



Configuring Load Balancing on the GGSN

This chapter describes how to configure a gateway GPRS support node (GGSN) to support load balancing functions using the Cisco IOS software Server Load Balancing (SLB) feature. GTP load balancing provides increased reliability and availability when you are using multiple Cisco GGSNs or non-Cisco GGSNs in your GPRS/UMTS network.

For a complete description of the GGSN commands in this chapter, refer to the *Cisco GGSN Release 5.2 Command Reference*. For a complete description of the other Cisco IOS SLB commands in this chapter, refer to the *IOS Server Load Balancing* feature module.

To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

This chapter includes the following sections:

- [Overview of GTP Load Balancing, page 12-1](#)
- [Configuring GTP Load Balancing, page 12-8](#)
- [Configuring Messaging Between the GGSN and Cisco IOS SLB, page 12-16](#) (Optional)
- [Monitoring and Maintaining the Cisco IOS SLB Feature, page 12-20](#)
- [Configuration Examples, page 12-21](#)



Note

You can also use the GTP Director Module (GDM) to obtain simple, round-robin load balancing in environments where non-Cisco GGSNs are found. For more information about GDM and load balancing, see the *GTP Director Module* section of this book.

Overview of GTP Load Balancing

This section provides an overview of the Cisco IOS SLB feature and GTP load balancing support on the GGSN. It includes the following sections:

- [Overview of Cisco IOS SLB, page 12-2](#)
- [GGSN GTP Load Balancing Support, page 12-3](#)
- [GTP SLB Restrictions, page 12-7](#)

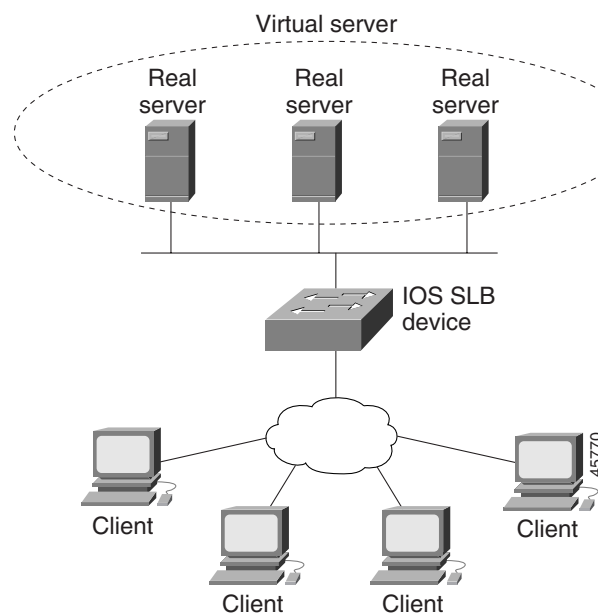
Overview of Cisco IOS SLB

The Cisco SLB feature is an IOS-based solution that provides IP server load balancing. Using the Cisco IOS SLB feature, you can define a *virtual server* that represents a group of *real servers* in a cluster of network servers known as a *server farm*. In this environment, the clients connect to the IP address of the virtual server. When a client initiates a connection to the virtual server, the Cisco IOS SLB feature chooses a real server for the connection, based on a configured *load-balancing algorithm*.

The Cisco IOS SLB feature also provides firewall load balancing, which balances flows across a group of *firewalls* called a *firewall farm*.

Figure 12-1 presents a logical view of a simple Cisco IOS SLB network.

Figure 12-1 Logical View of IOS SLB



Overview of GTP Load Balancing on the Catalyst 6500 / Cisco 7600 Platform

On the Catalyst 6500 / Cisco 7600 platform, GTP load balancing is supported by using the Cisco IOS SLB feature on the Supervisor 2/MSFC2.

On receiving a Create PDP Context request, the SLB on the MSFC2 will process only the Create PDP Context request sent to the GGSN virtual IP address. On receiving a Create PDP Context request, a real GGSN is selected based on the load at that time. Once the PDP context has been established by the GGSN, all subsequent transactions corresponding to the PDP contexts occurs directly between that GGSN and corresponding SGSN, bypassing the Cisco IOS SLB on the MSFC2.

On the Catalyst 6500 / Cisco 7600 platform:

- Multiple GGSN virtual farms are supported
- Load-balanced real servers can be internal or external to the Catalyst 6500 / Cisco 7600 chassis
- Each GGSN virtual farm must have one unique public IP address that is reachable from the SGSNs

- Each virtual farm can correspond to one or more access point names (APNs).
- The Domain Name System (DNS) server used by the SGSNs to resolve the APNs to a GGSN IP address should use the GGSN virtual IP address

GGSN GTP Load Balancing Support

Cisco IOS SLB provides GGSN GTP load balancing and increased reliability and availability for the GGSN. GGSN GTP load balancing supports a subset of the overall server load-balancing functions that are available in the Cisco IOS SLB feature. Therefore, the full scope of Cisco IOS SLB functions is not applicable to the general packet radio service/Universal Mobile Telecommunication System (GPRS/UMTS) environment. For more information about unsupported functions, see the [“GTP SLB Restrictions”](#) section on page 12-7.

When configuring GTP load balancing, a pool of GGSNs is configured as a server farm in Cisco IOS SLB. These are the GGSNs across which you want to load-balance GTP sessions. A virtual server instance is configured in IOS SLB to load balance GTP sessions across the GGSN farm. This virtual server is associated with the server farm that you configured in Cisco IOS SLB.

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Supported GTP Load Balancing Types

The Cisco IOS SLB supports two types of GTP load balancing:

- [GTP Load Balancing Without GTP Cause Code Inspection, page 12-4](#)
- [GTP Load Balancing With GTP Cause Code Inspection, page 12-4](#)

GTP Load Balancing Without GTP Cause Code Inspection

GTP load balancing *without* GTP cause code inspection enabled is recommended for Cisco GGSNs. It has the following characteristics:

- Can operate in dispatched mode or in directed server Network Address Translation (NAT) mode, but not in directed client NAT mode. In dispatched mode, the GGSNs must be Layer 2–adjacent to the Cisco IOS SLB device.
- Does not support stateful backup.
- Delivers tunnel creation messages destined to the virtual GGSN IP address to one of the real GGSNs, using the weighted round-robin load-balancing algorithm. See the “[Weighted Round-Robin](#)” section on page 12-5 for more information about this algorithm.
- Requires Dynamic Feedback Protocol (DFP) to account for secondary PDP contexts in GTP v1.

GTP Load Balancing With GTP Cause Code Inspection

GTP load balancing *with* GTP cause code inspection enabled allows Cisco IOS SLB to monitor all PDP context signaling flows to and from GGSN server farms. This enables Cisco IOS SLB to monitor GTP failure cause codes, detecting system-level problems in both Cisco and non-Cisco GGSNs.

[Table 12-1](#) lists the Create PDP Context response cause codes and the corresponding actions taken by Cisco IOS SLB.

Table 12-1 PDP Create Response Cause Codes and Corresponding Cisco IOS SLB Actions

Cause Code	Cisco IOS SLB Action
Request Accepted	Establish session
No Resource Available	Fail current real, reassign session, drop the response
All dynamic addresses are occupied	Fail current real, reassign session, drop the response
No memory is available	Fail current real, reassign session, drop the response
System Failure	Fail current real, reassign session, drop the response
Missing or Unknown APN	Forward the response
Unknown PDP Address or PDP type	Forward the response
User Authentication Failed	Forward the response
Semantic error in TFT operation	Forward the response
Syntactic error in TFT operation	Forward the response
Semantic error in packet filter	Forward the response
Syntactic error in packet filter	Forward the response
Mandatory IE incorrect	Forward the response
Mandatory IE missing	Forward the response
Optional IE incorrect	Forward the response
Invalid message format	Forward the response
Version not supported	Forward the response
PDP context without TFT already activated	Fail current real, reassign session, drop the response

GTP load balancing *with* GTP cause code inspection enabled has the following characteristics:

- Must operate in directed server NAT mode.
- Assigns PDP context creates from a specific International Mobile Subscriber ID (IMSI) to the same GGSN.
- Supports stateful backup.
- Tracks the number of open PDP contexts for each GGSN, which enables GGSN server farms to use the weighted least connections (**leastconns**) algorithm for GTP load balancing. See the “[Weighted Least Connections](#)” section on page 12-5 for more information about this algorithm.
- Enables Cisco IOS SLB to deny access to a virtual GGSN if the carrier code of the requesting IMSI does not match a specified value.
- Enables Cisco IOS SLB to support secondary PDP contexts, even without DFP.

Cisco IOS SLB Algorithms Supported for GTP Load Balancing

The following two Cisco IOS SLB algorithms are supported for GTP load balancing:

- [Weighted Round-Robin, page 12-5](#)
- [Weighted Least Connections, page 12-5](#)

Weighted Round-Robin

The weighted round-robin algorithm specifies that the real server used for a new connection to the virtual server is chosen from the server farm in a circular fashion. Each real server is assigned a weight, n , that represents its capacity to handle connections, as compared to the other real servers associated with the virtual server. That is, new connections are assigned to a given real server n times before the next real server in the server farm is chosen.

For example, assume a server farm made up of three real servers: ServerA with $n = 3$, ServerB with $n = 1$, and ServerC with $n = 2$. The first three connections to the virtual server are assigned to ServerA, the fourth connection to ServerB, and the fifth and sixth connections to ServerC.



Note

Assigning a weight of $n = 1$ to all of the servers in the server farm configures the Cisco IOS SLB device to use a simple round-robin algorithm.

GTP load balancing *without* GTP cause code inspection enabled requires the weighted round-robin algorithm. A server farm that uses weighted least connections can be bound to a virtual server that provides GTP load balancing without GTP cause code inspection enabled, but you cannot place that virtual server **INSERVICE**. If you try to do so, Cisco IOS SLB issues an error message.

Weighted Least Connections

When GTP cause code inspection is enabled, GTP load balancing supports the Cisco IOS SLB weighted least connections algorithm.

The weighted least connections algorithm specifies that the next real server chosen from a server farm for a new connection to the virtual server is the server with the fewest active connections. Each real server is assigned a weight for this algorithm, also. When weights are assigned, the server with the fewest connections is determined on the basis of the number of active connections on each server and the

relative capacity of each server. The capacity of a given real server is calculated as the assigned weight of that server divided by the sum of the assigned weights of all the real servers associated with that virtual server, or $n_1/(n_1+n_2+n_3\dots)$.

For example, assume a server farm made up of three real servers: ServerA with $n = 3$, ServerB with $n = 1$, and ServerC with $n = 2$. ServerA would have a calculated capacity of $3/(3+1+2)$, or half of all active connections on the virtual server, ServerB would have a calculated capacity of one-sixth of all active connections, and ServerC one-third of all active connections. At any point in time, the next connection to the virtual server would be assigned to the real server whose number of active connections is farthest below its calculated capacity.

**Note**

Assigning a weight of $n = 1$ to all of the servers in the server farm configures the Cisco IOS SLB device to use a simple least-connection algorithm.

GTP load balancing *without* GTP cause code inspection enabled *does not* support the weighted least connections algorithm.

GTP load balancing *with* GTP cause code inspection *does* support the weighted least connections algorithm.

Dynamic Feedback Protocol for Cisco IOS SLB

In GTP load balancing, Cisco IOS SLB detects when a PDP context is established, but it does not detect when PDP contexts are cleared, and therefore it cannot determine the number of open PDP contexts for each GGSN. Use the Cisco IOS SLB DFP to calculate GPRS/UMTS load-balancing weights dynamically.

With Cisco IOS SLB DFP support, a *DFP manager* in a load-balancing environment can initiate a TCP connection with a *DFP agent*. Thereafter, the DFP agent collects status information from one or more real host servers, converts the information to relative weights, and reports the weights to the DFP manager. The DFP manager factors in the weights when load balancing the real servers. In addition to reporting at user-defined intervals, the DFP agent sends an early report if there is a sudden change in a real server's status.

The weights calculated by DFP override the static weights you define using the **weight (server farm)** command. If DFP is removed from the network, Cisco IOS SLB reverts to the static weights.

You can define Cisco IOS SLB as a DFP manager, as a DFP agent for another DFP manager (such as DistributedDirector), or as both at the same time. In such a configuration, Cisco IOS SLB sends periodic reports to DistributedDirector, which uses the information to choose the best server farm for each new connection request. Cisco IOS SLB then uses the same information to choose the best real server within the chosen server farm.

DFP also supports the use of multiple DFP agents from different client subsystems (such as Cisco IOS SLB and GPRS/UMTS) at the same time.

In GTP load balancing, you can define Cisco IOS SLB as a DFP manager and define a DFP agent on each GGSN in the server farm, and the DFP agent can report the weights of the GGSNs. The DFP agents calculate the weight of each GGSN, based on CPU utilization, processor memory, and the maximum number of PDP contexts (mobile sessions) that can be activated for each GGSN.

The weight for each GGSN is based primarily on the ratio of existing PDP contexts on the GGSN and the maximum number of allowed PDP contexts. CPU and memory utilization become part of the weight calculation only after the utilization exceeds 85%. Because the maximum number of allowed PDP

contexts is considered to be the GGSNs maximum load, you should carefully consider the value that you configure in the **gprs maximum-pdp-context-allowed** command, which defaults to 10,000 PDP contexts.

GTP SLB Restrictions

The following restrictions apply when configuring GTP load balancing:

- For GTP load balancing without GTP cause code inspection enabled:
 - Operates in either dispatched mode or directed server NAT mode only
 - Cannot load balance network-initiated PDP context requests
 - Does not support the following Cisco IOS SLB functions:
 - Bind IDs
 - Client-assigned load balancing
 - Slow Start
 - Sticky connections
 - Stateful backup (not supported on the Catalyst 6500 / Cisco 7600 platform)
 - Weighted least connections load-balancing algorithm
- For GTP load balancing *with* GTP cause code inspection enabled:
 - Operates in directed server NAT mode only
 - Cannot load-balance network-initiated PDP context requests
 - Requires either the SGSN or the GGSN to echo its peer
 - Inbound and outbound traffic should be routed via Cisco IOS SLB
 - Does not support the following Cisco IOS SLB functions:
 - Bind IDs
 - Client-assigned load balancing
 - Slow Start
 - Sticky connections

Configuring GTP Load Balancing

This section includes the following topics:

- [GTP Load Balancing Configuration Task List, page 12-8](#)
- [Configuration Guidelines, page 12-8](#)

GTP Load Balancing Configuration Task List

This section lists the tasks used to configure GTP load balancing. Detailed configuration information is contained in the referenced sections of this document or other documents. Required and optional tasks are indicated.

1. On the Cisco IOS SLB, complete the following tasks:
 - a. [Configuring a Server Farm and Real Server, page 12-9](#) (Required)
 - b. [Configuring a Virtual Server, page 12-11](#) (Required)
 - c. [Configuring a GSN Idle Timer, page 12-13](#) (Optional if GTP cause code inspection is enabled)
 - d. [Configuring DFP Support, page 12-14](#) (Optional, but recommended)
2. On the GGSN, complete the following tasks:
 - a. [Configuring a Loopback Interface for GTP SLB, page 12-14](#) (Required)
 - b. [Configuring DFP Support on the GGSN, page 12-15](#) (Optional, but recommended)
3. Routing each GGSN to each associated serving GPRS support node (SGSN) (Required)
 The route can be static or dynamic but the GGSN needs to be able to reach the SGSN. For more information, see the [“Configuring a Route to the SGSN” section on page 7-5](#).
4. On the SGSN, route each SGSN to the virtual templates on each associated GGSN, and to the GGSN load-balancing virtual server (Required)
5. [Configuring Messaging Between the GGSN and Cisco IOS SLB, page 12-16](#) (Optional)

Configuration Guidelines

When configuring the network shared by Cisco IOS SLB and the GGSNs, keep the following considerations in mind:

- Specify static routes (using **ip route** commands) and real server IP addresses (using **real** commands) so that the Layer 2 information is correct and unambiguous.
- Configure the static route from the SGSN to the virtual server.
- Choose subnets carefully, using one of the following methods:
 - Do not overlap virtual template address subnets.
 - Specify next-hop addresses to real servers, not to interfaces on those servers.
- Cisco IOS SLB supports two types of GTP load balancing:
 - [GTP Load Balancing Without GTP Cause Code Inspection, page 12-4](#)
 - [GTP Load Balancing With GTP Cause Code Inspection, page 12-4](#)

- Cisco IOS SLB supports both GTP v0 and GTP v1. Support for GTP enables Cisco IOS SLB to become “GTP aware,” extending Cisco IOS SLB’s knowledge into Layer 5.
- On the Catalyst 6500 / Cisco 7600 platform, the following apply:
 - Multiple GGSN virtual farms are supported.
 - Load balanced real servers can be internal or external to the Catalyst 6500 / Cisco 7600 chassis.
 - Each GGSN virtual farm must have one unique public IP address that is reachable from the SGSNs.
 - Each virtual farm can correspond to one or more APNs.
 - The DNS server used by the SGSNs to resolve the APNs to a GGSN IP address should use the GGSN virtual IP address.

Configuring the Cisco IOS SLB for GTP Load Balancing

To configure GTP load balancing, you must complete the following tasks on the Cisco IOS SLB:



- [Configuring a Server Farm and Real Server, page 12-9](#) (Required)
- [Configuring a Virtual Server, page 12-11](#) (Required)
- [Configuring a GSN Idle Timer, page 12-13](#) (Optional)
- [Configuring DFP Support, page 12-14](#) (Optional, but recommended)


Configuring a Server Farm and Real Server

When you configure the server farm and real server on the Cisco IOS SLB for GTP load balancing, use the following guidelines to ensure proper configuration:

- If GTP cause code inspection is not enabled, accept the default setting (the weighted round-robin algorithm) for the **predictor** command.
If GTP cause code inspection is enabled, you can specify either the weighted round-robin algorithm (**roundrobin**) or the weighted least connections (**leastconns**) algorithm.
- Specify the IP addresses (virtual template addresses, for Cisco GGSNs) of the real servers performing the GGSN function, using the **real** command.
- Specify a reassign threshold less than the SGSN’s N3-REQUESTS counter value by using the **reassign** command.

To configure a Cisco IOS SLB server farm, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Router(config)# ip slb serverfarm <i>serverfarm-name</i> Router(config-slb-sfarm)#	Adds a server farm definition to the Cisco IOS SLB configuration, and enters server farm configuration mode.
Step 2	Router(config-slb-sfarm)# predictor [roundrobin leastconns]	Specifies the algorithm to be used to determine how a real server is selected.  Note In GTP load balancing <i>without</i> GTP cause code inspection enabled, you must accept the default setting (the weighted round-robin algorithm). See the following sections for more details about each algorithm: <ul style="list-style-type: none"> • Weighted Round-Robin, page 12-5 • Weighted Least Connections, page 12-5
Step 3	Router(config-slb-sfarm)# nat server	(Required if GTP cause code inspection is enabled; optional for GTP load balancing <i>without</i> cause code inspection enabled) Configures NAT server address translation mode on the server farm.
Step 4	Router(config-slb-sfarm)# real <i>ip-address</i> [<i>port</i>]	Identifies a real GGSN as a member of a server farm, using the IP address of the GGSN's virtual template interface, and enters real server configuration mode.
Step 5	Router(config-slb-real)# faildetect numconns <i>number-conns</i> [numclients <i>number-clients</i>]	(Optional) Specifies the number of consecutive connection failures and, optionally, the number of unique client connection failures, that constitute failure of the real server.
Step 6	Router(config-slb-real)# maxconns <i>number-conns</i>	(Optional) Specifies the maximum number of active connections allowed on the real server at one time.  Note In GTP load balancing <i>without</i> cause code inspection enabled, the impact of this command is minimal because a session will last no longer than the duration specified with the ip gtp request command.
Step 7	Router(config-slb-real)# reassign <i>threshold</i>	(Optional) Specifies the threshold of consecutive unacknowledged synchronizations or Create PDP Context requests that, if exceeded, results in an attempted connection to a different real server.

	Command	Purpose
Step 8	Router(config-slb-real)# retry <i>retry-value</i>	(Optional) Specifies the interval, in seconds, to wait between the detection of a server failure and the next attempt to connect to the failed server.
Step 9	Router(config-slb-real)# weight <i>weighting-value</i>	(Optional) Specifies the real server's workload capacity relative to other servers in the server farm.  Note If you use DFP, the static weights you define using the weight (server farm) command are overridden by the weights calculated by DFP. If DFP is removed from the network, Cisco IOS SLB reverts to the static weights.
Step 10	Router(config-slb-real)# inservice	Enables the real server for use by Cisco IOS SLB.

Configuring a Virtual Server




When you configure the virtual server on the Cisco IOS SLB for GTP load balancing, use the following guidelines to ensure proper configuration:

- Configure a static route from the SGSN to the virtual server.
- Specify a virtual GGSN IP address as the virtual server, and use the **udp** keyword option.
- To load-balance GTP v1 sessions, specify port number **2123**, if the GGSNs and SGSNs are in compliance with the ETSI standard, or specify port number **0** or **any** to configure an all-port virtual server (that is, a virtual server that accepts flows destined for all ports).
- To load-balance GTP v0 sessions, specify port number **3386**, if the GGSNs and SGSNs are in compliance with the European Telecommunications Standards Institute (ETSI) standard, or specify port number **0** or **any** to configure an all-port virtual server.
- To enable GTP load balancing *without* GTP cause code inspection, specify the **service gtp** keyword option.
- To enable GTP load balancing *with* GTP cause code inspection, specify the **service gtp-inspect** keyword option.

In GTP load balancing *without* GTP cause code inspection enabled, when you configure the GTP idle timer using the **idle** command, specify a GTP idle timer greater than the longest possible interval between PDP context requests on the SGSN.

To configure an Cisco IOS SLB virtual server, use the following commands, beginning in global configuration mode:

	Command	Purpose
Step 1	Router(config)# ip slb vserver <i>virtual_server-name</i>	Identifies a virtual server, and enters virtual server configuration mode.
Step 2	Router(config-slb-vserver)# virtual <i>ip-addr</i> [<i>netmask</i> [group]] { esp gre <i>protocol</i> } or Router(config-slb-vserver)# virtual <i>ip-addr</i> [<i>netmask</i> [group]] { tcp udp } [<i>port</i> any] [service <i>service</i>]	Specifies the virtual server IP address, type of connection, and optional TCP or UDP port number, Internet Key Exchange (IKE) Internet Security Association and Key Management Protocol (ISAKMP) or Wireless Session Protocol (WSP) setting, and service coupling. Note For GTP load balancing: <ul style="list-style-type: none"> – Specify a virtual GGSN IP address as the virtual server, and specify the udp keyword option. – To load-balance GTP v1 sessions, specify port number 2123, if the GGSNs and SGSNs are in compliance with the ETSI standard, or specify port number 0 or any to configure an all-port virtual server (that is, a virtual server that accepts flows destined for all ports). – To load-balance GTP v0 sessions, specify port number 3386, if the GGSNs and SGSNs are in compliance with the ETSI standard, or specify port number 0 or any to configure an all-port virtual server. – To enable GTP load balancing <i>without</i> GTP cause code inspection, specify the service gtp keyword option. – To enable GTP load balancing <i>with</i> GTP cause code inspection, specify the service gtp-inspect keyword option.
Step 3	Router(config-slb-vserver)# serverfarm <i>primary-farm</i> [backup <i>backup-farm</i>]	Associates a real server farm with a virtual server, or configures a backup server farm.

	Command	Purpose
Step 4	Router(config-slb-vserver)# idle [gtp request] <i>duration</i>	<p>(Optional) Specifies the minimum amount of time that Cisco IOS SLB maintains connection context in the absence of packet activity.</p> <p>The idle command specified without the gtp request keyword option controls the GTP idle timer for GTP load balancing <i>without</i> cause code inspection enable. The idle gtp request command controls the GTP idle timer for both GTP load balancing <i>without</i> cause code inspection enabled and for GTP load balancing <i>with</i> cause code inspection enabled. The idle gtp request is the recommended configuration.</p> <p> Note In GTP load balancing <i>without</i> GTP cause code inspection enabled, specify a GTP idle timer greater than the longest possible interval between PDP context requests on the SGSN.</p>
Step 5	Router(config-slb-vserver)# inservice	Enables the virtual server for use by Cisco IOS SLB.
Step 6	Router(config-slb-vserver)# client { <i>ip-address</i> <i>network-mask</i> [exclude] gtp carrier-code [<i>code</i>]}	<p>(Optional) Specifies which clients are allowed to use the virtual server.</p> <p> Note GTP load balancing supports only the gtp carrier-code option, and only if GTP cause code inspection is enabled.</p>
Step 7	Router(config-slb-vserver)# replicate casa <i>listen-ip</i> <i>remote-ip port</i> [<i>interval</i>] [password [0 7] <i>password timeout</i>]	<p>(Optional) Configures a stateful backup of Cisco IOS SLB decision tables to a backup switch.</p> <p> Note GTP load balancing <i>without</i> GTP cause code inspection enabled does not support this command.</p>

Configuring a GSN Idle Timer

When GTP cause code inspection is enabled, you can configure the amount of time that the Cisco IOS SLB will maintain sessions to and from an idle GGSN or SGSN.

To configure a GSN idle timer, enter the following command in global configuration mode on the Cisco IOS SLB:

Command	Purpose
Router(config)# ip slb timers gtp gsn <i>duration</i>	Changes the amount of time that Cisco IOS SLB maintains sessions to and from an idle GGSN or SGSN.

Configuring DFP Support

You can define Cisco IOS SLB as a DFP manager, as a DFP agent for another DFP manager (such as DistributedDirector), or as both at the same time. Depending on your network configuration, you might enter the commands for configuring Cisco IOS SLB as a DFP manager and the commands for configuring Cisco IOS SLB as a DFP agent on the same device or on different devices.

To configure Cisco IOS SLB as a DFP manager, and to identify a DFP agent with which Cisco IOS SLB can initiate connections, use the following commands, beginning in global configuration mode:

	Command	Description
Step 1	<code>Router(config)# ip slb dfp [password [0 7] password [timeout]]</code>	Configures DFP, supplies an optional password, and enters DFP configuration mode.
Step 2	<code>Router(config-slb-dfp)# agent ip_address port-number [timeout [retry_count [retry_interval]]]</code>	Identifies a DFP agent to which Cisco IOS SLB can connect.

Configuring the GGSN for GTP Load Balancing

To configure GTP load balancing on the GGSN, complete the tasks in the following sections:

- [Configuring a Loopback Interface for GTP SLB, page 12-14](#) (Required if using dispatched mode without GTP cause code inspection enabled)
- [Configuring DFP Support on the GGSN, page 12-15](#) (Optional, but recommended)

Configuring a Loopback Interface for GTP SLB

To enable GTP load balancing, a loopback interface must be configured with the same IP address as the virtual server on the Cisco IOS SLB on each GGSN in a farm.

To create a loopback interface, use the following commands, beginning in global configuration mode:

	Command	Description
Step 1	<code>Router(config)# interface loopback number</code>	Creates a loopback interface. A loopback interface is a virtual interface that is always up.
Step 2	<code>Router(config-if)# ip address ip-address mask</code>	Assigns an IP address to the loopback interface.

Configuring DFP Support on the GGSN

To configure DFP support for GTP SLB, you must complete the following tasks:

- [Configuring the GGSN as a DFP Agent, page 12-15](#)
- [Configuring the Maximum DFP Weight for a GGSN, page 12-15](#)
- [Configuring the Maximum Number of PDP Contexts for a GGSN, page 12-16](#)

Configuring the GGSN as a DFP Agent

For complete information on configuring a DFP agent, refer to the *DFP Agent Subsystem* feature module.

To define the port number to be used by the DFP manager (the Cisco IOS SLB in this instance) to connect to the DFP agent, enter the following commands in order, beginning in global configuration mode:

	Command	Description
Step 1	Router(config)# ip dfp agent gprs	Identifies a DFP agent subsystem and initiates DFP agent configuration mode.
Step 2	Router(config-dfp)# interval seconds	(Optional) Configures a DFP agent weight recalculation interval. Valid range is 5 to 65535. The default is 10.
Step 3	Router(config-dfp)# password [0 7] password [timeout]	Optional) Configures a DFP agent password for MD5 authentication.
Step 4	Router(config-dfp)# port port-number	Defines the port number to be used by the DFP manager to connect to the DFP agent.
Step 5	Router(config-dfp)# inservice	Enables the DFP agent for communication with a DFP manager. A DFP agent is inactive until both of the following conditions are met: <ul style="list-style-type: none"> • The DFP agent has been enabled using the inservice (DFP agent) command. • The client subsystem has changed the DFP agent's state to ACTIVE.

Configuring the Maximum DFP Weight for a GGSN

If you use DFP with GTP load balancing, each GGSN that acts as a DFP agent has a maximum weight that it can send to a DFP manager. For each GGSN, you can accept the default maximum weight, or you can specify a different maximum weight.

To specify the maximum weight for a GGSN, use the following command in global configuration mode on the GGSN:

Command	Purpose
Router(config)# gprs dfp max-weight [max-weight-value]	Specifies the maximum weight of a GGSN that is acting as a DFP agent.

Configuring the Maximum Number of PDP Contexts for a GGSN

If you use DFP with GTP load balancing, you must specify a maximum number of PDP contexts for each GGSN, using the **gprs maximum-pdp-context-allowed** command. *Do not* accept the default value of 10000 PDP contexts. Significantly lower values, including the default value of 10,000, can impact capacity in a GPRS/UMTS load-balancing environment.



Note

DFP weighs PPP PDPs against IP PDPs, with one PPP PDP equal to 8 IP PDPs. Therefore, when using DFP, be aware that the configured maximum number of PDP contexts affects the GGSN weight. The lower the maximum number of PDP contexts, the lower the weight, when all other parameters remain the same.

To configure a maximum number of PDP contexts for a GGSN, use the following command in global configuration mode on the GGSN:

Command	Purpose
Router(config)# gprs maximum-pdp-context-allowed [pdp-contexts]	Specifies the maximum number of PDP contexts (mobile sessions) that can be activated on the GGSN.

Configuring Messaging Between the GGSN and Cisco IOS SLB

The GGSN-IOS SLB messaging function enables you to configure a GGSN to notify the Cisco IOS SLB when a condition exists that affects a session forwarded by the IOS SLB, and to instruct the Cisco IOS SLB on how to react to the condition. For example, if a Create PDP Context request is rejected by the GGSN because of a Call Admission Control (CAC) failure, the GGSN notifies the Cisco IOS SLB that a CAC-related failure has occurred and instructs the Cisco IOS SLB to reassign the session to another GGSN in the server farm.

Notification messages sent by the GGSN include the following information elements (IEs):

- Type—Notification type (for example, reassign).
- Session identifier—Session key on the Cisco IOS SLB that identifies the session to which a notification belongs.
- Create response—Create response that the GGSN would send to the SGSN when a failure occurred. If there is not an alternate GGSN available to which to reassign the session, or if the maximum number of reassign attempts has been exceeded, the Cisco IOS SLB relays this information to the SGSN.

This section contains the following information:

- [Enabling GGSN-IOS SLB Messaging when Cisco IOS SLB is in Dispatched Mode, page 12-16](#)
- [Enabling GGSN-IOS SLB Messaging when Cisco IOS SLB is in Directed Server NAT Mode, page 12-17](#)

Enabling GGSN-IOS SLB Messaging when Cisco IOS SLB is in Dispatched Mode

If the Cisco IOS SLB is functioning in dispatched mode, the virtual server that forwarded the Create PDP Context request to the GGSN is known to the GGSN and the GGSN can send notification directly to the server. Therefore, the only step required to configure GGSN-IOS SLB messaging is to enable the messaging feature on the GGSN and on the Cisco IOS SLB.

To enable GGSN-IOS SLB messaging on the GGSN, use the following command in global configuration mode:

Command	Purpose
Router(config)# gprs slb notify {cac-failure}	Enables the GGSN to notify the Cisco IOS SLB when a UMTS QoS CAC or canonical QoS failure has caused a Create PDP Context request to be rejected.

To enable GGSN-IOS SLB messaging on the Cisco IOS SLB, use the following command in virtual server mode:

Command	Purpose
Router(config-slb-vserver)# gtp notification cac count	Enables GGSN-IOS SLB messaging on the Cisco IOS SLB and configures the maximum number of times a rejected Create PDP Context can be reassigned to a new real GGSN. The default is 2 (which is 3 real selections per session, including the initial send).

Enabling GGSN-IOS SLB Messaging when Cisco IOS SLB is in Directed Server NAT Mode

If the Cisco IOS SLB is functioning in directed server NAT mode, the virtual server is not known to the GGSN. Therefore, in addition to enabling the GGSN-IOS SLB messaging feature on the GGSN and Cisco IOS SLB, a list of virtual servers must be defined on the GGSN using the **gprs slb vserver** global configuration command and the Cisco IOS SLB mode of operation must be defined using the **gprs slb mode** global configuration command.



Note

If the Cisco IOS SLB operation mode and virtual servers are not defined, GGSN-IOS SLB messaging is not enabled even when the **gprs slb notify** and **gtp notification cac** commands are configured.

To enable GGSN-IOS SLB messaging on the GGSN when the Cisco IOS SLB is in Directed Server NAT Mode, use the following commands, while in global configuration mode:

	Command	Description
Step 1	Router(config)# gprs slb mode { dispatched directed }	Defines the Cisco IOS SLB operation mode for GGSN-IOS SLB messaging.
Step 2	Router(config)# gprs slb vservers <i>ip_address</i>	Configures the Cisco IOS SLB virtual servers to be notified by a GGSN when the condition configured using the gprs slb notify command occurs.
Step 3	Router(config)# gprs slb notify { cac-failure }	Enables the GGSN to notify the Cisco IOS SLB when a UMTS QoS CAC or canonical QoS failure has caused a Create PDP Context request to be rejected.

To enable GGSN-IOS SLB messaging on the Cisco IOS SLB, use the following command in virtual server mode:

Command	Purpose
Router(config-slb-vserver)# gtp notification cac count <i>count</i>	Enables GGSN-IOS SLB notification and configures the maximum number of times a create PDP context that is rejected can be reassigned to a new real GGSN. The default is 2 (including the initial send, 3 real selections per session).

Verifying the Cisco IOS SLB Configuration

This section describes how to verify the Cisco IOS SLB configuration. It includes the following topics:

- [Verifying the Virtual Server, page 12-18](#)
- [Verifying the Server Farm, page 12-19](#)
- [Verifying Cisco IOS SLB Connectivity, page 12-19](#)

Verifying the Virtual Server

The following **show ip slb vserver** command verifies the configuration of the virtual servers PUBLIC_HTTP and RESTRICTED_HTTP:

```
IOSSLB# show ip slb vserver

slb vserver      prot  virtual          state          conns
-----
PUBLIC_HTTP      TCP   10.0.0.1:80      OPERATIONAL    0
RESTRICTED_HTTP  TCP   10.0.0.2:80      OPERATIONAL    0
IOSSLB#
```

Verifying the Server Farm

The following **show ip slb reals** command displays the status of server farms PUBLIC and RESTRICTED, the associated real servers, and their status:

```
IOSSLB# show ip slb real
```

real	farm name	weight	state	conns
10.1.1.1	PUBLIC	8	OPERATIONAL	0
10.1.1.2	PUBLIC	8	OPERATIONAL	0
10.1.1.3	PUBLIC	8	OPERATIONAL	0
10.1.1.20	RESTRICTED	8	OPERATIONAL	0
10.1.1.21	RESTRICTED	8	OPERATIONAL	0

```
IOSSLB#
```

The following **show ip slb serverfarm** command displays the configuration and status of server farms PUBLIC and RESTRICTED:

```
IOSSLB# show ip slb serverfarm
```

server farm	predictor	nat	reals	bind id
PUBLIC	ROUNDROBIN	none	3	0
RESTRICTED	ROUNDROBIN	none	2	0

```
IOSSLB#
```

Verifying Cisco IOS SLB Connectivity

To verify that the Cisco IOS SLB feature has been installed and is operating correctly, ping the real servers from the Cisco IOS SLB switch, and then ping the virtual servers from the clients.

The following **show ip slb stats** command displays detailed information about the Cisco IOS SLB network status:

```
IOSSLB# show ip slb stats
Pkts via normal switching: 0
Pkts via special switching: 0
Pkts via slb routing: 0
Pkts Dropped: 0
Connections Created: 0
Connections Established: 0
Connections Destroyed: 0
Connections Reassigned: 0
Zombie Count: 0
Connections Reused: 0
Connection Flowcache Purges: 0
Failed Connection Allocs: 0
Failed Real Assignments: 0
RADIUS framed-ip Sticky Count: 0
RADIUS username Sticky Count: 0
```

See the [“Monitoring and Maintaining the Cisco IOS SLB Feature”](#) section on page 12-20 for additional commands used to verify Cisco IOS SLB networks and connections.


Monitoring and Maintaining the Cisco IOS SLB Feature

To clear, obtain, and display GTP SLB information on the GGSN, use the following commands in privileged EXEC mode:

Command	Purpose
Router# clear gprs slb statistics	Clears Cisco IOS SLB statistics.
Router# show gprs slb detail	Displays all Cisco IOS SLB-related information, such as operation mode, virtual server addresses for GGSN-IOS SLB messaging, SLB notifications, and statistics.
Router# show gprs slb mode	Displays the Cisco IOS SLB mode of operation.
Router# show gprs slb statistics	Displays Cisco IOS SLB statistics.
Router# show gprs slb vservers	Displays a list of defined Cisco IOS SLB virtual servers for GGSN-IOS SLB messaging.
Router# show ip slb stats	Displays Cisco IOS SLB statistics.
Router# show ip slb vserver [name <i>virtual_server</i>] [redirect] [detail]	Displays information about the virtual servers defined to Cisco IOS SLB.

To obtain and display information about the GTP SLB on the Cisco IOS SLB, use the following commands in privileged EXEC mode on the Cisco IOS SLB:

Command	Purpose
Router# show ip slb conns [vserver <i>virtual_server-name</i> client <i>ip-address</i> firewall <i>firewallfarm-name</i>] [detail]	Displays all connections handled by Cisco IOS SLB, or, optionally, only the connections associated with a particular virtual server or client.
Router# show ip slb dfp [agent <i>agent_ip_address</i> <i>port-number</i> manager <i>manager_ip_address</i> detail weights]	Displays information about DFP and DFP agents, and about the weights assigned to real servers.
Router# show ip slb gtp {gsn [<i>gsn-ip-address</i>] nsapi [<i>nsapi-key</i>] [detail]}	Displays Cisco IOS SLB GTP information when GTP load balancing with cause code inspection is enabled.
Router# show ip slb reals [<i>sfarm server-farm</i>] [detail]	Displays information about the real servers defined to Cisco IOS SLB.
Router# show ip slb replicate	Displays information about the Cisco IOS SLB replication configuration.
Router# show ip slb serverfarms [name <i>serverfarm-name</i>] [detail]	Displays information about the server farms defined to Cisco IOS SLB.

Command	Purpose
Router# <code>show ip slb sessions [gtp gtp-inspect radius]</code> <code>[vserver virtual-server] [client ip-addr netmask] [detail]</code>	Displays information about sessions handled by Cisco IOS SLB.  Note With GTP load balancing <i>without</i> cause code inspection, a session lasts no longer than the duration of the virtual server GTP idler time specified using the idle gtp request command .
Router# <code>show ip slb stats</code>	Displays Cisco IOS SLB statistics.
Router# <code>show ip slb vserver [name virtual_server] [redirect]</code> <code>[detail]</code>	Displays information about the virtual servers defined to Cisco IOS SLB.

Configuration Examples

This section provides real-world examples of the GGSN Cisco IOS SLB examples. For complete descriptions of the GGSN commands in this section, refer to the *Cisco GGSN Release 6.0 Command Reference*. For complete descriptions of the Cisco IOS SLB commands in this section, refer to the *IOS Server Load Balancing* feature module documentation.

This section includes the following information:

- [Cisco 7200 Platform Configuration Examples, page 12-21](#)
- [Catalyst 6500 / Cisco 7600 Platform Configuration Example, page 12-30](#)

Cisco 7200 Platform Configuration Examples

This section includes the following examples:

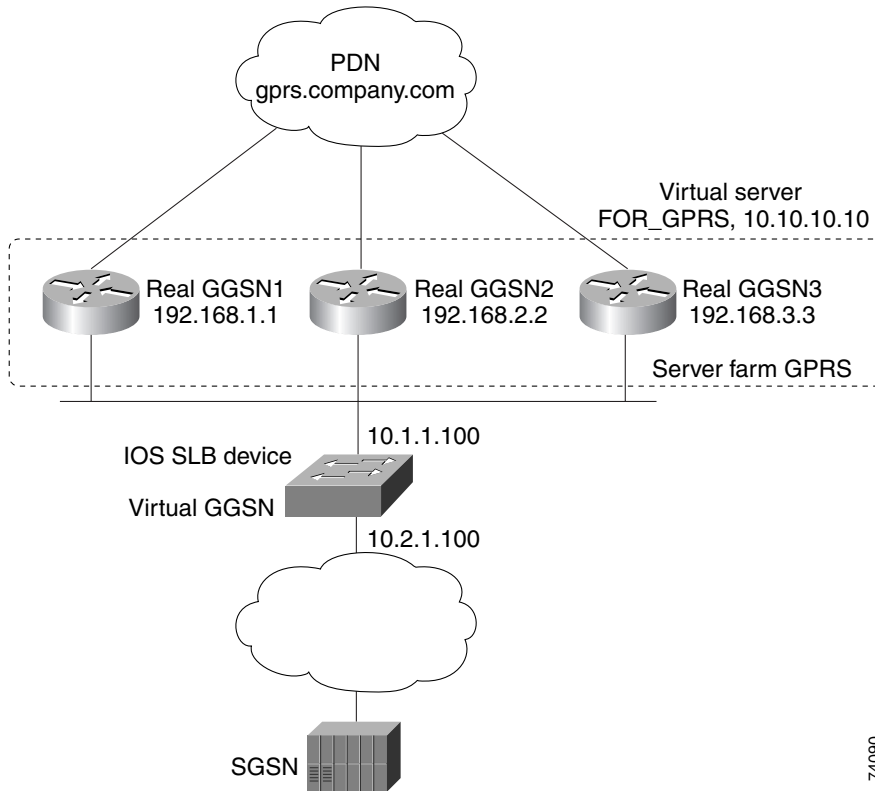
- [Cisco IOS SLB with GTP Load Balancing Configuration Example, page 12-21](#)
- [Cisco IOS SLB with GTP Load Balancing and NAT Example, page 12-26](#)
- [Cisco IOS SLB with GTP Load Balancing, NAT, and GTP Cause Code Inspection Example, page 12-29](#)

Cisco IOS SLB with GTP Load Balancing Configuration Example

Figure 12-2 shows a typical GTP load-balancing configuration *without* GTP cause code inspection enabled. In this configuration:

- Cisco IOS SLB can balance GTP flows across multiple real GGSNs. The SGSN “sees” the real GGSNs as a single virtual GGSN. This configuration increases the flow-handling capability of the real GGSNs and increases the reliability and availability.
- The IP address of the SGSN is 10.111.111.111.
- The virtual template address of GGSN1 is 192.168.1.1.
- The virtual template address of GGSN2 is 192.168.2.2.
- The virtual template address of GGSN3 is 192.168.3.3.

Figure 12-2 Cisco IOS SLB with GTP Load Balancing on a Cisco 7200 Series Router Platform



74090

Following are the configuration statements for the configuration shown in [Figure 12-2](#):

- [Cisco IOS SLB Configuration Statements, page 12-22](#)
- [GGSN1 Configuration Statements, page 12-23](#)
- [GGSN2 Configuration Statements, page 12-24](#)
- [GGSN3 Configuration Statements, page 12-25](#)

Detailed GGSN configuration examples are available throughout this book.

Cisco IOS SLB Configuration Statements

```
hostname GTP_SLB
!
ip domain-name gprs.com
!
ip slb serverfarm GPRS
  real 192.168.1.1
    weight 1
    faildetect numconns 255 numclients 8
    inservice
!
  real 192.168.2.2
    weight 1
    faildetect numconns 255 numclients 8
    inservice
!
  real 192.168.3.3
    weight 1
```

```

    faildetect numconns 255 numclients 8
    inservice
!
ip slb vserver FOR_GPRS
  virtual 10.10.10.10 udp 3386 service gtp
  serverfarm GPRS
  inservice
!
ip slb dfp password Cookies 0
  agent 10.1.1.201 1111 30 0 10
  agent 10.1.1.202 1111 30 0 10
  agent 10.1.1.203 1111 30 0 10
!
interface FastEthernet1/0
  description TO SERVERFARM GPRS
  ip address 10.1.1.100 255.255.255.0
  no ip redirects
  duplex half
!
interface FastEthernet3/0
  description TO SGSN
  ip address 10.2.1.100 255.255.255.0
  no ip mroute-cache
  duplex half
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
ip route 192.168.1.1 255.255.255.255 10.1.1.201
ip route 192.168.2.2 255.255.255.255 10.1.1.202
ip route 192.168.3.3 255.255.255.255 10.1.1.203

```

GGSN1 Configuration Statements

```

service gprs ggsn
!
hostname GGSN1
!
ip cef
!
ip dfp agent gprs
  port 1111
  password Cookies 0
  inservice
!
ip domain-name gprs.com
!
interface loopback 1
  description LOOPBACK SAME AS IOS SLB VSERVER ADDRESS
  ip address 10.10.10.10 255.255.255.255
  no ip mroute-cache
!
interface FastEthernet1/0
  description TO SLB
  ip address 10.1.1.201 255.255.255.0
  ip directed-broadcast
  no ip mroute-cache
  duplex half
!
interface Virtual-Template1
  description GTP VIRTUAL TEMPLATE
  ip address 192.168.1.1 255.255.255.0
  encapsulation gtp
  gprs access-point-list gprs1
!

```

```

ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
!
gprs access-point-list gprs1
  access-point 1
    access-point-name gprs.company.com
    access-mode non-transparent
    ip-address-pool dhcp-proxy-client
    dhcp-server 10.100.0.5 10.100.0.6
    dhcp-gateway-address 10.27.3.1
  exit
!
gprs maximum-pdp-context-allowed 45000
gprs qos map canonical-qos
gprs gtp path-echo-interval 0
gprs dfp max-weight 32

```

GGSN2 Configuration Statements

```

service gprs ggsn
!
hostname GGSN2
!
ip cef
!
ip dfp agent gprs
  port 1111
  password Cookies 0
  inservice
!
ip domain-name gprs.com
!
interface loopback 1
  description LOOPBACK SAME AS IOS SLB VSERVER ADDRESS
  ip address 10.10.10.10 255.255.255.255
  no ip mroute-cache
!
interface FastEthernet1/0
  description TO SLB
  ip address 10.1.1.202 255.255.255.0
  ip directed-broadcast
  no ip mroute-cache
  duplex half
!
interface Virtual-Template1
  description GTP VIRTUAL TEMPLATE
  ip address 192.168.2.2 255.255.255.0
  encapsulation gtp
  gprs access-point-list gprs1
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
!

```



```

gprs access-point-list gprs1
  access-point 1
    access-point-name gprs.company.com
    access-mode non-transparent
    ip-address-pool dhcp-proxy-client
    dhcp-server 10.100.0.5 10.100.0.6
    dhcp-gateway-address 10.27.3.1
  exit
!
gprs maximum-pdp-context-allowed 45000
gprs qos map canonical-qos
gprs gtp path-echo-interval 0
gprs dfp max-weight 32

```

GGSN3 Configuration Statements

```

service gprs ggsn
!
hostname GGSN3
!
ip cef
!
ip dfp agent gprs
  port 1111
  password Cookies 0
  inservice
!
ip domain-name gprs.com
!
interface loopback 1
  description LOOPBACK SAME AS IOS SLB VSERVER ADDRESS
  ip address 10.10.10.10 255.255.255.255
  no ip mroute-cache
!
interface FastEthernet1/0
  description TO SLB
  ip address 10.1.1.203 255.255.255.0
  ip directed-broadcast
  no ip mroute-cache
  duplex half
!
interface Virtual-Template1
  description GTP VIRTUAL TEMPLATE
  ip address 192.168.3.3 255.255.255.0
  encapsulation gtp
  gprs access-point-list gprs1
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
!

gprs access-point-list gprs1
  access-point 1
    access-point-name gprs.company.com
    access-mode non-transparent
    ip-address-pool dhcp-proxy-client
    dhcp-server 10.100.0.5 10.100.0.6
    dhcp-gateway-address 10.27.3.1
  exit
!
gprs maximum-pdp-context-allowed 45000
gprs qos map canonical-qos
gprs gtp path-echo-interval 0
gprs dfp max-weight 32

```

Cisco IOS SLB with GTP Load Balancing and NAT Example

The following example uses the same basic configuration as in the “[Cisco IOS SLB with GTP Load Balancing Configuration Example](#)” section on page 12-21, including the network shown in [Figure 12-2](#), but with the addition of NAT:

- [Cisco IOS SLB Configuration Statements, page 12-26](#)
- [GGSN1 Configuration Statements, page 12-27](#)
- [GGSN2 Configuration Statements, page 12-28](#)
- [GGSN3 Configuration Statements, page 12-28](#)

Cisco IOS SLB Configuration Statements

```
hostname GTP_SLB
!
ip domain-name gprs.com
!
ip slb serverfarm GPRS
  nat server
  real 192.168.1.1
  weight 1
  faildetect numconns 255 numclients 8
  inservice
!
  real 192.168.2.2
  weight 1
  faildetect numconns 255 numclients 8
  inservice
!
  real 192.168.3.3
  weight 1
  faildetect numconns 255 numclients 8
  inservice
!
ip slb vserver FOR_GPRS
  virtual 10.10.10.10 udp 3386 service gtp
  serverfarm GPRS
  inservice
!
ip slb dfp password Cookies 0
  agent 10.1.1.201 1111 30 0 10
  agent 10.1.1.202 1111 30 0 10
  agent 10.1.1.203 1111 30 0 10
!
interface FastEthernet1/0
  description TO SERVERFARM GPRS
  ip address 10.1.1.100 255.255.255.0
  no ip redirects
  duplex half
!
interface FastEthernet3/0
  description TO SGSN
  ip address 10.2.1.100 255.255.255.0
  no ip mroute-cache
  duplex half
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
ip route 192.168.1.1 255.255.255.255 10.1.1.201
ip route 192.168.2.2 255.255.255.255 10.1.1.202
ip route 192.168.3.3 255.255.255.255 10.1.1.203
```

GGSN1 Configuration Statements

```
service gprs ggsn
!
hostname GGSN1
!
ip cef
!
ip dfp agent gprs
  port 1111
  password Cookies 0
  inservice
!
ip domain-name gprs.com
!
interface FastEthernet1/0
  description TO SLB
  ip address 10.1.1.201 255.255.255.0
  ip directed-broadcast
  no ip mroute-cache
  duplex half
!
interface Virtual-Template1
  description GTP VIRTUAL TEMPLATE
  ip address 192.168.1.1 255.255.255.0
  encapsulation gtp
  gprs access-point-list gprs1
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
!
gprs access-point-list gprs1
  access-point 1
  access-point-name gprs.company.com
  access-mode non-transparent
  ip-address-pool dhcp-proxy-client
  dhcp-server 10.100.0.5 10.100.0.6
  dhcp-gateway-address 10.27.3.1
  exit
!

gprs maximum-pdp-context-allowed 45000
gprs qos map canonical-qos
gprs gtp path-echo-interval 0
gprs dfp max-weight 32
```

GGSN2 Configuration Statements

```

service gprs ggsn
!
hostname GGSN2
!
ip cef
!
ip dfp agent gprs
  port 1111
  password Cookies 0
  inservice
!
ip domain-name gprs.com
!
interface FastEthernet1/0
  description TO SLB
  ip address 10.1.1.202 255.255.255.0
  ip directed-broadcast
  no ip mroute-cache
  duplex half
!
interface Virtual-Template1
  description GTP VIRTUAL TEMPLATE
  ip address 192.168.2.2 255.255.255.0
  encapsulation gtp
  gprs access-point-list gprs1
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
!
gprs access-point-list gprs1
  access-point 1
  access-point-name gprs.company.com
  access-mode non-transparent
  ip-address-pool dhcp-proxy-client
  dhcp-server 10.100.0.5 10.100.0.6
  dhcp-gateway-address 10.27.3.1
  exit
!
gprs maximum-pdp-context-allowed 45000
gprs qos map canonical-qos
gprs gtp path-echo-interval 0
gprs dfp max-weight 32

```

GGSN3 Configuration Statements

```

service gprs ggsn
!
hostname GGSN3
!
ip cef
!
ip dfp agent gprs
  port 1111
  password Cookies 0
  inservice
!
ip domain-name gprs.com
!
interface FastEthernet1/0
  description TO SLB
  ip address 10.1.1.203 255.255.255.0
  ip directed-broadcast

```

```

no ip mroute-cache
duplex half
!
interface Virtual-Template1
description GTP VIRTUAL TEMPLATE
ip address 192.168.3.3 255.255.255.0
encapsulation gtp
gprs access-point-list gprs1
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
!
gprs access-point-list gprs1
access-point 1
access-point-name gprs.company.com
access-mode non-transparent
ip-address-pool dhcp-proxy-client
dhcp-server 10.100.0.5 10.100.0.6
dhcp-gateway-address 10.27.3.1
exit
!
gprs maximum-pdp-context-allowed 45000
gprs qos map canonical-qos
gprs gtp path-echo-interval 0
gprs dfp max-weight 32

```

Cisco IOS SLB with GTP Load Balancing, NAT, and GTP Cause Code Inspection Example

The following example uses the same basic configuration as in the “[Cisco IOS SLB with GTP Load Balancing and NAT Example](#)” section on page 12-26, including the network shown in [Figure 12-2](#), but with the GTP cause code inspection enabled. In this configuration:

- The GSN idle timer is set to 20 seconds.
- The GTP request idle timer is set to 15 seconds.
- The virtual server accepts PDP context creates only from international mobile subscriber identities (IMSI) with carrier code **mcc 222 mnc 22**.

Following are the configuration statements for the configuration shown in [Figure 12-2](#), with the addition of NAT and GTP cause code inspection support:

- [Cisco IOS SLB Configuration Statements, page 12-29](#)
- [GGSN1 Configuration Statements, page 12-27](#) (no change for GTP cause code inspection)
- [GGSN2 Configuration Statements, page 12-28](#) (no change for GTP cause code inspection)
- [GGSN3 Configuration Statements, page 12-28](#) (no change for GTP cause code inspection)

Cisco IOS SLB Configuration Statements

```

hostname GTP_SLB
!
ip domain-name gprs.com
!
ip slb timers gtp gsn 90
!
ip slb serverfarm GPRS
nat server
real 192.168.1.1
weight 1
faildetect numconns 255 numclients 8
inservice

```

```

!
real 192.168.2.2
  weight 1
  faildetect numconns 255 numclients 8
  inservice
!
real 192.168.3.3
  weight 1
  faildetect numconns 255 numclients 8
  inservice
!
ip slb vserver FOR_GPRS
  virtual 10.10.10.10 udp 0 service gtp-inspect
  client gtp carrier-code mcc 222 mnc 22
  serverfarm GPRS
  inservice
!
ip slb dfp password Cookies 0
  agent 10.1.1.201 1111 30 0 10
  agent 10.1.1.202 1111 30 0 10
  agent 10.1.1.203 1111 30 0 10
!
interface FastEthernet1/0
  description TO SERVERFARM GPRS
  ip address 10.1.1.100 255.255.255.0
  no ip redirects
  duplex half
!
interface FastEthernet3/0
  description TO SGSN
  ip address 10.2.1.100 255.255.255.0
  no ip mroute-cache
  duplex half
!
ip route 10.111.111.111 255.255.255.255 FastEthernet1/0
ip route 192.168.1.1 255.255.255.255 10.1.1.201
ip route 192.168.2.2 255.255.255.255 10.1.1.202
ip route 192.168.3.3 255.255.255.255 10.1.1.203

```

Catalyst 6500 / Cisco 7600 Platform Configuration Example

This section includes examples of Cisco IOS SLB with GTP load balancing and NAT configured on the Catalyst 6500 / Cisco 7600 platform:

- [Cisco IOS SLB Configuration Statements, page 12-30](#)
- [GGSN1 Configuration Statements, page 12-32](#)

Cisco IOS SLB Configuration Statements

```

hostname 6500-a
!
ip slb probe PINGPROBE ping
  interval 3
  faildetect 3
!
ip slb serverfarm MWAM1
  nat server
  probe PINGPROBE
!

```

```
real 9.9.9.72
  reassign 4
  faildetect numconns 255 numclients 8
  inservice
!
real 9.9.9.73
  reassign 4
  faildetect numconns 255 numclients 8
  inservice
!
real 9.9.9.74
  reassign 4
  faildetect numconns 255 numclients 8
  inservice
!
real 9.9.9.75
  reassign 4
  faildetect numconns 255 numclients 8
  inservice
!
real 9.9.9.76
  reassign 4
  faildetect numconns 255 numclients 8
  inservice
!
ip slb vserver V0-GGSN
  virtual 10.10.10.10 udp 3386 service gtp
  serverfarm MWAM1
  idle gtp request 100
  inservice
!
ip slb vserver V1-GGSN
  virtual 10.10.10.10 udp 2123 service gtp
  serverfarm MWAM1
  idle gtp request 100
  inservice
!
ip slb dfp password ciscodfp 0
  agent 9.9.9.72 1111 30 0 10
  agent 9.9.9.73 1111 30 0 10
  agent 9.9.9.74 1111 30 0 10
  agent 9.9.9.75 1111 30 0 10
  agent 9.9.9.76 1111 30 0 10
!
interface FastEthernet9/36
  description TO SGSN
  no ip address
  switchport
  switchport access vlan 302
!
interface Vlan101
  description Vlan to GGSN for GN
  ip address 10.1.1.1 255.255.255.0
!
interface Vlan302
  ip address 40.0.2.1 255.255.255.0
!
router ospf 300
  log-adjacency-changes
  summary-address 9.9.9.0 255.255.255.0
  redistribute static subnets route-map GGSN-routes
  network 40.0.2.0 0.0.0.255 area 300
  network 40.0.3.0 0.0.0.255 area 300
!
```

```

ip route 9.9.9.72 255.255.255.255 10.1.1.72
ip route 9.9.9.73 255.255.255.255 10.1.1.73
ip route 9.9.9.74 255.255.255.255 10.1.1.74
ip route 9.9.9.75 255.255.255.255 10.1.1.75
ip route 9.9.9.76 255.255.255.255 10.1.1.76
!
access-list 1 permit 9.9.9.0 0.0.0.255
!
route-map GGSN-routes permit 10
  match ip address 1
!
!
```

GGSN1 Configuration Statements

```

!
ip dfp agent gprs
  port 1111
  password ciscodfp 0
  inservice
!
interface Loopback100
  description GPRS GTP V-TEMPLATE IP ADDRESS
  ip address 9.9.9.72 255.255.255.0
!
interface GigabitEthernet0/0.2
  description Gn Interface
  encapsulation dot1Q 101
  ip address 10.1.1.72 255.255.255.0
  no cdp enable
!
interface Virtual-Template1
  description GTP v-access
  ip unnumbered Loopback100
  encapsulation gtp
  gprs access-point-list gprs
!
! route to SGSNs
ip route 40.1.2.1 255.255.255.255 10.1.1.1
ip route 40.2.2.1 255.255.255.255 10.1.1.1
```