



CHAPTER 1

Overview of GPRS and UMTS

This chapter briefly introduces the 2.5G General Packet Radio Service (GPRS) and the 3G Universal Mobile Telecommunications System (UMTS) technologies, and their implementation in Cisco Gateway GPRS Support Node (GGSN) software.

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Overview

GPRS and UMTS are evolutions of the Global System for Mobile Communication (GSM) networks. GSM is a digital cellular technology that is used worldwide, predominantly in Europe and Asia. GSM is the world's leading standard in digital wireless communications.

GPRS is a 2.5G mobile communications technology. 2.5G enables mobile wireless service providers to offer their mobile subscribers packet-based data services over GSM networks. Common applications of GPRS include the following: Internet access, intranet/corporate access, instant messaging, and multimedia messaging. GPRS was standardized by the European Telecommunications Standards Institute (ETSI). Today, GPRS is standardized by the Third Generation Partnership Program (3GPP).

UMTS is a 3G mobile communications technology that provides wideband Code Division Multiple Access (W-CDMA) radio technology. W-CDMA technology offers higher throughput, real-time services, and end-to-end Quality of Service (QoS). W-CDMA technology also delivers pictures, graphics, video communications, and other multimedia information, and voice and data to mobile wireless subscribers. UMTS is standardized by the 3GPP.

The GPRS/UMTS packet core comprises two major network elements:

- Gateway GPRS Support Node (GGSN)

Provides mobile cell phone users access to a public data network (PDN) or specified private IP networks.

The Cisco GGSN is implemented via Cisco IOS Software.

- Serving GPRS Support Node (SGSN)

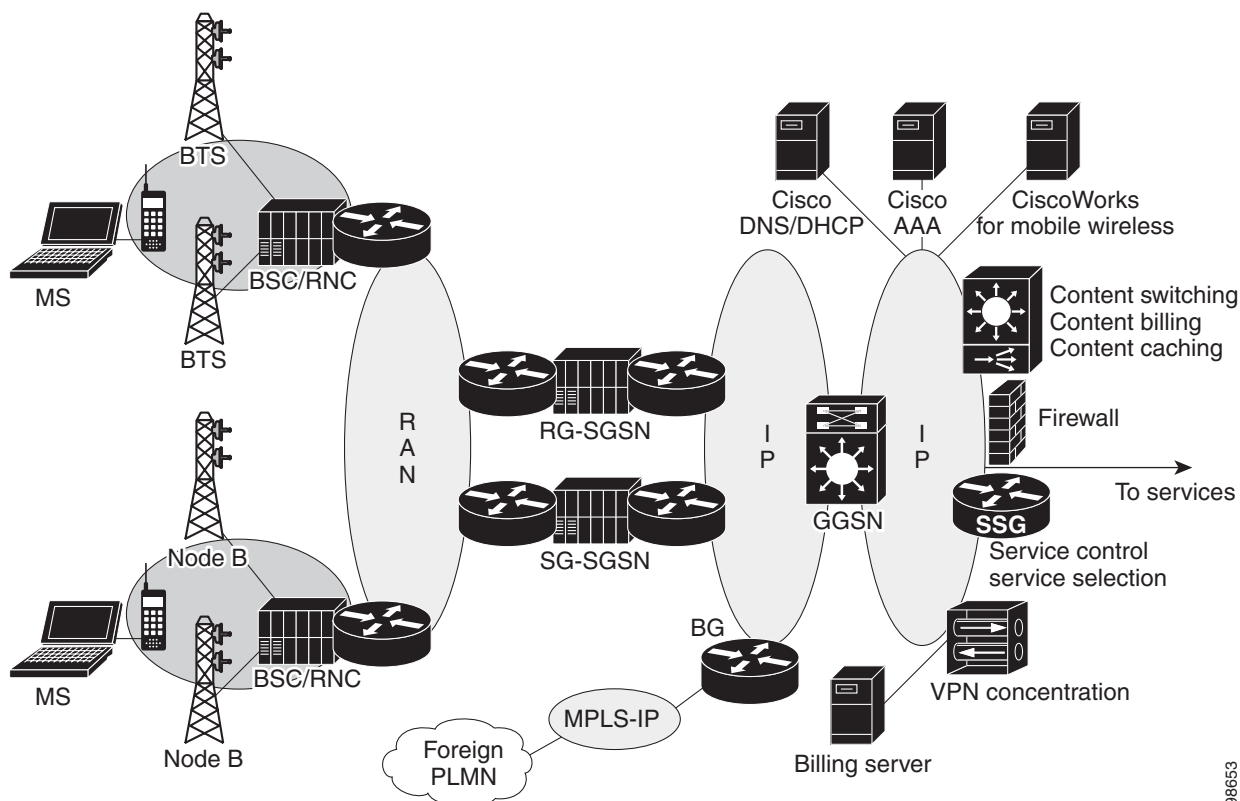
Connects the radio access network (RAN) to the GPRS/UMTS core. The SGSN:

- Tunnels user sessions to the GGSN.
- Sends data to and receives data from mobile stations
- Maintains information about the location of a mobile station (MS)
- Communicates directly with the MS and the GGSN.

SGSN support is available from Cisco partners or other vendors.

Figure 1-1 shows the network components with the GGSNs implemented on the Cisco Service and Application Module for IP (SAMI) in the Cisco 7600 Series Router.

Figure 1-1 GPRS/UMTS Network Components with GGSNs Implemented on the Cisco SAMI in the Cisco 7600 Series Router



As Figure 1-1 shows, the RAN is made up of different components for 2.5G and 3G.

In a 2.5G environment, the RAN comprises mobile stations that connect to a Base Transceiver Station (BTS). The BTS connects to a base station controller (BSC). In a 3G environment, the RAN is comprised of mobile stations that connect to a NodeB. The NodeB connects to a radio network controller (RNC).

The RAN connects to the GPRS/UMTS core through an SGSN. The SGSN tunnels user sessions to a GGSN that acts as a gateway to the services networks (for example, the Internet and intranet). The connection between the SGSN and the GGSN is enabled through a tunneling protocol called the GPRS tunneling protocol (GTP). GTP Version 0 (GTPv0) enables 2.5G applications, and GTP Version 1 (GTPv1) enables 3G applications. GTP is carried over IP.

Multiple SGSNs and GGSNs within a network are referred to collectively as GPRS support nodes (GSNs).

**Note**

Depending on the specific operator configuration, the RAN, the GPRS/UMTS core, and the services networks can be IP or Multiprotocol Label Switching (MPLS) networks.

To assign mobile sessions an IP address, the GGSN uses one of the following methods defined on an access point:

- Dynamic Host Configuration Protocol (DHCP)
- Remote Authentication Dial-In User Service (RADIUS) server
- Local address pool configured on the GGSN

The GGSN can use a RADIUS server to authorize and authenticate remote subscribers. DHCP and RADIUS services can be configured at the global level, or for each access point configured on the GGSN.

IPSec encryption is performed on the IPSec Virtual Private Network (VPN) Acceleration Services Module.

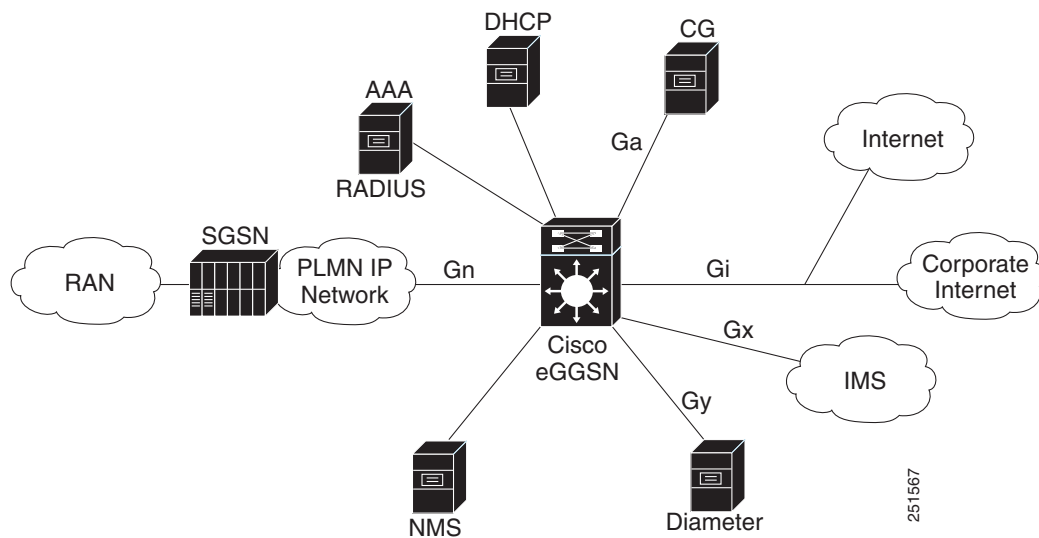
GPRS Interface Reference Model

The 2.5G GPRS and 3G UMTS standards use the term *interface* to identify the communication path between different network elements. The GPRS/UMTS standards define the requirements and characteristics of communication between different GPRS/UMTS network elements over these interfaces. These interfaces are commonly referred to in descriptions of GPRS/UMTS networks.

Figure 1-2 shows the primary interfaces that are implemented in the Cisco GGSN feature:

- Gn/Gp interface—Interface between the GGSN and the SGSN. The Gn interface is between two GSNs within the same public land mobile network (PLMN) in a GPRS/UMTS network. The Gp interface is between two GSNs in different PLMNs. GTP is a protocol defined on the Gn/Gp interface.
- Gi interface—Reference point between a GPRS/UMTS network and an external packet data network (PDN).
- Ga interface—Interface between a GGSN and charging gateway in a GPRS/UMTS network.

Figure 1-2 GGSN Interfaces



Additional interfaces implemented in the Cisco GGSN features, include:

- Gy—Interface to the Diameter server for Diameter Credit Control Application (DCCA) support for enhanced service-aware billing.
- Gx—Reference point between the Policy and Charging Rules Function (PCRF) and the Policy and Charging Enforcement Function (PCEF). The Gx interface is used for provisioning and removal of Policy and Charging Control (PCC) rules. The Gx interface uses the Diameter protocol.
- AAA Interface—Interface to Authentication, Authorization, and Accounting (AAA) server. The AAA interface uses the RADIUS protocol.
- DHCP—DHCP server interface.
- NMS—Network management interface.

Virtual Template Interface

To configure the connections between the GGSN and SGSN, and the GGSN and PDNs, the Cisco GGSN software uses an internal interface called a *virtual template* interface. A virtual template is a logical interface. It is not tied directly to a specific interface, but it can be associated dynamically with an interface.

As with a physical interface on a router, you can assign an IP address to the virtual template interface. You can also configure IP routing characteristics on the virtual template interface. You must configure certain GPRS/UMTS-specific elements on the virtual template interface, such as GTP encapsulation (necessary for communicating with the SGSN) and the access list the GGSN uses to determine which PDNs are accessible on the network.

Access Point Configuration

The GPRS/UMTS standards define a network identity called an access point name (APN). An APN identifies the service or network to which a subscriber can connect from a GGSN in a GPRS/UMTS network.

To configure APNs, the Cisco IOS GGSN software uses the following configuration elements:

- Access point—Defines an APN and its associated access characteristics, including security and method of dynamic addressing.
- Access point list—Logical interface that is associated with the virtual template of the GGSN. The access-point list contains one or more access points.
- Access group—Additional level of security that is configured at an access point to control access to and from a PDN. When an MS is permitted access to the GGSN as defined by a traditional IP access list, the IP access group defines whether access is permitted to the PDN (at the access point). The IP access group configuration can also define whether access from a PDN to an MS is permitted.

For more detailed information on access-point configuration, see the [“Configuring Access Points on the GGSN” section on page 9-7](#).

Benefits

The 2.5G GPRS technology provides the following benefits:

- Enables the use of a packet-based air interface over the existing circuit-switched GSM network. The packet-based air interface allows greater efficiency in the radio spectrum because the radio bandwidth is used only when packets are sent or received
- Supports upgrades to the existing GSM network infrastructure for network service providers who want to add GPRS services in addition to GSM, which is currently widely deployed
- Supports data rates that are faster than rates offered by traditional circuit-switched GSM data service
- Supports larger message lengths than Short Message Service (SMS)
- Supports a wide range of access to data networks and services. This access includes VPN/Internet service provider (ISP) corporate site access and Wireless Application Protocol (WAP).

In addition to the above, the 3G UMTS technology includes the following:

- Enhanced data rates of approximately 256 Mbps
- Supports connection-oriented Radio Access Bearers with specified QoS, enabling end-to-end QoS

Features Introduced in Cisco IOS Release 12.4(24)YE4

Cisco GGSN Release 10.2, Cisco IOS Release 12.4(24)YE4 introduces support for the following features:

- Credit-Control-Failure-Handling (CCFH) vendor-specific attribute value pair (AVP) tuning for prepaid and postpaid subscribers.

By default, when service-aware billing is implemented on the Cisco GGSN using a Diameter Credit Control Application, the Cisco GGSN receives a Diameter Credit-Control-Answer (CCA) and applies it uniformly for both prepaid and postpaid subscribers.

With Cisco GGSN Release 10.2 and later, you can associate up to 16 charging profiles with different subscribers in an APN. The ability to associate multiple charging profiles with different subscribers in an APN enables operators to customize the CCFH for both prepaid and postpaid subscribers. The CCFH determines how the GGSN behaves if a CCA failure occurs.

For information about this feature, see the [“Tuning CCFH for Prepaid and Postpaid Subscribers” section on page 8-29](#).

- Diameter Credit Control Application (DCCA) Credit Control Requests (CCRs) enhancements:
 - Support for grouping message-level AVPs under the Packet Switched Information (PS-Information) AVP. For information about this feature, see the [“Grouping AVPs under the Packet Switched Information AVP” section on page 8-32](#).
 - Support for grouping the International Mobile Subscriber Identity (IMSI) AVP under the Subscription-ID AVP. For information about this feature, see the [“Grouping the IMSI AVP under the Subscription-ID AVP” section on page 8-33](#).
 - Support for the following new AVPs:
 - The International Mobile Equipment Identity (IMEI) in the User-Equipment-Info AVP (group level)
 - 3GPP-SGSN-MCC-MNC AVP (message level)
 - 3GPP-MS-Timezone AVP (message level)

For a complete list of AVPs supported by the Cisco GGSN in DCCA messages, see [Appendix B, “Supported AVPs in DCCA Messages.”](#)

- Delayed quota reauthorization for DCCA subscribers. For information about this feature, see the [“Configuring the Quota Reauthorization Delay Timer” section on page 8-33](#).

Features Introduced in Cisco IOS Release 12.4(24)YE3

Cisco GGSN Release 10.1, Cisco IOS Release 12.4(24)YE3 introduces support for RADIUS Controlled Redirection.

The RADIUS Controlled HTTP Redirection feature enables the Cisco GGSN to redirect the HTTP traffic of subscribers to an Advice-of-Charge (AoC) page that notifies them of new tariff changes when they are roaming in a foreign PLMN.

For information about configuring RADIUS controlled HTTP redirection, see [“Configuring RADIUS Controlled HTTP Redirection” section on page 8-45](#).

Features Introduced in Cisco IOS Release 12.4(24)YE2

Cisco GGSN Release 10.0, Cisco IOS Release 12.4(24)YE2 introduces support for Overlapping Local IP Address Pools.

For information about configuring overlapping local IP address pools, see [“Configuring Overlapping Local IP Address Pools” section on page 12.](#)

Features Introduced in Cisco IOS Release 12.4(24)YE

Support for the following features is introduced in Cisco GGSN Release 10.0, Cisco IOS Release 12.4(24)YE:

- Single IP operation and management of the Cisco SAMI

Cisco GGSN Release 10.0 and later supports a Single IP architecture. The Single IP architecture enables a single view of the Cisco GGSN external interfaces (for example, the Gi, Gn, Ga, iSCSI, AAA, Diameter, etc.) and a single point of configuration and operation.

For information about the Single IP architecture, see [Chapter 2, “Overview of the Single IP Cisco GGSN.”](#)

- Enhanced prepaid subscriber features
 - Dynamic HTTP redirection and termination with Final Unit Indication (FUI)
 - Activity-based time billing—Activity-based billing, as defined in 3GPP, bills users for only the periods of on the network that activity is occurring, instead of billing them for the entire time they are logged on the network.

For about configuring these enhanced prepaid subscriber features, see the [“Configuring Activity-Based Time Billing for Prepaid Subscribers” section on page 8-41](#) and the [“Configuring FUI-Based HTTP Redirection” section on page 8-42.](#)

- Dynamic IP address management

With Release 10.0 and later, the Cisco GGSN supports dynamic IP address allocation. Dynamic IP address allocation enables operators to implement a Cisco GGSN without subnetting requirements. The Cisco GGSN supports dynamic IP address allocation from DHCP, RADIUS, and local pools.

For information about dynamic IP address management, see the [“Using Dynamic IP Address Management on the Cisco GGSN” section on page 13-17.](#)

- Cisco CSG2 load balancing

With the advent of a Single IP architecture of Cisco GGSN Release 10.0 and later, the Cisco GGSN quota server interface supports multiple Cisco CSG2s. Service-aware users from the Cisco GGSN are load-balanced among the Cisco CSG2s.

For information on Cisco CSG2 load balancing, see the [“Configuring Cisco CSG2 Load Balancing” section on page 8-49.](#)

- Online Charging System (OCS) load balancing

In earlier releases of the Cisco GGSN, you could configure only one DCCA server at a time per APN, however, you could configure different DCCA servers for the same APN on the GGSN instances on the Cisco SAMI.

With the transition to a single IP architecture in Cisco GGSN Release 10.0, the separate GGSN instances running on the six Cisco SAMI processors function as a single GGSN. To enable an APN to communicate with multiple DCCA servers, with Cisco GGSN Release 10.0 and later, you can configure multiple DCCA profiles under a charging profile that is applied to an APN.

For information about OCS load balancing, see the [“Specifying a DCCA Client Profile for Online Billing” section on page 8-26](#).

Features Introduced in Prior Releases

The Cisco GGSN also supports the following features and functionality introduced in prior releases:

- Release 99 (R99), Release 98 (R98), and Release 97 (R97) support and compliance
- GTPv0 and GTPv1 messaging
- IP Packet Data Protocol (PDP) and PPP PDP types
- Cisco Express Forwarding (CEF) switching for both GTPv0 and GTPv1, and for IP and PPP PDP types
- For GTPv1 PDPs, support of up to 11 secondary PDP contexts
- Multiple APNs per VRF instance
- VPN support
 - Virtual APNs
 - VPN routing and forwarding (VRF) per APN
 - Generic Routing Encapsulation (GRE) tunneling
 - Layer 2 Tunneling Protocol (L2TP) extension for PPP PDP type
 - PPP Regeneration for IP PDP type
 - 802.1Q virtual LANs (VLANs)
- Security features
 - Duplicate IP address protection
 - PLMN range checking
 - Blocking of foreign mobile stations
 - Anti-spoofing
 - Mobile-to-mobile redirection

- Quality of Service (QoS)
 - UMTS classes and interworking with differentiated services (DiffServ)
 - Delay QoS
 - Canonical QoS
 - GPRS QoS (R97/R98) conversion to UMTS QoS (R99) and the reverse
 - Call Admission Control (CAC)
 - Per-PDP policing
- Dynamic address allocation
 - External DHCP server
 - External RADIUS server
 - Local pools
- Per-APN statistics
- Anonymous access
- RADIUS authentication and accounting
- Accounting
 - Wait accounting
 - Per-PDP accounting
 - Authentication and accounting using RADIUS server groups mapped to APNs
 - 3GPP vendor-specific attributes (VSAs) for IP PDP type
 - Transparent mode accounting
 - Class attribute
 - Interim updates
 - Session idle timer
 - Packet of Disconnect (PoD)
- Dynamic Echo Timer
- GGSN interworking between 2.5G and 3G SGSNs with registration authority (RA) update from
 - 2.5G to 2.5G SGSN
 - 2.5G to 3G SGSN
 - 3G to 3G SGSN
 - 3G to 2.5G SGSN
- Charging
 - Time trigger
 - Charging profiles
 - Tertiary charging gateway
 - Switchback to primary charging gateway
 - Maintenance mode
- Maintenance mode
- Multiple trusted PLMN IDs

- GGSN-IOS SLB messaging
- Session timeout
- High-Speed Downlink Data Packet Access (HSDPA) and associated 3GPP R5 (as required).
- Enhanced Virtual APN
- New information elements (IEs) sent from the SGSN (user location, radio access technology [RAT], MS time zone (MSTZ), Customized Application for Mobile Enhanced Logic [CAMEL] charging information, and user location information IEs)
- GTP SLB stickiness
- GGSN-Initiated Update PDP Context Requests
- P-CSCF Discovery
- Enhanced MIBs for:
 - Cisco Content Services Gateway (CSG)
 - Diameter Credit Control Application (DCCA)
 - APN-level Periodic Accounting Timer
 - PPP-Regeneration Scalability
 - Direct tunnels
 - Change of Authorization
 - GGSN-initiated Update PDP Contexts
 - iSCSI
- RADIUS Change of Authorization (CoA) message support for dynamically change session authorizations.
- Downloadable QoS Profile (from an AAA server)
- PPP-Regeneration Scalability and Anonymous User Access for PPP-Regeneration
- Downloadable Pool Name Support
- Direct Tunnel Support

The direct tunnel feature enables an SGSN to establish a direct user plane tunnel between the radio network controller (RNC) and a GGSN.

The SGSN functions as the gateway between the RNC and the core network. It processes both signaling traffic (to track the location of mobile devices), and the actual data packets being exchanged between a mobile device and the Internet.

Before Cisco GGSN Release 8.0, a tunnel could only exist between the GGSN and SGSN, and between the SGSN and RNC. With this tunnel configuration, all data packets must pass through the SGSN. The SGSN has to terminate one tunnel, extract the packet, and put it into another tunnel. This process takes time and processing power.

With direct tunnel support, the SGSN can initiate a direct tunnel between the RNC and GGSN, and no longer have to process data packets. The SGSN continues to manage location issues by modifying the tunnel if a mobile device moves to an area served by another RNC.

Specifically, direct tunnel processing is as follows:

- a. The SGSN initiates the direct tunnel with an Update PDP Context Request that contains the following elements:
 - Direct Tunnel Flags IE with the DTI bit set to 1.
 - The RNC user traffic address
 - Data TEID
 - GGSN updates the RNC user traffic address and Data TEID. The GGSN uses the updated information when sending G-PDUs for the MS.
- b. If the GGSN receives an Error Indication message from the RNC user traffic address, it initiates an Update PDP Context request. The Update PDP Context request includes the Direct Tunnel Flags IE with the Error Indication bit set.
- c. Until the Update PDP Context response is received from the SGSN, the GGSN drops subsequent packets to the MS address.
- d. The Update PDP Context response is received from the SGSN. If the cause is “Request Accepted,” the PDP is preserved. If the cause is “Not Request Accepted,” the PDP is deleted locally.

**Note**

Direct tunnel support does not apply to international roaming. In addition, direct tunnel support does not apply when a prepaid system asks the SGSN to count the traffic flow.

- Granular Charging and Storage
- GRX Traffic Segregation
- Gx Interface Support
- Gy Interface Support
- Lawful Intercept
- Proxy-CSCF Load Balancing
- Standalone GGSN Prepaid Quota Enforcement
- Verbosity and Next Call Conditional Debugging
- HSPA QoS Extensions
- Multiple Subnets Behind the Mobile Station
- Layer 3 Geographical Redundancy
- Passive Route Suppression
- eGCDR Support for Cisco CSG2 Quota Server Configurations

