

# Ericsson Packet Core Network Overview

## DESCRIPTION

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# 1 Introduction

This document describes the Ericsson Packet Core Network. The purpose of the document is to provide an overview of the network architecture, network nodes and interfaces, and network evolution.

The Packet Core Network consists of several products, and this document contains information on the following products:

- SGSN-MME
- EPG

More information regarding, for example, nodes and interfaces can be found in the CPI library for each product.

## 1.1 Scope

This document provides a high-level description of the Ericsson Packet Core Network, and includes descriptions of nodes, interfaces, and network evolution. The document is valid for SGSN-MME and EPG.

## 1.2 Target Group

This document is intended as an overview of the Ericsson Packet Core Network for network operators, network and service planners, system engineers, and administrators. This document assumes a basic knowledge of data communication and telecommunications.

## 1.3 3GPP Standard Compliance

The SGSN-MME and EPG are compliant with 3GPP technical specifications as specified in the Statements of Compliance (SoCs).

# 2 Network Overview

This section provides an overview of the packet core network and the surrounding networks. A high-level illustration of the network is shown in Figure 1. For more information regarding different parts of the network and their functions, refer to the corresponding Technical Product Description Overview in the CPI Library.

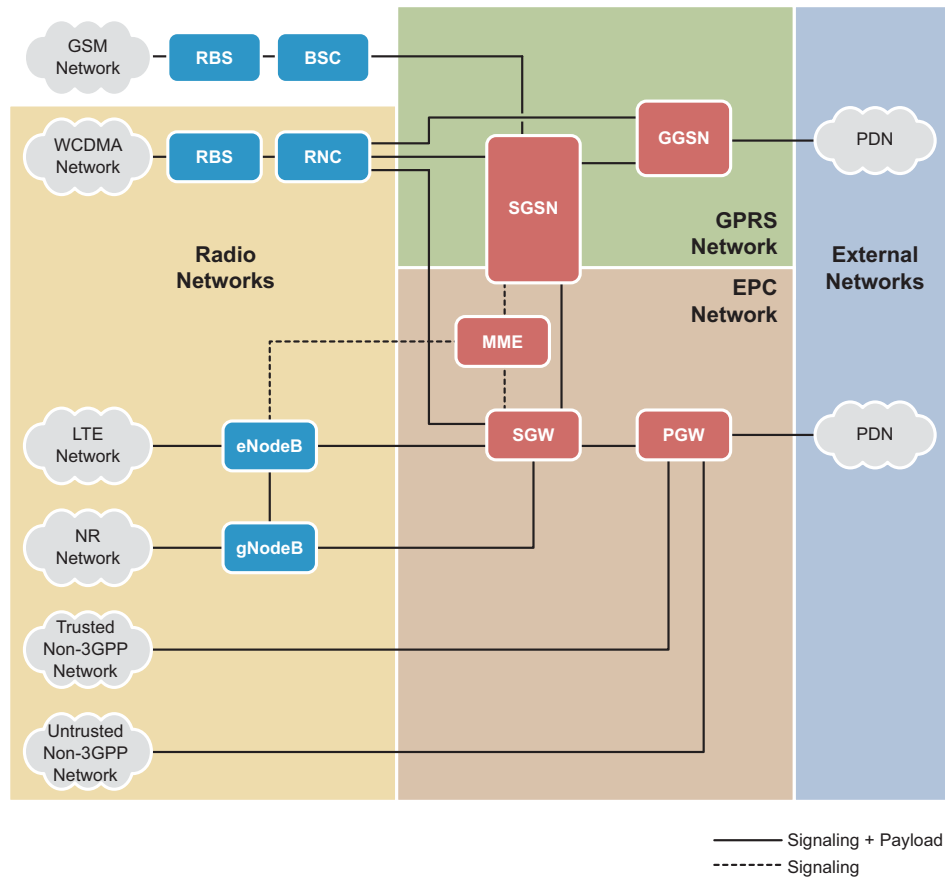


Figure 1 Network Overview

The Packet Core Network consists of two parts: the GPRS network and the EPC network.

GPRS provides packet data services to GSM and WCDMA systems. The Ericsson GPRS solution is integrated with the circuit switched part of the Ericsson GSM and WCDMA systems. The EPC provides packet data service for LTE, NR, and non-3GPP networks, including trusted non-3GPP network and untrusted non-3GPP network. There is no strict border between the GPRS and EPC nodes when they are implemented in the operators network, since the GPRS nodes from Ericsson can be upgraded with EPC, including 5G-EPC, functionality by software only.

The Evolved Packet System (EPS) consists of the UE, the LTE network, and the EPC network.

Both GPRS and EPC provide solutions for IP communication between UE and Packet Data Networks (PDNs), such as:

- The Internet
- A corporate Local Area Network (LAN)



- A Machine to Machine (M2M) server or network
- The service network of operators

The main nodes within the Packet Core Network are:

- SGSN
- MME
- GGSN
- SGW
- PDN Gateway (PGW)

The EPC products implement the different nodes as follows, in the GPRS and EPC networks:

- The SGSN-MME provides SGSN and MME functionality. It is possible to use the SGSN-MME with either SGSN functionality or MME functionality, or both.
- The EPG provides GGSN, SGW, and PGW functionality. It is possible to use the EPG with either GGSN functionality, SGW and PGW functionality, PGW functionality, SGW functionality, or all simultaneously.

Apart from the main Packet Switched nodes, there are several other nodes and systems in the GPRS and EPC network, such as support systems, O&M network, and other PLMNs. These are further described in the following sections.

## 2.1 GPRS Network

This section provides a high-level description of GPRS in GSM and WCDMA systems. The GPRS network is shown in Figure 2. For a description of the nodes and interfaces in the GPRS network, see Section 3 on page 8 and Section 4 on page 14.

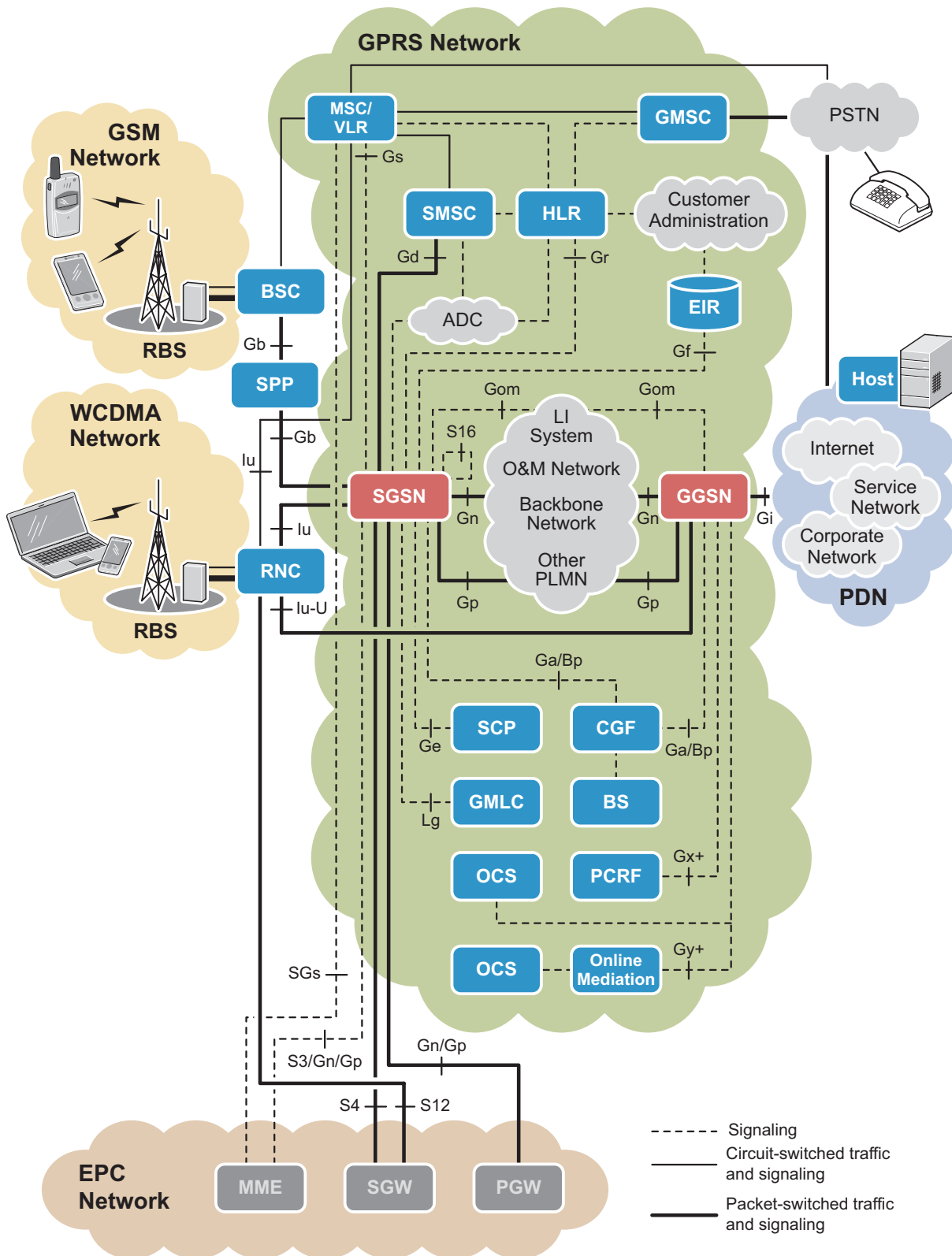


Figure 2 GPRS Network Nodes and Interfaces



With GPRS, users of WCDMA end-user services get fast and effective access to the Internet, a corporate LAN, or a service network of an operator through the Packet Switched Network. The packet data function does not influence the circuit switched services supported by GSM.

The traditional GSM system is circuit switched. It is used for telephony traffic between the UE and the Public Switched Telephone Network (PSTN), but it can also transfer packet data between UE and other UE or the Internet or a corporate LAN. The WCDMA system is a third generation (3G) mobile system that supports both Packet Switched and circuit switched communication. The WCDMA system increases the packet data transmission speed between UE and any PDN.

GPRS is the packet data service in both GSM and WCDMA systems.

The GPRS network consists of the following main nodes:

- SGSN
- GGSN

The GPRS network is connected to the following other networks and systems:

- A GSM or WCDMA radio network, which is the access network where the UE connects to the GPRS network.
- A PDN, which can be the Internet, a corporate network, or a dedicated service network. Hosts and terminals connected to the PDN are accessible to hosts and terminals connected to the radio network.
- The EPC network, providing mobility between GSM or WCDMA and LTE Radio Access Networks.
- The backbone network, which connects SGSNs and GGSNs. Hosts connected to the backbone network are only accessible from other hosts connected to the backbone network.
- The O&M network, which is the network for O&M systems. Hosts connected to the O&M network are only accessible from other hosts in the O&M network. The OSS-RC is an example of an O&M network node.
- The Lawful Interception (LI) system, which is an optional feature that makes it possible for law enforcement agencies to conduct electronic surveillance of UE.
- Other PLMNs, that is, other telecommunications networks providing mobile cellular services.

From a GSM perspective, the GPRS network is an extension of the circuit switched GSM network with some GPRS-specific additions. From a WCDMA system perspective, the GPRS network exists in parallel with the circuit switched network, as shown in Figure 2.



The circuit switched parts of the core network handle telephony and Circuit Switched Data, while GPRS adds a Packet Switched part of the core network for packet data. The SGSN and the GGSN are the main network nodes in the Packet Switched part of the core network. The SGSN provides, for example, mobility and session control for the UE. The GGSN is the gateway to external IP Networks. Operation and maintenance of an SGSN or a GGSN is typically performed by a management client with the SGSN or the GGSN as a server, for example, from the node management terminal.

The SGSN is connected to, but physically separated from, the circuit switched part of the cellular network.

GSM uses the same radio interface for both circuit switched and Packet Switched communication, according to the GSM standard. An end user requires UE that supports GPRS to be able to use the GPRS services. For GPRS services in the WCDMA system, an end user needs UE that supports the WCDMA system.

Circuit switched and Packet Switched services can be used either simultaneously or one at the time, depending on the capabilities of the UE and the radio networks. WCDMA system UE can be used for Packet Switched communication only, or both circuit switched and Packet Switched communication. GSM UE can be used for circuit switched communication, Packet Switched communication, or both.

In GSM, the same Radio Base Station (RBS) and BSC are used for GPRS packet data as for GSM circuit switched traffic. The GPRS part operates on the same Radio Frequencies as the circuit switched part of a GSM system.

The WCDMA system radio network consists of RBS and RNC nodes designed for both packet data and circuit switched communication with the UE.

## 2.2 EPC Network

This section provides a high-level description of the EPC network. The EPC network is shown in Figure 3. For a description of the nodes and interfaces in the EPC network, see Section 3 on page 8 and Section 4 on page 14.

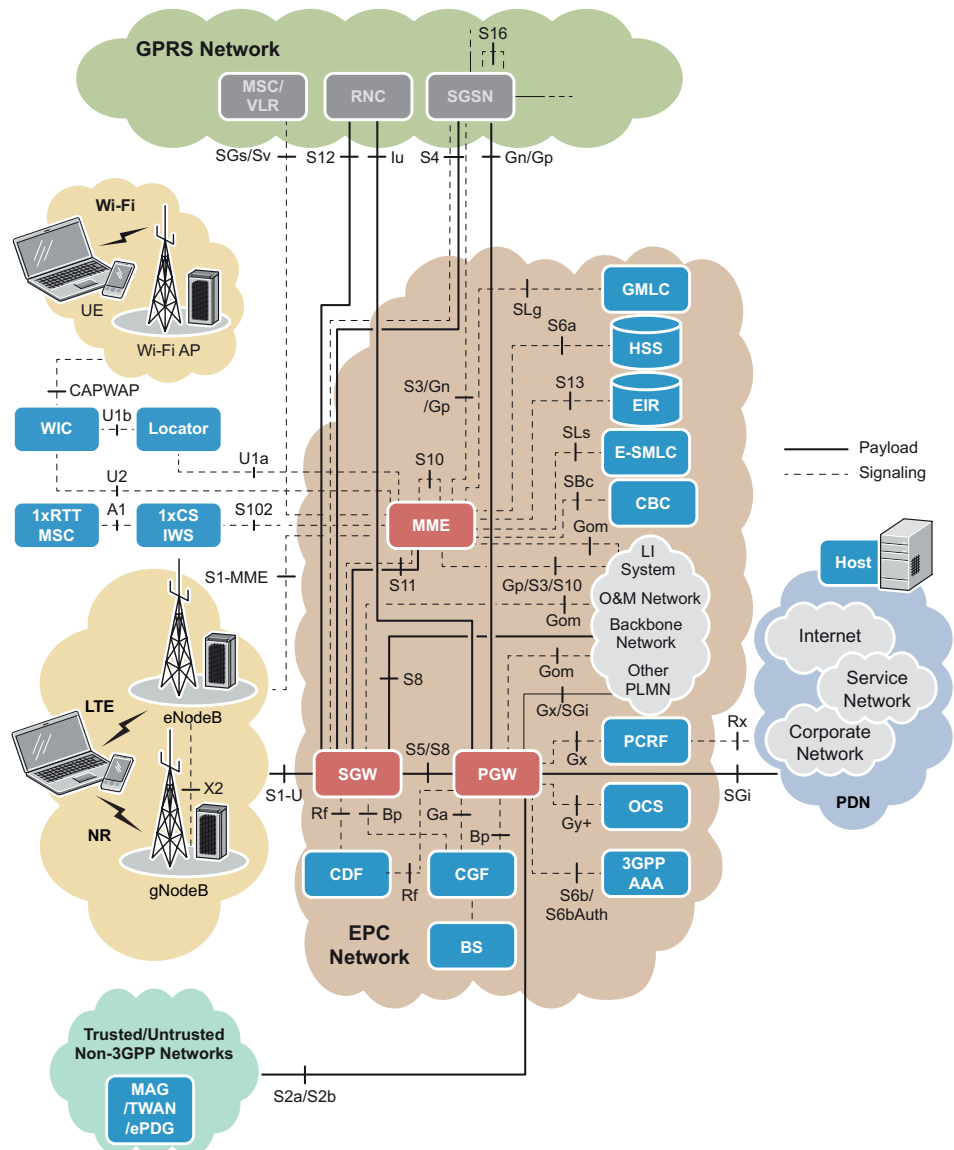


Figure 3 EPC Network Nodes and Interfaces

The EPC offers an optimized network architecture where the control plane is separated from the user plane. This, with LTE and NR technology, results in higher bit rates, faster throughput, and lower latency. All communication within the network is IP-based, and an always-on IP-connectivity is provided between the UE and a PDN. The UE is simultaneously associated both with LTE/eNodeB and NR/gNodeB. The EPC supports mobility within the LTE RAN, enabling UE to be handed over between eNodeBs, and Inter-Radio Access Technology (IRAT) mobility between LTE and GSM or WCDMA RANs. The 5G EPC supports Dual Connectivity with NR as secondary RAT in a non-standalone (NSA) NR configuration.



The EPC network consists of the following main nodes:

- MME
- SGSN
- SGW
- PGW

The EPC network is connected to the following other networks and systems:

- An LTE radio network, containing the eNodeB, which is the access network where the UE connects to the EPC network.
- An NR radio network, containing the gNodeB, which connects to the LTE/eNodeB, and acts as a secondary RAT.
- A PDN, which can be the Internet, a corporate network, or a dedicated service network. Hosts and terminals connected to the PDN are accessible to hosts and terminals connected to the radio network.
- The GPRS network, providing mobility between LTE and GSM or WCDMA Radio Access Networks.
- The TWAN and the MAG, providing connection between the trusted non-3GPP network and EPC.
- The Evolved Packet Data Gateway (ePDG), providing connection between the untrusted non-3GPP network and EPC.
- The backbone network, which connects the main nodes. Hosts connected to the backbone network are only accessible from hosts connected to the backbone network.
- The O&M network, which is the network for O&M systems. Hosts connected to the O&M network are only accessible from other hosts in the O&M network. The OSS-RC is an example of an O&M network node.
- The LI system, which is an optional feature that makes it possible for law enforcement agencies to conduct electronic surveillance of UE.
- The 1x Circuit Switched (1xCS) network.
- Other PLMNs, that is, other telecommunications networks providing mobile cellular services.



## 3 Nodes

This section describes the role of the nodes in the packet core network, listed in alphabetical order. The nodes are shown in Figure 2 and Figure 3. For more information, search for the corresponding node in the CPI library.

Table 1 Nodes

<b>1xCS IWS</b>	The 1xCS Interworking Solution (IWS) serves as a tunneling end point toward the MME for sending and receiving encapsulated 1xRTT signaling messages to and from the UE.
<b>3GPP AAA</b>	The 3GPP AAA server handles authentication, authorization, and accounting functions for UE devices that access the EPC from a non-3GPP network.
<b>BS</b>	The Billing System (BS) retrieves Charging Data Records (CDRs) from the SGSN, GGSN, PGW, and SGW.
<b>BSC</b>	<p>The BSC sets up, supervises, and disconnects circuit switched calls and Packet Switched data sessions. It has a high-capacity switch providing, for example, handover, cell configuration data, and channel assignment. One or several BSCs are served by one Mobile services Switching Center (MSC) for call handling, and several BSCs are served by one SGSN for packet data transmission. If SGSN Pool is used, the BSCs are connected to all or several SGSNs.</p> <p>The BSC forwards the circuit switched calls to the Mobile services Switching Center/Visitor Location Register (MSC/VLR) and packet data to the SGSN.</p>
<b>CAS</b>	The Customer Administration System (CAS) controls the HLR, Flexible Numbering Register (FNR), Authentication Center (AuC), and Equipment Identity Register (EIR) databases. The type of interface between the databases and the CAS can be chosen.
<b>CBC</b>	The Cell Broadcast Center (CBC) connects to the MME over the SBC interface. The CBC is responsible for the management of warning messages.
<b>CDF</b>	The SGW connects to a Charging Data Function (CDF) over the Diameter-based Rf interface. The Diameter network consists of client peers, server peers, and agents.
<b>CGF</b>	The Charging Gateway Function (CGF) receives CDRs from the SGSN, GGSN, PGW, and SGW in near real time and can store the CDRs in persistent storage. The CGF preprocesses the CDRs before delivery to a BS. The preprocessing can include validation, consolidation, and reformatting of the CDRs.



<b>EIR</b>	The Equipment Identity Register (EIR) holds information about UE and is involved in the International Mobile Station Equipment Identity (IMEI) check procedure. The IMEI check procedure can be performed to control the access to the network for a specific ME, for example to check if the ME has been stolen or is considered illegal.
<b>eNodeB</b>	The eNodeB is an enhanced base station that connects the UE with the EPC network. The main functionality of the eNodeB is radio bearer control, radio admission control, connection mobility control, and dynamic resource handling. The eNodeB is used for LTE networks.
<b>ePDG</b>	The ePDG manages the mobility-related signaling in the untrusted non-3GPP network for the UE device. The ePDG handles the communication with the UE and the establishment of the connection between the UE and PDN through the PGW. Besides, the ePDG also acts as a termination node of IPsec tunnels established with the UE to secure the data transmission.
<b>E-SMLC</b>	The Evolved Serving Mobile Location Center (E-SMLC) manages the overall coordination and scheduling of resources required for the location of a UE that is attached to E-UTRAN. It also calculates the final location and velocity estimate and estimates the achieved accuracy. The E-SMLC interacts with the UE to exchange location information applicable to UE-assisted and UE-based position methods. The E-SMLC also interacts with the E-UTRAN to exchange location information applicable to network assisted and network-based position methods.
<b>GGSN</b>	<p>The GGSN forwards uplink and downlink IP packets between the SGSN and the PDN or, when using 3GDT, to bypass the SGSN, directly between the RNC and the PDN.</p> <p>It also generates charging information for the UE, for example, use of GPRS network resources. Service-Aware Charging and Control (SACC) enables the GGSN to charge based on the different services used. The GGSN handles session management, that is, activation, modification, and deactivation of PDP contexts for sessions between the GGSN and the SGSN, and between the GGSN and the PDN. Session management also includes dynamic IP address allocation and QoS negotiation.</p>
<b>GMLC</b>	The Gateway Mobile Location Center (GMLC) is the node that interfaces with location applications that request Location Services for a specific subscriber. The GMLC can perform location application authorizations to check the validity of the requesting application.
<b>GMSC</b>	Gateway MSC (GMSC), see MSC Page 12.



<b>gNodeB</b>	The 5G EPC Network provides support of the New Radio (NR) as a secondary RAT in an NSA configuration. This is to benefit from 5G capabilities, for example, higher bit rates. The eNodeB can control a Dual Connectivity radio connection that uses a combination of LTE and NR. The UE is simultaneously associated both with LTE/eNodeB and NR/gNodeB.
<b>HeNB</b>	The Home eNodeB (HeNB) is a base station intended for home or business use and connects UE to the EPC network. The HeNB is connected either directly to the MME or through the HeNB GW. The HeNB can also be connected either directly to the SGW or through the HeNB GW. The main functionality of the HeNB is radio bearer control, radio admission control, connection mobility control, and dynamic resource handling.
<b>HeNB GW</b>	The Home eNodeB Gateway (HeNB GW) is an optional node that connects the HeNB to the MME.
<b>HLR</b>	<p>The HLR is a database holding subscription information for all UE subscribing to the GSM or WCDMA systems network. The HLR stores information for circuit switched and Packet Switched communication, for example, the location of UE, supplementary services, authentication parameters, and whether packet communication is enabled.</p> <p>For the Packet Switched part of the network, subscription information is fetched by the SGSN, and the HLR is used for the authentication procedure of the UE. In addition, the HLR stores the subscription information regarding UE-terminated SMS messages and whether to transfer SMS message through the SGSN.</p>
<b>Host</b>	The GPRS and EPC networks provides IP connectivity between the UE and an ISP or corporate LAN connected to the GPRS or EPC network. This enables the UE to connect to internet hosts providing IP-based services. The internet hosts are not included in the GPRS or EPC networks.
<b>HSS</b>	The HSS is a database holding subscription information for UE subscribing to the EPC network. The HSS stores, for example, the location of the UE on MME node level, and provides authentication and authorization functions. The HSS is similar to the HLR and Authentication Center (AuC).
<b>MAG</b>	The MAG (in CDMA2000 networks called HSGW) manages the mobility-related signaling in the non-3GPP network for the UE device. The MAG tracks the movements of the UE and signals to the PGW. The MAG acts as default router for the UE device.
<b>MME</b>	The Mobility Management Entity (MME) is the key control node in the EPC network. The main functionality of the MME is attach and detach of UE, authentication, choosing SGW and PGW for the UE, and management of PDN connections and EPC bearers. It also handles mobility procedures, UE tracking, and paging.



<b>MBMS-GW</b>	The Multimedia Broadcast/Multicast Service Gateway (MBMS-GW) connects to the MME over the Sm interface. The MBMS-GW can initiate Multimedia Broadcast and Multicast Service (MBMS) in the LTE access.
<b>MCE</b>	The Multi-cell/Multicast Coordination Entity (MCE) connects to the MME over the M3 interface. When the eMBMS feature is on, the MCE is responsible for broadcasting in its service areas.
<b>MSC/VLR</b>	<p>The Mobile services Switching Center (MSC) provides connections from GSM or WCDMA services to other networks, such as normal telephone networks or ISDN. It handles circuit switched transactions with the UE located in a Geographical Area designated as the MSC area. It is responsible for the setup, routing, control, and termination of the call, for management of inter-MSC handover and supplementary services, and for collecting charging information.</p> <p>The Visitor Location Register (VLR) is a database containing temporary information about all the UEs currently located in the area served by one MSC.</p>
<b>OCS</b>	The Online Charging System (OCS) enables real-time credit control and charging of user traffic. The OCS is responsible for applying rates to the service usage reported by the GGSN or PGW. If online charging is performed by a proprietary charging system not compliant with the 3GPP Gy or Gy+ interface, an Online Mediation system can be used.
<b>OSS-RC</b>	The Operations Support System for Radio and Core (OSS-RC) supports parameter setting and alarm surveillance of the nodes. The OSS-RC provides functionality for network management, configuration management, installation and upgrade, and High Availability solutions.
<b>PCRF</b>	The Policy and Charging Rules Function (PCRF) handles policy control decisions and flow-based charging control functionality. The main functionality of the PCRF is subscriber handling, device handling, access-aware handling, and flow-based charging.
<b>PGW</b>	The PGW is the gateway between the internal EPC network and external PDNs, for example, the Internet or a corporate LAN. The PGW provides IP connectivity toward external PDNs, policy and admission control, and packet filtering per user. The PGW can also be used for charging.
<b>RBS</b>	The RBS is the radio equipment that transmits and receives information over the radio interface to enable communication with the UE in the area. The RBS is used for GSM and WCDMA networks.



<b>RNC</b>	<p>The RNC is in charge of controlling the use and the integrity of the radio resources. It is responsible for handover decisions requiring signaling to the UE. An RNC supports combined or split information streams. One or several RNCs are served by one MSC for call handling, and several RNCs are served by one SGSN for packet data transmission.</p> <p>The RNC forwards the circuit switched calls to the MSC/VLR and packet data to the SGSN.</p>
<b>SCP</b>	<p>The Service Control Point (SCP) is a node in an SS7 telephone network that provides an interface to databases, which can reside within the SCP or in other computers. The SCP stores service and subscriber data and executes the service logic program that implements the Customized Applications for Mobile Networks Enhanced Logic (CAMEL) service.</p>
<b>SGSN</b>	<p>The SGSN is a GPRS node, which handles the communication with the UE and the establishment of the connection between UE and the PDN through the GGSN, PGW, or SGW.</p> <p>Unless SGSN pool is used, an SGSN serves all GSM or WCDMA systems subscribers physically located within the geographical SGSN area. The SGSN forwards IP packets to all GPRS-attached UEs within that SGSN service area and the GGSN, PGW, or SGW. Connections between the SGSN and the UE and between the SGSN and the GGSN or PGW are handled through session management, that is, through the activation, modification, and deactivation of PDP contexts.</p> <p>With the introduction of the S4 interface, the SGSN becomes a part of the EPC network with signal exchange and payload between the SGSN and the SGW.</p>
<b>SGW</b>	<p>The SGW routes and forwards the user packet data from the UE to the PGW or from the PGW to the UE. The SGW acts as a local mobility anchor for the user plane during inter-eNodeB handovers and provides charging functionality.</p>
<b>SMSC</b>	<p>The Short Message Service Center (SMSC) acts as a store and forward center for SMS messages. The SMSC is connected to the GPRS network through the Short Message Service Gateway MSC (SMS-GMSC) and the Short Message Service Interworking MSC (SMS-IWMSC). The SMS-GMSC and SMS-IWMSC are connected to the SGSN to enable GPRS UE to send and receive SMS messages over the Packet Switched domain through the SGSN.</p>



<b>SPP</b>	<p>The SGSN Pool Proxy (SPP) provides Gb over IP proxy function and SGSN pool proxy function. The SPP is an optional node that is placed between the BSC and the SGSN. If the BSC lacks support for Gb over IP, SGSN Pool, or both, it is possible to apply these features by using an SPP. However, this requires that the SGSN supports Gb over IP, SGSN Pool, or both, respectively.</p> <p>SPP is only applicable for GSM.</p>
<b>TWAN</b>	<p>TWAN is a node that terminates the UE Wi-Fi air link defined in IEEE 802.11 and connects the establishment between the UE and the PDN through the PGW.</p>
<b>UE</b>	<p>The UE is the device a person or system uses to access a PDN through the GPRS or EPC network. UE can also be referred to as MS in, for example, 3GPP standards. The term UE is used throughout this document.</p>
<b>Wi-Fi UE Locator</b>	<p>The Wi-Fi UE Locator stores the UE location information. When the UE registers into the MME, the MME sends the UE Location Update message to the Wi-Fi UE Locator. The Wi-Fi UE Locator is configured based on a Geographical Area (GA). If the UE moves to a new GA, the MME also sends the message to the Wi-Fi UE Locator based on the new GA.</p>
<b>WIC</b>	<p>The WIC is in charge of admitting UE into the Wi-Fi network. In the Wi-Fi integration feature, it retrieves the UE location information from the Wi-Fi UE Locator to find the MME serving the UE. It then requests the UE throughput in LTE from the MME to decide whether to allow the UE to stay in the Wi-Fi network. The WIC also maintains a mapping between Wi-Fi cells and LTE cells that have the overlapping coverage.</p>

## 4 Interfaces

This section describes the role of the interfaces in the packet core network, listed in alphabetical order. The interfaces are shown in Figure 2 and Figure 3. Each interface description states which node supports the interface. For more information, search for the corresponding interface in the CPI library.



Table 2 Interfaces

<b>Ga/Bp interface</b>	<p>The Ga/Bp interface connects the SGSN, GGSN, PGW, or SGW to a BS responsible for handling CDRs generated by traffic through the GGSN, PGW, or SGW. The connection to the BS can be mediated through a CGF.</p> <p>The interface is supported by SGSN-MME and EPG.</p>
<b>Gb interface</b>	<p>The Gb interface connects the SGSN to BSCs through Gb over IP, enabling exchange of signaling and payload.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Gd interface</b>	<p>The Gd interface connects the SGSN to the SMS-GMSC and the SMS-IWMSC using narrowband SS7, or SS7 over IP, enabling Short Message Service (SMS) messages to be sent and received.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Ge interface</b>	<p>The Ge interface connects the SGSN to the SCP using narrowband SS7 or SS7 over IP, enabling CAMEL-based real-time charging.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Gf interface</b>	<p>The Gf interface connects the SGSN to the EIR using narrowband SS7 or SS7 over IP for IMEI check.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Gn/Gp interface</b>	<p>The Gn/Gp interface connects two SGSNs, an SGSN to an MME, or the GGSN or PGW to an SGSN in a GPRS network. The Gn/Gp interface transports user data and control data between the GGSN or PGW and the SGSN. The Gn/Gp interface is based on the GTPv1 protocol.</p> <p>The interface is supported by the SGSN-MME and EPG.</p>



<b>Gom interface</b>	<p>Connects the node to O&amp;M equipment in the O&amp;M network, making it possible for an operator to communicate with the node.</p> <p>The interface is supported by the SGSN-MME and EPG.</p>
<b>Gr interface</b>	<p>The Gr interface connects the SGSN to the HLR using narrowband SS7 or SS7 over IP, enabling subscriber data management.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Gs interface</b>	<p>The Gs interface connects the SGSN to the MSC/VLR using narrowband SS7 or SS7 over IP, enabling cooperation between circuit switched and Packet Switched Networks.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Gx interface</b>	<p>The Gx interface connects the GGSN and PGW to a PCRF. The Gx interface enables the GGSN and PGW to receive QoS policy decisions from a PCRF. The Gx interface transports user data and control data between the PGW and a PCRF. The Gx interface is based on the Diameter protocol.</p> <p>The interface is supported by the EPG.</p>
<b>Gx+ interface</b>	<p>The Gx+ interface connects the GGSN or PGW to the PCRF, enabling the GGSN to receive authorization and policy control information for SACC traffic. The Gx+ interface is an Ericsson extension of the Gx interface.</p> <p>The interface is supported by the EPG.</p>
<b>Gy+ interface</b>	<p>The Gy+ interface connects the GGSN or PGW to an OCS, enabling credit control for SACC traffic. The connection to the OCS can be mediated by an online mediation node.</p> <p>The interface is supported by the EPG.</p>



<b>Iu interface</b>	<p>The Iu interface connects the SGSN to RNCs, enabling exchange of signaling and payload. The Iu Control-plane (Iu-C) interface is connected using SS7 over IP. The Iu User-plane (Iu-U) interface is connected using UDP over IP. The Iu interface also connects the GGSN and the PGW to RNCs.</p> <p>The interface is supported by the SGSN-MME and EPG.</p>
<b>Lg interface</b>	<p>The Lg interface connects the SGSN to the GMLC using narrowband SS7 or SS7 over IP. The main purpose of the Lg interface is to transfer UE location data from the SGSN to the GMLC.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>M3 interface</b>	<p>The M3 interface connects the MME to the MCE. The M3 interface is based on the SCTP protocol.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Rf interface</b>	<p>The Rf interface connects the SGW or PGW to a CDF. The Rf interface is used for offline charging.</p> <p>The interface is supported by the EPG.</p>
<b>S1-MME interface</b>	<p>The S1-MME interface connects the MME to eNodeBs. The S1-MME interface is based on SCTP. S1 Application Protocol (S1-AP) messages are transferred between the MME and eNodeB, and NAS messages are transferred between the MME and UE.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>S1-U interface</b>	<p>The S1-U interface connects the SGW to an eNodeB. The S1-U interface transports user data packets. The S1-U interface is based on the GTPv1-U protocol.</p> <p>The interface is supported by EPG.</p>



<b>S10 interface</b>	<p>The S10 interface connects the MME to other MMEs. It acts as a reference point between MMEs for MME relocation and enables MME to MME information transfer. The S10 interface is based on the GTPv2-C protocol.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>S102 interface</b>	<p>The S102 interface connects the MME to the 1xCS IWS. The S102 interface is based on the A21 protocol which uses User Datagram Protocol (UDP) over IP for transport.</p>
<b>S11-C interface</b>	<p>The S11-C interface connects the MME to the SGW. The S11-C interface is an IP-based interface used for EPC signaling between the MME and the SGW. The S11-C interface is based on the GTPv2-C protocol.</p> <p>The interface is supported by the SGSN-MME and EPG.</p>
<b>S11-U interface</b>	<p>The S11-U interface connects the SGW and an MME. The S11-U interface transports the user data associated with the UE devices with Narrowband IoT (NB-IoT) and WB-EUTRAN RAT types.</p> <p>The S11-U interface uses the GTP-U tunnel to carry T-PDU messages, containing the user packets encapsulated in GTP Protocol Data Units (G-PDUs). S11-U interface also uses GTP-U tunnel to carry GTP-U path management and tunnel management signaling messages between the MME and the SGW.</p> <p>The interface is supported by the SGSN-MME and EPG.</p>
<b>S12 interface</b>	<p>The S12 interface connects the RNC to the SGW, enabling the possibility to establish a direct tunnel. The S12 interface is based on the GTPv1-U protocol.</p> <p>The interface is supported by the EPG.</p>



<p><b>S13 interface</b></p>	<p>The S13 interface connects the MME to the EIR. Information for the optional licensed feature IMEI Check is transferred between the MME and the EIR. The S13 interface is based on the Diameter protocol.</p> <p>The interface is supported by the SGSN-MME.</p>
<p><b>S16 interface</b></p>	<p>The S16 interface connects two or more SGSNs that support the S3 interface or the S4 interface, through IP over Ethernet, enabling signal exchange. The S16 interface is based on the GTPv2 protocol.</p> <p>The interface is supported by the SGSN supporting the S4 interface.</p>
<p><b>S2a interface</b></p>	<p>The S2a interface contains PMIPv6-based S2a interface and GTP-based S2a interface.</p> <p>The PMIPv6-based S2a interface connects the PGW to an HSGW (also called MAG) in a trusted non-3GPP network. The S2a interface transports control data between the PGW and the HSGW. The PMIPv6-based S2a interface is supported by the EPG.</p> <p>The GTP-based S2a interface connects the PGW to a TWAN in a trusted non-3GPP network. The GTP-based S2a interface enables signal exchange and payload between the PGW and the TWAN. The GTP-based S2a interface is based on the GTPv2-C and GTPv1-U protocol. The GTP-based S2a interface is supported by the EPG.</p>
<p><b>S2b interface</b></p>	<p>The S2b interface connects the PGW to an ePDG in an untrusted non-3GPP network, allowing for both control and user plane signaling. The S2b interface is based on the GTPv2-C and GTPv1-U protocol.</p> <p>The interface is supported by the EPG.</p>



<b>S3 interface</b>	<p>The S3 interface connects an MME and an SGSN, that supports the S3 interface and the S4 interface, using IP over Ethernet, making it possible for an SGSN and an MME to communicate. The S3 interface is based on the GTPv2 protocol.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>S4 interface</b>	<p>The S4 interface connects the SGSN and the SGW, enabling signal exchange and payload. The S4 interface is based on the GTPv2-C and GTPv1-U protocol.</p> <p>The interface is supported by the SGSN-MME and EPG.</p>
<b>S5/S8 interface</b>	<p>The S5/S8 interface connects the SGW to a PGW. The S5/S8 interface transports user data packets and handles control plane signaling. The S5/S8 interface is based on the GTPv2 protocol.</p> <p>The interface is supported by the EPG.</p>
<b>S6a interface</b>	<p>The S6a interface connects the MME to the HSS. It enables transfer of subscription and authentication data for authenticating and authorizing user access. The S6a interface is based on the Diameter protocol.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>S6b interface</b>	<p>The S6b interface connects the PGW to a 3GPP AAA server. The S6b interface is used for authorization of UE devices in a non-3GPP network.</p> <p>The interface is supported by the EPG.</p>
<b>S6bAuth interface</b>	<p>The S6bAuth interface connects the PGW to a 3GPP AAA server. The S6bAuth interface is used for authorization of UE devices in LTE, CDMA, and untrusted WLAN networks.</p> <p>The interface is supported by the EPG.</p>



<b>S6d interface</b>	<p>The S6d interface connects the SGSN supporting the S4 interface to the HSS. It enables transfer of subscription and authentication data for authenticating and authorizing user access. The S6d interface is based on the Diameter protocol.</p> <p>The interface is supported by the SGSN supporting the S4 interface.</p>
<b>SBc interface</b>	<p>The SBc interface connects the MME to the Cell Broadcast Center (CBC). The SBc interface is based on SCTP.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>SGi and Gi interface</b>	<p>The SGi interface connects the PGW to a PDN, and the Gi interface connects the GGSN to a PDN. The interfaces transport user data IP packets between gateway and PDN, enabling exchange of signaling and payload. The interfaces also connect the gateway to the SASN. If RADIUS is used, the interfaces connect the gateway to the RADIUS server.</p> <p>The interfaces are supported by the EPG.</p>
<b>SGs interface</b>	<p>The SGs interface connects the MME to the MSC/VLR. It is used for registration in the MSC/VLR of UE performing combined procedure, to page the UE on behalf of the MSC/VLR, and to convey circuit switched related procedures through the MME.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>SLg interface</b>	<p>The SLg interface connects the MME to the GMLC. The SLg interface enables transfer of UE location data to the GMLC. The SLg interface is based on the Diameter protocol.</p> <p>The interface is supported by the SGSN-MME.</p>



<b>SLs interface</b>	<p>The SLs interface connects the MME to the E-SMLC. The interface is used for obtaining the location estimate for a target UE in EPS.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Sm interface</b>	<p>The Sm interface connects the MME to the MBMS-GW. The Sm interface is based on the GTPv2-C protocol.</p> <p>The interface is supported by the SGSN-MME.</p>
<b>Smp interface</b>	<p>The Smp interface connects the SGSN-MME to the Ericsson Service-Aware Policy Controller (SAPC) and enables direct interconnection between the two, with the SGW and PGW or the GGSN bypassed. It enables the provisioning of policy data from the SAPC to the SGSN-MME and the transmission of User Location Information from the SGSN-MME to the SAPC. The Smp interface is based on Diameter over SCTP.</p> <p>The interface is supported by the SGSN-MME.</p> <p><b>Note!</b> The Smp interface was named as Sx interface in SGSN-MME 1.9 and the previous releases. For backward compatibility, Sx is still kept in operation- and maintenance-related fields.</p>
<b>Sv interface</b>	<p>The Sv interface connects the SGSN-MME and the 3GPP MSC-S enhanced for Single Radio Voice Call Continuity (SRVCC). The Sv interface enables SRVCC from E-UTRAN access to 3GPP UTRAN/GERAN CS accesses for voice calls that are anchored in the IMS.</p> <p>The Sv interface is based on the GTPv2-C protocol. The interface is supported by the SGSN-MME.</p>



<b>Sxa interface</b>	The Sxa connects the user plane and control plane on the SGW. The interface is required for separated control and user planes.
<b>Sxb interface</b>	The Sxb interface connects the user plane and control plane on the PGW. The interface is required for separated control and user planes.
<b>U1a Interface</b>	The U1a interface connects the MME and the Wi-Fi UE Locator. It allows the Wi-Fi UE Locator to track UE locations.
<b>U2 Interface</b>	The U2 interface connects the MME and the WIC. It enables UE throughput query from the WIC.
<b>X2 interface</b>	The X2 interface connects an eNodeB with a gNodeB. It provides 5G capabilities via the LTE- and EPC-networks.

## 5 Highlighted Features

The following section describes some of the features available in the packet core network. For more information, search for the corresponding feature in the CPI library.

### 5.1 3G Direct Tunnel

3G Direct Tunnel (3GDT) is a powerful way of increasing throughput in the core network without extra investments in new network entities. 3GDT is an optional feature in the current 3GPP architecture. It enables direct user plane tunnels to be established, for payload between the RNC and the GGSN or PGW, within the Packet Switched domain to increase payload capacity.

Use of 3GDT can be configured individually on a subscriber and PDN basis and also per GGSN or PGW and RAN. 3GDT is applicable for WCDMA systems only.

### 5.2 End-To-End Quality of Service

End-to-End Quality of Service (QoS) is supported in the SACC R7 business solution, making it possible for operators to realize a full end-to-end QoS strategy



in their networks. End-to-End QoS enables the operator to manage strong growth in mobile data traffic, introduce differentiated offerings, and launch premium services.

The joint QoS capabilities in Ericsson RAN, Ericsson Mobile Transport Solutions, and EPC Network implement a full end-to-end strategy. The Packet Core Network has the possibility to detect that a service is used, provides the right QoS attributes, and also controls the QoS definition at establishment and modification of the radio connections through the RAN.

The End-to-End QoS functionality provides operators with the option to manage heavy users more transparently, as compared to strict bandwidth throttling. It also enables operators to create differentiation in their networks, both between subscribers and services, and to allocate and supply adequate network resources based on subscriber and service requirements.

From an End-to-End perspective, QoS can be enforced in a static or dynamic manner. Static QoS means that the QoS is defined according to the subscribed QoS defined in the HLR. Dynamic QoS means that the SAPC, which is an Ericsson PCRF, evaluates the QoS depending on different service, session, location and subscriber parameters, and different trigger conditions.

To provide efficient End-to-End QoS, it is recommended to use Ericsson products for at least the following network functions:

- HLR
- MME
- PCRF
- SGW
- PGW

## 5.3 SGSN Pool, MME Pool

### **SGSN Pool for GSM**

SGSN pool for GSM enables connection of one BSC to several SGSNs. The feature introduces a more flexible and efficient network architecture with built-in network redundancy, which replaces the traditional hierarchical network structure.

### **SGSN Pool for WCDMA**

SGSN Pool for WCDMA enables connection of one RNC to several SGSNs. The feature introduces a more flexible and efficient network architecture with built-in network redundancy, which replaces the traditional hierarchical network structure.



### MME Pool

MME Pool for LTE access makes it possible to connect one eNodeB to several MMEs. The feature introduces a flexible and efficient network architecture with built-in network redundancy, which replaces the traditional hierarchical network structure.

## 5.4 Triple Access SGSN-MME

The Ericsson SGSN-MME is designed to handle multiple subscribers using GSM, WCDMA, and LTE accesses over the 3GPP standardized interfaces. Triple access SGSN-MME is a highly flexible solution to optimize the use of the packet core network and simultaneously reduce the cost of operation. Triple access enables mobile operators to introduce LTE services gradually, in parallel with existing GSM and WCDMA services.

## 5.5 Event-Based Monitoring

Event-Based Monitoring (EBM) is a flexible performance monitoring solution for real-time and near-real-time event provisioning to O&M systems. EBM is an optional feature in the SGSN-MME for GSM, WCDMA, and LTE. It includes provisioning of near-real-time event information to an OSS-RC system for performance management, and real-time information to general O&M servers and databases for logging and storing of vast amounts of event data.

EBM logs successful and unsuccessful events for completed mobility and session management procedures. The results of the procedures are indicated by cause codes (3GPP cause codes) and detailed sub-cause codes. Using EBM, it is possible to define counters per cell and sub-cause code.

EBM is available for EPG, where it is used for recording session and mobility events for GSM, WCDMA and LTE.

## 5.6 S3/S4 Architecture Support

The S3/S4 architecture support feature introduces SGSN support for the S3, S4, S12, and S16 interfaces. S3/S4 architecture support brings Evolved Packet Core benefits to GSM and WCDMA networks, and implements a clean and uniform IP-based architecture for all access types.

## 5.7 IRAT Mobility over Gn/Gp or S3

The EPC network supports IRAT mobility between LTE and GSM or WCDMA Radio Access Networks over the Gn/Gp or S3 interface. In the IRAT mobility scenario, the SGSN is connected to the MME over the Gn/Gp or S3 interface and the PGW acts as an anchor for mobility between the different 3GPP accesses. If 3GDT is enabled, the GGSN is connected to the RAN over the Iu-U interface.



## 5.8 Multi-Operator Core Network

The Multi-Operator Core Network (MOCN) solution enables two or more operators to share a common radio network, without having to share a core network. In this way, an operator can provide its own set of services, but can share the expensive radio network. Using MOCN, the radio network directs the UE to the right SGSN or MME.

## 5.9 Gb over IP

With Gb over IP, dynamic (or automatic) configuration is introduced for the Gb interface.

To be able to use Gb over IP, the site LAN must support Ethernet VLAN, and be able to handle the additional load from Gb over IP.

The configuration information between the BSS and the SGSN is exchanged through the autoconfiguration procedures provided by the network service layer. Differentiated Services marking is supported with the same class for all the IP traffic over the Gb interface.

## 5.10 Public Warning System

The Public Warning System (PWS) feature enables the public within a particular area to receive timely and accurate warnings regarding disasters or other emergencies within LTE access area. The PWS feature is also applicable for Earthquake and Tsunami Warning System (ETWS) and Commercial Mobile Alert System (CMAS) services.

## 5.11 Geographically Redundant Pool

The Geographically Redundant Pool feature provides resilience against MME outage, S1-MME link failure, S11 link failure, and SGW failure, by preservation and service continuity of sessions. The basic idea is to duplicate UE contexts in a pool environment, to be used by MMEs in recovery scenarios.

## 5.12 LTE Broadcast

The LTE Broadcast feature enables broadcast services in the LTE radio network, for example, broadcast of TV channels and background applications such as downloading of files.



## 5.13 5G EPC

The 5G EPC Network provides support of the New Radio (NR) as a secondary RAT in a NSA configuration. This is to benefit from 5G capabilities, for example, higher bit rates. The eNodeB can control a Dual Connectivity radio connection that uses a combination of LTE and NR. The UE is simultaneously associated both with LTE/eNodeB and NR/gNodeB. NR Access Control, for NR services to the eNodeBs and NR-capable UEs, is also supported by this feature.

## 5.14 Service Chaining

The Service Chaining feature enables the EPG to steer subscriber traffic to third party service functions in the (S)Gi-LAN.

The EPG selects the service chain, which consists of an ordered list of service functions, using the predefined or dynamic PCC rules. By using service chaining, EPG, for example, can control which traffic flows are sent through video optimizers or an MSP.

**Note:** Service chaining is only supported by virtual EPG.

# 6 Radio Networks

This section provides a high-level description of the radio networks connected to the GPRS and EPC networks.

## 6.1 GPRS Radio Access Network

When a UE generates a data packet in a GSM radio network, the network forwards it on the first available radio channel. A single radio channel can be shared between different UEs. Depending on its capabilities, a UE can use up to eight downlink time slots and eight uplink time slots simultaneously. Data packets from UE can also use different radio channels in the GSM radio network.

In WCDMA systems, all UEs in a cell transmit and receive data over the same frequency. UEs are distinguished from each other by the codes assigned and the time slot structure used in GSM. Different data rates are possible depending on the length and structure of these codes.

Both GSM and WCDMA systems radio networks have a cellular structure, but they do not share nodes. A GSM radio network includes a GSM RBS and BSC, while a WCDMA system radio network includes a WCDMA system RBS and RNC. The cellular structure for a GSM or WCDMA system radio network is shown in Figure 4.

The main difference is that in GSM systems the sizes of the cells are static, while in WCDMA systems they are dynamic.

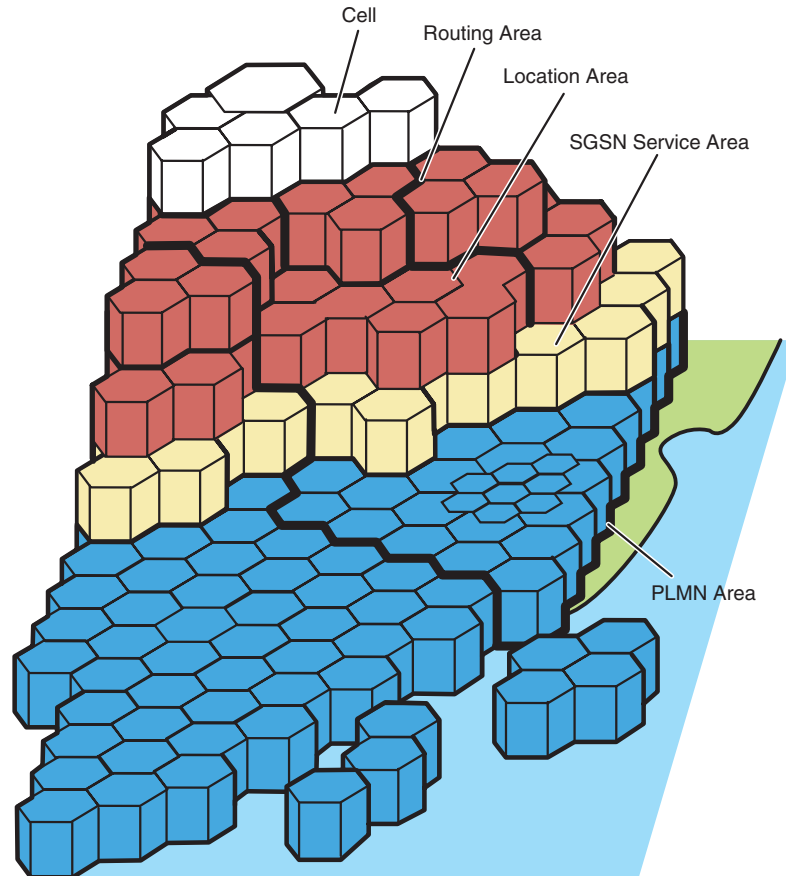


Figure 4 Network Structure in a GPRS Radio Network

A cellular network consists of the following main areas:

- Cell
- Routing Area
- Geographical Area
- Location Area
- SGSN Service area or SGSN Pool Service area
- PLMN area
- GSM GPRS Service area or WCDMA System Service area



### 6.1.1 Cell

A cell, either a GSM cell or a WCDMA system cell, is the smallest geographical unit in the GPRS service area. It is the basic unit of a mobile cellular network and is covered by a single RBS. GSM cells are covered by a GSM RBS and WCDMA system cells are covered by a WCDMA system RBS.

The size of a GSM cell is static, but can vary from cell to cell. When expecting many users per unit area, a geographically small cell is preferable, when expecting few users, a geographically large cell is preferable. A cell change in GSM can be visible to the Packet Switched part of the GSM network.

The size of a WCDMA system cell is dynamic and can change depending on load, that is, the number of users can vary within each cell. Therefore, cell planning differs between GSM and WCDMA systems. A cell change is not visible to the WCDMA system network.

### 6.1.2 Routing Area

A Routing Area (RA) is an area that is served by a given SGSN. One SGSN can handle several RAs. A UE can move between RAs within the SGSN area without roaming to a new SGSN. The size of an RA can range from a part of a city to an entire province, or even to a small country. An RA consists of one or more cells.

### 6.1.3 Geographical Area

A Geographical Area consists of a group of routing areas for the WCDMA access.

### 6.1.4 Location Area

A Location Area is a set of base stations that are grouped to optimize signaling. The Location Area can contain tens or hundreds of base stations, which share a single BSC or RNC. A Location Area consists of several RAs.

### 6.1.5 SGSN Service Area

An SGSN service area, which consists of one or more RAs, is the Geographical Area that is served by one SGSN. It is either a GSM SGSN area, a WCDMA system SGSN area, or both. An SGSN service area does not have to coincide with an MSC/VLR area. An SGSN pool area is the Geographical Area served by a pool of SGSNs.

### 6.1.6 PLMN Area

The service areas are divided into PLMNs. Each operator providing GPRS services has its own PLMN. Nevertheless, to enable shared networks, one SGSN can be shared by several PLMNs.

A PLMN is identified by the Mobile Country Code (MCC) and the Mobile Network Code (MNC).

### 6.1.7 GSM GPRS Service Area or WCDMA Systems Service Area

The GSM GPRS Service Area and the WCDMA Systems Service Area are the regions where GPRS services are available. GSM UE in the GSM GPRS Service Area and WCDMA system UE in the WCDMA Systems Service Area can send and receive data within the GPRS network. The Service Areas consist of several PLMNs.

Do not confuse GSM GPRS Service Areas with GSM Service Areas, not covered by GPRS.

## 6.2 EPC Radio Access Network

The cellular structure for an EPC radio network is shown in Figure 5.

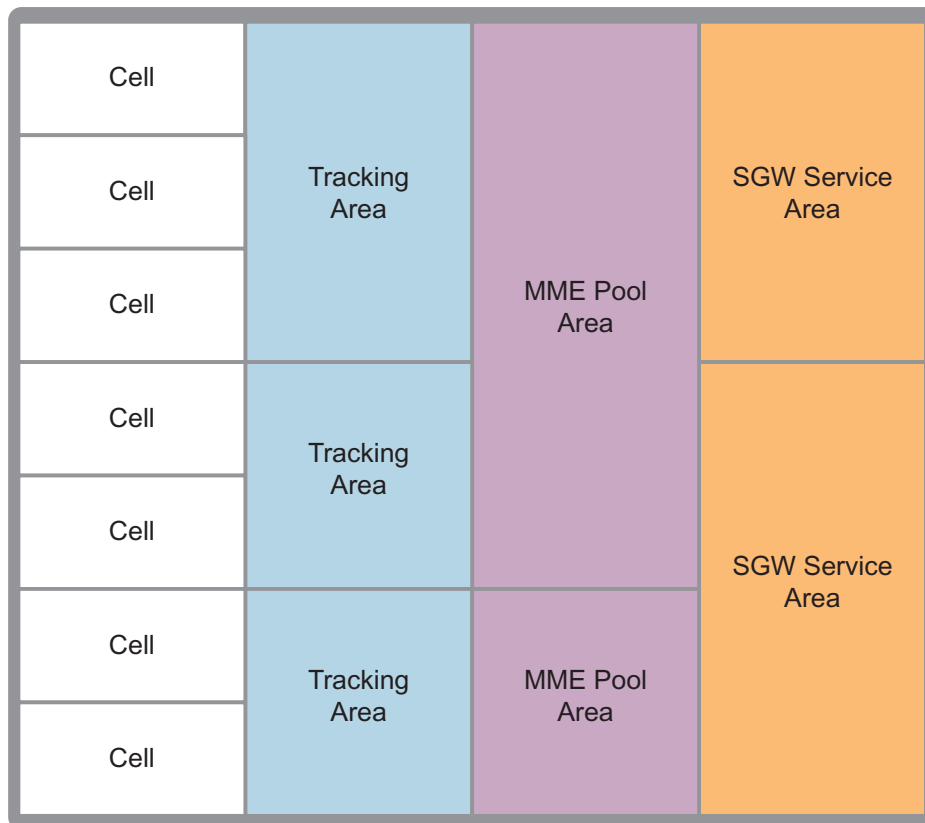


Figure 5 Network Structure in an EPC Radio Network

An EPC radio network consists of the following main areas:

- Cell



- Tracking Area
- Geographical Area
- MME pool area
- SGW service area

### 6.2.1 Cell

A cell is the smallest geographical unit in the EPC service area. It is the basic unit of a mobile cellular network and is covered by a single eNodeB. One eNodeB can handle multiple cells. The size of an EPC cell is static, but can vary from cell to cell. When expecting many users per unit area, a geographically small cell is preferable, when expecting few users, a geographically large cell is preferable.

### 6.2.2 Tracking Area

A Tracking Area (TA) consists of one or more cells. The size of a TA can range from a part of a city to an entire province. A TA can be covered by one or several MMEs. If MME pool is used, a UE can move between TAs within the MME area without having to change MME.

### 6.2.3 Geographical Area

A Geographical Area consists of a group of tracking areas for the LTE access.

The EPC network indicates a Geographical Area when paging the UE. This Geographical Area is translated to the actual cells that are paged within the E-UTRAN.

### 6.2.4 MME Pool Area

An MME pool area is defined as an area where the UE is served without having to change the serving MME. The MME pool area is served by one or more MMEs working in parallel, that is, one eNodeB is connected to several MMEs. An MME pool area consists of one or several TAs. As long as a UE remains within the pool service area, it is attached to a specific MME. If the MME is unavailable, the eNodeB reroutes the signaling for the attached UE to another MME in the pool.

### 6.2.5 SGW Service Area

An SGW service area consists of the cells between which the UE can move without having to change SGW. When the UE leaves the SGW service area, it initiates an SGW relocation procedure.