**SA WG2 Meeting #S2-143E  *S2-200xxxx***

**24 February – 9 March, 2021, Elbonia**

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| *CR-Form-v12.0* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.501** | **CR** | **2261** | **rev** | **-** | **Current version:** | **16.7.0** |  |
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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 |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:*** | KI #1-1, Update for supporting UL time sync with gPTP message | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | CATT, Ericsson, Samsung, ETRI?, NTT DOCOMO? | | | | | | | | | |
| ***Source to TSG:*** | SA2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | Vertical\_LAN | | | | |  | ***Date:*** | | | 2021-02-24 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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-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:*** | | Per TR 23.700-20 clause 8.1, it is concluded to support UL time synchronization with gPTP message. | | | | | | | | |
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| ***Summary of change:*** | | Add support for UL time synchronization with gPTP message. | | | | | | | | |
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| ***Consequences if not approved:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 5.27.1.2.2, 5.27.1.2.3, H.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:*** | |  | | | | | | | | |

\* \* \* \* 1st change \* \* \* \*

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

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 behavior of the 5GS bridge needs to comply with IEEE Std 802.1AS [104].

For downlink Time Synchronization for TSN, upon reception of a downlink gPTP message the NW-TT makes an ingress timestamping (TSi) 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) 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 Annex H.

UPF/NW-TT then forwards the gPTP message from TSN network to the DS-TT ports in Master state via PDU sessions terminating in this UPF that the UEs have established to the TSN network. 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: 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].

A UE receives the gPTP messages and forwards them to the DS-TT. The DS-TT then creates egress timestamping (TSe) 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 as follows:

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

- Removes Suffix field that contains TSi.

For uplink Time Synchronization for TSN, the ingress DS-TT performs the same operations for the received DL gPTP messages as NW-TT performs for the DL gPTP messages 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 downstream TSN node with the new cumulative rateRatio.

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

The UE forwards the gPTP message from TSN network to the UPF.

In the case of synchronizing end stations behind NW-TT, the egress TT is NW-TT. The UPF/NW-TT performs the same operations as DS-TT performs for the received DL gPTP messages.

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 forwards the received UL gPTP message transparently to the other UEs/DS-TT ports in Master state.

The Egress TT (NW-TT/DS-TT) performs the operations as follows:

- Adds the calculated residence time to the correction field.

- Removes Suffix field that contains TSi.

\* \* \* \* End of 1st change \* \* \* \*

\* \* \* \* 2nd change \* \* \* \*

#### 5.27.1.3 Support for multiple TSN working domains

Each TSN working domain sends its own gPTP messages. The related Ethernet frames carry the gPTP multicast Ethernet destination MAC address and the gPTP message carries a specific PTP "domainNumber" that indicates the time domain they are referring to. In the case of DL time synchronization, the NW-TT makes ingress timestamping (TSi) for the gPTP event messages of all domains and forwards the gPTP messages of all domains to the UEs as specified in clause 5.27.1.2.2.

A UE receives gPTP messages and forwards them all to the DS-TT. The DS-TT receives the original TSN GM clock timing information and the corresponding TSi via gPTP messages for one or more TSN working domains. The DS-TT then makes egress timestamping (TSe) for the gPTP event messages for every external TSN working domain. Ingress and egress time stamping are based on the 5G system clock at NW-TT and DS-TT.

In the case of UL time synchronization, to support the multiple TSN working domains, the ingress DS-TT and egress NW-TT/DS-TT performs the same operations for DL time synchronization., The UPF will not forward the UL gPTP messages back to the source DS-TT when the (even if the egress TT is a UE/DS-TT).

NOTE 1: An end-station can select TSN timing information of interest based on the "domainNumber" in the gPTP message.

The process described in clause 5.27.1.2.2 is thus repeated for each TSN working domain between a DS-TT and the NW-TT it is connected to.

NOTE 2: If all TSN working domains can be made synchronous and the synchronization can be provided by the 5G clock, the NW-TT generates the gPTP event messages of all domains using 5G clock, the NW-TT output ports towards the connected TSN networks propagate the 5G clock via gPTP messages (i.e. the 5G system acts as an IEEE Std 802.1AS [104] compliant time-aware system and in this case is the grandmaster for all the TSN working domains). When the gPTP event messages require to be forwarded toward DS-TT, the NW-TT makes the time generating the gPTP event message as TSi and sets the cumulative rateRatio value with 1.

NOTE 3: This Release of the specification supports multiple gPTP domains as defined in IEEE Std 802.1AS [104], and the TSN AF does not participate in the gPTP time synchronization process. If a 5GS TSN bridge supports stream gates and/or transmission gates as defined in IEEE Std 802.1Q [98], then they operate based on a single given gPTP domain.

\* \* \* \* End of 2nd change \* \* \* \*

\* \* \* \* 3rd change \* \* \* \*

# H.2 Signalling of ingress time for time synchronization

The ingress time is provided from the NW-TT/UPF to the DS-TT/UE for DL time synchronization, or from ingress DS-TT/UE to NW-TT/UPF or egress DS-TT/UE for UL time synchronization, as part of a gPTP Sync message using the Suffix field defined in clause 13.4 of IEEE Std 1588 [107]. The structure of the Suffix field follows the recommendation of clause 14.3 of IEEE Std 1588 [107], with an organizationId specific to 3GPP, an organizationSubType referring to an ingress timestamp, and data field that carries the ingress timestamp encoded as specified in clause 5.3.3 of IEEE Std 1588 [107]. TS 24.535 [117] specifies the fields in the gPTP Sync message.

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