**3GPP TSG-WG2 Meeting #161 *S2-2402426***

**Athens, Greece, 26 Feb - 1 March, 2024**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **23.501** | **CR** | **5331** | **rev** | **1** | **Current version:** | **18.4.0** |  |
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| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:***  | Clarification on support of PDU Set based QoS |
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| ***Source to WG:*** | Nokia, Nokia Shangai Bell |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | XRM |  | ***Date:*** | 2024-02-16 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Currently specifications assume the following:1. PDU Set QoS in the RAN using (PSDB, PSER) and marking of PDU Set Information in the UPF are linked. The UPF only provides PDU Set information if PDU Set QoS is active in the RAN. This precludes the possiblity to use PDU Set information in the RAN for PDU Set based packet discard with ordinary QoS (i.e. PER and PDB). This should be changed so that marking of PDU Set information by the UPF can be enabled for PDU Set based packet discard and/or for PDU Set based QoS.
2. Only PDU Set based QoS handling (PSDB, PSER based scheduling) or PDU based QoS handling (classic 5QI: PDB, PER based scheduling) applies in the RAN at any given time.
3. PDU Set based QoS handling in the RAN requires only one PDU Set based QoS parameter to be provided however it is unclear what the RAN should do to compute the other parameter for PDU Set based scheduling. This must be clarified.
4. Current spec allows PDU Set based QoS handling to apply only if either PSDB or PSER is provided to the RAN. Furthermore, it states that PSDB and PSER are optional, also they override PDB and PER respectively only when they are provided thus the spec could be interpreted as follows: PSDB and PER or PDB and PSER apply for a certain QoS Flow but this will result in mixed scheduling which goes against the intention that only PDU Set based scheduling or PDU based scheduling apply; otherwise it can result in indeterministic behaviour.

Thus, it must also be unambiguously clarified that both PDU Set based QoS and PDU based QoS parameters cannot be mixed and it must also be clarified how the PDU Set based QoS parameters are determined, when one is not provided or it must be agreed that at least PSDB and PSER are always mandatory.  |
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| ***Summary of change:*** | 1. Specify that marking of PDU Set information by the UPF can be enabled for PDU Set based packet discard and/or PDU Set based QoS. To enable PDU Set information insertion at the UPF requires:
	1. The prescence of a Protocol Description (in the PCC rule or configured on the SMF). This indicates the presence of XR traffic.
	2. An indication from the RAN that it supports at least one of PDU Set based QoS or PDU Set based packet discard
2. Specify that only PDU Set based handling or PDU based QoS handling applies.
3. Also clarify the applicability of the PDU Set based QoS parameters.

Alternative 1: if only one of the two parameters PSDB, PSER is provided to the RAN, the other value is determined based on local policies. Alternative 2: both are always provided for PDU Set based handling to be applicable. (preferred) |
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| ***Consequences if not approved:*** | Incorrect specification for PDU Set based handling. Mixed scheduling could also result in wrong behavior. It is not possible to enable PDU Set based packet discard independent of PDU Set based QoS using (PSER, PSDB) |
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| ***Clauses affected:*** | 5.7.7.1, 5.7.7.2, 5.7.7.3, 5.37.1, 5.37.5.1, 5.37.5.2, 5.37.5.3 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

 \* \* \* 1st Change \* \* \*

### 5.7.7 PDU Set QoS Parameters

#### 5.7.7.1 General

PDU Set QoS Parameters are used to support PDU Set based QoS handling in the NG-RAN. [Alternative 1a]: At least one PDU Set QoS Parameter shall be sent to the NG-RAN to enable PDU Set based QoS handling. If the RAN receives only PSDB and not PSER, the RAN uses PSDB for PDU Set based QoS. If the NG-RAN receives only PSER and not PSDB, the RAN uses PDB for PDU based QoS handling as in 5.7.3.4. [Alternative 2:] Both PSDB and PSER PDU Set QoS Parameters shall be sent to the NG-RAN to enable PDU Set based QoS handling.

[Alternative 1]: NOTE: at any given time, for a certain flow direction (UL or DL), RAN is expected to support either PDU Set based QoS handling as in this clause or PDU based QoS handling as in clause 5.7.3.4.

The following PDU Set QoS Parameters are specified:

1. PDU Set Delay Budget (PSDB).

2. PDU Set Error Rate (PSER).

3. PDU Set Integrated Handling Information (PSIHI).

For a given QoS Flow, the values of PSDB, PSER and PSIHI can be different for UL and DL.

The QoS Profile may include the PDU Set QoS Parameters described in this clause (see clause 5.7.1.2) for UL and/or DL direction. The PCF determines the PDU Set QoS Parameters based on information provided by AF and/or local configuration. The PDU Set QoS parameters are sent to the SMF as part of PCC rule. The SMF sends them to NG-RAN as part of the QoS Profile.

If the NG-RAN receives PDU Set QoS Parameters, it enables the PDU Set based QoS handling and applies PDU Set QoS Parameters as described in TS 38.300 [27], TS 38.413 [34] and TS 38.331 [51].

 \* \* \* 2nd Change \* \* \*

#### 5.7.7.2 PDU Set Delay Budget

The PDU Set Delay Budget (PSDB) defines an upper bound for the delay that a PDU Set may experience for the transfer between the UE and the N6 termination point at the UPF, i.e. the duration between the reception time of the first PDU (at the N6 termination point for DL or the UE for UL) and the time when all PDUs of a PDU Set have been successfully received (at the UE for DL or N6 termination point for UL). PSDB applies to the DL PDU Set received by the PSA UPF over the N6 interface, and to the UL PDU Set sent by the UE.

NOTE: To enable support for PSDB, it is required that a maximum inter arrival time between the first received PDU and the last received PDU of a PDU Set complies with SLA. This maximum inter arrival time does not exceed PSDB. NG-RAN behaviour when the SLA is not fulfilled is out of scope of this specification.

A QoS Flow is associated with at most one PDU Set Delay Budget value per direction. PSDB is an optional parameter that may be provided by the PCF. The provided PSDB can be used by the NG-RAN to support the configuration of scheduling and link layer functions.

[Alternative 1] When the PSDB is available, the PSDB supersedes the PDB for the given QoS Flow.

[Alternative 2] When the PSDB and PSER are available, the PSDB supersedes the PDB for the given QoS Flow.

The AN PSDB is derived at NG-RAN by subtracting CN PDB (as described in clause 5.7.3.4) from the PSDB.

 \* \* \* 3rd Change \* \* \*

#### 5.7.7.3 PDU Set Error Rate

The PDU Set Error Rate (PSER) defines an upper bound for the rate of PDU Sets that have been processed by the sender of a link layer protocol (e.g. RLC in RAN of a 3GPP access) but that are not successfully delivered by the corresponding receiver to the upper layer (e.g. PDCP in RAN of a 3GPP access). Thus, the PSER defines an upper bound for a rate of non-congestion related PDU Set losses. The purpose of the PSER is to allow for appropriate link layer protocol configurations (e.g. RLC and HARQ in RAN of a 3GPP access).

NOTE 1: In this Release, a PDU Set is considered as successfully delivered only when all PDUs of a PDU Set are delivered successfully.

NOTE 2: How RAN enforces PSER is up to RAN implementation.

A QoS Flow is associated with at most one PDU Set Error Rate value per direction. PSER is an optional parameter. [Alternative 1] If the PSER is available, the PSER supersedes the PER.

[Alternative 2] If the PSER and PSDB are available, the PSER supersedes the PER.

 \* \* \* 4th Change \* \* \*

## 5.37 Support for high data rate low latency services, eXtended Reality (XR) and interactive media services

### 5.37.1 General

This clause provides an overview of 5GS functionalities for support of XR services (AR/VR applications) and interactive media services that require high data rate and low latency communication, e.g. cloud gaming and tactile/multi-modal communication services according to service requirements documented in TS 22.261 [2]. The standardized 5QI characteristics for such interactive services are provided in Table 5.7.4-1 and TSCAI is used to describe the related traffic characteristics as defined in clause 5.27.2. Further enhancements for these interactive media services are as follows:

- The 5GS may support QoS policy control for multi-modal traffic, see clause 5.37.2.

- The 5GS may support network information exposure which can be based on ECN markings for L4S, see clause 5.37.3 or 5GS exposure API, see clause 5.37.4.

- The 5GS may support PDU Set based Handling comprising PDU Set identification and marking and one or more of PDU Set based QoS handling and PDU Set based packet discard , see clause 5.37.5.

- The 5GS may ensure that the UL and DL packets together meet the requested round trip delay and also update the delay for UL and DL considering QoS monitoring results, see clause 5.37.6.

- The 5GS may perform per-flow Packet Delay Variation (PDV) monitoring and policy control according to AF provided requirements, see clause 5.37.7.

- The 5GC may provide traffic assistance information to the NG-RAN to enable Connected mode DRX power saving, see clause 5.37.8.

\* \* 5th Change \* \* \*

### 5.37.5 PDU Set based Handling

#### 5.37.5.1 General

A PDU Set is comprised of one or more PDUs carrying an application layer payload such as a video frame or video slice. One or both of the following capabilities are supported for PDU Set based Handling:

- PDU Set based QoS handling and UPF PDU Set identification and marking

- PDU Set based packet discard and UPF PDU Set identification and marking

The PDU Set based QoS handling by the NG-RAN is determined by PDU Set QoS Parameters in the QoS profile of the QoS Flow (specified in clause 5.7.7) and PDU Set information provided by the PSA UPF via N3/N9 interface as described in clause 5.37.5.2. The PDU Set based QoS Handling can be applied for GBR and non-GBR QoS Flows.

PDU Set based packet discard by the NG-RAN is determined by the PDU Set information provided by the PSA UPF as described in clause 5.37.5.2, independent of the QoS profile.

The AF should provide PDU Set related assistance information for dynamic PCC control. One or more of the following PDU Set related assistance information may be provided to the NEF/PCF using the AF session with required QoS procedures in clauses 4.15.6.6 and 4.15.6.6a of TS 23.502 [3].

- PDU Set QoS Parameters as described in clause 5.7.7

- Protocol Description: Indicates the transport protocol used by the service data flow (e.g. RTP, SRTP) and information, e.g. the following:

- RTP [185] or SRTP [186];

- RTP or SRTP with RTP Header Extensions, including:

- RTP Header Extensions for PDU Set Marking as defined in TS 26.522 [179];

- Other RTP Header Extensions as defined RFC 8285 [189];

- RTP or SRTP without RTP Header Extensions, but together with RTP Payload Format (e.g. H.264 [187] or H.265 [188]);

- RTP or SRTP with RTP Header Extensions for PDU Set Marking as defined in TS 26.522 [179], and together with RTP Payload Format (e.g. H.264 [187] or H.265 [188]);

- RTP or SRTP with other RTP Header Extensions following RFC 8285 [189], and together with RTP Payload Format (e.g. H.264 [187] or H.265 [188]).

When RTP Header Extensions for PDU Set Marking (as defined in TS 26.522 [179] or other RTP header extensions as defined in RFC 8285 [189] is included, the differentiation between different RTP Header Extension Types should be supported.

When RTP Payload Format is included, the differentiation between different RTP Payload Formats should be supported.

NOTE 1: Multiplexing of different transport protocols and different media traffic for differentiated PDU Set QoS handling is not supported in the current Release.

AF provided PDU Set QoS Parameters and Protocol Description may be used in determining the PCC Rule by the PCF as defined in clause 6.1.3.27.4 of TS 23.503 [45] and the Protocol Description may be used for identifying the PDU Set information by the PSA UPF. The presence of the Protocol Description is also used to determine whether to enable PDU Set Identification and marking.

When the SMF receives the PCC rule, the SMF performs binding of the PCC rule to one QoS Flow as described in clause 6.1.3.2.4 of TS 23.503 [45]. If the PCC rule contains [Alternative 2:] both the PSDB and PSER PDU Set QoS Parameters, the SMF adds the PDU Set QoS parameters to the QoS Profile of the QoS Flow as described in clause 6.2.2.4 of TS 23.503 [45]. Alternatively, the SMF may be configured to support PDU Set based QoS Handling without receiving PCC rules from a PCF.

For the downlink direction, the PSA UPF identifies PDUs that belong to PDU Sets and marks them accordingly as described in clause 5.37.5.2. If the PSA UPF receives a PDU that does not belong to a PDU Set based on Protocol Description for PDU Set identification, then the PSA UPF still maps it to a PDU Set and determines the PDU Set Information as described in clause 5.37.5.2.

NOTE 2: If the PSA UPF receives a PDU that does not belong to a PDU Set, then it is assumed that the UPF determines the PDU Set Importance value based on pre-configuration.

For the uplink direction, the UE may identify PDU Sets, and how this is done is left up to UE implementation. The SMF may send Protocol Description associated with the QoS rule to UE.

NOTE 3: Using the Protocol Description or not is left to UE implementation. The use of Protocol Description does not impact QoS Flow Mapping in the UE.

In this Release, the PDU Set based QoS handling is supported in 5GS for UE registered in 3GPP access for single access PDU Session with IP PDU Session Type.

#### 5.37.5.2 PDU Set Information and Identification

To support PDU Set based QoS handling, the PSA UPF identifies PDUs that belong to PDU Sets and determines the below PDU Set Information which it sends to the NG-RAN in the GTP-U header. The PDU Set information is used by the NG-RAN for PDU Set based QoS handling as described above.

The PDU Set Information comprises:

- PDU Set Sequence Number.

- Indication of End PDU of the PDU Set.

- PDU Sequence Number within a PDU Set.

- PDU Set Size in bytes.

- PDU Set Importance, which identifies the relative importance of a PDU Set compared to other PDU Sets within a QoS Flow.

The NG-RAN may use the Priority Level (see clause 5.7.3.3) across QoS Flows and PDU Set Importance within a QoS Flow for PDU Set level packet discarding in presence of congestion.

NOTE 1: In addition to considering the PDU Set Importance within a QoS Flow, NG-RAN could also consider the relative PDU Set Importance across QoS Flows of the same Priority Level when determining which PDU Set needs to be discarded, which is up to implementation and configuration of operator.

NOTE 2: The PDU Set Information can be different for different PDU Sets within a QoS Flow.

If the NG-RAN has provided a PDU Set Based Handling Support Indication indicating that PDU Set handling is supported and either a Protocol Description is included in the PCC rule or PDU Set handling is enabled via operator configuration, the SMF instructs PSA UPF to perform PDU Set marking and may provide the PSA UPF the Protocol Description used by the service data flow. The Protocol Description may be received in the PCC rule, based on information provided by the AF or by PCF local policies as described in clause 5.37.5.1.

PSA UPF can identify the PDU Set Information using the Protocol Description and the received transport protocol headers and payload or using implementation specific means. The details of the RTP/SRTP headers, header extensions and/or payloads used to identify PDU Set Information are defined in TS 26.522 [179].

For each DL PDU received on N6 for which PDU Set based QoS handling is indicated from the SMF, the PSA UPF applies the rules for PDU Set identification and provides the available PDU Set Information to the RAN in the GTP-U header.

NOTE 3: The PSA UPF is expected to assign a unique PDU Set Sequence Number in the GTP-U header to each PDU Set of the QoS Flow.

#### 5.37.5.3 Non-homogenous support of PDU set based handling in NG-RAN

By sending at least [Alternative 2:] both the PSDB and the PSERPDU Set QoS parameter to the NG-RAN, the SMF requests the NG-RAN to activate PDU Set QoS handling for a given QoS flow.The NG-RAN provides the SMF with an indication of whether the PDU Set based handling is supported. Based on this indication, SMF may activate the PDU Set identification and marking in the PSA UPF.

NOTE 1: The NG-RAN indicates that PDU Set handling is supported if either PDU Set based QoS handling or PDU Set based packet discard is supported.

For the mobility procedures that may result in the change of NG-RAN for PDU Set based handling support, the target NG-RAN provides to the SMF with an indication of whether the target NG-RAN node supports PDU Set based handling, as specified in TS 38.413 [34]. Based on the target NG-RAN indication, the SMF may, upon completion of the mobility procedure, initiate the PDU Session modification procedure to provide PDU Set QoS parameters to NG-RAN and may configure the PSA UPF to activate/deactivate the PDU Set identification and marking.

In the case where the PSA UPF identifies and marks PDUs with PDU Set information in GTP-U header, it shall start doing so from a complete PDU Set.

 \* \* \* End of Change \* \* \*