



# Small Data over NAS, S11-U and SGi Interfaces

The MME support for small data transmission over NAS, S11-U and SGi interfaces is described in this chapter.

- [Feature Summary and Revision History, on page 1](#)
- [Feature Description, on page 2](#)
- [How it Works, on page 6](#)
- [Configuring Data over NAS, S11-U and SGi Interfaces, on page 16](#)
- [Monitoring and Troubleshooting Data over NAS, S11-U and SGi Interfaces, on page 21](#)

## Feature Summary and Revision History

### Summary Data

Applicable Product(s)	<ul style="list-style-type: none"> <li>• C-SGN</li> <li>• MME</li> </ul>
Applicable Platform(s)	<ul style="list-style-type: none"> <li>• UGP</li> <li>• VPC-DI</li> <li>• VPC-SI</li> </ul>
Default Setting	Disabled
Related Changes in This Release	Not applicable
Related Documentation	<ul style="list-style-type: none"> <li>• <i>Command Line Interface Reference</i></li> <li>• <i>Statistics and Counters Reference</i></li> </ul>

### Revision History

Revision Details	Release
The feature is tested and qualified on the ASR 5500 platform.	21.3

Revision Details	Release
First introduced.	N5.1 (21.1.V0)

## Feature Description

MME support for small data transmission over NAS, S11-U and SGi interfaces is a part of the CIoT EPS optimization. This feature describes the following aspects of small data transfer:

- IP data over NAS and S11-U interfaces
- Non-IP data over NAS and SGi interfaces

For information related to non-IP data over SCEF, see the *Non-IP Data Over SCEF* chapter in this guide.



### Important

This feature is license controlled. Contact your Cisco account representative for information on how to obtain a license.

As part of Release 13, the Narrowband Internet of Things (NB-IoT) is a new 3GPP defined radio interface. NB-IoT is optimized for machine type traffic. The NB-IoT RAT type is designed to reduce device costs and to minimize battery consumption. It is also adapted to work in difficult radio conditions, which is a frequent operational area for some machine type communication devices. Although NB-IoT is an independent radio interface, it is tightly connected with LTE and also shows up in its integration in the current LTE specifications.

The Non-Access Stratum (NAS) is a set of protocols in the Evolved Packet System. The NAS is used to convey non-radio signaling between the User Equipment (UE) and the Mobility Management Entity (MME) for an LTE/E-UTRAN access.

The NAS protocols perform:

- Mobility management - maintaining connectivity and active sessions with user equipment as the user moves
- Call control management
- Session management - establishing, maintaining and terminating communication links
- Identity management

The Access Stratum (AS) is the functional layer below NAS, working between the UE and radio network. It is responsible for transporting data over wireless connection and managing radio resources.

The S11-U interface is used for small data transmissions between the MME and S-GW. It is based on the existing GTP-U architecture. It is a GTPv1 user plane interface and carries small data sent and received over NAS between the MME and S-GW.

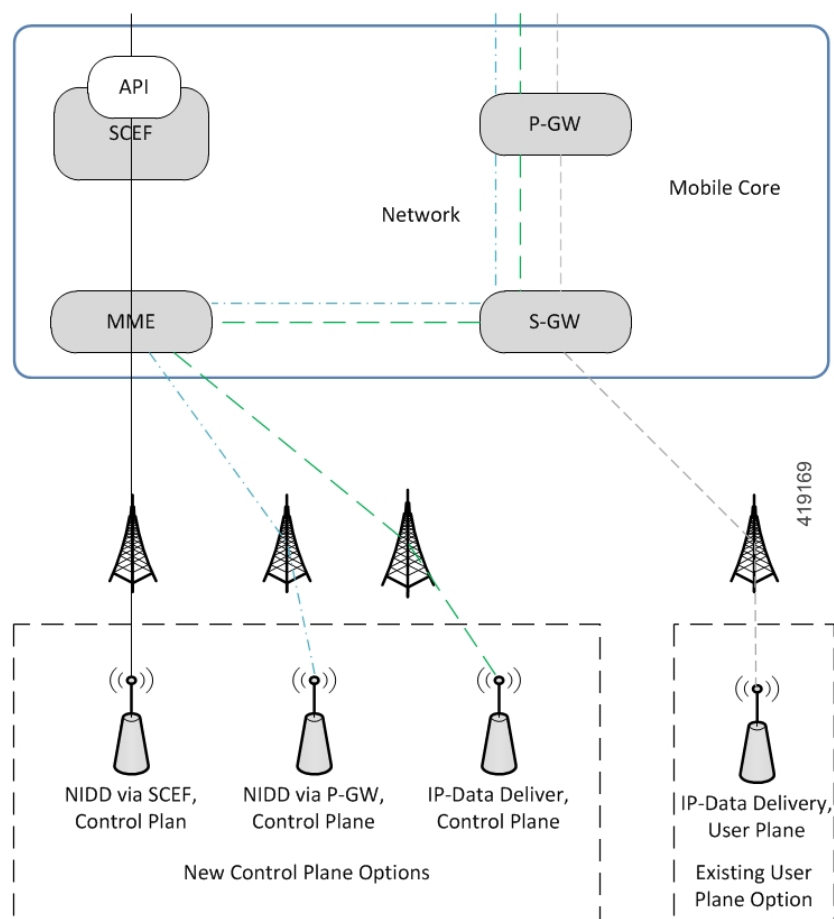
The SGi interface is an existing interface between the P-GW and packet data network (PDN). The PDN can be an operator's external public or private packet data network or an intra-operator packet data network.

## Data over NAS

Data over NAS is a mechanism designed for efficient small data transfer in 3GPP systems by using the existing signaling plane for small data transfer. Data over NAS utilizes the Signaling Radio Bearers (SRB) to carry data from UE to eNodeB. To facilitate small data transfer over NAS, the same data plane is used. This in turn results in reduced signaling and conserves the battery life of the UE. The user data is transported via the MME by encapsulating user data in NAS PDUs. This results in a reduced total number of control plane messages to send a short data transaction. Both IP and non-IP data can be sent over NAS. Small data transfer is even further optimized using Non-IP Data delivery (NIDD). Uplink data is transferred from the eNodeB to MME and data can also be transferred via the S-GW/P-GW (SGi) or to the SCEF and downlink data is also transmitted over the same paths in the reverse direction.

The following diagram illustrates the new control plane options for small data delivery.

**Figure 1: Control Plane Architecture for Small Data Delivery**



## Data Delivery via SGi Interface

Small data delivery via SGi is supported for both IP and non-IP PDNs. The S-GW or P-GW are existing nodes used for data transfer. The uplink data is transferred from the eNodeB to MME and further to the S-GW and then to the P-GW. Downlink data is also transmitted over the same paths in the reverse direction.

- IP data delivery via SGi interface

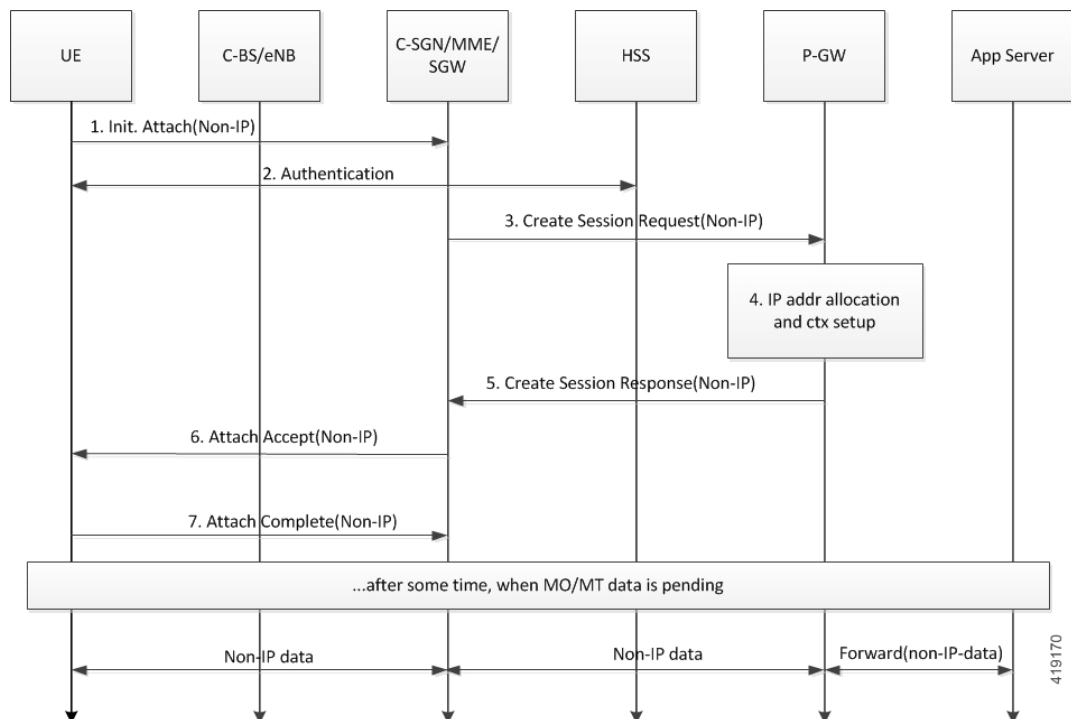
The IP packets are encapsulated in a transparent container in the EPS session management messages that are sent to the MME. The MME extracts the data from the container and forwards it to the S-GW, which in turn forwards it to the P-GW. The IP packets are then forwarded to the AS/Internet via the SGi interface. Data flows in the reverse direction in a similar manner.

#### • Non-IP data delivery via SGi interface

Non-IP data delivery is supported via the SGi interface using different point-to-point tunneling techniques. Point-to-point tunneling by UDP or IP encapsulation can be used. Support for the SGi based delivery of non-IP data can be used by any UE.

The following call flow illustrates non-IP data delivery over the SGi interface.

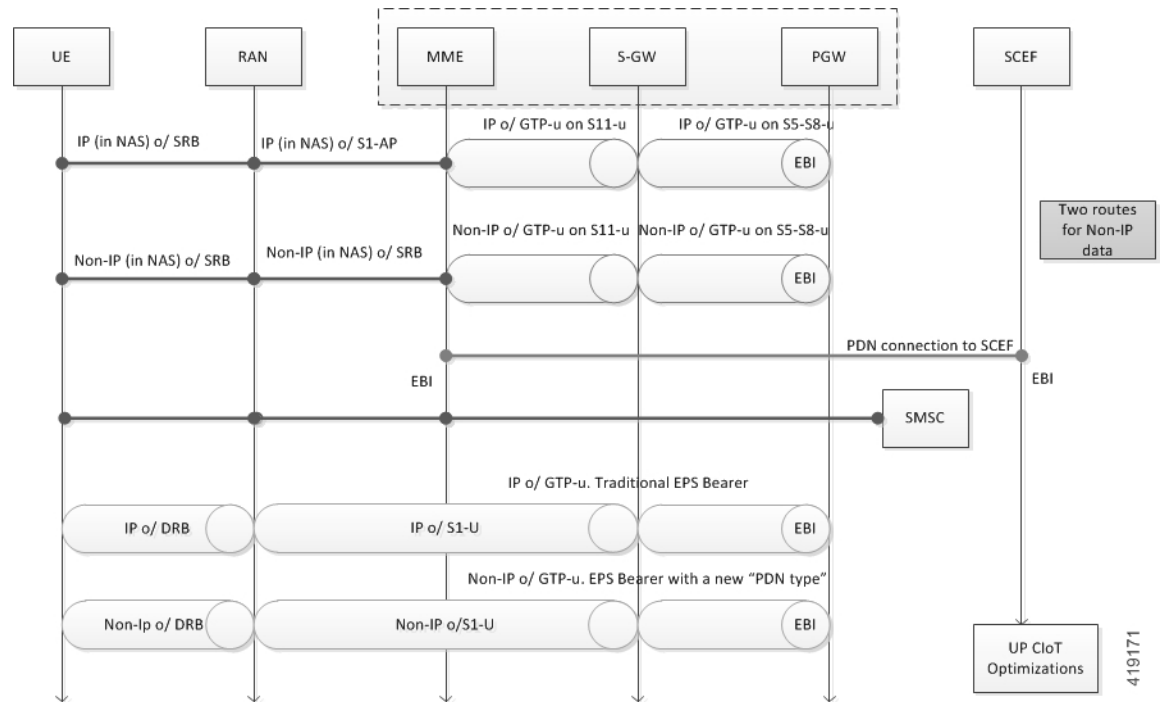
**Figure 2: Non-IP Data Delivery over the SGi Interface**



## Architecture

The following diagram illustrates the various data paths possible with and without CIoT EPS optimization for IP and non-IP data.

Figure 3: Data Paths - CloT Optimization for IP and Non-IP Data



- **S1 interface:** Exists between the eNodeB (RAN) and MME. It carries the signaling for data radio bearer (DRB) setup and NAS PDU (includes UE signaling and small data over NAS).
- **NAS:** The Non-Access Stratum (NAS) is a set of protocols between the UE and MME. It carries the UE signaling data for mobility management and session management. NAS allows small data to be transmitted using the Signaling Radio Bearer (SRB) over the S1AP protocol.
- **S1-U interface:** Exists between the E-UTRAN and S-GW for per bearer user plane tunneling and inter-eNodeB path switching during handover.
- **S5-C interface:** Exists between the S-GW and P-GW to control signaling. It is a GTPv2 control interface for tunnel management, creation/modification/deletion of per bearer user plane tunneling on the S5-U interface.
- **S5-U interface:** Exists between the S-GW and P-GW for user plane tunneling between S-GW and P-GW. It is a GTPv1 user plane interface for carrying IP and non-IP data within GTP-U.
- **S11-C interface:** Exists between the MME and S-GW to control signaling. It is a GTPv2 control interface for creation or modification or deletion of per bearer user plane tunneling on the S1-U and S11-U interfaces.
- **S11-U interface:** Exists between the MME and S-GW. It is a GTPv1 user plane interface and allows small data transmission over NAS between MME and S-GW.
- **SGi interface:** Exists between the P-GW and packet data network (PDN). The PDN can be an operator's external public or private packet data network or an intra-operator packet data network.
- **T6a interface:** Exists between the SCEF and MME. It enables transfer of non-IP data between MME and SCEF.

IP data over S1-U is the traditional IP data path from the UE to eNodeB over DRB and the eNodeB to S-GW over S1-U. IP data over S11-U makes use of CP CIoT optimization. The data path from the UE to eNodeB is over SRB, eNodeB to MME is over S1AP/NAS, and MME to S-GW is over the S11-U interface.

Non-IP data over S1-U interface is the traditional data path from the UE to eNodeB over DRB and the eNodeB to S-GW over S1-U. Non-IP data over S11-U makes use of CP CIoT optimization. The data path from the UE to eNodeB is over SRB, eNodeB to MME is over S1AP/NAS, and MME to S-GW is over the S11-U interface.

Non-IP data over T6a makes use of CP CIoT optimization. The data path from UE to the eNodeB is over SRB, eNodeB to MME is over NAS/S1AP, and MME to SCEF is over the T6a interface.

## Relationships to Other Features

The MME supports other CIoT optimization functions in order to provide support for IoT devices in the EPS network. The related features are:

- MME support for CIoT devices
- CIoT Optimizations for NB-IoT RAT and Attach Without PDN Connectivity Support
- Non-IP data over SCEF
- SMS over MME without SGs or CS attach

Refer to the other feature chapters in this guide for more information.

## How it Works

The following sections describe the Control Plane CIoT optimization, small data over NAS, data over S11-U interface, IP data over NAS and S11-U interface, and Non-IP data over NAS and SGi interface.

### Control Plane CIoT Optimization

The MME supports Control Plane CIoT optimization. The significant changes on the MME to support CP CIoT optimization are:

- The **ciot-optimisation** CLI command added in the Call Control Profile configuration mode enables or disables CP CIoT optimization for an UE. This command is used to specify the access type extension on which control plane optimization must be enabled. Control plane optimization can be enabled on both NB-IoT and WB-EUTRAN RATs or on either of them.
- The MME supports NAS IEs for CIoT optimization, additional octet in UE network capability (now 6 octets), additional octet in EPS Network Feature Support IE, additional Update Type and additional Update Result are included in the NAS IE. The activate default EPS bearer context request is marked as applicable only to control plane.
- The MME supports both attach with and without PDN.
- Intra-MME TAU with CP CIoT optimization is supported.
- A new PDN connection is supported as a part of CP CIoT optimization.
- Idle to Active transition and vice versa is allowed as a part of CP CIoT optimization.

- When CIoT optimization is enabled, it is assumed that all the S-GWs in the network support CIoT optimizations.
- No dedicated bearers are set up when CP CIoT optimization is enabled.
- No radio bearers are set up at the eNodeB for UEs using CP CIoT optimization.
- There is no change in the paging functions supported by the MME after the implementation of CIoT optimization.
- There is no change in the P-GW selection process and it is based on the APN as in the case of earlier releases. In case of non-IP PDNs, all the P-GWs serving the non-IP APN must be capable to route non-IP data and P-GWs are configured to route non-IP data.
- After a session manager re-start, the MME supports recovery of CP CIoT subscribers.

### Small data over NAS

Small data over NAS supports the following features:

- Partial ciphering for NAS messages
- NAS messages required for CP CIoT optimization with related NAS IE's are:
  - Control Plane Service Request
  - ESM Data Transport message
  - Service Accept
- Extended PCO (ePCO) IE in NAS
- Signaling Active Flag in TAU messages
- Release Assistance Indication received from UE is honored.
- New statistics are added to display the following information:
  - NAS messages received and sent.
  - Number of packets sent or received over NAS.
  - Number of data packets sent or received over NAS per UE, per PDN and per MME service.

New bulk statistics are added corresponding to the new counters listed above.

- MME data buffering is not supported.

### Data over S11-U Interface

Data over S11-U interface supports the following features:

- A new S11-U interface is introduced. The S11-U interface is a reference point between MME and Serving GW for user plane. It uses the existing GTPU protocol. It is a GTPv1 user plane interface and carries small data sent and received over NAS between MME and S-GW. The S11-U interface is introduced as a part of Control Plane CIoT EPS optimization.
- S11-C IEs are supported in the GTPCv2 control messages for corresponding S11-U information.

- Allocation and de-allocation of MME-S11U FTEID for S11-U data tunnel termination at MME is supported.
- The MME supports path management for the S11-U interface.
- Sending and receiving GTPU path failure and error indication on S11-U interface is supported.
  - On detecting Path Failure, all sessions on that path are disconnected.
  - On receiving Error Indication, session corresponding to that TEID is disconnected.
- Specific DSCP value can be configured for packets sent over the S11-U interface.
- S11-U GTPU sessions are recovered after a session manager restart.
- New statistics are introduced to display information on data packets sent or received over the S11-U per UE, per PDN and per MME service.
- New statistics are introduced to display information data packet sent/received over S11-U per GTPU service.

### IP data over NAS and S11-U Interface

IP data over NAS and S11-U interface supports the following features:

- The S11-U interface is a reference point between the MME and S-GW for user plane. It uses the existing GTP-U protocol. It is a GTPv1 user plane interface and carries small data sent and received over NAS between the MME and S-GW. The S11-U interface is added as a part of Control Plane CIoT EPS optimization.
- S11-C IEs are supported in the GTPCv2 control messages for corresponding S11-U information.
- New statistics are introduced to display information on data packets sent or received over the S11-U per UE, per PDN and per MME service. Corresponding bulk statistics are added for IP data over NAS.

### Non-IP data over NAS and SGi Interface

Non-IP data over NAS and SGi interface supports the following features:

- The S11-U interface is a reference point between the MME and S-GW for user plane. It uses the existing GTP-U protocol. It is a GTPv1 user plane interface and carries small data sent and received over NAS between the MME and S-GW. The S11-U interface is introduced as a part of Control Plane CIoT EPS optimization.
- S11-C IEs are supported in the GTPCv2 control messages for corresponding S11-U information.
- The CLI command added in the APN Profile Configuration mode configures the PDN type as either IP or non-IP. It is used to override the HSS provided APN subscription PDN type. This configuration is applicable during attach and additional PDN connectivity not during handovers. This command is also used to configure the non-IP data delivery mechanism (SGi/SCEF).
- Additional Context Identifier in the APN configuration is supported within the HSS subscription. It is used to select the default non-IP APN, when the UE has subscription for IP and non-IP APNs.
- Non-IP data delivery mechanism is supported. The SCEF ID and SCEF Realm can be specified using the **pdn-type** command in the APN Profile Configuration mode.



- Bearer Type IE in S1 Initial Context Setup / ERAB Setup / Handover Request message is supported. This bearer type is non-IP delivery mechanism (SGi) as non-IP for Non-IP PDNs using S1-U path. It is applicable for Non-IP PDN without CP CIoT optimization while using SGi interface and S1U path.
- The “Non-IP” PDN type is supported for GTPCv2 control messages towards S-GW/MME.
- Extended PCO (ePCO) in GTPCv2 control messages towards S-GW is supported.
- Inter and Intra RAT MME handovers for non-IP PDNs are supported without CP CIoT optimization (that is, while using S1-U interface for data path.)
- Inter MME or SGSN handover with CP CIoT optimization is not supported (that is, either for IP or non-IP).
- Non-IP PDNs which cannot not be transferred to the peer node are locally de-activated during handover (due to peer MME/SGSN limitation). New handover statistics for PDNs deactivated and handovers rejected due to peer not supporting non-IP PDN are displayed.
- New statistics are introduced to display information on Non-IP data packets sent/received over the S11-U interface per UE, per PDN and per MME service.
- New bulk statistics corresponding to the statistics are added for Non-IP data over NAS.

## Limitations

The known limitations with this feature are listed below:

- The MME does not support buffering of data.
- The MME does not support User Plane CIoT optimization.
- The maximum size of NAS PDU supported is 2KB.
- Switching data path from control plane CIoT optimization to S1-U while the UE is in ECM-connected state is not supported.
- Enforcement of Serving PLMN rate limit is not done at the MME.
- Inter-MME/SGSN handovers are not supported when control plane CIoT optimization is implemented (for both IP and non-IP).
- Intra-MME handovers are not supported when control plane CIoT optimization is implemented (for both IP and non-IP).
- Inter-MME/SGSN idle mode handovers are not supported when control plane CIoT optimization is implemented (for both IP and Non-IP).
- APN remap is not supported for non-IP PDN type.
- Idle mode handover to peer SGSN is not supported for Non-IP SGI PDNs.
- IPv6 is not supported for the S11-U interface.
- Execution of the **associate** or **no associate** command in the GTPU service under the MME EGTP service restarts the MME service.
- Removal or addition of the GTPU service that is already associated with the MME EGTP service restarts the MME service.

## Call Flows

### Attach with PDN using CP ClOT Optimization (SGi Path)

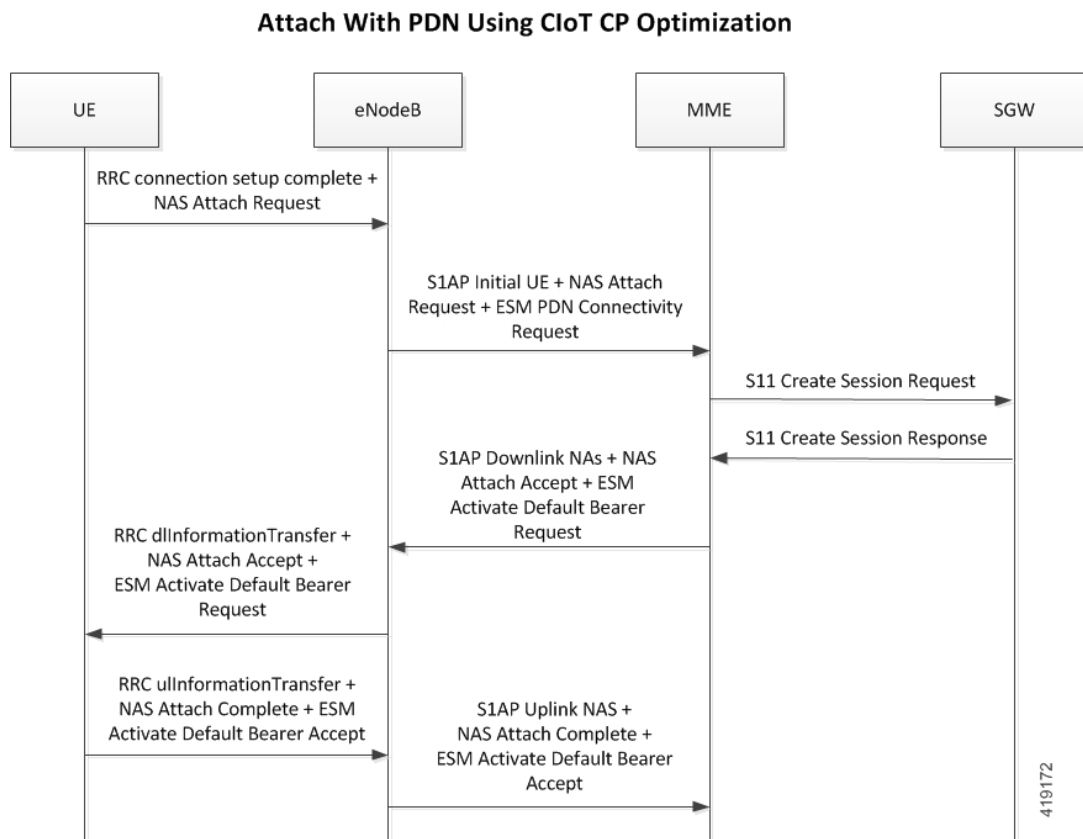
The following call flow diagram displays the Attach with PDN procedure with CP ClOT optimization.

This call flow does not display the following:

- HSS interaction for authentication and S6a Location update
- UE authentication
- Security setup

However, these procedures are applicable and performed by the MME for this call flow.

**Figure 4: Attach with PDN using ClOT Optimization**



Attach with CP ClOT optimization performs bearer setup on the UE and network (SGi/SCEF) without reserving radio resources in the RAN. Data Radio Bearer (DRB) is not setup on the eNodeB for the UE. Signaling Radio Bearer (SRB) is used for all communication over the air interface between UE and the eNodeB. The MME does not send the S1 Initial Context Setup request to the eNodeB. The eNodeB does not send RRC re-configuration to the UE as there is no Initial Context Setup at the eNodeB. The MME sends a NAS Attach Accept to the UE in S1 Downlink NAS Transport message instead of S1 Initial Context Setup request. The UE sends NAS Attach Complete in the S1 Uplink NAS Transport message. The MME establishes the S11-U

tunnel during S11 Create Session request/response signalling. S11 Modify Bearer request sent is not sent to the S-GW after Attach Complete is received from UE.

**Step 1:** The UE sends the RRC connection set up complete message and the NAS attach request to the eNodeB.

**Step 2:** The eNodeB sends the S1AP Initial UE Message, NAS attach request message and ESM PDN connectivity request to the MME.

**Step 3:** The MME sends the S11 create session request to the S-GW.

**Step 4:** The S-GW responds to the MME with the S11 create session response.

**Step 5:** The MME sends the S1AP downlink NAS message, NAS attach accept and ESM activate default bearer request to the eNodeB.

**Step 6:** The eNodeB in turn sends the RRC downlink information transfer message, NAS attach accept and ESM activate default bearer request to the UE.

**Step 7:** The UE sends the RRC uplink information transfer message, NAS attach complete and an ESM activate default bearer accept message to the eNodeB.

**Step 8:** The eNodeB sends the S1AP uplink NAS message, NAS attach complete and ESM activate default bearer accept message to the MME.

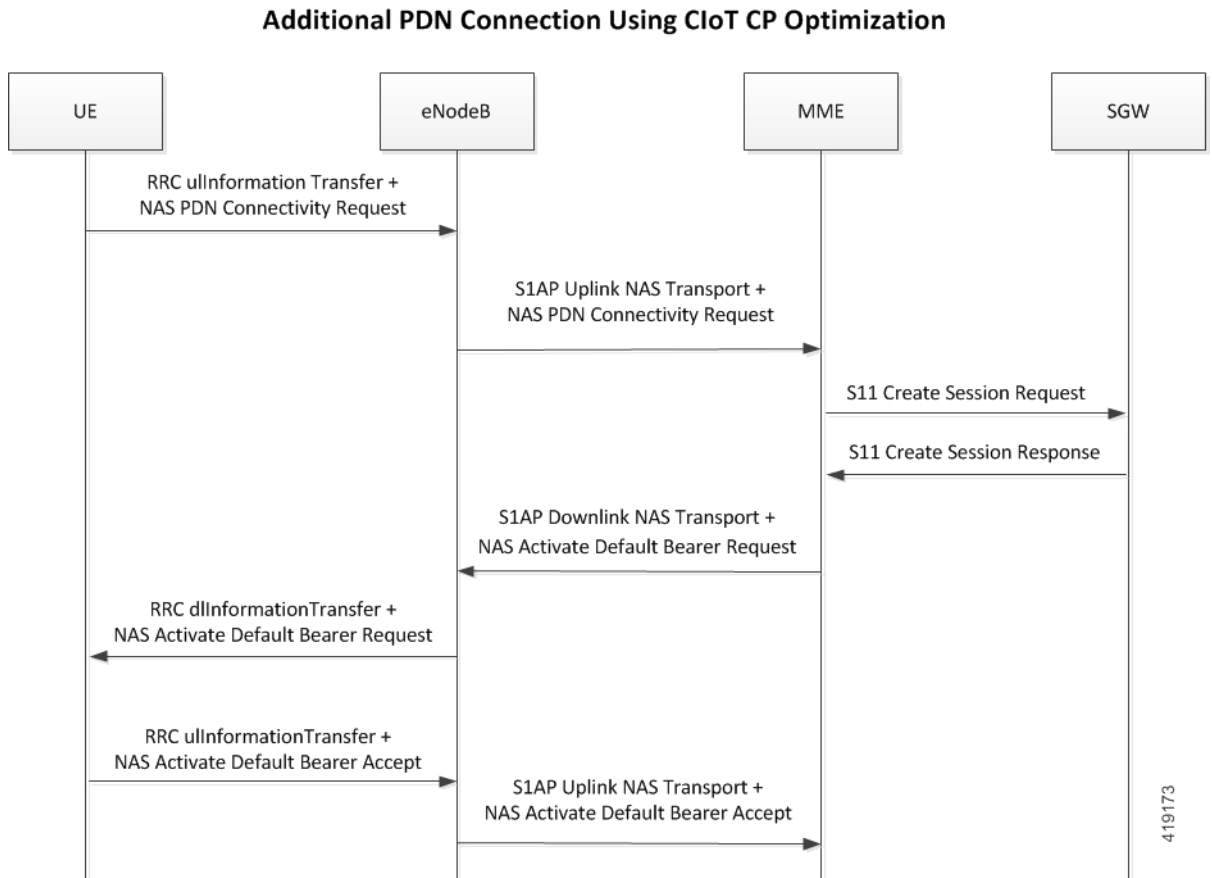
#### **Additional PDN Connection with CP Clot Optimization**

The following call flow diagram displays the additional PDN connection procedure with CP Clot optimization.

This call flow does not display the HSS interaction for S6a notify request.

However, these procedures are applicable and performed by the MME for this call flow.

Figure 5: Additional PDN Connection using Clot CP Optimization



Additional PDN connection with CP Clot optimization performs bearer setup on the UE and network (SGi/SCEF) without reserving radio resources in the RAN. Data Radio Bearer (DRB) is not setup on the eNodeB for the UE. Signaling Radio Bearer (SRB) is used for all communication over the air interface between UE and eNodeB. The MME does not send S1 ERAB Setup request to eNodeB. The eNodeB does not send RRC reconfiguration to the UE as there is no S1 ERAB Setup at the eNodeB. The MME sends a NAS Activate default EPS bearer context request to UE in S1 Downlink NAS Transport message instead of S1 ERAB Setup request. The UE sends NAS Activate Default Bearer Accept in the S1 Uplink NAS Transport message. The MME establishes the S11-U tunnel during S11 Create Session request/response signaling. S11 Modify Bearer request is not sent to the S-GW after Activate Default Bearer Accept is received from UE.

**Step 1:** The UE sends the RRC uplink information transfer message and the NAS PDN connectivity request to the eNodeB.

**Step 2:** The eNodeB sends the S1AP uplink NAS transport Message and the NAS PDN connectivity request to the MME.

**Step 3:** The MME sends the S11 create session request to the S-GW.

**Step 4:** The S-GW responds to the MME with the S11 create session response.

**Step 5:** The MME sends the S1AP downlink NAS transport message and the NAS activate default bearer request to the eNodeB.

**Step 6:** The eNodeB in turn sends the RRC downlink information transfer message and the NAS activate default bearer request accept to the UE.

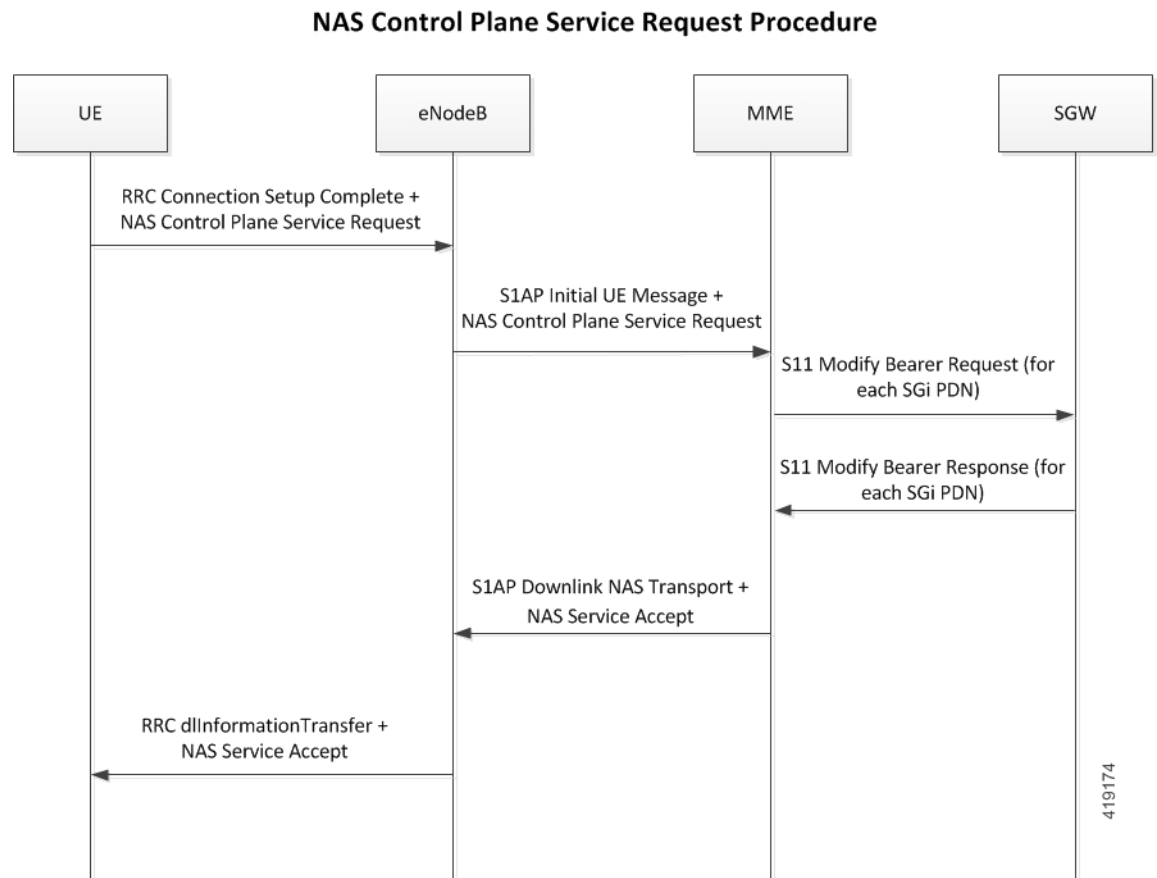
**Step 7:** The UE sends the RRC uplink information transfer message and the NAS activate default bearer accept message to the eNodeB.

**Step 8:** The eNodeB sends the S1AP uplink NAS message and the NAS activate default bearer accept message to the MME.

### Idle to Active Transition with Control Plane Service Request

The following call flow diagram displays an Idle to Active mode state transition for a CIoT UE.

**Figure 6: NAS Control Plane Service Request Procedure**



A CIoT UE transitioning from idle to active mode does not reserve any radio resources in the RAN. Data Radio Bearer (DRB) is not setup on the eNodeB for the UE. Signaling Radio Bearer (SRB) is used for all communication over the air interface between UE and the eNodeB. The MME does not send S1 Initial Context Setup request to the eNodeB. The eNodeB does not send RRC re-configuration to the UE as there is no Initial Context Setup at the eNodeB. The MME sends a NAS Service Accept to UE in S1 Downlink NAS Transport message and it brings up S11U tunnel for each SGi PDN through S11 Modify Bearer request/response signaling with the S-GW.

**Step 1:** The UE sends the RRC connection set up complete message and NAS control plane service request to the eNodeB.

**Step 2:** The eNodeB sends the S1AP initial UE message and NAS control plane service request to the MME.

**Step 3:** The MME sends the S11 modify bearer request to the S-GW for each SGi PDN.

**Step 4:** The S-GW responds to the MME with the S11 modify bearer response for each SGi PDN.

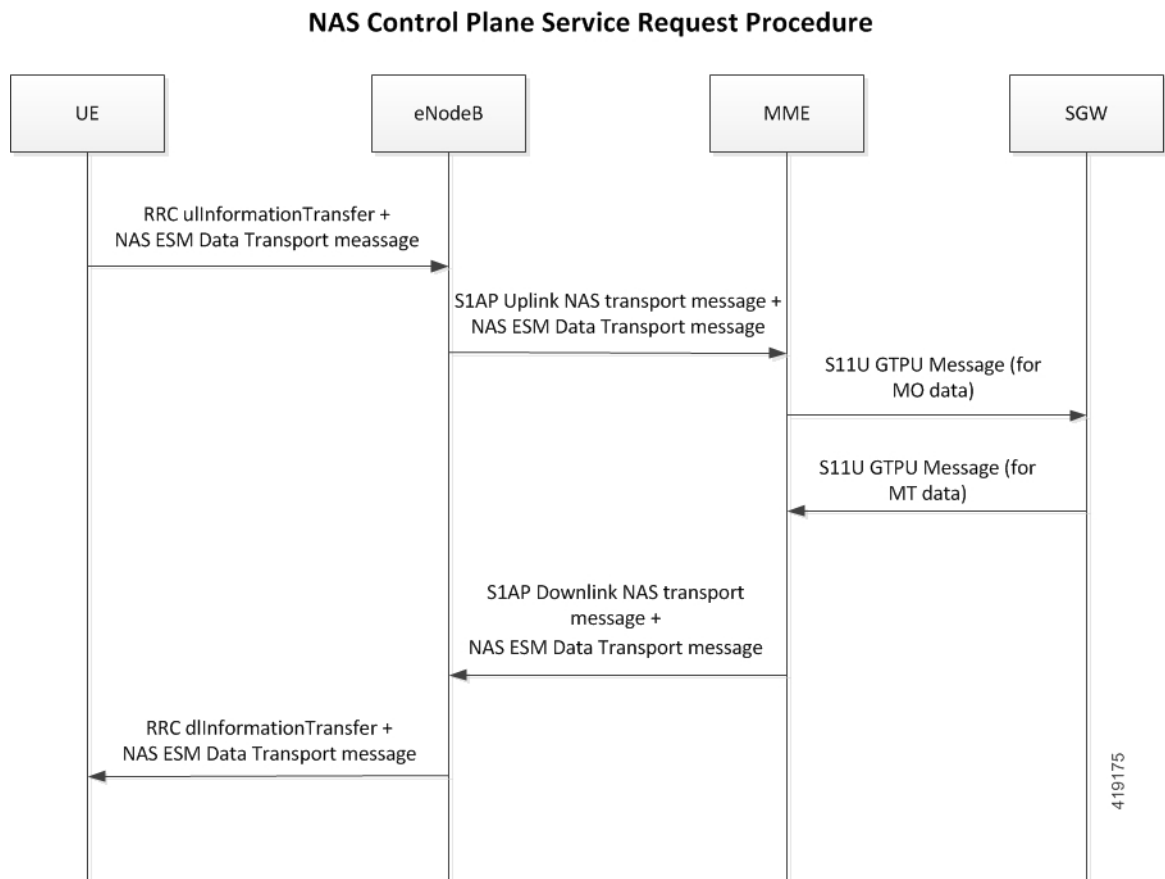
**Step 5:** The MME sends the S1AP downlink NAS transport message and NAS service accept message to the eNodeB.

**Step 6:** The eNodeB in turn sends the RRC downlink information transfer message and the NAS service accept message to the UE.

### MO and MT Data Exchange with CP Clot Optimization

The following call flow diagram displays MO and MT data exchange with Clot UE in active state (connected mode).

**Figure 7: NAS Control Plane Service Request Procedure**



MO and MT data exchange utilizes the SRB to carry data over NAS. The MME receives the ESM payload in NAS message from the UE and sends it to the S-GW over GTP-U using S11-U tunnel. The MME receives the GTP-U payload from S-GW over S11-U tunnel and sends it to the UE in a NAS message.

MO data can be sent by the UE to MME in the following NAS messages:

- NAS Control Plane Service Request

- NAS ESM Data Transport Message

MT data can be sent by the MME to the UE in the "NAS ESM Data Transport Message" message.

**Step 1:** The UE sends the RRC uplink information transfer message and the NAS ESM data transport message to the eNodeB.

**Step 2:** The eNodeB sends the uplink NAS transport message and the NAS ESM data transport message to the MME.

**Step 3:** The MME sends the S11-U GTP-U message to the S-GW for MO data.

**Step 4:** The S-GW responds to the MME with the S11-U GTP-U message for MT data.

**Step 5:** The MME sends the S1AP downlink NAS transport message and the NAS ESM data transport message to the eNodeB.

**Step 6:** The eNodeB in turn sends the RRC downlink information transfer message and the NAS ESM data transport message to the UE.

## Standards Compliance

The Small Data over NAS, S11-U and SGi Interfaces feature complies with the following standards:

- **3GPP TS 36.413 v13.4.0 (2016-09)**, 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP) (Release 13)
- **3GPP TS 23.401 v13.8.0 (2016-09)**, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (Release 13)
- **3GPP TS 24.301 v13.7.0 (2016-09)**, 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3 (Release 13)
- **3GPP TS 29.272 v13.7.0 (2016-09)**, 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Evolved Packet System (EPS); Mobility Management Entity (MME) and Serving GPRS Support Node (SGSN) related interfaces based on Diameter protocol (Release 13)
- **3GPP TS 29.274 v13.7.0 (2016-09)**, 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunneling Protocol for Control plane (GTPv2-C); Stage 3 (Release 13)
- **3GPP TS 23.682 v13.7.0 (2016-09)**, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Architecture enhancements to facilitate communications with packet data networks and applications (Release 13)

# Configuring Data over NAS, S11-U and SGi Interfaces

## Configuring Control Plane Clot Optimization

The **ciot-optimisation** CLI command has been introduced under the Call Control Profile to enable Clot optimization for an UE.

```
configure
  call-control-profile profile_name
    ciot-optimisation [ cp-optimisation access-type { all | nb-iot |
wb-eutran } | eps-attach-wo-pdn access-type { all | nb-iot | wb-eutran }
  ]
  remove ciot-optimisation cp-optimisation
  remove ciot-optimisation eps-attach-wo-pdn access-type { all | nb-iot
| wb-eutran }
  exit
```

### Notes:

- The **ciot-optimisation** command enables Clot optimization for an UE.
- The **cp-optimisation** keyword enables Control Plane optimization for an UE.
- The **remove** keyword deletes the existing configuration.
- The **access-type** keyword specifies the access type extension on which control plane optimization must be enabled. Control plane optimization can be enabled on both NB-IoT and WB-EUTRAN RATs or on either of them. Enabling one RAT type overrides the existing configuration.
- The **all** keyword enables control plane optimization for all access types. Both NB-IoT and WB-EUTRAN are considered as two independent access types for all functions.
- The **nb-iot** keyword enables control plane optimization for NB-IoT access type.
- The **wb-eutran** keyword enables control plane optimization for WB-EUTRAN access type.
- The **eps-attach-wo-pdn** keyword enables EPS attach without PDN support for an UE.
- The call-control-profile can be associated with the operator-policy and the Clot optimization can be enabled or disabled on a per subscriber (IMSI) basis.
- This command is disabled by default.

### Verifying the Configuration

Execute the **show call-control-profile full name *profile-name*** command to verify the configured values. For example:

```
show call-control-profile full name profile_name
CIoT Optimisation:
  CIoT Optimisation: Enabled/Disabled
  Access-Type: all/nb-iot/wb-eutran/N/A
```



## Configuring PDN Type in the APN Profile

The **pdn-type** CLI command added in the APN Profile Configuration mode specifies the PDN type indicator in the APN profile.

```
configure
  apn-profile profile_name
    pdn-type { ip | non-ip { sgi | t6a [ scef-id scef_id [ scef-realm
realm_name ] ] } }
    remove pdn-type
  exit
```

### Notes:

- Use this command to specify the Cellular IoT PDN type. The user has an option to override the HSS provided APN subscription PDN type. This command is applicable only during Attach and additional PDN connectivity, and not during Handover scenarios.
- The **remove** keyword deletes the existing configuration.
- The **ip** keyword configures the Cellular IoT PDN type as IP PDN.
- The **non-ip** keyword configures the Cellular IoT PDN type as non-IP PDN.
- The **sgi** keyword configures the Cellular IoT Non-IP PDN delivery path type as SGI.
- The **t6a** keyword configures the Cellular IoT Non-IP PDN delivery path type as T6a.
- The **scef-id** *scef\_id* keyword optionally specifies the SCEF ID. The *scef\_id* is an alphanumeric string of 1 to 63 characters.
- The **scef-realm** *realm\_name* keyword optionally specifies the SCEF diameter realm name. The *realm\_name* is an alphanumeric string of 1 to 127 characters.
- This command is disabled by default.

### Verifying the Configuration

Execute the **show apn-profile** *profile\_name* command to verify the configured values. For example:

```
show apn-profile full name profile_name
PDN Type : NON-IP/IP/Not configured
NON-IP Delivery Mechanism Type : SGI/T6a
SCEF-Id : SCEF_Identifier
SCEF-Realm : SCEF_diameter_realm_name
```

## Configuring Serving PLMN Rate Control

The **serving-plmn-rate-control** CLI command added in the Call Control Profile Configuration mode configures the serving PLMN rate control for control plane CIoT optimization. The serving PLMN rate control limits the rate at which UE or P-GW / SCEF sends data over the control plane when CP optimization is enabled.

```
configure
  call-control-profile profile_name
    serving-plmn-rate-control ul-rate ul_rate_value dl-rate dl_rate_value
```

```

remove serving-plmn-rate-control
exit

```

**Notes:**

- The **remove** keyword deletes the existing configuration.
- The **ul-rate** *ul\_rate\_value* keyword configures the maximum number of data NAS PDUs that the UE can send in uplink path per deci-hour (6 minutes). The uplink rate is an integer from 10 up to 65535. A value of 65535 in this case implies no limit on the number of PDUs that the UE can send in the uplink path per deci-hour.
- The **dl-rate** *dl\_rate\_value* keyword configures the maximum number of data NAS PDUs that the P-GW / SCEF can send in the downlink path to the UE per deci-hour (6 minutes). The downlink rate is an integer from 10 up to 65535. A value of 65535 in this case implies no limit on the number of PDUs that the P-GW / SCEF can send in the downlink path per deci-hour.
- This command is disabled by default.

**Verifying the Configuration**

Execute the **show call-control-profile full name** *profile\_name* command to verify the configured values. For example:

```

show call-control-profile full name profile_name
Serving PLMN Rate Control : Enabled/Disabled
  UL Rate                  : x pdus per deci hour.
  DL Rate                  : x pdus per deci hour.

```

## Configuring DSCP Value in the GTPU Packets from MME on the S11-U Interface

The **ip** CLI command added in the APN Profile Configuration mode defines the IP parameters for the APN profile. This command is used to configure:

- SGSN/S-GW action in response to detected IP source violations
- DSCP marking for downlink and uplink configuration per traffic class
- QoS class diffserv code

The **s11u-mme** keyword is added in this command which is used to configure the S11-U interface parameters.

```

configure
  apn-profile profile_name
    ip { qos-dscp { { { downlink | uplink } { background forwarding |
conversational forwarding | interactive traffic-handling-priority priority
forwarding | streaming forwarding } + } | s11u-mme value } | source-violation
  { deactivate [ all-pdp | exclude-from accounting | linked-pdp |
tolerance-limit } | discard [ exclude-from-accounting ] | ignore }
    default ip { qos-dscp [ downlink | uplink | s11u-mme ] |
source-violation }
    no ip qos-dscp { downlink | uplink } { background | conversational
| interactive | streaming } +

```

**Important**

All parameters that are not specifically configured will be included in the configuration with default values.

Notes:

- The **default** keyword resets the configuration to the default values.
- The **no** keyword disables the specified IP QoS-DSCP mapping.
- The **qos-dscp** keyword configures the Differentiated Services Code Point (DCSP) marking to be used for sending packets of a particular 3GPP QoS class.
- The **s11u-mme** keyword configures the S11-U interface parameters. The DSCP values can be specified using this keyword. The DSCP value for S11-U interface can be separately specified for each APN. This keyword is not enabled by default. The default value is “**be**”.

The DSCP values configured for the S11-U interface are:

- af11 - Designates use of Assured Forwarding 11 PHB
- af12 - Designates use of Assured Forwarding 12 PHB
- af13 - Designates use of Assured Forwarding 13 PHB
- af21 - Designates use of Assured Forwarding 21 PHB
- af22 - Designates use of Assured Forwarding 22 PHB
- af23 - Designates use of Assured Forwarding 23 PHB
- af31 - Designates use of Assured Forwarding 31 PHB
- af32 - Designates use of Assured Forwarding 32 PHB
- af33 - Designates use of Assured Forwarding 33 PHB
- af41 - Designates use of Assured Forwarding 41 PHB
- af42 - Designates use of Assured Forwarding 42 PHB
- af43 - Designates use of Assured Forwarding 43 PHB
- be - Designates use of Best Effort forwarding PHB
- cs0 - Designates use of Class Selector 0 PHB
- cs1 - Designates use of Class Selector 1 PHB
- cs2 - Designates use of Class Selector 2 PHB
- cs3 - Designates use of Class Selector 3 PHB
- cs4 - Designates use of Class Selector 4 PHB
- cs5 - Designates use of Class Selector 5 PHB
- cs6 - Designates use of Class Selector 6 PHB
- cs7 - Designates use of Class Selector 7 PHB
- ef - Designates use of Expedited Forwarding PHB

## Sample Configuration



### Important

If you modify the **interface-type** command, the parent service (service within which the eGTP/GTP-U service is configured) will automatically restart. Service restart results in dropping of active calls associated with the parent service.

**configure**

```

call-control-profile profile_name
  ciot-optimisation cp-optimisation access-type all
  ciot-optimisation eps-attach-wo-pdn access-type all
  exit
operator-policy name policy_name
  associate call-control-profile profile_name
  apn network-identifier apn_net_id_1 apn-profile apn_profile_name_1

  apn network-identifier apn_net_id_1 apn-profile apn_profile_name_1

  exit
apn-profile profile_name_1
  pdn-type non-ip t6a
  exit
apn-profile profile_name_2
  pdn-type non-ip sgi
  exit
lte-policy
  subscriber-map map_name
  precedence number match-criteria all operator-policy-name
policy_name
  exit
exit
context ingress
  mme-service service_name
  bind s1-mme ipv4-address ipv4_address
  s1-mme sctp port port_number
  mme-id group-id id mme-code code
  plmn-id mcc mcc_value mnc mnc_value
  associate egtp-service egtp_svc_name context context_name
  associate hss-peer-service svc_name context context_name
  associate subscriber-map map_name

  exit
egtp-service service_name
  interface-type interface-mme
  gtpc bind ipv4-address ipv4_address
  associate gtpu-service name
  exit
gtpu-service service_name
  bind ipv4-address ipv4_address
  exit
exit
end

```

The configuration can be verified by issuing the following show commands:

- **show configuration**
- **show mme-service all**
- **show call-control-profile full all**
- **show apn-profile full all**

## Monitoring and Troubleshooting Data over NAS, S11-U and SGI Interfaces

This section provides information on show commands, disconnect reasons, diameter attributes and bulk statistics for this feature.

### Show Command(s) and/or Outputs

#### **show call-control-profile full name *profile\_name***

The following new fields are added to the output of this command to display the configured CP ClIoT optimization parameters:

- ClIoT Optimisation
- CP-Optimisation
- Access-Type
- Serving PLMN Rate Control
- UL Rate
- DL Rate

#### **show apn-profile full name *profile\_name***

The following new fields are added to the output of this command to display the configured PDN type:

- PDN Type
- Non-IP Delivery Mechanism Type
- SCEF-Id
- SCEF-Realm

#### **show subscriber all**

The following new field is added to the output of this command to display the new network type:

- (N) – Non-IP

**show mme-service session full all**

The following new fields are displayed in the output of this command if CP ClIoT optimization is enabled:

- ClIoT Optimisation Information
  - NB-IoT RAT
  - Attach Without PDN Support
  - CP-ClIoT Optimization
- PDN Type
- PDN Data Delivery Interfacea
- Non-IP Data Delivery Mechanism Identifier
- S11U MME TEID: Displays the S11U MME Tunnel Identifier.
- S11U SGW TEID: Displays the S11U SGW Tunnel Identifier
- S11U MME IPv4 Addr: Displays the S11U MME IPv4 transport address
- S11U MME IPv6 Addr: Displays the S11U MME IPv6 transport address
- S11U SGW IPv4 Addr: Displays the S11U SGW IPv4 transport address
- S11U SGW IPv6 Addr: Displays the S11U SGW IPv6 transport address

**show mme-service db record imsi *imsi\_number***

The following new fields are added to the output of this command:

- Non-IP-PDN-Type-Indicator
- Non-IP-Data-Delivery-Mechanism
- SCEF-ID
- SCEF-Realm

**show mme-service statistics**

The following new ECM statistics are added to display the UE-initiated CP service request events and network-initiated CP service request events. These parameters are displayed only if CP ClIoT optimization is enabled.

- UE Initiated CP Service Request Events
  - Attempted
  - Success
  - Failures
- NW Initiated CP Service Request Events
  - Attempted

- Success
- Failures
- New EMM message statistics are added to display the number of NAS service accept messages sent, partially ciphered NAS messages received and NAS control plane service request messages received:
  - Service Accept
  - Partially Ciphered messages
  - CP Service Request
- New ESM procedure statistics are added to display the number of Non-IP PDN Connections over SCEF (t6a), Non-IP PDN Connections over SGi (s1u or s11u) and PDN Disconnections over SCEF (t6a) attempted, successful and failed:
  - NON-IP PDN Connections With SCEF
    - Attempted
    - Success
    - Failures
  - NON-IP PDN Connections With SGI
    - Attempted
    - Success
    - Failures
  - NON-IP PDN Connections With SCEF
    - Attempted
    - Success
    - Failures
- New statistics are added to display the Non-IP PDN statistics - the number of non-IP PDN Connections over SCEF (T6a), number of Non-IP PDN Connections over SGi (S1U or S11-U) and all non-IP PDN connections (the total sum of non-IP PDN connections over SCEF and SGi):
  - NON-IP PDN Statistics
  - All PDNs
  - SCEF PDNs
  - SGI PDNs
- New statistics have been added to display the number of attached calls, connected calls and idle calls for NB-IoT subscribers, Attach without PDN subscribers and CP-CIoT enabled subscribers:
  - NB-IoT Subscribers
    - Attached Calls

- Connected Calls
- Idle Calls
- Attach Without PDN Subscribers
  - Attached Calls
  - Connected Calls
  - Idle Calls
- CP-CIoT Enabled Subscribers
  - Attached Calls
  - Connected Calls
  - Idle Calls
- New statistics have been added to the show output and are grouped according to:
  - Data over NAS statistics
  - IP data over S11-U statistics
  - Non-IP data over S11-U statistics
  - Data over T6a statistics

Received packets (Rx packets), Received bytes (Rx Bytes), Transmitted packets (Tx Packets), Transmitted Bytes (Tx Bytes), Received packets dropped (Rx Drop Packets), Received Bytes dropped (Rx Drop Bytes), Transmitted packets dropped (Tx Drop Packets) and Transmitted bytes dropped (Tx Drop Bytes) are displayed for each of the above listed group of statistics.

- Data Over NAS Statistics
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes
- IP Data Over S11U Statistics
  - Rx Packets
  - Rx Bytes
  - Tx Packets



- Tx Bytes
- Rx Drop Packets
- Rx Drop Bytes
- Tx Drop Packets
- Tx Drop Bytes
  
- NON-IP Data Over S11U Statistics
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes
  
- Data Over T6A (SCEF) Statistics
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes

**show mme-service statistics verbose**

New statistics are added to display number of Idle mode Outbound Relocation using TAU/RAU Denied, Idle mode Outbound Relocation using TAU/RAU with PDN deactivation at MME, Connected mode Outbound Relocation Denied and Connected mode Outbound Relocation with PDN deactivation at MME.

- NON-IP Statistics
  - Outbound Relocation for TAU/RAU - Denied (Context Failure)
  - No SGI Non-IP sup by peer MME
  - No SCEF Non-IP sup by peer MME

- Outbound Relocation for TAU/RAU - PDN Deactivation
  - No SGI Non-IP sup by peer S3 SGSN
  - No SCEF Non-IP sup by peer S3 SGSN
  - No SGI Non-IP sup by peer Gn SGSN
  - No SCEF Non-IP sup by peer Gn SGSN
  - No SGI Non-IP sup by peer MME
  - No SCEF Non-IP sup by peer MME
- Outbound Handover Denied (HO Prep Failure)
  - No SGI Non-IP sup by peer Node
  - No SCEF Non-IP sup by peer Node
- Outbound Relocation using S1HO/SRNS/PSHO - PDN Deactivation
  - No SGI Non-IP sup by peer S3 SGSN
  - No SCEF Non-IP sup by peer S3 SGSN
  - No SGI Non-IP sup by peer Gn SGSN
  - No SCEF Non-IP sup by peer Gn SGSN
  - No SGI Non-IP sup by peer MME
  - No SCEF Non-IP sup by peer MME

**show mme-service session counters imsi *imsi\_number***

The following new fields are added to the output of this command. These statistics are displayed only when CP CIoT optimization is enabled.

- ECM events:
  - UE Initiated CP Service Request Event
    - Attempted
    - Success
    - Failures
  - NW Initiated CP Service Request Events
    - Attempted
    - Success
    - Failures
- ESM events:
  - NON-IP PDN Connections to SCEF

- Attempted
- Success
- Failures
- NON-IP PDN Connections to SGI:
  - Attempted
  - Success
  - Failures
- PDN Disconnections to SCEF:
  - Attempted
  - Success
  - Failures
- Control Plane User Data Statistics:
  - Cumulative Data Over NAS Statistics:
    - Rx Packets
    - Rx Bytes
    - Tx Packets
    - Tx Bytes
    - Rx Drop Packets
    - Rx Drop Bytes
    - Tx Drop Packets
    - Tx Drop Bytes
  - Cumulative IP Data Over S11U Statistics:
    - Rx Packets
    - Rx Bytes
    - Tx Packets
    - Tx Bytes
    - Rx Drop Packets
    - Rx Drop Bytes
    - Tx Drop Packets
    - Tx Drop Bytes
  - Cumulative Non- IP Data Over S11U Statistics:

- Rx Packets
- Rx Bytes
- Tx Packets
- Tx Bytes
- Rx Drop Packets
- Rx Drop Bytes
- Tx Drop Packets
- Tx Drop Bytes
  
- Cumulative Data Over T6A (SCEF) Statistics:
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes
  
- Per PDN Statistics
- APN Name
- Data Over NAS Statistics
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes
  
- IP Data Over S11U Statistics:
  - Rx Packets
  - Rx Bytes

- Tx Packets
- Tx Bytes
- Rx Drop Packets
- Rx Drop Bytes
- Tx Drop Packets
- Tx Drop Bytes
  
- Non-IP Data Over S11U Statistics:
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes
  
- Data Over T6A (SCEF) Statistics:
  - Rx Packets
  - Rx Bytes
  - Tx Packets
  - Tx Bytes
  - Rx Drop Packets
  - Rx Drop Bytes
  - Tx Drop Packets
  - Tx Drop Bytes
  
- Partially Ciphred messages

**show session disconnect-reasons verbose**

The following new statistics are added to the output of this command:

- mme-gtpu-path-failure-s11u
- mme-gtpu-err-ind-s11u

## Bulk Statistics

The following bulk statistics are added in the MME Schema in support of the Small Data over NAS, S11-U and SGi Interfaces feature.

**Table 1: MME Schema**

Counter	Description
<b>NAS bulk statistics</b>	
nas-data-pkts-rx	Total number of user data packets received over NAS.
nas-data-pkts-tx	Total number of user data packets transmitted over NAS.
nas-data-bytes-rx	Total number of user data in bytes received over NAS.
nas-data-bytes-tx	Total number of user data in bytes transmitted over NAS.
nas-data-pkts-rx-drop	Total number of user data in bytes received over NAS, but dropped by MME.
nas-data-pkts-tx-drop	Total number of user data in bytes transmitted over NAS, but transmission failed.
<b>S11-U IP data bulk statistics</b>	
s11u-ip-data-pkts-rx	Total number of IP packets received over S11U Interface.
s11u-ip-data-pkts-tx	Total number of IP packets transmitted over S11U Interface.
s11u-ip-data-bytes-rx	Total number of IP data in bytes received over S11U Interface.
s11u-ip-data-bytes-tx	Total number of IP data in bytes transmitted over S11U Interface.
s11u-ip-data-pkts-rx-drop	Total number of IP packets received over S11U Interface, but dropped by MME.
s11u-ip-data-pkts-tx-drop	Total number of IP packets transmitted over S11U Interface, but transmission failed.
s11u-ip-data-bytes-rx-drop	Total number of IP data in bytes received over S11U Interface, but dropped by MME.
s11u-ip-data-bytes-tx-drop	Total number of IP data in bytes transmitted over S11U Interface, but transmission failed.
<b>S11-U Non-IP data bulk statistics</b>	

Counter	Description
s11u-nonip-data-pkts-rx	Total number of NON-IP packets received over S11U Interface.
s11u-nonip-data-pkts-tx	Total number of NON-IP packets transmitted over S11U Interface.
s11u-nonip-data-bytes-rx	Total number of NON-IP data in bytes received over S11U Interface.
s11u-nonip-data-bytes-tx	Total number of NON-IP data in bytes transmitted over S11U Interface.
s11u-nonip-data-pkts-rx-drop	Total number of NON-IP packets received over S11U Interface, but dropped by MME.
s11u-nonip-data-pkts-tx-drop	Total number of NON-IP packets transmitted over S11U Interface, but transmission failed.
s11u-nonip-data-bytes-rx-drop	Total number of NON-IP data in bytes received over S11U Interface, but dropped by MME.
s11u-nonip-data-bytes-tx-drop	Total number of NON-IP data in bytes transmitted over S11U Interface, but transmission failed.
<b>EMM message bulk statistics</b>	
emm-msgrx-cp-service-req	Total number of EMM control messages received - Control Plane service requests.
emm-msgtx-service-accept	Total number of EMM Service Accept messages sent.
emm-msgrx-partially-ciphered	Total number of EMM control messages received - partially ciphered messages.
<b>ESM message bulk statistics</b>	
esm-msgtx-esm-data-transport	Total number of ESM control messages sent - ESM Data Transport.
esm-msgrx-esm-data-transport	Total number of ESM control messages received - ESM Data Transport.
<b>CP CIoT subscribers bulk statistics</b>	
attached-cp-ciot-subscriber	Total number of attached UEs with CP Optimization Enabled.
connected-cp-ciot-subscriber	Total number of CP Optimization Enabled subscribers in connected state.
idle-cp-ciot-subscriber	Total number of CP Optimization Enabled subscribers in idle state.
<b>Non-IP PDN bulk statistics</b>	

Counter	Description
nonip-pdn-all	Total number of Non-IP PDN connections.
nonip-pdn-scef	Total number of Non-IP PDN connections with SCEF.
nonip-pdn-sgi	Total number of Non-IP PDN connections with SGI.
<b>ECM procedure bulk statistics</b>	
ecmevent-ue-cp-srvcreq-attempt	Total number of EPS Connection Management events - UE-initiated service requests - attempted.
ecmevent-ue-cp-srvcreq-success	Total number of EPS Connection Management events - UE-initiated service requests - successes.
ecmevent-ue-cp-srvcreq-failure	Total number of EPS Connection Management events - UE-initiated service requests - failures.
ecmevent-nw-cp-srvcreq-attempt	Total number of EPS Connection Management events - Network-initiated service requests - attempted.
ecmevent-nw-cp-srvcreq-success	Total number of EPS Connection Management events - Network-initiated service requests - successful.
ecmevent-nw-cp-srvcreq-failure	Total number of EPS Connection Management events - Network-initiated service requests - failures.
<b>Non-IP PDN connect procedure bulk statistics</b>	
esmevent-nonip-pdncon-scef-attempt	Total number of EPS Session Management events - PDN connections of PDN type Non-IP with SCEF - attempted.
esmevent-nonip-pdncon-scef-success	Total number of EPS Session Management events - PDN connections of PDN type Non-IP with SCEF - successes.
esmevent-nonip-pdncon-scef-failure	Total number of EPS Session Management events - PDN connections of PDN type Non-IP with SCEF - failures.
esmevent-nonip-pdncon-sgi-attempt	Total number of EPS Session Management events - PDN connections of PDN type Non-IP with SGI - attempted.
esmevent-nonip-pdncon-sgi-success	Total number of EPS Session Management events - PDN connections of PDN type Non-IP with SGI - successes.
esmevent-nonip-pdncon-sgi-failure	Total number of EPS Session Management events - PDN connections of PDN type Non-IP with SGI - failures.
<b>Idle mode handover of non-IP PDN bulk statistics</b>	



Counter	Description
outbound-tau-rau-denied-no-sgnipdn-sup	Total number of Outbound Context failure due to Peer's limitation for SGI Non-IP PDN support.
outbound-tau-rau-denied-no-scnipdn-sup	Total number of Outbound Context failure due to Peer's limitation for SCEF Non-IP PDN support.
outbound-tau-rau-pdn-deact-no-sgnipdn-sup-s3	Total number of PDN deactivations during Outbound TAU/RAU due to Peer S3 SGSN limitation for SGI Non-IP PDN support.
outbound-tau-rau-pdn-deact-no-sgnipdn-sup-gn	Total number of PDN deactivations during Outbound TAU/RAU due to Peer GN SGSN limitation for SGI Non-IP PDN support.
outbound-tau-rau-pdn-deact-no-sgnipdn-sup-mme	Total number of PDN deactivations during Outbound TAU/RAU due to Peer MME limitation for SGI Non-IP PDN support.
outbound-tau-rau-pdn-deact-no-scnipdn-sup-s3	Total number of PDN deactivations during Outbound TAU/RAU due to Peer S3 SGSN limitation for SCEF Non-IP PDN support.
outbound-tau-rau-pdn-deact-no-scnipdn-sup-gn	Total number of PDN deactivations during Outbound TAU/RAU due to Peer GN SGSN limitation for SCEF Non-IP PDN support.
outbound-tau-rau-pdn-deact-no-scnipdn-sup-mme	Total number of PDN deactivations during Outbound TAU/RAU due to Peer MME limitation for SCEF Non-IP PDN support.
<b>Connected mode handover of non-IP PDN bulk statistics</b>	
outbound-ho-denied-no-sgnipdn-sup	Total number of Outbound S1Ho/SRNS/PSHO failure due to Peer's limitation for SCEF Non-IP PDN support.
outbound-ho-pdn-deact-no-sgnipdn-sup-s3	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer S3 SGSN limitation for SGI Non-IP PDN support.
outbound-ho-pdn-deact-no-sgnipdn-sup-gn	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer GN SGSN limitation for SGI Non-IP PDN support.
outbound-ho-pdn-deact-no-sgnipdn-sup-mme	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer MME limitation for SGI Non-IP PDN support.
outbound-ho-pdn-deact-no-scnipdn-sup-s3	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer S3 SGSN limitation for SCEF Non-IP PDN support.

Counter	Description
outbound-ho-pdn-deact-no-scnipdn-sup-gn	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer GN SGSN limitation for SCEF Non-IP PDN support.
outbound-ho-pdn-deact-no-scnipdn-sup-mme	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer MME limitation for SCEF Non-IP PDN support.
outbound-ho-denied-no-sgnipdn-sup	Total number of outbound S1HO/SRNS/PSHO failure due to Peer's limitation for SGI Non-IP PDN support.
outbound-ho-denied-no-scnipdn-sup	Total number of Outbound S1Ho/SRNS/PSHO failure due to Peer's limitation for SCEF Non-IP PDN support.
outbound-ho-pdn-deact-no-sgnipdn-sup-s3	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer S3 SGSN limitation for SGI Non-IP PDN support.
outbound-ho-pdn-deact-no-sgnipdn-sup-gn	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer GN SGSN limitation for SGI Non-IP PDN support.
outbound-ho-pdn-deact-no-sgnipdn-sup-mme	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer MME limitation for SGI Non-IP PDN support.
outbound-ho-pdn-deact-no-scnipdn-sup-s3	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer S3 SGSN limitation for SCEF Non-IP PDN support.
outbound-ho-pdn-deact-no-scnipdn-sup-gn	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer GN SGSN limitation for SCEF Non-IP PDN support.
outbound-ho-pdn-deact-no-scnipdn-sup-mme	Total number of PDN deactivations during Outbound S1HO/SRNS/PSHO due to Peer MME limitation for SCEF Non-IP PDN support.

## Disconnect Reasons

The following disconnect reasons are added in support of the Small Data over NAS, S11-U and SGi Interfaces feature.

- **mme-gtpu-path-failure-s11u:** This disconnect reason is pegged when the session gets disconnected due to path failure on S11-U path between MME and S-GW.
- **mme-gtpu-err-ind-s11u:** This disconnect reason is pegged when the session gets disconnected due to GTP-U Error Indication received on S11-U interface on MME.

## Diameter Attributes

Diameter Attribute Value Pairs (AVPs) carry specific authentication, accounting, authorization, routing and security information as well as configuration details for the request and reply.

The following Diameter attributes are added in support of the Small Data over NAS, S11-U and SGI Interfaces feature.

### Non-IP-PDN-Type-Indicator

This AVP indicates whether the APN has a Non-IP PDN type.

**Vendor ID** 10415

**VSA Type** 1681

**AVP Type** ENUM

**AVP Flag** V

### Non-IP-Data-Delivery-Mechanism

This AVP indicates the mechanism to be used for Non-IP data delivery for a given APN.

**Vendor ID** 10415

**VSA Type** 1682

**AVP Type** UINT32

**AVP Flag** V

### Additional-Context-Identifier

This AVP indicates the identity of another default APN to be used when the subscription profile of the user contains APNs with both IP-based and non-IP PDN types.

**Vendor ID** 10415

**VSA Type** 1683

**AVP Type** UINT32

**AVP Flag** V

## Troubleshooting

The troubleshooting scenarios described in this section help in resolving minor issues related to incorrect configurations.

If the Control Plane CIoT optimization is not functioning as configured, use the following troubleshooting steps to resolve the issue:

1. Verify the **ciot-optimisation** command configuration.
2. Execute the **show call-control-profile full name *profile\_name*** and **show mme-service session full all** commands to verify if the call-control profile criteria matches that of the UE.

3. Use the **monitor subscriber** CLI command to ensure that the UE supports and has requested for Control Plane optimization in NAS Attach or TAU messages.
4. Verify if the GTP-U service is configured correctly and is associated with the S11-U interface. See the sample configuration documented in this chapter.
5. Ensure that the current S-GW selected for the UE supports the S11-U interface.

If the PDN setup fails for PDN type non-IP, use the following troubleshooting steps to resolve the issue:

1. Execute the **show mme-service db record imsi** *imsi\_number* command to verify if the non-IP PDN is present in the subscription provided by the HSS.
2. If the HSS provided subscription is missing or incorrect, add a non-IP PDN type by executing the **pdn-type** CLI command in the APN Profile Configuration mode.
3. Ensure that the P-GW serving the APN supports non-IP.
4. Ensure that the current S-GW selected for the UE supports non-IP.

If the PDN setup fails for PDN type non-IP, use the following troubleshooting steps to resolve the issue:

1. 1. Execute the **show mme-service db record imsi** *imsi\_number* command to verify if the non-IP PDN is present in the subscription provided by the HSS.
2. Execute the **show call-control-profile full name** *profile\_name* and **show mme-service session full all** commands to verify if the call-control profile criteria matches that of the UE.
3. Use the **monitor subscriber** CLI command to ensure that the UE supports and has requested for Control Plane optimization in NAS Attach or TAU messages.