



## 5G NSA for SGSN

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## Feature Summary and Revision History

### Summary Data

|  |   |
|--|---|
| Applicable Product(s) or Functional Area | SGSN  |
| Applicable Platform(s)                   | ASR 5000  |
| Feature Default                          | Disabled - Configuration Required   |
| Related Changes in This Release          | Not applicable  |
| Related Documentation                    | <ul style="list-style-type: none"><li>• <i>5G Non Standalone Solution Guide</i></li><li>• <i>AAA Interface Administration and Reference</i></li><li>• <i>Command Line Interface Reference</i></li><li>• <i>SGSN Administration Guide</i></li><li>• <i>Statistics and Counters Reference</i></li></ul> |

### Revision History

| Revision Details  | Release |
|-------------------|---------|
| First introduced. | 21.5    |

# Feature Description

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

- **Dual Connectivity with New Radio (DCNR):**

The UE supporting dual connectivity with New Radio (NR) sets the DCNR bit to "dual connectivity with NR supported" in the MS network capability IE of the "Attach Request" or "Routing Area Update Request" message.

If the MS supports dual connectivity of E-UTRA with New Radio (NR), then the MS sets the Dual connectivity of E-UTRA with NR capability bit to "Mobile station supports dual connectivity of E-UTRA with NR" in the MS network capability IE of the "Attach Request" or "Routing Area Update Request" message.

SGSN informs DCNR support to GGSN by setting the DCNR bit in the UP Function Selection Indication Flags IE of the Create PDP Context Request message.

If all the conditions (UE DCNR capable, SGSN 5G-NSA support) are met, SGSN sends the GPRS Location Update Request with "nrAsSecondaryRAT" bit set in the Supported Features IE in MAP Interface Gr.

- **Dynamic Gateway Selection:**

When DCNR capable UE attempts to register in SGSN and all DCNR validations are successful (for example, DCNR feature configuration on SGSN, HLR not sending "access-restriction" for NR, and so on) for dynamic gateway selection, SGSN uses the following service parameters received from DNS server (in NAPTR response) over other service parameters to select NR capable gateway:

- x-3gpp-pgw:x-gn+nc-nr
- x-3gpp-pgw:x-gp+nc-nr

In order to select a network node with a particular network capability, the character string "+nc-<network capability>" must be appended to the "app-protocol" name where "nc" indicates "network capability", "nr" indicates "new radio", "x-gn" is "app protocol" and "x-3gpp-ggsn/pgw" are app services.

For a DCNR capable UE, when the service parameters are received without network capability and new radio character string "+nc-nr", SGSN uses other service parameters to perform dynamic gateway selection.

When the dynamic selection of gateway fails for any other reasons, SGSN fallbacks and selects the locally configured gateway.

- **DCNR Support to GGSN:**

SGSN advertises the DCNR feature support by sending "NR as Secondary RAT" feature bit in "Supported Features" towards HLR, if DCNR feature is configured at SGSN and UE advertises DCNR capability in NAS.

When DCNR capable UE attempts to register in SGSN and when all DCNR validations are successful (for example, DCNR feature configuration on SGSN, HLR not sending access-restriction for NR, and so on), the SGSN sets the UP Function Selection Indication Flags IE with DCNR flag set to 1 in the Create PDP Context Request message. This flag enables the selection of a PGW-U optimized for NR, when the UE establishes the PDN connection first through Gn-SGSN and the Gn-SGSN will pass a corresponding indication over Gn/Gp to the GGSN/P-GW.

- **Subscription Control:**

SGSN handles the reception of "NR as Secondary RAT Not Allowed" bit in Extended-Access Restriction Data IE in "Insert Subscriber Data" message from HLR.

- **Extended Bandwidth:**

SGSN handles the reception of "Extended Maximum Bit rate DL" and "Extended Maximum Bit rate UL" in AMBR IE received in the "Insert Subscriber Data" message from HLR.

- **Access Restriction Data:**

SGSN supports Access Restriction data information in MM Context IE while receiving/sending from/to peer SGSN during ISRAU and SRNS Relocation procedures.

## How It Works

### Limitations

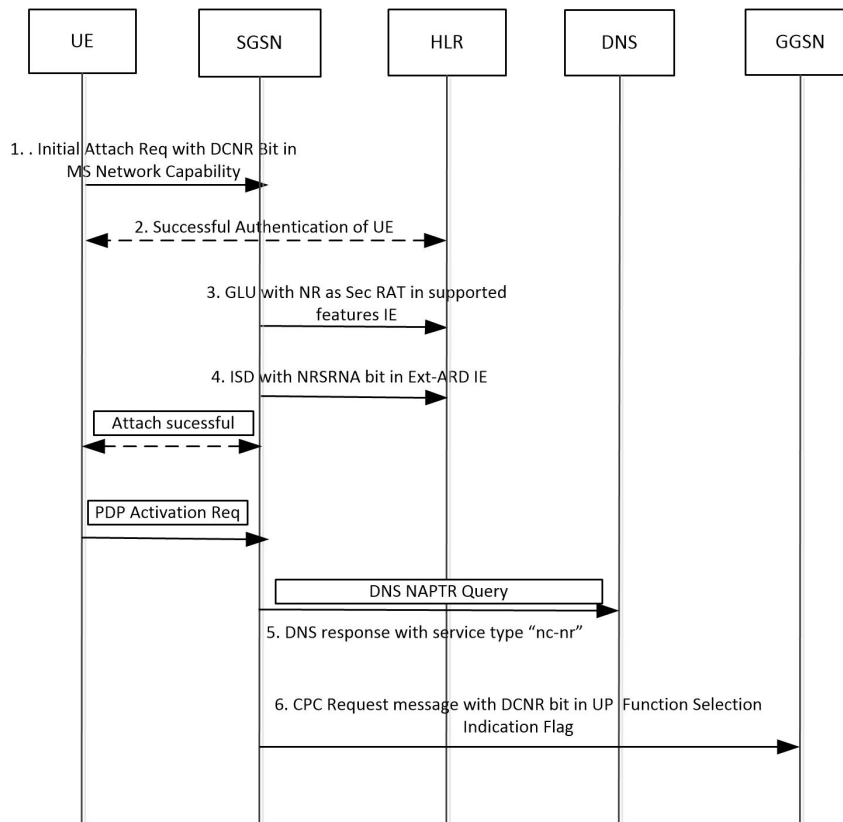
This section describes the known limitations for 5G NSA feature:

- To support EPC QoS parameters like "APN-AMBR", "E-ARP" and "UE-AMBR", "Support for EPC QoS Attributes on SGSN" feature must be enabled. Currently this feature is supported only on 3G not on 2G. So Extended Bandwidth support is only on 3G-SGSN.
- 5G-NSA enabled SGSN uses only MAP Protocol on the Gr Interface, Diameter Protocol on the s6d Interface is not supported.
- If HLR does not send "Extended-Access Restriction" data IE in Insert Subscriber Data message, SGSN assumes that NR as secondary RAT is allowed and it processes the UE request as DCNR enabled.
- When SGSN cannot find a collocated PGW/GGSN which "+nc-nr" in DNS response, SGSN falls back and triggers "A" query to get the normal GGSN information.
- SGSN with 5G-NSA feature enabled selects only the collocated PGW/GGSN in DNS response, for example "*x-3gpp-pgw x-gn+nc-nr/ x-3gpp-pgw x-gp+nc-nr.*"

### Flows

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

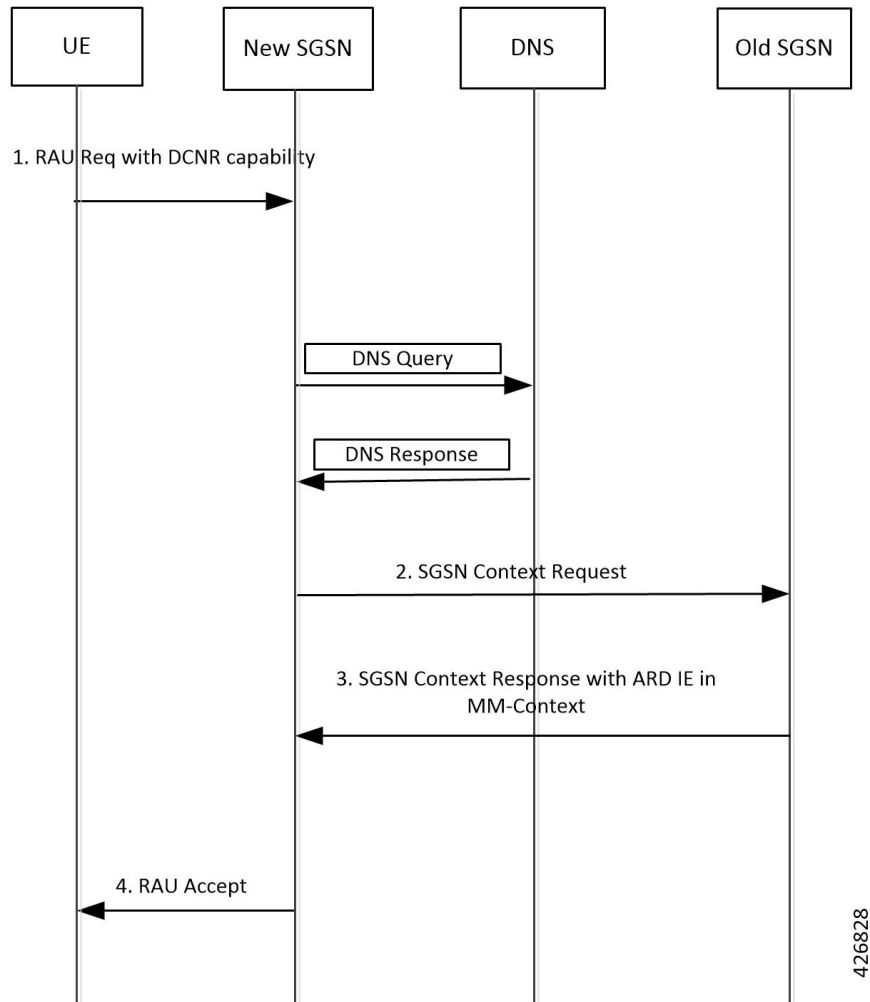
Figure 1: Initial Attach Request with DCNR



1. DCNR capable UE sends "DCNR bit" in NAS message "Attach Request" in "MS Network Capability" IE.
2. SGSN successfully authenticates the UE.
3. SGSN advertises the DCNR feature support by sending "NR as Secondary RAT" feature bit in "Supported Features".
4. If HLR determines that the UE is not authorized for DCNR services, HLR sends Subscription-Data with "Extended Access-Restriction" carrying "NR as Secondary RAT Not Allowed".
5. SGSN determines the Gateway which is NR capable from the DNS response.
6. SGSN sends Create PDP Context Request with the UP Function Selection Indication Flags coded with DCNR bit to the selected gateway.

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Figure 2: Inter SGSN RAU



1. DCNR capable UE sets “DCNR bit” in NAS message “RAU Request” in “MS Network Capability” IE.
2. New-SGSN triggers SGSN Context Request message to OLD-SGSN where the UE is previously attached to get UE context.
3. OLD-SGSN fills the MM-Context with Access-Restriction Data IE with NRSRNA in SGSN Context Response message.
4. After Authentication and verifying subscription information, NEW SGSN sends RAU Accept message to UE.

## Standards Compliance

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

- 3GPP 23.003 Release 15.2.0 - 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; 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 29.002 Release 15.2.0 - 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Mobile Application Part (MAP) specification.
- 3GPP 24.008 Release 15.1.0 - 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Mobile radio interface Layer 3 specification; Core network protocols; Stage 3.
- 3GPP 29.060 Release 15.1.0 - 3rd Generation Partnership Project Technical Specification Group Core Network; General Packet Radio Service (GPRS); GPRS Tunneling Protocol (GTP) across the Gn and Gp interface.
- 3GPP 29.303 Release 15.1.0 - 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Domain Name System Procedures; Stage 3.
- 3GPP 29.303 Release 15.2.0 - 3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Domain Name System Procedures; Stage 3.

## Configuring 5G NSA for SGSN

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

Configuring 5G NSA involves:

### 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 as an alphanumeric string of 1 to 64 characters.
- **no**: Disables the DCNR configuration in the call control profile.
- **remove**: Removes the DCNR configuration from the call control profile.

Removes existing configuration related to DCNR at Call-Control-Profile level (either 'dcnr' or 'no dcnr'), and behaviour depends on the configuration at sgsn-global level.

### Configuring DCNR in SGSN Global Configuration

Use the following configuration to enable Dual Connectivity with New Radio (DCNR) for 5G NSA support in the SGSN Global Configuration mode.

With this configuration, SGSN processes the UEs with 5G capability and selects the gateways that are NR capable to inform the peer MME/SGSN nodes.

```
config
sgsn-global
[ no ] dcnr
end
```

**NOTES:**

- **dcnr**: Configures DCNR to support 5G NSA.
- **no**: Disables the DCNR support.
- This feature is applicable only to Gn-SGSN.

## 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 sgsn-mode**

The output of this command includes the following fields:

SGSN Global Configuration:

- Dual Connectivity Support with NR capability

**show subscribers sgsn-only/gprs-only full**

The output of this command includes the following fields:

MS Network Capability:

- DCNR capability: Indicates MS is capable of DCNR or not.

Subscription Data:

Extended ARD:

- NR-As-Secondary-RAT-Not-Allowed - Advertises the DCNR feature support by sending “NR as Secondary RAT” feature bit towards HLR provided DCNR feature is configured at SGSN and UE advertises DCNR capability in NAS.

**show gmm-sm statistics**

The output of this command includes the following fields:

Session Statistics:

Attached Subscribers:

- 3G-with-DCNR-Attached - The total number of subscribers with DCNR allowed for 3G service.
- 2G-with-DCNR-Attached - The total number of subscribers with DCNR allowed for 2G service.

#### Activated Subscribers:

- 3G Activated with DCNR - Total number of activated subscribers with DCNR capable allowed for 2g service.
- 2G Activated with DCNR - Total number of activated subscribers with DCNR capable allowed for 2g service.

#### Activate PDP Contexts:

##### Total Actv PDP Ctx:

- 3G-Actv Pdp CTx with DCNR - The total number of active PDP contexts established with NR capable P-GW/GGSN.
- 2G-Actv Pdp Ctx with DCNR - The total number of active PDP contexts established with NR capable P-GW/GGSN.

#### Message Statistics:

##### Specific Procedures:

##### Attach Request:

- 3G-with-DCNR-Cap-Attached - Total number of 3G Attach Requests received from DCNR capable UEs.
- 2G-with-DCNR-Cap-Attached - Total number of 2G Attach Requests received from DCNR capable UEs.

##### Attach Accept:

##### Total-Attach-Accept:

- 3G-Attach-Accept-with-DCNR - Total number of 3G Attach Requests accepted with DCNR allowed for DCNR capable UEs.
- 2G-Attach-Accept-with-DCNR - Total number of 2G Attach Requests accepted with DCNR allowed for DCNR capable UEs.

##### Attach Complete:

- 3G-Att-Comp-with-DCNR-Cap - Total number of attach complete received for DCNR allowed UEs for 3G service.
- 2G-Att-Comp-with-DCNR-Cap - Total number of attach complete received for DCNR allowed UEs for 2G service.

##### Attach Reject:

- 3G-Attach-Reject-with-DCNR - Total number of 3G Attach Requests Rejected for DCNR capable UEs.
- 2G-Attach-Reject-with-DCNR - Total number of 2G Attach Requests Rejected for DCNR capable UEs.

##### Routing Area Update Request:



- 3G-RAU-Req-with-DCNR-Cap - Total number of 3G RAU Requests received from DCNR capable UEs.
- 2G-RAU-Req-with-DCNR-Cap - Total number of 2G RAU Requests received from DCNR capable UEs.

#### Routing Area Update Accept:

- 3G-RAU-Acc-with-DCNR-Cap - Total number of 3G RAU Requests accepted with DCNR allowed for DCNR capable UEs.
- 2G-RAU-Acc-with-DCNR-Cap - Total number of 2G RAU Requests accepted with DCNR allowed for DCNR capable UEs.

#### Routing Area Update Complete:

- 3G-RAU-Comp-with-DCNR-Cap - Total number of 3G RAU complete received for DCNR allowed UEs.
- 2G-RAU-Comp-with-DCNR-Cap - Total number of 2G RAU complete received for DCNR allowed UEs.

#### Routing Area Update Reject:

- 3G-RAU-Rej-with-DCNR-Cap - Total number of 3G RAU Requests Rejected for DCNR capable UEs.
- 2G-RAU-Rej-with-DCNR-Cap - Total number of 2G RAU Requests Rejected for DCNR capable UEs.

#### Session Management Messages Statistics:

- 3G-Actv-Request-with-DCNR-Capability - Total number of 3G Activation Requests received for DCNR allowed UEs.
- 2G-Actv-Request-with-DCNR-Capability - Total number of 2G Activation Requests received for DCNR allowed UEs.

#### Primary-Actv-Request:

- 3G-Primary-Actv-Request-with-DCNR-Capability - Total number of 3G primary Activation Requests received for DCNR allowed UEs.
- 2G-Primary-Actv-Request-with-DCNR-Capability - Total number of 2G primary Activation Requests received for DCNR allowed UEs

#### Activate Context Accept:

- 3G-Acvt-Accept-with-DCNR - Total number of 3G Primary Activation Accepted with PDP context established with NR capable P-GW/GGSN.
- 2G-Acvt-Accept-with-DCNR - Total number of 2G Primary Activation Accepted with PDP context established with NR capable P-GW/GGSN.

#### Activate Context Reject:

- 3G-Acvt-Reject-with-DCNR - Total number of 3G Primary Activation Rejected for DCNR allowed UEs
- 2G-Acvt-Reject-with-DCNR - Total number of 2G Primary Activation Rejected for DCNR. allowed UEs.

#### SRNS statistics:

### Attempted

Inter-SRNS UE involved Inter-SRNS UE not involved (new SGSN with MME) -

- Inter-SRNS NRSRNA UE involved Inter-SRNS NRSRNA UE not involved (old SGSN) - Inter-SGSN SRNS from the local SGSN to the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed.
- Inter-SRNS NRSRNA UE involved Inter-SRNS NRSRNA UE not involved (new SGSN) - Inter-SGSN SRNS to the local SGSN from the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed

Inter-SRNS UE not involved (new SGSN with MME):

- Inter-SRNS NRSRNA UE not involved (old SGSN) - Inter-SGSN SRNS from the local SGSN to the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed
- Inter-SRNS NRSRNA UE not involved (new SGSN) – Inter-SGSN SRNS from the local SGSN to the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed.

Successful:

Total SRNS:

- Intra-SGSN SRNS (new SGSN with MME) - Intra SGSN from local SGSN to peer MME is attempted with relocation type UE not Involved /Involved and DCNR allowed.
- Inter-SRNS NRSRNA UE involved (old SGSN) - Inter-SGSN SRNS to the peer SGSN from the local SGSN with dcnr is attempted with relocation type 'UE involved' and DCNR allowed.
- Inter-SRNS NRSRNA UE involved (new SGSN) - Inter-SGSN SRNS to the peer SGSN from the local SGSN with DCNR is attempted with relocation type 'UE involved' and DCNR allowed.

## Bulk Statistics

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

| Bulk Statistics            | Description  |
|----------------------------|--|
| 2G-attached-with-dcnr      | The total number of subscribers with DCNR allowed for 2G service.                          |
| 2G-attached-pdp-with-dcnr  | the total number of subscribers attached having PDF established with NR capable P-GW/GGSN. |
| 2G-activated-pdp-with-dcnr | The total number of active PDP contexts established with NR capable P-GW/GGSN.             |
| 2G-attach-req-with-dcnr    | The total number of 2G Attach Requests received from DCNR capable UEs.                     |
| 2G-attach-accept-with-dcnr | The total number of 2G Attach Requests accepted with DCNR allowed for DCNR capable UEs.    |
| 2G-attach-reject-with-dcnr | The total number of 2G Attach Requests Rejected for DCNR capable UEs.                      |

| Bulk Statistics                          | Description  |
|--|--|
| 2G-rau-with-dcnr                         | The total number of 2G RAU Requests received from DCNR capable UEs.  |
| 2G-rau-accept-with-dcnr                  | The total number of 2G RAU Requests accepted with DCNR allowed for DCNR capable UEs.                       |
| 2G-rau-complete-with-dcnr                | The total number of 2G RAU complete received for DCNR allowed UEs.   |
| 2G-rau-reject-with-dcnr                  | The total number of 2G RAU Requests Rejected for DCNR capable UEs.   |
| 2G-total-active-with-dcnr                | The total number of 2G Activation Requests received for DCNR allowed UEs.                                  |
| 2G-total-primary-active-with-dcnr        | The total number of 2G primary Activation Requests received for DCNR allowed UEs.                          |
| 2G-total-primary-active-accept-with-dcnr | The total number of 2G Primary Activation Accepted with PDP context established with NR capable P-GW/GGSN. |
| 2G-total-primary-active-reject-with-dcnr | The total number of 2G Primary Activation Rejected for DCNR.allowed UEs.                                   |
| 3G-attach-complete-with-dcnr             | The total number of attach complete received for DCNR allowed UEs.   |
| 2G-attach-complete-with-dcnr             | The total number of attach complete received for DCNR allowed UEs.   |
| 3G-attached-with-dcnr                    | The total number of subscribers with DCNR allowed for 3G service.  |
| 3G-attached-pdp-with-dcnr                | The total number of subscribers attached having pdp established with NR capable P-GW/GGSN.                 |
| 3G-activated-pdp-with-dcnr               | The total number of active PDP contexts established with NR capable P-GW/GGSN.                             |
| 3G-attach-req-with-dcnr                  | The total number of 3G Attach Requests received from DCNR capable UEs.                                     |
| 3G-attach-accept-with-dcnr               | The total number of 3G Attach Requests accepted with DCNR allowed for DCNR capable UEs.                    |
| 3G-attach-reject-with-dcnr               | The total number of 3G Attach Requests Rejected for DCNR capable UEs.                                      |
| 3G-rau-with-dcnr                         | The total number of 3G RAU Requests received from DCNR capable UEs.  |

| Bulk Statistics   | Description  |
|---|--|
| 3G-rau-accept-with-dcnr   | The total number of 3G RAU Requests accepted with DCNR allowed for DCNR capable UEs.   |
| 3G-rau-complete-with-dcnr   | The total number of 3G RAU complete received for DCNR allowed UEs.   |
| 3G-rau-reject-with-dcnr   | The total number of 3G RAU Requests Rejected for DCNR capable UEs.   |
| 3G-total-active-with-dcnr   | The total number of 3G Activation Requests received for DCNR allowed UEs.  |
| 3G-total-primary-active-with-dcnr   | The total number of 3G primary Activation Requests received for DCNR allowed UEs.  |
| 3G-total-primary-active-accept-with-dcnr  | The total number of 3G Primary Activation Accepted with PDP context established with NR capable P-GW/GGSN.                       |
| 3G-total-primary-active-reject-with-dcnr  | The total number of 3G Primary Activation Rejected for DCNR.allowed UEs.   |
| <b>Important</b> It is an assumed that all the UEs are DCNR capable for the below mentioned counters. |  |
| att_old_sgsn_inter_srns_dcnr_ue_involved  | Inter-SGSN is attempted with relocation type 'UE involved' and DCNR allowed.   |
| att_old_sgsn_inter_srns_dcnr_ue_not_involved  | Inter-SGSN SRNS from the local SGSN to the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed.       |
| att_new_sgsn_inter_srns_dcnr_ue_involved  | Inter-SGSN SRNS to the local SGSN from the peer SGSN is attempted with relocation type 'UE involved' and DCNR allowed.           |
| att_new_sgsn_inter_srns_dcnr_ue_not_involved  | Inter-SGSN SRNS to the local SGSN from the peer SGSN is attempted with relocation type 'UE not involved and DCNR allowed.        |
| suc_old_sgsn_inter_srns_dcnr_ue_involved  | Inter-SGSN SRNS to the peer SGSN from the local SGSN with DCNR is attempted with relocation type 'UE involved' and DCNR allowed. |
| suc_old_sgsn_inter_srns_dcnr_ue_not_involved  | Inter-SGSN SRNS from the local SGSN to the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed.       |
| suc_new_sgsn_inter_srns_dcnr_ue_involved  | Inter-SGSN SRNS to the peer SGSN from the local SGSN with DCNR is attempted with relocation type 'UE involved' and DCNR allowed. |

| Bulk Statistics                              | Description  |
|--|--|
| suc_new_sgsn_inter_srns_dcnr_ue_not_involved | Inter-SGSN SRNS from the local SGSN to the peer SGSN is attempted with relocation type 'UE not involved' and DCNR allowed. |

