

Wireless Priority Services

Table 1: Feature History

Feature Name	Release Information	Description
Wireless priority paging enhancement	2026.03.0	This support ensures high-priority (WPS) calls receive correct network priority precedence by enabling the SMF to dynamically update or re-issue paging requests if an elevated priority is detected during an active paging procedure.
SBI Message Priority Enhancement	2023.04	The SBI Message Priority (SMP) mechanism uses the "3gpp-Sbi-Message-Priority" custom HTTP header to set and carry the message priority between the client and the server. The custom HTTP header enforces the message priority end to end between the client and the server through one or more proxies. **Note** Stream Priority mechanism is not supported.

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Feature Summary and Revision History

Summary Data

Table 2: 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 3: Revision History

Revision Details	Release
Enhancements to SBI Message Priority Mechanism and Message-Prioritization based on Procedures	2023.04.0
5QI Mapping support introduced	2023.03.0
UPF Interaction while Deleting WPS Dynamic Rule	2021.01.0
SBI Message Priority Mechanism and Message-Prioritization based on Procedures are introduced.	2021.01.0
The Wireless Priority Services feature is fully qualified in this release.	2020.03.0
First introduced. This feature is not fully qualified in this release. For more information, contact your Cisco Account representative.	2020.02.0

Feature Description

The Wireless Priority Services (WPS) feature is supported on the SMF over 5GC. The SMF validates prioritization of WPS services for session creation or modification and various handover scenarios. The SMF also evaluates the WPS services for Paging-Policy Differentiation for Network Triggered Service Request procedures.

SMF also detects priority calls based on ARP through local configurations to classify sessions as WPS and allows users to use nonstandard QCIs in addition to ARP for WPS calls.

QoS properties corresponding to these nonstandard QCI values are configured locally on the gNB. SMF only supports values added on the SMF to map nonstandard QCI to DSCP values on the data path.

Important With release 2021.02.0, SMF will not set an MP flag in the N4 message while deleting the dynamic rule if no other existing rules ARP isn't matching wps-profile.

Use Cases

The WPS feature implements the 3GPP recommendations for wireless priority support for the following use cases in 5GS and EPS. The use cases are defined as per 3GPP TS 23.501 (sections 5.16.3, 5.16.4, 5.16.5, 5.16.6, 5.19, and 5.21).

WPS supports the following use cases:

- Multimedia Priority Services , on page 3
- DSCP Marking for N3, S5-U, or S2-B over PFCP, on page 8

Multimedia Priority Services

The Multimedia Priority Service (MPS) allows priority access to system resources to Service Users, creating the ability to deliver or complete sessions of a high priority nature. Service Users are government-authorized personnel, emergency management officials or other authorized users. MPS supports priority sessions on an "end-to-end" priority basis. MPS includes signalling priority and media priority.

MPS provides the ability to invoke, modify, maintain and release sessions with priority, and deliver the priority media packets under network congestion conditions.

All MPS-subscribed UEs get priority for QoS Flows (for example, used for IMS signalling) when established to the DN that is configured to have priority for a given Service User by configuring MPS-appropriate values in the QoS profile in the UDM. Service Users are treated as On Demand MPS subscribers and not On Demand MPS subscribers, based on regional or national regulatory requirements. On Demand service is based on Service User invocation or revocation explicitly and applied to the media QoS Flows being established. Not On Demand MPS service does not require invocation and provides priority treatment for all QoS Flows only to the DN that is configured to have priority for a given Service User after attachment to the 5G network.

Priority treatment for MPS includes priority message handling for Mobility Management procedures. Priority treatment for MPS session requires appropriate ARP and 5QI setting for QoS Flows according to the operator's policy.

MPS priority mechanisms can be classified as subscription-related mechanism and invocation-related mechanism. Subscription-related mechanisms can be applied as "always applied" and "conditionally applied".

Subscription-related mechanisms that are conditionally applied include:

- UDM—One or more ARP priority levels are assigned for prioritized or critical services. The ARP of the prioritized QoS Flows for each DN is configured to an appropriate ARP priority level.
- PCF—The "IMS Signalling Priority" information is configured for the subscriber in the UDM, and the PCF modifies the ARP of the QoS Flow used for IMS signalling.

Invocation-related mechanisms can be applied for mobile-originated SIP call or sessions, for mobile-terminated SIP call or sessions, and for Priority PDU connectivity services.

On-Demand MPS Service

The invocation-related priority mechanisms for prioritized services are based on communication with an Application Server and between the Application Server and the PCF over Rx or N5 interface (as described in 3GPP TS 23.228, clause 5.21, in the case of MPS using IMS).

Invocation-related mechanisms for Mobile Originations (for example, through SIP or IMS) are explained as follows:

- PCF:
  - When an indication for a session reaches over the Rx or N5 interface and the UE does not have priority for the signaling QoS Flow, the PCF derives the ARP and 5QI parameters plus associated QoS characteristics as appropriate, as per the Service Provider policy (specified in 3GPP TS 23.503, clause 6.1.3.11).
  - For MPS sessions, when establishing or modifying a QoS Flow as part of the session origination procedure, the PCF selects the ARP and 5QI parameters, and the associated QoS characteristics, as appropriate, to provide priority to the QoS Flows.
  - When all active sessions to a particular DN are released and the UE is not configured for priority treatment to that particular PDU session, the PCF downgrades the IMS Signaling QoS Flows from appropriate settings of the ARP and 5QI parameters and the associated QoS characteristics, as appropriate, to those entitled by the UE based on subscription.

Invocation-related mechanisms for Mobile Terminations (for example, through SIP or IMS) are explained as follows:

- PCF: When an indication for a session reaches over the Rx or N5 interface, the mechanisms as described above for Mobile Originations are applied.
- UPF: If an IP packet arrives at the UPF for a UE that is CM-IDLE, the UPF sends a "Data Notification" including the information to identify the QoS Flow for the DL data packet to the SMF (specified in 3GPP TS 23.502, clause 4.2.3.3.
- SMF: If the SMF receives the "Data Notification" message for a QoS Flow associated with an ARP priority level value for priority use, delivery of priority indication during the Paging procedure is provided by inclusion of the ARP in the N11 interface "N1N2MessageTransfer" message (specified in 3GPP TS 23.502, clause 4.2.3.3).
- AMF: If the AMF receives the "N1N2MessageTransfer" message containing an ARP priority level value for priority use, the AMF handles the request with priority. AMF also includes the "Paging Priority" IE in the N2 "Paging" message configured to a value assigned to indicate about an existing IP packet at the UPF requiring higher priority (specified in 3GPP TS 23.502, clause 4.2.3.3).
- SMF: For a UE that is not configured for a higher priority, upon receiving the "N7 Session Management Policy Modification" message from the PCF with an ARP priority level for priority use, the SMF sends an "N1N2MessageTransfer" to update the ARP for the Signaling QoS Flows (specified in 3GPP TS 23.502, clause 4.3.3.2).
- AMF: After receiving the "N1N2MessageTransfer" message from the SMF with an ARP priority level for priority use, the AMF updates the ARP for the Signaling QoS Flows (specified in 3GPP TS 23.502, clause 4.3.3.2).

- (R)AN: Inclusion of the "Paging Priority" in the N2 "Paging" message triggers priority handling of paging during congestion at the (R)AN (specified in 3GPP TS 23.502, clause 4.2.3.3).

Invocation-related mechanisms for the Priority PDU connectivity services:

- PCF:
  - If the state of the Priority PDU connectivity services is modified from disabled to enabled, the QoS Flows controlled by the Priority PDU connectivity services are established or modified to have the service appropriate configuration of the ARP and 5QI parameters and the associated QoS characteristics, using the PDU Session Modification procedure (specified in of 3GPP TS 23.502, clause 4.3.3).
  - If the state of Priority PDU connectivity services is modified from enabled to disabled, the QoS Flows controlled by the Priority PDU connectivity services are modified from service appropriate configuration of the ARP and 5QI parameters and the associated QoS characteristics, to those entitled by the UE as per subscription, using the PDU Session Modification procedure (specified in 3GPP TS 23.502 clause 4.3.3).

Message-Priority Indication over GTP-C

An overloaded node performs message prioritization when handling incoming messages during an overloaded condition. This condition is based on the relative GTP-C message priority signaled in the GTP-C header.

When message throttling is performed:

- GTP requests related to priority traffic (eMPS as described in 3GPP TS 22.153) and emergency have the highest priority. Depending on regional or national requirements and the network operator policy, these GTP requests are the last to be throttled when applying traffic reduction. The priority traffic is exempted from throttling due to GTP overload control up to the point where the requested traffic reduction cannot be achieved without throttling the priority traffic.
- For other types of sessions, message throttling considers the relative priority of the messages so that low priority messages are considered for throttling before the other messages. The relative priority of the messages is derived from the relative priority of the procedure for which the message is being sent (as specified in clause 12.3.9.3.2) or derived from the session parameters such as APN and ARP.

The high priority messages are given lower preference to throttle and low priority messages are given higher preference to throttle. An overloaded node also applies these message prioritization schemes when handling incoming initial messages during an overloaded condition, as part of the self-protection mechanism.

A sending GTP-C entity determines the relative message priority to signal in the message according to either procedure based or session parameters. If the message affects multiple bearers (for example, Modify Bearer Request), the relative message priority considers the highest priority ARP among all the bearers.

A GTP-C entity sets the same message priority in a Triggered message or Triggered Reply message as received in the corresponding Initial message or Triggered message respectively. For incoming GTP-C messages that do not have a message priority in the GTP-C header, the receiving GTP-C entity:

- Applies a default priority if the incoming message is an Initial message.
- Applies the message priority sent in the Initial message or Triggered message if the incoming message is a Triggered message or Triggered Reply message.

The nodes in the network homogenously support this feature to prevent an overloaded node to process initial messages received from the non-supporting nodes. These messages are received according to the default priority. The overloaded node processes initial messages that are received from the supporting nodes according to the message priority signaled in the GTP-C message.

Message-Prioritization based on Session Parameters

Message prioritization is also performed based on the session parameters, such as APN and ARP. The procedures and messages associated with the higher priority sessions are given lesser priority while throttling than the procedures and messages associated with the lower priority sessions. Within each group of sessions, the messages are further prioritized based on the category of the procedure for which the message is being sent.

Message Prioritization Based on Procedures

Message prioritization is performed based on the relative priority of the procedure for which the message is being sent. Procedures are grouped into various categories and each of these categories are assigned a priority. In addition, within a given category of procedures, messages can be further prioritized based on session parameters, such as APN, QCI, ARP or LAPI.

Messages with a high priority are given lower preference to throttle and messages with low priority are given higher preference to throttle. The grouping of the procedures isn't performed based on an individual GTP-C entity but while considering all the procedures in general. A GTP-C entity considers the procedures applicable to it and prioritizes message throttling based on the category of the procedure. The categories are listed in decreasing order of priority with category 1 having the highest priority. For each category, a nonexhaustive list of messages is provided. Any existing or newly defined message in future is considered based on the category of the procedure for which the message is sent. Following are the categories of a procedure:

1. UE session mobility within and across 3GPP or non-3GPP access—Procedures involving active or idle mode UE mobility, such that GTP-C signalling involved are classified under this category. Some examples are X2 or S1 based handover with or without an SGW change, TAU or RAU with a change of MMEor SGSN with or without an SGW change, and 3GPP access to trusted non-3GPP access handover. Throttling of these messages during the procedures related to UE session mobility results in the failure of the corresponding procedures. This failure can cause PDN disconnection or the interruption of the services. As a result, the following messages, when sent during the procedures belonging to this category, must be considered with the highest priority. Hence, these messages are given the lowest preference to throttle.
   - Create Session Request.
   - Create Session Request with "handover" indication bit set.
   - Modify Bearer Request.
   - Modify Bearer Request with "handover" indication bit set.
   - Modify Access Bearer Request.

2. Release of PDN connection or bearer resources—Procedures resulting in the deactivation of an existing PDN connection, the deactivation of bearers or of data forwarding tunnel of an UE leads to freeing up of the resources at the overloaded node. These procedures ease the overload situation as the freed up resources can be used for serving the remaining of the UEs. Hence, the following messages that belong to this category and cause the deactivation of PDN connection or bearers or data forwarding tunnels, must be treated with the next lower level of priority. Hence, these messages are given the corresponding preference whilst throttling:

- Delete Session Request.
- Delete Bearer Request.
- Delete Bearer Command.
- Delete Indirect Data Forwarding Tunnel Request.

3. Miscellaneous session management procedures—This category consists of the session management procedures, except the PDN connection creation and bearer creation or modification procedures. Some examples are location reporting, when it isn't combined with other mobility procedures and Service request and S1 release procedure. These procedures do not impact the ongoing service of the UE. Hence, the following messages when sent during the procedures identified under this category, must be treated with the next lower level of priority. Hence, these messages are given the corresponding preference whilst throttling.
   - Release Access Bearer Request.
   - Modify Bearer Request.
   - Change Notification.
   - Suspend Notification.
   - Resume Notification.

4. Request for new PDN Connection or bearer resources or modification of existing bearer resources—This category consists of the procedures requesting the creation of PDN connection, creation or modification of bearers, or creation of data forwarding tunnel. Throttling of the messages belonging to this category cause denial of new services while continuing with the existing services. In this overload condition, an overloaded node, due to lack of resources, isn't able to provide new services while trying to maintain the existing services. When the following messages are sent during the procedures belonging to this category are considered with the lowest level of priority. Hence, these messages are given highest preference to throttle:
   - Create Session Request during PDN connection request.
   - Create Bearer Request.
   - Update Bearer Request.
   - Bearer Resource Command.
   - Modify Bearer Command.
   - Create Indirect Data Forwarding Tunnel Request.
   - Downgrade the DSCP marking of the data packets for the session when quota exhausts.

Message-Priority Header for PFCP

When the message throttling is performed:

- PFCP requests related to priority traffic (that is, eMPS as described in 3GPP TS 22.153) and emergency have the highest priority. Depending on regional or national requirements and network operator policy, these PFCP requests are the last to be throttled when applying traffic reduction. Throttling exempts the

priority traffic due to PFCP overload control up to the point where the requested traffic reduction cannot be achieved without throttling the priority traffic.

- For other types of sessions, the message throttling considers the relative priority of the messages so that the messages with low priority are first considered for the throttling. The relative priority of the messages is derived from the relative priority of the procedure for which the message is being sent or derived from the session parameters such as APN and ARP.

A PFCP entity determines whether to configure and use the message priority in PFCP signalling, based on operator policy. A sending PFCP entity determines the relative message priority to signal in the message which are derived from the session parameters, such as APN and ARP. If the message affects multiple bearers, the relative message priority is determined considering the highest priority ARP among all the bearers. A PFCP entity must configure the same message priority in a Response message as received in the corresponding Request message.

For incoming PFCP messages that do not have a message priority in the PFCP header, the receiving PFCP entity:

- Applies a default priority if the incoming message is a Request message.
- Applies the message priority sent in the Request message if the incoming message is a Response message.

The SMF and UPF functions in the network homogenously support this feature to prevent an overloaded node to process the Request messages received from the non-supporting nodes according to the default priority. With this support, an overloaded node does not need to process the Request messages received from supporting nodes according to the message priority signalled in the PFCP message.

DSCP Marking for N3, S5-U, or S2-B over PFCP

Transport Level Marking

Transport level marking is the process of marking traffic with a DSCP value based on the locally configured mapping from the QCI and optionally the ARP priority level. For EPC, the S-GW and PGW-C perform transport level marking on a per EPS bearer basis. For 5GC, the S-GW and PGW-C perform transport level marking on a per QoS flow basis.

The UPF performs transport level marking with a DSCP value based on the mapping from the 5QI, the Priority Level (if explicitly signaled), and optionally the ARP priority level configured at the SMF. The CP function controls transport level marking by providing the DSCP in the ToS or Traffic Class within the Transport Level Marking IE in the FAR (associated to the PDR matching the traffic to be marked).

The UP function performs transport level marking for the detected traffic and sends the marked packet to the peer entity. The CP function changes transport level marking by changing the Transport Level Marking IE in the related FAR.

WPS Profile Support

The SMF+PGW-C supports the WPS profile defined with ARP and DSCP marking value to be configured for GTP-C and PFCP Protocol IP-headers. Use the WPS profile to configure the message priority in the GTP-C and PFCP protocols.

The SMF+PGW-C allows a maximum of 64 WPS profiles and each WPS profile is associated in the DNN profile. For more information, see the Configuring Wireless Priority Services, on page 12 section.

SBI Message Priority Mechanism

The primary usage of SBI Message Priority (SMP) is to provide guidance to 5GC NF acting as HTTP/2 clients or servers while making throttling decisions related to overload control. You can use the priority information for routing in the proxies. Eventually a server uses the priority information to process higher-priority requests before lower-priority requests. The SMP mechanism uses the "3gpp-Sbi-Message-Priority" custom HTTP header to set and carry the message priority between the client and the server. The custom HTTP header enforces the message priority end to end between the client and the server through one or more proxies.

Note Stream Priority mechanism is not supported.

The header contains the HTTP/2 message priority value: The encoding of the header follows the ABNF as defined in IETF RFC 7230 [12].

```
3gpp-Sbi-Message-Priority = "3gpp-Sbi-Message-Priority" ":" (DIGIT / %x31-32 DIGIT / "3"
%x30-31)
```

A message with

```
3gpp-Sbi-Message-Priority "0"
```

has the highest priority.

Example:

```
3gpp-Sbi-Message-Priority: 10
```

How it works

The SBI Message Priority Mechanism functions in the following way:

- A client, proxy, and a server uses the **3gpp-Sbi-Message-Priority** value while configuring or evaluating the priority of a message.
- The client assigns the request priority by adding the **3gpp-Sbi-Message-Priority** custom HTTP header to the message and setting its value.
- If the server assigns a different priority to the response message then the server assigns the response priority by adding the **3gpp-Sbi-Message-Priority** custom HTTP header to the message and setting its value.

For more information on the configurations, see the *Configuring Message Priority Profile* and *Association of Message Priority Profile* .

WPS Session Critical Information

Following are the important WPS session critical information:

- SMF does not identify a session as WPS during establishment and hence priority tagging based on establishment is not possible on the SMF. SMF is not aware of MCS and MPS subscription or establishment causes.
- SMF does not support any special access rights enforcement for WPS session configuration or for WPS session monitoring.
- SMF does not support any hardware isolation between WPS and non-WPS users.

- IPSEC support on N4 is not supported for WPS. IPSEC is enabled at interface/peer level.
- Upgrade the UPF before the SMF for the SBI message priority feature to work smoothly. Otherwise, configure the new priority values on the SMF only after UPF is upgraded. UPF supports Message Priority (MP) values 1 to 3 in older releases. If SMF gets upgraded first, and new configuration gets applied on the N4 interface, then UPF ignores new values and treats those sessions as normal call.
- If new priority values are configured post upgrade, then on the UPF, old sessions uses old MP values that were applied before the upgrade and new sessions uses new MP values. Due to this there can be conflicting MP values for sessions of same type and session recovery based on the priority does not work as expected untill MP values of old sessions gets updated. MP values of old sessions gets updated during subsequent N4 modification from SMF.
- If a message priority profile is associated to any QoS profile or DNN profile or WPS profile, SMF enables this SBI message priority feature. Else, the SBI message priority feature remains disabled and SMF sends the hardcoded values as before on N4 and GTP interfaces.

Session Type Conflict Resolution at SMF

Under the following criteria there can be session type conflict resolution at SMF:

- SMF tags a session as emergency, if the DNN is tagged to emergency or if a session gets created automatically.
- SMF tags a session as IMS, when a Bearer/flow gets created with the QCI configured as IMS under the DNN profile.
- SMF tags a session as WPS based on the ARP received from PCF.

When a session satisfies multiple conditions, a session type gets tagged based on the following criteria.

```
WPS > Emergency > IMS
```

SMF does not send any session type to the UPF. UPF maps the session to priority through configuration. For more information, see the *UPF Configuration Guide*.

WPS Session VLAN Tagging

SMF does not allocate a separate VLAN for WPS during session establishment. SMF supports configuration of nexthop address per address range in an ip-pool. UPF maps nexthop to the VLAN.

How it Works

This section describes how Wireless Priority Service (WPS) feature works.

Standards Compliance

The Wireless Priority Services feature complies with the following standards:

- 3GPP TS 22.153
- 3GPP TS 23.228
- 3GPP TS 23.282

- 3GPP TS 23.379
- 3GPP TS 23.501
- 3GPP TS 23.502
- 3GPP TS 23.503
- 3GPP TS 24.301

5QI Mapping Support

Feature Description

SMF currently detects priority calls (WPS) based on ARP. To use QCI in addition to ARP for WPS calls, SMF supports 5QI Remapping functionality to enable mapping of nonstandard QCI with the standard QCI, which UE can understand.

The SMF facilitates the following functions:

- **Seamless handover to 4G**: The SMF remaps the QCI sent in a mapped EPS QoS parameter with a mapped EPS bearer context to the configured value.
- **Seamless handover to 5G**: The SMF remaps the QCI sent in QoS Flow description in the protocol configuration option in the Create Session Response, Create Bearer Request, and Update Bearer Request.

QCI Modification for Dynamic Rules

In certain scenarios, existing sessions can be upgraded from non-WPS to WPS or downgraded from WPS to non-WPS. In such cases, the PCF sends an N7 notification to the SMF along with a new QCI/ARP (QoS Class Identifier/Allocation and Retention Priority).

If the new QCI is configured to be NAS-remapped, the SMF includes the remapped QCI in the parameter list of QoS Flow Descriptions within the N1 modification command message sent to the UE (User Equipment) if it is connected to a 5G RAT (Radio Access Technology).

For UEs connected to 4G or Wi-Fi RATs, the remapped QCI is sent within the QoS Flow Description as part of the protocol configuration option in the Update Bearer request.

During Wi-Fi Handover, if the PCF sends a nonstandard QCI for which the SMF has a remapping configuration, the remapped QCI specified in the configuration is sent to the UE in the N1 PDU (Protocol Data Unit) establishment response, the Create Session response, or the Create Bearer Request.

SMF remaps configuration and any run time configuration change is applied only during the following procedures:

- New default bearer session creation
- New QoS flow or bearer creation request from PCF
- QCI upgrade or downgrade from PCF
- Wi-Fi handover

For more information, see the Remapping Nonstandard QCI to Standard QCI, on page 15.

Collision Between Original QCI and Remapped QCI

If there is a collision between existing bearer with new bearer with the same QCI or mapped QCI, SMF rejects some QoS flow configurations based on the following conditions:

- If the PCF sends a QCI, which gets remapped to an existing QCI associated with a flow or bearer, the SMF rejects the creation of the bearer or any QCI upgrade or downgrade request.
- If the PCF sends a QCI for the creation of a new bearer/flow, and there is already an existing flow/bearer with the same remapped QCI, the SMF rejects the PCF's request for creating the new bearer.
- Given that the SMF is configured to remap QCI=x to QCI=y and QCI=z to QCI=y, if the PCF sends a rule with QCI=x, resulting in the creation of a flow/bearer, any subsequent request from the PCF with QCI=z is rejected by the SMF.

Example: The following remapping configuration is not allowed/accepted by the system:

- ```
  profile qos qosp-ims
      qosflow qi5 131 nas-remap 131
  ```
- ```
  profile qos qosp-ims
      qosflow qi5 131 nas-remap 132
      qosflow qi5 132 nas-remap 131
  ```
- ```
  profile qos qosp-ims
      qosflow qi5 131 nas-remap 132
      qosflow qi5 132 nas-remap 133
  ```

For more information, see the Remapping Nonstandard QCI to Standard QCI.

Configuring Wireless Priority Services

This section describes how to configure the Wireless Priority Services feature.

Configuring the WPS Profile

Use the following sample configuration to configure the WPS profile.

```
config
  profile wps wps_profilename
     arp arp_value
    dscp [ n3 n3_value | message-priority { [ { gtpc | pfcp } [ arp | dscp
 ] ] }
     end
```

NOTES:

- **profile wps** *wps_profilename*: Accesses the Wireless Priority Services Profile configuration. *wps_profilename* must be an alphanumeric string of 1 to 63 characters.
- **arp** *arp_value*: Specifies the range of ARP levels. *arp_value* must be an integer from 1 to 15 separated either by "," or "-".
```

Important If you are upgrading SMF from Release 2023.03.0 to a later release, make sure you manually reconfigure the ARP parameter in the WPS profile after the upgrade is complete.

- **dscp [n3** *n3_value* **]** : Specifies the DSCP marking value for the N3 interface. The N3 value indicates the UP DSCP marking value within the range 0 to 0x3F.
- **message-priority { gtpc pfcp }**: Specifies the message priority for GTP-C and PFCP.

Verifying the WPS Profile Configuration

This section describes how to verify the WPS Profile configuration.

Run the **show running-config** command to view the configuration.

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

```
show running-config profile wps wps1
   profile wps wps1
   arp 1,4-6,9
   dscp n3 10
   message-priority [ pfcp gtpc ]
   exit
```

Associating WPS Profile under DNN Profile

Use the following sample configuration to associate the WPS profile with the configured DNN profile.

```
config
  profile dnn profile_dnn_name
     wps-profile wps_profile_name
     end
```

NOTES:

- **wps-profile** *wps_profile_name*: Enables the Wireless Priority Services Profile configuration. This profile is configured under the existing DNN profile configuration.

Verifying WPS Profile under DNN Profile

This section describes how to verify the WPS profile configuration under the DNN profile.

Execute the **show running-config** command to view the configuration.

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

```
show running-config profile dnn intershat
profile dnn intershat
network-element-profiles chf chf1
network-element-profiles amf amf1
network-element-profiles pcf pcf1
network-element-profiles udm udm1
charging-profile chgprf1
virtual-mac b6:6d:47:47:47:47
wps-profile wps1
ssc-mode 2 allowed [ 3 ]
```

```
session type IPV4 allowed [ IPV6 IPV4V6 ]
upf apn intershat
exit
```

Configuration Verification

To view the WPS parameters per subscriber session, use the **show subscriber** command.

The following is an example output of the **show subscriber** command.

```
show subscriber supi imsi-123456789012345 nf-service smf
subscriber-details
{
  "subResponses": [
    {
      "status": true,
      "genericInfo": {
        "supi": "imsi-123456789012345",
        "pei": "imei-123456786666660",
        "pduSessionId": 5,
        "pduSesstype": "Ipv4PduSession",
        "accessType": "3GPP_ACCESS",
        "dnn": "intershat",
        "plmnId": {
          "mcc": "123",
          "mnc": "456"
        },
        "sScMode": 1,
        "uetimeZone": "UTC+12:00",
        "allocatedIp": "209.165.200.233",
        "nrLocation": {
          "ncgi": {
            "mcc": "123",
            "mnc": "456",
            "nrCellId": "123456789"
          },
          "tai": {
            "mcc": "123",
            "mnc": "456",
            "tac": "1820"
          }
        },
        "alwaysOn": "None",
        "dcnr": "None",
        "wps": "Wps Session",
        "ratType": "NR",
        "ueType": "NR Capable UE",
        "sessTimeStamp": "2021-05-28 12:46:11.165805357 +0000 UTC",
        "callDuration": "2.925145554s",
        "ipPool": "poolv4",
        "commonId": 11,
        "snssai": {
          "sd": "Abf123",
          "sst": 2
        },
        .
        .
        .
```

Remapping Nonstandard QCI to Standard QCI

Use the following sample configuration to enable and remap the QCI sent in the QoS Flow parameter list to the needed configuration value. This remapping process is applicable for N1 PDU Establishment Accept and PDU Session Modification procedures.

```
config
   profile qos qos_profile_name
      dscp-map qi5 qos_id
      qosflow qi5 nonstandard_value nas-remap standard_value
      arp-priority-level arp_value uplink user-datagram dscp-marking
dscp_marking_value
      arp-priority-level arp_value downlink { encsp-header { copy-inner |
dscp-marking dscp_marking_value } | user-datagram dscp-marking dscp_marking_value
 } }
      commit
```

NOTES:

- **dscp-map qi5** *qos_id*: Specify the ID for the authorized QoS parameters. *qos_id* must be an integer in the range of 1–255.
- **qosflow qi5** *nonstandard_value* **nas-remap** *standard_value*: SMF remaps the 5QI that is sent in the parameter list in the QoS Flow descriptions to the configured value. **nas-remap** *standard_value* accepts the mapped 5QI value in the range 1–255. For example, **qosflow qi5** *131* **nas-remap***1*.
- **arp-priority-level** *arp_value* **uplink user-datagram dscp-marking** *dscp_marking_value*: Configure the ARP priority level and then set the DSCP value in the inner IP header in the uplink direction. This DSCP value is applied to the packets with the configured 5QI value.

  arp_value must be an integer in the range of 1–255.

  dscp_marking_value must be a hexadecimal number from 0x00 through 0x3F.
- **arp-priority-level** *arp_value* **downlink { encsp-header { copy-inner | dscp-marking** *dscp_marking_value* **} | user-datagram dscp-marking** *dscp_marking_value* **} }**: Configure the ARP priority level and then set the DSCP value to be applied to the encapsulation header or user datagram.

  If **encsp-header** is configured, set the DSCP in the outer-ip header in the downlink direction or copy the DSCP value from the inner IP header to the outer IP header.

  If **user-datagram** is configured, set the DSCP in the inner IP header in the downlink direction.

  arp_value must be an integer in the range of 1–255.

  dscp_marking_value must be a hexadecimal number from 0x00 through 0x3F.

The following is an example configuration.

```
[smf] smf(config)# profile qos qos_A5972
[smf] smf(config-qos-qos_A5972)# qosflow qi5 1
Possible completions:
  arp-priority-level
  downlink
  gfbr
  mfbr
  nas-remap
  uplink
```

```
[smf] smf(config-qos-qos_A5972)# qosflow qi5 1 nas-remap 2
```

Configuring Message Priority Profiles

Use the following sample configuration to configure a message-priority for all interfaces.

```
config
     profile message-priority msg_priority_profile_name
     interface [ any | pfcp | gtp | sbi [ { create | update | delete } ]
 ]
        priority value range
     exit
```

NOTES:

- **interface [any | pfcp | gtp | sbi [{ create | update | delete }]]**:
  - **interface [any | pfcp | gtp | sbi]** : Specify priority value per interface. For example, for the SBI interface, configure as per procedure. If a procedure is not configured, same value is applied for all procedures. Interface type is optional and if not configured, the same value is applied across all interfaces.
  - **priority** *value*: Specifies the range of priority levels 0–31 for sbi or 0–15 for pfcp, gtp, or any, where 0 indicates the highest priority, while 31 or 15 indicates the lowest priority.



Note Priority is not populated in outbound messages, which are selftriggered. For example, outbound messages triggered by timer expiry.

Verifying Message Priority Profile

The following is the example output of the **Show running-config for profile message-priority** command.

```
Show running-config for profile-> message-priority :

profile message-priority test

  interface pfcp,any priority value 15

 interface gtp priority value 10

 interface sbi priority value 20

 interface sbi procedure create priority value 0

 interface sbi procedure update priority value 10

 interface sbi procedure delete priority value 20

exit
```

Associating Message Priority Profiles

Associate Message Priority for WPS

You can associate WPS profile with ARP and message priority profile using the following configuration.

```
config
  profile wps wps_profile_name
     arp  arp_value [ qci ] message-priority-profile profile_name
  exit
```

NOTES

- **profile wps** *wps_profile_name*: Accesses the Wireless Priority Services Profile configuration. *dynamic_wps* must be an alphanumeric string of 1 to 63 characters.
- **arp** *arp_value* **message-priority-profile** *profile-name*: Specify an ARP value in the range from 1 to 15.
- **qci message-priority-profile** *profile_name*: Wireless Priority session is decided based on the ARP and optionally on the QCI.
- **message-priority-profile** *profile_name* : This parameter is used only if the message priority profile is not associated. For example, **message-priority-profile** *[pfcp gtpc]*.

Verifying Message Priority Profiles under WPS

To view WPS parameters based on message priority profiles, use the **show full-configuration profile wps** command.

The following is an example output of the **show full-configuration profile wps** command.

```
[smf] smf(config)# show full-configuration profile wps

profile wps test

  arp 1,8

  arp 5-7 message-priority-profile test

exit
```

Associate Message Priority Profile with QoS

You can associate message priority profile to a QoS profile and to the QCI or ARP in the QoS profile. The following configuration works for emergency calls coming with dedicated DNN, for example, “sos”.

```
config
  profile qos  qos-profile-name
      message-priority-profile profile_name
      qosflow qi5  nonstandard_value arp-priority-level arp_value
message-priority-profile profile_name
 exit
```

NOTES:

- **message-priority-profile** *profile_name* : Associates message priority profile to qos profile.
- **qosflow qi5** *nonstandard_value* : Message priority profile associated to QCI and the one associated to QoS profile.

- **arp-priority-level** *arp_value* : Message priority profile associated to ARP. Specify the ARP value in the range between 1 to 255.

  The Message priority profile associated to QCI or ARP or QoS profile, or message priority profile associated to WPS are negotiated to find the one which has the better priority.



Note If there is no message priority profile associated to a default bearer/flow, QCI or ARP, then message priority value is considered from message priority profile that is associated to a QoS profile for the IMS and emergency calls. When a dedicated bearer/flow gets created, message priority is considered from message priority profile associated to QCI or ARP depending on the configuration.

Verifying Profile QoS Configuration

To view QoS flow based on message priority profiles, use the **show full-configuration profile qos** command.

The following is an example output of the **show full-configuration profile qos** command.

```
[smf] smf(config)# show full-configuration profile qos test

profile qos test

  message-priority-profile test

  qosflow qi5 5 arp-priority-level 5 message-priority-profile mpp1

exit
```

Associate Message Priority Profile for Emergency

If there is a PDU session establishment with some other DNN, say “IMS” and if a session type is set to emergency, use the following sample configuration to specify a specific priority to an emergency call.

```
config
  profile dnn  dnn_profile_name
    emergency-message-priority-profile  profile_name
  exit
```

NOTES:

- **emergency-message-priority-profile** *profile_name* : Enables message priority negotiation with emergency message priority profile.



Note Message Priority (MP) value of IMS-Inactive is derived from IMS-Active where,

$MP_{IMS\text{-}Active}$ = MP selected for IMS dedicated bearer/flow.

$MP_{IMS\text{-}Inactive} = MP_{IMS\text{-}Active} + 1$

Verifying Message Priority Under DNN

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

```
Show running-config for profile-> dnn :

profile dnn intershat

 emergency-message-priority-profile test

exit
```

Configuring SMF to Exclude WPS Sessions from Overload Throttling

Use the sample configuration to exclude WPS sessions from overload throttling for the GTP interface.



Note Overload exclusion is based only on the ARP/5QI/DNN/MP and not based on DSCP.

```
config
  profile overload ovld_ctrl_prfl
    overload-exclude-profile self-protection ovld_exclude_wps
    node level
      tolerance minimum minimum_value
      tolerance maximum maximum_value
      reduction-metric minimum minimum_value
      reduction-metric maximum maximum_value
    advertise
      interval value
      change-factor value
      validity-period value
     exit
    interface interface_name
      overloaded-action [ advertise ]
     exit
   exit
  exit
profile overload-exclude ovld_exclude_wps
   dnn-list dnn_list
   arp-list arp_list
   qi5-list qi5_list
   message-priority priority_valuemessage-priority { n4 | n7 | n10 | n11 |
n16 | n40 | s5 } upto priority_val
exit
```

NOTES:

- **overload-exclude-profile self-protection** *ovld_exclude_wps*: Excludes WPS sessions from overload throttling.
- **profile overload-exclude** *ovld_exclude_wps* **message-priority** *priority_value*: Allows GTP overload exclude support.
- **message-priority { n4 | n7 | n10 | n11 | n16 | n40 | s5 } upto** *priority_val*: Specify the interface from which the incoming SMF traffic should be excluded from throttling as per the priority value.

Configuring Overload Exclusion at an Endpoint Level

Use the following configuration to configure overload exclusion at an endpoint level for the SBI interface.

```
config
   instance instance-id instance_id
      endpoint sbi
         overload-control threshold threshold_limit threshold_range action
action_status action_code range exclude message-priority value
         commit
      end
```

NOTES:

- **overload-control**: Specify the overload control at endpoint level.
- **threshold** : Specify the threshold limit and range.
- *threshold_limit*: Specify the threshold limit. *threshold_limit* must be one of the following:
  - *low*: Specify the low threshold limit for overload protection.
  - *high*: Specify the high threshold limit for overload protection.
  - *critical*: Specify the critical threshold limit for overload protection.
- *thershold_range*: Specify the threshold range. *threshold_range* must be an integer in the range of 10 – 100000.
- **action** : Specify the action to be taken for the threshold limit.
- *action_status*: Specify the action for the threshold limit. *action_status* must be:
  - **reject**: Reject the inbound messages if the specified threshold range is met.
- *action_code*: Specify the action status code. *action_code* must be:
  - **reject-code**: Specify the reject status code.
- *range*: Specify the range of the action code. *range* must be an integer in the range of 100 – 600.
- **exclude message-priority** *value*: Specify the SBI MP overload exclude value.

The following is an example configuration:

```
profile overload ovld_ctrl_prfl
 overload-exclude-profile self-protection ovld_exclude_wps
 node-level
  tolerance minimum 80
  tolerance maximum 95
  reduction-metric minimum 10
  reduction-metric maximum 100
  advertise
   interval        60
   change-factor   5
   validity-period 600
  exit
  interface gtpc
```

```
   overloaded-action [ advertise ]
  exit
 exit
exit

profile overload-exclude ovld_exclude_wps
 dnn-list [ sos ]
 arp-list [ 2 3 4 ]
 qi5-list [ 1 2]
 message-priority s5 upto <unsignedInt, 0 .. 15>
exit

config
  instance instance-id 1
    endpoint sbi
      overload-control threshold high 10000 action reject reject-code 200 exclude
message-priority <value>
    exit
  exit
exit
```

Message Priority Negotiation for High-Priority Message

Table 4: Feature History

Feature Name	Release Information	Description
Message Priority Negotiation for High Priority Messages	2024.04.1	At any given circumstance, the SMF must ensure that the high-priority messages (WPS, emergency, and so on.) continue uninterruptedly. SMF uses Message Priority (MP) Negotiation to ensure uninterrupted communication between SMF and peer nodes. This mechanism allows the SMF to compare the message priority value present in the inbound message with the message priority value present in the local configuration. This way, the high priority inbound and outbound messages in a WPS session get prioritized and processed on SMF. **Default Setting:** Always Enabled

Message Priority Negotiation

SMF receives and sends messages over SBI, GTPC, and PFCP interfaces. SMF connects with PCF to gather ARP and QCI values. Based on these values, it fetches the configured message priority for the corresponding interfaces. This message priority value is set for sending the outgoing messages.

However, this message priority value is not enough for prioritizing messages. In this case, SMF does not consider the message priority present in the incoming messages. This may cause SMF to de-prioritize even the high-priority incoming messages.

Also, SMF does not receive any message priority value before interacting with PCF. In this case, the outgoing messages do not contain any message priority value. This may cause a high-priority outgoing message from SMF to get de-prioritized on the receiving peer node.

This feature enhances the process of message prioritization. It allows SMF to extract the message priority value present in the incoming message and negotiate it with the configured message priority value for that interface. SMF then selects the lowest message priority value and sets it for all the incoming and outgoing messages for that session.

This allows SMF to prioritize the messages with high message priority over messages with lower message priority in any session. This also helps SMF to set high-priority for the outgoing messages.

For more details on message throttling and exclusion based on message-priority from specific SMF interfaces, see the Configuring SMF to Exclude WPS Sessions section.

Policy and data race condition management for priority paging

The WPS Priority Paging enhancement is designed to ensure that Wireless Priority Service (WPS) calls, typically used for high-priority voice communications, receive the appropriate network priority precedence. This feature guarantees that when a high-priority call is initiated for an idle subscriber, the network correctly identifies and pages the device with the required elevated priority, regardless of other concurrent network events.

The challenge can be when two independent events can arrive at the SMF simultaneously when a user is in an idle state:

- A notification from the Policy Control Function (PCF) specifying an elevated Allocation and Retention Priority (ARP) for a voice or WPS flow.
- A report from the User Plane Function (UPF) indicating that downlink data has arrived for the idle user, triggering a standard paging request.

If the data arrival event is processed slightly faster than the policy update, the SMF triggers paging using the default ARP. By the time the high-priority policy update arrives, the paging process is already underway or completed, causing the Radio Access Network (RAN) to treat the call as a normal data session rather than a high-priority WPS event. This results in failure to meet the required WPS priority standards.

To address the challenge, this enhancement introduces intelligent collision handling to ensure the highest priority is always applied to the paging request:

- The SMF continuously monitors incoming policy updates from the PCF. If an update containing an elevated ARP arrives while a paging procedure is in progress, the SMF compares the new priority against the priority currently used for the active paging request.
- If the incoming policy update carries a higher priority than the current paging request, the SMF automatically generates and sends an updated paging request to the Access and Mobility Management Function (AMF).
- By updating the paging request with the elevated ARP, the SMF ensures the RAN receives the correct priority information, allowing the network to allocate necessary resources to prioritize the WPS/voice call.
- The system ignores re-paging requests if the new priority is lower than or equal to the priority already in progress, preventing unnecessary signaling overhead.

The elevated ARP paging support covers both dedicated bearer QoS and authorized default QoS.

The Paging Priority Indicator (PPI) is derived from PCF-provided 5QI and ARP values through configured QoS and PPD profiles. Additionally, if SmPolicyDecision validation fails after PDU modification, the SMF sends an N2 release to clean up resources.

If a subsequent PCF update or downlink data report maps to a different Paging Policy Indicator (PPI) than the one already signaled, the SMF resends the paging request (N1N2 Message Transfer Request) so the network re-pages the device according to the updated policy.



Note This option is enabled by default to comply with WPS requirements and no manual configuration is needed; SMF manages priority logic based on PCF policies. You can monitor paging messages are sent with elevated ARP values using internal system statistics that identify them.

WPS Priority Paging ensures the page reflects the correct priority. While the device is idle, the SMF evaluates the applicable priority, from either the policy update or the DSCP marking, and if it is higher than the priority already used, it (re-)issues the page at that elevated priority. This means the device is paged or re-paged at the correct, higher priority, so the RAN gives it appropriate precedence. When the device responds and reconnects, all session flows (default and dedicated) are activated with the updated higher-priority QoS. If the policy update is later rejected or fails, the temporary priority uplift is rolled back to maintain session consistency.

Benefits:

- Correct priority for WPS/priority subscribers, whether from policy change or data marking.
- Improved success rate and lower latency for priority session activation during congestion.
- Consistent QoS across all flows upon device reconnection.
- Safe fallback: unchanged behavior for non-qualifying sessions; feature can be disabled via CLI.

Elevated-priority paging applies when these base conditions are met and at least one priority trigger is present:

Base conditions:

- Device is on 5G access.
- Session is idle (no active user-plane/data connection).
- Feature is enabled (default).

Priority triggers:

- A policy update raises the session’s QoS.
- Downlink data is marked (DSCP) as priority traffic per configured DSCP-to-ARP mapping.

If base conditions are not met or no priority trigger is present, paging behaves as before.

Table 5: Statistics for tracking N2 messages with uplifted ARP

KPI Name	Type	Description or Formula	Label
smf_n2_message_stats	counter	Total number of N2 messages sent by the SMF categorized by whether the ARP was uplifted.	uplifted_arp

WPS OAM Support

SMF Session Gauge Counters

The "wps" label is introduced at the SMF service for session-level gauage counters that support WPS and non-WPS functionality.

For example:

```
smf_session_counters{always_on="disable",app_name="smf",cluster="smf",data_center="unknown",dnn="intershat",
instance_id="0",pdu_type="ipv4",rat_type="NR",service_name="smf-service",ssc_mode="ssc_mode_1",wps="non_wps"}
 10
smf_session_counters{always_on="disable",app_name="smf",cluster="smf",data_center="unknown",dnn="intershat",
instance_id="0",pdu_type="ipv4",rat_type="NR",service_name="smf-service",ssc_mode="ssc_mode_1",wps="wps"}
 20
```

N4 Interface Metrics

The N4 interface counters related to message priority include:

- SESSION_DELETION_REQUEST
- SESSION_ESTABLISHMENT_REQUEST
- SESSION_MODIFICATION_REQUEST

An example of the N4 interface metrics:

```
proto_pfcp_msg_total{app_name="SMF",cluster="Local",data_center="DC",instance_id="0",
message_direction="outbound",message_name="SESSION_DELETION_REQUEST",msgpriority=true,
service_name="protocol",status="accepted",transport_type="origin"} 4
proto_pfcp_msg_total{app_name="SMF",cluster="Local",data_center="DC",instance_id="0",
message_direction="outbound",message_name="SESSION_ESTABLISHMENT_REQUEST",msgpriority=true,
service_name="protocol",status="accepted",transport_type="origin"} 6
proto_pfcp_msg_total{app_name="SMF",cluster="Local",data_center="DC",instance_id="0",
message_direction="outbound",message_name="SESSION_MODIFICATION_REQUEST",msgpriority=true,
service_name="protocol",status="accepted",transport_type="origin"} 20
```

GTPv2 Metrics

The GTPv2 counters related to message priority include:

- NumCreateBearerSuccess
- NumRxCreateBearerRes
- NumTxCreateSessionReq

An example of the GTPv2 metrics:

```
gtpc_app_priority_events{app_name="SMF",cluster="Local",data_center="DC",
event_type="NumCreateBearerSuccess",instance_id="0",interface_type="S5",priority_msg="true",service_name="gtpc-ep"}
 2
gtpc_app_priority_events{app_name="SMF",cluster="Local",data_center="DC",
event_type="NumRxCreateBearerRes",instance_id="0",interface_type="S5",priority_msg="true",service_name="gtpc-ep"}
 2
gtpc_app_priority_events{app_name="SMF",cluster="Local",data_center="DC",
event_type="NumTxCreateSessionReq",instance_id="0",interface_type="S5",priority_msg="true",service_name="gtpc-ep"}
 2
```

KPIs

Following KPIs are supported for this feature:

```
sum(policy_dynamic_pcc_rules_total{pccrule_change_type="binding_param_change",event="attempted"})
```

```
sum(policy_dynamic_pcc_rules_total{pccrule_change_type="binding_param_change",event="success"})
```

```
sum(policy_dynamic_pcc_rules_total{pccrule_change_type="binding_param_change",event="failure"})
```

Table 6: Statistics for Tracking the Number of Times QCI or ARP is Modified

KPI Name	Type	Description or Formula	Label
policy_dynamic_pcc_rules_total	counter	Total number of dynamic pcc rules added, modified, or deleted as part of different procedures.	pccrule_change_type,status