



Multiple and Virtual DNN Support

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Feature Summary and Revision History

Summary Data

Table 1: Summary Data

Applicable Product(s) or Functional Area	SMF
Applicable Platform(s)	SMI
Feature Default Setting	Disabled – Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 2: Revision History

Revision Details	Release
Added support for IPv6 interface ID generation based on SBI VIP address and CommonId of the subscriber.	2021.01.1

Revision Details	Release
SMF supports the maximum limit of 2048 for the following configurations: <ul style="list-style-type: none"> • Precedence • Operator policy • DNN policy • DNN profile 	2021.01.0
SMF supports case insensitive DNN configuration.	2020.02.5.t1
First introduced.	Pre-2020.02.0

Feature Description



Important The PGW-C term used in this chapter denote the EPS interworking functionality supported by SMF and must not be assumed as a standalone P-GW that is used in the LTE network.

The multi-DNN support enables the SMF to have multiple PDN connections for end users to provide different services including Internet and VoNR services.

The SMF fetches the locally configured profile-based Data Network Name (DNN) in PDU Session Establishment Request from the AMF. Then, the SMF maintains the PDN connections based on using SUPI and PDU Session ID. The SMF includes the received DNN in all SBI interfaces to authorize the end user to fetch subscription information, policy, and charging related information. The SMF provisions the forward path information to the UPF. The SMF integrates the multi-DNN support with the IP Address Management (IPAM) module to allocate address to the end user based on received DNN. The SMF maps the DNN profile that is derived from subscriber policies. The SMF also fetches DNN and IPv4 and IPv6 path information based on IPAM pool configuration and updates the UPF as part of node association interactions.



Note Multiple DNN is supported only for 5GS procedures and is not qualified for EPS Session using SBI interfaces.

The SMF supports virtual DNN mapping based on a subscriber profile. It supports mapping of a UE-requested DNN to a configured DNN and sends the selected DNN profile towards the configured network interfaces.

DNN Case Insensitive Support

The DNN configuration in SMF is case insensitive. The configuration accepts a string from 1 through 62 alphanumeric characters, that is case insensitive. It can also contain dots (.) and/or dashes (-).

This feature is extended to support all DNN configurations and validations.

How It Works

The DNN profile lookup is based on subscriber policy or DNN policy. You can associate these policies in the SMF profile configuration. The subscriber policy has a higher precedence over the DNN policy when both the configurations are available.

The subscriber policy consists of a list of precedence values. The selection of precedence is based on various values. For example, the subscriber SUPI, GPSI, Serving PLMN, NSSAI, Charging Characteristics, and IMSI. Each precedence has an associated operator policy and the DNN policy is chosen from the selected operator policy.

The DNN policy can have a DNN profile configuration for each UE-requested DNN. The DNN profile has a Virtual or Mapped DNN with its list of interfaces.

The order of selection for a Virtual DNN is as follows:

- Based on subscriber policy, the order of selection is as follows: smf-profile > smf-service > subscriber-policy > precedence > operator-policy > dnn-policy > dnn-profile (based on UE-requested DNN) > Virtual DNN mapping.
- Based on the DNN policy, the order of selection is as follows: smf-profile > dnn-policy > dnn-profile (based on UE-requested DNN) > Virtual DNN mapping.

PCF, CHF, UDM, UPF, and Resource Manager (RMGR) are the supported interfaces for Virtual DNN mapping.

If the Virtual DNN mapping is not configured, the UE-requested DNN is used across all the interfaces.

Limitations

This feature has the following limitation:

- The SMF includes first-configured DNN profile in "dnnSmfInfoList" of NFProfile during registration with NRF.

Configuring Virtual DNN

This section describes how to configure the Virtual DNN feature.

Configuring the Virtual DNN feature involves the following steps:

1. [Configuring Subscriber Policy, on page 4](#)
2. [Configuring Operator Policy and Associating a DNN Policy, on page 5](#)
3. [Configuring a DNN Policy, on page 6](#)
4. [Configuring a Virtual DNN under a DNN Profile, on page 6](#)
5. [Associating Subscriber Policy under the SMF Service, on page 7](#)

Configuring Subscriber Policy

To configure the subscriber policy, use the following sample configuration:

```

config
  policy subscriber subscriber_policy_name
    precedence precedence_value

    gpsi-start-range gpsi_start_range_value
    gpsi-stop-range gpsi_stop_range_value
    imsi { mcc mcc_value | mnc mnc_value | msin msin_value }
    imsi-start-range imsi_start_value
    imsi-stop-range imsi_stop_value
    operator-policy operator_policy_name
    pei-start-range pei_start_range_value
    pei-stop-range pei_stop_range_value
    sdt sdt_value
    serving-plmn { mcc mcc_value | mnc mnc_value | mnc-list mnc_list_value
  }

  serving-plmn serving_plmn_value
  sst sst_value
  supi-start-range supi_start_range_value
  supi-stop-range supi_stop_range_value
end

```

NOTES:

- **precedence** *precedence_value*: Specify the precedence value associated with the subscriber policy. The maximum limit for precedence is 2048.
- **gpsi-start-range** *gpsi_start_range_value*: Specify the GPSI start range value to be associated with the subscriber policy. *gpsi_start_range_value* must be an integer in the range from 1000000000 through 999999999999999.
- **gpsi-stop-range** *gpsi_stop_range_value*: Specify the GPSI stop range value to be associated with the subscriber policy. *gpsi_stop_range_value* must be an integer in the range from 1000000000 through 999999999999999.
- **imsi** { **mcc** *mcc_value* | **mnc** *mnc_value* | **msin** *msin_value*}: Specify the IMSI value by providing the MCC, MNC, or MSIN value that is to be associated with the subscriber policy.
- **imsi-start-range** *imsi_start_value*: Specify the IMSI start range value. *imsi_start_value* must be an integer in the range from 1000000000 through 999999999999999.
- **imsi-stop-range** *imsi_stop_value*: Specify the IMSI stop range value. *imsi_stop_value* must be an integer in the range from 1000000000 through 999999999999999.
- **operator-policy** *operator_policy_name*: Specify the operator policy to be associated with the subscriber policy. The maximum limit for operator policy is 2048.
- **pei-start-range** *pei_start_range_value*: Specify the PEI start range value. *pei_start_range_value* must be an integer in the range from 1000000000 through 999999999999999.

- **pei-stop-range** *pei_stop_range_value*: Specify the PEI stop range value. *pei_stop_range_value* must be an integer in the range from 1000000000 through 99999999999999.
- **sdt** *sdt_value*: Specify the SDT value be associated with the subscriber policy. *sdt_value* must be a 6-digit octet string in the [0-9a-fA-F]{6} - 000000 - ffffff format. For example, 1A2B3c.
- **serving-plmn { mcc *mcc_value* mnc *mnc_value* mnc-list *mnc_list_values* }**: Specify the 3-digit Mobile Country Code (MCC), 2- or 3-digit Mobile Network Code (MNC), or the list of MNC values of the serving PLMN. *mcc_value* and *mnc_value* must be a string. *mnc_list_values* must be a string, such as [580 660].
- **sst** *sst_value*: Specify the Slice/Service Type (SST) value. *sst_value* must be a 2-digit octet string in the [0-9a-fA-F]{2} - 00 to FF format. For example, A8.
- **supi-start-range** *supi_start_range_value*: Specify the SUPI start range value. *supi_start_range_value* must be an integer in the range from 1000000000 through 99999999999999.
- **supi-stop-range** *supi_stop_range_value*: Specify the SUPI stop range value. *supi_stop_range_value* must be an integer in the range from 1000000000 through 99999999999999.

Configuration Verification

To verify the policy-related configuration details, use one of the following commands:

show subscriber policy *policy_name* or **show full** in the policy configuration mode.

The following is an example output of the show command:

```
smf(config-subscriber-polSub)# show full
policy smf polSmf
precedence 1
  sst                22
  sdt                232322
  serving-plmn mcc  210
  serving-plmn mnc  90
  supi-start-range 1000000000000001
  supi-stop-range  1000000000000010
  gpsi-start-range 1000000000
  gpsi-stop-range  9999999999

operator-policy opPol1
!
```

Configuring Operator Policy and Associating a DNN Policy

To configure the operator policy, use the following sample configuration:

```
config
  policy operator operator_policy_name
    policy dnn dnn_policy_name [ [ secondary secondary_dnn_policy_name ] [
network-capability network_capability ] ]
  end
```

NOTES:

- **policy dnn** *dnn_policy_name* [[**secondary** *secondary_dnn_policy_name*] [**network-capability** *network_capability*]] : Specify the parameters of primary DNN policy to be associated with the operator policy. *dnn_policy_name* must be a string.
 - **secondary** *secondary_dnn_policy_name*: If the parameters of DNN policy to be associated with the operator policy don't match with the primary policy, specify the secondary DNN policy for fallback. *secondary_dnn_policy_name* must be a string.
 - **network-capability** *network_capability*: Specify the network capability configuration details for the respective operator policy that you have selected. The *network_capability* value must be a string.

Configuring a DNN Policy

To configure the DNN policy, use the following configuration:

```
config
  policy dnn dnn_policy_name
    dnn dnn_name profile dnn_profile_name dnn-list dnn_list
  exit
exit
```

NOTES:

- **policy dnn** *dnn_policy_name*: Specify the DNN policy. *dnn_policy_name* must be an alphanumeric string.
 - In releases prior to 2021.01.0: The maximum limit for DNN policy is 512.
 - In 2021.01.0 and later releases, the limit for DNN policy is increased from 512 to 2048.
- **dnn** *dnn_name*: Specify the virtual DNN profile to map with the specified network DNN profile. *dnn_name* must be an alphanumeric string.
- **profile** *dnn_profile_name*: Specify the network DNN profile. *dnn_profile_name* must be an alphanumeric string.
 - In releases prior to 2021.01.0: The maximum limit for DNN profile is 512.
 - In 2021.01.0 and later releases, the limit for DNN profile is increased from 512 to 2048.
- **dnn-list** *dnn_list*: Specify the list of DNNs supported by the UPF node.

Configuring a Virtual DNN under a DNN Profile

To configure a virtual DNN under a DNN profile, use the following sample configuration:

```
config
  profile dnn profile_name
    dnn dnn_name network-function-list [ chf | pcf | upf ]
  profile profile_name
end
```

NOTES:

- **dnn** *dnn_name*: Specify the DNN name. *dnn_name* must be an alphanumeric string.

- **network-function-list**: Specify the network functions that the selected DNN profile will be sent. Supported values are **chf**, **pcf**, and **upf**.

Associating Subscriber Policy under the SMF Service

To associate a subscriber policy under SMF service, use the following sample configuration:

```
config
  profile smf smf_profile_name
    service name service_name
      subscriber-policy subscriber_policy_name
    end
```

NOTES:

- **subscriber-policy *subscriber_policy_name***: Specify the subscriber policy name. *subscriber_policy_name* must be an alphanumeric string.

DNN Profile Offline Mode Support

Feature Description

The Data Network Name (DNN) Profile Offline Mode Support feature allows new sessions, or subsequent messages of existing sessions, to use the updated configuration values when the DNN is in offline mode. This feature enables SMF to switch the DNN to offline mode.



Important

You must clear the subscriber sessions before switching DNN to offline mode while changing the configuration for which dynamic change is not allowed. New session requests are rejected until the DNN is changed back to online mode.

How it Works

This section describes how the DNN Profile Offline Mode Support feature works for the supported SMF configurations.

DNN Policy

DNN Policy configuration defines the DNN Profile mapping with the DNN. After the DNN to profile mapping is changed, new subscriber for the same DNN uses the updated DNN Profile. So, there is no impact on existing subscribers.

DNN Profile

DNN profile defines various parameters for a particular DNN.

The following table describes if the dynamic configuration change is allowed or if the DNN must be set to an offline mode.

Table 3: DNN Profile Configuration and its Impact During Dynamic Update

Configuration Parameters	Dynamic Change	Impact on Existing Sessions
DnsServers	Allowed	No impact
DnnInfo	Allowed	New values are used after database reload of the session
NetworkElementProfile	Not recommended (See NOTES)	
Timeout	Allowed	No impact
ChargingProfile	Not recommended (See NOTES)	
RemoteVmac	Allowed	No impact
PcscfProfile	Allowed	No impact
PpdProfile	Allowed	Immediate (new values are used)
DefaultSscMode	Allowed	No impact
DefaultPduSession	Allowed	No impact
AllowedPduSession	Allowed	No impact
QosProfile	Allowed	Immediate (new values are used)
UpfApn	Allowed	No impact
SecondaryAuthen	Allowed	No impact
LocalAuthorization	Allowed	No impact

NOTES:

- It is recommended not to modify or delete the NetworkElementProfile and ChargingProfile configuration parameters. If the parameters are changed, then the behavior for:
 - NetworkElementProfile: Messages for the existing sessions may be sent on new servers.
 - ChargingProfile: There may be some inconsistencies related to Usage Reporting Rules (URRs) between SMF and UPF.
- For modifying the DNN profile mapping, the DNN profile must be in the offline mode.
- It is recommended to review the messages shown in the help string before executing the CLI commands.
- Switch the DNN profile to an offline mode when configuring the parameters dynamically. This step avoids the network impact, which is caused by the configuration changes.

Subscriber Policy

SMF uses subscriber policy to select the operator policy based on the following options:

- SUPI range
- SST (Slice/Service Type)

- IMSI range
- GPSI
- PEI
- SDT (Slice Differentiator Type)
- S-NSSAI
- PLMN ID

Change in Subscriber Policy configuration can be applied dynamically as it has no impact on the existing sessions. SMF selects the operator policy for the new sessions based on the updated configurations.

Limitations

The following limitations apply when the DNN is in the offline mode:

- The subsequent 5G calls for the offline DNN are rejected with the HTTP Cause - HTTP_STATUS_CODE_503_SERVICE_UNAVAILABLE, and 5GSMCause as “Service option temporarily out of order”.
- The subsequent 4G calls for the offline DNN are rejected with the GTP cause “No resources available”.

Configuring the DNN Profile Offline Mode Support Feature

This section describes how to enable the offline mode for a DNN profile.

Configuring the DNN Profile to Offline Mode

To configure the DNN profile to offline mode, use the following sample configuration:

```
config
  profile dnn dnn_profile_name
    mode dnn_mode
  end
```

NOTES:

- **profile dnn *dnn_profile_name***: Specify the DNN profile.
- **mode *dnn_mode***: Specify the DNN mode of operation. When the DNN mode is set to **offline**, the new sessions are rejected. The default value is **online**.

Verifying the DNN Profile Offline Mode Configuration

This section describes how to verify if the DNN profile is set to the offline mode.

The following is an example output of the **show running-config profile dnn *profile_name*** command.

```
show running-config profile dnn intershat
  profile dnn intershat
    mode offline
    network-element-profiles chf chf1
    network-element-profiles amf amf1
```

```

network-element-profiles pcf pcf1
network-element-profiles udm udml
charging-profile chgprf1
virtual-mac b6:6d:47:47:47:47
ssc-mode 2 allowed [ 3 ]
session type IPV4 allowed [ IPV6 IPV4V6 ]
upf apn intershat
dcsr true
exit

```

DNN Profile Offline Mode OAM Support

This section describes operations, administration, and maintenance information for this feature.

Bulk Statistics Support

The following label is introduced as part of this feature:

- LABEL_DISC_PDUSETUP_DNN_OFFLINE: This label is defined to indicate that the call is rejected because the DNN is in the offline mode.

IP Pool Allocation per DNN

Feature Description

The IP Pool Allocation per DNN feature supports mapping of a UE-requested DNN to a configured DNN for IP Pool selection. This feature is supported for the SMF and PGW-C in 5G and 4G.

The IP Pool Allocation per DNN feature supports the following functionalities:

- Enables SMF to support a new configuration under the DNN profile to enable mapping of the UE-requested DNN to a DNN that is associated with an IP pool.
- Sends the mapped DNN over Remote Procedure Call (gRPC) to the Resource Manager functionality under Node Manager service for IP allocation.
- Supports the new configuration for IP Pool DNN over the virtual DNN with Redundancy Manager, if available.
- Sends the UE-requested DNN when both the new configuration for IP pool and the virtual DNN are unavailable.

How it Works

This section provides a brief of how the IP Pool Allocation per DNN feature works.

- The DNN profile lookup is based on the subscriber policy or DNN policy. The DNN profiles are associated in the SMF profile configuration. The subscriber policy takes precedence over the DNN policy when both the configurations are present.
- The subscriber policy contains a list of precedence values. The selection of the precedence is based on the SUPI, GPSI, serving PLMN, and NSSAI value of the subscriber.

- Each precedence has an associated operator policy. The DNN policy is picked from the selected operator policy.
- The DNN policy can have a DNN profile configuration for each of the UE-requested DNNs.
- The DNN profile contains the virtual or mapped DNN with its list of interfaces. This is an existing configuration and Redundancy Manager is also in the list of interfaces. For more information, see the [Configuring a Virtual DNN under a DNN Profile, on page 6](#) section.
- The new configuration under the DNN profile contains the mapping of the UE-requested DNN to IP Pool DNN.
- The DNN profile selection occurs in the following order:
 - Based on subscriber policy, the order of selection is as follows: smf-profile > smf-service > subscriber-policy > precedence > operator-policy > dnn-policy > dnn-profile (based on UE-requested DNN) > Virtual DNN mapping.
 - Based on the DNN policy, the order of selection is as follows: smf-profile > dnn-policy > dnn-profile (based on UE requested Dnn) > Virtual DNN mapping.

**Note**

- New IP pool DNN mapping takes precedence over the existing virtual DNN configuration if the Redundancy Manager configuration exists.
- If both the configurations for the Redundancy Manager are not present, the UE-requested DNN is used to select the IP pool.
- If the mapped DNN does not have the IP pool configured, then IP allocation fails, and the call is deleted.
- Both the EPS and 5G calls follow the same principles for IP allocation for a DNN.

Configuring IP Pool Allocation

This section describes how to configure the IP Pool Allocation per DNN feature.

Configuring the IP Pool Allocation per DNN involves either one of the following steps:

1. Configuring virtual DNN under DNN profile. For more information, see the [Configuring a Virtual DNN under a DNN Profile, on page 6](#) section.

**Note**

This is a generic configuration along with other interfaces as an option.

2. Allocating the IP pool per DNN

**Note**

This configuration is specifically only for IP allocation.

Allocating the IP Pool per DNN

To allocate the IP pool per DNN, use the following sample configuration:

```
config
  profile dnn dnn_profile_name
    dnn rmgr rmgr_name
  end
```

NOTES:

- **profile dnn *dnn_profile_name***: Map the Virtual DNN profile with the specified network DNN profile. *dnn_profile_name* must be an alphanumeric string.
- **dnn rmgr *rmgr_name***: Specify the Redundancy Manager to which the DNN profile will be sent. *rmgr_name* must be an alphanumeric string.

Verifying IP Pool Allocation Configuration

This section describes how to verify the IP pool allocation configuration.

Use the **show full** CLI command in the DNN Profile Configuration mode to verify the configuration associated with IP pool allocation per DNN.

The following is an example output of this show command.

```
[unknown] smf(config-dnn-cisco123)# show full
profile dnn intershat
dns primary ipv4 209.165.200.231
dns primary ipv6 2001:DB8:1::1
dns secondary ipv4 209.165.200.232
dns secondary ipv6 2001:DB8:1::2
network-element-profile-list chf [ chgser1 ]
dnn starent.com network-function-list [ upf chf rmgr ]
dnn rmgr cisco.com
charging-profile chgprf1
virtual-mac      01-00-5E-90-10-00
pcscf-profile    pcscf1
ppd-profile      ppdl
ssc-mode 1
session type IPV4
.
.
.
```