3GPP TSG-RAN WG3 #112-e R3-212737

**E-meeting, 17th – 27th May 2021**

Source: CATT (moderator)

Title: CB # 111\_UnmappedQoSflowsDisaggregated

Agenda Item: 9.3.8.1

Document for: Approval

# Introduction

**CB: # 111\_UnmappedQoSflowsDisaggregated**

**- Check RAN2 agreement (RAN2 #96?)**

**- does this scenario make sense in disaggregated arch?**

**- include 2293/2294 in discussion**

**- include 1993/4/5 in discussion**

(CATT - moderator)

Summary of offline disc [R3-212737](file:///C%3A%5CUsers%5Cliuaijuan%5CAppData%5CLocal%5CMicrosoft%5CWindows%5CINetCache%5CContent.Outlook%5CIDLQ5HGM%5CInbox%5CR3-212737.zip)

Considering the online views on the scenario, this CB is proposed to have two phases. The first phase intends to focus mainly on the scenario and possibly the principle of solution, and if there are enough consensuses, the second phase focuses on detail CRs.

The deadline for the first phase is 16:00 UTC on 21st May (Friday).

# For the Chairman’s Notes

**Proposal 1: Confirm that the cases shown in Annex A of TS 38.300 are all valid regardless of whether gNB-CU-CP/UP split architecture is supported.**

**Proposal 2: For downlink, agree with the following handling principle: The gNB-CU-CP may decide not to include the unmapped QoS flow at all within any “QoS Flows Information To Be Setup” of “DRB To Setup Item” structure, when setting up the PDU session. When receiving a DL data packet, the gNB-CU-UP can then distinguish such case by checking whether the QFI of this packet is included in the E1AP configuration of any of the established DRBs or not. If not, the gNB-CU-UP will send an E1AP DL DATA NOTIFICATION message toward the gNB-CU-CP.**

**Proposal 3: For uplink, the text description for the UL Data Notification procedure should be updated to include the case of the *QoS Flows Information To Be Setup* IE.**

**Proposal 4: For uplink, an optional IE, criticality reject, should be added into the *QoS Flows Information To Be Setup* IE, in order to indicate ignoring the QoS flows included within the *QoS Flows Information To Be Setup* IE (i.e. establishing a DRB with no flow mapped toward it)**

# Discussion (second phase)

## Confirming the scenarios

All company agrees that the scenarios listed in Annex A of TS 38.300 is valid for aggregated gNBs, and at least the UL part (i.e. Annex A.6) is valid for disaggregated gNBs.

For the DL scenario in disaggregated gNBs, while the majority of companies believe it is valid, some companies still raised some concern on time delay. However, one company commented that the time delay is not a problem:

* Annex A.3 of TS 38.300 already introduces an extra time delay of one round trip time of Uu regardless of whether the gNB is disaggregated or not. So this feature seems to be applicable only for non-delay-sensitive QoS flows.
* It seems also possible for the gNB-CU-UP to send the packet over the Uu through an existing DRB before receiving the remapping configuration from the gNB-CU-CP, which can be up to the gNB-CU-UP’s implementation.

Therefore, companies (especially the companies which raise the concerns in the first phase) are invited to confirm for another time whether the time delay is still considered to be a concern. If the opinion is still split, the moderator suggests sending an LS to RAN2, in order to further check the scenario when it may apply, as well as the gain of this feature.

**Questions X1-1**: After the first round of discussion, do companies agree that the DL cases shown in Annex A of TS 38.300, especially A.3, are intended to be supported for the disaggregated architecture?

| Company | Comment |
| --- | --- |
| CATT | Yes.As shown in the first phase of discussion, we believe that this feature can apply for non-delay sensitive QoS flows, and on the other hand the UP delay can be reduced to nearly 0 by an implementation-based method similar to the case of uplink, i.e. sending through the default DRB first. |
| Nokia | Both DL and UL scenarios defined by RAN2 in 38.300 should also be applicable in case of disaggregated gNB architecture. |
| Huawei | Agree with Nokia.  |
| Samsung | As we commented during the first round, RAN2 only concentrate on Uu part. RAN2 has thought the issue has no impact on network and it is just gNB implementation issue e.g. when to trigger DBR configuration over Uu. That’s why RAN3 is not involved on this issue.For Uu interface, not configuring DRB may save some RRC signaling. But the signaling over E1 is not critical as Uu. Even though with RAN2 agreement, the mapping over E1 can still be configured like for N1/N2. This doesn’t contradict with RAN2 agreement. Then when the data packet is coming, the CP just need to configure the UE over Uu. This will reduce the delay. |
| ZTE | Agree with Nokia.  |
| Intel | Agree with Nokia. To support RAN2 use case, for DL, CU-CP should be allowed not to configure over E1 immediately (during N1 setup), and to configure later after the actual QoS flow arrives at CU-UP and CU-UP notifies such event. We should not force the implementation to always configure over E1 immediately during N1 setup.  |
| Ericsson | Agree with Samsung. RAN2 scenario does not consider E1. It is still possible to support the scenario over Uu, while configuring the full mapping over E1 |

Considering the fact that we may not converge on Question X-1 and thus a LS to RAN2 is needed, we draft an LS and invite companies to check whether it is ok. This LS can be found in the draft folder.

**Questions X1-2**: Any comment on the draft LS?

| Company | Comment |
| --- | --- |
| CATT | The LS is ok for us. |
| Nokia | Do not see the LS as necessary, |
| Huawei | We are fine to send the LS, since the LS is beneficial for us to proceed (similar to the EHC de-syn LS over E1AP).  |
| Huawei | We are fine to send the LS, since the LS is beneficial for us to proceed (similar to the EHC de-syn LS over E1AP).  |
| Samsung | How to perform over E1 is in RAN3 domain. Is there any issue if the mapping is configured over E1 but no mapping is indicated to the UE?  |
| ZTE | We are fine to send the LS |
| Intel | Agree with Nokia. We also don’t see the need for an LS to RAN2.  |
| Ericsson | No strong view. But if we send an LS to RAN2, E1 should be out of the scope. |

## CRs to agree

Based on the first phase of discussion, we propose to agree with the CRs [6–9] (for DL) and the updated form of [13, 14] (for UL). All of these CRs can be found in the CB folder on the ftp server.

If any company has any comment over these CRs (e.g. whether Rel-15 ones are needed), please provide it in the following tabular.

**Questions X2**: Any comment on the six draft CRs?

| Company | Comment |
| --- | --- |
| CATT | We fully agree with the DL CRs including both stage 2 and stage 3 CRs.For the UL CR(s),we are OK with the current change in the CR. Besides that, for the UL CR(s), we think the case of modifying an existing DRB might also be considered, i.e. we might add the new indication IE not only into the *DRB To* ***Setup*** *Item* but into the *DRB To* ***Modify*** *Item* as well, in order to cover the following scenario:Before Reconfiguration:* Default DRB: DRB #1
* QoS flow #1: None;
* QoS flow #2: DRB #1.

After Reconfiguration (QoS flow #2 is released):* Default DRB: DRB #1
* QoS flow #1: None.

How to inform the gNB-CU-UP of the mapping change DRB #1?In order not to include 2 IEs which will occupies 2 IEIs, the new “*Ignore Mapping Rule Indication*” IE seems better to be renamed toward “*Blank DRB Indication*”, which indicates to **ignore** the mapping rule for the case of *DRB To* ***Setup*** *Item* and to **release** the mapping rule for the case of *DRB To* ***Modify*** *Item*.As to the release, we prefer to have both Rel-15 and Rel-16 CR. |
| Nokia | Required changes from our view given in Phase 1.However, the CRs should be limited to Rel 16. The functionality under discussion is not critical in our view, and the system can operate well without these changes. In regard to CATT proposal above, we see it is as not needed and covering the setup case sufficient. |
| Huawei | For UL CRs, we prefer to have both R15/R16 CRs. But it is ok to follow majority views. About the CATT comments on the UL CR(s), we have some sympathy of this scenario, but think there is no need to further complicate this case.  |
| Samsung | DL CRs are pending to conclusion in 3.1For UL CRs, we are still not convinced that the indication is needed. If CU-CP decides to configure a DRB, it would assume some Qos Flows should be mapped to the DRB. Otherwise, there is no value to configure the DRB. |
| ZTE | R16 CR is enough. We are fine for both UL/DL CRs. |
| Intel | We prefer to address DL and UL all together as they are all related to supporting the RAN2 use-cases defined in TS 38.300 which we missed. Having R16 CRs only (for both DL and UL) are fine with us. And in regard to CATT proposal above for “modify”, agree with Nokia.  |
| Ericsson | No conclusion for DL yet.UL CRs may be acceptable for rel-16, but it is probably better to conclude on DL first so we have the full picture |

# Discussion (first phase)

## Confirming the scenarios

According to Annex A of TS 38.300, it is allowed that a QoS flow is not mapped on any DRB as long as there is no corresponding data at present. This reflects the agreement in the RAN2#97 meeting [1]:

Agreements

1: RAN2 to confirm that the timing of non-default DRB establishment (RAN to UE) for QoS Flow configured during PDU Session Establishment could be done NOT at the same time as PDU Session Establishment. (up to eNB implementation)

2 Working assumption from RAN2#96 is confirmed. i.e. First UL packet that doesn't have a mapping to a DRB, is mapped to a default DRB.

Based on this agreement, RAN2 added Annex A into TS 38.300 during the RAN2#98 meeting [2][3]. It is suggested to be an informative annex during the RAN2#97-bis meeting only because “they result from the existing agreements” [4]:

|  |
| --- |
| R2-1703431 Stage 2 message flows for 5G QoS Intel Corporation discussion Rel-15 NR\_newRAT-Core- Nokia suggest this could be an informative annex in the stage 2, as they result from the existing agreements. - Intel explain the difference to SA2 is that it captures the RAN part of reflective mapping. - Qualcomm think they pictures look similar to what is in SA2 specs.* [97bis#xx][NR] QoS message flows (Intel)

 Progress the QoS message flows based our existing agreements and focussing on parts that are not covered in SA2 specifications.  Intended outcome: TP for an annex of stage 2 Deadline: Thursday 27/04/2017  |

And after some rewording in later meetings, the Annex A into TS 38.300 became what we see now:

|  |
| --- |
| A.3 New QoS Flow with Explicit RRC SignallingThe following figure shows an example message flow when explicit RRC signalling is used for a new QoS flow. In this example, the gNB receives from UPF a first downlink packet associated with a QFI, for which the QoS parameters are already known from the PDU session establishment, but for which there is no association to any DRB yet in AS. |
| A.6 UE Initiated UL QoS FlowThe following figure shows an example message flow when the UE AS receives an UL packet for a new QoS flow for which a QFI to DRB mapping rule does not exist. |

**Questions 1-1**: Do companies agree that the cases shown in Annex A of TS 38.300, especially A.3 and A.6, are valid? I.e. companies are invited to confirm the supporting of the feature that a QoS flow is established in the N1/N2 but not mapped to any DRB over the Uu.

| Company | Comment |
| --- | --- |
| CATT | Yes. |
| Nokia | Yes |
| Huawei | Yes |
| Intel | Yes |
| ZTE | Yes |
| Ericsson | Yes, for monolithic gNBs |
| Samsung | The above agreements from RAN2 point of view is mainly on Uu interface i.e. a QoS flow is established in the N1/N2 but not indicated to the UE to which DRB the Qos flow is mapped.RAN2 is assuming aggregated gNB case. In the flow of A.3 and A.6, the F1/E1 part is grey area which is not covered e.g. whether E1 is similar to N1/N2 so that a QoS flow is established and mapped to a DRB or it is similar to Uu. This should be decided by RAN3.In disaggregated scenario, during PDU Session Establishment, the CU-CP doesn’t configure the Qos flow to DRB mapping. When the CU-UP receives a packet for a Qos flow, it indicate to the CU-CP, CU-CP configure DRB over E1/F1. This will bring delay unnecessary. We don’t see the technical benefit. |

**Moderator’s summary: All companies agree that the cases shown in Annex A of TS 38.300 are all valid for the case of aggregated gNB.**

During the online discussion, some companies questioned whether the DL part of this feature (i.e. Annex A.2/3 of TS 38.300) is applicable for gNB-CU-CP/UP split architecture. The main concern was the latency for this feature introduces an extra delay.

On the other side, no company questioned whether the UL part of this feature (i.e. Annex A.6 of TS 38.300) is applicable for gNB-CU-CP/UP split architecture, which is already supported over E1 with UL Data Notification procedure.

**Questions 1-2**: Do companies agree that the DL cases shown in Annex A of TS 38.300, especially A.3, are intended to be supported for the disaggregated architecture?

| Company | Comment |
| --- | --- |
| CATT | Yes.Considering that this feature mainly benefits Uu (i.e. within RAN2 scope, avoiding establishing unnecessary DRBs), we think that it should be supported regardless of whether and how the gNB adopts split architecture.Please note that A.6 also quotes A.2/3, so the intention seems to be that, whenever A.6 is supported, A.2/3 should also be supported as well.For the concern of latency, we think this is not a problem as A.3 introduces an extra delay over Uu regardless of whether and how the gNB adopts split architecture. This is clearly shown in the figure within A.3 (i.e. firstly RRC connection reconfiguration, then UP data delivery):Therefore this feature is intended to be applicable for only latency-non-sensitive QoS flows anyhow. Latency is not a problem. |
| Nokia | Both DL and UL scenarios defined by RAN2 in 38.300 should also be applicable in case of disaggregated gNB architecture. However, Release 16 support is sufficient. |
| Huawei | Yes.  |
| Intel | Yes. This is about RAN2 scenarios that should be honored regardless of whether CP-UP is separated or not. If the latency of deciding mapping later when the actual packet arrives is a concern in case of CP-UP separated, then gNB-CU-CP can always choose to decide mapping for new QoS flow and establish onto gNB-CU-UP immediately.  |
| ZTE | Both DL and UL case should be supported regardless of whether CP-UP is separated or not. |
| Ericsson | Not all the scenarios supported for monolithic gNBs have to be supported for disaggregated gNBs if the benefit does not overtake the additional complexity. For the DL case, many questions and issues would be remaining in case of disaggregated architecture. What should the CU-UP do with the non-mapped QoS Flow packets:* Send it to the default bearer? If yes from which point in time and from which packet should the CU-UP send the flow with the new mapping?
* Wait for the CU-CP to reconfigure the bearer? What happens if there is no response from CU-CP?

[CATT]This can be up to the gNB-CU-UP’s implementation. If the gNB-CU-UP wishes, it can surely send the packet over the default bearer or even any existing bearer. Or if it doesn’t withes so, it can also buffer the DL packet. The UE doesn’t maintain DL QoS-flow-to-DRB mapping anyway.Please note that this case may happen as well even for aggregated gNB: Upon the DL packet arriving, the gNB may decide to map it toward a new DRB, and for this case it needs to set up the new DRB over the Uu. What should the gNB do with the non-mapped QoS Flow packets before the RRC connection reconfiguration procedure completes?And for the question of “when to start sending the packet according to the new mapping”, this is literally the same issue as QoS remapping procedure, which is already supported well.And the last thing: What happens if there is no response from the gNB-CU-CP? This shouldn’t happen in principle. If the gNB-CU-CP doesn’t configure every flow to map toward a DRB it should always send a Bearer Context Modification Request message toward the gNB-CU-UP after receiving a DL Data Notification message. We needn’t consider such rare case. |
| Samsung | RAN2 has thought the issue has no impact on network. It is just gNB implementation issue e.g. when to trigger DBR configuration over Uu. That’s why RAN3 is not involved on this issue.From Uu interface, to configure DRB may save some RRC signaling. But the signaling over E1 is not critical as Uu. Even though with RAN2 agreement, the mapping over E1 can still be configured like for N1/N2. This doesn’t contradict with RAN2 agreement. Then when the data packet is coming, the CP just need to configure the UE over Uu. This will reduce the delay. |

**Moderator’s summary: 7 companies provide feedback. 5 companies agree that the cases shown in Annex A of TS 38.300 are intended to be supported for the disaggregated architecture, 1 company opposes, 1 company doesn’t show clear opinion. The moderator suggest following the majority. In addition, one company comments that it can be supported only from Rel-16 on.**

**Proposal 1: Confirm that the cases shown in Annex A of TS 38.300 are all valid regardless of whether gNB-CU-CP/UP split architecture is supported.**

## E1 handling principle to support the DL scenario

In [5], it is observed that the gNB-CU-UP can not indicate toward the gNB-CU-CP that “DL data with new QFI” arrives, so that the gNB-CU-CP can not behave as specified in Annex A.2/3 of TS 38.300.

Two potential options are proposed as follows in gNB-CU-CP/UP split scenario:

* Option 1: The gNB-CU-CP can decide not to include the unmapped QoS flow at all within any “QoS Flows Information To Be Setup” of “DRB To Setup Item” structure, when setting up the PDU session. When receiving a DL data packet, the gNB-CU-UP can then distinguish such case by checking whether the QFI of this packet is included in the E1AP configuration of any of the established DRBs or not. If not, the gNB-CU-UP will send an E1AP DL DATA NOTIFICATION message toward the gNB-CU-CP.
* Option 2: The gNB-CU-CP can include this QoS flow into the default DRB when setting up PDU session. The gNB-CU-UP will then send an E1AP DL DATA NOTIFICATION message toward the gNB-CU-CP upon receiving a DL packet belonging to any QoS flow in the default DRB.

Option 1 is proposed in [5], and the associated CRs are provided in [6–9].

**Questions 2-1**: If the cases shown in Annex A.2/3 are to be supported in gNB-CU-CP/UP split architecture, which option do you prefer? Companies are also welcome to provide other feasible options.

| Company | Comment |
| --- | --- |
| CATT | Option 1. According to Table 1 in [5], Option 1 is clearly more preferable than Option 2. |
| Nokia | Option 1. |
| Huawei | Both options are fine with us |
| Intel | Option 1.  |
| ZTE | Both solutions are all acceptable |

**Moderator’s summary: 7 companies’ opinion is valid on this issue:**

* **5 companies agree with Option 1;**
* **2 companies agree with Option 2;**
* **1 company prefer a solution other than the two listed here (maybe we can call it “Option 3”, whose principle is “The gNB-CU-CP decides what DRB should contain this QoS flow when setting up the PDU session and inform the gNB-CU-UP, but does not inform the UE”);**
* **1 company oppose the scenario.**

**The moderator suggest following the majority.**

**Proposal 2: For downlink, agree with the following handling principle: The gNB-CU-CP may decide not to include the unmapped QoS flow at all within any “QoS Flows Information To Be Setup” of “DRB To Setup Item” structure, when setting up the PDU session. When receiving a DL data packet, the gNB-CU-UP can then distinguish such case by checking whether the QFI of this packet is included in the E1AP configuration of any of the established DRBs or not. If not, the gNB-CU-UP will send an E1AP DL DATA NOTIFICATION message toward the gNB-CU-CP.**

## E1 handling principle to support the UL scenario

The analysis for the UL scenario is provided in [10]. There is already a method on E1AP which can handle this issue: the **UL Data Notification** procedure. The existing text description of this procedure is given as follows.

* This procedure is initiated by the gNB-CU-UP to notify the gNB-CU-CP that an UL packet including a QFI value in the SDAP header not configured by the *Flow Mapping Information* IE is received for the first time at the default DRB. The procedure uses UE-associated signalling.

It is observed that the current UL Data Notification procedure is limited to only for the DRB modify case for the default DRB.

Also it is proposed that over E1, there may be the case where CU-CP does not configure mapping rule for the default DRB during PDU session establishment, as described in TS 38.300 Annex A.6.

Therefore, two proposals are given:

* Proposal 1: Update the procedure text for UL Data Notification (i.e. adding the QoS Flows Information To Be Setup IE in the text as follows).

This procedure is initiated by the gNB-CU-UP to notify the gNB-CU-CP that an UL packet including a QFI value in the SDAP header not configured by the ***QoS Flows Information To Be Setup* IE** or the *Flow Mapping Information* IE is received for the first time at the default DRB. The procedure uses UE-associated signalling.

* Proposal 2: Introduce a new IE to ignore the mapping rule of the QoS Flows Information To Be Setup IE for the default DRB.

The associated CRs are provided in [11–12].

**Questions 3-1**: For the case shown in Annex A.6 to be supported in gNB-CU-CP/UP split architecture, do you agree with the above two proposals?

| Company | Comment |
| --- | --- |
| CATT | Yes. |
| Nokia | Proposal 1 above seems not aligned with the CR introducing the changes. What is actually proposed in R3-211994 is a clarification in the procedural text of the UL Data Notification procedure (i.e. not a new IE). Proposal 2: Can be agreeable. For the CU-UP a request from an unmapped default bearer needs to be optional to keep backwards compatibility. However, the IE should be criticality reject. Otherwise, CU-CP will never be aware of whether the bearer was setup as expected or not.  |
| Huawei | Thanks to Nokia pointing out the proposal1. Indeed the proposal in the discussion paper/CR should be corrected (please see the update above). For P2, we are fine to set the criticality of “Ignore Mapping Rule Indication” IE to reject.  |
| Intel | Agree with Nokia and Huawei.  |
| ZTE | Agree with Nokia and Huawei.  |
| Ericsson | UL might be easier to support because timing and delay issues does not exist. Proposals are ok after the changes proposed by Nokia. Rel-16 CRs are enough |
| Samsung | Proposal 1 is ok.Proposal 2 is not needed. Because if CU-CP decides to configure a DRB, it would assume some Qos Flows should be mapped to the DRB. Otherwise, there is no value to configure the DRB. |

**Moderator’s summary: All companies agree with Proposal 1. 6 companies agree with Proposal 2 while 1 company opposes. For Proposal 2, it is also commented that the “ignore mapping” indicator should be criticality reject. The moderator suggest following the majority.**

**Proposal 3: For uplink, the text description for the UL Data Notification procedure should be updated to include the case of the *QoS Flows Information To Be Setup* IE.**

**Proposal 4: For uplink, an optional IE, criticality reject, should be added into the *QoS Flows Information To Be Setup* IE, in order to indicate ignoring the QoS flows included within the *QoS Flows Information To Be Setup* IE (i.e. establishing a DRB with no flow mapped toward it)**

# Conclusion, recommendations [if needed]

# Reference

[1] R2-1702451; Report of 3GPP TSG RAN WG2 meeting #97, Athens, Greece; ETSI MCC.

[2] R2-1706011; TP from [97bis#15][NR] QoS message flows; Intel Corporation.

[3] R2-1707601; Report of 3GPP TSG RAN2#98 meetinng, Hangzhou, China; ETSI MCC.

[4] R2-1704001; Report of 3GPP TSG RAN2 meeting #97bis, Spokane, USA; ETSI MCC.

[5] R3-211694; Discussion on E1AP handling for unmapped flows in DL; CATT, CATT, Intel Corporation, Huawei, China Telecom.

[6] R3-212293; CR for 38.460 on E1AP handling for unmapped DL QoS flows; Intel Corporation, CATT, Huawei, China Telecom.

[7] R3-212294; CR for 38.460 on E1AP handling for unmapped DL QoS flows; Intel Corporation, CATT, Huawei, China Telecom.

[8] R3-211695; CR on E1AP handling for unmapped DL QoS flows; CATT, Intel Corporation, Huawei, China Telecom.

[9] R3-211696; CR on E1AP handling for unmapped DL QoS flows; CATT, Intel Corporation, Huawei, China Telecom.

[10] R3-211993; Correction for UL Data Notification over E1; Huawei, Intel Corporation, CATT, China Telecom.

[11] R3-211994; Correction for UL Data Notification over E1; Huawei, Intel Corporation, CATT, China Telecom.

[12] R3-211995; Correction for UL Data Notification over E1; Huawei, Intel Corporation, CATT, China Telecom.

# Annex: Annex A of TS 38.300

Annex A (informative):
QoS Handling in RAN

A.1 PDU Session Establishment

The following figure shows an example message flow for a PDU session establishment. NAS procedures details between gNB and 5GC can be found in TS 23.501 [3], TS 23.502 [22] and TS 38.413 [26].

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**Figure A.1-1: PDU session establishment**

1. UE requests a PDU session establishment to AMF.

2. AMF sends a PDU SESSION RESOURCE SETUP REQUEST message to gNB, which includes the NAS message to be sent to the UE with NAS QoS related information.

3. gNB sends an *RRCReconfiguration* message to UE including the configuration of at least one DRB and the NAS message received at Step 2.

4. UE establishes the DRB(s) for the new PDU session and creates the QFI to DRB mapping rules.

5. UE sends an *RRCReconfiguration* *Complete* message to gNB.

6. gNB sends a PDU SESSION RESOURCE SETUP RESPONSE message to AMF.

7. User Plane Data can then be exchanged between UE and gNB over DRB(s) according to the mapping rules and between UPF and gNB over the tunnel for the PDU session. QFI marking over Uu is optional (see clause 12) while QFI marking over NG-U is always present.

A.2 New QoS Flow with RQoS

The following figure shows an example message flow when RQoS is used for a new QoS flow. In this example, the gNB receives from UPF a first downlink packet associated with a QFI for which the QoS parameters are known from the PDU session establishment, but for which there is no association to any DRB yet in AS.

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**Figure A.2-1: DL data with new QFI sent over existing DRB**

0. PDU session and DRB(s) have been already established.

1. gNB receives a downlink packet with a new QFI from UPF.

2. gNB decides to send the new QoS flow over an existing DRB.

NOTE: If gNB decides to send it over a new DRB, it needs to establish the DRB first.

3. gNB sends the DL packet over the selected DRB with the new QFI and RDI set in the SDAP header.

4. UE identifies the QFI and RDI in the received DL packet and the DRB on which the packet was received. The AS mapping rules are then updated accordingly.

5. User Plane Data for the new QoS flow can then be exchanged between UE and gNB over the DRB according to the updated mapping rules and between UPF and gNB over the tunnel for the PDU session.

A.3 New QoS Flow with Explicit RRC Signalling

The following figure shows an example message flow when explicit RRC signalling is used for a new QoS flow. In this example, the gNB receives from UPF a first downlink packet associated with a QFI, for which the QoS parameters are already known from the PDU session establishment, but for which there is no association to any DRB yet in AS.

****

**Figure A.3-1: DL data with new QFI sent over existing DRB**

0. PDU session and DRB(s) have been already established.

1. gNB receives a downlink packet with a new QFI from UPF.

2. gNB decides to send the new QoS flow over an existing DRB using explicit RRC signalling for updating the AS mapping rules.

3. gNB sends an *RRCReconfiguration* message to UE with the new QFI to DRB mapping rule. gNB may also decide to update the DRB configuration if required to meet the QoS requirements for the new QoS Flow.

4. UE updates the QFI to DRB mapping rules and configuration (if received).

5. UE sends an *RRCReconfigurationComplete* message to gNB.

6. User Plane Data for the new QoS flow can then be exchanged between UE and gNB over the DRB according to the updated mapping rules and between UPF and gNB over the tunnel for the PDU session.

A.4 New QoS Flow with Explicit NAS Signalling

The following figure shows an example message flow when the gNB receives a new QoS flow establishment request from CN that involves NAS explicit signalling. The QoS flow establishment request provides the gNB and UE with the QoS parameters for the QFI. In this example, the gNB decides to establish a new DRB (rather than re-use an existing one) for this QoS flow and provides the mapping rule over RRC signalling. NAS procedures details between gNB and 5GC can be found in TS 23.501 [3], TS 23.502 [22] and TS 38.413 [26].

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**Figure A.4-1: DL data with new QoS Flow ID sent over new DRB with explicit signalling**

0. PDU session DRB(s) have been already established.

1. gNB receives a PDU SESSION RESOURCE MODIFY REQUEST message from AMF for a new QoS flow.

2. If gNB cannot find an existing DRB to map this new QoS flow, it decides to establish a new DRB.

3. gNB sends an *RRCReconfiguration* message to UE including the DRB configuration with the new QFI to DRB mapping rule and the NAS message received at step 1.

4. UE establishes the DRB for the new QoS flow associated with this PDU session and updates the mapping rules.

5. UE sends an *RRCReconfigurationComplete* message to gNB.

6. gNB sends a PDU SESSION RESOURCE MODIFY RESPONSE message to AMF.

7. User Plane Data can then be exchanged between UE and gNB over DRB(s) according to the mapping rules and between UPF and gNB over the tunnel for the PDU session.

A.5 Release of QoS Flow with Explicit Signalling

The following figure shows an example message flow when the gNB receives a request to release a QoS flow from CN that involves explicit NAS signalling. NAS procedures details between gNB and 5GC can be found in TS 23.501 [3], TS 23.502 [22] and TS 38.413 [26].

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**Figure A.5-1: Release of QoS Flow with Explicit Signalling**

0. PDU session and DRB(s) have been already established.

1. gNB receives a PDU SESSION RESOURCE MODIFY REQUEST message from AMF to release a QoS flow.

2. The gNB decides to release corresponding the QFI to DRB mapping rule. Since the DRB also carries other QoS flows, the DRB is not released.

3. gNB sends an *RRCReconfiguration* message to UE to release the QFI to DRB mapping rule.

4. UE updates the AS QFI to DRB mapping rules to release this QFI to DRB mapping rule.

5. UE sends an *RRCReconfigurationC*omplete message to gNB.

6. gNB sends a PDU SESSION RESOURCE MODIFY RESPONSE message to AMF.

A.6 UE Initiated UL QoS Flow

The following figure shows an example message flow when the UE AS receives an UL packet for a new QoS flow for which a QFI to DRB mapping rule does not exist.

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**Figure A.6-1: UL packet with a new QoS flow for which a mapping does not exist in UE**

0. PDU session and DRBs (including a default DRB) have been already established.

1. UE AS receives a packet with a new QFI from UE NAS.

2. UE uses the QFI of the packet to map it to a DRB. If there is no mapping of the QFI to a DRB in the AS mapping rules for this PDU session, then the packet is assigned to the default DRB.

3. UE sends the UL packet on the default DRB. The UE includes the QFI in the SDAP header.

4. gNB sends UL packets to UPF and includes the corresponding QFI.

5. If gNB wants to use a new DRB for this QoS flow, it sets up one. It can also choose to move the QoS flow to an existing DRB using RQoS or RRC signalling (see clauses A.2 and A.3).

6. User Plane Data for the new QoS flow can then be exchanged between UE and gNB over the DRB according to the updated mapping rules and between UPF and gNB over the tunnel for the PDU session.