**SA WG2 Meeting #S2-143E S2-210xxxx**

**24 February - 9 March 2021, Electronic, Elbonia (revision of S2-210xxxx)**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
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|  | **23.501** | **CR** | **<CR#>** | **rev** | **-** | **Current version:** | **16.7.0** |  |
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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 |  | Core Network |  |

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|  |
| ***Title:***  | KI#1, adding GM capability from NW-TT and control GM in NW-TT |
|  |  |
| ***Source to WG:*** | ZTE |
| ***Source to TSG:*** | SA WG2 |
|  |  |
| ***Work item code:*** | IIoT |  | ***Date:*** | 2021-01-19 |
|  |  |  |  |  |
| ***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 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)* |
|  |  |
| ***Reason for change:*** | As concluded in TR 23.700-20, this CR adds M capability from NW-TT and control GM in NW-TT. |
|  |  |
| ***Summary of change:*** |  |
|  |  |
| ***Consequences if not approved:*** |  |
|  |  |
| ***Clauses affected:*** |  |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

*FIRST CHANGE*

5.27.1 TSN Time Synchronization

5.27.1.1 General

For supporting TSN time synchronization, the 5GS is integrated with the external network as a TSN bridge as described in clauses 4.4.8 and 5.28.1. It shall be modelled as an IEEE Std 802.1AS [104] compliant entity according to TS 22.104 [105]. For TSN time synchronization, the entire E2E 5G system can be considered as an IEEE Std 802.1AS [104] "time-aware system". Only the TSN Translators (TTs) at the edges of the 5G system need to support the IEEE Std 802.1AS [104] operations. UE, gNB, UPF, NW-TT and DS- TTs are synchronized with the 5G GM (i.e. the 5G internal system clock) which shall serve to keep these network elements synchronized. The TTs located at the edge of 5G system fulfil some functions related to IEEE Std 802.1AS [104], e.g. gPTP support, timestamping, rateRatio. Figure 5.27.1-1 illustrates the 5G and TSN grandmaster (TSN GM) clock distribution model via 5GS.

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**Figure 5.27.1-1: 5G system is modelled as IEEE Std 802.1AS [104] compliant time aware system for supporting TSN time synchronization**

Figure 5.27.1-1 depicts the two synchronizations systems considered: the 5GS synchronization and the TSN domain synchronization, as well as the Master (M) and Slave (S) ports considered when the TSN GM is located at TSN working domain.

- 5GS synchronization: Used for NG RAN synchronization. 5G RAN synchronization is specified in TS 38.331 [28].

- TSN domain synchronization: Provides synchronization service to TSN network. This process follows IEEE Std 802.1AS [104].

The two synchronization processes can be considered independent from each other and the gNB only needs to be synchronized to the 5G GM clock.

The TSN GM clock may be inside UE/DS-TT or UPF/NW-TT depending on the TT capability and network deployment.

To enable TSN domain synchronization, the 5GS calculates and adds the measured residence time between the TTs into the Correction Field (CF) of the synchronization packets of the TSN working domain.

In this Release, 5GS only supports method b) defined in IEEE 802.1AS [104] clause 10.3.1.1 for determining the grandmaster PTP Instance and the time-synchronization spanning tree.

This implies that in this release the 5GS Bridge PTP port states are assumed to be locally configured in DS-TT and NW-TT as follows:

- For DS-TT ports the PTP port state is MasterPort for all gPTP domains.

- When the TSN GM is external to the 5GS, for one of the NW-TT ports (per each gPTP domain) the PTP port state is SlavePort and for all other NW-TT ports of the same gPTP domain the PTP port state is either PassivePort or MasterPort (depending on implementation).

- When the 5GS is configured as master (5G GM) for a gPTP domain for the connected networks, all NW-TT ports are in MasterPort state for that gPTP domain.

*Next 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. 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.

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 UPF/NW-TT can be locally configured or controlled by TSN AF as grandmaster clock.

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.

*Next CHANGE*

5.27.1.2.X NW-TT is controlled as grandmaster clock

The UPF/NW-TT may indicate the grandmaster clock capability to TSN AF via BMIC. If the UPF/NW-TT is GM capable, the TSN AF configures UPF/NW-TT with the required parameters for grandmaster clock.

For the BMCA procedure, the behavoir of UPF/NW-TT defined in the 5.27.1.1.

When the UPF/NW-TT act as the grandmaster clock, the Master port on the NW-TT port propagate the 5G clock via (g)PTP messages (i.e. the 5G system acts as an IEEE Std 802.1AS [104] or IEEE 1588 [107] compliant grandmaster for the TSN working domains) towards the connected TSN network. When the (g)PTP event messages require to be forwarded toward Master port on the DS-TT, the NW-TT generating the (g)PTP event message as defined in the 5.27.1.2.2. The cumulative rateRatio value is set with 1.

*Next CHANGE*

5.28.3 Port and bridge management information exchange in 5GS

5.28.3.1 General

Port and bridge management information is exchanged between CNC and TSN AF. The port management information, is related to Ethernet ports located in DS-TT or NW-TT.

5GS shall support transfer of standardized and deployment-specific port management information transparently between TSN AF and DS-TT or NW-TT, respectively inside a Port Management Information Container. NW-TT may support one or more ports. In this case, each port uses separate Port Management Information Container. 5GS shall also support transfer of standardized and deployment-specific bridge management information transparently between TSN AF and NW-TT, respectively inside a Bridge Management Information Container. Table 5.28.3.1-1 and Table 5.28.3.1-2 list standardized port management information and bridge management information, respectively.

**Table 5.28.3.1-1: Standardized port management information**

|  |  |  |  |
| --- | --- | --- | --- |
| **Port management information** | **Applicability (see NOTE 6)** | **Supported operations by TSN AF** | **Reference** |
|  | **DS-TT** | **NW-TT** | **(see NOTE 1)** |  |
| **General** |  |  |  |  |
| Port management capabilities (see NOTE 2) | X | X | R |  |
| **Bridge delay related information** |  |  |  |  |
| txPropagationDelay | X | X | R | IEEE Std 802.1Qcc [95] clause 12.32.2.1 |
| **Traffic class related information** |  |  |  |  |
| Traffic class table | X | X | RW | IEEE Std 802.1Q [98] clause 12.6.3 and clause 8.6.6. |
| **Gate control information** |  |  |  |  |
| GateEnabled | X | X | RW | IEEE Std 802.1Q [98] Table 12-29 |
| AdminBaseTime | X | X | RW | IEEE Std 802.1Q [98] Table 12-29 |
| AdminControlList | X | X | RW | IEEE Std 802.1Q [98] Table 12-29 |
| AdminCycleTime (see NOTE 3) | X | X | RW | IEEE Std 802.1Q [98] Table 12-29 |
| AdminControlListLength (see NOTE 3) | X | X | RW | IEEE Std 802.1Q [98] Table 12-28 |
| Tick granularity | X | X | R | IEEE Std 802.1Q [98] Table 12-29 |
| **General Neighbor discovery configuration****(NOTE 4)** |  |  |  |  |
| adminStatus | D | X | RW | IEEE Std 802.1AB [97] clause 9.2.5.1 |
| lldpV2LocChassisIdSubtype | D | X | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2LocChassisId | D | X | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2MessageTxInterval | D | X | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2MessageTxHoldMultiplier | D | X | RW | IEEE Std 802.1AB [97] Table 11-2 |
| **NW-TT port neighbor discovery configuration** |  |  |  |  |
| lldpV2LocPortIdSubtype |  | X | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2LocPortId |  | X | RW | IEEE Std 802.1AB [97] Table 11-2 |
| **DS-TT port neighbor discovery configuration** |  |  |  |  |
| lldpV2LocPortIdSubtype | D |  | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2LocPortId | D |  | RW | IEEE Std 802.1AB [97] Table 11-2 |
| **Neighbor discovery information for each discovered neighbor of NW-TT** |  |  |  |  |
| lldpV2RemChassisIdSubtype |  | X | R | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2RemChassisId |  | X | R | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2RemPortIdSubtype |  | X | R | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2RemPortId |  | X | R | IEEE Std 802.1AB [97] Table 11-2 |
| TTL |  | X | R | IEEE Std 802.1AB [97] clause 8.5.4 |
| **Neighbor discovery information for each discovered neighbor of DS-TT****(NOTE 5)** |  |  |  |  |
| lldpV2RemChassisIdSubtype | D |  | R | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2RemChassisId | D |  | R | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2RemPortIdSubtype | D |  | R | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2RemPortId | D |  | R | IEEE Std 802.1AB [97] Table 11-2 |
| TTL | D |  | R | IEEE Std 802.1AB [97] clause 8.5.4.1 |
| **Stream Parameters****(NOTE 11)** |  |  |  |  |
| MaxStreamFilterInstances | X |  | R | IEEE Std 802.1Q [98] clause 12.31.1.1 |
| MaxStreamGateInstances | X |  | R | IEEE Std 802.1Q [98] clause 12.31.1.2 |
| MaxFlowMeterInstances | X |  | R | IEEE Std 802.1Q [98] clause 12.31.1.3 |
| SupportedListMax | X |  | R | IEEE Std 802.1Q [98] clause 12.31.1.4 |
| **Per-Stream Filtering and Policing information**(NOTE 10) |  |  |  |  |
| Stream Filter Instance Table(NOTE 8) |  |  |  | IEEE Std 802.1Q [98] Table 12-32 |
| > Stream Identification type | X | X | RW | IEEE 802.1CB [83] clause 9.1.1.6 |
| > Stream Identification Controlling Parameters | X | X | RW | IEEE 802.1CB [83] clauses 9.1.2, 9.1.3, 9.1.4(NOTE 12) |
| > PrioritySpec | X | X | RW | IEEE Std 802.1Q [98] Table 12-32 |
| > StreamGateInstanceID | X | X | RW | IEEE Std 802.1Q [98] Table 12-32 |
| Stream Gate Instance Table(NOTE 9) |  |  |  | IEEE Std 802.1Q [98] Table 12-33 |
| StreamGateInstance | X | X | R | IEEE Std 802.1Q [98] Table 12-33 |
| PSFPAdminBaseTime | X | X | RW | IEEE Std 802.1Q [98] Table 12-33 |
| PSFPAdminControlList | X | X | RW | IEEE Std 802.1Q [98] Table 12-33 |
| PSFPAdminCycleTime | X | X | RW | IEEE Std 802.1Q [98] Table 12-33 |
| PSFPTickGranularity | X | X | R | IEEE Std 802.1Q [98] Table 12-33 |
| NOTE 1: R = Read only access; RW = Read/Write access.NOTE 2: Indicates which standardized and deployment-specific port management information is supported by DS-TT or NW-TT.NOTE 3: AdminCycleTime and AdminControlListLength are optional for gate control information.NOTE 4: If DS-TT supports neighbor discovery, then TSN AF sends the general neighbor discovery configuration for DS-TT Ethernet ports to DS-TT. If DS-TT does not support neighbor discovery, then TSN AF sends the general neighbor discovery configuration for DS-TT Ethernet ports to NW-TT using the Bridge Management Information Container (refer to Table 5.28.3.1-2) and NW-TT performs neighbor discovery on behalf on DS-TT. When a parameter in this group is changed, it is necessary to provide the change to every DS-TT and the NW-TT that belongs to the 5GS TSN bridge. It is mandatory that the general neighbor discovery configuration is identical for all DS-TTs and the NW-TTs that belongs to the bridge.NOTE 5: If DS-TT supports neighbor discovery, then TSN AF retrieves neighbor discovery information for DS-TT Ethernet ports from DS-TT. If DS-TT does not support neighbor discovery, then TSN AF retrieves neighbor discovery information for DS-TT Ethernet ports from NW-TT, using the Bridge Management Information Container (refer to Table 5.28.3.1-2), the NW-TT performing neighbor discovery on behalf on DS-TT.NOTE 6: X = applicable; D = applicable when validation and generation of LLDP frames is processed at the DS-TT.NOTE 7: Void.NOTE 8: There is a Stream Filter Instance Table per Stream.NOTE 9: There is a Stream Gate Instance Table per Gate.NOTE 10: TSN AF indicates the support for PSFP to the CNC only if each DS-TT and NW-TT of the 5GS bridge has indicated support of PSFP. DS-TT indicates support of PSFP using port management capabilities, i.e. by indicating support for the Per-Stream Filtering and Policing information and by setting higher than zero values for MaxStreamFilterInstances, MaxStreamGateInstances, MaxFlowMeterInstances, SupportedListMax parameters. When available, TSN AF uses the PSFP information for determination of the traffic pattern information as described in Annex I. The PSFP information can be used at the DS-TT (if supported) and at the NW-TT (if supported) for the purpose of per-stream filtering and policing as defined in IEEE Std 802.1Q [98] clause 8.6.5.1.NOTE 11: TSN AF composes a Stream Parameter Table towards the CNC. It is up to TSN AF how it composes the Stream Parameter Table based on the numerical values as received from DS-TT and NW-TT port(s) and for the bridge for each individual parameter.NOTE 12: The set of Stream Identification Controlling Parameters depends on the Stream Identification type value as defined in IEEE Std 802.1CB [83] Table 9-1 and clauses 9.1.2, 9.1.3, 9.1.4. |

**Table 5.28.3.1-2: Standardized bridge management information**

|  |  |  |
| --- | --- | --- |
| **Bridge management information** | **Supported operations by TSN AF****(see NOTE 1)** | **Reference** |
| **Information for 5GS Bridge** |  |  |
| Bridge Address | R |  |
| Bridge ID | R |  |
| NW-TT port numbers | R |  |
| **Traffic forwarding information**  |  |  |
| Static Filtering Entry (NOTE 3) | RW | IEEE Std 802.1Q [98] clause 8.8.1 |
| **General Neighbor discovery configuration****(NOTE 2)** |  |  |
| adminStatus | RW | IEEE Std 802.1AB [97] clause 9.2.5.1 |
| lldpV2LocChassisIdSubtype | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2LocChassisId | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2MessageTxInterval | RW | IEEE Std 802.1AB [97] Table 11-2 |
| lldpV2MessageTxHoldMultiplier | RW | IEEE Std 802.1AB [97] Table 11-2 |
| **DS-TT port neighbor discovery configuration for DS-TT ports (NOTE 4)** |  |  |
| **>DS-TT port neighbor discovery configuration for each DS-TT port** |  |  |
| >> DS-TT port number | RW |  |
| >> lldpV2LocPortIdSubtype | RW | IEEE Std 802.1AB [97] Table 11-2 |
| >> lldpV2LocPortId | RW | IEEE Std 802.1AB [97] Table 11-2 |
| **Discovered neighbor information for DS-TT ports****(NOTE 4)** |  |  |
| **>Discovered neighbor information for each DS-TT port****(NOTE 4)** |  |  |
| >> DS-TT port number | R |  |
| >> lldpV2RemChassisIdSubtype | R | IEEE Std 802.1AB [97] Table 11-2 |
| >> lldpV2RemChassisId | R | IEEE Std 802.1AB [97] Table 11-2 |
| >> lldpV2RemPortIdSubtype | R | IEEE Std 802.1AB [97] Table 11-2 |
| >> lldpV2RemPortId | R | IEEE Std 802.1AB [97] Table 11-2 |
| >> TTL | R | IEEE Std 802.1AB [97] clause 8.5.4.1 |
| **Stream Parameters (NOTE 5)** |  |  |
| MaxStreamFilterInstances | R | IEEE Std 802.1Q [98] |
| MaxStreamGateInstances | R | IEEE Std 802.1Q [98] |
| MaxFlowMeterInstances | R | IEEE Std 802.1Q [98] |
| SupportedListMax | R | IEEE Std 802.1Q [98] |
| **NW-TT GM capability (NOTE X)** |  |  |
| gmCapable | R | TRUE/FALSE |
| Supported PTP type | RW |  |
| Supported PTP versions | RW |  |
| **GM clock configuration**  |  |  |
| gmEnable (Note Y) | RW |  |
| Time Domain | RW | IEEE Std 802.1AS [104] clause 8.1 |
| PTP type | RW |  |
| PTP version | RW |  |
| clock identity | R | IEEE Std 802.1AS [104] clause 8.6.2.6.IEEE Std 1588 [107] clause 7.5.2.2 |
| grandmaster clock accuracy | R | IEEE Std 802.1AS [104] clause 8.6.2.3IEEE Std 1588 [107] 7.6.2.6 |
| clockClass | R | IEEE Std 802.1AS [104] clause 8.6.2.2IEEE Std 1588 [107] 7.6.2.5 |
| offsetScaledLogVariance | R | IEEE Std 802.1AS [104] clause 8.6.2.4IEEE Std 1588 [107] 7.6.3.3 |
| priority1 | RW | IEEE Std 802.1AS [104] clause 8.6.2.1IEEE Std 1588 [107] 7.6.2.2 |
| priority2 | RW | IEEE Std 802.1AS [104] clause 8.6.2.5IEEE Std 1588 [107] 7.6.2.3 |
| logMessageInterval | RW | IEEE Std 802.1AS [104] clause 10.7.2.2IEEE Std 1588 [107] 13.3.2.11 |
|  |  |  |
|  |  |  |
| NOTE 1: R = Read only access; RW = Read/Write access.NOTE 2: General neighbor discovery information is included only when NW-TT performs neighbor discovery on behalf of DS-TT. When a parameter in this group is changed, it is necessary to provide the change to every DS-TT and the NW-TT that belongs to the 5GS TSN bridge.NOTE 3: If the Static Filtering Entry information is present, NW-TT uses Static Filtering Entry information to determine the NW-TT egress port for forwarding UL TSC traffic. If the Static Filtering Entry information is not present, then the forwarding information as in clause 5.8.2.5.3 applies. This release of the specification does not support Static Filtering Entries in the downlink direction.NOTE 4: DS-TT discovery configuration and DS-TT discovery information are used only when DS-TT does not support LLDP and NW-TT performs neighbor discovery on behalf of DS-TT.NOTE 5: TSN AF indicates the support for PSFP to the CNC only if each DS-TT and NW-TT of the 5GS bridge have indicated support of PSFP. The support of PSFP at the NW-TT ports is expressed by setting higher than zero values for MaxStreamFilterInstances, MaxStreamGateInstances, MaxFlowMeterInstances, SupportedListMax parameters.NOTE X: The supported PTP type indicates the time synchronization mode the UPF/NW-TT support, e.g. time-aware system, Boundary Clock, peer-to-peer Transparent Clock, end-to-end Transparent Clock. The supported PTP version indicates the PTP version the UPF/NW-TT support, e.g. gPTP, PTP over UDP/IPv4, PTP over UPD/IPv6.NOTE X: The TSN AF can enable or disable the GM clock in the NW-TT if the UPF/NW-TT is gmCapable. |

Exchange of port and bridge management information between TSN AF and NW-TT or DS-TT allows TSN AF to:

1) retrieve port management information for a DS-TT or NW-TT Ethernet port or bridge management information for a 5GS TSN bridge;

2) send port management information for a DS-TT or NW-TT Ethernet port or bridge management information for a 5GS TSN bridge;

3) subscribe to and receive notifications if specific port management information for a DS-TT or NW-TT Ethernet port changes or bridge management information changes.

Exchange of port management information between TSN AF and NW-TT or DS-TT is initiated by DS-TT or NW-TT to:

- notify TSN AF if port management information has changed that TSN AF has subscribed for.

Exchange of bridge management information between TSN AF and NW-TT is initiated by NW-TT to:

- notify TSN AF if bridge management information has changed that TSN AF has subscribed for.

Exchange of port management information is initiated by DS-TT to:

- provide port management capabilities, i.e. provide information indicating which standardized and deployment-specific port management information is supported by DS-TT.

TSN AF indicates inside the Port Management Information Container or Bridge Management Information Container whether it wants to retrieve or send port or bridge management information or intends to (un-)subscribe for notifications.

*END OF CHANGES*