Voice over New Radio

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
First introduced.	Pre-2020.02.0

Feature Description

New Radio (NR) is the 5G radio access technology, and Voice over NR (VoNR) is the voice or video over the 5G network. VoNR is the target voice or video communication solution for 5G networks.

Voice services in 5GS over NG-RAN continue to be based on IP Multimedia Subsystem (IMS), such as Voice over LTE (VoLTE). VoNR is supported only when 5GS is connected to the IMS core.

Standards Compliance

The VoNR feature complies with the following standards:

- 3GPP TS 23.228, Release 15.3.0
- 3GPP TS 23.501, Release 15.4.0
- 3GPP TS 23.502, Release 15.4.0

VoNR P-CSCF Address Support

Feature Description

The SMF supports IMS Protocol Data Unit (PDU) Session Creation and fetches the P-CSCF addresses to be sent to the UE during initial attach over NR.

How it Works

The serving PLMN AMF sends an indication toward the UE during the registration procedure to indicate whether an IMS voice over PS session is supported in the 3GPP access network. A UE with "IMS voice over PS" voice capability over 3GPP access takes this indication into account when performing voice domain selection. The UE includes extended Protocol Configuration Options (ePCO) IE in "PDU Session Establishment Request" by setting P-CSCF container options in the AMF. Further, the AMF forwards these ePCO IE options in smContextCreate Request towards the SMF. The SMF fetches the P-CSCF addresses based on DNN profile, which maintains IMS-related data. The SMF includes P-CSCF IPv4 and IPv6 address in N1N2Message Transfer towards the AMF as per PDN-Types and requested P-CSCF container values.

Important The SMF does not include the P-CSCF address if the UE does not set the P-CSCF container options in the ePCO IE.

Call Flows

This section describes the call flow that is associated with this feature.

VoNR PDU Session Creation Call Flow

This section describes the VoNR PDU Session Creation call flow.

Figure 1: VoNR PDU Session Creation Call Flow

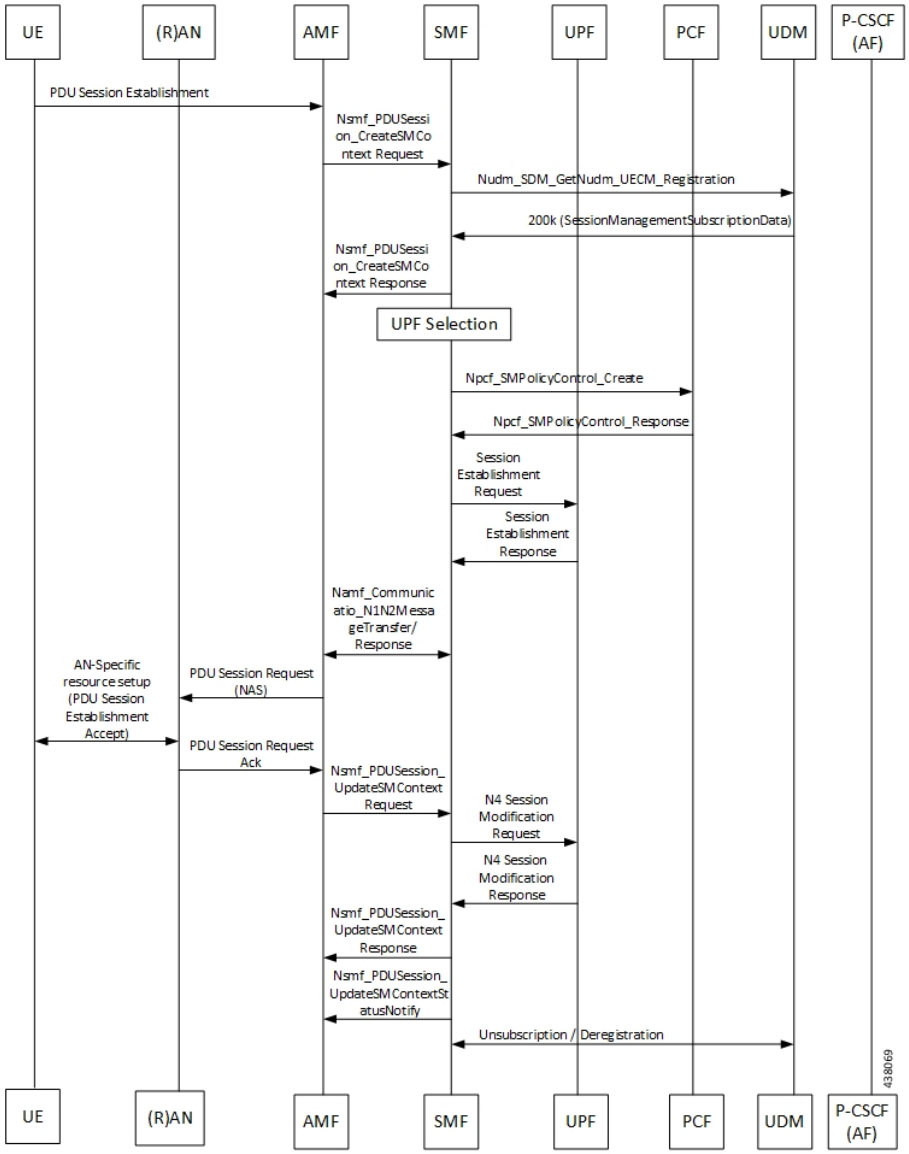


Table 3: VoNR PDU Session Creation Call Flow Description

Step	Description
1	Based on the UE registration with the RAN and the AMF, the UE set to "voice centric" for 5GS ensures that the voice service is always available. The UE selects the respective DNN for IMS. The UE initiates N1-Message with “PDU Session Establishment Request” by including container identifier “P-CSCF IPv4/IPv6 Request” in ePCO IE. NOTE: The DNN can be common for both the “voice” and “data” centric services.
2	The AMF performs the SMF selection as described in 3GPP TS 23.501.

Step	Description
3	The AMF sends Nsmf_PDUSession_CreateSMContext Request to the SMF by including N1 and N2 Message as Multipart along with ePCO IE if it is received from the UE in "PDU Session Establishment Request".
4	The SMF fetches the session management subscription data for the corresponding SUPI, DNN, and S-NSSAI. If it is not available locally, the SMF retrieves the subscription data using Nudm_SDM_Get and subscribes for the subscription data change notification using Nudm_SDM_Subscribe. The UDM retrieves this information from UDR using Nudr_DM_Query and subscribes to the notifications from the UDR for the same data by Nudr_DM_subscribe. The S-NSSAI used with the UDM is the S-NSSAI with value for the HPLMN. The SMF uses the DNN Selection Mode to decide the retrieval of session management subscription data. If the SMF is not subscribed for subscription data (DNN, S-NSSAI), then the SMF uses local configuration instead of session management subscription data.
5	The UDM provides the subscription details to the SMF. Based on the local configuration or session management subscription data from UDM for the respective DNN, the "IMS Voice over PS" is supported.
6	The SMF sends Nsmf_PDUSession_CreateSMContext Response (Cause, SM Context ID, or N1 SM container (PDU Session Reject (Cause))) by processing the PDU Session Establishment Request. The SMF creates an SM context and responds to the AMF by providing an SM Context Identifier.
7	The SMF also selects one or more UPFs based on SSC mode, PDU Session-Type, and voice or data-centric services based on DNN capabilities.
8	The SMF initiates "Npcf_SMPolicyControl_Create" Request by including "SmPolicyContextData", which contains Supi, pduSessionId, ratType, servingNetwork, userLocationInfo, ueTimeZone, Pei, Online/Offline charging, chargingcharacteristics, PDU Session-Type, allocated UE IP address/prefix(es), subsDefQos, and information.
9	The PCF responds back with "Npcf_SMPolicyControl_CreateResponse (200 OK)" by including "SmPolicyDecision" in the message to the SMF. "SmPolicyDecision" contains the sessionRules, pccRules, qosDecs, chgDecs, chargingInfo, traffConDecs, umDecs, qosChars, and so on as defined in the 3GPP TS 29.512, Section 5.6.2.4. All these parameters are only applicable for "IMS Voice over PS session". This section does not cover Data and Voice PDU sessions. **Note** When a UE initiates a Resource Modification Request, and if the SMF includes the "qosFlowUsage" attribute containing "IMS_SIG" within SmPolicyUpdateContextDatadata structure and the PCF accepts that a QoS flow dedicated to IMS signaling can be used, the PCF returns the "qosFlowUsage" containing "IMS_SIG" value within the SmPolicyDecision data structure. The PCC rules provided have the 5QI applicable for IMS signaling.
10	The SMF initiates "N4 Session Establishment Request" to the UPF and provides packet detection, enforcement, and reporting rules to be installed on the UPF for this PDU session.

Step	Description
11	The UPF acknowledges by sending an N4 Session Establishment Response. If CN Tunnel Info is allocated by the UPF, the CN Tunnel Info is provided to SMF in this step.
12	The SMF sends Namf_Communication_N1N2MessageTransfer to the SMF. This transfer message includes the PDU Session ID, N2 SM information (PDU Session ID, QFI(s), QoS Profile(s), CN Tunnel Info, S-NSSAI from the Allowed NSSAI, Session-AMBR, PDU Session Type, User Plane Security Enforcement information, UE Integrity Protection Maximum Data Rate), N1 SM container (PDU Session Establishment Accept (QoS Rule(s) and QoS Flow level QoS parameters if needed for the QoS Flow(s) associated with the QoS rule(s), selected SSC mode, S-NSSAI(s), DNN, allocated IPv4 address, interface identifier, Session-AMBR, selected PDU Session Type, Reflective QoS Timer (if available), P-CSCF address(es), and [Always-on PDU Session])). The N1 SM container contains the PDU Session Establishment Accept that the AMF provides to the UE. If the UE requested P-CSCF discovery, then the message also includes the P-CSCF IP addresses as determined by the SMF. The SMF fetches these P-CSCF addresses from DNN configuration, which are locally provisioned under DNN with IMS-Support and list of P-CSCF addresses or P-CSCF FQDN.
13	The AMF sends N2 PDU Session Request (N2 SM information, NAS message (PDU Session ID, N1 SM container (PDU Session Establishment Accept))) to (R)AN.
14	The (R)AN issues AN-specific signaling exchange to the UE that is related with the information received from the SMF. The (R)AN also allocates (R)AN N3 Tunnel Info for the PDU session. The (R)AN forwards the NAS message (PDU Session ID, N1 SM container (PDU Session Establishment Accept)) that was provided in Step 12 to the UE. The (R)AN provides the NAS message only if the necessary (R)AN resources are established and the allocation of (R)AN Tunnel Info is successful.
15	The (R)AN sends N2 PDU Session Response (PDU Session ID, Cause, N2 SM information (PDU Session ID, AN Tunnel Info, List of accepted/rejected QFI(s), User Plane Enforcement Policy Notification)) to the AMF. The AN Tunnel Info corresponds to the Access Network address of the N3 tunnel corresponding to the PDU session. If the (R)AN rejects QFI(s) the SMF is responsible of updating the QoS rules and QoS flow-level QoS parameters if needed for the QoS flow associated with the QoS rule(s) in the UE accordingly. The NG-RAN rejects the establishment of UP resources for the PDU session when it cannot fulfill User Plane Security Enforcement information with a value of Required. The SMF releases the PDU session and the NG-RAN sends notification to the SMF when it cannot fulfill a User Plane Security Enforcement with a value of Preferred.

Step	Description
16	The AMF sends Nsmf_PDUSession_UpdateSMContext Request (N2 SM information, Request Type) to the SMF. The AMF forwards the N2 SM information received from (R)AN to the SMF. If the list of rejected QFI(s) is included in N2 SM information, the SMF releases the rejected QFI(s) associated QoS profiles. If the User Plane Enforcement Policy Notification in the N2 SM information indicates that no user plane resources can be established, and the User Plane Enforcement Policy indicated "required" as described in 3GPP TS 23.501, Section 5.10.3, the SMF releases the PDU session.
17	The SMF initiates an N4 Session Modification procedure with the UPF. The SMF provides AN Tunnel Info to the UPF and the corresponding forwarding rules.
18	The UPF provides an N4 Session Modification Response to the SMF.
19	The SMF sends Nsmf_PDUSession_UpdateSMContext Response (Cause) to the AMF.
20	(Conditional) The SMF sends Nsmf_PDUSession_SMContextStatusNotify (Release) to the AMF.
21	If during the procedure, any time after Step 5, the PDU Session Establishment is not successful, the SMF informs the AMF by invoking Nsmf_PDUSession_SMContextStatusNotify (Release). The SMF also releases any N4 session(s) created, any PDU session address if allocated (for example, IP address) and releases the association with PCF, if any.

Limitations

Currently, only up to 64 address lists can be configured for both P-CSCF IPv4 and IPv6 addresses.

Configuring the VoNR P-CSCF Address Support

This section describes how to configure VoNR P-CSCF Address Support.

Configuring VoNR P-CSCF Address Support involves the following steps:

1. Creating P-CSCF Profile
2. Configuring P-CSCF Server Selection Method
3. Configuring P-CSCF Server Parameters
4. Defining P-CSCF Profile in DNN Profile Configuration

Creating P-CSCF Profile

Use the following configuration to create a P-CSCF profile instance:

```
configure
   profile pcscf pcscf_profile_name
   end
```

NOTES:

- **pcscf** *pcscf_profile_name*: Specifies the P-CSCF profile. This command creates a P-CSCF profile and provides access to the P-CSCF Profile Configuration mode. For details on the commands supported in this mode, see the *pcscf-profile* section in this document. *pcscf_profile_name* must be an alphanumeric string.

Configuring P-CSCF Server Selection

Use the following configuration to configure the P-CSCF server selection method:

```
configure
   profile pcscf pcscf_profile_name
      pcscf-selection round-robin
      end
```

NOTES:

- **pcscf-selection round-robin**: Configures the P-CSCF server selection method. Currently, round-robin is the only supported algorithm for the server selection.
- This command performs the round-robin selection of P-CSCF server based on the configured precedence value.

Configuring P-CSCF IPv4 Server

Use the following configuration to configure the P-CSCF IPv4 server:

```
configure
   profile pcscf pcscf_profile_name
      v4-list
      end
```

NOTES:

- **v4-list**: Prompts you to configure the P-CSCF IPv4 server details.
- Entering the **v4-list** command takes you to the P-CSCF IPv4 Server Configuration mode. For details on the commands supported in this mode, see the *CLI Reference Content*.

Configuring P-CSCF Primary and Secondary Server IPv4 Address

Use the following configuration to configure the IPv4 address of the primary and secondary P-CSCF servers.

```
configure
   profile pcscf pcscf_profile_name
      v4-list
         precedence value
            primary ipv4_address
            secondary ipv4_address
            end
```

NOTES:

- **precedence** *value*: Specifies the precedence value. *value* must be an integer in the range of 1-64. This precedence value is used for the round-robin selection of P-CSCF server. The lower the precedence, the higher the priority.
- **primary** *ipv4_address*: Specifies the IPv4 address of the primary P-CSCF server in dotted-decimal notation.
- **secondary** *ipv4_address*: Specifies the IPv4 address of the secondary P-CSCF server in dotted-decimal notation.

Configuring P-CSCF IPv6 Server

Use the following configuration to configure the P-CSCF IPv6 server:

```
configure
   profile pcscf pcscf_profile_name
      v6-list
      end
```

NOTES:

- **v6-list**: Prompts you to configure the P-CSCF IPv6 server details.
- Entering the **v6-list** command prompts you to the P-CSCF IPv6 Server Configuration mode. For details on the commands supported in this mode, see the *CLI Reference* section.

Configuring P-CSCF Primary and Secondary Server IPv6 Address

Use the following configuration to configure the IPv6 address of the primary and secondary P-CSCF servers:

```
configure
   profile pcscf pcscf_profile_name
      v6-list
         precedence value
            primary ipv6_address
            secondary ipv6_address
            end
```

NOTES:

- **precedence** *value*: Specifies the precedence value. *value* must be an integer in the range of 1-64. This precedence value is used for the round-robin selection of P-CSCF server. The lower the precedence, the higher the priority.
- **primary** *ipv6_address*: Specifies the IPv6 address of the primary P-CSCF server in colon-separated hexadecimal notation.
- **secondary** *ipv6_address*: Specifies the IPv6 address of the secondary P-CSCF server in colon-separated hexadecimal notation.

Configuring P-CSCF IPv4v6 Server

Use the following configuration to configure the P-CSCF IPv4v6 server:

```
configure
   profile pcscf pcscf_profile_name
      v4v6-list
      end
```

NOTES:

- **v4v6-list**: Prompts you to configure the P-CSCF IPv4v6 server details.
- Entering the **v4v6-list** command takes you to the P-CSCF IPv4v6 Server Configuration mode. For details on the commands supported in this mode, see the *CLI Reference* section.

Configuring P-CSCF Primary and Secondary Server IPv4v6 Address

This section describes how to configure the IPv4v6 address of the primary and secondary P-CSCF servers.

```
configure
   profile pcscf pcscf_profile_name
      v4v6-list
         precedence value
            primary ipv4 ipv4_address ipv6 ipv6_address
            secondary { [ ipv4 ipv4_address ] [ ipv6 ipv6_address ] }
            end
```

NOTES:

- **precedence** *value*: Specifies the precedence value. *value* must be an integer in the range of 1-64. This precedence value is used for the round-robin selection of P-CSCF server. The lower the precedence, the higher the priority.
- **primary ipv4** *ipv4_address* **ipv6** *ipv6_address*: Specifies the IPv4 and IPv6 address of the primary P-CSCF server in dotted-decimal notation and colon-separated hexadecimal notation respectively.
- **secondary { [ipv4** *ipv4_address* **] [ipv6** *ipv6_address* **] }**: Specifies the IPv4 and IPv6 address of the secondary P-CSCF server in dotted-decimal notation and colon-separated hexadecimal notation respectively.

Defining P-CSCF Profile in DNN Profile Configuration

Use the following configuration to configure the P-CSCF profile in the existing DNN profile configuration:

```
configure
   profile dnn dnn_profile_name
      pcscf-profile pcscf_profile_name
      end
```

NOTES:

- **pcscf-profile** *pcscf_profile_name*: This command defines the P-CSCF profile to be associated with the DNN profile. *pcscf_profile_name* must be the name of the configured P-CSCF profile.

Verifying the Feature Configuration

Use the following show command to verify the P-CSCF FQDN feature configuration.

show running-config

The following is an example of the output of this show command:

```
profile pcscf pcscf1
fqdn cisco.com
v4-list
precedence 3
primrary 3.3.3.1
secondary 3.3.3.2
exit
precedence 5
primary 5.5.5.1
secondary 5.5.5.2
exit
```

VoNR MO and MT Call Support

Feature Description

The SMF supports Mobile Originated (MO) and Mobile Terminated (MT) VoNR with 5G QoS Identifier (5QI) as Guaranteed Bit Rate (GBR) flow for UE after the IMS PDU Session Creation. The SMF further supports VoNR calls for the following mobility (inter gNB, inter AMF) scenarios:

- MO and MT calls for idle mode UE
- MO and MT calls when the UE is handing over

During the mobility scenario of VoNR MO and MT calls, make sure to consider the following points:

- VoNR GBR flows are supported during UE and network service request procedures, Xn and N2 based handover.
- QoS failures at N1 and N2 interface, which are rejected by UE and gNB, are not handled by SMF.
- Charging features are not integrated with VoNR MO and MT, and mobility features.

Call Flows

This section describes the call flows associated with this feature.

VoNR MO Call Handling Procedure

This section describes the VoNR MO call handling procedure.

Figure 2: VoNR MO Call Handling Flow

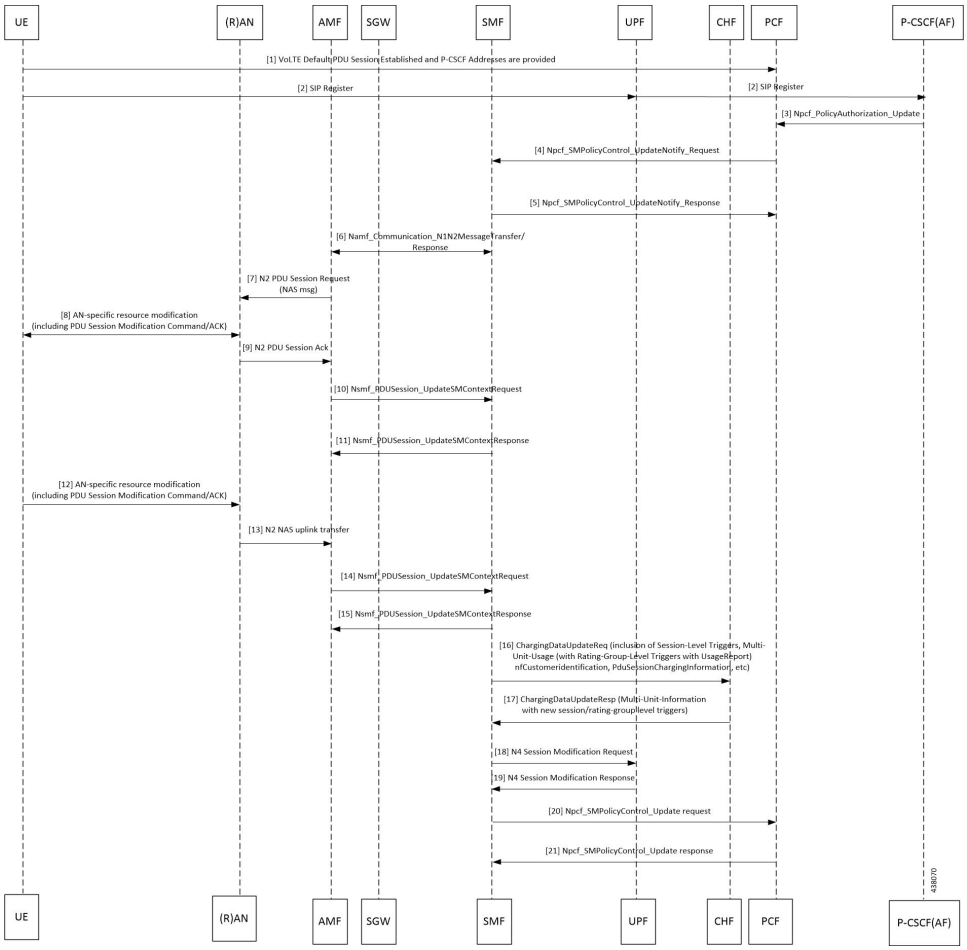


Table 4: VoNR MO Call Handling Flow Description

Step	Description
1	The SMF performs the PDU Session Establishment as described in the VoNR PDU Session Creation Call Flow, on page 2 section.
2	The UE initiates SIP Registration towards the called-party via UPF, P-CSCF through the backed IMS core network.
3	P-CSCF sends “Npcf_PolicyAuthorization_Update” to PCF to enforce policies, modify service information, gate control, modify subscription to SDF notification/deactivation, updating of traffic routing information, and so on (as defined in 3GPP TS 29.514). This service allows the NF consumer to subscribe and unsubscribe the notification of events (for example, change of Access Type, RAT type, or changes of the PLMN identifier).
4	The PCF sends Npcf_SMPolicyControl_UpdateNotify request to update and/or delete the PCC rule(s) PDU session-related policy context at the SMF and Policy Control Request Trigger information. This enforces PCC rules, policy control request triggers, SDF, and charging related information.

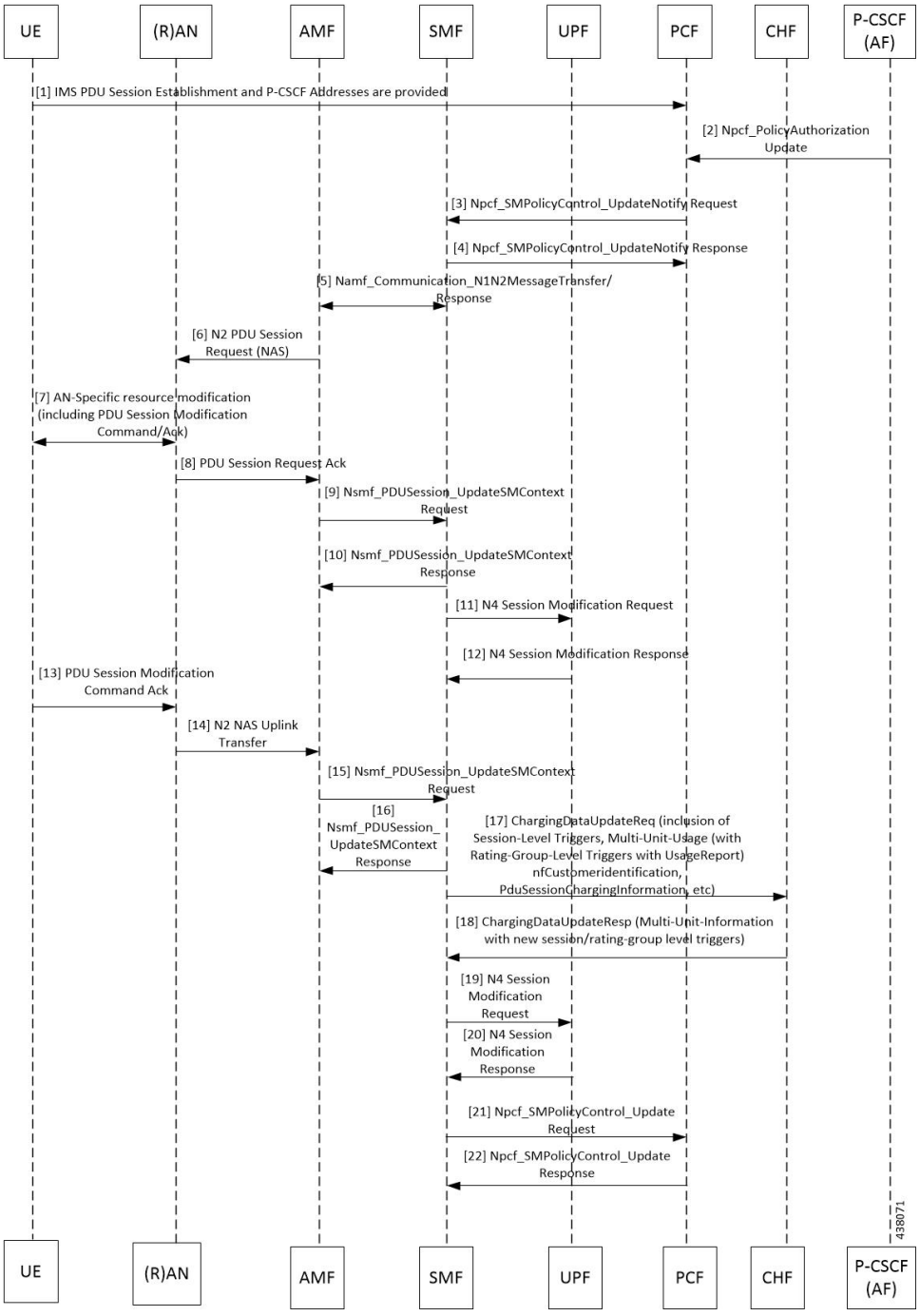
Step	Description
5	The SMF processes the received PCC rules and sends 200 OK message for a successful scenario. When the processing of any content fails, the SMF includes "400 Bad Request" in “Npcf_SMPolicyControl_UpdateNotify request” and sends it along with appropriate cause value as defined in 3GPP TS 29.512.
6	The SMF sends Namf_Communication_\nN1N2MessageTransfer/Response (PDU Session ID, QFIs, QoS Profile(s), Session-AMBR), N1 SM container (PDU Session Modification Command (PDU Session ID, QoS rule(s), QoS Flow level parameters if needed for the QoS Flow(s) associated with the QoS rule(s), QoS rule operation, and QoS Flow level QoS parameters operation, Session-AMBR))). If the UE is in CM-IDLE state or Mobility handover (HO) state, see the procedure in VoNR MO Call Flow for UE in Idle Mode, on page 14.
7	The AMF sends N2 PDU Session Request (N2 SM information received from SMF, NAS message (PDU Session ID, N1 SM container (PDU Session Modification Command))) message to the (R)AN.
8	The (R)AN issues AN specific signalling exchange with the UE that is related with the information received from SMF. For example, in an NG-RAN, an RRC Connection Reconfiguration takes place with the UE modifying the necessary (R)AN resources related to the PDU session.
9	The (R)AN acknowledges N2 PDU Session Request by sending a N2 PDU Session ACK (N2 SM information (List of accepted/rejected QFIs, AN Tunnel Info, PDU Session ID, Secondary RAT usage data), User Location Information) message to the AMF. In case of Dual Connectivity, if one or more QFIs were added to the PDU session, the master RAN node assigns one or more of these QFIs to an NG-RAN node which was not involved in the PDU session earlier. In this case, the AN Tunnel Info includes a new N3 tunnel endpoint for QFIs assigned to the new NG-RAN node. Correspondingly, if one or more QFIs were removed from the PDU session, a (R)AN node may no longer be involved in the PDU session anymore, and the corresponding tunnel endpoint is removed from the AN Tunnel Info. The NG-RAN rejects QFIs if it cannot fulfill the User Plane Security Enforcement information for a corresponding QoS Profile, for example, due to the UE Integrity Protection Maximum Data Rate being exceeded.
10	The AMF forwards the N2 SM information and the User Location Information received from the (R)AN to the SMF via Nsmf_PDUSession_UpdateSMContext service operation. If the (R)AN rejects QFIs, the SMF updates the QoS rules and QoS parameters if needed for the QoS flow(s) associated with the QoS rule(s) in the UE accordingly.
11	The SMF sends an Nsmf_PDUSession_UpdateSMContext Response. N2 SM information includes Secondary RAT Usage Data.
12	The UE acknowledges the PDU Session Modification Command by sending a NAS message (PDU Session ID, N1 SM container (PDU Session Modification Command ACK)) message.
13	The (R)AN forwards the NAS message to the AMF.

Step	Description
14	The AMF forwards the N1 SM container (PDU Session Modification Command ACK) and User Location Information received from the (R)AN to the SMF via Nsmf_PDUSession_UpdateSMContext service operation.
15	The SMF sends an Nsmf_PDUSession_UpdateSMContext Response. If the SMF-initiated modification is to delete QoS Flows (for example, triggered by PCF) which do not include QoS Flow associated with the default QoS rule and the SMF does not receive response from the UE, the SMF marks that the status of those QoS Flows is to be synchronized with the UE.
16	SMF sends ChargingDataUpdateReq by including Multi-Unit-Usage with Rating-Group-Id that are received as part of Charging_Description of Sm_PolicyControl_UpdateNotify_Request to install PCC Rules.
17	CHF provides ChargingDataUpdtaeResp with Multi-Unit-Information for received Rating-Group values in requested message. CHF also provides parameter changes for Session-Level and Rating-Group values.
18	The SMF updates N4 session of the UPF(s) that are involved in the PDU Session Modification by sending N4 Session Modification Request (N4 Session ID) message to the PCF. For a PDU Session of Ethernet PDU Session Type, the SMF notifies the PCF to add or remove Ethernet Packet Filter Set(s) and forwarding rule(s). The UPFs that are impacted in the PDU Session Modification procedure depend on the modified QoS parameters and the deployment. For example, in case of the session AMBR of a PDU Session with UL flow classifier (CL) changes, only the UL CL is involved.
19	The PCF sends an N4 session modification response message containing any information that the PCF has to provide to the SMF in response to the control information received.
20	For PCF-initiated policy modification case, the SMF notifies the PCF whether the PCC decision could be enforced or not by performing an SMF-initiated SM Policy Association Modification procedure as defined in 3GPP TS 23.502, Section 4.16.5.1. The SMF notifies any entity that has subscribed to User Location Information related with PDU Session change.
21	The PCF sends an Npcf_SMPolicyControl_Update response with updated policy information about the PDU session.

VoNR MT Call Handling Procedure

This section describes the VoNR MT call handling procedure.

Figure 3: VoNR MT Call Handling Flow

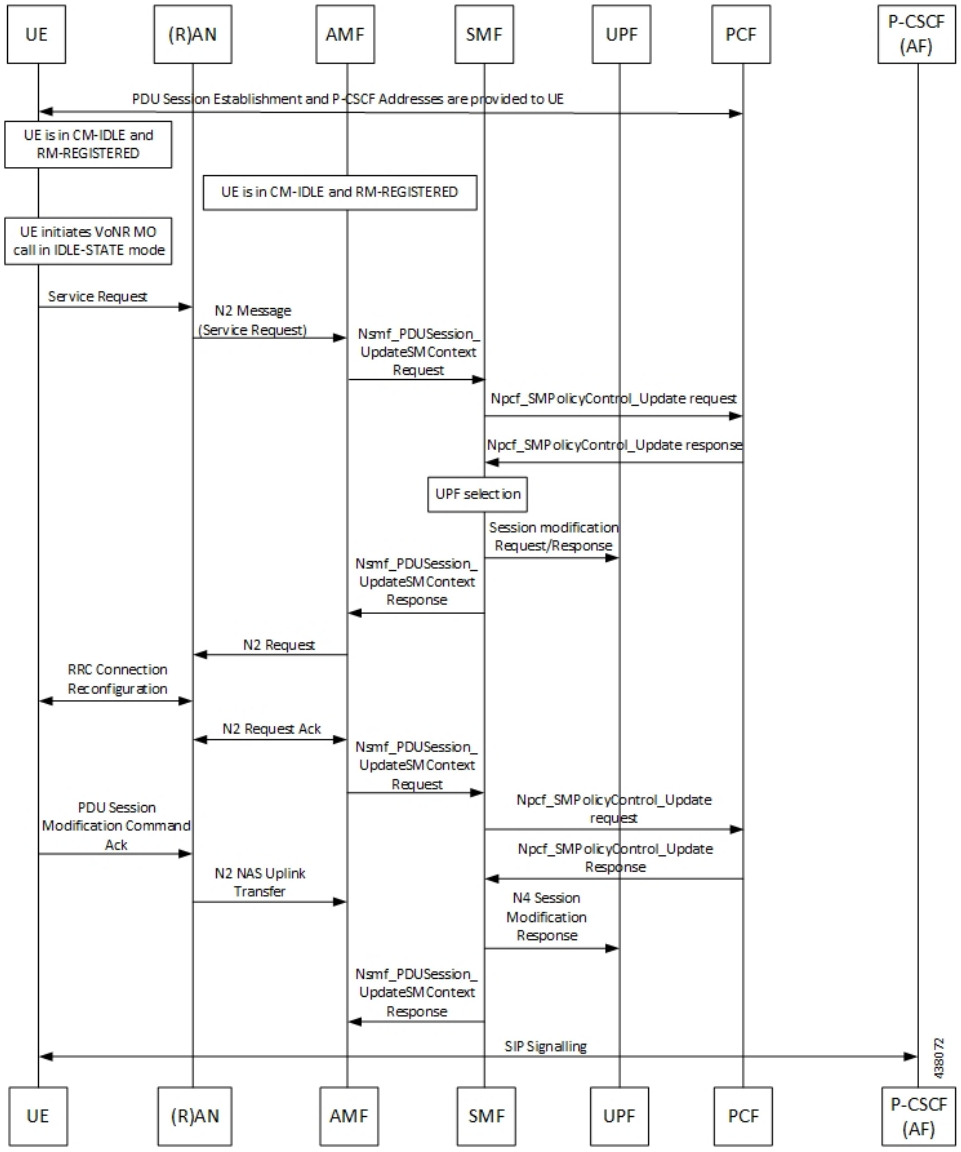


The VoNR MT call handling procedure remains the same as the VoNR MO call handling procedure except for the SIP Registration Request initiated from UE to P-CSCF(AF) through the UPF.

VoNR MO Call Flow for UE in Idle Mode

This section describes the VoNR MO call handling procedure when the UE is in idle mode.

Figure 4: VoNR MO Call Handling Flow for UE in Idle Mode



Step	Description
1	The SMF performs the PDU session establishment as described in VoNR PDU Session Creation Call Flow, on page 2 section, and fetches the P-CSCF addresses for sending it to the UE. The SMF programs UPF with Paging Policy Differentiation (PPD) for the respective PDU session as part of N4 interface by provisioning flows, and traffic detection information for every PDR.
2	The UE maintains its state in CM-IDLE and RM-REGISTERED.
3	The UPF maintains the UE in CM-IDLE and RM-REGISTERED state.
4	The UE initiates the VoNR call in CM-IDLE state.

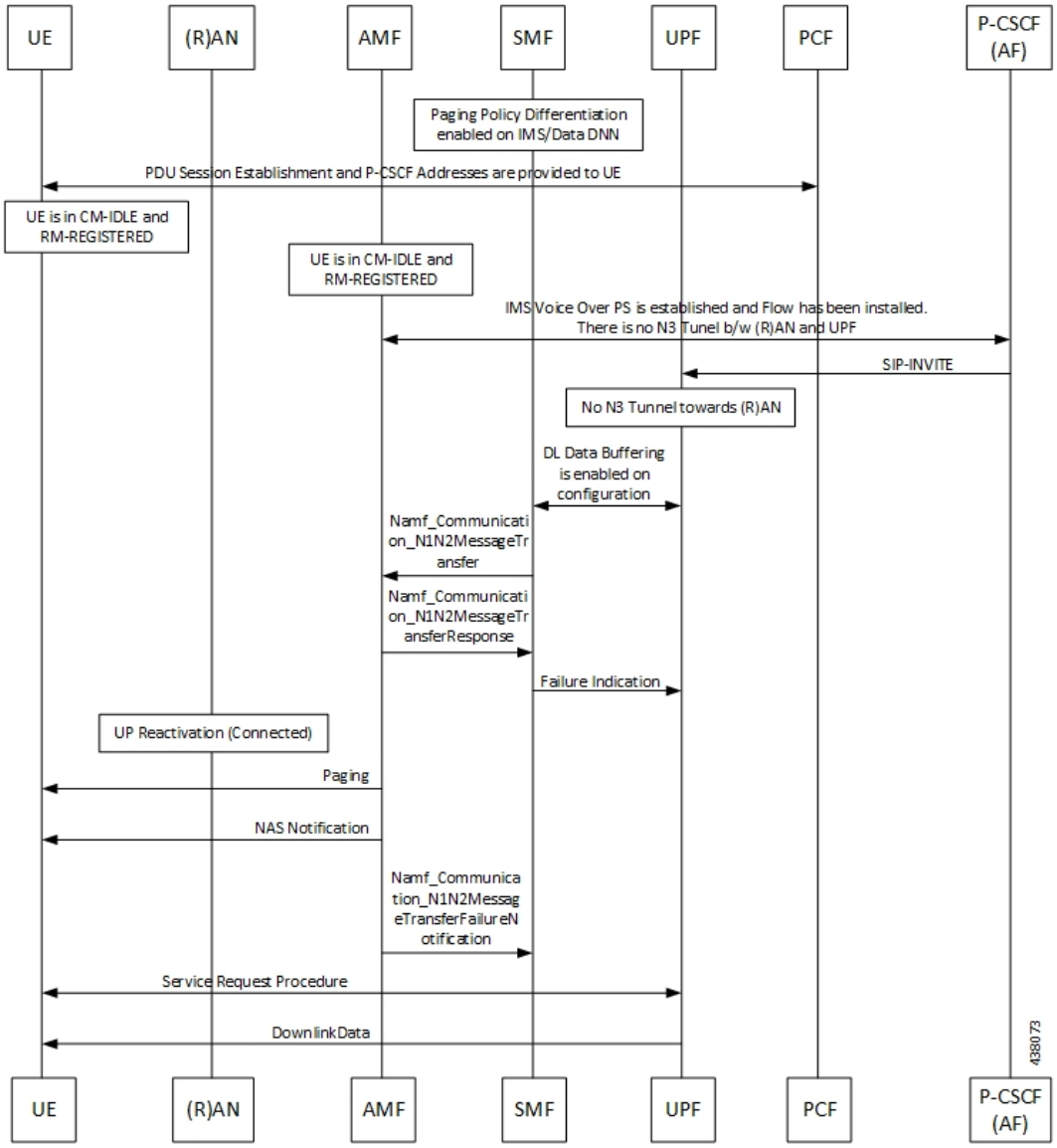
Step	Description
5	The UE performs Service-Request procedures as defined in 3GPP TS 23.502.
6	The RAN sends N2 message (service request) to the AMF.
7	The AMF sends Nsmf_PDUSession_UpdateSMContext Request (PDU Session ID(s), Operation Type, UE Location information, Access Type, RAT Type, UE presence in LADN service area, Indication of Access Type can be changed) to the SMF.
8	If the AMF notifies the SMF that the access type of the PDU session can be changed, and if the PCC is deployed, the SMF performs an SMF-initiated SM Policy Association Modification procedure as defined in 3GPP TS 23.502, Section 4.16.5.1.
9	The PCF provides the updated PCC Rule(s) to the SMF.
10	The SMF performs the UPF selection. **NOTE**: Selection of multiple or other UPFs is currently not supported.
11	The SMF initiates an N4 Session Modification request to the UPF. The SMF provides (R)AN Tunnel Info and the corresponding forwarding rules to the UPF. The UPF provides an N4 Session Modification Response to the SMF.
12	The SMF sends Nsmf_PDUSession_UpdateSMContext Response (N2 SM information (PDU Session ID, QFI(s), QoS profile(s), CN N3 Tunnel Info, S-NSSAI, User Plane Security Enforcement, UE Integrity Protection Maximum Data Rate), N1 SM Container, Cause) to the AMF. The SMF sends N1 SM Container and/or N2 SM Information to the AMF when applicable.
13	The AMF sends N2 Request (N2 SM information received from SMF, security context, Mobility Restriction List, Subscribed UE-AMBR, MM NAS Service Accept, list of recommended cells, TAs, NG-RAN node identifiers, UE Radio Capability, Core Network Assistance Information, Tracing Requirements) to the (R)AN.
14	The NG-RAN performs RRC Connection Reconfiguration with the UE depending on the QoS Information for all the QoS Flows of the PDU sessions whose UP connections are activated, and Data Radio Bearers.
15	The (R)AN sends N2 Request Acknowledgement message (N2 SM information (AN Tunnel Info, List of accepted QoS Flows for the PDU Sessions whose UP connections are activated, List of rejected QoS Flows for the PDU Sessions whose UP connections are activated), PDU Session ID) to the AMF. The N2 Request ACK message includes N2 SM information, for example, AN Tunnel Info. NG-RAN responds N2 SM information with separate N2 message (for example, N2 tunnel setup response) if the AMF sends separate N2 message.

Step	Description
16	The AMF sends Nsmf_PDUSession_UpdateSMContext Request (N2 SM information, RAT Type, Access Type) per PDU Session to the SMF. The AMF determines Access Type and RAT Type based on the Global RAN Node ID associated with the N2 interface. If the AMF received N2 SM information (one or multiple), then the AMF forwards the N2 SM information to the relevant SMF per PDU Session ID. If the UE Time Zone has changed compared to the last reported UE Time Zone, then the AMF includes the UE Time Zone IE in this message.
17	The SMF notifies the PCF whether the PCC decision could be enforced or not by performing an SMF-initiated SM Policy Association Modification procedure as defined in 3GPP TS 23.502, Section 4.16.5.1. The SMF notifies any entity that has subscribed to User Location Information related with PDU Session change.
18	The PCF sends an Npcf_SMPolicyControl_Update response with updated policy information about the PDU session.
19	The SMF updates N4 session of the UPF(s) that are involved in the PDU session modification by sending N4 Session Modification Request (N4 Session ID) message to the UPF. For a PDU session of Ethernet PDU Session Type, the SMF notifies the UPF to add or remove Ethernet Packet Filter Set(s) and forwarding rule(s). The UPFs that are impacted in the PDU Session Modification procedure depend on the modified QoS parameters and the deployment. For example, in case of the session AMBR of a PDU session with UL CL changes, only the UL CL is involved. The UPF sends an N4 session modification response message containing any information that the UPF has to provide to the SMF in response to the control information received.
20	The SMF sends a Nsmf_PDUSession_UpdateSMContext Response. The N2 SM information includes Secondary RAT Usage Data.

VoNR MT Call Flow for UE in Idle Mode

This section describes the VoNR MT call handling procedure when the UE is in idle mode.

Figure 5: VoNR MT Call Flow for UE in Idle Mode



The VoNR MT call flow remains the same as the VoNR MO call flow for service request when the UE is in CM-IDLE state except the following:

- The SIP-INVITE received by P-CSCF
- The PCC rule enforcements triggered from PCF towards SMF.

NOTE: The PCC rules, QoS, PDR, and traffic detection rule enforcements remain the same as the VoNR MT Call Handling procedure as defined in VoNR MT Call Handling Procedure, on page 13VoNR MT Call Handling Procedure.

When the AMF receives Namf_Communication_N1N2MessageTransfer Request (N2 SM information (PDU Session ID, QFI(s), QoS Profile(s), Session-AMBR), N1 SM container (PDU Session Modification Command (PDU Session ID, QoS rule(s), QoS Flow level parameters if needed for the QoS Flow(s) associated with the

QoS rule(s), QoS rule operation, and QoS Flow level parameters operation, Session-AMBR))) when the UE is in CM-IDLE state. If the UE is in CM-IDLE state and an Asynchronous type communication (ATC) is activated, the AMF updates and stores the UE context based on the Namf_Communication_N1N2MessageTransfer.

The AMF performs paging operations to the UE, and the UE triggers service request procedure. Once the paging is established, the AMF decides QoS Flows, QoS rules, and Session-AMBR that need to be accepted, which are received in Namf_Communication_N1N2MessageTransfer Request and the AMF performs Nsmf_PDUSession_UpdateSMContext operation with SMF to notify on accepting the QoS Flows, QoS rules, session-AMBR, and so on.

Paging Policy Differentiation Support

Feature Description

The SMF supports Paging Policy Differentiation feature by providing a configuration at PLMN, DNN, and 5QI level for data and IMS DNN sessions of the UE. The SMF provides Paging Policy Indicator based on UPF data. The SMF also supports QoS flow (PPI, ARP, and 5QI) towards the AMF over N11 interface.

Call Flows

This section describes the call flows associated with this feature.

VoNR Paging Policy Differentiation Procedure

This section describes the VoNR Paging Policy Differentiation procedure.

Figure 6: VoNR Paging Policy Differentiation Call Flow

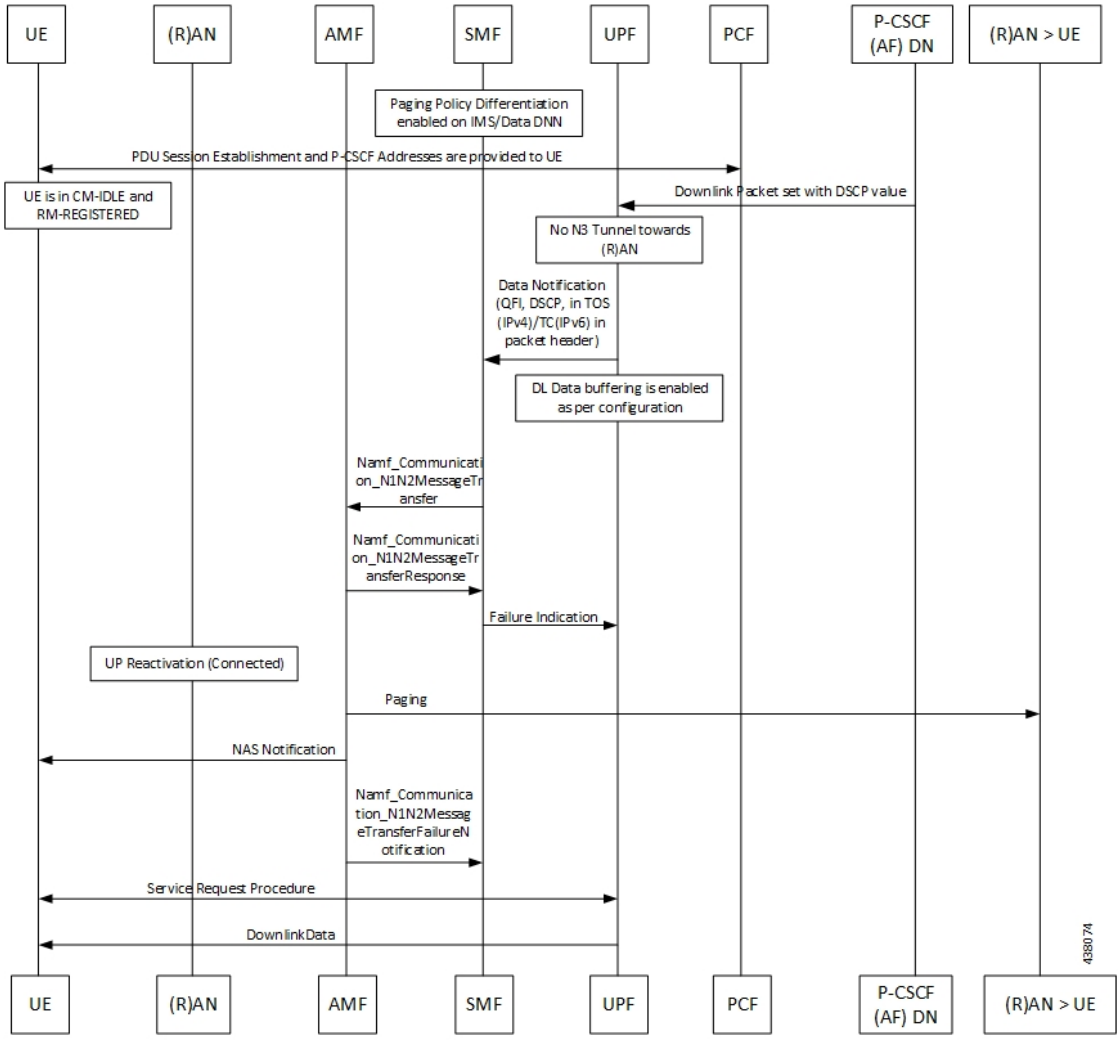


Table 5: VoNR Paging Policy Differentiation Call Flow Description

Step	Description
1	The SMF enables Paging Policy Differentiation (PPD) under DNN profile based on DNN, 5QI, and PLMN.
2	The SMF performs the PDU session establishment as described in VoNR PDU Session Creation Call Flow section, and fetches the P-CSCF addresses for sending it to the UE. The SMF programs UPF with PPD for the respective PDU session as part of N4 interface by provisioning flows, and traffic detection information for every PDR.
3	The UPF detects if any Downlink (DL) Packet is set with \nDSCP value (TOS in IPv4 / TC in IPv6) when PPD is enabled for the PDU session.
4	The UPF detects that there is no forwarding path as there is no N3 Tunnel for the DSP marked DL packets.

Step	Description
5	The UPF sends Data-Notification (QFI, DSCP in TOS (IPv4) / TC (IPv6) in packet header).
6	The UPF enables DL Data buffering based on the buffering configuration. The UPF sends Data Notification (N4 Session ID, Information to identify the QoS Flow for the DL data packet, DSCP) message to the SMF. **1.** On arrival of the first DL data packet for any QoS Flow, the UPF sends Data Notification message to the SMF, if the SMF has not previously notified the UPF (in which case the next steps are skipped). **2.** If the UPF receives DL data packets for another QoS Flow in the same PDU session, the UPF sends another Data Notification message to the SMF. **3.** If the Paging Policy Differentiation feature (as specified in TS 23.501, section 5.4.3) is supported by the UPF and if the PDU Session type is IP, the UPF includes the DSCP in TOS (IPv4) / TC (IPv6) value from the IP header of the DL data packet and the information to identify the QoS Flow for the DL data packet. **4.** The SMF sends the Data Notification Acknowledgement message to the UPF. **5.** The UPF forwards the DL data packets towards the SMF on request. The SMF buffers the data packets.
7	The SMF determines the AMF and invokes the Namf_Communication_N1N2MessageTransfer to the AMF including the PDU Session ID based on N4 Session ID. The SMF, while waiting for the User Plane Connection to be activated, receives additional Data Notification message. The SMF derives a different Paging Policy Indicator according to the additional Data Notification or the DSCP of the data packet. The SMF invokes a new Namf_Communication_N1N2MessageTransfer indicating the higher priority or different Paging Policy Indicator to the AMF. When supporting Paging Policy Differentiation, the SMF determines the Paging Policy Indicator related to the downlink data that has been received from the UPF or triggered the Data Notification message, based on the DSCP as described in 3GPP TS 23.501, section 5.4.3. The SMF indicates the Paging Policy Indicator in the Namf_Communication_N1N2MessageTransfer.
8	The AMF sends Namf_Communication_N1N2MessageTransfer response to the SMF with a cause “Attempting to reach UE" if the UE is in CM_IDLE State. If the UE is in CM-CONNECTED state, then the AMF sends a Namf_Communication_N1N2MessageTransfer response to the SMF immediately with a cause "N1/N2 transfer success".
9	The SMF sends Failure Indication to the UPF on receiving a negative response from AMF.
10	The AMF initiates paging towards the UE through the (R)AN.
11	The AMF initiates NAS Notification towards the UE.

Step	Description
12	The AMF notifies the SMF by sending Namf_Communications_N1N2MessageTransfer Failure Notification to the Notification Target Address provided by the SMF if the UE does not respond to paging. The AMF is unaware of an ongoing Mobility Management (MM) procedure that prevents the UE from responding. The AMF receives an N14 Context Request message indicating that the UE performs Registration procedure with another AMF.
13	If the UE is in CM-IDLE state, upon receiving a paging request for a PDU session associated to 3GPP access, the UE initiates the UE Triggered Service Request procedure as defined in 3GPP TS 23.502, Section 4.2.3.2.

Configuring the VoNR Paging Profile Differentiation

This section describes how to configure VoNR Paging Profile Differentiation feature.

Configuring VoNR Paging Profile Differentiation feature involves the following steps:

1. Creating PPD Profile
2. Configuring PPD Profile Parameters
3. Enabling PPD in DNN Profile Configuration

Creating PPD Profile

Use the following configuration to create an instance of PPD profile:

```
configure
   profile ppd ppd_profile_name
   end
```

NOTES:

- **ppd** *ppd_profile_name*: Specifies the PPD profile. This command creates a PPD profile and provides access to the PPD Profile Configuration mode. For details on the commands supported in this mode, see the *ppd-profile* section in this document. *ppd_profile_name* must be an alphanumeric string.

Configuring PPD Profile Parameters

Use the following configuration to define the PPD profile parameters:

```
configure
   profile ppd ppd_profile_name
      5qi 5qi_value
      dscp dscp_value { ppi ppi_value }
      end
```

NOTES:

- **5qi**: Specifies the list of 5QI Priority Level. *5qi_value* must be an integer in the range of 0-127. To list the different priority levels, use comma and hyphen as needed. For example, 5QI 3,10-15,65.

- **dscp** *dscp_value*: Specifies the DSCP value. *dscp_value* must be an integer in the range of 0-63.
- **ppi** *ppi_value:* Specifies the paging policy indicator value. *ppi_value* must be an integer in the range of 0-7.

Enabling PPD in DNN Profile Configuration

Use the following configuration to enable the PPD feature in the existing DNN profile configuration:

```
configure
   profile dnn dnn_profile_name
      ppd-profile ppd_profile_name
      end
```

NOTES:

- **ppd-profile** *ppd_profile_name*: This command defines the PPD profile to be associated with the DNN profile. *pdd_profile_name* must be the name of the configured PPD profile.
- This command enables the PPD feature in the DNN profile based on the configured values of DNN, 5QI, and PLMN.

Verifying the Feature Configuration

Use the following show command to verify the feature configuration details.

show running-config

The following is an example of the output of this show command:

```
product smf# show running-config
profile dnn dnntst1
pcscf-profile pcscf1
!
```

P-CSCF FQDN

Feature Description

The SMF sends the DNS queries to the DNS server through the DNS proxy server to fetch a maximum of two P-CSCF IP addresses. This operation helps in resolving the Fully Qualified Domain Name (FQDN) of the P-CSCF. This release provides the configuration support for the P-CSCF FQDN within the SMF profile.

For more information on the configuration commands, see the Configuring the P-CSCF FQDN, on page 24 section.

Relationships

The P-CSCF FQDN feature works only when the DNS proxy is configured. For more information on the DNS proxy configuration, see the *DNS Proxy Integration in SMF* chapter.

Configuring the P-CSCF FQDN

Use the following configuration to define the FQDN of the P-CSCF.

```
configure
   profile pcscf pcscf_profile_name
      fqdn domain_name
      end
```

NOTES:

- **pcscf-profile** *pcscf_profile_name*: Specifies the P-CSCF profile name, and enters into the P-CSCF Profile Configuration mode. *pcscf_profile_name* must be an alphanumeric string.
- **fqdn** *domain_name*: Specifies the FQDN of the P-CSCF server. *domain_name* must be an alphanumeric string.

Verifying the Feature Configuration

Use the following show command to verify the feature configuration details.

show running-config

The following is an example of the output of this show command:

```
profile ppd ppdtemp
5QI 3,10-15,65
dscp 15 ppi 2
dscp 20 ppi 3
!
profile dnn ims
ppd-profile ppdtemp
!
```