**3GPP TSG-SA2 Meeting #168 *S2-2503862***

**Stor-Göteborg, SE, 07th April 2025 – *(was S2-25xxxxx)***

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.501** | **CR** | **6268** | **rev** | - | **Current version:** | **18.9.0** |  |
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| *For* [***HE******LP***](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 | **X** | Radio Access Network |  | Core Network | **X** |

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| ***Title:*** | 5GS common time reference traceable to UTC | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Nokia | | | | | | | | | |
| ***Source to TSG:*** | SA2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | Vertical\_LAN, IIoT | | | | |  | ***Date:*** | | | 2025-03-28 |
|  |  | | | |  | |  | | |  |
| ***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 can be 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-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Current specification assumes the UPF/NW-TT and the gNB are time synchronized with the 5G internal system clock. The 5G internal system clock is however abstract as in real deployments the gNB deployments may be extremely distributed thus the 5G System entities (gNBs, UPF/NW-TTs) may not all have synchronized using the same epoch (origin of time). This causes an issue for residence time calculation in the UE/DS-TT or UPF/NW-TT. There is also no way for the UE to know the offset between the epoch used by the serving gNB and the serving UPF.  In TS 38.401 clause 9.1 for gNB synchronization, there is a requirement that in case of TDD-unicast area not isolated, the common time reference shall be traceable to UTC. To addres the problem of the presence of multiple epochs in different user plane nodes and NG-RAN nodes in the 5G system, this CR proposes to clarify in the specification that the 5G common time reference applies for 5G System. | | | | | | | | |
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| ***Summary of change:*** | | It is proposed that the 5G System, NG-RAN nodes and the user plane nodes are synchronized to the common reference time.  Also, 5G internal system clock reference is used for time stamping in 5.27.1.2.2 | | | | | | | | |
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| ***Consequences if not approved:*** | | Uncertain support for residence time calculation where multiple epoch are used in gNB, NW-TT and DS-TT. | | | | | | | | |
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| ***Clauses affected:*** | | 5.27.1.2.1, 5.27.1.2.2 | | | | | | | | |
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|  | | **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:*** | |  | | | | | | | | |

\* \* \* \* First change \* \* \* \*

#### 5.27.1.2 Distribution of timing information

##### 5.27.1.2.1 Distribution of 5G internal system clock

The 5G internal system clock shall be traceable to a common time reference.

NOTE: The above requirement does not apply when 5G System supports only ASTI based time synchronization for a given UE.

The 5G internal system clock shall be made available to all user plane nodes in the 5G system. The UPF and NW-TT may get the 5G internal system clock via the underlying PTP compatible transport network with mechanisms outside the scope of 3GPP. The 5G internal system clock shall be made available to UE with signalling of time information related to absolute timing of radio frames as described in TS 38.331 [28]. The 5G internal system clock shall be made available to DS-TT by the UE.

\* \* \* \* Next change \* \* \* \*

##### 5.27.1.2.2 Distribution of grandmaster clock and time-stamping

5.27.1.2.2.1 Distribution of gPTP Sync and Follow\_Up messages

The mechanisms for distribution of TSN GM clock and time-stamping described in this clause are according to IEEE Std 802.1AS [104].

NOTE 1: It means Externally-observable behaviour of the 5GS bridge needs to comply with IEEE Std 802.1AS [104].

For downlink Time Synchronization, upon reception of a downlink gPTP message from NW-TT port in Follower state, the NW-TT makes an ingress timestamping (TSi) using 5G internal system clock for each gPTP event (Sync) message and uses the cumulative rateRatio received inside the gPTP message payload (carried within Sync message for one-step operation or Follow\_up message for two-step operation) to calculate the link delay from the upstream TSN node (gPTP entity connected to NW-TT) expressed in TSN GM time as specified in IEEE Std 802.1AS [104]. NW-TT then calculates the new cumulative rateRatio (i.e. the cumulative rateRatio of the 5GS) as specified in IEEE Std 802.1AS [104] and modifies the gPTP message payload (carried within Sync message for one-step operation or Follow\_up message for two-step operation) as follows:

- Adds the link delay from the upstream TSN node in TSN GM time to the correction field.

- Replaces the cumulative rateRatio received from the upstream TSN node with the new cumulative rateRatio.

- Adds TSi in the Suffix field of the gPTP packet as described in clause H.2.

The UPF/NW-TT uses the ingress port number of the NW-TT and domainNumber and sdoId in the received gPTP message to assign the gPTP message to a PTP instance in the NW-TT. If the NW-TT does not have a matching PTP instance, the UPF/NW-TT discards the message. The UPF/NW-TT then forwards the gPTP message from TSN network to the PTP ports in DS-TT(s) in Leader state within this PTP instance via PDU sessions terminating in this UPF that the UEs have established to the TSN network. The UPF/NW-TT also forwards the gPTP message to the PTP ports in NW-TT in Leader state within this PTP instance. All gPTP messages are transmitted on a QoS Flow that complies with the residence time upper bound requirement specified in IEEE Std 802.1AS [104].

NOTE 2: Leader and Follower terms in this specification maps to Master and Slave terms respectively for (g)PTP time synchronization as specified in IEEE Std 802.1AS [104] and IEEE Std 1588 [126]. This terminology can require update depending on the IEEE 1588 WG response to SA WG2.

NOTE 3: The sum of the UE-DS-TT residence time and the PDB of the QoS Flow needs to be lower than the residence time upper bound requirement for a time-aware system specified in IEEE Std 802.1AS [104] in the following cases:

a) If the PTP port in DS-TT is in Follower state and a PTP port in the NW-TT is in Leader state; or

b) a PTP port in DS-TT is in Leader state and a PTP port in NW-TT is in Follower state.

NOTE 4: If the PTP port in DS-TT is in a Follower state and a PTP port in another DS-TT is in Leader state, then the sum of the residence time for these two DS-TT ports and the PDB of the QoS flow of the two PDU Sessions needs to be lower than the residence time upper bound requirement for a time-aware system specified in IEEE Std 802.1AS [104].

A UE receives the gPTP messages and forwards them to the DS-TT. The DS-TT then creates egress timestamping (TSe) using 5G internal system clock for the gPTP event (Sync) messages for external TSN working domains. The difference between TSi and TSe is considered as the calculated residence time spent within the 5G system for this gPTP message expressed in 5GS time. The DS-TT then uses the rateRatio contained inside the gPTP message payload (carried within Sync message for one-step operation or Follow\_up message for two-step operation) to convert the residence time spent within the 5GS in TSN GM time and modifies the payload of the gPTP message that it sends towards the downstream TSN node (gPTP entity connected to DS-TT) as follows:

- Adds the calculated residence time expressed in TSN GM time to the correction field.

- Removes Suffix field that contains TSi.

If the ingress DS-TT has indicated support of the IEEE Std 802.1AS [104] PTP profile as described in clause K.2.1 and the network has configured a PTP instance with the IEEE Std 802.1AS [104] PTP profile for the ingress DS-TT, the ingress DS-TT performs the following operations for received UL gPTP messages for the PTP instance:

- Adds the link delay from the upstream TSN node (gPTP entity connected to DS-TT) in TSN GM time to the correction field.

- Replaces the cumulative rateRatio received from the upstream TSN node (gPTP entity connected to DS-TT) with the new cumulative rateRatio.

- Adds TSi in the Suffix field of the gPTP packet.

The UE transparently forwards the gPTP message from DS-TT to the UPF/NW-TT. If the ingress DS-TT port is in Passive state, the UPF/NW-TT discards the gPTP messages. If the ingress DS-TT port is in Follower state, the UPF/NW-TT forwards the gPTP messages as follows:

- In the case of synchronizing end stations behind NW-TT, the egress port is in UPF/NW-TT. For the received UL gPTP messages, the egress UPF/NW-TT performs the following actions:

- Adds the calculated residence time expressed in TSN GM to the correction field.

- Removes Suffix field that contains TSi.

- In the case of synchronizing TSN end stations behind DS-TT, the egress TT is DS-TT of the other UE and the UPF/NW-TT uses the port number of the ingress DS-TT and domainNumber and sdoId in the received gPTP message to assign the gPTP message to a PTP instance in the NW-TT. If the NW-TT does not have a matching PTP instance, the UPF/NW-TT discards the message. The UPF/NW-TT then forwards the received UL gPTP message to the PTP ports in DS-TT(s) in Leader state within this PTP instance. The egress DS-TT performs same actions as egress UPF/NW-TT in previous case.

\* \* \* \* End of changes \* \* \* \*