Configuring Multiprotocol BGP (MP-BGP) Support for CLNS

This module describes configuration tasks to configure multiprotocol BGP (MP-BGP) support for CLNS, which provides the ability to scale Connectionless Network Service (CLNS) networks. The multiprotocol extensions of Border Gateway Protocol (BGP) add the ability to interconnect separate Open System Interconnection (OSI) routing domains without merging the routing domains, thus providing the capability to build very large OSI networks.

Restrictions for Configuring MP-BGP Support for CLNS

The configuration of MP-BGP support for CLNS does not support the creation and use of BGP confederations within the CLNS network. We recommend the use of route reflectors to address the issue of a large internal BGP mesh.

BGP extended communities are not supported by the MP-BGP Support for CLNS feature.

The following BGP commands are not supported by the MP-BGP Support for CLNS feature:

- **auto-summary**
- **neighbor advertise-map**
- **neighbor distribute-list**
- **neighbor soft-reconfiguration**
- **neighbor unsuppress-map**

Information About Configuring MP-BGP Support for CLNS

Address Family Routing Information

By default, commands entered under the **router bgp** command apply to the IPv4 address family. This will continue to be the case unless you enter the **no bgp default ipv4-unicast** command as the first command under the **router bgp** command. The **no bgp default ipv4-unicast** command is configured on the router to disable the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

Design Features of MP-BGP Support for CLNS

The configuration of MP-BGP support for CLNS allows BGP to be used as an interdomain routing protocol in networks that use CLNS as the network-layer protocol. This feature was developed to solve a scaling issue with a data communications network (DCN) where large numbers of network elements are managed remotely. For details about the DCN issues and how to implement this feature in a DCN topology, see the DCN Network Topology, on page 4.

BGP, as an Exterior Gateway Protocol, was designed to handle the volume of routing information generated by the Internet. Network administrators can control the BGP routing information because BGP neighbor relationships (peering) are manually configured and routing updates use incremental broadcasts. Some interior routing protocols such as Intermediate System-to-Intermediate System (IS-IS), in contrast, use a form of automatic neighbor discovery and broadcast updates at regular intervals.

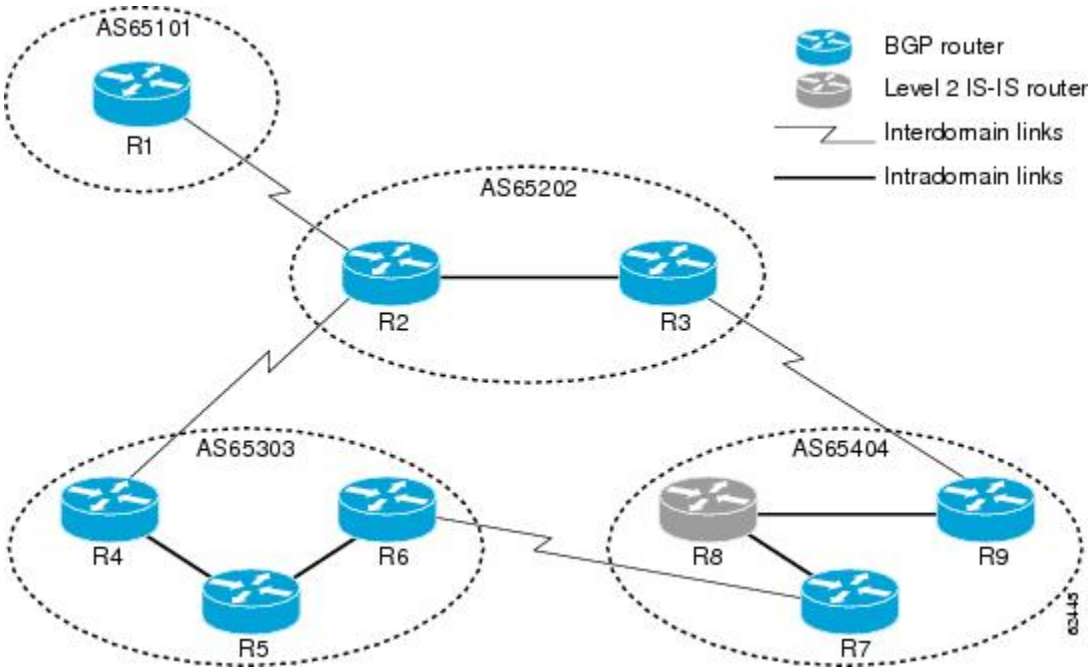
CLNS uses network service access point (NSAP) addresses to identify all its network elements. Using the BGP address-family support, NSAP address prefixes can be transported using BGP. In CLNS, BGP prefixes are inserted into the CLNS Level 2 prefix table. This functionality allows BGP to be used as an interdomain routing protocol between separate CLNS routing domains.

Implementing BGP in routers at the edge of each internal network means that the existing interior protocols need not be changed, minimizing disruption in the network.

Generic BGP CLNS Network Topology

The figure below shows a generic BGP CLNS network containing nine routers that are grouped into four different autonomous systems (in BGP terminology) or routing domains (in OSI terminology). To avoid confusion, we will use the BGP terminology of autonomous systems because each autonomous system is numbered and therefore more easily identified in the diagram and in the configuration discussion.

Figure 1: Components in a Generic BGP CLNS Network



Within each autonomous system, IS-IS is used as the intradomain routing protocol. Between autonomous systems, BGP and its multiprotocol extensions are used as the interdomain routing protocol. Each router is running either a BGP or Level 2 IS-IS routing process. To facilitate this feature, the BGP routers are also running a Level 2 IS-IS process. Although the links are not shown in the figure, each Level 2 IS-IS router is connected to multiple Level 1 IS-IS routers that are, in turn, connected to multiple CLNS networks.

Each autonomous system in this example is configured to demonstrate various BGP features and how these features work with CLNS to provide a scalable interdomain routing solution. In the figure above, the autonomous system AS65101 has a single Level 2 IS-IS router, R1, and is connected to just one other autonomous system, AS65202. Connectivity to the rest of the network is provided by R2, and a default route is generated for R1 to send to R2 all packets with destination NSAP addresses outside of AS65101.

In AS65202 there are two routers, R2 and R3, both with different external BGP (eBGP) neighbors. Routers R2 and R3 are configured to run internal BGP (iBGP) over the internal connection between them.

AS65303 shows how the use of BGP peer groups and route reflection can minimize the need for TCP connections between routers. Fewer connections between routers simplifies the network design and the amount of traffic in the network.

AS65404 shows how to use redistribution to communicate network reachability information to a Level 2 IS-IS router that is not running BGP.

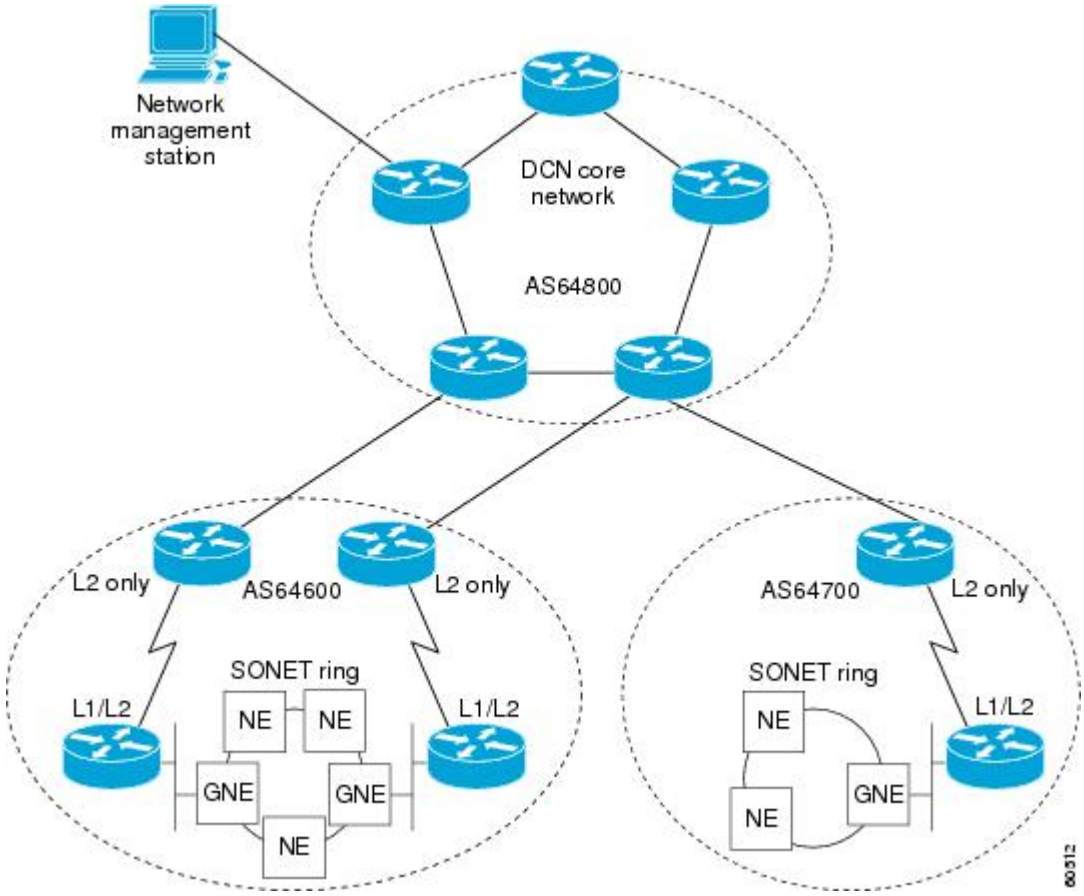
The configuration tasks and examples are based on the generic network design shown in the figure above. Configurations for all the routers in the figure are listed in the Implementing MP-BGP Support for CLNS Example, on page 31.

DCN Network Topology

The Multiprotocol BGP (MP-BGP) Support for CLNS feature can benefit a DCN managing a large number of remote SONET rings. SONET is typically used by telecommunications companies to send data over fiber-optic networks.

The figure below shows some components of a DCN network. To be consistent with the BGP terminology, the figure contains labels to indicate three autonomous systems instead of routing domains. The network elements--designated by NE in Figure 2--of a SONET ring are managed by OSI protocols such as File Transfer, Access, and Management (FTAM) and Common Management Information Protocol (CMIP). FTAM and CMIP run over the CLNS network-layer protocol, which means that the routers providing connectivity must run an OSI routing protocol.

Figure 2: Components in a DCN Network



IS-IS is a link-state protocol used in this example to route CLNS. Each routing node (networking device) is called an intermediate system (IS). The network is divided into areas defined as a collection of routing nodes. Routing within an area is referred to as Level 1 routing. Routing between areas involves Level 2 routing. Routers that link a Level 1 area with a Level 2 area are defined as Level 1-2 routers. A network element that connects to the Level 2 routers that provide a path to the DCN core is represented by a gateway network element--GNE in Figure 2. The network topology here is a point-to-point link between each network element router. In this example, a Level 1 IS-IS router is called an NE router.

Smaller Cisco routers such as the Cisco 2600 series were selected to run as the Level 1-2 routers because shelf space in the central office (CO) of a service provider is very expensive. A Cisco 2600 series router has limited processing power if it is acting as the Level 1 router for four or five different Level 1 areas. The number of Level 1 areas under this configuration is limited to about 200. The entire Level 2 network is also limited by the speed of the slowest Level 2 router.

To provide connectivity between NE routers, in-band signaling is used. The in-band signaling is carried in the SONET/Synchronous Digital Hierarchy (SDH) frame on the data communications channel (DCC). The DCC is a 192-KB channel, which is a very limited amount of bandwidth for the management traffic. Due to the limited signaling bandwidth between network elements and the limited amount of processing power and memory in the NE routers running IS-IS, each area is restricted to a maximum number of 30 to 40 routers. On average, each SONET ring consists of 10 to 15 network elements.

With a maximum of 200 areas containing 10 to 15 network elements per area, the total number of network element routers in a single autonomous system must be fewer than 3000. Service providers are looking to implement over 10,000 network elements as their networks grow, but the potential number of network elements in an area is limited. The current solution is to break down the DCN into a number of smaller autonomous systems and connect them using static routes or ISO Interior Gateway Routing Protocol (IGRP). ISO IGRP is a proprietary protocol that can limit future equipment implementation options. Static routing does not scale because the growth in the network can exceed the ability of a network administrator to maintain the static routes. BGP has been shown to scale to over 100,000 routes.

To implement the Multiprotocol BGP (MP-BGP) Support for CLNS feature in this example, configure BGP to run on each router in the DCN core network--AS64800 in Figure 2--to exchange routing information between all the autonomous systems. In the autonomous systems AS64600 and AS64700, only the Level 2 routers will run BGP. BGP uses TCP to communicate with BGP-speaking neighbor routers, which means that both an IP-addressed network and an NSAP-addressed network must be configured to cover all the Level 2 IS-IS routers in the autonomous systems AS64600 and AS64700 and all the routers in the DCN core network.

Assuming that each autonomous system--for example, AS64600 and AS64700 in Figure 2--remains the same size with up to 3000 nodes, we can demonstrate how large DCN networks can be supported with this feature. Each autonomous system advertises one address prefix to the core autonomous system. Each address prefix can have two paths associated with it to provide redundancy because there are two links between each autonomous system and the core autonomous system. BGP has been shown to support 100,000 routes, so the core autonomous system can support many other directly linked autonomous systems because each autonomous system generates only a few routes. We can assume that the core autonomous system can support about 2000 directly linked autonomous systems. With the hub-and-spoke design where each autonomous system is directly linked to the core autonomous system, and not acting as a transit autonomous system, the core autonomous system can generate a default route to each linked autonomous system. Using the default routes, the Level 2 routers in the linked autonomous systems process only a small amount of additional routing information. Multiplying the 2000 linked autonomous systems by the 3000 nodes within each autonomous system could allow up to 6 million network elements.

Benefits of MP-BGP Support for CLNS

The Multiprotocol BGP (MP-BGP) Support for CLNS feature adds the ability to interconnect separate OSI routing domains without merging the routing domains, which provides the capability to build very large OSI networks. The benefits of using this feature are not confined to DCN networks, and can be implemented to help scale any network using OSI routing protocols with CLNS.

How to Configure MP-BGP Support for CLNS

Configuring and Activating a BGP Neighbor to Support CLNS

To configure and activate a BGP routing process and an associated BGP neighbor (peer) to support CLNS, perform the steps in this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **no bgp default ipv4-unicast**
5. **neighbor** {*ip-address* | *peer-group-name*} **remote-as** *as-number*
6. **address-family nsap** [**unicast**]
7. **neighbor** *ip-address* **activate**
8. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router bgp** *as-number* **Example:** `Router(config)# router bgp 65101`	Configures a BGP routing process and enters router configuration mode. • The *as-number* argument identifies the autonomous system in which the router resides. Valid values are from 0 to 65535. Private autonomous system numbers that can be used in internal networks range from 64512 to 65535.
Step 4	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

	Command or Action	Purpose
Step 5	**neighbor** {*ip-address* | *peer-group-name*} **remote-as** *as-number* **Example:** `Router(config-router)# neighbor 10.1.2.2 remote-as 64202`	Adds an IP address or peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router.

Step 6	**address-family nsap** [**unicast**]
	Example:
	`Router(config-router)#`
	`address-family nsap`
		Specifies the NSAP address family and enters address family configuration mode.
		• The optional **unicast** keyword specifies the NSAP unicast address prefixes. By default, the router is placed in configuration mode for the unicast NSAP address family if the **unicast** keyword is not specified with the **address-family nsap** command.

Step 7	**neighbor** *ip-address* **activate**
	Example:
	`Router(config-router-af)#`
	`neighbor 10.1.2.2 activate`
		Enables the BGP neighbor to exchange prefixes for the NSAP address family with the local router.
		Note
		If you have configured a peer group as a BGP neighbor, you do not use this command because peer groups are automatically activated when any peer group parameter is configured.

Step 8	**end**
	Example:
	`Router(config-router-af)#`
	`end`
		Exits address family configuration mode and returns to privileged EXEC mode.

Configuring an IS-IS Routing Process

When an integrated IS-IS routing process is configured, the first instance of the IS-IS routing process configured is by default a Level 1-2 (intra-area and interarea) router. All subsequent IS-IS routing processes on a network running CLNS are configured as Level 1. All subsequent IS-IS routing processes on a network running IP are configured as Level-1-2. To use the Multiprotocol BGP (MP-BGP) Support for CLNS feature, configure a Level 2 routing process.

To configure an IS-IS routing process and assign it as a Level-2-only process, perform the steps in this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *area-tag*
4. **net** *network-entity-title*

5. **is-type** [**level-1** | **level-1-2** | **level-2-only**]
6. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router isis** *area-tag* **Example:** `Router(config)# router isis osi-as-101`	Configures an IS-IS routing process and enters router configuration mode for the specified routing process. • The *area-tag* argument is a meaningful name for a routing process. It must be unique among all IP and CLNS routing processes for a given router.
Step 4	**net** *network-entity-title* **Example:** `Router(config-router)# net 49.0101.1111.1111.1111.1111.00`	Configures a network entity title (NET) for the routing process. • If you are configuring multiarea IS-IS, you must specify a NET for each routing process.
Step 5	**is-type** [**level-1**	**level-1-2**	**level-2-only**] **Example:** `Router(config-router)# is-type level-1`	Configures the router to act as a Level 1 (intra-area) router, as both a Level 1 router and a Level 2 (interarea) router, or as an interarea router only. • In multiarea IS-IS configurations, the first instance of the IS-IS routing process configured is by default a Level 1-2 (intra-area and interarea) router. All subsequent IS-IS routing processes on a network running CLNS are configured as Level 1. All subsequent IS-IS routing processes on a network running IP are configured as Level 1-2.

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

Configuring Interfaces That Connect to BGP Neighbors

When a router running IS-IS is directly connected to an eBGP neighbor, the interface between the two eBGP neighbors is activated using the **clns enable** command, which allows CLNS packets to be forwarded across the interface. The **clns enable** command activates the End System-to-Intermediate System (ES-IS) protocol to search for neighboring OSI systems.

Note Running IS-IS across the same interface that is connected to an eBGP neighbor can lead to undesirable results if the two OSI routing domains merge into a single domain.

When a neighboring OSI system is found, BGP checks that it is also an eBGP neighbor configured for the NSAP address family. If both the preceding conditions are met, BGP creates a special BGP neighbor route in the CLNS Level 2 prefix routing table. The special BGP neighbor route is automatically redistributed in to the Level 2 routing updates so that all other Level 2 IS-IS routers in the local OSI routing domain know how to reach this eBGP neighbor.

To configure interfaces that are being used to connect with eBGP neighbors, perform the steps in this procedure. These interfaces will normally be directly connected to their eBGP neighbor.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask*
5. **clns enable**
6. **no shutdown**
7. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:**	Specifies the interface type and number and enters interface configuration mode.

	Command or Action	Purpose
	`Router(config)# interface serial 2/0/0`	
Step 4	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.1.2.2 255.255.255.0`	Configures the interface with an IP address.

Step 5	**clns enable**
	Example:
	`Router(config-if)#`
	`clns enable`
		Specifies that CLNS packets can be forwarded across this interface.
		• The ES-IS protocol is activated and starts to search for adjacent OSI systems.

Step 6	**no shutdown** **Example:** `Router(config-if)# no shutdown`	Turns on the interface.
Step 7	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring Interfaces Connected to the Local OSI Routing Domain

To configure interfaces that are connected to the local OSI routing domain, perform the steps in this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip address** *ip-address mask*
5. **clns router isis** *area-tag*
6. **ip router isis** *area-tag*
7. **no shutdown**
8. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface gigabitethernet 0/1/1`	Specifies the interface type and number and enters interface configuration mode.
Step 4	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.2.3.1 255.255.255.0`	Configures the interface with an IP address. **Note** This step is required only when the interface needs to communicate with an iBGP neighbor.

Step 5	**clns router isis** *area-tag*
	Example:
	`Router(config-if)#`
	`clns router isis osi-as-202`
		Specifies that the interface is actively routing IS-IS when the network protocol is ISO CLNS and identifies the area associated with this routing process.

Step 6	**ip router isis** *area-tag*
	Example:
	`Router(config-if)#`
	`ip router isis`
	`osi-as-202`
		Specifies that the interface is actively routing IS-IS when the network protocol is IP and identifies the area associated with this routing process.
		Note
		This step is required only when the interface needs to communicate with an iBGP neighbor, and the IGP is IS-IS.

Step 7	**no shutdown** **Example:** `Router(config-if)# no shutdown`	Turns on the interface.
Step 8	**end** **Example:**	Exits interface configuration mode and returns to privileged EXEC mode.

	Command or Action	Purpose
	`Router(config-if)# end`	

Advertising Networking Prefixes

Advertising NSAP address prefix forces the prefixes to be added to the BGP routing table. To configure advertisement of networking prefixes, perform the steps in this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **no bgp default ipv4-unicast**
5. **neighbor** {*ip-address* | *peer-group-name*} **remote-as** *as-number*
6. **address-family nsap** [**unicast**]
7. **network** *nsap-prefix* [**route-map** *map-tag*]
8. **neighbor** *ip-address* **activate**
9. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router bgp** *as-number* **Example:** `Router(config)# router bgp 65101`	Configures a BGP routing process and enters router configuration mode for the specified routing process.
Step 4	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

	Command or Action	Purpose
Step 5	**neighbor** {*ip-address* | *peer-group-name*} **remote-as** *as-number* **Example:** `Router(config-router)# neighbor 10.1.2.2 remote-as 64202`	Adds an IP address or peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router.
Step 6	**address-family nsap** [**unicast**] **Example:** `Router(config-router)# address-family nsap`	Specifies the NSAP address family and enters address family configuration mode. • The optional **unicast** keyword specifies the NSAP unicast address prefixes. By default, the router is placed in unicast NSAP address family configuration mode if the **unicast** keyword is not specified with the **address-family nsap** command.
Step 7	**network** *nsap-prefix* [**route-map** *map-tag*] **Example:** `Router(config-router-af)# network 49.0101.1111.1111.1111.1111.00`	Advertises a single prefix of the local OSI routing domain and enters it in the BGP routing table. **Note** It is possible to advertise a single prefix, in which case this prefix could be the unique NSAP address prefix of the local OSI routing domain. Alternatively, multiple longer prefixes, each covering a small portion of the OSI routing domain, can be used to selectively advertise different areas. • The advertising of NSAP address prefixes can be controlled by using the optional **route-map** keyword. If no route map is specified, all NSAP address prefixes are redistributed.
Step 8	**neighbor** *ip-address* **activate** **Example:** `Router(config-router-af) neighbor 10.1.2.2 activate`	Specifies that NSAP routing information will be sent to the specified BGP neighbor. **Note** See the description of the **neighbor** command in the documents listed in the "Additional References" for more details on the use of this command.

Step 9	**end**
	Example:
	`Router(config-router-af)#`
	`end`
		Exits address family configuration mode and returns to privileged EXEC mode.

Redistributing Routes from BGP into IS-IS

Route redistribution must be approached with caution. We do not recommend injecting the full set of BGP routes into IS-IS because excessive routing traffic will be added to IS-IS. Route maps can be used to control which dynamic routes are redistributed.

To configure route redistribution from BGP into IS-IS, perform the steps in this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *area-tag*
4. **net** *network-entity-title*
5. **redistribute** *protocol as-number* [*route-type*] [**route-map** *map-tag*]
6. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router isis** *area-tag* **Example:** `Router(config)# router isis osi-as-404`	Configures an IS-IS routing process and enters router configuration mode for the specified routing process. **Note** You cannot redistribute BGP routes into a Level 1-only IS-IS routing process.
Step 4	**net** *network-entity-title* **Example:** `Router(config-router)# net 49.0404.7777.7777.7777.7777.00`	Configures a NET for the routing process. • If you are configuring multiarea IS-IS, you must specify a NET for each routing process.
Step 5	**redistribute** *protocol as-number* [*route-type*] [**route-map** *map-tag*] **Example:**	Redistributes NSAP prefix routes from BGP into the CLNS Level 2 routing table associated with the IS-IS routing process when the *protocol* argument is set to **bgp**and the *route-type* argument is set to **clns**.

	Command or Action	Purpose
	`Router(config-router)# redistribute bgp 65404 clns`	• The *as-number* argument is defined as the autonomous system number of the BGP routing process to be redistributed into CLNS. • The redistribution of routes can be controlled by using the optional **route-map** keyword. If no route map is specified, all BGP routes are redistributed.

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

Redistributing Routes from IS-IS into BGP

Route redistribution must be approached with caution because redistributed route information is stored in the routing tables. Large routing tables may make the routing process slower. Route maps can be used to control which dynamic routes are redistributed.

To configure route redistribution from IS-IS into BGP, perform the steps in this procedure.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **no bgp default ipv4-unicast**
5. **address-family nsap** [**unicast**]
6. **redistribute** *protocol* [*process-id*] [*route-type*] [**route-map** *map-tag*]
7. **end**

DETAILED STEPS

Procedure

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

	Command or Action	Purpose
	`Router# configure terminal`	
Step 3	**router bgp** *as-number* **Example:** `Router(config)# router bgp 65202`	Configures a BGP routing process and enters router configuration mode for the specified routing process.
Step 4	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

Step 5	**address-family nsap** [**unicast**]
	Example:
	`Router(config-router)#`
	`address-family nsap`
		Specifies the NSAP address family and enters address family configuration mode.

Step 6	**redistribute** *protocol* [*process-id*] [*route-type*] [**route-map** *map-tag*] **Example:** `Router(config-router-af)# redistribute isis osi-as-202 clns route-map internal-routes-only`	Redistributes routes from the CLNS Level 2 routing table associated with the IS-IS routing process into BGP as NSAP prefixes when the *protocol* argument is set to **isis**and the *route-type* argument is set to **clns**. • The *process-id* argument is defined as the area name for the relevant IS-IS routing process to be redistributed. • The redistribution of routes can be controlled by using the optional **route-map** keyword. If no route map is specified, all Level 2 routes are redistributed.

Step 7	**end**
	Example:
	`Router(config-router-af)#`
	`end`
		Exits address family configuration mode and returns to privileged EXEC mode.

Configuring BGP Peer Groups and Route Reflectors

BGP peer groups reduce the number of configuration commands by applying a BGP **neighbor** command to multiple neighbors. Using a BGP peer group with a local router configured as a BGP route reflector allows BGP routing information received from one member of the group to be replicated to all other group members. Without a peer group, each route reflector client must be specified by IP address.

To create a BGP peer group and use the group as a BGP route reflector client, perform the steps in this procedure. This is an optional task and is used with internal BGP neighbors. In this task, some of the BGP

syntax is shown with the *peer-group-name* argument only and only one neighbor is configured as a member of the peer group. Repeat Step 9 to configure other BGP neighbors as members of the peer group.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **no bgp default ipv4-unicast**
5. **neighbor** *peer-group-name* **peer-group**
6. **neighbor** *peer-group-name* **remote-as** *as-number*
7. **address-family nsap** [**unicast**]
8. **neighbor** *peer-group-name* **route-reflector-client**
9. **neighbor** *ip-address* **peer-group** *peer-group*
10. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router bgp** *as-number* **Example:** `Router(config)# router bgp 65303`	Configures a BGP routing process and enters router configuration mode for the specified routing process.
Step 4	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.
Step 5	**neighbor** *peer-group-name* **peer-group** **Example:** `Router(config-router)# neighbor ibgp-peers peer-group`	Creates a BGP peer group.

	Command or Action	Purpose
Step 6	**neighbor** *peer-group-name* **remote-as** *as-number* **Example:** `Router(config-router)# neighbor ibgp-peers remote-as 65303`	Adds the peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router.

Step 7	**address-family nsap** [**unicast**]
	Example:
	`Router(config-router)#`
	`address-family nsap`
		Specifies the NSAP address family and enters address family configuration mode.

Step 8	**neighbor** *peer-group-name* **route-reflector-client**
	Example:
	`Router(config-router-af)#`
	`neighbor ibgp-peers route-reflector-client`
		Configures the router as a BGP route reflector and configures the specified peer group as its client.

Step 9	**neighbor** *ip-address* **peer-group** *peer-group*
	Example:
	`Router(config-router-af)#`
	`neighbor 10.4.5.4 peer-group ibgp-peers`
		Assigns a BGP neighbor to a BGP peer group.

Step 10	**end**
	Example:
	`Router(config-router-af)#`
	`end`
		Exits address family configuration mode and returns to privileged EXEC mode.

Filtering Inbound Routes Based on NSAP Prefixes

Perform this task to filter inbound BGP routes based on NSAP prefixes. The **neighbor prefix-list in** command is configured in address family configuration mode to filter inbound routes.

Before you begin

You must specify either a CLNS filter set or a CLNS filter expression before configuring the **neighbor** command. See descriptions for the **clns filter-expr** and **clns filter-set** commands for more information.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*

4. **no bgp default ipv4-unicast**
5. **address-family nsap** [**unicast**]
6. **neighbor** {*ip-address*| *peer-group-name*}**prefix-list** {*clns-filter-expr-name*| *clns-filter-set-name*} **in**
7. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router bgp** *as-number* **Example:** `Router(config)# router bgp 65200`	Configures a BGP routing process and enters router configuration mode for the specified routing process.
Step 4	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

Step 5	**address-family nsap** [**unicast**]
	Example:
	`Router(config-router)#`
	`address-family nsap`
		Specifies the address family and enters address family configuration mode.

Step 6	**neighbor** {*ip-address*| *peer-group-name*}**prefix-list** {*clns-filter-expr-name*| *clns-filter-set-name*} **in**
	Example:
	`Router(config-router-af)#`
	`neighbor 10.23.4.1 prefix-list abc in`
		Specifies a CLNS filter set or CLNS filter expression to be used to filter inbound BGP routes.
		• The *clns-filter-expr-name* argument is defined with the **clns filter-expr** configuration command.
		• The *clns-filter-set-name* argument is defined with the **clns filter-set** configuration command.

Step 7	**end** **Example:**	Exits address family configuration mode and returns to privileged EXEC mode.

	Command or Action	Purpose
	`Router(config-router-af)#` `end`	

Filtering Outbound BGP Updates Based on NSAP Prefixes

Perform this task to filter outbound BGP updates based on NSAP prefixes, use the **neighbor prefix-list out** command in address family configuration mode. This task is configured at Router 7 in the figure above (in the "Generic BGP CLNS Network Topology" section). In this task, a CLNS filter is created with two entries to deny NSAP prefixes starting with 49.0404 and to permit all other NSAP prefixes starting with 49. A BGP peer group is created and the filter is applied to outbound BGP updates for the neighbor that is a member of the peer group.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **clns filter-set** *name* [**deny**] **template**
4. **clns filter-set** *name* [**permit**] **template**
5. **router bgp** *as-number*
6. **no bgp default ipv4-unicast**
7. **neighbor** *peer-group-name* **peer-group**
8. **neighbor** {*ip-address* | *peer-group-name*} **remote-as** *as-number*
9. **address-family nsap** [**unicast**]
10. **neighbor** {*ip-address* | *peer-group-name*} **prefix-list** {*clns-filter-expr-name* | *clns-filter-set-name*} **out**
11. **neighbor** *ip-address* **peer-group** *peer-group*
12. **end**

DETAILED STEPS

Procedure

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

	Command or Action	Purpose
Step 3	**clns filter-set** *name* [**deny**] **template** **Example:** `Router(config)# clns filter-set routes0404 deny 49.0404...`	Defines a NSAP prefix match for a deny condition for use in CLNS filter expressions. • In this example, a deny action is returned if an address starts with 49.0404.
Step 4	**clns filter-set** *name* [**permit**] **template** **Example:** `Router(config)# clns filter-set routes0404 permit 49...`	Defines a NSAP prefix match for a permit condition for use in CLNS filter expressions. • In this example, a permit action is returned if an address starts with 49. **Note** Although the permit example in this step allows all NSAP addresses starting with 49, the match condition in Step 3 is processed first so the NSAP addresses starting with 49.0404 are still denied.
Step 5	**router bgp** *as-number* **Example:** `Router(config)# router bgp 65404`	Configures a BGP routing process and enters router configuration mode for the specified routing process.
Step 6	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.
Step 7	**neighbor** *peer-group-name* **peer-group** **Example:** `Router(config-router)# neighbor ebgp-peers peer-group`	Creates a BGP peer group. • In this example, the BGP peer group named ebgp-peers is created.
Step 8	**neighbor** {*ip-address* | *peer-group-name*} **remote-as** *as-number* **Example:** `Router(config-router)# neighbor ebgp-peers remote-as 65303`	Adds an IP address or peer group name of the BGP neighbor in the specified autonomous system to the BGP neighbor table of the local router. • In this example, the peer group named ebgp-peers is added to the BGP neighbor table.
Step 9	**address-family nsap** [**unicast**] **Example:** `Router(config-router)# address-family nsap`	Specifies the NSAP address family and enters address family configuration mode.

	Command or Action	Purpose
Step 10	**neighbor** {*ip-address* | *peer-group-name*} **prefix-list** {*clns-filter-expr-name* | *clns-filter-set-name*} **out** **Example:** `Router(config-router-af)# neighbor ebgp-peers prefix-list routes0404 out`	Specifies a CLNS filter set or CLNS filter expression to be used to filter outbound BGP updates. • The *clns-filter-expr-name* argument is defined with the **clns filter-expr** configuration command. • The *clns-filter-set-name* argument is defined with the **clns filter-set** configuration command. • In this example, the filter set named routes0404 was created in Step3 and Step 4.
Step 11	**neighbor** *ip-address* **peer-group** *peer-group* **Example:** `Router(config-router-af)# neighbor 10.6.7.8 peer-group ebgp-peers`	Assigns a BGP neighbor to a BGP peer group.
Step 12	**end** **Example:** `Router(config-router-af)# end`	Exits address family configuration mode and returns to privileged EXEC mode.

Originating Default Routes for a Neighboring Routing Domain

To create a default CLNS route that points to the local router on behalf of a neighboring OSI routing domain, perform the steps in this procedure. This is an optional task and is normally used only with external BGP neighbors.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-number*
4. **no bgp default ipv4-unicast**
5. **address-family nsap** [**unicast**]
6. **neighbor** {*ip-address* | *peer-group-name*} **default-originate** [**route-map** map-tag]
7. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router bgp** *as-number* **Example:** `Router(config)# router bgp 64803`	Configures a BGP routing process and enters router configuration mode for the specified routing process.
Step 4	**no bgp default ipv4-unicast** **Example:** `Router(config-router)# no bgp default ipv4-unicast`	Disables the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

Step 5	**address-family nsap** [**unicast**]
	Example:
	`Router(config-router)#`
	`address-family nsap`
		Specifies the NSAP address family and enters address family configuration mode.

Step 6	**neighbor** {*ip-address* | *peer-group-name*} **default-originate** [**route-map** map-tag]
	Example:
	`Router(config-router-af)#`
	` neighbor 172.16.2.3 default-originate`
		Generates a default CLNS route that points to the local router and that will be advertised to the neighboring OSI routing domain.

Step 7	**end**
	Example:
	`Router(config-router-af)#`
	`end`
		Exits address family configuration mode and returns to privileged EXEC mode.

Verifying MP-BGP Support for CLNS

To verify the configuration, use the **show running-config** EXEC command. Sample output is located in the Implementing MP-BGP Support for CLNS Example, on page 31. To verify that the Multiprotocol BGP (MP-BGP) Support for CLNS feature is working, perform the following steps.

SUMMARY STEPS

1. **show clns neighbors**
2. **show clns route**
3. **show bgp nsap unicast summary**
4. **show bgp nsap unicast**

DETAILED STEPS

Procedure

Step 1 show clns neighbors

Use this command to confirm that the local router has formed all the necessary IS-IS adjacencies with other Level 2 IS-IS routers in the local OSI routing domain. If the local router has any directly connected external BGP peers, the output from this command will show that the external neighbors have been discovered, in the form of ES-IS adjacencies.

In the following example, the output is displayed for router R2, shown in the figure above (in the "Generic BGP CLNS Network Topology" section). R2 has three CLNS neighbors. R1 and R4 are ES-IS neighbors because these nodes are in different autonomous systems from R2. R3 is an IS-IS neighbor because it is in the same autonomous system as R2. Note that the system ID is replaced by CLNS hostnames (r1, r3, and r4) that are defined at the start of each configuration file. Specifying the CLNS hostname means that you need not remember which system ID corresponds to which hostname.

Example:

```
Router# show clns neighbors
Tag osi-as-202:
System Id      Interface   SNPA            State  Holdtime  Type Protocol
r1             Se2/0       *HDLC*          Up     274       IS   ES-IS
r3             Et0/1       0002.16de.8481  Up     9         L2   IS-IS
r4             Se2/2       *HDLC*          Up     275       IS   ES-IS
```

Step 2 show clns route

Use this command to confirm that the local router has calculated routes to other areas in the local OSI routing domain. In the following example of output from router R2, shown in the figure above (in the "Generic BGP CLNS Network Topology" section), the routing table entry--i 49.0202.3333 [110/10] via R3--shows that router R2 knows about other local IS-IS areas within the local OSI routing domain.

Example:

```
Router# show clns route
Codes: C - connected, S - static, d - DecnetIV
       I - ISO-IGRP,  i - IS-IS,  e - ES-IS
       B - BGP,       b - eBGP-neighbor
C  49.0202.2222 [2/0], Local IS-IS Area
C  49.0202.2222.2222.2222.2222.00 [1/0], Local IS-IS NET
b  49.0101.1111.1111.1111.1111.00 [15/10]
```

```
      via r1, Serial2/0
i  49.0202.3333 [110/10]
      via r3, GigabitEthernet0/1/1
b  49.0303.4444.4444.4444.4444.00 [15/10]
      via r4, Serial2/2
B  49.0101 [20/1]
      via r1, Serial2/0
B  49.0303 [20/1]
      via r4, Serial2/2
B  49.0404 [200/1]
      via r9
i  49.0404.9999.9999.9999.9999.00 [110/10]
      via r3, GigabitEthernet0/1/1
```

Step 3 show bgp nsap unicast summary

Use this command to verify that the TCP connection to a particular neighbor is active. In the following example output, search the appropriate row based on the IP address of the neighbor. If the State/PfxRcd column entry is a number, including zero, the TCP connection for that neighbor is active.

Example:

```
Router# show bgp nsap unicast summary
BGP router identifier 10.1.57.11, local AS number 65202
BGP table version is 6, main routing table version 6
5 network entries and 8 paths using 1141 bytes of memory
6 BGP path attribute entries using 360 bytes of memory
4 BGP AS-PATH entries using 96 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP activity 5/0 prefixes, 8/0 paths, scan interval 60 secs
Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
10.1.2.1        4 65101      34      34        6    0    0 00:29:11        1
10.2.3.3        4 65202      35      36        6    0    0 00:29:16        3
```

Step 4 show bgp nsap unicast

Enter the **show bgp nsap unicast** command to display all the NSAP prefix routes that the local router has discovered. In the following example of output from router R2, shown in the figure above (in the "Generic BGP CLNS Network Topology" section), a single valid route to prefix 49.0101 is shown. Two valid routes--marked by a *--are shown for the prefix 49.0404. The second route is marked with a *>i sequence, representing the best route to this prefix.

Example:

```
Router# show bgp nsap unicast
BGP table version is 3, local router ID is 192.168.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network          Next Hop            Metric LocPrf Weight Path
*> 49.0101          49.0101.1111.1111.1111.1111.00
                                                         0 65101 i
* i49.0202.2222     49.0202.3333.3333.3333.3333.00
                                               100       0 ?
*>                  49.0202.2222.2222.2222.2222.00
                                                     32768 ?
* i49.0202.3333     49.0202.3333.3333.3333.3333.00
                                               100       0 ?
*>                  49.0202.2222.2222.2222.2222.00
                                                     32768 ?
*> 49.0303          49.0303.4444.4444.4444.4444.00
                                                         0 65303 i
```

```
*  49.0404          49.0303.4444.4444.4444.4444.00
                                                        0 65303 65404 i
*>i                 49.0404.9999.9999.9999.9999.00
                                              100       0 65404 i
```

Troubleshooting MP-BGP Support for CLNS

The **debug bgp nsap unicast**commands enable diagnostic output concerning various events relating to the operation of the CLNS packets in the BGP routing protocol to be displayed on a console. These commands are intended only for troubleshooting purposes because the volume of output generated by the software when they are used can result in severe performance degradation on the router. See the *Cisco IOS Debug Command Reference* for more information about using these **debug** commands.

To troubleshoot problems with the configuration of MP-BGP support for CLNS and to minimize the impact of the **debug**commands used in this procedure, perform the following steps.

SUMMARY STEPS

1. Attach a console directly to a router running the Cisco software release that includes the Multiprotocol BGP (MP-BGP) Support for CLNS feature.
2. **no logging console**
3. Use Telnet to access a router port.
4. **enable**
5. **terminal monitor**
6. **debug bgp nsap unicast** [*neighbor-address* | **dampening** | **keepalives** | **updates**]
7. **no terminal monitor**
8. **no debug bgp nsap unicast** [*neighbor-address* | **dampening** | **keepalives** | **updates**]
9. **logging console**

DETAILED STEPS

Procedure

Step 1 Attach a console directly to a router running the Cisco software release that includes the Multiprotocol BGP (MP-BGP) Support for CLNS feature.

Note
This procedure will minimize the load on the router created by the **debug bgp nsap unicast** commands because the console port will no longer be generating character-by-character processor interrupts. If you cannot connect to a console directly, you can run this procedure via a terminal server. If you must break the Telnet connection, however, you may not be able to reconnect because the router may be unable to respond due to the processor load of generating the **debug bgp nsap unicast** output.

Step 2 **no logging console**

This command disables all logging to the console terminal.

Step 3 Use Telnet to access a router port.

Step 4 **enable**

Enter this command to access privileged EXEC mode.

Step 5 **terminal monitor**

This command enables logging on the virtual terminal.

Step 6 **debug bgp nsap unicast** [*neighbor-address* | **dampening** | **keepalives** | **updates**]

Enter only specific **debug bgp nsap unicast**commands to isolate the output to a certain subcomponent and minimize the load on the processor. Use appropriate arguments and keywords to generate more detailed debug information on specified subcomponents.

Step 7 **no terminal monitor**

This command disables logging on the virtual terminal.

Step 8 **no debug bgp nsap unicast** [*neighbor-address* | **dampening** | **keepalives** | **updates**]

Enter the specific **no debug bgp nsap unicast**command when you are finished.

Step 9 **logging console**

This command reenables logging to the console.

Configuration Examples for MP-BGP Support for CLNS

Example: Configuring and Activating a BGP Neighbor to Support CLNS

In the following example, the router R1, shown in the figure below, in the autonomous system AS65101 is configured to run BGP and activated to support CLNS. Router R1 is the only Level 2 IS-IS router in autonomous system AS65101, and it has only one connection to another autonomous system via router R2 in AS65202. The **no bgp default ipv4-unicast** command is configured on the router to disable the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers. After the NSAP address family configuration mode is enabled with the **address-family nsap** command, the router is configured to advertise the NSAP prefix of 49.0101 to its BGP neighbors and to send NSAP routing information to the BGP neighbor at 10.1.2.2.

```
router bgp 65101
 no bgp default ipv4-unicast
 address-family nsap
  network 49.0101...
  neighbor 10.1.2.2 activate
  exit-address-family
```

Example: Configuring an IS-IS Routing Process

In the following example, R1, shown in the figure below, is configured to run an IS-IS process:

```
router isis osi-as-101
 net 49.0101.1111.1111.1111.1111.00
```

The default IS-IS routing process level is used.

Configuring Interfaces Example

In the following example, two of the interfaces of the router R2, shown in the figure below, in the autonomous system AS65202 are configured to run CLNS. GigabitEthernet interface 0/1/1 is connected to the local OSI routing domain and is configured to run IS-IS when the network protocol is CLNS using the **clns router isis** command. The serial interface 2/0 with the local IP address of 10.1.2.2 is connected with an eBGP neighbor and is configured to run CLNS through the **clns enable** command:

```
interface serial 2/0
 ip address 10.1.2.2 255.255.255.0
 clns enable
 no shutdown
!
interface gigabitethernet 0/1/1
 ip address 10.2.3.1 255.255.255.0
 clns router isis osi-as-202
 no shutdown
```

Advertising Networking Prefixes Example

In the following example, the router R1, shown in the figure below, is configured to advertise the NSAP prefix of 49.0101 to other routers. The NSAP prefix unique to autonomous system AS65101 is advertised to allow the other autonomous systems to discover the existence of autonomous system AS65101 in the network.

```
router bgp 65101
 no bgp default ipv4-unicast
 neighbor 10.1.2.2 remote-as 64202
 address-family nsap
  network 49.0101...
  neighbor 10.1.2.2 activate
```

Example: Redistributing Routes from BGP into IS-IS

In the following example, the routers R7 and R9, shown in the figure below, in the autonomous system AS65404 are configured to redistribute BGP routes into the IS-IS routing process called osi-as-404. Redistributing the BGP routes allows the Level 2 IS-IS router, R8, to advertise routes to destinations outside the autonomous system AS65404. Without a route map being specified, all BGP routes are redistributed.

Router R7

```
router isis osi-as-404
 net 49.0404.7777.7777.7777.7777.00
 redistribute bgp 65404 clns
```

Router R9

```
router isis osi-as-404
```

```
 net 49.0404.9999.9999.9999.9999.00
 redistribute bgp 65404 clns
```

Example: Redistributing Routes from IS-IS into BGP

In the following example, the router R2, shown in the figure below, in the autonomous system AS65202 is configured to redistribute Level 2 CLNS NSAP routes into BGP. A route map is used to permit only routes from within the local autonomous system to be redistributed into BGP. Without a route map being specified, every NSAP route from the CLNS level 2 prefix table is redistributed. The **no bgp default ipv4-unicast** command is configured on the router to disable the default behavior of the BGP routing process exchanging IPv4 addressing information with BGP neighbor routers.

```
clns filter-set internal-routes permit 49.0202...
!
route-map internal-routes-only permit 10
 match clns address internal-routes
!
router isis osi-as-202
 net 49.0202.2222.2222.2222.2222.00
!
router bgp 65202
 no bgp default ipv4-unicast
 address-family nsap
 redistribute isis osi-as-202 clns route-map internal-routes-only
```

Configuring BGP Peer Groups and Route Reflectors Example

Router R5, shown in the figure above (in the "Generic BGP CLNS Network Topology" section), has only iBGP neighbors and runs IS-IS on both interfaces. To reduce the number of configuration commands, configure R5 as a member of a BGP peer group called ibgp-peers. The peer group is automatically activated under the **address-family nsap** command by configuring the peer group as a route reflector client allowing it to exchange NSAP routing information between group members. The BGP peer group is also configured as a BGP route reflector client to reduce the need for every iBGP router to be linked to each other.

In the following example, the router R5 in the autonomous system AS65303 is configured as a member of a BGP peer group and a BGP route reflector client:

```
router bgp 65303
 no bgp default ipv4-unicast
 neighbor ibgp-peers peer-group
 neighbor ibgp-peers remote-as 65303
 address-family nsap
  neighbor ibgp-peers route-reflector-client
  neighbor 10.4.5.4 peer-group ibgp-peers
  neighbor 10.5.6.6 peer-group ibgp-peers
  exit-address-family
```

Filtering Inbound Routes Based on NSAP Prefixes Example

In the following example, the router R1, shown in the figure below, in the autonomous system AS65101 is configured to filter inbound routes specified by the default-prefix-only prefix list:

```
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
```

```
!
router isis osi-as-101
 net 49.0101.1111.1111.1111.1111.00
!
router bgp 65101
 no bgp default ipv4-unicast
 neighbor 10.1.2.2 remote-as 64202
 address-family nsap
  network 49.0101.1111.1111.1111.1111.00
  neighbor 10.1.2.2 activate
  neighbor 10.1.2.2 prefix-list default-prefix-only in
```

Example: Filtering Outbound BGP Updates Based on NSAP Prefixes

In the following example, outbound BGP updates are filtered based on NSAP prefixes. This example is configured at Router 7 in the figure below. In this task, a CLNS filter is created with two entries to deny NSAP prefixes starting with 49.0404 and to permit all other NSAP prefixes starting with 49. A BGP peer group is created and the filter is applied to outbound BGP updates for the neighbor that is a member of the peer group.

```
clns filter-set routes0404 deny 49.0404...
clns filter-set routes0404 permit 49...
!
router bgp 65404
 no bgp default ipv4-unicast
 neighbor ebgp-peers remote-as 65303
 address-family nsap
   neighbor ebgp-peers prefix-list routes0404 out
   neighbor 10.6.7.8 peer-group ebgp-peers
```

Example: Originating a Default Route and Outbound Route Filtering

In the figure below, autonomous system AS65101 is connected to only one other autonomous system, AS65202. Router R2 in AS65202 provides the connectivity to the rest of the network for autonomous system AS65101 by sending a default route to R1. Any packets from Level 1 routers within autonomous system AS65101 with destination NSAP addresses outside the local Level 1 network are sent to R1, the nearest Level 2 router. Router R1 forwards the packets to router R2 using the default route.

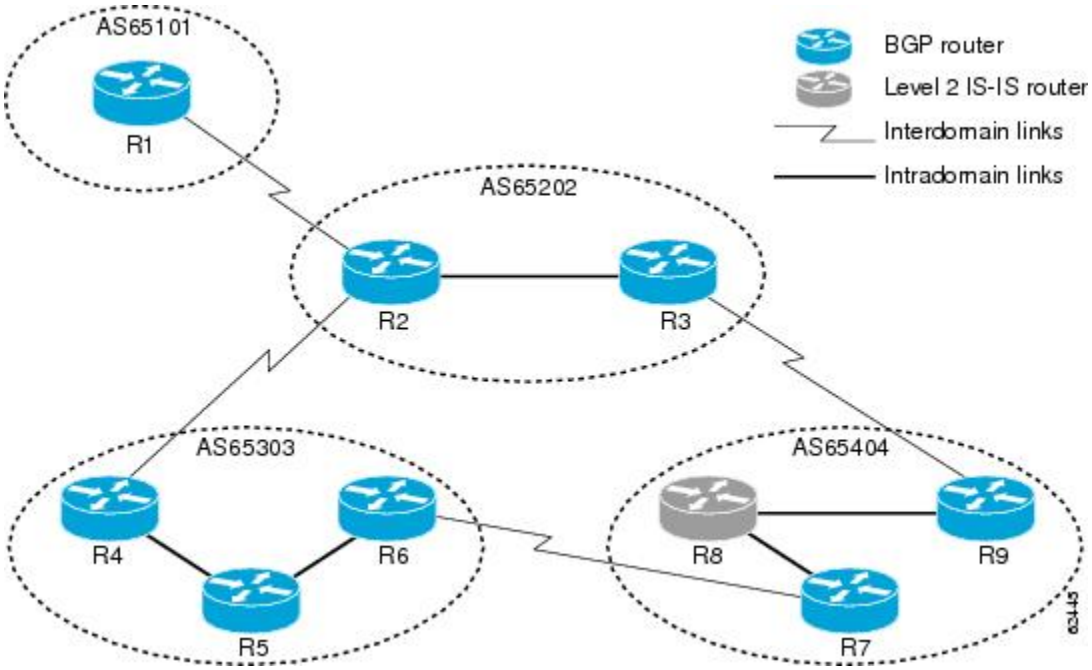
In the following example, the router R2, shown in the figure below, in the autonomous system AS65202 is configured to generate a default route for router R1 in the autonomous system AS65101, and an outbound filter is created to send only the default route NSAP addressing information in the BGP update messages to router R1.

```
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
!
router bgp 65202
 no bgp default ipv4-unicast
 neighbor 10.1.2.1 remote-as 64101
 address-family nsap
  network 49.0202...
  neighbor 10.1.2.1 activate
  neighbor 10.1.2.1 default-originate
  neighbor 10.1.2.1 prefix-list default-prefix-only out
```

Implementing MP-BGP Support for CLNS Example

The figure below shows a generic BGP CLNS network containing nine routers that are grouped into four different autonomous systems (in BGP terminology) or routing domains (in OSI terminology). This section contains complete configurations for all routers shown in the figure below.

Figure 3: Components in a Generic BGP CLNS Network



If you need more details about commands used in the following examples, see the configuration tasks earlier in this document and the documents listed in the Additional References, on page 36.

Autonomous System AS65101

Router 1

```
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
!
router isis osi-as-101
 net 49.0101.1111.1111.1111.1111.00
!
router bgp 65101
 no bgp default ipv4-unicast
 neighbor 10.1.2.2 remote-as 65202
 address-family nsap
  neighbor 10.1.2.2 activate
  neighbor 10.1.2.2 prefix-list default-prefix-only in
  network 49.0101...
  exit-address-family
!
interface serial 2/0
 ip address 10.1.2.1 255.255.255.0
```

```
 clns enable
 no shutdown
```

Autonomous System AS65202

Router 2

```
clns filter-set default-prefix-only deny 49...
clns filter-set default-prefix-only permit default
!
clns filter-set internal-routes permit 49.0202...
!
route-map internal-routes-only permit 10
  match clns address internal-routes
!
router isis osi-as-202
  net 49.0202.2222.2222.2222.2222.00
!
router bgp 65202
  no bgp default ipv4-unicast
  neighbor 10.1.2.1 remote-as 65101
  neighbor 10.2.3.3 remote-as 65202
  neighbor 10.2.4.4 remote-as 65303
  address-family nsap
    neighbor 10.1.2.1 activate
    neighbor 10.2.3.3 activate
    neighbor 10.2.4.4 activate
    redistribute isis osi-as-202 clns route-map internal-routes-only
    neighbor 10.1.2.1 default-originate
    neighbor 10.1.2.1 prefix-list default-prefix-only out
    exit-address-family
!
interface gigabitethernet 0/1/1
  ip address 10.2.3.2 255.255.255.0
  clns router isis osi-as-202
  no shutdown
!
interface serial 2/0
  ip address 10.1.2.2 255.255.255.0
  clns enable
  no shutdown
!
interface serial 2/2
  ip address 10.2.4.2 255.255.255.0
  clns enable
  no shutdown
```

Router 3

```
clns filter-set internal-routes permit 49.0202...
!
route-map internal-routes-only permit 10
  match clns address internal-routes
!
router isis osi-as-202
 net 49.0202.3333.3333.3333.3333.00
!
router bgp 65202
 no bgp default ipv4-unicast
 neighbor 10.2.3.2 remote-as 65202
```

```
 neighbor 10.3.9.9 remote-as 65404
 address-family nsap
  neighbor 10.2.3.2 activate
  neighbor 10.3.9.9 activate
  redistribute isis osi-as-202 clns route-map internal-routes-only
  exit-address-family
!
interface gigabitethernet 0/1/1
 ip address 10.2.3.3 255.255.255.0
 clns router isis osi-as-202
 no shutdown
!
interface serial 2/2
 ip address 10.3.9.3 255.255.255.0
 clns enable
 no shutdown
```

Autonomous System AS65303

Router 4

```
router isis osi-as-303
 net 49.0303.4444.4444.4444.4444.00
!
router bgp 65303
 no bgp default ipv4-unicast
 neighbor 10.2.4.2 remote-as 65202
 neighbor 10.4.5.5 remote-as 65303
 address-family nsap
  no synchronization
  neighbor 10.2.4.2 activate
  neighbor 10.4.5.5 activate
  network 49.0303...
  exit-address-family
!
interface gigabitethernet 0/2/1
 ip address 10.4.5.4 255.255.255.0
 clns router isis osi-as-303
 no shutdown
!
interface serial 2/3
 ip address 10.2.4.4 255.255.255.0
 clns enable
 no shutdown
```

Router 5

```
router isis osi-as-303
 net 49.0303.5555.5555.5555.5555.00
!
router bgp 65303
 no bgp default ipv4-unicast
 neighbor ibgp-peers peer-group
 neighbor ibgp-peers remote-as 65303
 address-family nsap
  no synchronization
  neighbor ibgp-peers route-reflector-client
  neighbor 10.4.5.4 peer-group ibgp-peers
  neighbor 10.5.6.6 peer-group ibgp-peers
  exit-address-family
```

```
!
interface gigabitethernet 0/2/1
 ip address 10.4.5.5 255.255.255.0
 clns router isis osi-as-303
 no shutdown
!
interface gigabitethernet 0/3/1
 ip address 10.5.6.5 255.255.255.0
 clns router isis osi-as-303
 no shutdown
```

Router 6

```
router isis osi-as-303
 net 49.0303.6666.6666.6666.6666.00
!
router bgp 65303
 no bgp default ipv4-unicast
 neighbor 10.5.6.5 remote-as 65303
 neighbor 10.6.7.7 remote-as 65404
 address-family nsap
  no synchronization
  neighbor 10.5.6.5 activate
  neighbor 10.6.7.7 activate
  network 49.0303...
!
interface gigabitethernet 0/3/1
 ip address 10.5.6.6 255.255.255.0
 clns router isis osi-as-303
 no shutdown
!
interface serial 2/2
 ip address 10.6.7.6 255.255.255.0
 clns enable
 no shutdown
```

Autonomous System AS65404

Router 7

```
clns filter-set external-routes deny 49.0404...
clns filter-set external-routes permit 49...
!
route-map noexport permit 10
  match clns address external-routes
  set community noexport
!
router isis osi-as-404
 net 49.0404.7777.7777.7777.7777.00
 redistribute bgp 404 clns
!
router bgp 65404
 no bgp default ipv4-unicast
 neighbor 10.6.7.6 remote-as 65303
 neighbor 10.8.9.9 remote-as 65404
 address-family nsap
  neighbor 10.6.7.6 activate
  neighbor 10.8.9.9 activate
  neighbor 10.8.9.9 send-community
  neighbor 10.8.9.9 route-map noexport out
```

```
  network 49.0404...
!
interface gigabitethernet 1/0/1
 ip address 10.7.8.7 255.255.255.0
 clns router isis osi-as-404
 ip router isis osi-as-404
 no shutdown
!
interface serial 2/3
 ip address 10.6.7.7 255.255.255.0
 clns enable
 no shutdown
```

Router 8

```
router isis osi-as-404
 net 49.0404.8888.8888.8888.8888.00
!
interface gigabitethernet 1/0/1
 ip address 10.7.8.8 255.255.255.0
 clns router isis osi-as-404
 ip router isis osi-as-404
 no shutdown
!
interface gigabitethernet 1/1/1
 ip address 10.8.9.8 255.255.255.0
 clns router isis osi-as-404
 ip router isis osi-as-404
 no shutdown
```

Router 9

```
clns filter-set external-routes deny 49.0404...
clns filter-set external-routes permit 49...
!
route-map noexport permit 10
  match clns address external-routes
  set community noexport
!
router isis osi-as-404
 net 49.0404.9999.9999.9999.9999.00
 redistribute bgp 404 clns
!
router bgp 65404
 no bgp default ipv4-unicast
 neighbor 10.3.9.3 remote-as 65202
 neighbor 10.7.8.7 remote-as 65404
 address-family nsap
  network 49.0404...
  neighbor 10.3.9.3 activate
  neighbor 10.7.8.7 activate
  neighbor 10.7.8.7 send-community
  neighbor 10.7.8.7 route-map noexport out
!
interface serial 2/3
 ip address 10.3.9.9 255.255.255.0
 clns enable
 no shutdown
!
interface gigabitethernet 1/1/1
 ip address 10.8.9.9 255.255.255.0
```

```
clns router isis osi-as-404
ip router isis osi-as-404
no shutdown
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
BGP commands	Cisco IOS IP Routing: BGP Command Reference

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 Configuring MP-BGP Support for CLNS

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 http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for MP-BGP Support for CLNS

Feature Name	Releases	Feature Information
Multiprotocol BGP (MP-BGP) Support for CLNS	Cisco IOS XE Release 2.6	

Feature Name	Releases	Feature Information
		The Multiprotocol BGP (MP-BGP) Support for CLNS feature provides the ability to scale Connectionless Network Service (CLNS) networks. The multiprotocol extensions of Border Gateway Protocol (BGP) add the ability to interconnect separate Open System Interconnection (OSI) routing domains without merging the routing domains, thus providing the capability to build very large OSI networks. The following commands were introduced or modified by this feature: • **address-family nsap** • **clear bgp nsap** • **clear bgp nsap dampening** • **clear bgp nsap external** • **clear bgp nsap flap-statistics** • **clear bgp nsap peer-group** • **debug bgp nsap** • **debug bgp nsap dampening** • **debug bgp nsap updates** • **neighbor prefix-list** • **network (BGP and multiprotocol BGP)** • **redistribute (BGP to ISO ISIS)** • **redistribute (ISO ISIS to BGP)** • **show bgp nsap** • **show bgp nsap community** • **show bgp nsap community-list** • **show bgp nsap dampened-paths** • **show bgp nsap filter-list** • **show bgp nsap flap-statistics** • **show bgp nsap inconsistent-as** • **show bgp nsap neighbors** • **show bgp nsap paths** • **show bgp nsap quote-regexp** • **show bgp nsap regexp** • **show bgp nsap summary**

Glossary

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

AS --autonomous system. An IP term to describe a routing domain that has its own independent routing policy and is administered by a single authority. Equivalent to the OSI term "routing domain."

BGP --Border Gateway Protocol. Interdomain routing protocol that exchanges reachability information with other BGP systems.

CLNS --Connectionless Network Service . An OSI network-layer protocol.

CMIP --Common Management Information Protocol. In OSI, a network management protocol created and standardized by ISO for the monitoring and control of heterogeneous networks.

DCC --data communications channel.

DCN --data communications network.

ES-IS --End System-to-Intermediate System. OSI protocol that defines how end systems (hosts) announce themselves to intermediate systems (routers).

FTAM --File Transfer, Access, and Management. In OSI, an application-layer protocol developed for network file exchange and management between diverse types of computers.

IGP --Interior Gateway Protocol. Internet protocol used to exchange routing information within an autonomous system.

IGRP --Interior Gateway Routing Protocol. A proprietary Cisco protocol developed to address the issues associated with routing in large, heterogeneous networks.

IS --intermediate system. Routing node in an OSI network.

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

ISO --International Organization for Standardization. International organization that is responsible for a wide range of standards, including those relevant to networking. ISO developed the Open System Interconnection (OSI) reference model, a popular networking reference model.

NSAP address --network service access point address. The network address format used by OSI networks.

OSI --Open System Interconnection. International standardization program created by ISO and ITU-T to develop standards for data networking that facilitate multivendor equipment interoperability.

routing domain --The OSI term that is equivalent to autonomous system for BGP.

SDH --Synchronous Digital Hierarchy. Standard that defines a set of rate and format standards that are sent using optical signals over fiber.

SONET --Synchronous Optical Network. High-speed synchronous network specification designed to run on optical fiber.