**SA WG2 Meeting #S2-140E S2-200xxxx**

**19 August - 2 September, 2020, Electronic (revision of S2-20xxxxx)**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
|  |
|  | **23.501** | **CR** |  | **rev** | **-** | **Current version:** | **16.5.1** |  |
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| *For* ***HE******LP*** *on using this form: comprehensive instructions can be found at http://www.3gpp.org/Change-Requests.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **X** | Core Network | **X** |

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|  |
| ***Title:***  | Delay clarifications, IEEE TSN LS response  |
|  |  |
| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | Vertical\_LAN |  | ***Date:*** | 2020-07-28 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-16 |
|  | *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. | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)Rel-12 (Release 12)Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
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| ***Reason for change:*** | Note that the IEEE LS also indicated the need for a more clear definition: “the arrival time of the data burst” is not sufficiently precise.* The current specification wording is not fully clear on that the PDB is measured up to the N6 termination point at the UPF.
* The current specification is not fully clear on that the downlink BAT at the AN in the TSCAI is a the latest possible burst arrival, not an exact value, since it is calculated using the CN PDB which is an upper bound to the delay in the CN.
* Since the BAT is derived from the PSFP gate open intervals in this release of the specification, there is no guarantee that the traffic actually arrives at the start of the BAT. The BAT represents the start of the burst window of opportunity, but the actual traffic may arrive later. In fact, the CNC may set the PSFP gate open intervals delibaretely longer than the actual known burst.
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| ***Summary of change:*** | * Clarify that the PDB is measured up to the N6 termination point at the UPF. There is no technical change in the PDB definition; the text update is proposed to better clarify the existing definition.
* Clarify that the downlink BAT at the AN in the TSCAI is the latest possible start of the data burst window at the AN.
* Clarify that the BAT represents the start of the data burst window, when traffic may arrive, but the actual traffic may arrive later.
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| ***Consequences if not approved:*** | Specification remains unclear.  |
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| ***Clauses affected:*** | 5.7.3.4, 5.27.2 |
|  |  |
|  | **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:*** |  |

**\* \* \* \* Start of Change \* \* \* \***

#### 5.7.3.4 Packet Delay Budget

The Packet Delay Budget (PDB) defines an upper bound for the time that a packet may be delayed between the UE and the N6 termination point at the UPF. For a certain 5QI the value of the PDB is the same in UL and DL. In the case of 3GPP access, the PDB is used to support the configuration of scheduling and link layer functions (e.g. the setting of scheduling priority weights and HARQ target operating points). For GBR QoS Flows using the Delay-critical resource type, a packet delayed more than PDB is counted as lost if the data burst is not exceeding the MDBV within the period of PDB and the QoS Flow is not exceeding the GFBR. For GBR QoS Flows with GBR resource type not exceeding GFBR, 98 percent of the packets shall not experience a delay exceeding the 5QI's PDB.

The 5G Access Network Packet Delay Budget (5G-AN PDB) is determined by subtracting a static value for the Core Network Packet Delay Budget (CN PDB), which represents the delay between any N6 termination point at the UPF (for any UPF that may possibly be selected for the PDU Session) and the 5G-AN from a given PDB.

NOTE 1: For a standardized 5QI, the static value for the CN PDB is specified in the QoS characteristics Table 5.7.4-1.

NOTE 2: For a non-standardized 5QI, the static value for the CN PDB is homogeneously configured in the network.

For GBR QoS Flows using the Delay-critical resource type, in order to obtain a more accurate delay budget PDB available for the NG-RAN, a dynamic value for the CN PDB, which represents the delay between the UPF terminating N6 for the QoS Flow and the 5G-AN, can be used. If used for a QoS Flow, the NG-RAN shall apply the dynamic value for the CN PDB instead of the static value for the CN PDB (which is only related to the 5QI). Different dynamic value for CN PDB may be configured per uplink and downlink direction.

NOTE 3: The configuration of transport network on CN tunnel can be different per UL and DL, which can be different value for CN PDB per UL and DL.

NOTE 4: It is expected that the UPF deployment ensures that the dynamic value for the CN PDB is not larger than the static value for the CN PDB. This avoids that the functionality that is based on the 5G-AN PDB (e.g. MDBV, NG-RAN scheduler) has to handle an unexpected value.

The dynamic value for the CN PDB of a Delay-critical GBR 5QI may be configured in the network in two ways:

- Configured in each NG-RAN node, based on a variety of inputs such as different IP address(es) or TEID range of UPF terminating the N3 tunnel and based on different combinations of PSA UPF to NG-RAN under consideration of any potential I-UPF, etc;

- Configured in the SMF, based on different combinations of PSA UPF to NG-RAN under consideration of any potential I-UPF. The dynamic value for the CN PDB for a particular QoS Flow shall be signalled to NG-RAN (during PDU Session Establishment, PDU Session Modification, Xn/N2 handover and the Service Request procedures) when the QoS Flow is established or the dynamic value for the CN PDB of a QoS Flow changes, e.g. when an I-UPF is inserted by the SMF.

If the NG-RAN node is configured locally with a dynamic value for the CN PDB for a Delay-critical GBR 5QI, and receives a different value via N2 signalling for a QoS Flow with the same 5QI, local configuration in RAN node determines which value takes precedence.

Services using a GBR QoS Flow and sending at a rate smaller than or equal to the GFBR can in general assume that congestion related packet drops will not occur.

NOTE 5: Exceptions (e.g. transient link outages) can always occur in a radio access system which may then lead to congestion related packet drops. Packets surviving congestion related packet dropping may still be subject to non-congestion related packet losses (see PER below).

Services using Non-GBR QoS Flows should be prepared to experience congestion-related packet drops and delays. In uncongested scenarios, 98 percent of the packets should not experience a delay exceeding the 5QI's PDB.

The PDB for Non-GBR and GBR resource types denotes a "soft upper bound" in the sense that an "expired" packet, e.g. a link layer SDU that has exceeded the PDB, does not need to be discarded and is not added to the PER. However, for a Delay critical GBR resource type, packets delayed more than the PDB are added to the PER and can be discarded or delivered depending on local decision.

**\* \* \* \* Next Change \* \* \* \***

### 5.27.2 TSC Assistance Information (TSCAI)

TSC assistance information describes TSC traffic characteristics for use in the 5G System. The knowledge of TSN traffic pattern is useful for the gNB to allow it to more efficiently schedule periodic, deterministic traffic flows either via Configured Grants, Semi-Persistent Scheduling or with dynamic grants. TSC assistance information, as defined in Table 5.27.2-1, is provided from SMF to 5G-AN, e.g. upon QoS Flow establishment. The TSCAI parameters are set according to corresponding parameters obtained from the TSN AF. The TSN AF identifies the PDU session as described in clause 5.28.2.

The TSN AF is responsible for obtaining PSFP (IEEE 802.1Q [98]) parameters and use them to calculate traffic pattern parameters (such as burst arrival time with reference to the ingress port, periodicity, and flow direction) and responsible of forwarding these parameters in TSC Assistance Container to the SMF (via PCF). TSN AF may enable aggregation of TSN streams if the TSN streams belong to the same traffic class, terminate in the same egress port and have the same periodicity and compatible Burst arrival time. One set of parameters and one container are being calculated by the AF for multiple TSN streams to enable aggregation of TSN streams to the same QoS Flow.

Annex I describe how the traffic pattern information is determined.

NOTE 1: Further details of aggregation of TSN streams (including determination of burst arrival times that are compatible so that TSN streams can be aggregated) are left for implementation.

In this case, TSN AF creates one TSC Assistance Container for the aggregated TSN streams. The SMF will bind PCC rules with a TSC Assistance Container as described in clause 6.1.3.2.4 of TS 23.503 [45]. The SMF derives TSCAI on a per QoS Flow basis and send it to 5G-AN. The Burst Arrival Time and Periodicity component of the TSCAI that the SMF signals to the 5G-AN are specified with respect to the 5G clock. The SMF is responsible for mapping the Burst Arrival Time and Periodicity from a TSN clock to the 5G clock based on the time offset and cumulative rateRatio between TSN time and 5GS time as measured and reported by the UPF.

The TSCAI parameter determination in SMF is done as follows:

- For traffic in downlink direction, the SMF corrects the Burst Arrival Time in the TSN Assistance Container based on the latest received time offset measurement from the UPF and sets the TSCAI Burst Arrival Time as the sum of the corrected value and CN PDB as described in clause 5.7.3.4, representing the latest possible time instance when the data burst window may arrive to the AN.

- For traffic in uplink direction, the SMF corrects the Burst Arrival Time in the TSN Assistance Container based on the latest received time offset measurement from the UPF and sets the TSCAI Burst Arrival Time as the sum of the corrected value and UE-DS-TT Residence Time.

- The SMF corrects the Periodicity in the TSN Assistance Container by the previously received cumulative rateRatio from the UPF and sets the TSCAI Periodicity as the corrected value.

- The SMF sets the TSCAI Flow Direction as the Flow Direction in the TSN Assistance Container.

NOTE 2: In order for the TSN AF to get Burst Arrival Time, Periodicity on a per TSN stream basis, support for IEEE 802.1Q [98] (as stated in clause 4.4.8.2) Per-Stream Filtering and Policing (PSFP) with stream gate operation is a prerequisite.

In this release of the specification, the Burst Arrival Time represents the start of the data burst window; the actual traffic arrives within this data burst window and may come later than the start of the data burst window.

In the case of drift between TSN time and 5G time, the UPF updates the offset to SMF using the N4 Report Procedure as defined in TS 23.502 [3] clause 4.4.3.4. In the case of change of cumulative rateRatio between TSN time and 5G time, the UPF updates the cumulative rateRatio to SMF using the N4 Report Procedure as defined in TS 23.502 [3] clause 4.4.3.4. The SMF may then trigger a PDU Session Modification as defined in TS 23.502 [3] clause 4.3.3 in order to update the TSCAI parameter to the NG-RAN without requiring AN or N1 specific signalling exchange with the UE.

NOTE 3: In order to prevent frequent updates from the UPF, the UPF sends the offset or the cumulative rateRatio only when the difference between the current measurement and the previously reported measurement is larger than a threshold as described in TS 23.502 [3] clause 4.4.3.4.

Table 5.27.2-1: TSC Assistance Information

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| --- | --- |
| Assistance Information | Description |
| Flow Direction | The direction of the TSC flow (uplink or downlink). |
| Periodicity | It refers to the time period between start of two bursts. |
| Burst Arrival time | For uplink flow direction: The start of the data burst window at the egress interface of the UE. For downlink flow direction: The latest possible start of the data burst window at the ingress of the RAN. |

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