	--
Step 9	**ip nat inside source** {**list** {*access-list-number*| *access-list-name*} | **route-map** *map-name*} {**interface** *type number*| **pool** *name*} [**mapping-id** *map-id* | **overload**| **reversible**| **vrf** *vrf-name*][**oer**] **Example:** `Router(config)# ip nat inside source interface FastEthernet1/0 overload oer`	Establishes dynamic source translation with overloading, specifying the interface. • Use the **interface** keyword and type and number arguments to specify an interface. • Use the **oer** keyword to allow OER to operate with NAT and control traffic class routing using static routing.
Step 10	**interface** *type number* **Example:** `Router(config)# interface FastEthernet1/0`	Specifies an interface and enters interface configuration mode.

	Command or Action	Purpose
Step 11	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.114.11.8 255.255.255.0`	Sets a primary IP address for the interface.
Step 12	**ip nat inside** **Example:** `Router(config-if)# ip nat inside`	Marks the interface as connected to the inside.
Step 13	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and returns to configuration mode.
Step 14	**interface** *type number* **Example:** `Router(config)# interface ethernet 0`	Specifies a different interface and returns to interface configuration mode.
Step 15	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 172.17.233.208 255.255.255.0`	Sets a primary IP address for the interface.
Step 16	**ip nat outside** **Example:** `Router(config-if)# ip nat outside`	Marks the interface as connected to the outside.

What to Do Next

Routing protocol peering or static redistribution must be configured between the border routers and other routers in the OER-managed network.

The master controller implements policy changes by altering IP routing behavior in the OER-managed network. If iBGP peering is enabled on the border routers, the master controller will inject iBGP routes into routing tables on the border routers. To configure iBGP peering on the border routers managed by OER, proceed to the Configuring iBGP Peering on the Border Routers Managed by OER task.

If BGP is configured on the border routers and another IGP is deployed in the internal network, proceed to the Redistributing BGP Routes into an IGP in an OER-Managed Network task for more information about configuring redistribution from BGP into the IGP.

If BGP is not configured in the internal network, then static routes to the border exits must be configured and the static routes must be redistributed into the IGP. For more information, see the Redistributing Static Routes into an IGP in an OER-Managed Network task.

If you need to configure static redistribution into EIGRP, see the Redistributing Static Routes into EIGRP in an OER-Managed Network task for more information.

Configuring iBGP Peering on the Border Routers Managed by OER

Perform this task at each border router to configure iBGP peering on the border routers managed by OER. The master controller implements policy changes by altering IP routing behavior in the OER-managed network. If iBGP peering is enabled on the border routers, the master controller will inject iBGP routes into routing tables on the border routers. The border routers advertise the preferred route through standard iBGP peering.

The local preference attribute is used to set the preference for injected BGP prefixes. If a local preference value of 5000 or higher has been configured for default BGP routing, you should configure a higher value in OER. Default local preference and static tag values are configurable with the **mode** command in OER master controller configuration mode.

All OER injected routes remain local to an autonomous system. The no-export community is automatically applied to injected routes to ensure that they are not advertised to external networks. Before injecting a route, the master controller verifies that a parent route with a valid next hop exists. This behavior is designed to prevent traffic from being lost.

Routing protocol peering must be established in your network and consistently applied to the border routers; the border routers should have a consistent view of the network.

Note In Cisco IOS Release 12.4(6)T and prior releases, the IP address for each eBGP peering session must be reachable from the border router via a connected route. Peering sessions established through loopback interfaces or with the **neighbor ebgp-multihop** command are not supported. In Cisco IOS Release 12.4(9)T and 12.2(33)SRB, the **neighbor ebgp-multihop** command is supported.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *autonomous-system-number*
4. **address-family ipv4** [**mdt** | **multicast** | **tunnel** | **unicast** [**vrf** *vrf-name*] | **vpnv4** [**unicast**]
5. **neighbor** {*ip-address* | *peer-group-name*} **remote-as** *autonomous-system-number*
6. **neighbor** {*ip-address* | *peer-group-name*} **activate**
7. **end**

DETAILED STEPS

	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	**router bgp** *autonomous-system-number* **Example:** `Router(config)# router bgp 65534`	Enters router configuration mode to create or configure a BGP routing process.
Step 4	**address-family ipv4** [**mdt** | **multicast** | **tunnel** | **unicast** [**vrf** *vrf-name*] | **vpnv4** [**unicast**] **Example:** `Router(config-router)# address-family ipv4 unicast`	Enters address-family configuration mode to configure a BGP address family session. • The example creates an IPv4 unicast address family session.
Step 5	**neighbor** {*ip-address* | *peer-group-name*} **remote-as** *autonomous-system-number* **Example:** `Router(config-router)# neighbor 10.100.1.3 remote-as 65534`	Establishes BGP peering with the specified neighbor or border router.
Step 6	**neighbor** {*ip-address* | *peer-group-name*} **activate** **Example:** `Router(config-router)# neighbor 10.100.1.3 activate`	Enables the exchange of routing information under an address family.
Step 7	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

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What to Do Next

If BGP is configured on the border routers and another IGP is deployed in the internal network, proceed to the Redistributing BGP Routes into an IGP in an OER-Managed Network task for more information about configuring redistribution from BGP into the IGP.

If BGP is not configured in the internal network, then static routes to the border exits must be configured and the static routes must be redistributed into the IGP. For more information, see the Redistributing Static Routes into an IGP in an OER-Managed Network task.

If you need to configure static redistribution into EIGRP, see the Redistributing Static Routes into EIGRP in an OER-Managed Network task for more information.

Redistributing BGP Routes into an IGP in an OER-Managed Network

This task explains how to redistribute BGP routes into an IGP in an OER-managed network. Some of the examples in the Detailed Steps section of this task show redistribution into OSPF, but EIGRP, IS-IS, or RIP could also be used in this configuration.

When redistributing BGP routes into any IGP, be sure to use the **ip prefix-list** and **route-map** command statements to limit the number of prefixes. Redistributing full BGP routing tables into an IGP can have a detrimental effect on IGP network operation.

IGP peering, static routing, and static route redistribution must be applied consistently throughout the OER-managed network; the border routers should have a consistent view of the network.

Note When two or more border routers are deployed in an OER-managed network, the next hop to an external network on each border router, as installed in the RIB, cannot be an IP address from the same subnet.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip prefix-list** *list-name* [**seq** *seq-value*] {**deny** *network* / *length* | **permit** *network* / *length*} [**ge** *ge-value*] [**le** *le-value*]
4. **ip prefix-list** *list-name* [**seq** *seq-value*] {**deny** *network* / *length* | **permit** *network* / *length*} [**ge** *ge-value*] [**le** *le-value*]
5. **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
6. **match ip address prefix-list** *prefix-list-name*
7. **exit**
8. **router bgp** *autonomous-system-number*
9. **bgp redistribute-internal**
10. **exit**
11. **router** {**eigrp** *autonomous-system-number* | **is-is** [*area-tag*] | **ospf** *process-id* | **rip**}
12. **redistribute static** [**metric** *metric-value*] [**route-map** *map-tag*] [**subnets**]
13. **end**

DETAILED STEPS

	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 prefix-list** *list-name* [**seq** *seq-value*] {**deny** *network* / *length* | **permit** *network* / *length*} [**ge** *ge-value*] [**le** *le-value*] **Example:** `Router(config)# ip prefix-list PREFIXES seq 5 permit 10.200.2.0/24`	Defines the prefix range to redistribute into the IGP. • Any prefix length can be specified. • The first longest match is processed in the IP prefix list. • This example creates a prefix list named PREFIXES and the entry permits the 10.200.2.0/24 subnet.
Step 4	**ip prefix-list** *list-name* [**seq** *seq-value*] {**deny** *network* / *length* | **permit** *network* / *length*} [**ge** *ge-value*] [**le** *le-value*] **Example:** `Router(config)# ip prefix-list PREFIXES seq 10 deny 0.0.0.0/0`	Defines additional prefix list entries. • Any prefix length can be specified. • The first longest match is processed in the IP prefix list. • This example prefix list entry denies all other prefixes.
Step 5	**route-map** *map-tag* [**permit** | **deny**] [*sequence-number*] **Example:** `Router(config)# route-map BGP permit 10`	Enters route-map configuration mode to configure a route map. • The example creates a route map named BGP.
Step 6	**match ip address prefix-list** *prefix-list-name* **Example:** `Router(config-route-map)# match ip address prefix-list PREFIXES`	Creates a prefix list match clause entry in a route map to redistribute BGP prefixes. • The example references the prefix list named PREFIXES as match criteria.

	Command or Action	Purpose
Step 7	**exit** **Example:** `Router(config-route-map)# exit`	Exits route-map configuration mode and returns to global configuration mode.
Step 8	**router bgp** *autonomous-system-number* **Example:** `Router(config)# router bgp 65534`	Enters router configuration mode to configure a BGP routing process.
Step 9	**bgp redistribute-internal** **Example:** `Router(config-router)# bgp redistribute-internal`	Enables BGP redistribution into an IGP.
Step 10	**exit** **Example:** `Router(config-router)# exit`	Exits router configuration mode and returns to global configuration mode.
Step 11	**router** {**eigrp** *autonomous-system-number* | **is-is** [*area-tag*] | **ospf** *process-id* | **rip**} **Example:** `Router(config)# router ospf 1`	Enters router configuration mode and creates a routing process. • The example creates an OSPF routing process.
Step 12	**redistribute static** [**metric** *metric-value*] [**route-map** *map-tag*] [**subnets**] **Example:** `Router(config-router)# redistribute static route-map BGP subnets`	Redistributes static routes into the specified protocol. • The example configures the IGP to accept the redistributed BGP routes that pass through the route map. • In OSPF, the **subnets** keyword must be entered if you redistribute anything less than a major network **Note** Only the syntax used in this context is displayed. For more details, see the *Cisco IOS IP Routing Protocols Command Reference*.

	Command or Action	Purpose
Step 13	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

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What to Do Next

The master controller implements policy changes by altering default routing behavior in the OER-managed network. If iBGP peering is enabled on the border routers, the master controller will inject iBGP routes into routing tables on the border routers.

If BGP is not configured in the internal network, then static routes to the border exits must be configured and the static routes must be redistributed into the IGP. For more information, see the Redistributing Static Routes into an IGP in an OER-Managed Network task.

If you need to configure static redistribution into EIGRP, see the Redistributing Static Routes into EIGRP in an OER-Managed Network task for more information.

Redistributing Static Routes into an IGP in an OER-Managed Network

This task shows how to redistribute static routes into an IGP in an OER-managed network. This task should be performed on the border routers.

OER applies a default tag value of 5000 to injected temporary static routes. The static route is filtered through a route map and then redistributed into the IGP. If you use the tag value of 5000 for another routing function, you should use a different tag value for that function, or you can change the default static tag values by configuring the **mode** command in OER master controller configuration mode.

Before injecting a route, the master controller verifies that a parent route with a valid next hop exists. This behavior is designed to prevent traffic from being lost.

If static routing is configured in your network and no IGP is deployed, OER will inject temporary static routes as necessary. No redistribution or other specific network configuration is required.

The following IGPs are supported; EIGRP, OSPF, Intermediate System-to-Intermediate System (IS-IS), and RIP.

Caution Caution must be applied when redistributing OER static routes into an IGP. The routes injected by OER may be more specific than routes in the IGP, and it will appear as if the OER border router is originating these routes. To avoid routing loops, the redistributed OER static routes should never be advertised over a WAN by an OER border router or any other router. Route filtering and stub network configuration can be used to prevent advertising the OER static routes. If the OER static routes are redistributed to routers terminating the OER external interfaces, routing loops may occur.

Note OER supports static route redistribution into EIGRP; however, it is configured differently. Proceed to the Redistributing Static Routes into EIGRP in an OER-Managed Network task for more information.

IGP peering, static routing, and static route redistribution must be applied consistently throughout the OER-managed network; the border routers should have a consistent view of the network.

Note When two or more border routers are deployed in an OER-managed network, the next hop to an external network on each border router, as installed in the RIB, cannot be an IP address from the same subnet as the next hop on the other border router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*] [*name*] [**permanent**] [**tag** *tag*]
4. **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
5. **match tag** *tag-value* [*...tag-value*]
6. **set metric** *metric-value*
7. **exit**
8. **router** {**is-is** *area-tag* | **ospf** *process-id* | **rip**}
9. **redistribute static** [**metric** *metric-value*] [**route-map** *map-tag*]
10. **end**

DETAILED STEPS

	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.

	Command or Action	Purpose
Step 3	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*] [*name*] [**permanent**] [**tag** *tag*] **Example:** `Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 0`	Configures a static route. • A static route must be configured for each external interface. The static route is configured only on the border routers. The static route must include any prefixes that need to be optimized.
Step 4	**route-map** *map-tag* [**permit** | **deny**] [*sequence-number*] **Example:** `Router(config)# route-map STATIC permit 10`	Enters route-map configuration mode and creates a route map. • The example creates a route map named STATIC.
Step 5	**match tag** *tag-value* [*...tag-value*] **Example:** `Router(config-route-map)# match tag 5000`	Redistribute routes in the routing table that match the specified tag value. • 5000 must be configured for this tag value unless you have configured a different value with the **mode** command.
Step 6	**set metric** *metric-value* **Example:** `Router(config-route-map)# set metric -10`	Sets the metric value for prefixes that pass through the route map. • A metric value that is less than 1 must be configured in order for the OER injected static route to be preferred by default routing. • The example set the metric value for the OER injected routes to -10.
Step 7	**exit** **Example:** `Router(config-route-map)# exit`	Exits route-map configuration mode and returns to global configuration mode.
Step 8	**router** {**is-is** *area-tag* | **ospf** *process-id* | **rip**} **Example:** `Router(config)# router rip`	Enters router configuration mode and creates a routing process for the specified routing protocol.

	Command or Action	Purpose
Step 9	**redistribute static** [**metric** *metric-value*] [**route-map** *map-tag*] **Example:** `Router(config-router)# redistribute static route-map STATIC`	Redistributes static routes into the specified protocol. • The example configures the IGP to redistribute static routes injected from the REDISTRIBUTE_STATIC route map. **Note** In OSPF, the **subnets** keyword must be entered if you redistribute anything less than a major network.
Step 10	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

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What to Do Next

If you need to configure static redistribution into EIGRP, see the Redistributing Static Routes into EIGRP in an OER-Managed Network task for more information.

Redistributing Static Routes into EIGRP in an OER-Managed Network

This task explains how to redistribute static routes into EIGRP. For EIGRP configurations, a tag is applied to the static route and the tag is then filtered through a route map. Two route map sequences are configured in this task. A route map named BLUE is configured to permit both configured static routes and OER static routes, and BLUE is the route map used to redistribute both types of static routes into EIGRP. A route map named RED is configured to permit only the configured static routes and implicitly deny the OER static routes. A distribute list uses the RED route map to filter outbound advertisements on the Ethernet 0 and Ethernet 1 egress interfaces. By denying the OER static route outbound advertisements, routing loops can be avoided.

OER applies a default tag value of 5000 to injected temporary static routes. The static route is filtered through a route map and then redistributed into the IGP.

Before injecting the temporary static route, the master controller verifies that a parent static route with a valid next hop exists. This behavior is designed to prevent traffic from being lost.

Caution Caution must be applied when redistributing OER static routes into an IGP. The routes injected by OER may be more specific than routes in the IGP, and it will appear as if the OER border router is originating these routes. To avoid routing loops, the redistributed OER static routes should never be advertised over a WAN by an OER border router or any other router. Route filtering and stub network configuration can be used to prevent advertising the OER static routes. If the OER static routes are redistributed to routers terminating the OER external interfaces, routing loops may occur.

IGP peering, static routing, and static route redistribution must be applied consistently throughout the OER-managed network; the border routers should have a consistent view of the network.

Note When two or more border routers are deployed in an OER-managed network, the next hop, as installed in the RIB, to an external network on each border router cannot be an IP address from the same subnet.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*] [*name*] [**permanent**] [**tag** *tag*]
4. **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
5. **match tag** *tag-value* [*...tag-value*]
6. **match tag** *tag-value* [*...tag-value*]
7. **exit**
8. **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
9. **match tag** *tag-value* [*...tag-value*]
10. **exit**
11. **router eigrp** *autonomous-system-number*
12. **no auto-summary**
13. **network** *ip-address* [*wildcard-mask*]
14. **redistribute static** [**metric** *metric-value*] [**route-map** *map-tag*]
15. **distribute-list** {*acl-number* | *acl-name* | *prefix-list-name*} **out** [*interface-name* | *routing-process* | *autonomous-system-number*]
16. **end**

DETAILED STEPS

	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.

	Command or Action	Purpose
Step 3	**ip route** *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [*distance*] [*name*] [**permanent**] [**tag** *tag*] **Example:** `Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 0 tag 10`	Configures a static route. • A static route must be configured for each external interface. The static route is configured only on the border routers. The static route must include any prefixes that need to be optimized. • Under EIGRP, a tag is applied to the static route. The tag is then filtered through a route map.
Step 4	**route-map** *map-tag* [**permit** | **deny**] [*sequence-number*] **Example:** `Router(config)# route-map BLUE permit 10`	Enters route-map configuration mode and creates a route map. • A route map named BLUE is configured.
Step 5	**match tag** *tag-value* [*...tag-value*] **Example:** `Router(config-route-map)# match tag 5000`	Redistributes additional routes in the routing table that match the specified tag value. • This example matches the default OER tag value applied to injected temporary static routes.
Step 6	**match tag** *tag-value* [*...tag-value*] **Example:** `Router(config-route-map)# match tag 10`	Redistributes routes in the routing table that match the specified tag value. • This example matches the configured static route tag.
Step 7	**exit** **Example:** `Router(config-route-map)# exit`	Exits route-map configuration mode and returns to global configuration mode.
Step 8	**route-map** *map-tag* [**permit** | **deny**] [*sequence-number*] **Example:** `Router(config)# route-map RED permit 10`	Enters route-map configuration mode and creates a route map. • A route map named RED is configured.
Step 9	**match tag** *tag-value* [*...tag-value*] **Example:** `Router(config-route-map)# match tag 10`	Redistributes routes in the routing table that match the specified tag value. • This example matches the configured static route tag.

	Command or Action	Purpose
Step 10	**exit** **Example:** `Router(config-route-map)# exit`	Exits route-map configuration mode and returns to global configuration mode. • By exiting route map configuration mode with no deny statements, an implicit deny is in effect for the OER static routes.
Step 11	**router eigrp** *autonomous-system-number* **Example:** `Router(config)# router eigrp 1`	Enters router configuration mode and creates an EIGRP routing process.
Step 12	**no auto-summary** **Example:** `Router(config-router)# no auto-summary`	Disables automatic summarization under the EIGRP routing process.
Step 13	**network** *ip-address* [*wildcard-mask*] **Example:** `Router(config-router)# network 192.168.0.0 0.0.255.255`	Specifies a network for an EIGRP routing process. • The network state must cover any interfaces and prefixes that have to be optimized for the internal network.
Step 14	**redistribute static** [**metric** *metric-value*] [**route-map** *map-tag*] **Example:** `Router(config-router)# redistribute static route-map BLUE`	Redistributes static routes into the specified protocol. • The example configures redistribution of static routes that are filtered through the route map named BLUE, into EIGRP. • Both configured static and OER static routes are redistributed.
Step 15	**distribute-list** {*acl-number* | *acl-name* | *prefix-list-name*} **out** [*interface-name* | *routing-process* | *autonomous-system-number*] **Example:** `Router(config-router)# distribute-list RED out Ethernet 0`	Applies a distribute list to filter outbound advertisements. • The distribute list must be applied to egress interfaces. • Using the route map named RED, the OER static routes are filtered out of outbound advertisements on Ethernet interface 0.

	Command or Action	Purpose
Step 16	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

Registering an Application Interface Provider and Configuring Host Devices

Perform this task at a master controller to register an application interface provider with the master controller and to configure host devices. In Cisco IOS Release 12.4(15)T the OER application interface was introduced. The OER application interface defines the mode of communication and messaging between applications and the network for the purpose of optimizing the traffic associated with the applications. A provider must be registered with an OER master controller before the application can interface with OER.

Multiple providers can be registered and multiple host devices can be configured under each provider, but a host device cannot be configured under multiple providers. The OER application interface has a maximum number of five concurrent sessions. After the provider is registered using this task, an application running on a host device can initiate a session with the master controller.

To view information about providers and any default policies created by applications using the OER application interface, see the Displaying Information about Application Interface Provider Activity. For more details about the OER application interface, see OER Application Interface.

The master controller and border routers must be running Cisco IOS Release 12.4(15)T, or later release.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **oer master**
4. **api provider** *provider-id* [**priority** *value*]
5. **host-address** *ip-address* [**key-chain** *key-chain-name*] [**priority** *value*]
6. Repeat Step 5 to configure additional host devices as required.
7. **end**

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**oer master** **Example:** `Router(config)# oer master`	Enters OER master controller configuration mode to configure a router as a master controller. • A master controller and border router process can be enabled on the same router (for example, in a network that has a single router with two exit links to different service providers). **Note** Only the syntax used in this context is displayed. For more details, see the *Cisco IOS Optimized Edge Routing Command Reference*.
Step 4	**api provider** *provider-id* [**priority** *value*] **Example:** `Router(config-oer-mc)# api provider 1 priority 3000`	Registers a provider with an OER master controller and enters OER master controller application interface provider configuration mode. • Use the **priority** keyword to assign a priority for this provider when there are multiple providers. The lower the number, the higher the priority. The default priority is 65535, the lowest priority. • In this example, the provider is assigned an ID of 1 and a priority of 3000.
Step 5	**host-address** *ip-address* [**key-chain** *key-chain-name*] [**priority** *value*] **Example:** `Router(config-oer-mc-api-provider)# host-address 10.1.2.2 key-chain OER_HOST1`	Configures information about a host device used by a provider to communicate with an OER master controller. • Use the **priority** keyword to assign a priority for this host device when there are multiple host devices. The lower the number, the higher the priority. The default priority is 65535, the lowest priority. • In this example, the host IP address of 10.1.2.2 is configured, the key chain password is set to OER_HOST1, and the priority is not configured and will be set to the default value of 65535.
Step 6	Repeat Step 5 to configure additional host devices as required.	--
Step 7	**end** **Example:** `Router(config-router)# end`	Exits OER master controller application interface provider configuration mode and returns to privileged EXEC mode.

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Troubleshooting Tips

Use the **debug oer api** command on the master controller to troubleshoot issues with registering a provider or configuring a host device. Use the **detailed** keyword with caution in a production network.

Displaying Information about Application Interface Provider Activity

Perform this task on a master controller to display information about providers and any default policies created by applications using the OER application interface. In Cisco IOS Release 12.4(15)T the OER application interface was introduced. The OER application interface defines the mode of communication and messaging between applications and the network for the purpose of optimizing the traffic associated with the applications. This task can be used after a provider is registered with an OER master controller using the Registering an Application Interface Provider and Configuring Host Devices task and an application on a host device initiates a session. The **show** commands can be entered in any order.

- The master controller and border routers must be running Cisco IOS Release 12.4(15)T, or later release.
- Perform the Registering an Application Interface Provider and Configuring Host Devices task and run an application from a host device using the OER application interface.

SUMMARY STEPS

1. **enable**
2. **show oer api provider** [**detail**]
3. **show oer master policy** [*sequence-number* | policy-name | **default** | **dynamic**]
4. **show oer master prefix** [**detail**| **inside**[**detail**] | **learned** [**delay**| **inside**| **throughput**] | *prefix* [**detail** | **policy**| **report**| **traceroute** [*exit-id* | *border-address* | **current**] [**now**]]]

DETAILED STEPS

Step 1 **enable**

Enables privileged EXEC mode. Enter your password if prompted.

Example:

```
Router> enable
```

Step 2 **show oer api provider** [**detail**]

This command is used to display provider and host information including the ID of each configured provider, the priority of the provider and the host (if configured), and the IP addresses of each configured host device.

Example:

```
Router# show oer api provider detail
API Version: Major 2, Minor 0
  Provider id 1001, priority 65535
   Host ip 10.3.3.3, priority 65535
    Session id 9, Version Major 2, Minor 0
    Num pfx created 2, Num policies created 2
    Last active connection time (sec) 00:00:01
    Policy ids : 101, 102,
   Host ip 10.3.3.4, priority 65535
    Session id 10, Version Major 2, Minor 0
    Num pfx created 1, Num policies created 1
    Last active connection time (sec) 00:00:03
    Policy ids : 103,
  Provider id 2001, priority 65535
   Host ip 172.19.198.57, priority 65535
    Session id 11, Version Major 2, Minor 0
```

```
    Num pfx created 0, Num policies created 0
    All Prefix report enabled
    All exit report enabled
```

Step 3 **show oer master policy** [*sequence-number* | policy-name | **default** | **dynamic**]

This command is used to display policy information. The following example uses the **dynamic** keyword to display the policies dynamically created by provider applications. Note that the first two dynamic policies were generated by the same host device at 10.3.3.3 and in the same session ID of 9, but the third section is for a different host device at 10.3.3.4.

Example:

```
Router# show oer master policy dynamic
Dynamic Policies:

  proxy id 10.3.3.3
  sequence no. 18446744069421203465, provider id 1001, provider priority 65535
    host priority 65535, policy priority 101, Session id 9
  backoff 90 90 90
  delay relative 50
  holddown 90
  periodic 0
  probe frequency 56
  mode route control
  mode monitor both
  mode select-exit good
  loss relative 10
  jitter threshold 20
  mos threshold 3.60 percent 30
  unreachable relative 50
  next-hop not set
  forwarding interface not set
  resolve delay priority 11 variance 20
  resolve utilization priority 12 variance 20

proxy id 10.3.3.3
  sequence no. 18446744069421269001, provider id 1001, provider priority 65535
    host priority 65535, policy priority 102, Session id 9
  backoff 90 90 90
  delay relative 50
  holddown 90
  periodic 0
  probe frequency 56
  mode route control
  mode monitor both
  mode select-exit good
  loss relative 10
  jitter threshold 20
  mos threshold 3.60 percent 30
  unreachable relative 50
  next-hop not set
  forwarding interface not set
  resolve delay priority 11 variance 20
  resolve utilization priority 12 variance 20

  proxy id 10.3.3.4
  sequence no. 18446744069421334538, provider id 1001, provider priority 65535
    host priority 65535, policy priority 103, Session id 10
  backoff 90 90 90
  delay relative 50
  holddown 90
  periodic 0
  probe frequency 56
  mode route control
  mode monitor both
  mode select-exit good
  loss relative 10
  jitter threshold 20
```

```
  mos threshold 3.60 percent 30
  unreachable relative 50
  next-hop not set
  forwarding interface not set
  resolve delay priority 11 variance 20
  resolve utilization priority 12 variance 20
```

Step 4 **show oer master prefix** [**detail**| **inside**[**detail**] | **learned** [**delay**| **inside**| **throughput**] | *prefix* [**detail** | **policy**| **report**| **traceroute** [*exit-id* | *border-address* | **current**] [**now**]]]

This command is used to display the status of monitored prefixes. Using the **report** keyword, the following example shows prefix statistics including information about provider report requests for the 10.1.1.0 prefix:.

Example:

```
Router# show oer master prefix 10.1.1.0/24 report
Prefix Performance Report Request
   Created by: Provider 1001, Host 10.3.3.3, Session 9
   Last report sent 3 minutes ago, context 589855, frequency 4 min

Prefix Performance Report Request
   Created by: Provider 1001, Host 10.3.3.4, Session 10
   Last report sent 1 minutes ago, context 655372, frequency 3 min

OER Prefix Statistics:
 Pas - Passive, Act - Active, S - Short term, L - Long term, Dly - Delay (ms),
 P - Percentage below threshold, Jit - Jitter (ms),
 MOS - Mean Opinion Score
 Los - Packet Loss (packets-per-million), Un - Unreachable (flows-per-million),
 E - Egress, I - Ingress, Bw - Bandwidth (kbps), N - Not applicable
 U - unknown, * - uncontrolled, + - control more specific, @ - active probe all
 # - Prefix monitor mode is Special, & - Blackholed Prefix
 % - Force Next-Hop, ^ - Prefix is denied

Prefix                  State     Time Curr BR         CurrI/F         Protocol
                      PasSDly  PasLDly   PasSUn   PasLUn  PasSLos  PasLLos
                      ActSDly  ActLDly   ActSUn   ActLUn      EBw      IBw
                      ActSJit  ActPMOS  ActSLos  ActLLos
--------------------------------------------------------------------------------
10.1.1.0/24             INPOLICY        0 10.3.3.3        Et4/3           BGP
                              N        N        N        N        N        N
                            138      145        0        0        N        N
                              N        N
```

Configuration Examples for Setting Up OER Network Components

Configuring the OER Master Controller Example

The following configuration example, starting in global configuration mode, shows the minimum configuration required to configure a master controller process to manage the internal network. A key-chain configuration named OER is defined in global configuration mode.

```
Router(config)# key chain OER

Router(config-keychain)# key 1

Router(config-keychain-key)# key-string KEYSTRING2
Router(config-keychain-key)# end
```

The master controller is configured to communicate with the 10.100.1.1 and 10.200.2.2 border routers. The keepalive interval is set to 10 seconds. Route control mode is enabled. Internal and external OER-controlled border router interfaces are defined.

```
Router(config)# oer master

Router(config-oer-mc)# keepalive 10
Router(config-oer-mc)# logging

Router(config-oer-mc)# border 10.100.1.1 key-chain OER
Router(config-oer-mc-br)# interface Ethernet 0/0 external

Router(config-oer-mc-br)# interface Ethernet 0/1 internal
Router(config-oer-mc-br)# exit
Router(config-oer-mc)# border 10.200.2.2 key-chain OER
Router(config-oer-mc-br)# interface Ethernet 0/0 external

Router(config-oer-mc-br)# interface Ethernet 0/1 internal
Router(config-oer-mc)# exit
```

Configuring an OER Border Router Example

The following configuration example, starting in global configuration mode, shows the minimum required configuration to enable a border router. The key-chain configuration is defined in global configuration mode.

```
Router(config)# key chain OER
Router(config-keychain)# key 1
Router(config-keychain-key)# key-string KEYSTRING2
Router(config-keychain-key)# end
```

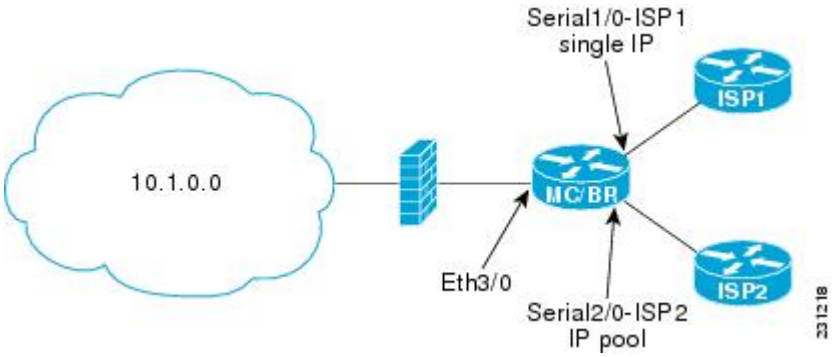
The key-chain OER is applied to protect communication. An interface is identified to the master controller as the local interface (source) for OER communication.

```
Router(config)# oer border

Router(config-oer-br)# local Ethernet 0/1
Router(config-oer-br)# master 192.168.1.1 key-chain OER
Router(config-oer-br)# end
```

Configuring OER to Control Traffic with Static Routing in Networks Using NAT Example

The following configuration example configures a master controller to allow OER to control traffic with static routing in a network using NAT. This example shows how to use a pool of IP addresses for the NAT translation.

Figure 9 OER and NAT Network Diagram



In the diagram above there is a combined master controller and border router that is connected to the Internet through two different ISPs. The configuration below allows OER to optimize traffic classes while permitting the internal users access to the internet. In this example the traffic classes to be translated using NAT are specified using an access list and a route map. The use of a pool of IP addresses for NAT translation is then configured and the **oer** keyword is added to the **ip nat inside source** command to configure OER to keep existing traffic classes flowing through the interface that is the source address that was translated by NAT. New NAT translations can be given the IP address of the interface that OER has selected for the packet.

Note The OER static routing NAT solution is a single box solution and configurations with interfaces on multiple routers using NAT and managed by OER are not supported.

```
Router(config)# access-list 1 permit 10.1.0.0 0.0.255.255
Router(config)# route-map isp-2 permit 10BGP permit 10
Router(config-route-map)# match ip address access-list 1
Router(config-route-map)# match interface serial 2/0
Router(config-route-map)# exit
Router(config)# ip nat pool ISP2 209.165.201.1 209.165.201.30 prefix-length 27
Router(config)# ip nat inside source route-map isp-2 pool ISP2 oer
Router(config)# interface FastEthernet 3/0
Router(config-if)# ip address 10.1.11.8 255.255.255.0
Router(config-if)# ip nat inside
Router(config-if)# exit

Router(config)# interface serial 1/0
Router(config-if)# ip address 192.168.3.1 255.255.255.0
Router(config-if)# ip nat outside
Router(config-if)# exit

Router(config)# interface serial 2/0
Router(config-if)# ip address 172.17.233.208 255.255.255.0
Router(config-if)# ip nat outside
Router(config-if)# end
```

For more details about configuring NAT, see the Configuring NAT for IP Address Conservation chapter of the *Cisco IOS IP Addressing Services Configuration Guide* .

Configuring iBGP Peering on the Border Routers Managed by OER Example

The following example, starting in global configuration mode, shows how to establish peering between two routers in autonomous system 65534 and to configure standard community exchange:

Border Router Configuration

```
Router(config)# router bgp 65534
Router(config-router)# neighbor 10.100.1.3 remote-as 65534

Router(config-router)# address-family ipv4
Router(config-router-af)# neighbor 10.100.1.3 activate
Router(config-router-af)# neighbor 10.100.1.3 send-community standard
```

Internal Border Peer Configuration

```
Router(config)# router bgp 65534
Router(config-router)# neighbor 10.100.1.2 remote-as 65534

Router(config-router)# address-family ipv4
Router(config-router-af)# neighbor 10.100.1.2 activate

Router(config-router-af)# neighbor 10.100.1.2 send-community standard
```

Redistributing BGP Routes into an IGP in an OER-Managed Network Example

The following example, starting in global configuration mode, shows how to configure BGP to OSPF redistribution from the border router. Although this example shows redistribution into OSPF, EIGRP, IS-IS, or RIP could also be used in this configuration.

Note When redistributing BGP routes into any IGP, be sure to use the **ip prefix-list** and **route-map** command statements to limit the number of prefixes. Redistributing full BGP routing tables into an IGP can have a detrimental effect on IGP network operation.

Border Router Configuration

```
Router(config)# ip prefix-list PREFIXES seq 5 permit 10.200.2.0/24

Router(config)# ip prefix-list PREFIXES seq 10 deny 0.0.0.0/0
Router(config)# !
Router(config)# route-map BGP permit 10
Router(config-route-map)# match ip address prefix-list PREFIXES
Router(config-route-map)# exit

Router(config)# router bgp 65534
Router(config-router)# bgp redistribute-internal
```

IGP Peer Configuration

```
Router(config)# router ospf 1

Router(config-router)# redistribute bgp 65534 route-map BGP subnets
```

Redistributing Static Routes into an IGP in an OER-Managed Network Example

The following example, starting in global configuration mode, shows how to configure static redistribution to allow the master controller to influence routing in an internal network that is running RIP. The **match tag** command is used to match OER-injected temporary static routes. The **set metric**command is used to set the preference of the injected static route.

Border Router Configuration

```
Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 0
Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 1
Router(config)# route-map STATIC permit 10
Router(config-route-map)# match tag 5000
Router(config-route-map)# set metric -10

Router(config-route-map)# exit

Router(config)# router rip
Router(config-router)# network 192.168.0.0

Router(config-router)# network 172.16.0.0
Router(config-router)# redistribute static route-map STATIC
```

Internal Border Peer Configuration

```
Router(config)# route rip
Router(config-router)# network 192.168.0.0
Router(config-router)# network 172.16.0.0
```

Redistributing Static Routes into EIGRP in an OER-Managed Network Example

The following example, starting in global configuration mode, shows how to configure static redistribution to allow the master controller to influence routing in an internal network that is running EIGRP. Two route map sequences are configured in this example. A route map named BLUE is configured to permit both configured static routes and OER static routes, and BLUE is the route map used to redistribute both types of static routes into EIGRP. A route map named RED is configured to permit only the configured static routes and implicitly deny the OER static routes. A distribute list uses the RED route map to filter outbound advertisements on the Ethernet 0 and Ethernet 1 egress interfaces. By denying the OER static route outbound advertisements, routing loops can be avoided.

Border Router Configuration

```
Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 0 tag 10

Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 1 tag 10
```

```
Router(config)# route-map BLUE permit 10
Router(config-route-map)# match tag 5000

Router(config-route-map)# match tag 10

Router(config-route-map)# exit
Router(config)# route-map RED permit 20

Router(config-route-map)# match tag 10
Router(config-route-map)# exit
Router(config)# route eigrp 1

Router(config-router)# no auto-summary

Router(config-router)#
redistribute static route-map BLUE

Router(config-router)# network 10.0.0.0
Router(config-router)# network 172.16.0.0

Router(config-router)# network 192.168.0.0

Router(config-router)# distribute-list route-map RED out Ethernet 0

Router(config-router)# distribute-list route-map RED out Ethernet 1
```

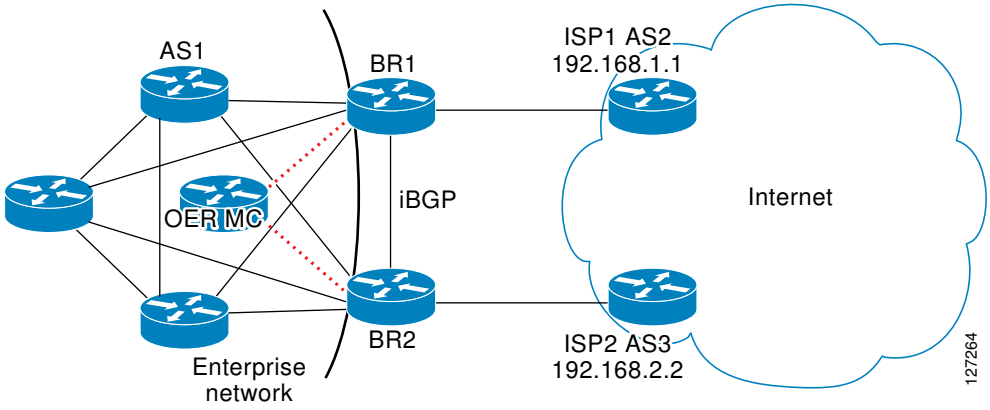
Internal Border Peer Configuration

```
Router(config)# route eigrp 1
Router(config-router)# no auto-summary
Router(config-router)# network 10.0.0.0
Router(config-router)# network 172.16.0.0
Router(config-router)# network 192.168.0.0
Router(config-router)# end
```

OER Master Controller and Two Border Routers Deployment Example

The figure below shows an OER-managed network with two border router processes and a master controller process deployed separately on Cisco routers.

Figure 10 Master Controller Deployed with Two Border Routers



The master controller performs no routing functions. BGP is deployed on the border routers and internal peers in the OER-managed network. Each border router has an eBGP peering session with a different ISP. The eBGP peers (ISP border routers) are reachable through connected routes. Injected prefixes are advertised in the internal network through standard iBGP peering.

OER MC Configuration

The following example, starting in global configuration mode, shows the master controller configuration.

```
Router(config)# key chain OER

Router(config-keychain)# key 1
Router(config-keychain-key)# key-string CISCO
Router(config-keychain-key)# exit

Router(config)# oer master
Router(config-oer-mc)# border 10.100.1.1 key-chain OER
Router(config-oer-mc-br)# interface Ethernet 0/0 external

Router(config-oer-mc-br-if)# exit

Router(config-oer-mc-br)# interface Serial 1/1 internal
Router(config-oer-mc-br-if)# end
Router(config-oer-mc)# border 10.200.2.2 key-chain OER
Router(config-oer-mc-br)# interface Ethernet 2/2 external

Router(config-oer-mc-br-if)# exit

Router(config-oer-mc-br)# interface Serial 3/3 internal

Router(config-oer-mc-br-if)# end
```

BR1 Configuration

The following example, starting in global configuration mode, shows the configuration for BR1. eBGP peering is established with ISP1 (192.168.1.1 AS2). Standard community exchange and iBGP peering are established with BR2 (10.200.2.2) and internal peers (in the 10.150.1.0/24 network).

```
Router(config)# key chain OER

Router(config-keychain)# key 1

Router(config-keychain-key)# key-string CISCO
Router(config-keychain-key)# exit

Router(config-keychain)# exit

Router(config)# oer border
Router(config-oer-br)# master 172.16.1.1 key-chain OER
Router(config-oer-br)# local Serial 1/1
Router(config-oer-br)# exit

Router(config)# router bgp 1

Router(config-router)# neighbor 192.168.1.1 remote-as 2
Router(config-router)# neighbor 10.200.2.2 remote-as 1

Router(config-router)# neighbor 10.150.1.1 remote-as 1

Router(config-router)# neighbor 10.150.1.2 remote-as 1
Router(config-router)# neighbor 10.150.1.3 remote-as 1

Router(config-router)# address-family ipv4 unicast

Router(config-router-af)# neighbor 192.168.1.1 activate
Router(config-router-af)# neighbor 10.200.2.2 activate

Router(config-router-af)# neighbor 10.200.2.2 send-community standard
Router(config-router-af)# neighbor 10.150.1.1 activate

Router(config-router-af)# neighbor 10.150.1.1 send-community standard

Router(config-router-af)# neighbor 10.150.1.2 activate

Router(config-router-af)# neighbor 10.150.1.2 send-community standard
```

```
Router(config-router-af)# neighbor 10.150.1.3 activate

Router(config-router-af)# neighbor 10.150.1.3 send-community standard

Router(config-router-af)# end
```

BR2 Configuration

The following example, starting in global configuration mode, shows the configuration for BR2. eBGP peering is established with ISP2 (192.168.2.2 AS1). Standard community exchange and iBGP peering is established with BR2 (10.100.1.1) and internal peers (in the 10.150.1.0/24 network).

```
Router(config)# key chain OER
Router(config-keychain)# key 1

Router(config-keychain-key)# key-string CISCO

Router(config-keychain-key)# end
Router(config)# oer border

Router(config-oer-br)# master 172.16.1.1 key-chain OER
Router(config-oer-br)# local Serial 1/1

Router(config-oer-br)# exit

Router(config)# router bgp 1
Router(config-router)# neighbor 192.168.2.2 remote-as 3

Router(config-router)# neighbor 10.100.1.1 remote-as 1
Router(config-router)# neighbor 10.150.1.1 remote-as 1

Router(config-router)# neighbor 10.150.1.2 remote-as 1

Router(config-router)# neighbor 10.150.1.3 remote-as 1

Router(config-router)# address-family ipv4 unicast

Router(config-router-af)# neighbor 192.168.2.2 activate

Router(config-router-af)# neighbor 10.200.2.2 activate
Router(config-router-af)# neighbor 10.200.2.2 send-community standard
Router(config-router-af)# neighbor 10.150.1.1 activate

Router(config-router-af)# neighbor 10.150.1.1 send-community standard

Router(config-router-af)# neighbor 10.150.1.2 activate

Router(config-router-af)# neighbor 10.150.1.2 send-community standard

Router(config-router-af)# neighbor 10.150.1.3 activate
Router(config-router-af)# neighbor 10.150.1.3 send-community standard
Router(config-router-af)# end
```

Internal Peer Configuration

The following example, starting in global configuration mode, shows the internal peer configuration. Standard full-mesh iBGP peering is established with BR1 and BR2 and the internal peers in autonomous system 1.

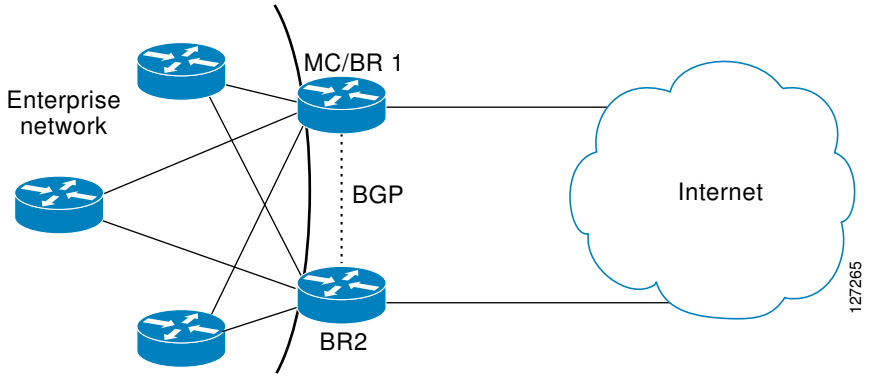
```
Router(config)# router bgp 1
Router(config-router)# neighbor 10.100.1.1 remote-as 1
Router(config-router)# neighbor 10.200.2.2 remote-as 1
Router(config-router)# neighbor 10.150.1.1 remote-as 1

Router(config-router)# neighbor 10.150.1.2 remote-as 1
Router(config-router)# neighbor 10.150.1.3 remote-as 1
Router(config-router)# address-family ipv4 unicast
```

```
Router(config-router-af)# neighbor 10.100.1.1 activate
Router(config-router-af)# neighbor 10.100.1.1 send-community standard
Router(config-router-af)# neighbor 10.200.2.2 activate

Router(config-router-af)# neighbor 10.200.2.2 send-community standard

Router(config-router-af)# neighbor 10.150.1.1 activate

Router(config-router-af)# neighbor 10.150.1.1 send-community standard
Router(config-router-af)# neighbor 10.150.1.2 activate
Router(config-router-af)# neighbor 10.150.1.2 send-community standard

Router(config-router-af)# neighbor 10.150.1.3 activate
Router(config-router-af)# neighbor 10.150.1.3 send-community standard
Router(config-router-af)# end
```

OER MC and BR Process Deployed on a Single Router with a Second Border Router Example

The diagram below shows an OER-managed network with two border routers. BR1 is configured to run a master controller and border router process.

Figure 11 OER Master Controller and Border Router Process Deployed on a Single Router with a Second Border Router



BR2 is configured as a border router. The internal network is running OSPF. Each border router peers with a different ISP. A static route to the egress interface is configured on each border router. The static routes are then redistributed into OSPF. Injected prefixes are advertised through static route redistribution.

BR1 Configuration: Master Controller and Border Router on a Single Router with Load Distribution Policy

The following example, starting in global configuration mode, shows the configuration of BR1. This router is configured to run both a master controller and a border router process. BR1 peers with ISP1. A traffic load distribution policy is configured under the master controller process that is applied to all exit links in the OER-managed network.

```
Router(config)# key chain OER
Router(config-keychain)# key 1
Router(config-keychain-key)# key-string CISCO

Router(config-keychain-key)# exit
Router(config-keychain)# exit
Router(config)# oer border

Router(config-oer-br)# master 10.100.1.1 key-chain OER
Router(config-oer-br)# local Loopback 0
```

```
Router(config-oer-br)# exit

Router(config)# oer master
Router(config-oer-mc)# logging
Router(config-oer-mc)# border 10.100.1.1 key-chain OER

Router(config-oer-mc-br)# interface Serial 0/0 external

Router(config-oer-mc-br-if)# exit
Router(config-oer-mc-br)# interface Ethernet 1/1 internal
Router(config-oer-mc-br-if)# exit

Router(config-oer-mc-br)# exit
Router(config-oer-mc)# border 10.200.2.2 key-chain OER

Router(config-oer-mc-br)# interface Serial 2/2 external
Router(config-oer-mc-br-if)# exit
Router(config-oer-mc-br)# interface Ethernet 3/3 internal

Router(config-oer-mc-br-if)# exit
Router(config-oer-mc-br)# exit

Router(config-oer-mc)# exit

Router(config)# ip route 0.0.0.0 0.0.0.0 Serial 0/0
Router(config)# !

Router(config)# route-map STATIC

Router(config-route-map)# match tag 5000

Router(config-route-map)# set metric -10
Router(config-route-map)# exit
Router(config)# router ospf 1

Router(config-router)# network 10.0.0.0 0.0.0.255 area 0
Router(config-router)# redistribute static route-map STATIC subnets

Router(config-router)# end
```

BR2 Configuration

The following example, starting in global configuration mode, shows the configuration of BR2. This router is configured to run only a border router process.

```
Router(config)# key chain OER

Router(config-keychain)# key 1
Router(config-keychain-key)# key-string CISCO
Router(config-keychain-key)# exit

Router(config-keychain)# exit
Router(config)# oer border

Router(config-oer-border)# master 10.100.1.1 key-chain OER

Router(config-oer-border)# local Ethernet3/3

Router(config-oer-border)# exit

Router(config)# ip route 0.0.0.0 0.0.0.0 Serial 2/2
Router(config)# !
Router(config)# route-map STATIC permit 10

Router(config-route-map)# match tag 5000
Router(config-route-map)# set metric -10

Router(config-route-map)# exit
Router(config)# router ospf 1
Router(config-router)# network 10.0.0.0 0.255.255.255 area 0
```

```
Router(config-router)# redistribute static route-map STATIC

Router(config-router)# end
```

Internal Peer Configuration

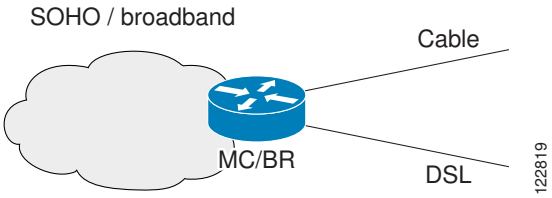
The following example, starting in global configuration mode, configures an OSPF routing process to establish peering with the border routers and internal peers. No redistribution is configured on the internal peers.

```
Router(config)# router ospf 1
Router(config-router)# network 10.0.0.0 0.255.255.255 area 0

Router(config-router)# redistribute static route-map STATIC subnets
Router(config-router)# end
```

OER Master Controller and Border Router Deployed on a Single Router Example

The figure below shows a SOHO network in which the master controller and border router process are set up on a single router.

Figure 12 OER Deployed on a Single Router in a SOHO Configuration



The router connects the SOHO network with two ISPs. OER is configured to learn prefixes based on highest outbound throughput and lowest delay. Prefixes with a response time longer than 80 milliseconds are out-of-policy and moved if the performance on the other link conforms to the policy.

Master Controller and Border Router Configuration on a Single Router

The following example, starting in global configuration mode, shows an OER master controller and border router process deployed on a single router:

```
Router(config)# key chain OER

Router(config-keychain)# key 1
Router(config-keychain-key)# key-string KEYSTRING2
Router(config-keychain-key)# exit
Router(config-keychain)# exit

Router(config)# oer border
Router(config)# logging
Router(config-oer-br)# master 10.100.1.1 key-chain OER
Router(config-oer-br)# local Loopback 0
Router(config-oer-br)# exit

Router(config)# oer master
Router(config-oer-mc)# logging
Router(config-oer-mc)# border 10.100.1.1 key-chain OER
Router(config-oer-mc-br)# interface Ethernet 0/0 external
```

```
Router(config-oer-mc-br-if)# exit

Router(config-oer-mc-br)# interface Ethernet 1/1 external

Router(config-oer-mc-br-if)# exit
Router(config-oer-mc-br)# interface Ethernet 2/2 internal

Router(config-oer-mc-br-if)# exit

Router(config-oer-mc-br)# exit

Router(config-oer-mc)# exit

Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 0/0

Router(config)# ip route 0.0.0.0 0.0.0.0 Ethernet 1/1

Router(config)# end
```

Registering an Application Interface Provider and Configuring Host Devices Example

The following configuration example shows how to register a provider on a master controller. In this example, more than one provider is configured, so the priority is set for each provider. For the single host device configured for provider 1, no priority is set and the default priority value of 65535 is assigned giving this host device a lower priority than both the host devices configured for provider 2. After the provider is registered and an application on a host device initiates a session, some **show** commands can be entered on the master controller to help you track provider activity.

```
Router(config)# oer master
Router(config-oer-mc)# api provider 1 priority 3000
Router(config-oer-mc-api-provider)# host-address 10.1.2.2 key-chain OER_HOST
Router(config-oer-mc-api-provider)# exit
Router(config-oer-mc)# api provider 2 priority 4000
Router(config-oer-mc-api-provider)# host-address 10.2.2.2 key-chain OER_HOST
priority 3000
Router(config-oer-mc-api-provider)# host-address 10.2.2.3 key-chain OER_HOST
priority 4000
Router(config-oer-mc-api-provider)# end
!
Router# show oer api provider detail
Router# show oer master policy dynamic
Router# show oer master prefix 10.1.1.0/24 report
```

Where to Go Next

Now that your OER network components are set up, you should read through the other modules in the following order:

- Using OER to Profile the Traffic Classes
- Measuring the Traffic Class Performance and Link Utilization Using OER
- Configuring and Applying OER Policies
- Using OER to Control Traffic Classes and Verify the Route Control Changes

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS Master Command List	http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html
Command Lookup Tool	http://tools.cisco.com/Support/CLILookup
Cisco OER technology overview	Cisco IOS Optimized Edge Routing Overview module
Concepts and configuration tasks required to set up OER network components.	Setting Up OER Network Components module
Cisco OER commands: complete command syntax, command mode, command history, defaults, usage guidelines and examples	*Cisco IOS Optimized Edge Routing Command Reference*
Key Chain Authentication: information about authentication key configuration and management in Cisco IOS software	Managing Authentication Keys section of the Configuring IP Routing Protocol-Independent Features chapter in the *IP Routing: Protocol-Independent Configuration Guide*

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified.	—

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
No new or modified RFCs are supported, and support for existing RFCs has not been modified.	—

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

Feature Information for Setting Up OER Network Components

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 3 Feature Information for Setting Up OER Network Components

Feature Name	Releases	Feature Configuration Information
Optimized Edge Routing	12.3(8)T 12.2(33)SRB	OER was introduced.
Automatic Port Configuration [1]	12.3(11)T 12.2(33)SRB	Support for automatic port configuration was introduced. Communication between the master controller and border router is automatically carried over port 3949 when connectivity is established. Port 3949 is registered with IANA for OER communication. Manual port number configuration is required only if you are running Cisco IOS Release 12.3(8)T or if you need to configure OER communication to use a dynamic port number. No commands were introduced by this feature.

1 This is a minor enhancement. Minor enhancements are not typically listed in Feature Navigator.

Feature Name	Releases	Feature Configuration Information
Support for NAT and Static Routing[2]	12.3(14)T 12.2(33)SRB	Support to allow OER to control traffic class routing using static routing in networks using NAT. The following command was modified by this feature: **ip nat inside source**.
Support for VLAN Interfaces[3]	12.3(14)T 12.2(33)SRB	Support to configure a VLAN interface as an internal interface was introduced. No commands were introduced by this feature.
Performance Routing - Application Interface	12.4(15)T	The Performance Routing - Application Interface feature introduces support for an OER application interface. The application interface defines the mode of communication and messaging between applications and the network for the purpose of optimizing the traffic associated with the applications. A provider must be registered with an OER master controller before the application can interface with OER. Host devices in the provider network running an application that communicates with OER using the application interface must also be configured at an OER master controller with an IP address and key chain password. The following commands were introduced or modified by this feature: **api provider**, **debug oer api**, **host-address**, **show oer api provider**, **show oer master policy**, and **show oer master prefix**.

2 This is a minor enhancement. Minor enhancements are not typically listed in Feature Navigator.

3 This is a minor enhancement. Minor enhancements are not typically listed in Feature Navigator.

Feature Name	Releases	Feature Configuration Information
OER Border Router Only Functionality	12.2(33)SXH	In Cisco IOS Release 12.2(33)SXH support for using a Cisco Catalyst 6500 series switch as an OER border router was introduced. Only border router functionality is included in the Cisco IOS Release 12.2(33)SXH images; no master controller configuration is available. The master controller that communicates with the Cisco Catalyst 6500 series switch being used as a border router must be a router running Cisco IOS Release 12.4(6)T or a later release. The OER master controller software has been modified to handle the limited functionality supported by the Cisco Catalyst 6500 border routers. Using the Route Processor (RP), the Catalyst 6500 border routers can capture throughput statistics only for a traffic class compared to the delay, loss, unreachability, and throughput statistics collected by non-Catalyst 6500 border routers. A master controller automatically detects the limited capabilities of the Catalyst 6500 border routers and downgrades other border routers to capture only the throughput statistics for traffic classes. By ignoring other types of statistics, the master controller is presented with a uniform view of the border router functionality. The following command was introduced or modified by this feature: **show oer border passive cache**.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.