



# CHAPTER 14

## Configuring Load Balancing on the GGSN

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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 complete descriptions of the GGSN commands in this chapter, see *Cisco GGSN Command Reference* for the Cisco GGSN release you are using. For complete descriptions of the other Cisco IOS SLB commands in this chapter, see 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 14-1](#)
- [Configuring GTP Load Balancing, page 14-7](#)
- [Monitoring and Maintaining the Cisco IOS SLB Feature, page 14-25](#)
- [Configuration Examples, page 14-26](#)

### 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 14-1](#)
- [Overview of GTP Load Balancing, page 14-2](#)
- [GTP SLB Restrictions, page 14-7](#)

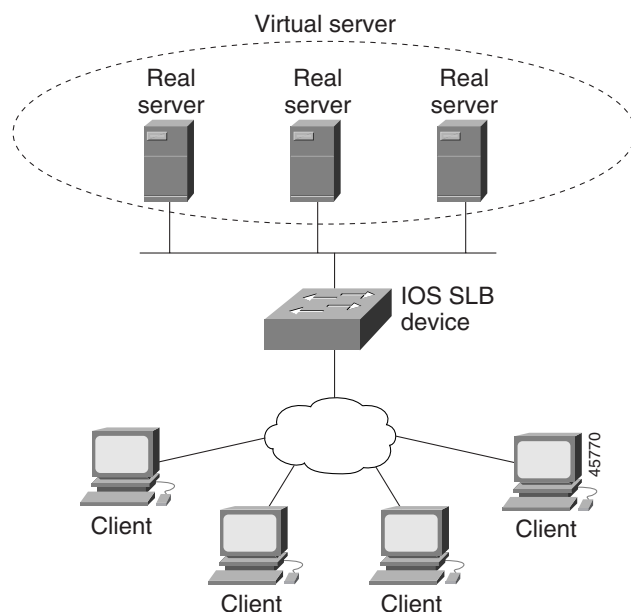
### Overview of Cisco IOS SLB

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 called 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 14-1 presents a logical view of a simple Cisco IOS SLB network.

**Figure 14-1** Logical View of IOS SLB



## Overview of GTP Load Balancing

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 14-7.

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 Cisco 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.

When configuring GTP load balancing:

- GTP load balancing is supported by using the Cisco IOS SLB feature on the supervisor engine.
- The IOS SLB on the supervisor engine processes only the Create PDP Context requests sent to the GGSN virtual IP address. When a Create PDP Context request is received, a real GGSN is selected based on the load at that time. Once the PDP context is established, all subsequent transactions corresponding to the PDP contexts occurs directly between that GGSN and corresponding SGSN, bypassing the Cisco IOS SLB on the supervisor engine.

- In addition:
  - Multiple virtual servers are supported
  - Load-balanced real servers can be internal or external to the Cisco 7600 chassis
  - Each virtual server must have one unique public IP address that is reachable from the SGSNs
  - Each virtual server 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.

## 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 14-3](#)
- [GTP Load Balancing With GTP Cause Code Inspection, page 14-3](#)

### 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 14-4](#) for more information about this algorithm.
- Requires Dynamic Feedback Protocol (DFP) to account for GTPv1 secondary PDP contexts.

### 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 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 14-1](#) lists the Create PDP Context response cause codes and the corresponding actions taken by Cisco IOS SLB.

**Table 14-1 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

**Table 14-1 PDP Create Response Cause Codes and Corresponding Cisco IOS SLB Actions**

Cause Code	Cisco IOS SLB Action
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, or, if GTP APN-aware load balancing is configured, to the same server farm.
- Supports stateful backup.
- Tracks the number of open PDP contexts for each GGSN or APN, which enables server farms to use the weighted least connections (**leastconns**) algorithm for GTP load balancing. See the “[Weighted Least Connections](#)” section on page 14-5 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 IPDP 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 14-4](#)
- [Weighted Least Connections, page 14-5](#)

### 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 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 to the maximum number of allowed PDP contexts.

By default, the CPU and memory utilization become part of the DFP weight calculation only after the utilization exceeds 85 percent. You can use the **min-cpu-load** and **mem-load** keyword options added to the **gprs dfp** global configuration command to customize the percentage of utilization at which the CPU and memory loads are included in the weight calculation.



#### Note

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 IMSI Sticky Database Support

Cisco IOS SLB can select a GGSN, or APN if GTP APN-aware load balancing is configured, for a given International Mobile Subscriber ID (IMSI), and forward all subsequent Packet Data Protocol (PDP) create requests from the same IMSI to the selected GGSN or APN.

To enable this feature, Cisco IOS SLB uses a GTP IMSI sticky database, which maps each IMSI to its corresponding real server, in addition to its session database.

The Cisco IOS SLB creates a sticky database object when it processes the first Create PDP Context request for a given IMSI. The Cisco IOS SLB removes the sticky object when it receives a notification to do so from the real server, or as a result of inactivity. When the last PDP belonging to an IMSI is deleted, the GGSN notifies Cisco IOS SLB to remove the sticky object.

### Sticky Database Support and GTP APN-Aware Load Balancing

The sticky IMSI feature prevents sessions from the same user for the same APN being assigned to different GGSNs. With server farm selection based on APN (PAN-aware load balancing), the sticky IMSI feature ensures that a sticky entry is for the same server farm based on the APN before the IMSI can be issued. If a new Create PDP Context request is for a different APN, which causes GTP SLB to select a different server farm than the one for which the sticky entry was created, the server farm is respected over the real because if the real belongs to a different server farm, the serverfarm might not support the APN.

## GTP APN-Aware Load Balancing

With Cisco IOS software release 12.2(18) SRB and later on the supervisor engine, *GTP APN-aware* load balancing can be configured.

Using the GTP APN-aware feature, a set of APNs can be mapped to a server farm in the Cisco IOS SLB. Multiple server farms can be created, each supporting a different set of APNs. Create PDP context requests are balanced across APNs.

For information on configuring GTP APN-aware load balancing, see the [“Configuring GTP APN-Aware Load Balancing” section on page 14-15](#).

## 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
    - Stateful backup (not supported on the 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 14-8](#)
- [Configuration Guidelines, page 14-8](#)

## 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 14-9](#) (Required)
  - b. [Configuring a Virtual Server, page 14-11](#) (Required)
  - c. [Configuring a GSN Idle Timer, page 14-14](#) (Optional if GTP cause code inspection is enabled)
  - d. [Configuring DFP Support, page 14-14](#) (Optional, but recommended)
  - e. [Configuring GTP APN-Aware Load Balancing, page 14-15](#) (Optional)
2. On the GGSN, complete the following tasks:
  - a. [Configuring a Loopback Interface for GTP SLB, page 14-19](#) (Required)
  - b. [Configuring DFP Support on the GGSN, page 14-20](#) (Optional, but recommended)
  - c. [Configuring Messaging from the GGSN to the Cisco IOS SLB, page 14-21](#) (Optional)
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 9-4](#).
4. On the SGSN, route each SGSN to the virtual templates on each associated GGSN, and to the GGSN load-balancing virtual server (Required)

## 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 14-3](#)
  - [GTP Load Balancing With GTP Cause Code Inspection, page 14-3](#)
- 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 Cisco 7600 platform, the following apply:
  - Multiple GTP virtual servers are supported.
  - Load balanced real servers can be internal or external to the Cisco 7600 chassis.
  - Each GTP virtual server must have one unique public IP address that is reachable from the SGSNs.
  - Each virtual server 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 GTP virtual IP address.
- When configuring GTP APN-aware load balancing:
  - Cisco IOS software release 12.2(18) SRB and later is required on the supervisor engine and Cisco GGSN Release 7.0, Cisco IOS Release 12.4(9)XG and later is required on the GGSN.
  - GTP load balancing with GTP cause code inspection enabled is not supported.
  - For a given IOS SLB GTP map, you can configure up to 100 **pan** commands, however, because APN maps can impact performance, we recommend that you do not configure more than 10 APN maps per vserver.
  - The primary and backup virtual servers should have the same mapping rules.
  - The same real cannot be configured in multiple server farms.

## 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 14-9](#) (Required)
- [Configuring a Virtual Server, page 14-11](#) (Required)
- [Configuring a GSN Idle Timer, page 14-14](#) (Optional)
- [Configuring DFP Support, page 14-14](#) (Optional, but recommended)
- [Configuring GTP APN-Aware Load Balancing, page 14-15](#) (Optional)
- [Verifying the Cisco IOS SLB Configuration, page 14-18](#) (Optional)

### 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
<b>Step 1</b>	Router-SLB(config)# <b>ip slb serverfarm</b> <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.
<b>Step 2</b>	Router-SLB(config-slb-sfarm)# <b>predictor</b> [ <b>roundrobin</b>   <b>leastconns</b> ]	Specifies the algorithm to use to determine how a real server is selected.  <b>Note</b> 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"> <li>• <a href="#">Weighted Round-Robin, page 14-4</a></li> <li>• <a href="#">Weighted Least Connections, page 14-5</a></li> </ul>
<b>Step 3</b>	Router-SLB(config-slb-sfarm)# <b>nat server</b>	(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.
<b>Step 4</b>	Router-SLB(config-slb-sfarm)# <b>real ip-address</b> [ <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.
<b>Step 5</b>	Router-SLB(config-slb-real)# <b>faildetect numconns</b> <i>number-conns</i> [ <b>numclients</b> <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.
<b>Step 6</b>	Router-SLB(config-slb-real)# <b>maxconns</b> <i>number-conns</i>	(Optional) Specifies the maximum number of active connections allowed on the real server at one time.  <b>Note</b> 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 <b>ip gtp request</b> command.
<b>Step 7</b>	Router-SLB(config-slb-real)# <b>reassign</b> <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.
<b>Step 8</b>	Router-SLB(config-slb-real)# <b>retry</b> <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.

	Command	Purpose
<b>Step 9</b>	Router-SLB(config-slb-real)# <b>weight</b> <i>weighting-value</i>	(Optional) Specifies the real server's workload capacity relative to other servers in the server farm.  <b>Note</b> If you use DFP, the static weights you define using the <b>weight (server farm)</b> command are overridden by the weights calculated by DFP. If DFP is removed from the network, Cisco IOS SLB reverts to the static weights.
<b>Step 10</b>	Router-SLB(config-slb-real)# <b>inservice</b>	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
<b>Step 1</b>	Router-SLB(config)# <b>ip slb vserver</b> <i>virtual_server-name</i>	Identifies a virtual server, and enters virtual server configuration mode.
<b>Step 2</b>	Router-SLB(config-slb-vserver)# <b>virtual ip-addr</b> <i>[netmask [group]] {esp   gre   protocol}</i>  or  Router(config-slb-vserver)# <b>virtual ip-addr</b> <i>[netmask [group]] {tcp   udp} [port   any]</i> <i>[service 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.  <b>Note</b> For GTP load balancing:  <ul style="list-style-type: none"> <li>- Specify a virtual GGSN IP address as the virtual server, and specify the <b>udp</b> keyword option.</li> <li>- To load-balance GTP v1 sessions, specify port number <b>2123</b>, if the GGSNs and SGSNs are in compliance with the ETSI standard, or specify port number <b>0</b> or <b>any</b> to configure an all-port virtual server (that is, a virtual server that accepts flows destined for all ports).</li> <li>- To load-balance GTP v0 sessions, specify port number <b>3386</b>, if the GGSNs and SGSNs are in compliance with the ETSI standard, or specify port number <b>0</b> or <b>any</b> to configure an all-port virtual server.</li> <li>- To enable GTP load balancing <i>without</i> GTP cause code inspection, specify the <b>service gtp</b> keyword option.</li> <li>- To enable GTP load balancing <i>with</i> GTP cause code inspection, specify the <b>service gtp-inspect</b> keyword option.</li> </ul>

	Command	Purpose
<b>Step 3</b>	<pre>Router-SLB(config-slb-vserver)# <b>serverfarm</b> primary-farm [<b>backup</b> backup-farm [<b>sticky</b>]] [<b>map</b> map-id <b>priority</b> priority]</pre>	<p>Associates a real server farm with a virtual server.</p> <ul style="list-style-type: none"> <li>• <b>backup</b>—(Optional) Configures a backup server farm</li> <li>• <b>backup backup-farm [sticky]</b>—(Optional) Configures a backup server farm and optionally specifies to use sticky connections in the backup server farm.</li> <li>• <b>map map-id priority priority</b>—(Optional) Associates an IOS SLB protocol map to a server farm for GTP APN-aware load balancing and defines the priority for that map. Maps are searched based on priority. The lower the number, the higher the priority.</li> </ul> <p><b>Note</b> Multiple instances of the <b>serverfarm</b> command are allowed if configured with the <b>map</b> keyword option. The default server farm (without the <b>map</b> keyword option) is limited to a single instance.</p> <p><b>Note</b> To change map configurations the virtual server must be taken out of service.</p> <p><b>Note</b> The NAT modes on the primary and backup server farms for each map must match.</p>
<b>Step 4</b>	<pre>Router-SLB(config-slb-vserver)# <b>idle</b> [<b>gtp request</b>] duration</pre>	<p>(Optional) Specifies the minimum amount of time that Cisco IOS SLB maintains connection context in the absence of packet activity.</p> <p>The <b>idle</b> command specified without the <b>gtp request</b> keyword option controls the GTP idle timer for GTP load balancing <i>without</i> cause code inspection enable. The <b>idle gtp request</b> 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 <b>idle gtp request</b> is the recommended configuration.</p> <p><b>Note</b> 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>
<b>Step 5</b>	<pre>Router-SLB(config-slb-vserver)# <b>inservice</b></pre>	<p>Enables the virtual server for use by Cisco IOS SLB.</p>

	Command	Purpose
Step 6	Router-SLB(config-slb-vserver)# <b>client</b> { <i>ip-address network-mask</i> [ <b>exclude</b> ]   <b>gtp carrier-code</b> [ <i>code</i> ]}	(Optional) Specifies which clients are allowed to use the virtual server.  <b>Note</b> GTP load balancing supports only the <b>gtp carrier-code</b> option, and only if GTP cause code inspection is enabled.
Step 7	Router-SLB(config-slb-vserver)# <b>replicate casa</b> <i>listen-ip remote-ip port</i> [ <i>interval</i> ] [ <b>password</b> [0   7] <i>password timeout</i> ]	(Optional) Configures a stateful backup of Cisco IOS SLB decision tables to a backup switch.  <b>Note</b> GTP load balancing <i>without</i> GTP cause code inspection enabled does not support this command.

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

## Configuring GTP APN-Aware Load Balancing

GTP APN-aware load balancing enables you to load balance across APNs.

When implementing GTP APN-aware load balancing, a set of APNs must be defined in a Cisco IOS SLB GTP map created on the IOS SLB. Then, the IOS SLB GTP map must be associated with a server farm under the virtual template on the IOS SLB.

To configure GTP APN-aware load balancing, complete the tasks in the following sections:

- [Configuring a Cisco IOS SLB GTP Map for GTP APN-Aware Load Balancing, page 14-15](#)
- [Associating an IOS SLB GTP Map to a Server Farm on the Virtual Server, page 14-16](#)

### Prerequisites and Restrictions

When configuring GTP APN-aware load balancing:

- Cisco IOS software release 12.2(18) SRB and later is required on the supervisor engine and Cisco GGSN Release 7.0, Cisco IOS Release 12.4(9)XG and later is required on the GGSN.
- GTP load balancing with GTP cause code inspection enabled is not supported.
- For a given IOS SLB GTP map, you can configure up to 100 **apn** commands, however, because APN maps can impact performance, we recommend that you do not configure more than 10 APN maps per vserver.
- The primary and backup virtual servers should have the same mapping rules.
- The same real cannot be configured in multiple server farms.

### Configuring a Cisco IOS SLB GTP Map for GTP APN-Aware Load Balancing

To enable APN-aware load balancing, an IOS SLB GTP map that groups certain APNs must be configured.

To configure an IOS SLB GTP map for load balancing across APNs, use the following commands, beginning in global configuration mode:

	Command	Purpose
<b>Step 1</b>	Router-SLB(config)# <b>ip slb map</b> <i>map-id protocol</i>	<p>Configures an IOS SLB protocol map and enter SLB map configuration mode.</p> <ul style="list-style-type: none"> <li>• <i>map-id</i>—IOS SLB protocol map identifier. The valid range is from 1 to 255. The map ID must be globally unique across all service types.</li> <li>• <i>protocol</i>—Protocol associated with the map. This should match the vserver service type. <ul style="list-style-type: none"> <li>– <b>gtp</b>—For general packet radio service (GPRS) load balancing, configures an IOS SLB GPRS Tunneling Protocol (GTP) map and enters SLB GTP map configuration mode.</li> <li>– <b>radius</b>—For RADIUS load balancing, configures an IOS SLB RADIUS map and enters SLB RADIUS map configuration mode.</li> </ul> </li> </ul> <p><b>Note</b> With this release, GTP maps are supported.</p>
<b>Step 2</b>	Router-SLB(config-slb-map)# <b>apn</b> <i>string</i>	<p>Configures an ASCII regular expression string to be matched against the access point name (APN) for general packet radio service (GPRS) load balancing.</p> <p><b>Note</b> For a given IOS SLB GTP map, you can configure up to 100 <b>apn</b> commands, however, because APN maps can impact performance, we recommend that you do not configure more than 10 APN maps per vserver.</p>

### Associating an IOS SLB GTP Map to a Server Farm on the Virtual Server

After an IOS SLB GTP map is created, it must be associated to the server farm when configuring the virtual server.



**Note**

To change map configurations the virtual server must be taken out of service. The NAT modes on the primary and backup server farms for each map must match.



To specify a IOS SLB GTP map when associating a server farm with the virtual server, use the following command in virtual server configuration mode on the IOS SLB:

Command	Purpose
<pre>Router-SLB(config-slb-vserver)# <b>serverfarm</b> primary-farm [<b>backup</b> backup-farm [<b>sticky</b>]] [<b>map</b> map-id <b>priority</b> priority]</pre>	<p>Associates a real server farm with a virtual server.</p> <ul style="list-style-type: none"> <li>• <b>backup</b>—(Optional) Configures a backup server farm</li> <li>• <b>backup backup-farm [sticky]</b>—(Optional) Configures a backup server farm and optionally specifies to use sticky connections in the backup server farm.</li> <li>• <b>map map-id priority priority</b>—(Optional) Associates an IOS SLB protocol map to a server farm for GTP APN-aware load balancing and defines the priority for that map. Maps are searched based on priority. The lower the number, the higher the priority.</li> </ul> <p><b>Note</b> Multiple instances of the <b>serverfarm</b> command are allowed if configured with the <b>map</b> keyword option. The default server farm (without the <b>map</b> keyword option) is limited to a single instance.</p> <p><b>Note</b> To change map configurations the virtual server must be taken out of service.</p> <p><b>Note</b> The NAT modes on the primary and backup server farms for each map must match.</p>

### GTP APN-Aware Load Balancing Configuration Example

The following configuration example, from the IOS SLB, shows the IOS SLB GTP map configuration, and the map-to-server farm association under the virtual template.

```
!
/* server-farm configurations */
ip slb serverfarm farm1
  real 10.0.0.1
  inservice
  real 10.0.0.2
  inservice
ip slb serverfarm farm4
  real 10.0.0.7
  inservice
  real 10.0.0.8
  inservice
ip slb serverfarm farm5
  real 10.0.0.9
  inservice
  real 10.0.0.10
  inservice
!
/* GTP maps for GTP APN-aware SLB */
ip slb map 1 gtp
  apn www.*.edu
ip slb map 4 gtp
  apn abc.company1.com
  apn xyz.company2.com
ip slb map 5 gtp
```

```

    apn company3.com
!
/* associate the GTP map with server farm under virtual server */
ip slb vserver GGSN_SERVER
  virtual 10.10.10.10 udp 0 service gtp
  serverfarm farm1 map 1 priority 3
  serverfarm farm2 backup farm4 map 1 priority 2
  serverfarm farm4 map 4 priority 5
  serverfarm farm5 map 5 priority 4
  serverfarm farm6

```

## 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 14-18](#)
- [Verifying the Server Farm, page 14-18](#)
- [Verifying Cisco IOS SLB Connectivity, page 14-19](#)

### Verifying the Virtual Server

The following **show ip slb vserver** command verifies the configuration of the virtual servers PUBLIC\_HTTP and RESTRICTED\_HTTP:

```
Router-SLB# 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:

```
Router-SLB# 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:

```
Router-SLB# 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 is 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:

```
Router-SLB# 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 14-25 for additional commands used to verify Cisco IOS SLB networks and connections.

## 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 14-19 (Required if using dispatched mode without GTP cause code inspection enabled)
- [Configuring DFP Support on the GGSN](#), page 14-20 (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	Router-GGSN(config)# <b>interface loopback</b> <i>number</i>	Creates a loopback interface. A loopback interface is a virtual interface that is always up.
Step 2	Router-GGSN(config-if)# <b>ip address</b> <i>ip-address mask</i>	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 14-20](#)
- [Configuring the DFP Weight for a GGSN, page 14-20](#)
- [Configuring the Maximum Number of PDP Contexts for a GGSN, page 14-21](#)

### Configuring the GGSN as a DFP Agent

For complete information on configuring a DFP agent, see *DFP Agent Subsystem* feature module.

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

	Command	Description
Step 1	Router-GGSN(config)# <b>ip dfp agent gprs</b>	Identifies a DFP agent subsystem and initiates DFP agent configuration mode.
Step 2	Router-GGSN(config-dfp)# <b>interval</b> <i>seconds</i>	(Optional) Configures a DFP agent weight recalculation interval.
Step 3	Router-GGSN(config-dfp)# <b>password</b> [0 7] <i>password</i> [ <i>timeout</i> ]	Optional) Configures a DFP agent password for MD5 authentication.
Step 4	Router-GGSN(config-dfp)# <b>port</b> <i>port-number</i>	Defines the port number for the DFP manager to use to connect to the DFP agent.
Step 5	Router-GGSN(config-dfp)# <b>inservice</b>	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"> <li>• The DFP agent is enabled using the inservice (DFP agent) command.</li> <li>• The client subsystem has changed the DFP agent's state to ACTIVE.</li> </ul>

### Configuring the 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 (85%), or you can specify a different maximum weight. You can also configure the percentage of utilization at which the CPU and memory loads are included in the weight calculation using the **cpu-load** and **mem-load** keyword options.

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

Command	Purpose
Router-GGSN(config)# <b>gprs dfp</b> { <b>max-weight</b> <i>max-weight</i>   <b>min-cpu-load</b> <i>min-cpu-load</i>   <b>mem-load</b> <i>min-mem-load</i> }	<p>Specifies DFP weight parameters of a GGSN that is acting as a DFP agent, where:</p> <ul style="list-style-type: none"> <li>• <b>max-weight</b>—Specifies the maximum weight sent by the GGSN, acting as a DFP agent, to a DFP manager. The valid range is 1 to 100. The default is 8.</li> <li>• <b>min-cpu-load</b>—Specifies the minimum percentage at which to start including the CPU load in the DFP weight calculation. The valid range is 10 to 75 percent.</li> <li>• <b>mem-load</b>—Specifies the minimum percentage at which to start including the memory load in the DFP weight calculation. The valid range is 10 to 75 percent.</li> </ul>

### 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 IPv4 PDPs. One IPv6 PDP counts as four IPv4 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-GGSN(config)# <b>gprs maximum-pdp-context-allowed</b> [ <i>pdp-contexts</i> ]	Specifies the maximum number of PDP contexts (mobile sessions) that can be activated on the GGSN.

### Configuring Messaging from the GGSN to the Cisco IOS SLB

The GGSN-IOS SLB messaging feature enables you to configure the GGSN to notify the Cisco IOS SLB when a certain condition exists that affects a session forwarded by the Cisco IOS SLB. The notification also instructs the Cisco IOS SLB on how to react to the condition.

There are two types of GGSN-IOS SLB notifications that can be configured using the **gprs slb notify** command—CAC failure notifications and delete notifications (for GTP IMSI sticky database support). The following sections describe how to configure each of them:

- [Configuring Support for GGSN-IOS SLB Messaging CAC Failure Notifications, page 14-22](#)
- [Configuring Support for GGSN-IOS SLB Messaging Delete Notifications \(GTP IMSI Sticky Database Support\), page 14-23](#)

## Configuring Support for GGSN-IOS SLB Messaging CAC Failure Notifications

The GGSN can be configured to notify the Cisco IOS SLB when a UMTS QoS CAC failure has caused a Create PDP Context request to be rejected.

CAC failure notifications sent by the GGSN include the following information elements (IEs):

- Type—Notification type (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 is exceeded, the Cisco IOS SLB relays this information to the SGSN.

The way you configure support for CAC failure notifications depends on whether the Cisco IOS SLB is operating in dispatched mode or directed server NAT mode. For information on each procedure, see the following sections:

- [Configuring CAC Failure Notification Support when the Cisco IOS SLB is in Dispatched Mode, page 14-22](#)
- [Configuring CAC Failure Notification Support when the Cisco IOS SLB is in Directed Server NAT Mode, page 14-23](#)

### Configuring CAC Failure Notification Support when the 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 CAC failure notifications directly to the server.

To configure the GGSN to send CAC failure notifications to the Cisco IOS SLB when the Cisco IOS SLB is in dispatched mode, use the following command in global configuration mode:

	Command	Description
Step 1	Router-GGSN(config) # <b>gprs slb mode dispatched</b>	Defines dispatched as the Cisco IOS SLB operation mode for GGSN-IOS SLB messaging. <b>Note</b> The default is dispatched mode.
Step 2	Router-GGSN(config) # <b>gprs slb notify cac-failure</b>	Enables the GGSN to notify the Cisco IOS SLB when a UMTS QoS CAC failure has caused a Create PDP Context request to be rejected.

To enable CAC failure notification support on the Cisco IOS SLB, use the following command in virtual server mode:

Command	Purpose
Router-SLB(config-slb-vserver) # <b>gtp notification cac count</b>	Enables support of GGSN-IOS SLB messaging CAC failure notifications 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).

### Configuring CAC Failure Notification Support when the 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 configuring the GGSN to send CAC failure notifications to the Cisco IOS SLB, a list of virtual servers must be defined on the GGSN using the **gprs slb vsrver** command in global configuration mode, and the Cisco IOS SLB mode of operation must be defined using the **gprs slb mode** command in global configuration mode.



#### Note

If the Cisco IOS SLB operation mode and virtual servers are not defined on the GGSN when the Cisco IOS SLB is functioning in directed server NAT mode, support for CAC failure notification is not enabled, even if the **gprs slb notify cac-failure** and **gtp notification cac** commands are configured.

To enable the GGSN to send CAC failure notifications to the Cisco IOS SLB when the Cisco IOS SLB is in directed server NAT mode, use the following commands in global configuration mode:

	Command	Description
Step 1	Router-GGSN(config)# <b>gprs slb mode directed</b>	Defines directed server NAT as the Cisco IOS SLB operation mode for GGSN-IOS SLB messaging. <b>Note</b> The default is dispatched mode.
Step 2	Router-GGSN(config)# <b>gprs slb notify cac-failure</b>	Enables the GGSN to notify the Cisco IOS SLB when a UMTS QoS CAC failure has caused a Create PDP Context request to be rejected.
Step 3	Router-GGSN(config)# <b>gprs slb vsrver ip_address</b> [ <b>next-hop ip ip-address</b> [ <b>vrf name</b> ]]	Configures the Cisco IOS SLB virtual server(s) to be notified by a GGSN when the condition defined using the <b>gprs slb notify</b> command occurs.  Optionally, also configures the IP address of the next-hop that can be used to reach the virtual server and specifies the VPN routing and forwarding instance.

To enable CAC failure notification support on the Cisco IOS SLB, use the following command in virtual server mode:

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

### Configuring Support for GGSN-IOS SLB Messaging Delete Notifications (GTP IMSI Sticky Database Support)

When support for delete notifications is configured on the GGSN and the Cisco IOS SLB, a sticky database entry is created on the Cisco IOS SLB when the first Create PDP Context request from a subscriber is received. When the last PDP context of that IMSI is deleted on the GGSN, the GGSN sends a delete notification to the Cisco IOS SLB that instructs the Cisco IOS SLB to remove the sticky entry from the database.

**Note**

This configuration requires that the **virtual** virtual server configuration command be configured with the **service gtp** keywords specified.

**Note**

If the **sticky gtp imsi** command is configured under multiple vservers, the group number configuration facilitate sharing of the sticky object in the event the same MS connects through different vservers. All vservers that have the same sticky group number share the sticky IMSI entry for a user.

To configure the GGSN to send a delete notification to the Cisco IOS SLB when the last PDP context of an IMSI is deleted on the GGSN, use the following commands in global configuration mode:

	Command	Description
Step 1	Router-GGSN(config)# <b>gprs slb mode</b> { <b>dispatched</b>   <b>directed</b> }	Defines the Cisco IOS SLB operation mode for GGSN-IOS SLB messaging. The default is dispatched mode.
Step 2	Router-GGSN(config)# <b>gprs slb notify session-deletion</b>	Configures the GGSN to send a delete notification message to the Cisco IOS SLB when the last PDP context associated with an IMSI is deleted.
Step 3	Router-GGSN(config)# <b>gprs slb vservers</b> <i>ip_address</i> [ <b>next-hop ip</b> <i>ip_address</i> [ <b>vrf name</b> ]]	Configures the Cisco IOS SLB virtual server(s) to be notified by a GGSN when the condition defined using the <b>gprs slb notify</b> command occurs.  Optionally, also configures the IP address of the next-hop that can be used to reach the virtual server and specifies the VPN routing and forwarding instance.

To configure GTP IMSI sticky database support on the Cisco IOS SLB, use the following command in virtual server configuration mode:

Command	Purpose
Router-SLB(config-slb-vserver)# <b>sticky gtp imsi</b> [ <b>group number</b> ]	Enables Cisco IOS SLB to load-balance GTP Create PDP Context requests to the same real server that processed all previous create requests for a given IMSI.



# 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-GGSN# <b>clear gprs slb statistics</b>	Clears Cisco IOS SLB statistics.
Router-GGSN# <b>show gprs slb detail</b>	Displays all Cisco IOS SLB-related information, such as operation mode, virtual server addresses for GGSN-IOS SLB messaging, SLB notifications, and statistics.
Router-GGSN# <b>show gprs slb mode</b>	Displays the Cisco IOS SLB mode of operation.
Router-GGSN# <b>show gprs slb statistics</b>	Displays Cisco IOS SLB statistics.
Router-GGSN# <b>show gprs slb vservers</b>	Displays a list of defined Cisco IOS SLB virtual servers for GGSN-IOS SLB messaging.

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

Command	Purpose
Router=SLB# <b>show ip slb stats</b>	Displays Cisco IOS SLB statistics.
Router=SLB# <b>show ip slb sticky gtp imsi</b> [ <i>id imsi</i> ]	Displays only entries of the Cisco IOS SLB sticky database associated with the Cisco IOS SLB GTP IMSI sticky database, and shows all of the Network Service Access Point Identifiers (NSAPIs) that the user has used as primary PDPs.  Optionally, displays only those sticky database entries associated with the specified IMSI.
Router=SLB# <b>show ip slb vserver</b> [ <i>name virtual_server</i> ] [ <i>redirect</i> ] [ <i>detail</i> ]	Displays information about the virtual servers defined to Cisco IOS SLB.

## Configuration Examples

This section provides an example of the GGSN Cisco IOS SLB examples. For complete descriptions of the GGSN commands in this section, see *Cisco GGSN Release Command Reference*. For complete descriptions of the Cisco IOS SLB commands in this section, see the *IOS Server Load Balancing* feature module documentation.

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

- [Cisco IOS SLB Configuration Example, page 14-26](#)
- [GGSN1 Configuration Example, page 14-28](#)

### Cisco IOS SLB Configuration Example

```

hostname 7600-a
!
ip slb probe PINGPROBE ping
interval 3
faildetect 3
!
ip slb serverfarm SAMI1
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 SAMI1
    idle gtp request 100
    inservice
!
ip slb vserver V1-GGSN
    virtual 10.10.10.10 udp 2123 service gtp
    serverfarm SAMI1
    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 Example

```
!  
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
```