

5G NSA for MME

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Feature Summary and Revision History

Summary Data

Applicable Product(s) or Functional Area	MME
Applicable Platform(s)	• ASR 5000 • ASR 5500 • VPC-DI • VPC-SI
Feature Default	Disabled - Configuration Required
Related Changes in This Release	Not applicable
Related Documentation	• *5G Non Standalone Solution Guide* • *AAA Interface Administration and Reference* • *Command Line Interface Reference* • *MME Administration Guide* • *Statistics and Counters Reference*

Revision History

Revision Details	Release

The 5G NSA support for Secondary RAT Usage Reporting feature is qualified on the ASR 5500 platform.	21.17
The 5G NSA supports Secondary RAT Usage Reporting. **Important** This feature is not fully qualified in this release, and is available only for testing purposes. For more information, contact your Cisco Account Representative.	21.16
The 5G NSA solution for MME supports the following functionality in this release: • Ultra-Low Latency QCI bearers handover from MME to Gn-SGSN • NR security algorithms for DCNR capable UEs to support 5G security	21.10
The 5G NSA solution for MME supports the following functionality in this release: • DCNR capability exchange with peer SGSN in MM context over S3 interface • MME support of statistics for DCNR PDNs • NR security algorithms for DCNR capable UEs to support 5G security **Important** Support for 5G security is not fully qualified in this release.	21.9
The 5G NSA solution is qualified on the ASR 5000 platform.	21.5
First introduced.	21.8

Feature Description

The 5G NSA solution for MME supports the following functionalities:

- **E-RAB Modification Procedure:**

  When SCG (Secondary Cell Group) bearer option is applied to support DCNR, this procedure allows the Master eNodeB to switch a bearer to Secondary eNodeB without changing the S1-MME association.

- **NR Capable S-GW/P-GW Selection:**

  When DCNR capable UE attempts to register in MME and when all DCNR validations are successful (for example DCNR feature configuration on MME, HSS not sending access-restriction for NR, and so on), for dynamic S-GW and P-GW selection, MME uses the following service parameters received from DNS server (in NAPTR response) over other service parameters to select NR capable S-GW/P-GW.

  - x-3gpp-sgw:x-s5-gtp+nc-nr
  - x-3gpp-pgw:x-s5-gtp+nc-nr

When the dynamic selection of S-GW/P-GW fails for any other reasons, MME falls back and selects the locally configured S-GW/P-GW.

- **Dynamic S-GW/P-GW Selection:**

  Dynamic S-GW and P-GW selection by MME for DCNR capable UE is supported. When a DCNR capable UE attempts to register in MME and when all DCNR validations are successful (DCNR feature configuration on MME, HSS not sending access-restriction for NR, and so on), the MME sets the "UP Function Selection Indication Flags" IE with DCNR flag set to 1 in "Create Session Request" message. This feature supports the CUPS architecture for SGW-C and PGW-C to select SGW-U and PGW-U and support dual connectivity with NR. When S-GW receives this IE over S11, it sends the IE over S5 to P-GW. If S-GW receives the IE in a non-CUPS deployment, it is ignored.

- **URLCC QCI Support:**

  For Ultra-Reliable and Low Latency Communications (URLCC), MME supports — QCI 80 (Non-GBR resource type), QCI 82 (GBR resource type), and QCI 83 (GBR resource type). MME establishes the default bearers with URLLC QCI 80, which is typically used by low latency eMBB applications. MME establishes the dedicated bearers with URLLC QCI 82 and QCI 83 (also with QCI 80 if dedicated bearers of non-GBR type to be established), which is typically used by discrete automation services (industrial automation).

- **PDNs with UP Function Selection Indication:**

  Based on the DCNR flag in the UP Function Selection Indication Flags IE, new statistics and bulk statistics are supported for the total number of current active, setup, and released DCNR PDNs on MME.

- **NR Support in GTP MM Context over S3 Interface:**

  MME supports the DCNR capability exchange with peer SGSN over the S3 interface. The DCNR restriction can be notified by the peer SGSN during handover to MME. The DCNR restriction information helps the target MME in performing the right S-GW selection.

  During handovers, the target MME performs gateway selection before getting the subscription information from the HSS and hence MME may select the NR capable S-GW for DCNR restricted UE. To prevent this, the peer SGSN will notify the Restriction information (NRSRNA) through the GTP MM context in Identification-Response/Context-Response/Forward-Relocation-Request message to MME. The S3-DCNR support includes both GTPv2 and GTPv1 protocol for S4-SGSN and Gn-SGSN respectively.

- **5G Security:**

  The "UE Additional Security Capability" and "Replayed UE Additional Security Capability" IEs for MME are supported as per 3GPP TS 24.301.

  The MME supports handling of the "UE Additional Security Capability" IE for DCNR capable UEs. This information element is used by the UE in Attach Request and Tracking Area Update messages to indicate which additional security algorithms are supported by the UE.

  The MME includes the "Replayed UE Additional Security Capability" IE if the MME supports handling of UE additional security capabilities, if the MME is initiating a Security Mode Command during an Attach or Tracking Area Update procedure and the Attach Request or Tracking Area Update Request message included a "UE Additional Security Capability" IE.

  The "NR UE Security Capability" IE will be included by MME in the S1AP messages — INITIAL CONTEXT SETUP REQUEST, UE CONTEXT MODIFICATION REQUEST, HANDOVER REQUEST, PATH SWITCH ACKNOWLEDGE and DOWNLINK NAS TRANSPORT for MME as per 3GPP TS36.41.

The eNode-B includes the "NR UE Security Capability" IE in PATH SWITCH REQUEST to be processed by the MME.

- **High Throughput:**

  5G NR offers downlink data throughput up to 20 Gbps and uplink data throughput up to 10 Gbps. Some interfaces in EPC have the support to handle (encode/decode) 5G throughput ranges. For example, NAS supports up to 65.2 Gbps (APN-AMBR) and S5/S8/S10/S3 (GTP-v2 interfaces) support up to 4.2 Tbps. The diameter interfaces such as S6a and Gx support only up to 4.2Gbps throughput, S1-AP supports only up to 10 Gbps and NAS supports up to 10 Gbps (MBR, GBR). New AVP/IE are introduced in S6a, Gx , S1-AP and NAS interfaces to support 5G throughput rates. See the *How It Works* section for more information.

- **Extended QoS:**

  MME supports the extended QoS values towards S-GW in legacy IEs - APN-AMBR, Bearer QoS, and Flow QoS.

- **Supported IEs:**

  S1-AP interface:

  - Extended UE-AMBR Downlink
  - Extended UE-AMBR Uplink
  - Extended E-RAB Maximum Bit Rate Downlink
  - Extended E-RAB Maximum Bit Rate Uplink
  - Extended E-RAB Guaranteed Maximum Bit Rate Downlink
  - Extended E-RAB Guaranteed Maximum Bit Rate Uplink

  NAS interface:

  - Extended EPS quality of service
  - Extended APN aggregate maximum bit rate

- **ULL QCI bearers handover from MME to Gn-SGSN Support:**

  For Ultra-Low Latency (ULL) MME is configured to map the Ultra-Low Latency values 80, 82, and 83 to Pre-Release8 QoS during handover from MME. Maximum Bit Rate (MBR) and Guaranteed Bit Rate (GBR) limits are increased to 4Tbps. MME supports outbound handover on GnGp interface to Gn-SGSN with ULL-QCI values 80, 82, and 83.

- **UE additional Security Capability:**

  MME includes “UE additional security capability” IE in MM-Context over S10 interface during handover if it is available, otherwise includes the length of UE additional security capability as zero.

  MME processes “UE additional security capability” for NR received in MM-Context over S10 interface during Handover only if it is not available. If the received length of UE additional security capability is zero, then it is not present in MM-context.

Secondary RAT Usage Reporting

When a Secondary RAT is used in conjunction with E-UTRAN, operator may wish to record the data volume sent on the Secondary RAT. The PLMN locally activates the Secondary RAT Usage Data Reporting by E-UTRAN O & M. The E-UTRAN reports uplink and downlink data volumes to the EPC for the Secondary RAT on a per EPS bearer basis and per time interval. If E-UTRAN is also configured to make periodic reports, if there is no event to trigger a report before the period expires. MME handle these reports received from eNodeB in S1-AP messages and forwards it to S-GW / P-GW via GTPV2 messages.



Important MME behavior in Routing Area Update Procedure involving “MME and S3 SGSN”, will be similar to Routing Area Update Procedure involving “MME and Gn/Gp SGSN” where secondary RAT report will be sent over Change Notification to P-GW if reporting to P-GW is enabled. And report will be sent over Delete Session Request to S-GW if MME had received the Serving GW change indication.

How It Works

Architecture

This section describes the external interfaces required to support the 5G NSA architecture.

S6a (HSS) Interface

The S6a interface supports new AVPs "Extended-Max-Requested-BW-UL" and "Extended-Max-Requested-BW-DL" in grouped AVP "AMBR" to handle the 5G throughput ranges. When the maximum bandwidth value for UL (or DL) traffic is higher than 4294967295 bits per second, the "Max-Requested-Bandwidth-UL" AVP (or DL) must be set to the upper limit 4294967295 and the "Extended-Max-Requested-BW-UL" AVP (or DL) must be set to the requested bandwidth value in kilobits per second.

S1AP (eNodeB) Interface

Extended UE-AMBR

The S1AP interface supports new IEs "Extended UE Aggregate Maximum Bit Rate Downlink" and "Extended UE Aggregate Maximum Bit Rate Uplink" in the grouped IE "UE Aggregate Maximum Bit Rate", where the units are bits/second. If the Extended UE Aggregate Maximum Bit Rate Downlink/Uplink IE is included, then the UE Aggregate Maximum Bit Rate Downlink/Uplink IE must be ignored.

Extended E-RAB MBR/GBR

The S1AP interface supports new AVPs "Extended E-RAB Maximum Bit Rate Downlink/Uplink" and "Extended E-RAB Guaranteed Bit Rate Downlink/Uplink" in the "GBR QoS Information" grouped IE, where the units are bits/second.

NAS (UE) Interface

Extended APN Aggregate Maximum Bit Rate

The new IE "Extended APN aggregate maximum bit rate" is added in all applicable NAS messages to convey the 5G throughput (beyond 65.2Gbps) over NAS. The existing IE in NAS "APN-AMBR" supports APN-AMBR values up to 65.2Gbps.

Extended EPS Quality of Service

The new IE "Extended EPS Quality of Service" is added in all applicable NAS messages to convey the 5G throughput (beyond 10Gbps) over NAS. The existing IE in NAS "EPS Quality of Service" supports MBR and GBR values up to 10Gbps.

Limitations

This section describes the known limitations for the 5G NSA feature:

- DCNR for S3 interface is supported only for inbound handover of UE from 2G/3G to 4G.
- MME does not support the NR capable gateway selection during connected mode inbound handover from Gn-SGSN.
- Maximum of 11 reports can be sent in single GTPV2 message towards S-GW.
- Reports sent without handover flag during handover procedure will be dropped by MME.
- Reports are not stored as part of session recovery.
- At any point of time only two reports per bearer will be handled by MME.
- Filling of “Secondary RAT Data Usage Request” IE in E-RAB MODIFY REQUEST message and handling of report in ERAB Modify RESPONSE is not supported.
- During 4g to 3g/2g IRAT handover without S-GW change, if PGW reporting is enabled, reports will be sent over the Change Notification message. Reports will not be sent to S-GW, even if the S-GW reporting is configured.

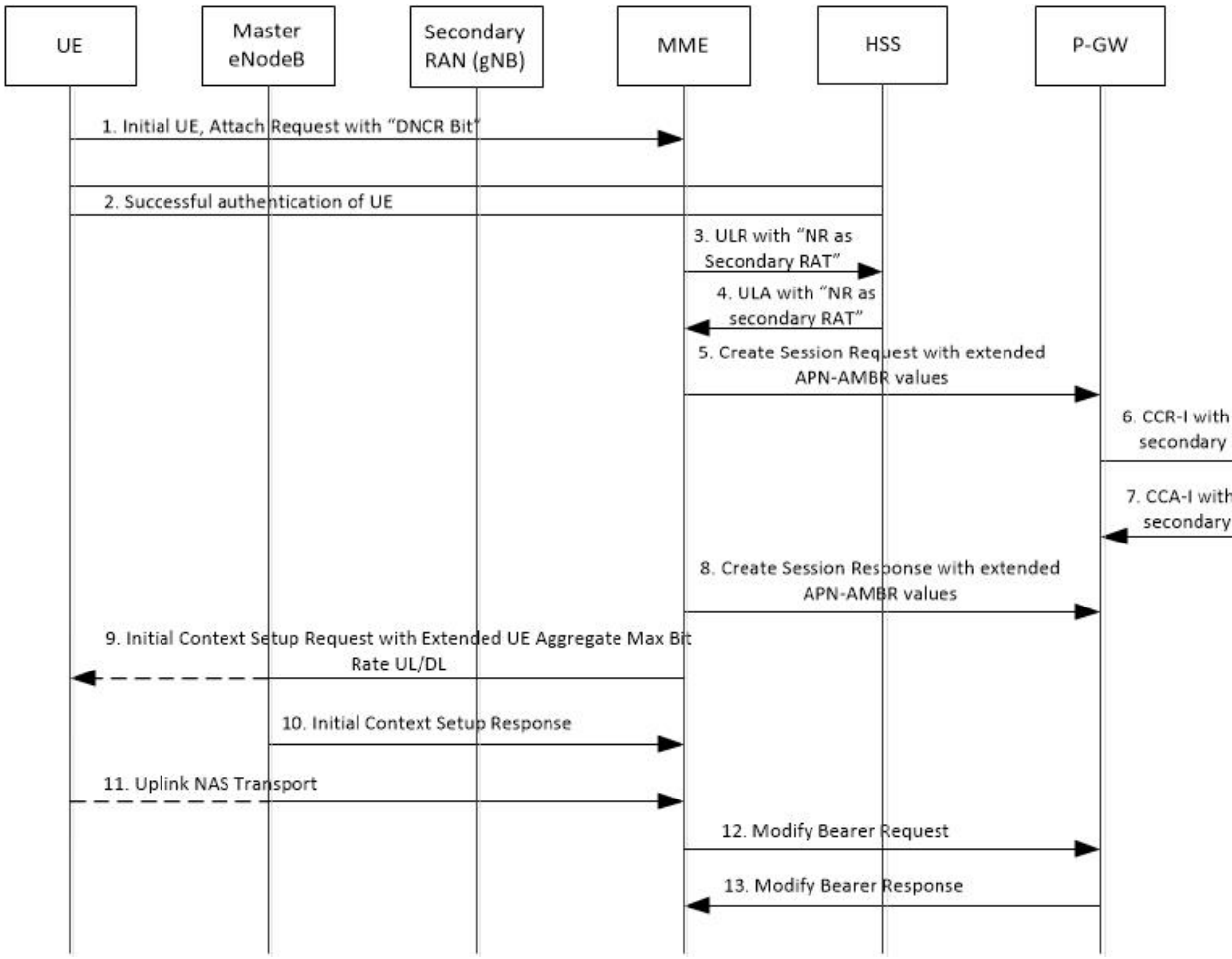
Flows

This section describes the call flow procedures related to MME for 5G NSA.

Initial Registration Procedure

The following call flow illustrates the Initial Registration procedure for DCNR capable UE.

Initial Registration of DCNR Capable UE



Step	Description
1	The DCNR capable UE sets the "DCNR bit" in NAS message "Attach Request" in "UE Network Capability" IE. DCNR must be enabled at MME service or call control profile depending upon the operator requirement.
2	MME successfully authenticates the UE.
3	As part of the authorization process, while sending ULR to HSS, MME advertises the DCNR support by sending the "NR as Secondary RAT" feature bit in "Feature-List-ID-2".

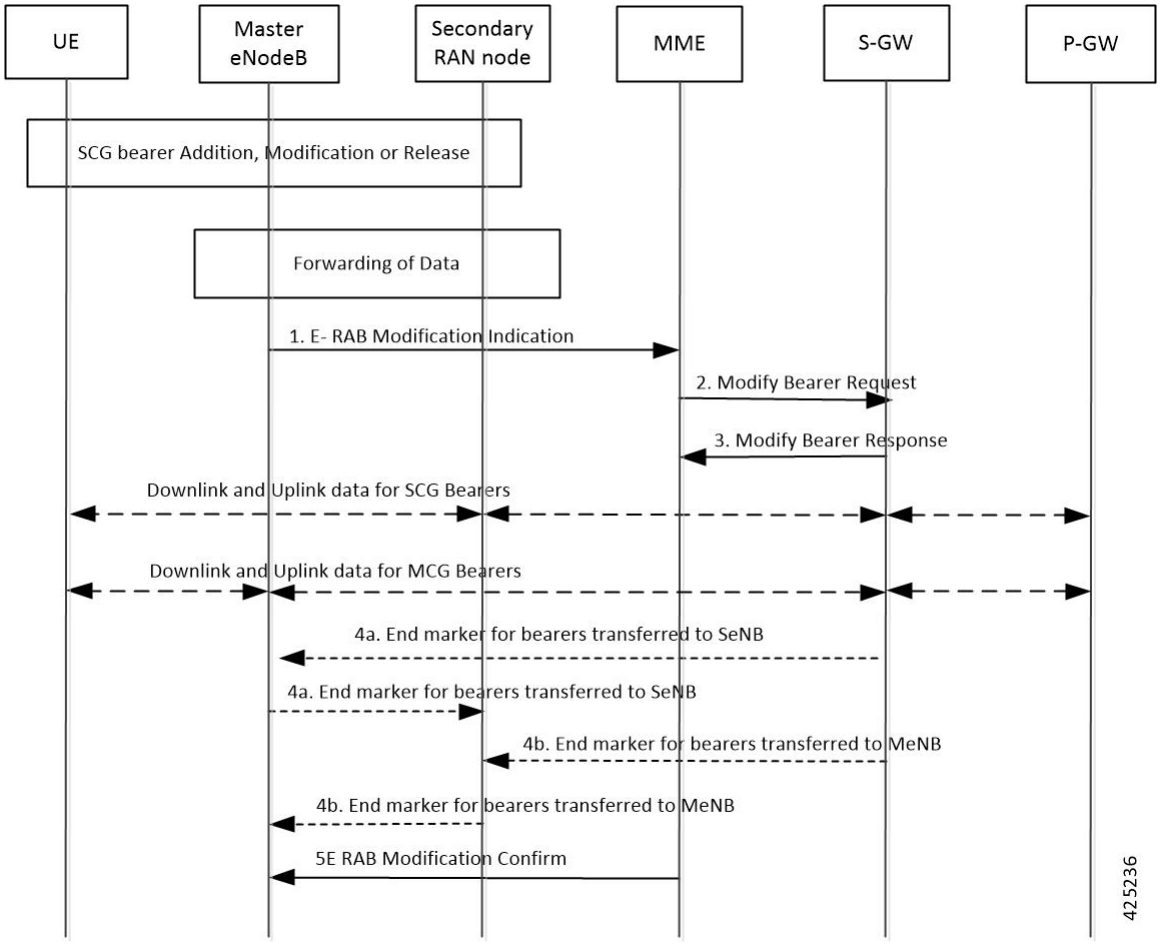
Step	Description
4	HSS sends ULA by advertising the DCNR by sending "NR as Secondary RAT" feature bit in "Feature-List-ID-2", "Max-Requested-Bandwidth-UL" as 4294967295 bps, "Max-Requested-Bandwidth-DL" as 4294967295 bps, and the extended bandwidth values in AVPs "Extended-Max-Requested-BW-UL" and "Extended-Max-Requested-BW-DL". If HSS determines that the UE is not authorized for DCNR services, then HSS sends Subscription-Data with "Access-Restriction" carrying "NR as Secondary RAT Not Allowed".
5	MME sends the Create Session Request message with the extended APN-AMBR values in existing AMBR IE. As the APN-AMBR values in GTPv2 interface are encoded in kbps, the existing AMBR IE handles the 5G NSA bit rates.
6	P-GW sends CCR-I to PCRF advertising the DCNR by sending "Extended-BW-NR" feature bit in "Feature-List-ID-2", "APN-Aggregate-Max-Bitrate-UL" as 4294967295 bps, "APN-Aggregate-Max-Bitrate-DL" as 4294967295 bps, and the extended bandwidth values in AVPs "Extended-APN-AMBR-UL" and "Extended-APN-AMBR-DL".
7	PCRF sends CCA-I advertising the DCNR by sending "Extended-BW-NR" feature bit in "Feature-List-ID-2", "APN-Aggregate-Max-Bitrate-UL" as 4294967295 bps, "APN-Aggregate-Max-Bitrate-DL" as 4294967295 bps, and the extended bandwidth values in AVPs "Extended-APN-AMBR-UL" and "Extended-APN-AMBR-DL". PCRF can offer the same extended APN-AMBR values that are requested by PCRF or modify the extended APN-AMBR values. P-GW enforces the APN-AMBR values accordingly.
8	P-GW honors the APN-AMBR values as offered by PCRF and sends the extended APN-AMBR values in existing APN-AMBR IE in the Create Session Response message.

Step	Description
9	MME computes the UE-AMBR values and sends the extended UE-AMBR values in new IEs "Extended UE Aggregate Maximum Bit Rate Downlink" and "Extended UE Aggregate Maximum Bit Rate Uplink" by setting the legacy "UE AMBR Uplink" and "UE AMBR Downlink" values to the maximum allowed value 10000000000 bps (10 Gbps) in the "Initial Context Setup Request" message. MME sends the APN-AMBR values up to 65.2 Gbps in existing APN-AMBR IE in NAS Activate Default EPS Bearer Context Request – Attach Accept. If the APN-AMBR values are beyond 65.2 Gbps, MME sends the extended APN-AMBR values in "Extended APN Aggregate Maximum Bit Rate" IE. If ULA is received with "Access-Restriction" carrying "NR as Secondary RAT Not Allowed", MME sends the Initial Context Setup Request message with "NR Restriction" bit set in Handover Restriction List IE. MME sets the RestrictDCNR bit to "Use of dual connectivity with NR is restricted" in the EPS network feature support IE of the Attach Accept message. UE provides the indication that dual connectivity with NR is restricted to the upper layers accordingly. If the DCNR feature is not configured at MME service or call control profile, then MME sets the RestrictDCNR bit to "Use of dual connectivity with NR is restricted" in the EPS network feature support IE of the Attach Accept message. UE provides the indication that dual connectivity with NR is restricted to the upper layers accordingly.
10	eNodeB sends the Initial Context Setup Response message. If master eNodeB determines to establish the bearer on secondary eNodeB, F-TEID of the secondary eNodeB may be sent (transport layer address and TEID of secondary eNodeB). It is transparent to MME if the bearer is established on master eNodeB or secondary eNodeB.
11	eNodeB sends Uplink NAS Transport with NAS message "Complete - Activate Default EPS Bearer Context Accept".
12	MME sends the Modify Bearer Request message to S-GW with S1-U F-TEID details as received in the Initial Context Setup Response message.
13	MME receives the Modify Bearer Response message from S-GW.

E-RAB Modification Procedure

When Secondary Cell Group (SCG) bearer option is applied to support DCNR, the E-RAB Modification procedure is used to transfer bearer contexts to and from secondary eNodeB or secondary gNodeB.

Figure 1: E-RAB Modification Procedure by Master eNodeB



Step	Description
1	The master eNodeB (MeNB) sends an E-RAB Modification Indication message (eNodeB address(es) and TEIDs for downlink user plane for all the EPS bearers) to the MME. The MeNB indicates if each bearer is modified or not. The "E-RAB to be Modified List" IE contains both "E-RAB to Be Modified Item" and "E-RAB not to Be Modified Item" IEs. For the bearer that need to be switched to secondary eNodeB/gNodeB (SeNB), the "E-RAB to Be Modified Item" IE contains the transport layer address of gNodeB and TEID of gNodeB.
2	The MME sends a Modify Bearer Request message (eNodeB address(es) and TEIDs for downlink user plane for all the EPS bearers) per PDN connection to the S-GW, only for the affected PDN connections.
3	The S-GW returns a Modify Bearer Response message (S-GW address and TEID for uplink traffic) to the MME as a response to the Modify Bearer Request message.
4	For the bearers transferred to SeNB, S-GW sends one or more end marker packets on the old path (to MeNB) immediately after switching the path.

Step	Description
5	The MME confirms E-RAB modification with the E-RAB Modification Confirm message. The MME indicates if each bearer was successfully modified, retained, unmodified or already released by the EPC.

Standards Compliance

Cisco's implementation of the 5G NSA feature complies with the following standards:

- 3GPP 23.003 Release 15.2.0 - Numbering, addressing and identification.
- 3GPP 23.401 Release 15.2.0 - General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access
- 3GPP 29.272 Release 15.2.0 - Evolved Packet System (EPS); Mobility Management Entity (MME) and Serving GPRS Support Node (SGSN) related interfaces based on Diameter protocol
- 3GPP 29.274 Release 15.2.0 - 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3
- 3GPP 29.303 Release 15.2.0 - Domain Name System Procedures

Cisco's implementation of the Secondary RAT Usage Reporting complies with the following standards:

- 3GPP 29.274: 15.5.0 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunneling Protocol for Control plane (GTPv2-C) Stage 3
- 3GPP 36.413: 15.3.0 Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)
- 3GPP 23.401: 15.5.0 General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access

Configuring 5G NSA for MME

This section describes how to configure 5G NSA to support MME.

Configuring 5G NSA on MME involves:

- Enabling DCNR in MME Service, on page 11
- Enabling DCNR in Call Control Profile, on page 12
- Configuring APN AMBR Values, on page 12
- Configuring Dedicated Bearer MBR Values, on page 15
- Configuring UE AMBR Values , on page 16

Enabling DCNR in MME Service

Use the following configuration to enable DCNR to support 5G NSA.

```
configure
   context context_name
      mme-service service_name
         [ no ] dcnr
         end
```

NOTES:

- **mme-service** *service_name*: Creates an MME service or configures an existing MME service in the current context. *service_name* specifies the name of the MME service, name must be an string from 1 to 63 characters.
- **no**: Disables the DCNR configuration.
- The **dcnr** CLI command is disabled by default.

Enabling DCNR in Call Control Profile

Use the following configuration to enable Dual Connectivity with New Radio (DCNR) to support 5G Non Standalone (NSA).

```
configure
   call-control-profile profile_name
      [ no | remove ] dcnr
      end
```

NOTES:

- **call-control-profile** *profile_name*: Creates an instance of a call control profile. *profile_name* specifies the name of the call control profile, it must be an string from 1 to 64 characters.
- **no**: Disables the DCNR configuration in the call control profile.
- **remove**: Removes the DCNR configuration from the call control profile.
- The **dcnr** CLI command is disabled by default.

Configuring APN AMBR Values

Use the following configuration to configure the APN aggregate maximum bit rate (AMBR) that will be stored in the Home Subscriber Server (HSS).

```
configure
   apn-profile profile_name
      qos apn-ambr max-ul mbr_up max-dl mbr_down
      remove qos apn-ambr
      end
```

NOTES:

- **apn-profile** *profile_name*: Creates an instance of an access point name (APN) profile. *profile_name* specifies the name of the APN profile as an alphanumeric string of 1 to 64 characters.
- **qos**: Configures the quality of service (QoS) parameters to be applied.
- **apn-ambr**: Configures the aggregate maximum bit rate (AMBR) for the APN.

- **max-ul** *mbr_up*: Defines the maximum bit rates for uplink traffic. *mbr_up* must be an integer from 1 to 4000000000000 (4 Tbps).
- **max-dl** *mbr_down*: Defines the maximum bit rates for downlink traffic. *mbr_up* must be an integer from 1 to 4000000000000 (4 Tbps).
- **remove**: Removes the APN AMBR changes from the configuration for this APN profile.

Enabling Secondary RAT Data Usage Report in Call Control Profile

Use the following configuration to enable Secondary RAT Data Usage Report to support 5G NSA.

```
configure
     call-control-profile profile_name
        secondary-rat data-usage-report { pgw [ sgw ] | sgw [ pgw ] }
        [ no | remove ] secondary-rat data-usage-report
        end
```



Important Both CLI configuration and the current running procedure are taken into account while filling the flags IRSGW/IRPGW in GTPv2 messages towards S-GW/P-GW.

NOTES:

- **no**: Disables the Secondary RAT Usage Report at call-control-profile.
- **remove**: Removes the Secondary-RAT Usage Report configuration from call-control-profile. It fallbacks to MME service-level configuration.
- **secondary-rat data-usage-report { pgw [sgw] | sgw [pgw] }** MME sets IR-SGW and IR-PGW flags based on the available options configured for Secondary-RAT data usage report. By default, MME disables the Secondary-RAT data usage reporting towards both SGW and PGW. If the configuration is removed from call-control-profile, then it fall-back to MME-SERVICE level configuration for Secondary-RAT-Data-Usage-Report functionality.
  - **secondary-rat data-usage-report sgw** Disables the Secondary-RAT Usage Report option for P-GW and enables only for S-GW.
  - **secondary-rat data-usage-report pgw** Disables the Secondary-RAT Usage Report option for SGW and enables only for PGW.
  - **secondary-rat data-usage-report sgw pgw** Enables Secondary-RAT Usage Report option for both SGW and PGW.
  - **secondary-rat data-usage-report pgw sgw** Enables Secondary-RAT Usage Report option for both SGW and PGW.

Enabling Secondary RAT Data Usage Report in MME Service

Use the following configuration to enable Secondary RAT Data Usage Report to support 5G NSA.

```
configure
  context context_name
    mme-service service_name
      secondary-rat data-usage-report { pgw [ sgw ] | sgw [ pgw ] }
      no secondary-rat data-usage-report
      end
```



Important Both CLI configuration and the current running procedure are taken into account while filling the flags IRSGW/IRPGW in GTPv2 messages towards S-GW/P-GW.

NOTES:

- **no**: Disables the Secondary RAT Usage Report at mme-service.
- **secondary-rat data-usage-report { pgw [sgw] | sgw [pgw] }** MME sets IR-SGW and IR-PGW flags based on the available options configured for Secondary-RAT data usage report. By default, MME disables the Secondary-RAT data usage reporting towards both SGW and PGW. If the configuration is removed from call-control-profile, then it fall-back to MME-SERVICE level configuration for Secondary-RAT-Data-Usage-Report functionality.
  - **secondary-rat data-usage-report sgw**: Disables the Secondary-RAT Usage Report option for P-GW and enables only for S-GW.
  - **secondary-rat data-usage-report pgw** : Disables the Secondary-RAT Usage Report option for S-GW and enables only for P-GW.
  - **secondary-rat data-usage-report sgw pgw**: Enables Secondary-RAT Usage Report option for both S-GW and P-GW.
  - **secondary-rat data-usage-report pgw sgw**: Enables Secondary-RAT Usage Report option for both S-GW and P-GW.

Configuring Pre-Release 8 QoS Mapping QCI

Use the following configuration to configure mapping of EPC QOS (non-standard QCIs) to 3GPP Pre-Release 8 QOS.

```
configure
  bearer-control-profile profile_name
    pre-rel8-qos-mapping qci qci_val
    remove pre-rel8-qos-mapping qci
    end
```

NOTES:

- **bearer-control-profile** *profile_name*: Creates an instance of a bearer control profile. *profile_name* specifies the name of the bearer control profile as an alphanumeric string of 1 to 64 characters.
- **remove**: Removes the DCNR configuration from the call control profile.
- **qci** *qci_val*: Specifies the QoS Class Identifier. *qci_val* must be an integer between 1 to 9, 65, 66, 69, 70, 80, 82, and 83.

Configuring Dedicated Bearer MBR Values

Use the following configuration to configure the quality of service maximum bit rate (MBR) values for the dedicated bearer.

```
configure
  apn-profile apn_profile_name
    qos dedicated-bearer mbr max-ul mbr_up max-dl mbr_down
    remove qos dedicated-bearer
    end
```

NOTES:

- **apn-profile** *apn_profile*: Creates an instance of an Access Point Name (APN) profile. *apn_profile_name* specifies the name of the APN profile as an alphanumeric string of 1 to 64 characters.
- **qos**: Configures the quality of service (QoS) parameters to be applied.
- **dedicated-bearer mbr**: Configures the maximum bit rate (MBR) for the dedicated bearer.
- **max-ul** *mbr_up*: Defines the maximum bit rate for uplink traffic. *mbr_up* must be an integer from 1 to 4000000000000 (4 Tbps).
- **max-dl** *mbr_down*: Defines the maximum bit rate for downlink traffic. *mbr_down* must be an integer from 1 to 4000000000000 (4 Tbps).
- **remove**: Deletes the dedicated bearer MBR changes from the configuration for this APN profile.

Configuring Dedicated Bearer MBR Values

Use the following configuration to configure the quality of service maximum bit rate (MBR) values for the dedicated bearer.

```
configure
  bearer-control-profile profile_name
    dedicated-bearer { mbr mbr-up mbr_up mbr-down mbr_down | gbr gbr-up gbr_up
 gbr-down gbr_down
    remove dedicated-bearer { gbr | mbr }
    end
```

NOTES:

- **bearer-control-profile** *profile_name*: Creates an instance of a bearer control profile. *profile_name* specifies the name of the bearer control profile as an string from 1 to 64 characters.
- **dedicated-bearer mbr**: Configures the maximum bit rate (MBR) for the dedicated bearer.
- **gbr-up** *gbr_up*: Defines the guaranteed bit rate for uplink traffic. *gbr_up* must be an integer from 1 to 4000000000000 (4 Tbps).
- **gbr-down** *gbr_down*: Defines the guaranteed bit rate for downlink traffic. *gbr_down* must be an integer from 1 to 4000000000000 (4 Tbps).
- **mbr-up** *mbr_up*: Defines the maximum bit rate for uplink traffic. *mbr_up* must be an integer from 1 to 4000000000000 (4 Tbps).

- **mbr-down** *mbr_down*: Defines the maximum bit rate for downlink traffic. *mbr_down* must be an integer from 1 to 4000000000000 (4 Tbps).
- **remove**: Deletes the dedicated bearer MBR changes from the configuration for this bearer control profile.

Configuring UE AMBR Values

Use the following configuration to configure the values for aggregate maximum bit rate stored on the UE (UE AMBR).

```
configure
  call-control-profile profile_name
    qos ue-ambr { max-ul mbr_up max-dl mbr_down }
    remove qos ue-ambr
    end
```

NOTES:

- **call-control-profile** *profile_name*: Creates an instance of a call control profile. *profile_name* specifies the name of a call control profile entered as an alphanumeric string of 1 to 64 characters.
- **qos**: Configures the quality of service (QoS) parameters to be applied.
- **ue-ambr**: Configures the aggregate maximum bit rate stored on the UE (UE AMBR).
- **max-ul** *mbr_up*: Defines the maximum bit rate for uplink traffic. *mbr_up* must be an integer from 1 to 4000000000000 (4 Tbps).
- **max-dl** *mbr_down*: Defines the maximum bit rate for uplink traffic. *mbr_down* must be an integer from 1 to 4000000000000 (4 Tbps).
- **remove**: Deletes the configuration from the call control profile.

Monitoring and Troubleshooting

This section provides information regarding show commands and bulk statistics available to monitor and troubleshoot the 5G NSA feature.

Show Commands and Outputs

show mme-service db record imsi

The output of this command includes the following fields:

ARD:

- Dual-Connectivity-NR-not-allowed — Displays True or False to identify if the ARD received from HSS indicates the DCNR feature is allowed for the given IMSI or not.

show mme-service name <mme_svc_name>

The output of this command includes the "DCNR" field to indicate if the DCNR feature is enabled or disabled at MME service.

show mme-service session full all

The output of this command includes the following fields:

UE DC-NR Information:

- DC-NR capable UE — Indicates whether the UE is DCNR capable.
- DC-NR operation allowed — Indicates whether the DCNR operation is allowed by MME for the DCNR capable UE.

show mme-service statistics

- Dual Connectivity with NR Statistics:

  Attach Procedure

  - Attach Request Rcvd — The number of Attach Request messages received with UE advertising DCNR support.
  - Attach Acc DCNR allowed — The number of Attach Accept messages sent by the MME acknowledging the DCNR support for UE (Restrict DCNR bit not set in Attach Accept).
  - Attach Acc DCNR denied — The number of Attach Accepts sent by MME rejecting the DCNR support for the UE (Restrict DCNR bit set in Attach Accept).
  - Attach Reject Sent — The number of Attach Reject messages sent by MME whose corresponding Attach Request messages have DCNR support capability.
  - Attach Complete Rcvd — The number of Attach Complete messages received by MME whose corresponding Attach Request messages have DCNR support capability.

  Intra-MME TAU Procedure

  - TAU Request Rcvd — The number of TAU Request messages received for Intra-MME TAU procedure with UE advertising DCNR support.
  - TAU Accept DCNR allowed — The number of TAU Accept messages sent by the MME acknowledging the DCNR support for UE (Restrict DCNR bit not set in TAU Accept) for Intra-MME TAU procedure.
  - TAU Accept DCNR denied — The number of TAU Accept messages sent by the MME rejecting the DCNR support for UE (Restrict DCNR bit set in TAU Accept) for Intra-MME TAU procedure.
  - TAU Complete Rcvd — The number of TAU Complete messages received by the MME whose corresponding Intra-MME TAU Requests have DCNR support capability.

  Inter-MME TAU Procedure

  - TAU Request Rcvd — The number of TAU Request messages received for Inter-MME TAU procedure with UE advertising DCNR support.

- TAU Accept DCNR allowed — The number of TAU Accept messages sent by the MME acknowledging the DCNR support for UE (Restrict DCNR bit not set in TAU Accept) for Inter-MME TAU procedure.
- TAU Accept DCNR denied — The number of TAU Accept messages sent by the MME rejecting the DCNR support for UE (Restrict DCNR bit set in TAU Accept) for Inter-MME TAU procedure.
- TAU Reject Sent — The number of TAU Reject messages sent by the MME whose corresponding Inter-MME TAU Requests have DCNR support capability.
- TAU Complete Rcvd — The number of TAU Complete messages received by the MME whose corresponding Inter-MME TAU Requests have DCNR support capability.

Dual Connectivity with NR Subscribers

- Attached Calls — The number of DCNR supported UEs attached with the MME.
- Connected Calls — The number of DCNR supported UEs in connected mode at the MME.
- Idle Calls — The number of DCNR supported UEs in idle mode at the MME.

Node Selection:

SGW DNS:

- Common — The number of times S-GW DNS selection procedures are performed with DNS RR excluding the NR network capability.
- NR Capable — The number of times S-GW DNS selection procedures are performed with DNS RR including the NR network capability.

SGW Local Config

- Common — The number of times S-GW selection procedures are performed with locally configured S-GW address, without considering the NR network capability.

PGW DNS:

- Common — The number of times P-GW DNS selection procedures are performed with DNS RR excluding the NR network capability.
- NR Capable — The number of times P-GW DNS selection procedures are performed with DNS RR including the NR network capability.

PGW Local Config:

- Common — The number of times P-GW selection procedures are performed with locally configured P-GW address, without considering the NR network capability.

Important When UE is defined with "UE usage type" and "NR Capable", S-GW/P-GW via DNS is selected in the following order:

1. MME chooses S-GW/P-GW that support both +ue and +nr services.
2. If step 1 fails, MME selects S-GW/P-GW that supports +nr service only.
3. If step 2 fails, MME selects S-GW/P-GW that supports +ue service only.
4. If step 3 fails, MME selects S-GW/P-GW without +nr or +ue service.

- Handover Statistics:
  - Bearer Statistics
    - ERAB Modification Indication
      - Attempted — The number of bearers for which the E-RAB Modification Indication procedure is attempted (bearer level stats).
      - Success — The number of bearers for which the E-RAB Modification Indication procedure has succeeded (bearer level stats).
      - Failures — The number of bearers for which the E-RAB Modification Indication procedure has failed (bearer level stats).

- ESM Statistics:

  DCNR User PDN Connections:
  - Attempted — The total number of attempts made for DCNR user PDN connections associated with all MME services on the system.
  - Success — The total number of successful attempts for DCNR user PDN connections associated with all MME services on the system.
  - Failures — The total number of attempts failed for DCNR user PDN connections associated with all MME services on the system.

- DCNR User PDN Statistics:
  - All PDNs — Displays statistics for all DCNR user PDNs, connected and idle, through the MME service(s) on the system.
  - Connected PDNs — Displays statistics for connected DCNR user PDNs through the MME service(s) on the system.
  - Idle PDNs — Displays statistics for idle DCNR user PDNs through the MME service(s) on the system.

- Paging Initiation for PS QCI-80, QCI 82, and QCI 83 Events:
  - Attempted — The total number of ECM statistics related to PS paging initiation events attempted for QCI 80, QCI 82, and QCI 83.

- Success — The total number of ECM statistics related to PS paging initiation events successful for QCI 80, QCI 82, and QCI 83.
- Failures — The total number of ECM statistics related to PS paging initiation events failed for QCI 80, QCI 82, and QCI 83.
  - Success at Last n eNB — The total number of ECM statistics related to PS paging initiation events succeeded at the last known eNodeB for QCI 80, QCI 82, and QCI 83.
  - Success at Last TAI — The total number of ECM statistics related to PS paging initiation events succeeded at the eNodeB in the TAI from which the UE was last heard for QCI 80, QCI 82, and QCI 83.
  - Success at TAI List — The total number of ECM statistics related PS paging initiation events succeeded at the eNodeB in all TAIs present in the TAI list assigned to the UE for QCI 80, QCI 82, and QCI 83.

show mme-service statistics dcnr

The output of this command includes the following fields:

Secondary RAT Usage Reports Rx Count

- UE Ctxt Release Req — Indicates the number of secondary RAT data usage reports received in UE context release request message.
- UE Ctxt Release Cmpl — Indicates the number of secondary RAT data usage reports received in UE context release complete message .
- E-RAB Mod Ind — Indicates the number of secondary RAT data usage reports received in eRAB Modification Indication message.
- E-RAB Release Ind — Indicates the number of secondary RAT data usage reports received in eRAB Release Indication message.
- E-RAB Release Resp — Indicates the number of secondary RAT data usage reports received in eRAB Release Response message.
- Secondary RAT Data Usage Report[Periodic] — Indicates the number of secondary RAT data usage reports received in Secondary RAT Data Usage Report message without Handover flag.
- Seccondary RAT Data Usage Report[Handover] — Indicates the number of secondary RAT data usage reports received in Secondary RAT Data Usage Report message with Handover flag.
- S10 Fwd Reloc Cmpl Ack — Indicates the number of secondary RAT data usage reports received in Forward Reloc Complete Ack message from MME to MME.
- Dropped Periodic Report[HO in progress] — Indicates the number of secondary RAT data usage reports dropped when Secondary RAT Data Usage Report message was received without Handover flag during Handover.

Secondary RAT Usage Reports Tx Count:

- Create Session Req — Indicates the number of secondary RAT data usage reports sent in Create Session Request .

- Delete Session Req — Indicates the number of secondary RAT data usage reports sent in Delete Session Request.
- Delete Bearer Rsp — Indicates the number of secondary RAT data usage reports sent in Delete Bearer Response .
- Release Access Brr Req — Indicates the number of secondary RAT data usage reports sent in Release Access Bearer Request.
- Delete Bearer Cmd —Indicates the number of secondary RAT data usage reports sent in Delete Bearer Command.
- Modify Bearer Req — Indicates the number of secondary RAT data usage reports sent in Modify Bearer Request.
- Change Notification — Indicates the number of secondary RAT data usage reports sent in Change Notification.
- S10 Fwd Reloc Cmpl Ack — Indicates the number of secondary RAT data usage reports sent in Forward Reloc Complete Ack.

show mme-service statistics s1ap

The output of this command includes the following fields:

S1AP Statistics:

Transmitted S1AP Data:

- E-RAB Modification Cfm — Indicates the number of E-RAB Modification Confirm messages sent by MME upon successful E-RAB modification procedure.

Received S1AP Data

- E-RAB Mod Ind — Indicates the number of E-RAB Modification Indication messages received from the master eNodeB.

Received S1AP Data:

- Secondary RAT Data Usage Report — Indicates the number of Secondary RAT Data Usage Report messages received from eNodeB.

show subscribers mme-service

The output of this command includes the "DCNR Devices" field to indicate the number of DCNR devices that are attached to the MME.

show call-control-profile full all

The output of this command includes the following fields:

- DCNR
- Secondary RAT Usage Report

show mme-service all

The output of this command includes the following fields:

- DCNR
- Secondary RAT Usage Report

Bulk Statistics

This section provides information on the bulk statistics for the 5G NSA feature on MME.

MME Schema

The following 5G NSA feature related bulk statistics are available in the MME schema.

Bulk Statistics	Description
attached-dcnr-subscriber	The current total number of attached subscribers capable of operating in DCNR.
connected-dcnr-subscriber	The current total number of subscribers capable of operating in DCNR and in connected state.
idle-dcnr-subscriber	The current total number of subscribers capable of operating in DCNR and in idle state.
dcnr-attach-req	The total number of Attach Request messages that are received with DCNR supported.
dcnr-attach-acc-allowed	The total number of Attach Accept messages that are sent with DCNR allowed.
dcnr-attach-acc-denied	The total number of Attach Accept messages that are sent with DCNR denied.
dcnr-attach-rej	The total number of DCNR requested Attach Rejected messages.
dcnr-attach-comp	The total number of Attach Complete messages that are received for DCNR supported attaches.
dcnr-intra-tau-req	The total number of Intra-TAU Request messages that are received with DCNR supported.
dcnr-intra-tau-acc-allowed	The total number of Intra-TAU Accept messages that are sent with DCNR allowed.
dcnr-intra-tau-acc-denied	The total number of Intra-TAU Accept messages that are sent with DCNR denied.
dcnr-intra-tau-comp	The total number of Intra-TAU Complete messages that are received for DCNR supported requests.

Bulk Statistics	Description
dcnr-inter-tau-req	The total number of Inter-TAU Request messages that are received with DCNR supported.
dcnr-inter-tau-acc-allowed	The total number of Inter-TAU Accept messages that are sent with DCNR allowed.
dcnr-inter-tau-acc-denied	The total number of Inter-TAU Accept messages that are sent with DCNR denied.
dcnr-inter-tau-rej	The total number of DCNR requested Inter-TAU Request messages that are rejected.
dcnr-inter-tau-comp	The total number of Inter-TAU Complete messages that are received for DCNR supported requests.
s1ap-recdata-eRabModInd	The total number of S1 Application Protocol - E-RAB Modification Indication messages received from all eNodeBs.
s1ap-transdata-eRabModCfm	The total number of E-RAB Modification Confirmation messages sent by the MME to the eNodeB.
erab-modification-indication-attempted	The total number of bearers for which E-RAB Modification Indication messages were sent.
erab-modification-indication-success	The total number of bearers for which E-RAB Modification Indication messages were sent.
erab-modification-indication-failures	The total number of bearers for which E-RAB Modification Indication failed as shown in E-RAB Modification Indication Confirm message.
emmevent-path-update-attempt	The total number of EPS Mobility Management events - Path Update attempted.
emmevent-path-update-success	The total number of EPS Mobility Management events - Path Update successes.
emmevent-path-update-failure	The total number of EPS Mobility Management events - Path Update failures.
dcnr-dns-sgw-selection-common	The total number of times S-GW DNS selection procedures are performed with DNS RR excluding NR network capability.
dcnr-dns-sgw-selection-nr	The total number of times S-GW DNS selection procedures were performed with DNS RR including NR network capability.

Bulk Statistics	Description
dcnr-dns-sgw-selection-local	The total number of times S-GW selection procedures were performed with locally configured S-GW address, without considering the NR network capability.
dcnr-dns-pgw-selection-common	The total number of times P-GW DNS selection procedures were performed with DNS RR excluding NR network capability.
dcnr-dns-pgw-selection-nr	The total number of times P-GW DNS selection procedures were performed with DNS RR including NR network capability.
dcnr-dns-pgw-selection-local	The total number of times P-GW selection procedures were performed with locally configured P-GW address, without considering the NR network capability.
esmevent-dcnr-user-pdncon-attempt	The total number of EPS Session Management events - DCNR User PDN connections - attempted.
esmevent-dcnr-user-pdncon-success	The total number of EPS Session Management events - DCNR User PDN connections - successes.
esmevent-dcnr-user-pdncon-failure	The total number of EPS Session Management events - DCNR User PDN connections - failures.
pdn-dcnr-user-all	The current total number of DCNR user PDN connections in any state.
pdn-dcnr-user-connected	The current total number of DCNR user connected PDNs.
pdn-dcnr-user-idle	The current total number of DCNR user idle PDNs.
ps-qci-80-paging-init-events-attempted	The total number of ECM statistics related to PS paging initiation events attempted for QCI 80.
ps-qci-80-paging-init-events-success	The total number of ECM statistics related to PS paging initiation events successful for QCI 80.
ps-qci-80-paging-init-events-failures	The total number of ECM statistics related to PS paging initiation events failed for QCI 80.
ps-qci-80-paging-last-enb-success	The total number of ECM statistics related to PS paging initiation events succeeded at the last known eNodeB for QCI 80.
ps-qci-80-paging-last-tai-success	The total number of ECM statistics related to PS paging initiation events succeeded at an eNodeB in the TAI from which the UE was last heard for QCI 80.

Bulk Statistics	Description
ps-qci-80-paging-tai-list-success	The total number of ECM statistics related to PS paging initiation events succeeded at an eNodeB in all TAIs present in the TAI list assigned to the UE for QCI 80.
ps-qci-82-paging-init-events-attempted	The total number of ECM statistics related to PS paging initiation events attempted for QCI 82.
ps-qci-82-paging-init-events-success	The total number of ECM statistics related to PS paging initiation events successful for QCI 82.
ps-qci-82-paging-init-events-failures	The total number of ECM statistics related to PS paging initiation events failed for QCI 82.
ps-qci-82-paging-last-enb-success	The total number of ECM statistics related to PS paging initiation events succeeded at the last known eNodeB for QCI 82.
ps-qci-82-paging-last-tai-success	The total number of ECM statistics related to PS paging initiation events succeeded at an eNodeB in the TAI from which the UE was last heard for QCI 82.
ps-qci-82-paging-tai-list-success	The total number of ECM statistics related to PS paging initiation events succeeded at an eNodeB in all TAIs present in the TAI list assigned to the UE for QCI 82.
ps-qci-83-paging-init-events-attempted	The total number of ECM statistics related to PS paging initiation events attempted for QCI 83.
ps-qci-83-paging-init-events-success	The total number of ECM statistics related to PS paging initiation events successful for QCI 83.
ps-qci-83-paging-init-events-failures	The total number of ECM statistics related to PS paging initiation events failed for QCI 83.
ps-qci-83-paging-last-enb-success	The total number of ECM statistics related to PS paging initiation events succeeded at the last known eNodeB for QCI 83.
ps-qci-83-paging-last-tai-success	The total number of ECM statistics related to PS paging initiation events succeeded at an eNodeB in the TAI from which the UE was last heard for QCI 83.
ps-qci-83-paging-tai-list-success	The total number of ECM statistics related to PS paging initiation events succeeded at an eNodeB in all TAIs present in the TAI list assigned to the UE for QCI 83.

Bulk Statistics	Description
s1ap-recdata-secratdatausagerep	Total number of Secondary RAT Data Usage Report messages received by MME.
dcnr-s1ap-rx-srur-uectxtrelreq	Total number of reports received in UE Context Release Request.
dcnr-s1ap-rx-srur-uectxtrelcmpl	Total number of reports received in UE Context Release Complete.
dcnr-s1ap-rx-srur-erabmodind	Total number of reports received in eRAB Modification Indication.
dcnr-s1ap-rx-srur-erabrelind	Total number of reports received in eRAB Release Indication.
dcnr-s1ap-rx-srur-erabrelres	Total number of reports received in eRAB Release Response.
dcnr-s10-rx-srur-fwdrelcmpack	Total number of reports received in Forward Relocation Complete Ack.
dcnr-s11-tx-srur-csreq	Total number of reports sent in Create Session Request.
dcnr-s11-tx-srur-dsreq	Total number of reports sent in Delete Session Request.
dcnr-s11-tx-srur-dbrsp	Total number of reports sent in Delete Bearer Response.
dcnr-s11-tx-srur-rabreq	Total number of reports sent in Release Access bearer Request.
dcnr-s11-tx-srur-dbcmd	Total number of reports sent in Delete Bearer Command.
dcnr-s11-tx-srur-mbreq	Total number of reports sent in Modify Bearer Request.
dcnr-s11-tx-srur-chngnot	Total number of reports sent in Change Notification.
dcnr-s10-tx-srur-fwdrelcmpack	Total number of reports sent in Forward Relocation Complete Ack.
dcnr-s1ap-rx-srur-periodicdropped	Total number of reports dropped when Secondary RAT Data Usage Report message was received without Handover flag during Handover.
dcnr-s1ap-rx-srdur-periodic	Total number of reports received in Secondary RAT Data Usage Report message without Handover flag.
dcnr-s1ap-rx-srdur-ho	Total number of reports received in Secondary RAT Data Usage Report message with Handover flag.

TAI Schema

The following 5G NSA feature related bulk statistics are available in the TAI schema.

Bulk Statistics	Description
tai-esmevent-dcnr-user-pdncon-attempt	The total number of DCNR User PDN connection EPS Session Management events attempted per TAI.
tai-esmevent-dcnr-user-pdncon-success	The total number of successful DCNR User PDN connection EPS Session Management events per TAI.
tai-esmevent-dcnr-user-pdncon-failure	The total number of failed DCNR User PDN connection EPS Session Management events per TAI.