cnSGW-C Overview

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Product Description

cnSGW-C is a Control Plane Network Function (NF) of the converged core network (4G-5GC). The Serving Gateway Control Plane Function (cnSGW-C) is built on top of the SMI architecture. cnSGW-C acts as a UE anchor and supports mobility procedures, along with session setup and termination procedures, as specified in *3GPP TS 23.401* and *3GPP TS 23.214*.

The Serving Gateway Control Plane Function (cnSGW-C) provides the functionality of the S-GW as defined by *TS 23.401 [2]*, except for the functions that are performed by the SGW-U, as described in *3GPP Spec 23.214 Table 4.3.2-1*. In addition, the cnSGW-C is responsible for selecting the SGW-U (as described in 3*GPP Spec 23.214 clause 4.3.3*) and for controlling the SGW-U with respect to the functions described in *TS 23.214 Table 4.3.2-1*.

With SMF (IWF) support based on Cisco Cloud Native Platform, it is recommended to support cnSGW-C functionality on Cloud Native Platform for better hardware utilization and O&M activities.

Converged Core Overview

The converged core solution provides an advanced, cloud-native, converged control plane with the capability to support 4G and 5G devices, and use cases.

Important This release supports only the cloud-native integrated S-GW and SMF instance with S5C and cnSGW-C functionalities.

The converged core solution removes the operational complexity by providing a unified core network to handle all types of subscribers and use cases.

The operator has the following benefits:

- Improves the overall network efficiency by reducing signaling between cnSGW-C and SMF while handling a 4G subscriber or handoff from 5G to 4G coverage area.
- Reduces latency introduced due to the extra hop SGW-U for a subscriber in 4G coverage area, by collapsing the data path in the Converged UPF, thus improving the overall user experience.
- Provides ability to use a unified subscriber policy and billing infrastructure using SBA interfaces for 4G and 5G devices.

The solution supports the following converged control plane and user plane functions:

- Converged Control Plane Functions
  - Integrates S-GW and SMF network functions as a single deployment, under a single Kubernetes namespace, to support 4G and 5G devices from E-UTRAN/NR (converged core gateway)
  - Supports logical network functions (data)
- Converged User Plane Functions
  - Integrates UPF and SGW-U functionalities as a single network function
  - Provides simultaneous support for N4 and Sxa interfaces
  - Terminates multiple control planes in a single deployment

Use Cases

This section describes the use cases that cnSGW-C supports:

- **cnSGW-C Configuration**

  The cnSGW-C base configuration provides a detailed view of configurations required for the cnSGW-C to be operational. The configuration includes setting up the infrastructure to deploy the cnSGW-C, deploying the cnSGW-C through SMI, and configuring the Ops Center for exploiting the cnSGW-C capabilities over time. For more information on SMI, see the *Ultra Cloud Core SMI Cluster Deployer Operations Guide*.

  The following features are related to this use case:

  - APN Profile Support
  - Service Configuration Enhancements
  - UPF Selection Support

  For Converged Core deployment, cnSGW-C is deployed using Converged Ops Center.

- **Session Management**

  Every UE accessing the EPC is associated with a single S-GW. cnSGW-C supports multiple PDN for given UE. As a part of Session Management, cnSGW-C supports the following:

- Default and dedicated bearer establishment
- Bearer modification
- Bearer deactivation

The following features are related to this use case:

- 3GPP RAN/NAS Cause Codes Support
- Change Notification Request Handling
- Context Replacement Support
- Dedicated Bearer Support
- Delete Bearer and Delete Session Request
- DSCP Marking for CP Signaling Messages
- eMPS and WPS Support
- Emergency Call Support
- Idle Session Timeout Settings
- Initial Attach Support
- Multiple PDN Attach or Detach Procedures
- Presence Reporting Area
- Update Bearer Request and Response
- VoLTE Call Prioritization

- **Support for UE Mobility**

  cnSGW-C is a mobility anchor point for UE. In LTE Network, there can be mobility between eNodeB to eNodeB, with or without MME change. UE can also move from one cnSGW-C to another cnSGW-C with different modes, S1-based Relocation, X2-based Relocation, and 5G-4G interworking.

  The following features are related to this use case:

  - IDFT Support
  - Intra-MME and Inter-MME Handover Procedures
  - Modify Bearer Request Support
  - Presence Reporting Area
  - SGW Relocation Support

- **S1-Release/Buffering/Downlink Data Notification**

  cnSGW-C handles releasing S1-U bearer between eNodeB and SGW-U. When cnSGW-C receives Radio Access Bearers (RAB) message indicating that S1-U bearers are released, it updates User Plane and moves UE to IDLE state. When in IDLE state, if UE receives downlink data packet, cnSGW-C generates DDN message towards MME to page UE.

cnSGW-C also supports DDN Throttling, DDN Delay, and High Priority feature for DDN.

The following features are related to this use case:

- Access Bearer Release Support
- Downlink Data Notification
- DDN Advance Features

- **Retransmission and Timeout**

  For all procedures, as per *3GPP TS 23.401/29.274*, cnSGW-C supports N3-Retransmission, and T3-Timeout Support. These are supported for S11, S5, and Sx interfaces.

  The following feature is related to this use case:

  - GTPv2 and Sx Messages Retransmission and Timeout Handling

- **Failure and Error Handling**

  cnSGW-C supports handling of:

  - Failure response for Create Session Request as part of initial attach procedure and additional PDN setup procedure
  - PGW-initiated Dedicated Bearer Creation (DBC) procedure failure scenario
  - Radio Access Bearers (RAB), Modify Bearer Request and Response (MBR) from PGW and User Plane

  The following feature is related to this use case:

  - Failure and Error Handling Support

- **Load/overload Control Functions**

  cnSGW-C supports:

  - Exchange of load/overload control information and actions during peer node overload over Sx interface.
  - Handling load/overload information on GTPv2 interface.

  The following features are related to this use case:

  - GTPv2 Load/Overload Support
  - Sx Load/Overload Control Handling

- **cnSGW-C Charging Support**

  cnSGW-C supports:

  - Offline Charging (Gz).
  - Writing CDR to local disk storage. The CDR files are pushed to SFTP server periodically.
  - CDR generation for selected subscribers. This is achieved by enabling CDR generation per Operator Policy through call control profile.

The following feature is related to this use case:

- SGW Charging Support

- **Peer and Path Management for GTPC and Sx**

  cnSGW-C supports:

  - Peer management for MME (S11 peers), PGW (S5 Peers), and User Plane.
  - Peer monitoring through ECHO Request/Response and Heartbeat Request/Response.
  - Handling of path failure events for S11 and S5 peers.

  The following features are related to this use case:

  - GTPC and Sx Path Management
  - GTPC Path Failure
  - Customization of Path Failure Detection
  - Sx Path Failure

- **Redundancy Support**

  The cnSGW-C deployment in K8 cluster plays a vital role to support High Availability (HA) and Geographic Redundancy (GR).

  The Redundancy Support ensures stateful session continuity among the clusters during the rack or cluster failures.

  The cnSGW-C achieves the HA through redundant set-up of each cluster component such that any single point of failure is avoided.

  The GR provides rack-level redundancy to replicate data between two separate K8 Clusters across rack. On RACK/Cluster failure, traffic switches to a remote RACK to process the traffic. The failure can be due to power failure, multi-compute failures, network failure, multi-POD failure, BFD link failure, and so on.

  The following features are related to this use case:

  - Redundancy Support
  - High Availability Support

- **Dynamic Routing**

  Dynamic routing enables L3 peering with Leafs, in addition to L2 Static routing.

  The following feature is related to this use case:

  - Dynamic Routing by Using BGP

- **GTPU Path Management and Session Management**

  The UPF notifies an Error Indication message for a GTP-U peer to the sender when a GTP-PDU is received with a TEID that does not exist. This ensures that there are no stale sessions or bearers, and maintains consistency in the network.

Error Indication and GTP-U Path Failure Indication communication between S-GW and UPF nodes is supported over the N4 interface. For the neighbor nodes, the communication is supported over the S1u/S5u interfaces. Behavior variations of local-purge or signal-peer for Error Indication and GTP-U Path Failure are considered in this implementation.

The following features are related to this use case:

- GTPU Error Indication
- GTPU Path Failure

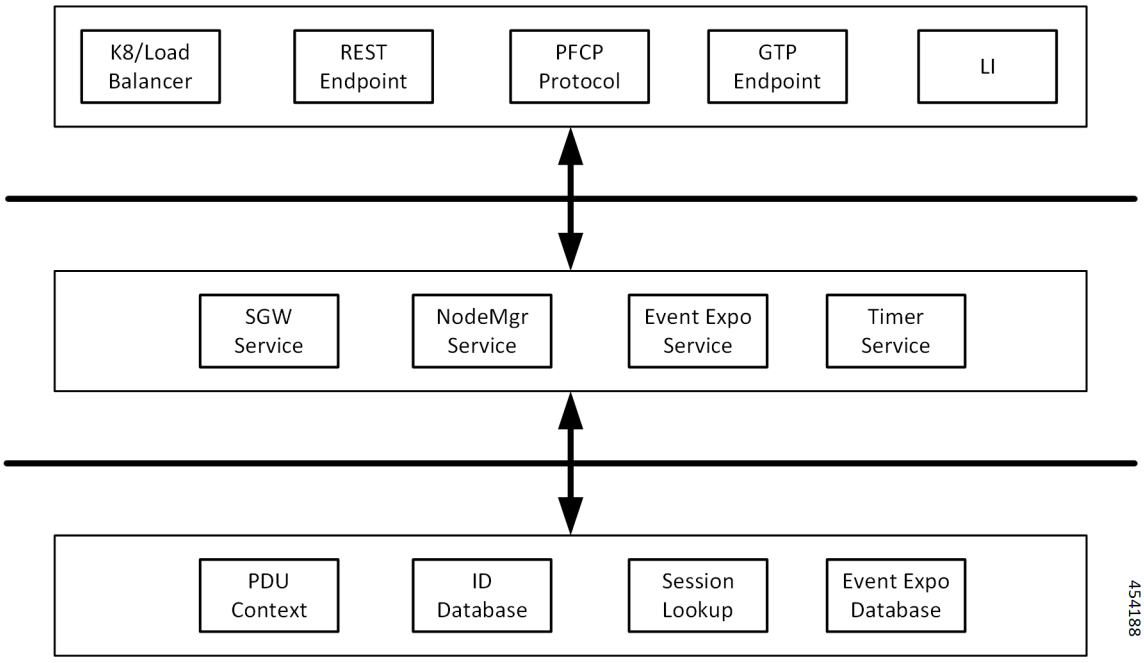
Deployment Architecture and Interfaces

cnSGW-C is a part of the converged core network functions portfolio with a common mobile core platform architecture. The core network functions include Access and Mobility Management Function (AMF), Policy Control Function (PCF), Session Management Function (SMF), and User Plane Function (UPF).

cnSGW-C Architecture

cnSGW-C network function consists of loosely coupled microservices. The microservice decomposition is based on a three-layered architecture, as illustrated in the following figure:

Figure 1: cnSGW-C Architecture



The following are the three layers of the cnSGW-C architecture:

- Layer 1 - Protocol and Load Balancer services (Stateless)
- Layer 2 - Application services (Stateless)

• Layer 3 - Database services (Stateful)

cnSGW-C Deployment

cnSGW-C NF is deployed in a separate namespace as an independent NF.

Figure 2: cnSGW-C Deployment

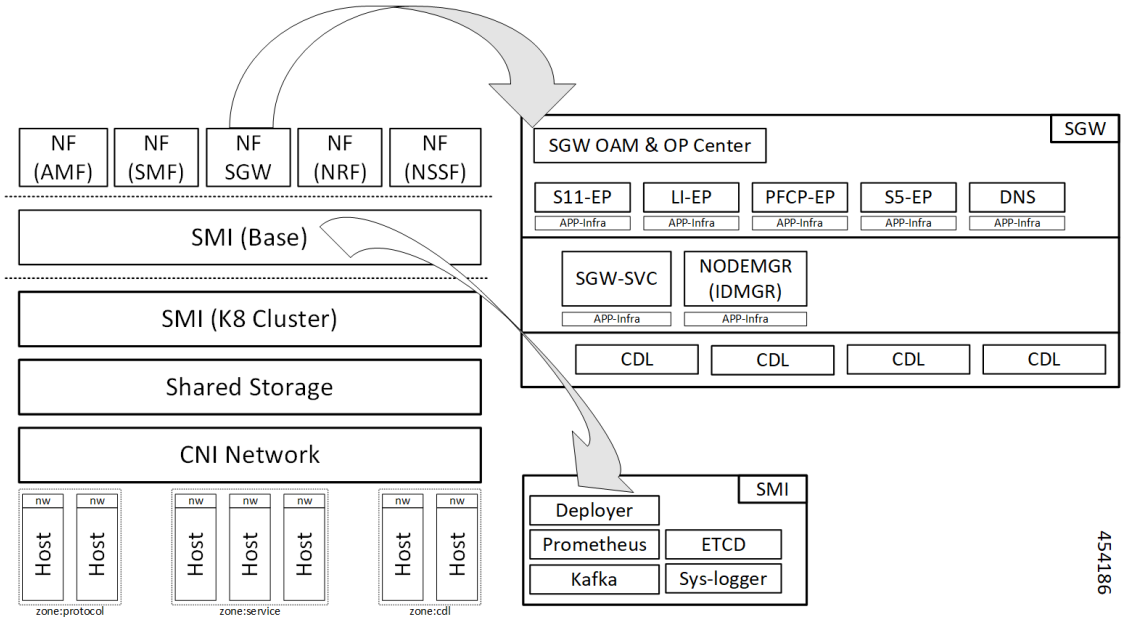
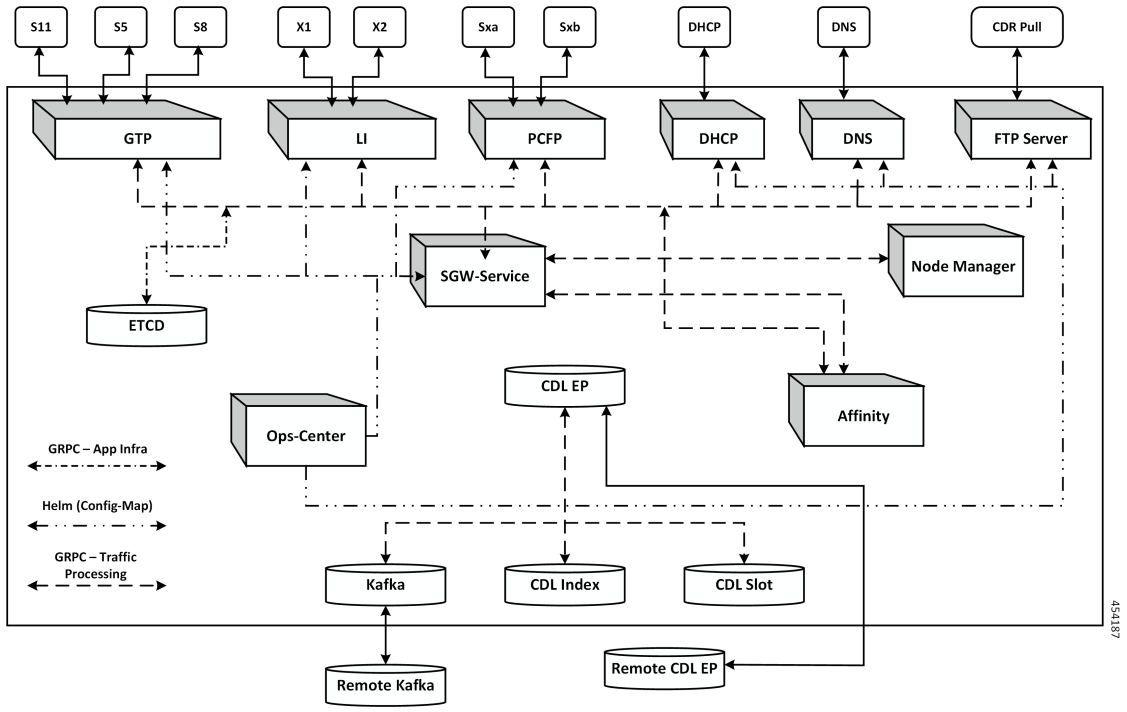


Figure 3: cnSGW-C HELM Chart



Converged Core Architecture

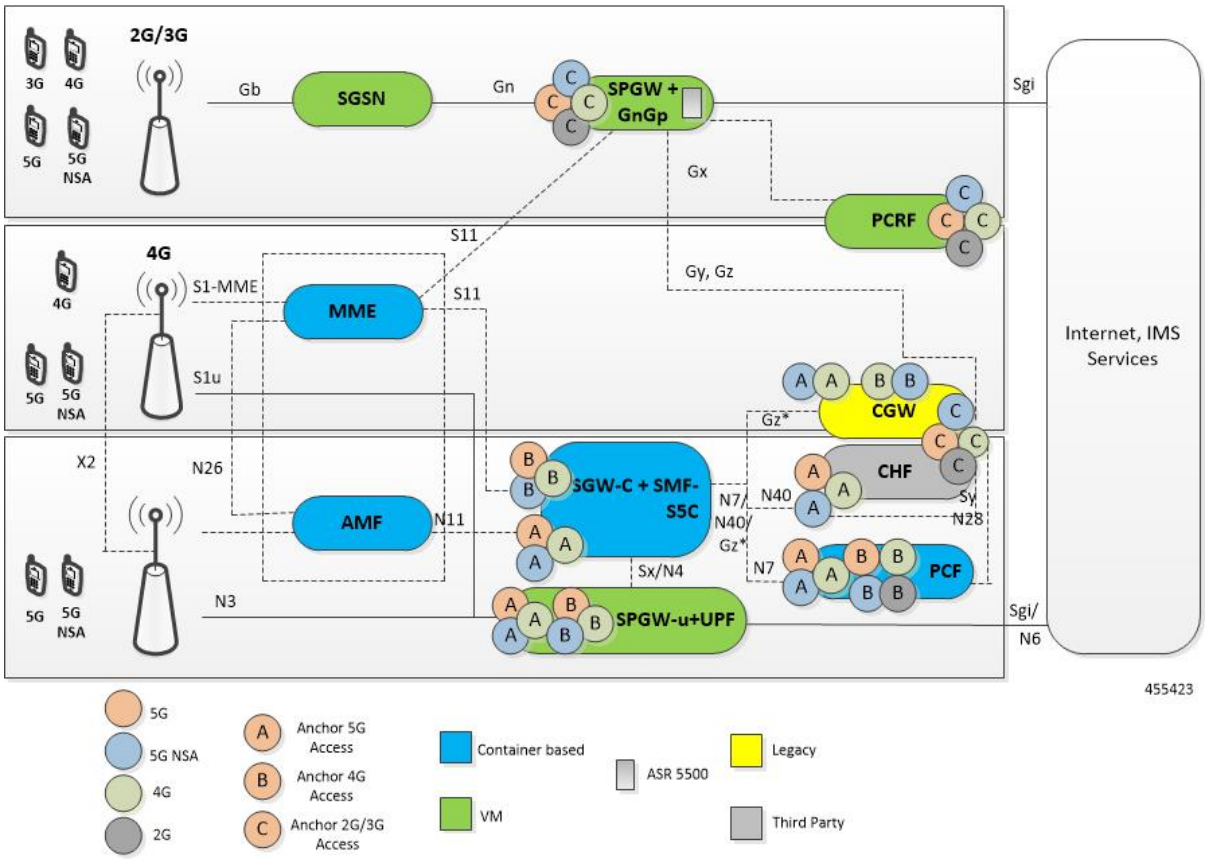
The converged core solution provides a single unified platform which is based on SMI architecture. The supporting architecture integrates the cloud-native S-GW and SMF deployment with 5GC and cnSGW-C functionalities. The solution uses 3GPP-defined SBA interfaces for policy and charging functions.

In the converged core architecture, the 4G and 5G capable UEs are anchored on the same control plane instance. The control plane instance provides the SMF, 5GC, and cnSGW-C functionalities.

The handoffs between 4G and 5G access types are seamless for 5G capable devices. The handoffs from LTE to UTRAN (bi-directional communication between 4G/5G and 3G/2G) are not seamless for 4G capable devices.

The following figure illustrates the supported network architecture.

Figure 4: Converged Core Architecture



The UPF deployed as a part of this solution is a VPC-SI VM. The UPF deployment is VM-based, and supports:

- SGW-U, PGW-U, and UPF functionalities in the same instance, and exposes the Sxa, Sxb, Sxab, or N4 interface towards the control plane.
- Multiple CP instances (up to 4) simultaneously.

Converged Core Deployment

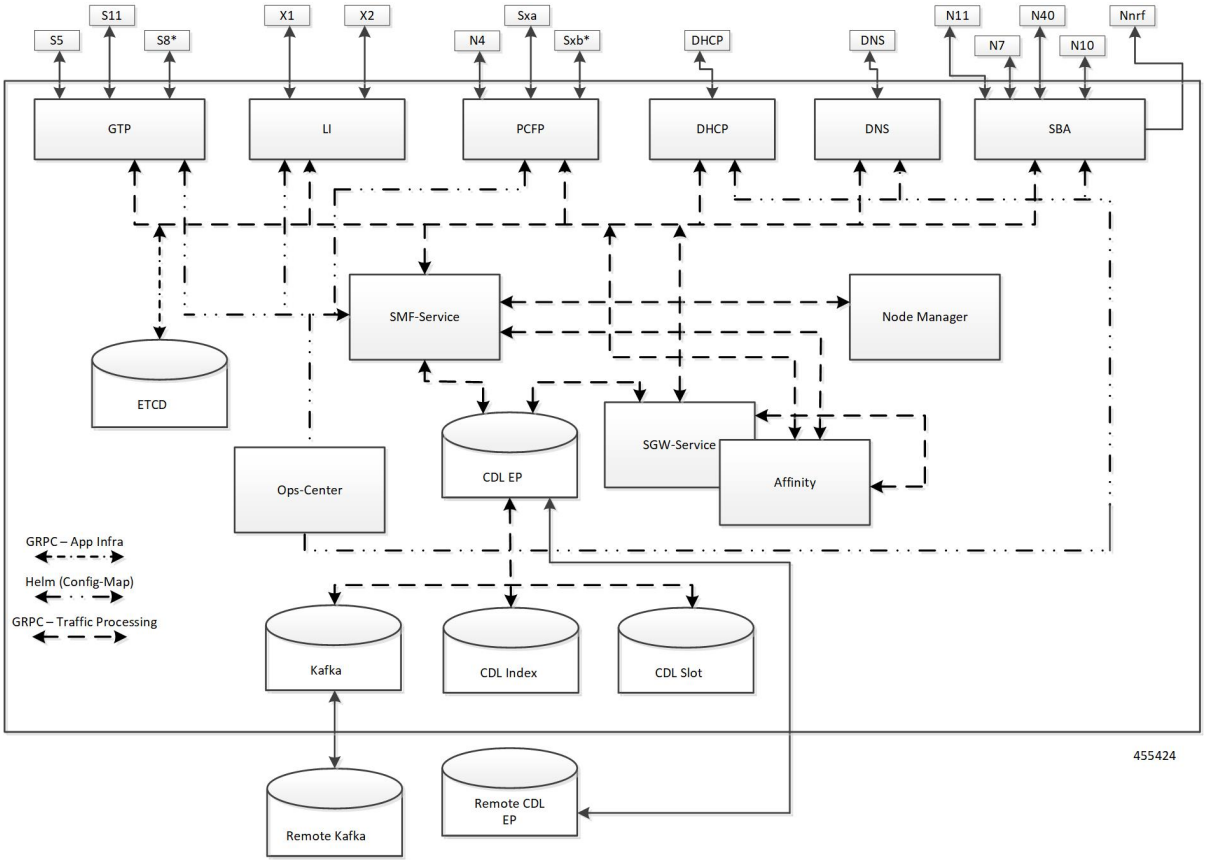
The converged core deployment is based on the converged control plane and unified user plane infrastructure for all use cases.

In the converged core deployment, all 4G and 5G-capable UEs are anchored on the 5G core (SMF) with SBA interfaces towards PCF.

The converged core deployment has a converged Ops Center that allows the configuration of cnSGW-C and SMF services along with other microservices. A single product helm chart is used to install components.

The following figure illustrates the Kubernetes deployment for the converged S-GW and SMF network function.

Figure 5: Kubernetes Deployment



The protocol layer services are shared across SMF and S-GW. The GTP endpoint terminates the S11 interface and S5/S8 interface. Similarly, the PFCP (protocol) endpoint terminates the N4 and Sxa interfaces.

The SMF and S-GW services are deployed as distinct pods and the session processing is segregated. Both the service pods use CDL for storing subscriber sessions.

Supported Interfaces

This section describes the interfaces supported between cnSGW-C and other network functions in the 5GC.

- S11—Reference point between the SGW and the MME
- S5/S8—Reference point between the SGW and the PGW/SMF
- Sxa—Reference point between the SGW-C and the SGW-U
- Gz—Reference point between the SGW-C and the Charging Server

Life Cycle of Data Packet

For information on life cycle of a data packet, see Initial Attach Support.

License Information

cnSGW-C supports Cisco Smart Licensing. For more information, see Smart Licensing Support.

Standards Compliance

cnSGW-C complies with the following 3GPP standards:

- *3GPP TS 23.401 "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access"*
- *3GPP TS 23.402 "Architecture enhancements for non-3GPP accesses"*
- *3GPP TS 29.274 "Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C);"*
- *3GPP TS 23.214 "Architecture enhancements for control and user plane separation of EPC nodes"*
- *3GPP TS 29.244 "Interface between the Control Plane and the User Plane nodes"*
- *3GPP TS 24.008 "Mobile radio interface Layer 3 specification; Core network protocols; Stage 3"*
- *3GPP TS 23.007 "Restoration procedures"*
- *3GPP TS 22.153 "Multimedia priority service"*
- *3GPP TS 33.107 "3G security; Lawful interception architecture and functions"*