**3GPP TSG-SA2 Meeting #154-AH-e *S2-2300205***

**Electronic, 16 January - 20 January 2023 (revision of)**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.501** | **CR** | **03844** | **rev** | **-** | **Current version:** | **18.0.0** |  |
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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:*** | Support of integration with IETF Deterministic Networking | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Ericsson | | | | | | | | | |
| ***Source to TSG:*** | SA2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | DetNet | | | | |  | ***Date:*** | | | 2023-01-05 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | B |  | | | | | ***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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Document DetNet interworking in the specifications per TR 23.700-46 conclusions. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Include DetNet interworking functionality in the specification. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Conclusions of the DetNet study are not documented. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 4.4.8, 4.4.8.X (new), 5.8.2.11.1, 5.8.2.11.9, 5.27.0, 5.27.2, 5.28, 5.28.X (new), 6.2.29 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS/TR 23.501 CR 3845, 23.502 CR 23.503 CR 806. | | |
| ***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 Changes \* \* \*

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[X] IETF RFC 8655: "Deterministic Networking Architecture".

[Y] IETF RFC 8343: "A YANG Data Model for Interface Management".

[Z] IETF RFC 8344: "A YANG Data Model for IP Management".

[V] IETF RFC 7224: " IANA Interface Type YANG Module".

[P] IETF draft-ietf-detnet-yang: "Deterministic Networking (DetNet) YANG Model".

[Q] IETF RFC 6241: "Network Configuration Protocol (NETCONF) ".

[R] IETF RFC 8040: "RESTCONF Protocol".

[S] IETF RFC 8939: "Deterministic Networking (DetNet) Data Plane: IP".

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

### 4.4.8 Architecture to enable Time Sensitive Communication, Time Synchronization and Deterministic Networking

#### 4.4.8.1 General

The 5G System can be extended to support the following:

a) Integration as a bridge in an IEEE 802.1 Time Sensitive Networking (TSN). The 5GS bridge supports the Time sensitive communication as defined in IEEE 802.1 Time Sensitive Networking (TSN) standards. The architecture is described in clause 4.4.8.2.

This Release supports of the specification, integration of the 5G System with IEEE 802.1 TSN networks that apply the fully centralized configuration model as defined in IEEE Std 802.1Qcc [95]. IEEE TSN is a set of standards to define mechanisms for the time-sensitive (i.e. deterministic) transmission of data over Ethernet networks.

b) Enablers for AF requested support of Time Synchronization and/or some aspects of Time Sensitive Communication. The architecture is described in clause 4.4.8.3.

c) Enablers for interworking with TSN network deployed in the transport network. This option can be used simultaneously with either option a) or b). The architecture is described in clause 5.28a. The interworking is applicable when the transport network deploys the fully centralized configuration model as defined in IEEE Std 802.1Qcc [95].

d) Integration as a router in a Deterministic Network as defined in IETF RFC 8655 [X]. The architecture is described in clause 4.4.8.4.

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

#### 4.4.8.X Architecture to support IETF Deterministic Networking

The 5G System is integrated with the Deterministic Network as defined in RFC 8655 [X] as a DetNet transit router, see Figure 4.4.8.4-1. The TSCTSF performs mapping in the control plane between the 5GS internal functions and the DetNet controller. 5G System specific procedures in 5GC and RAN remain hidden from the DetNet controller.



Figure 4.4.8.X-1: 5GS Architecture to support IETF Deterministic Networking

On the device side, the UE is connected with a DetNet system, which may be a DetNet End System or a DetNet Node.

The architecture does not require the DS-TT functionality to be supported in the device nor require the user plane NW-TT functionality to be supported in the UPF, however, it can co-exist with such functions. For the reporting of information of the network side ports, NW-TT control plane function is used.

DetNet may be used in combination with time synchronization mechanisms as defined in clause 5.27, but it does not require usage of these mechanisms.

5GS acts as a DetNet router in the DetNet domain. Use cases where the 5GS acts as a sub-network (see RFC 8655 [X] clause 4.1.2) are also possible but do not require any additional 3GPP standardization. A special case where the 5GS can act as a sub-network is when the 5GS acts as a TSN network, which is supported by the 3GPP specifications based on the architecture in clause 4.4.8.2.

NOTE: For DetNet interworking, it is assumed that there is a business agreement to support the use of the DetNet controller so that it can be regarded trusted for the operator. Depending on the needs of a given deployment, functions such as the authentication, authorization and potential throttling of signalling from the DetNet controller can be achieved by including such functionalities in the TSCTSF.

The routing of the downlink packets is achieved using the existing 3GPP functions.

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

##### 5.8.2.11.1 General

These parameters are used by SMF to control the functionality of the UPF as well as to inform SMF about events occurring at the UPF.

The N4 session management procedures defined in clause 4.4.1 of TS 23.502 [3] will use the relevant parameters in the same way for all N4 reference points: the N4 Session Establishment procedure as well as the N4 Session Modification procedure provide the control parameters to the UPF, the N4 Session Release procedure removes all control parameters related to an N4 session, and the N4 Session Level Reporting procedure informs the SMF about events related to the PDU Session that are detected by the UPF.

The parameters over N4 reference point provided from SMF to UPF comprises an N4 Session ID and may also contain:

- Packet Detection Rules (PDR) that contain information to classify traffic (PDU(s)) arriving at the UPF;

- Forwarding Action Rules (FAR) that contain information on whether forwarding, dropping or buffering is to be applied to a traffic identified by PDR(s);

- Multi-Access Rules (MAR) that contain information on how to handle traffic steering, switching and splitting for a MA PDU Session;

- Usage Reporting Rules (URR) contains information that defines how traffic identified by PDR(s) shall be accounted as well as how a certain measurement shall be reported;

- QoS Enforcement Rules (QER), that contain information related to QoS enforcement of traffic identified by PDR(s);

- Session Reporting Rules (SRR) that contain information to request the UP function to detect and report events for a PDU session that are not related to specific PDRs of the PDU session or that are not related to traffic usage measurement.

- Trace Requirements;

- Port Management Information Container in 5GS;

- Bridge/Router Information.

The N4 Session ID is assigned by the SMF and uniquely identifies an N4 session.

If the UPF indicated support of Trace, the SMF may activate a trace session during a N4 Session Establishment or a N4 Session Modification procedure. In that case it provides Trace Requirements to the UPF. The SMF may deactivate an on-going trace session using a N4 Session Modification procedure. There shall be at most one trace session activated per N4 Session at a time.

For the MA PDU Session, the SMF may add an additional access tunnel information during an N4 Session Modification procedure by updating MAR with addition of an FAR ID which refers to an FAR containing the additional access tunnel information for the MA PDU session for traffic steering in the UPF. For the MA PDU Session, the SMF may request Access Availability report per N4 Session, during N4 Session Establishment procedure or N4 Session Modification procedure.

A N4 Session may be used to control both UPF and NW-TT behaviour in the UPF. A N4 session support and enable exchange of bridge/router configuration between the SMF and the UPF:

- Information that the SMF needs for bridge/router management (clause 5.8.2.11.9);

- Information that 5GS transparently relays between the TSN AF or NEF and the NW-TT: transparent Port Management Information Container along with the associated NW-TT port number.

- Information that 5GS transparently relays between the TSN AF or NEF and the NW-TT: transparent user plane node Management Information Container (clause 5.8.2.11.14).

When a N4 Session related with bridge/router management is established, the UPF allocates a dedicated port number for the device side of the PDU Session. The UPF then provides to the SMF following configuration parameters for the N4 Session:

- port number.

- user-plane node ID.

To support TSN, the user-plane node ID is Bridge ID. The User Plane Node ID/Bridge ID may be pre-configured in the UPF based on deployment.

After the N4 session has been established, the SMF and UPF may at any time exchange transparent user plane node and Port Management Information Container over a N4 session.

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

##### 5.8.2.11.9 Bridge/Router Information

The following table describes the User plane node Information (UI) that includes the information required to configure a 5GS logical bridge/router for TSC or Deterministic Networking PDU Sessions.

Table 5.8.2.11.9-1: User plane node Information

|  |  |  |
| --- | --- | --- |
| Attribute | Description | Comment |
| Port Number | Port Number allocated by the node for a given PDU Session |  |
| User plane node ID | Bridge identifier of the 5GS TSN bridge, or user-plane node ID. |  |

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

## 5.27 Enablers for Time Sensitive Communications,Time Synchronization and Deterministic Networking

### 5.27.0 General

This clause describes 5G System features that can be used independently or in combination to enable time-sensitive communication,time synchronization and deterministic networking:

- Delay-critical GBR;

- A hold and forward mechanism to schedule traffic as defined in IEEE Std 802.1Q-2018 [98] for Ethernet PDU Sessions in DS-TT and NW-TT (see clause 5.27.4) to de-jitter flows that have traversed the 5G System if the 5G System is to participate transparently as a bridge in a TSN network;

- TSC Assistance Information: describes TSC flow traffic characteristics as described in clause 5.27.2 that may be provided optionally for use by the gNB, to allow more efficiently schedule radio resources for periodic traffic and applies to PDU Session type Ethernet and IP.

- Time Synchronization: describes how 5GS can operate as a PTP Relay (IEEE Std 802.1AS [104]), as a Boundary Clock or as Transparent Clock (IEEE Std 1588 [126]) for PDU Session type Ethernet and IP.

The 5G System integration as a bridge in an IEEE 802.1 TSN network as described in clause 5.28 can make use of all features listed above.

To support any of the above features to enable time-sensitive communication, time synchronization and deterministic networking, during the PDU Session establishment, the UE shall request to establish a PDU Session as an always-on PDU Session, and the PDU Sessions are established as Always-on PDU session as described in clause 5.6.13. In this release of the specification, to use any of the above features to enable time-sensitive communication,time synchronization and deterministic networking:

- Home Routed PDU Sessions are not supported;

- PDU Sessions are supported only for SSC mode 1;

- Service continuity is not supported when the UE moves from 5GS to EPS .i.e. interworking with EPS is not supported for a PDU Session for time synchronization or TSC or deterministic networking.

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

### 5.27.2 TSC Assistance Information (TSCAI) and TSC Assistance Container (TSCAC)

#### 5.27.2.1 General

TSC Assistance Information (TSCAI) is defined in Table 5.27.2-1 and describes TSC traffic characteristics for use in the 5G System. TSCAI may be used by the 5G-AN, if provided by SMF. The knowledge of TSC traffic pattern is useful for 5G-AN as it allows more efficiently scheduling of QoS Flows that have a periodic, deterministic traffic characteristics either via Configured Grants, Semi-Persistent Scheduling or with Dynamic Grants.

The TSCTSF determines the TSC Assistance Container (defined in Table 5.27.2-2) based on information provided by an AF/NEF or a DetNet controller as described in clause 5.27.2.3 and provides it to the PCF for IP type and Ethernet type PDU Sessions. In the case of integration with IEEE TSN network, the TSN AF determines TSC Assistance Container as described in clause 5.27.2.2 and provides it to the PCF for Ethernet PDU Sessions. The PCF receives the TSC Assistance Container from the TSCTSF or the TSN AF and forwards it to the SMF as part of PCC rule as described in clause 6.1.3.23a of TS 23.503 [45].

The SMF binds a PCC rule with a TSC Assistance Container to a QoS Flow as described in clause 6.1.3.2.4 of TS 23.503 [45]. The SMF uses the TSC Assistance Container to derive the TSCAI for that QoS Flow and sends the derived TSCAI to the NG-RAN. The Periodicity, Burst Arrival Time, and Survival Time components of the TSCAI are specified by the SMF with respect to the 5G clock. The SMF is responsible for mapping the Burst Arrival Time and Periodicity from an external clock (when available) to the 5G clock based on the time offset and cumulative rateRatio (when available) between the external clock time and 5GS time as measured and reported by the UPF. The SMF determines the TSCAI as described in clause 5.27.2.4.

A Survival Time, which indicates the time period an application can survive without any data burst, may be provided by TSN AF/AF or by the TSCTSF either in terms of maximum number of messages (message is equivalent to all packets of a data burst) or in terms of time units. Only a single data burst is expected within a single time period referred to as the periodicity.

The SMF may send an update of the TSCAI to the NG-RAN as defined in clauses 4.3.3.2, 4.9.1.2.2 and 4.9.1.3.2 of TS 23.502 [3].

Table 5.27.2-1: TSC Assistance Information (TSCAI)

|  |  |
| --- | --- |
| 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 data bursts. |
| Burst Arrival Time (optional) | The latest possible time when the first packet of the data burst arrives at either the ingress of the RAN (downlink flow direction) or the egress of the UE (uplink flow direction). |
| Survival Time (optional) | Survival Time, as defined in TS 22.261 [2], refers to the time period an application can survive without any data burst. |
| Burst Arrival Time Window (BAT Window) (optional)  (NOTE 1) (NOTE 2) | Indicates the acceptable earliest and latest arrival time of the first packet of the data burst at either the ingress of the RAN (downlink flow direction) or the egress of the UE (uplink flow direction). |
| Capability for BAT adaptation (optional) (NOTE 1) | Indicates that the AF will adjust the burst sending time according to the network provided Burst Arrival Time offset (see clause 5.27.2.5). |
| NOTE 1: Only one of the parameters (BAT Window or Capability for BAT adaptation) can be provided.  NOTE 2: The parameter will only be provided together with Burst Arrival Time. | |

Table 5.27.2-2: TSC Assistance Container (TSCAC)

|  |  |
| --- | --- |
| 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 data bursts. |
| Burst Arrival Time (optional) | The time when the first packet of the data burst arrives at the ingress port of 5GS for a given flow direction (DS-TT for uplink, NW-TT for downlink). |
| Survival Time (optional) | It refers to the time period an application can survive without any data burst, as defined in TS 22.261 [2]. |
| Time Domain (optional) | The (g)PTP domain of the TSC flow. |
| Burst Arrival Time Window (BAT Window) (optional)  (NOTE 1) (NOTE 2) | Indicates the acceptable earliest and latest arrival time of the first packet the data burst at the ingress port of 5GS for a given flow direction (DS-TT for uplink, NW-TT for downlink). |
| Capability for BAT adaptation (optional) (NOTE 1) | It indicates that the AF will adjust the burst sending time according to the network provided Burst Arrival Time offset (see clause 5.27.2.5). |
| NOTE 1: Only one of the parameters (BAT Window or Capability for BAT adaptation) can be provided.  NOTE 2: The parameter will only be provided together with Burst Arrival Time. | |

#### 5.27.2.2 TSC Assistance Container determination based on PSFP

In the case of integration with IEEE TSN network, the TSN AF determines a TSC Assistance Container (defined in Table 5.27.2-2) and provides it to the PCF. The determination of TSC Assistance Container based on Per-Stream Filtering and Policing (PSFP) information applies only to Ethernet type PDU Sessions.

NOTE 1: This clause assumes that PSFP information as defined in IEEE Std 802.1Q [98] and Table 5.28.3.1-1is provided by CNC. PSFP information may be provided by CNC if TSN AF has declared PSFP support to CNC. TSN AF indicates the support for PSFP to CNC only if all the DS-TT and NW-TT ports of the 5GS Bridge have indicated support of PSFP. Means to derive the TSC Assistance Container if PSFP is not supported by 5GS and/or the CNC are beyond the scope of this specification.

The TSN AF may be able to identify the ingress port and thereby the PDU Session as described in clause 5.28.2.

The TSN AF interfaces towards the CNC for the PSFP (IEEE Std 802.1Q [98]) managed objects that correspond to the PSFP functionality implemented by the DS-TT and the NW-TT. Thus, when PSFP information is provided by the CNC, the TSN AF may extract relevant parameters from the PSFP configuration. The TSN AF calculates traffic pattern parameters (such as burst arrival time with reference to the ingress port and periodicity). TSN AF also obtains the flow direction as specified in clause 5.28.2. Survival Time may be pre-configured in TSN AF.

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. When Survival Time information is provided for a TSN stream, then it should not be aggregated with other TSN streams into a single QoS Flow, or if they are aggregated, then the Survival Time parameter shall not be provided. One set of parameters and one TSC Assistance Container are created by the TSN 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 2: 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.

NOTE 3: In order for the TSN AF to get Burst Arrival Time, Periodicity on a per TSN stream basis, support for IEEE Std 802.1Q [98] (as stated in clause 4.4.8.2) Per-Stream Filtering and Policing (PSFP) with stream gate operation is a prerequisite.

For a UE-UE TSC stream, the (TSN) AF divides the stream into one uplink stream and one or more downlink streams as defined in clause 5.28.2. The TSN AF binds the uplink and downlink streams to the PDU Sessions, and provides the streams on AF Session basis to the PCF(s). The TSN AF calculates traffic pattern parameters for the UL and the DL stream using the PSFP configuration (if provided) respectively:

- For the uplink stream, the Flow Direction is set to uplink and traffic pattern parameters (such as burst arrival time with reference to the ingress port and periodicity) is determined as described in Annex I.

- For downlink stream, the Flow Direction is set to downlink, the burst arrival time is set to sum of burst arrival time of the UL stream and 5GS Bridge delay of PDU Session carrying the UL stream, and the periodicity is determined as described in Annex I.

#### 5.27.2.3 TSC Assistance Container determination by TSCTSF

The TSCTSF constructs TSC Assistance Container (defined in Table 5.27.2-2) based on information provided (directly or via NEF) by the AF for IP or Ethernet type PDU Sessions, or by the DetNet controller for IP type PDU Sessions.

In the case of an AF request, the AF may provide Flow Direction, Burst Arrival Time (optional) at the UE/DS-TT (uplink) or UPF/NW-TT (downlink), Maximum Burst Size, Periodicity, Survival Time (optional), and a Time Domain (optional) to the TSCTSF. If the AF is able to adjust the burst sending time, the AF may in addition provide a BAT Window or the Capability for BAT adaptation to the TSCTSF. Based on these parameters, the TSCTSF constructs a TSC Assistance Container and provides it to PCF. If the AF provides to the TSCTSF a Burst Arrival Time or Periodicity without corresponding Time Domain, the TSCTSF sets the Time Domain = "5GS" in the TSC Assistance Container.

NOTE: The Maximum Burst Size is signalled separately, i.e. it is not part of the TSC Assistance Container.

The AF provides these parameters to the NEF and the NEF forwards these parameters to the TSCTSF. The AF trusted by the operator provides these parameters to the TSCTSF directly.

In the case of deterministic networking, the TSCTSF constructs the TSC Assistance Container based on information provided by the DetNet controller as defined in TS 23.503 clause 6.1.3.23b.

The TSCTSF sends the TSC Assistance Container to the PCF as follows:

- The TSCTSF uses the UE IP address/DS-TT port MAC address to identify the PCF and N5 association related to the PDU Session of a UE/DS-TT.

#### 5.27.2.4 TSCAI determination based on TSC Assistance Container

The SMF determines the TSCAI (defined in Table 5.27.2-1) for the QoS Flow based on the TSC Assistance Container of the PCC rule bound to the QoS Flow. This clause is applicable irrespective of whether the TSC Assistance Container is determined by the TSN AF or by the TSCTSF.

The Burst Arrival Time and Periodicity component of the TSCAI that the SMF sends to the 5G-AN are specified with respect to the 5G clock. The SMF is responsible for mapping the Burst Arrival Time and Periodicity in the TSC Assistance Container from an external clock to the 5G clock based on the time offset and cumulative rateRatio (when available) between external time and 5GS time as measured and reported by the UPF. The SMF may correct the TSCAI based on the UPF report for time offset and cumulative rateRatio between external PTP 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 TSC 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 when the first packet of the data burst arrives at the AN.

- For traffic in uplink direction, the SMF corrects the Burst Arrival Time in the TSC 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, representing the latest possible time when the first packet of the data burst arrives at the egress of the UE. How the SMF corrects the Burst Arrival Time if the UE-DS-TT Residence Time has not been provided by the UE is up to SMF implementation.

- The SMF corrects the Periodicity in the TSC Assistance Container using the cumulative rateRatio if the cumulative rateRatio was previously received from the UPF and sets the TSCAI Periodicity as the corrected value. Otherwise, the SMF sets the received Periodicity in the TSCAI without any correction.

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

- If Survival Time is provided in terms of maximum number of messages, the SMF converts maximum number of messages into time units by multiplying its value by the TSCAI Periodicity, and sets the TSCAI Survival Time to the calculated value. If Survival Time is provided in time units, the SMF corrects the Survival Time using the cumulative rateRatio if the cumulative rateRatio was previously received from the UPF and sets the TSCAI Survival Time to the corrected value. Otherwise, SMF sets the TSCAI Survival Time without correction.

- If the TSC Assistance Container contains a BAT Window, the SMF sets and corrects the indicated earliest and latest possible arrival time of the first packet in the same way it is described for the correction of the Burst Arrival Time above.

- If the TSC Assistance Container contains a Capability for BAT adaptation, the SMF sets the Capability for BAT adaptation in the TSCAI.

Depending on whether the Time Domain is provided in the TSC Assistance container, SMF may perform the following:

- the SMF provisions the UPF/NW-TT to report the clock drifting between 5G clock and the external GM clock for the (g)PTP time domain number that is configured to the NW-TT.

- the SMF provisions the UPF/NW-TT to report the clock drifting between 5G clock and the external GM clock for the given Time Domain number.

The SMF uses the N4 Association Setup or Update procedures as described in clause 4.4.3 of TS 23.502 [3] to provision the UPF to report the clock drifting.

If the SMF has clock drift information for a Time Domain and if the Time Domain matches with the Time Domain in the TSC Assistance Container (i.e. clock drift between 5G timing and AF supplied Time Domain determined based on UPF reporting), or Time Domain information is not provided in the TSC Assistance Container, then the SMF may adjust the TSCAI information so that it reflects the 5GS Clock as described in clause 5.27.2.1.

If the SMF does not have synchronization information for a requested Time Domain in the TSC Assistance Container, or the Time Domain in the TSC Assistance Container is set to a value = "5GS", then the TSCAI information will be used without adjustment.

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

NOTE 4: 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 clause 4.4.3.4 of TS 23.502 [3].

#### 5.27.2.5 RAN feedback for Burst Arrival Time offset

##### 5.27.2.5.1 Overview

If the NG-RAN receives a TSCAI containing a BAT Window or the Capability for BAT adaptation for a QoS Flow, the NG-RAN can determine a BAT offset in order to align the arrival of the traffic bursts with the next expected transmission opportunity over the air interface in each direction (i.e. DL or UL). The BAT offset can take a positive or a negative values.

NG-RAN may support the following feedback mechanisms:

- Proactive RAN feedback for Burst Arrival Time adaptation: NG-RAN may provide a Burst Arrival Time offset as part of QoS flow establishment or modification as illustrated in clause 5.27.2.5.2;

- Reactive RAN feedback for Burst Arrival Time adaptation: NG-RAN may provide a Burst Arrival Time offset after QoS flow establishment as illustrated in clause 5.27.2.5.3.

##### 5.27.2.5.2 Proactive RAN feedback for Burst Arrival Time adaptation with BAT

If the RAN receives a Burst Arrival Time and either the capability for BAT adaptation or a Burst Arrival Time Window in the TSCAI for a QoS Flow, the 5GS will perform the following actions:

- The NG-RAN can determine a BAT offset in order to align the expected arrival of the traffic bursts (as indicated in the BAT) with the time when the next transmission over the air interface in each direction (i.e. DL or UL) is expected. Alternatively, NG-RAN may choose to not send 'BAT offset' in response if AF provided BAT is acceptable by NG-RAN. If BAT window was included in TSCAI, then the BAT offset shall always be provided by NG-RAN and it shall be within the BAT Window. The BAT offset is calculated with reference to earliest arrival time of received BAT Window.

- The BAT offset is provided from NG-RAN to the SMF in the response to the QoS Flow establishment or modification request. The SMF provides the BAT offset to the PCF and the PCF notifies the AF as described in clause 6.1.3.23a of TS 23.503 [45].

NOTE: It is assumed that the feedback from RAN implies the RAN accepts the BAT offset.

- If interworking with a TSN network deployed in the transport network is supported, the SMF/CUC uses the periodicity and BAT offset accepted by the RAN to adjust the EarliestTransmitOffset and LatestTransmitOffset in the Talker/Listener Group in IEEE 801.Qcc [95] as described in clause 5.28a.2.

Editor's note: Whether RAN may provide periodicity feedback is FFS.

##### 5.27.2.5.2 Reactive RAN feedback

If the RAN receives the capability for BAT adaptation in the TSCAI and notification control is enabled for this QoS Flow, the 5GS will perform the following actions:

- If NG-RAN determines that the PDB of the QoS flow cannot be fulfilled in DL direction, then if supported, NG-RAN shall determine a BAT offset value which reduces the time between the arrival of the traffic bursts and the time of the next possible transmission over the air interface. NG-RAN shall not provide a BAT offset with the same value until the PDB of the QoS Flow can be fulfilled again.

NOTE: NG-RAN determines BAT offset value in reference to the current arrival time of the bursts experienced by RAN.

- The BAT offset is provided from NG-RAN to the SMF when sending the notification towards the SMF that the "GFBR can no longer be guaranteed" described in clause 5.7.2.4. The SMF provides the BAT offset to the PCF and the PCF provides the BAT offset to the AF as part of notifying the AF as described in clause 6.1.3.23a of TS 23.503 [45]

Editor's note: UL BAT adaptation is subject to feedback from RAN WG2.

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

## 5.28 Support of integration with Time Sensitive Communications,Time Synchronization, TSN and Deterministic Networking

### 5.28.0 General

5GS supports interoperation with Time Sensitive Networking (TSN). Two basic deployment scenarios for integration of TSN are supported:

- **Integration of 5GS into a TSN data network (DN):** In this scenario, 5GS is deployed in a TSN DN to provide wireless connectivity. From the perspective of the TSN DN, the 5GS is modelled as a Layer 2 Ethernet Bridge of the TSN DN.

- **Integration of 5GS with TSN enabled transport network (TN):** In this scenario, a TSN TN is deployed to realize the N3 interface between (R)AN and UPF. From the perspective of the TSN TN, (R)AN and UPF act as End Stations of the TSN TN.

Clauses 5.28.1 to 5.28.4 define the 5GS integration in TSN DN as a 5GS bridge and clause 5.28a defines the 5GS integration with a TSN TN.

In addition to supporting interoperation with TSN, 5GS also supports integration with Time Synchronization and integration with Deterministic Networking

### 5.28.1 5GS bridge management for TSN

5GS acts as a Layer 2 Ethernet Bridge. When integrated with IEEE TSN network, 5GS functions acts as one or more TSN Bridges of the TSN network. The 5GS Bridge is composed of the ports on a single UPF (i.e. PSA) side, the user plane tunnel between the UE and UPF, and the ports on the DS-TT side. For each 5GS Bridge of a TSN network, the port on NW-TT support the connectivity to the TSN network, the ports on DS-TT side are associated to the PDU Session providing connectivity to the TSN network.

The granularity of the 5GS TSN bridge is per UPF for each network instance or DNN/S-NSSAI. The bridge ID of the 5GS TSN bridge is bound to the UPF ID of the UPF as identified in TS 23.502 [3]. The TSN AF stores the binding relationship between a port on UE/DS-TT side and a PDU Session during reporting of 5GS TSN bridge information. The TSN AF also stores the information about ports on the UPF/NW-TT side. The UPF/NW-TT forwards traffic to the appropriate egress port based on the traffic forwarding information. From the TSN AF point of view, a 5GS TSN bridge has a single NW-TT entity within UPF and the NW-TT may have multiple ports that are used for traffic forwarding.

NOTE 1: How to realize single NW-TT entity within UPF is up to implementation.

NOTE 2: Ethernet PDU Session type in this release of the specification may be subject to the constraint that it supports a single N6 interface in a UPF associated with the N6 Network Instance.

There is only one PDU Session per DS-TT port for a given UPF. All PDU Sessions which connect to the same TSN network via a specific UPF are grouped into a single 5GS bridge. The capabilities of each port on UE/DS-TT side and UPF/NW-TT side are integrated as part of the configuration of the 5GS Bridge and are notified to TSN AF and delivered to CNC for TSN bridge registration and modification.

NOTE 3: It is assumed that all PDU Sessions which connect to the same TSN network via a specific UPF are handled by the same TSN AF.



Figure 5.28.1-1: Per UPF based 5GS bridge

NOTE 4: If a UE establishes multiple PDU Sessions terminating in different UPFs, then the UE is represented by multiple 5GS TSN bridges.

In order to support IEEE 802.1Q features related to TSN, including TSN scheduled traffic (clause 8.6.8.4 in IEEE Std 802.1Q-2018 [98]) over 5GS Bridge, the 5GS supports the following functions:

- Configure the bridge information in 5GS.

- Report the bridge information of 5GS Bridge to TSN network after PDU Session establishment.

- Receiving the configuration from TSN network as defined in clause 5.28.2.

- Map the configuration information obtained from TSN network into 5GS QoS information (e.g. 5QI, TSC Assistance Information) of a QoS Flow in corresponding PDU Session for efficient time-aware scheduling, as defined at clause 5.28.2.

The bridge information of 5GS Bridge is used by the TSN network to make appropriate management configuration for the 5GS Bridge. The bridge information of 5GS Bridge includes at least the following:

- Information for 5GS Bridge:

- Bridge ID

Bridge ID is to distinguish between bridge instances within 5GS. The Bridge ID can be derived from the unique bridge MAC address as described in IEEE Std 802.1Q [98], or set by implementation specific means ensuring that unique values are used within 5GS;

- Number of Ports;

- list of port numbers.

- Capabilities of 5GS Bridge as defined in IEEE Std 802.1Qcc [95]:

- 5GS Bridge delay per port pair per traffic class, including 5GS Bridge delay (dependent and independent of frame size, and their maximum and minimum values: independentDelayMax, independentDelayMin, dependentDelayMax, dependentDelayMin), ingress port number, egress port number and traffic class.

- Propagation delay per port (txPropagationDelay), including transmission propagation delay, egress port number.

- VLAN Configuration Information.

NOTE 5: This Release of the specification does not support the modification of VLAN Configuration Information at the TSN AF.

- Topology of 5GS Bridge as defined in IEEE Std 802.1AB [97]:

- LLDP Configuration Information.

- Chassis ID subtype and Chassis ID of the 5GS Bridge.

- LLDP Discovery Information for each discovered neighbor of each NW-TT port and DS-TT port.

- Traffic classes and their priorities per port as defined in IEEE Std 802.1Q [98].

- Stream Parameters as defined in clause 12.31.1 in IEEE Std 802.1Q [98], in order to support PSFP:

- MaxStreamFilterInstances: The maximum number of Stream Filter instances supported by the bridge;

- MaxStreamGateInstances: The maximum number of Stream Gate instances supported by the bridge;

- MaxFlowMeterInstances: The maximum number of Flow Meter instances supported by the bridge (optional);

- SupportedListMax: The maximum value supported by the bridge of the AdminControlListLength and OperControlListLength parameters.

The following parameters: independentDelayMax and independentDelayMin, how to calculate them is left to implementation and not defined in this specification.

DS-TT and NW-TT report txPropagationDelay to the TSN AF relative to the time base of the TSN GM clock (identified by the TSN time domain number received in PMIC). If the TSN AF has subscribed for notifications on txPropagationDelay and if the difference to the previously reported txPropagationDelay is larger than the txPropagationDelayDeltaThreshold received in PMIC, the corresponding DS-TT or NW-TT informs the TSN AF about the updated txPropagationDelay using PMIC signalling.

NOTE 6: Configuration of TSN time domain number and txPropagationDelayDeltaThreshold via PMIC is optional for NW-TT. NW-TT can instead be pre-configured with the threshold and the single time domain that is used by the CNC for bridge configuration and reporting.

Bridge ID of the 5GS Bridge, port number(s) of the Ethernet port(s) in NW-TT could be preconfigured on the UPF. The UPF is selected for a PDU Session serving TSC as described in clause 6.3.3.3.

This release of the specification requires that each DS-TT port is assigned with a globally unique MAC address.

NOTE 7: The MAC address of the DS-TT port must not be used in user data traffic; it is used for identification of the PDU Session and the associated bridge port within the 3GPP system.

When there are multiple network instances within a UPF, each network instance is considered logically separate. The network instance for the N6 interface (clause 5.6.12) may be indicated by the SMF to the UPF for a given PDU Session during PDU Session establishment. UPF allocates resources based on the Network Instance and S-NSSAI and it is supported according to TS 29.244 [65]. DNN/S-NSSAI may be indicated by the SMF together with the network instance to the UPF for a given PDU Session during PDU Session establishment procedure.

The TSN AF is responsible to receive the bridge information of 5GS Bridge from 5GS, as well as register or update this information to the CNC.

### 5.28.2 5GS Bridge configuration for TSN

The configuration information of 5GS Bridge as defined in clause 8.6.8.4 of IEEE Std 802.1Q [98], includes the following:

- Bridge ID of 5GS Bridge.

- Configuration information of scheduled traffic on ports of DS-TT and NW-TT:

- Egress ports of 5GS Bridge, e.g. ports on DS-TT and NW-TT;

- Traffic classes and their priorities.

NOTE 1: In this Release of the specification, scheduled traffic (clause 8.6.8.4 in IEEE 802.1Q-2018 [98]) is only supported with protected windows, (see clause Q.2 in IEEE 802.1Q [98]), therefore, it is enough to support AdminControlList, AdminBaseTime, AdminCycleTime and TickGranularity for the configuration of the 5GS.

The configuration information of 5GS Bridge as defined in IEEE Std 802.1Q [98], includes the following:

- Chassis ID of 5GS Bridge;

- Traffic forwarding information as defined in clause 8.8.1 of IEEE Std 802.1Q [98]:

- Destination MAC address and VLAN ID of TSN stream;

- Port number in the Port MAP as defined in clause 8.8.1 of IEEE Std 802.1Q [98].

- Configuration information per stream according to clause 8.6.5.1 of IEEE Std 802.1Q [98] including:

- Stream filters.

- Stream gates.

NOTE 2: In order to support clause 8.6.5.1 of IEEE Std 802.1Q [98], it is required to support the Stream Identification function as specified by IEEE Std 802.1CB [83].

The SMF report the MAC address of the DS-TT port of the related PDU Session to TSN AF via PCF. The association between the DS-TT MAC address, 5GS Bridge ID and port number on DS-TT is maintained at TSN AF and further used to assist to bind the TSN traffic with the UE's PDU session.

Two models are supported to configure 5GS QoS for TSN traffic:

- Based on the assumption that PSFP information is always provided by CNC: In this case the QoS Flows are setup based on the PSFP information provided by CNC;

NOTE 3: PSFP information may be provided by CNC if TSN AF has declared PSFP support to CNC. TSN AF indicates the support for PSFP to CNC only if each DS-TT and NW-TT of the 5GS bridge has indicated support of PSFP.

- Without requiring PSFP information provided by the CNC.: In this case, pre-configured QoS Flows are used and configured e.g. during PDU session establishment as described in clause 5.28.4. Additional QoS Flows are setup as necessary based on the PSFP, if available, as described in this clause.

When PSFP information is available, TSN AF identifies the ingress and egress port for the TSN stream as described in Annex I and determines the DS-TT port MAC address(es) identifying the corresponding PDU session(s) carrying the TSN stream. Flow direction of a TSN stream is determined as follows: if the ingress port is a DS-TT port, then the Flow direction is UL; otherwise if the ingress port(s) is (are) NW-TT port, the Flow direction is DL. Flow direction is part of the TSCAI as defined in clause 5.27.2.

The TSN AF uses the stream filter instances of PSFP information to derive the service data flow for TSN streams. The TSN AF uses the Priority values in the stream filter instances in PSFP information (if available) as defined in clause 8.6.5.1 of IEEE Std 802.1Q [98], the 5GS bridge delay information (see clause 5.27.5) and may additionally use scheduled traffic information as defined in clause 8.6.8.4 of IEEE Std 802.1Q [98], to derive the TSN QoS information (i.e. priority and delay) for a given TSN stream or flow of aggregated TSN streams as specified in clause 5.28.4.

The TSN AF identifies the egress port(s) for the TSN stream using local configuration or static filtering entry that matches the TSN stream. If the TSN AF determines that the TSN stream is for UE-UE communication (i.e. ingress and egress ports are in DS-TTs), the TSN AF divides the stream into one uplink stream and one or more downlink streams and provides the streams on AF Session basis to the PCF(s). The SMF applies local switching as specified in clause 5.8.2.13 or clause 5.8.2.5.3 in order to enable UPF locally forward uplink stream from one PDU session as downlink stream in another PDU session.

When CNC configures the PSFP information to the TSN AF, TSN AF determines the TSC Assistance Container as described in clause 5.27.2. The TSN AF associates the TSN QoS information and TSC Assistance Container (if available) with the corresponding service data flow description and provides to the PCF and the SMF as defined in clause 6.1.3.23 of TS 23.503 [45].

NOTE 4: When the TSN stream priority information from PSFP is not available (priority value in stream filters is set to wild card), in certain configurations it can be possible to use the scheduled traffic information as defined in clause 8.6.8.4 of IEEE Std 802.1Q [98] to derive the Priority of the TSN stream. For example, when there is a single downlink stream for a given DS-TT port, it can be possible to determine the affected DS-TT port in the downlink and the associated TSN stream priority based on the scheduled traffic information of the affected egress port, and to derive an estimated MDBV based on the gate open interval and the assumed ingress port bitrate.

If TSN AF provides PSFP and/or scheduled traffic information to DS-TT and NW-TT then DS-TT and NW-TT execute on this information relative to the time base of the TSN GM clock (identified by the TSN time domain number received in PMIC).

NOTE 5: Configuration of TSN time domain number via PMIC is optional for NW-TT. NW-TT can instead be pre-configured with the single time domain that is used by the CNC for bridge configuration and reporting.

### 5.28.3 Port and user plane node management information exchange in 5GS

#### 5.28.3.1 General

Port number for the PDU Session is assigned by the UPF during PDU session establishment. The port number for a PDU Session shall be reported to the SMF from the UPF and further stored at the SMF. The SMF provides the port number via PCF to the TSN AF or TSCTSF. TSN AF or TSCTSF maintains an association between the port number for the PDU Session and the DS-TT port MAC address (with Ethernet type PDU session) or IP address (applicable for TSCTSF only, with IP type PDU Session) of the UE. If a PDU session for which SMF has reported a port number to TSN AF or TSCTSF is released, then SMF informs TSN AF or TSCTSF accordingly. The port number for the PDU Session corresponds to the device side port of the 5GS bridge or router. When the device supports the DS-TT functionality, the port number represents the DS-TT port number corresponding to the given PDU Session.

NOTE 1: Port number can refer either to Ethernet port or PTP port or a port of a DetNet router. In Ethernet type PDU Sessions, it is assumed that the PTP port number is the same as the associated Ethernet port number.

When the DS-TT or the NW-TT functions are used, the 5GS shall support transfer of standardized and deployment-specific port management information transparently between TSN AF or TSCTSF 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 user plane node management information transparently between TSN AF or TSCTSF and NW-TT, respectively inside a User Plane Node Management Information Container. Table 5.28.3.1-1 and Table 5.28.3.1-2 list standardized port management information and user plane node management information, respectively.

If TSN AF is deployed, i.e. if 5GS is integrated with an IEEE TSN network, the port and user plane node management information is exchanged between CNC and TSN AF. The port management information is related to ports located in DS-TT or NW-TT. The user plane node management information container is related to 5GS bridge management.

If TSN AF is not deployed, the port and user plane node management information is exchanged between TSCTSF and DS-TT/NW-TT.

NOTE 2: The time synchronization parameters used in Port Management Information Container and User Plane Node Management Information Container are from IEEE Std 1588 [126], Edition 2019, and from IEEE Std 802.1AS [104]. Since the IEEE time synchronization data sets are not exposed, care needs to be taken when interoperating with devices supporting Edition 2008, IEEE Std 1588-2008 [107] (which can be the case when operating under the SMPTE profile, ST 2059-2:2015 [127]) and using a common management.

Table 5.28.3.1-1: Standardized port management information

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Port management information | Applicability (see NOTE 6) | | Supported operations by TSN AF | Supported operations by TSCTSF | Reference |
|  | DS-TT | NW-TT | (see NOTE 1) | (see NOTE 1) |  |
| **General** |  |  |  |  |  |
| Port management capabilities (see NOTE 2) | X | X | R | R |  |
| **Bridge delay related information** |  |  |  |  |  |
| txPropagationDelay | X | X | R | - | IEEE Std 802.1Qcc [95] clause 12.32.2.1 |
| txPropagationDelayDeltaThreshold (see NOTE 23) | X | X | RW |  |  |
| **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 12-29 |
| AdminCycleTimeExtension | X | X | RW | - | IEEE Std 802.1Q [98] Table 12-29 |
| Tick granularity | X | X | R | - | IEEE Std 802.1Q [98] Table 12-29 |
| SupportedListMax | 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 (NOTE 26)** |  |  |  |  |  |
| 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 |
| **Information for deterministic networking for each NW-TT port (NOTE 27)** |  |  |  |  |  |
| IP address |  | X |  | R | IETF RFC 8344 [Z] |
| Prefix length |  | X |  | R | IETF RFC 8344 [Z] |
| MTU size |  | X |  | R | IETF RFC 8344 [Z] |
| Interface type |  | X |  | R | IETF RFC 8343 [Y] |
| MAC address |  | X |  | R | IETF RFC 8343 [Y] |
| List of Neighbors |  | X |  | R | IETF RFC 8344 [Z] |
| > 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 |
| StreamGateInstanceIndex | X | X | RW | - | 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 |
| PSFPAdminCycleTimeExtension | X | X | R | - | IEEE Std 802.1Q [98] Table 12-33 |
| **Time Synchronization Information** |  |  |  |  |  |
| TSN Time domain number (NOTE 24) | X | X | RW |  |  |
| Supported PTP instance types (NOTE 13) | X |  | R | R | IEEE Std 1588 [126] clause 8.2.1.5.5 |
| Supported transport types (NOTE 14) | X |  | R | R |  |
| Supported delay mechanisms (NOTE 15) | X |  | R | R | IEEE Std 1588 [126] clause 8.2.15.4.4 |
| PTP grandmaster capable (NOTE 16) | X |  | R | R |  |
| gPTP grandmaster capable (NOTE 17) | X |  | R | R |  |
| Supported PTP profiles (NOTE 18) | X |  | R | R |  |
| Number of supported PTP instances | X |  | R | R |  |
| **PTP instance specification** |  |  |  |  |  |
| PTP Instance ID (NOTE 25) | X | X | RW | RW |  |
| > PTP profile (NOTE 19) | X |  | RW | RW |  |
| > Transport type (NOTE 20) | X |  | RW | RW |  |
| > Grandmaster enabled (NOTE 21) | X |  | RW | RW |  |
| **IEEE Std 1588 [126] data sets (NOTE 22)** |  |  |  |  |  |
| > defaultDS.clockIdentity | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.2.2 |
| > defaultDS.clockQuality.clockClass | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.3.1.2 |
| > defaultDS.clockQuality.clockAccuracy | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.3.1.3 |
| > defaultDS.clockQuality.offsetScaledLogVariance | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.3.1.4 |
| > defaultDS.priority1 | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.1 |
| > defaultDS.priority2 | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.2 |
| > defaultDS.domainNumber | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.3 |
| > defaultDS.sdoId | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.5 |
| > defaultDS.instanceEnable | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.5.2 |
| > defaultDS.instanceType | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.1.5.5 |
| > portDS.portIdentity | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.2.1 |
| > portDS.portState | X | X | R | R | IEEE Std 1588 [126] clause 8.2.15.3.1 |
| > portDS.logMinDelayReqInterval | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.3.2 |
| > portDS.logAnnounceInterval | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.1 |
| > portDS.announceReceiptTimeout |  | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.2 |
| > portDS.logSyncInterval | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.3 |
| > portDS.delayMechanism | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.4 |
| > portDS.logMinPdelayReqInterval | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.5 |
| > portDS.versionNumber | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.6 |
| > portDS.minorVersionNumber | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.7 |
| > portDS.delayAsymmetry | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.8 |
| > portDS.portEnable | X | X | RW | RW | IEEE Std 1588 [126] clause 8.2.15.5.1 |
| > timePropertiesDS.currentUtcOffset | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.4.2 |
| > timePropertiesDS.timeSource | X |  | RW | RW | IEEE Std 1588 [126] clause 8.2.4.9 |
| > externalPortConfigurationPortDS.desiredState |  |  | RW | RW | IEEE Std 1588 [126] clause 15.5.3.7.15.1 |
| **IEEE Std 802.1AS [104] data sets (NOTE 22)** |  |  |  |  |  |
| > defaultDS.clockIdentity | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.2 |
| > defaultDS.clockQuality.clockClass | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.2 |
| > defaultDS.clockQuality.clockAccuracy | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.3 |
| > defaultDS.clockQuality.offsetScaledLogVariance | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.4 |
| > defaultDS.priority1 | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.5 |
| > defaultDS.priority2 | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.6 |
| > defaultDS.timeSource | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.15 |
| > defaultDS.domainNumber | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.16 |
| > defaultDS.sdoId | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.3 |
| > defaultDS.instanceEnable | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.2.19 |
| > portDS.portIdentity |  | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.2 |
| > portDS.portState |  | X | R | R | IEEE Std 802.1AS [104] clause 14.8.3 |
| > portDS.ptpPortEnabled | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.4 |
| > portDS.delayMechanism | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.5 |
| > portDS.isMeasuringDelay | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.6 |
| > portDS.asCapable | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.7 |
| > portDS.meanLinkDelay | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.8 |
| > portDS.meanLinkDelayThresh | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.9 |
| > portDS.delayAsymmetry | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.10 |
| > portDS.neighborRateRatio | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.11 |
| > portDS.initialLogAnnounceInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.12 |
| > portDS.currentLogAnnounceInterval | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.13 |
| > portDS.useMgtSettableLogAnnounceInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.14 |
| > portDS.mgtSettableLogAnnounceInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.15 |
| > portDS.announceReceiptTimeout |  | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.16 |
| > portDS.initialLogSyncInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.17 |
| > portDS.currentLogSyncInterval | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.18 |
| > portDS.useMgtSettableLogSyncInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.19 |
| > portDS.mgtSettableLogSyncInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.20 |
| > portDS.syncReceiptTimeout |  | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.21 |
| > portDS.syncReceiptTimeoutTimeInterval |  | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.22 |
| > portDS.initialLogPdelayReqInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.23 |
| > portDS.currentLogPdelayReqInterval | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.24 |
| > portDS.useMgtSettableLogPdelayReqInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.25 |
| > portDS.mgtSettableLogPdelayReqInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.26 |
| > portDS.initialLogGptpCapableMessageInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.27 |
| > portDS.currentLogGptpCapableMessageInterval | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.28 |
| > portDS.useMgtSettableLogGptpCapableMessageInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.29 |
| > portDS.mgtSettableLogGptpCapableMessageInterval | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.30 |
| > portDS.initialComputeNeighborRateRatio | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.31 |
| > portDS.currentComputeNeighborRateRatio | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.32 |
| > portDS.useMgtSettableComputeNeighborRateRatio | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.33 |
| > portDS.mgtSettableComputeNeighborRateRatio | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.34 |
| > portDS.initialComputeMeanLinkDelay | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.35 |
| > portDS.currentComputeMeanLinkDelay | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.36 |
| > portDS.useMgtSettableComputeMeanLinkDelay | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.37 |
| > portDS.mgtSettableComputeMeanLinkDelay | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.38 |
| > portDS.allowedLostResponses | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.39 |
| > portDS.allowedFaults | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.40 |
| > portDS.gPtpCapableReceiptTimeout | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.41 |
| > portDS.versionNumber | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.42 |
| > portDS.nup | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.43 |
| > portDS.ndown | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.44 |
| > portDS.oneStepTxOper | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.45 |
| > portDS.oneStepReceive | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.46 |
| > portDS.oneStepTransmit | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.47 |
| > portDS.initialOneStepTxOper | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.48 |
| > portDS.currentOneStepTxOper | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.49 |
| > portDS.useMgtSettableOneStepTxOper | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.50 |
| > portDS.mgtSettableOneStepTxOper | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.51 |
| > portDS.syncLocked | X | X | R | R | IEEE Std 802.1AS [104] clause 14.8.52 |
| > portDS.pdelayTruncatedTimestampsArray | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.53 |
| > portDS.minorVersionNumber | X | X | RW | RW | IEEE Std 802.1AS [104] clause 14.8.54 |
| > timePropertiesDS.currentUtcOffset | X |  | RW | RW | IEEE Std 802.1AS [104] clause 14.5.2 |
| > externalPortConfigurationPortDS.desiredState |  | X | RW | RW | IEEE Std 802.1AS [104] clause 14.12.2 |
| NOTE 1: R = Read only access; RW = Read/Write access; ― = not supported.  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 User Plane Node 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. TSN AF indicates the neighbor discovery information for each discovered neighbor of DS-TT port to CNC. 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 User Plane Node 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 clause 8.6.5.1 of IEEE Std 802.1Q [98].  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.  NOTE 13: Enumeration of supported PTP instance types. Allowed values as defined in clause 8.2.1.5.5 of IEEE Std 1588 [126].  NOTE 14: Enumeration of supported transport types. Allowed values: IPv4 (as defined in Annex C of IEEE Std 1588 [126]), IPv6 (as defined in IEEE Std 1588 [126] Annex D), Ethernet (as defined in Annex E of IEEE Std 1588 [126]).  NOTE 15: Enumeration of supported PTP delay mechanisms. Allowed values as defined in clause 8.2.15.4.4 of IEEE Std 1588 [126].  NOTE 16: Indicates whether DS-TT supports acting as a PTP grandmaster.  NOTE 17: Indicates whether DS-TT supports acting as a gPTP grandmaster.  NOTE 18: Enumeration of supported PTP profiles, each identified by PTP profile ID, as defined in clause 20.3.3 of IEEE Std 1588 [126].  NOTE 19: PTP profile to apply, identified by PTP profile ID, as defined in clause 20.3.3 of IEEE Std 1588 [126].  NOTE 20: Transport type to use. Allowed values: IPv4 (as defined in Annex C of IEEE Std 1588 [126]), IPv6 (as defined in IEEE Std 1588 [126] Annex D), Ethernet (as defined in Annex E of IEEE Std 1588 [126]).  NOTE 21: Indicates whether to act as grandmaster or not, i.e. whether to send Announce, Sync and optionally Follow\_Up messages.  NOTE 22: The IEEE Std 802.1AS [104] data sets apply if the IEEE 802.1AS PTP profile is used; otherwise the IEEE Std 1588 [126] data sets apply.  NOTE 23: Indicates how much the txPropagationDelay needs to change so that DS-TT/NW-TT report a change in txPropagationDelay to TSN AF. This is optional for NW-TT.  NOTE 24: Indicates the gPTP domain (identified by a domain number) that is assumed by the CNC as the reference clock for time information in the scheduled traffic (gate control) information, PSFP information and bridge delay related information. This is optional for NW-TT.  NOTE 25: PTP Instance ID uniquely identifies a PTP instance within the user plane node.  NOTE 26: TSN AF indicates the neighbor discovery information for each discovered neighbor of NW-TT port to CNC.  NOTE 27: Applicable in case of interworking with IETF Deterministic Networking. |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | | | | | |

Table 5.28.3.1-2: Standardized user plane node management information

|  |  |  |  |
| --- | --- | --- | --- |
| User plane node management information | Supported operations by TSN AF | Supported operations by TSCTSF | Reference |
|  | (see NOTE 1) | (see NOTE 1) |  |
| **Information for 5GS Bridge** |  |  |  |
| User plane node Address | R | R |  |
| User plane node ID | R | R |  |
| NW-TT port numbers | R | 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] |
| **Time synchronization information** |  |  |  |
| Supported PTP instance types (NOTE 6) | R | R |  |
| Supported transport types (NOTE 7) | R | R |  |
| Supported delay mechanisms (NOTE 8) | R | R |  |
| PTP grandmaster capable (NOTE 9) | R | R |  |
| gPTP grandmaster capable (NOTE 10) | R | R |  |
| Supported PTP profiles (NOTE 11) | R | R |  |
| Number of supported PTP instances | R | R |  |
| **Time synchronization information for PTP instances (NOTE 16)** |  |  |  |
| **> PTP instance specification** |  |  |  |
| >> PTP Instance ID (NOTE 17) | RW | RW |  |
| >> PTP profile (NOTE 12) | RW | RW |  |
| >> Transport type (NOTE 13) | RW | RW |  |
| >> Grandmaster candidate enabled | RW | RW |  |
| **IEEE Std 1588 [126] data sets (NOTE 15)** |  |  |  |
| >> defaultDS.clockIdentity | RW | RW | IEEE Std 1588 [126] clause 8.2.1.2.2 |
| >> defaultDS.clockQuality.clockClass | RW | RW | IEEE Std 1588 [126] clause 8.2.1.3.1.2 |
| >> defaultDS.clockQuality.clockAccuracy | RW | RW | IEEE Std 1588 [126] clause 8.2.1.3.1.3 |
| >> defaultDS.clockQuality.offsetScaledLogVariance | RW | RW | IEEE Std 1588 [126] clause 8.2.1.3.1.4 |
| >> defaultDS.priority1 | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.1 |
| >> defaultDS.priority2 | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.2 |
| >> defaultDS.domainNumber | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.3 |
| >> defaultDS.sdoId | RW | RW | IEEE Std 1588 [126] clause 8.2.1.4.5 |
| >> defaultDS.instanceEnable | RW | RW | IEEE Std 1588 [126] clause 8.2.1.5.2 |
| >> defaultDS.externalPortConfigurationEnabled | RW | RW | IEEE Std 1588 [126] clause 8.2.1.5.3 |
| >> defaultDS.instanceType | RW | RW | IEEE Std 1588 [126] clause 8.2.1.5.5 |
| >> timePropertiesDS.currentUtcOffset | RW | RW | IEEE Std 1588 [126] clause 8.2.4.2 |
| >> timePropertiesDS.timeSource | RW | RW | IEEE Std 1588 [126] clause 8.2.4.9 |
| **IEEE Std 802.1AS [104] data sets (NOTE 15)** |  |  |  |
| >> defaultDS.clockIdentity | RW | RW | IEEE Std 802.1AS [104] clause 14.2.2 |
| >> defaultDS.clockQuality.clockClass | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.2 |
| >> defaultDS.clockQuality.clockAccuracy | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.3 |
| >> defaultDS.clockQuality.offsetScaledLogVariance | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.4 |
| >> defaultDS.priority1 | RW | RW | IEEE Std 802.1AS [104] clause 14.2.5 |
| >> defaultDS.priority2 | RW | RW | IEEE Std 802.1AS [104] clause 14.2.6 |
| >> defaultDS.timeSource | RW | RW | IEEE Std 802.1AS [104] clause 14.2.15 |
| >> defaultDS.domainNumber | RW | RW | IEEE Std 802.1AS [104] clause 14.2.16 |
| >> defaultDS.sdoId | RW | RW | IEEE Std 802.1AS [104] clause 14.2.18 |
| >> defaultDS.externalPortConfigurationEnabled | RW | RW | IEEE Std 802.1AS [104] clause 14.2.4.3 |
| >> defaultDS.instanceEnable | RW | RW | IEEE Std 802.1AS [104] clause 14.2.19 |
| >> timePropertiesDS.currentUtcOffset | RW | RW | IEEE Std 802.1AS [104] clause 14.5.2 |
| **Time synchronization information for DS-TT ports** |  |  |  |
| **> Time synchronization information for each DS-TT port** |  |  |  |
| > DS-TT port number | RW | RW |  |
| **>> Time synchronization information for each PTP Instance** |  |  |  |
| >> PTP Instance ID (NOTE 17) | RW | RW |  |
| >> Grandmaster on behalf of DS-TT enabled (NOTE 14) | RW | RW |  |
| **IEEE Std 1588 [126] data sets (NOTE 15)** |  |  |  |
| >> portDS.portIdentity | RW | RW | IEEE Std 1588 [126] clause 8.2.15.2.1 |
| >> portDS.portState | R | R | IEEE Std 1588 [126] clause 8.2.15.3.1 |
| >> portDS.logMinDelayReqInterval | RW | RW | IEEE Std 1588 [126] clause 8.2.15.3.2 |
| >> portDS.logAnnounceInterval | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.1 |
| >> portDS.announceReceiptTimeout | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.2 |
| >> portDS.logSyncInterval | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.3 |
| >> portDS.delayMechanism | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.4 |
| >> portDS.logMinPdelayReqInterval | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.5 |
| >> portDS.versionNumber | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.6 |
| >> portDS.minorVersionNumber | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.7 |
| >> portDS.delayAsymmetry | RW | RW | IEEE Std 1588 [126] clause 8.2.15.4.8 |
| >> portDS.portEnable | RW | RW | IEEE Std 1588 [126] clause 8.2.15.5.1 |
| >> externalPortConfigurationPortDS.desiredState | RW | RW | IEEE Std 1588 [126] clause 15.5.3.7.15.1 |
| **IEEE Std 802.1AS [104] data sets (NOTE 15)** |  |  |  |
| >> portDS.portIdentity | RW | RW | IEEE Std 802.1AS [104] clause 14.8.2 |
| >> portDS.portState | R | R | IEEE Std 802.1AS [104] clause 14.8.3 |
| >> portDS.ptpPortEnabled | RW | RW | IEEE Std 802.1AS [104] clause 14.8.4 |
| >> portDS.delayMechanism | RW | RW | IEEE Std 802.1AS [104] clause 14.8.5 |
| >> portDS.isMeasuringDelay | R | R | IEEE Std 802.1AS [104] clause 14.8.6 |
| >> portDS.asCapable | R | R | IEEE Std 802.1AS [104] clause 14.8.7 |
| >> portDS.meanLinkDelay | R | R | IEEE Std 802.1AS [104] clause 14.8.8 |
| >> portDS.meanLinkDelayThresh | RW | RW | IEEE Std 802.1AS [104] clause 14.8.9 |
| >> portDS.delayAsymmetry | RW | RW | IEEE Std 802.1AS [104] clause 14.8.10 |
| >> portDS.neighborRateRatio | R | R | IEEE Std 802.1AS [104] clause 14.8.11 |
| >> portDS.initialLogAnnounceInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.12 |
| >> portDS.currentLogAnnounceInterval | R | R | IEEE Std 802.1AS [104] clause 14.8.13 |
| >> portDS.useMgtSettableLogAnnounceInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.14 |
| >> portDS.mgtSettableLogAnnounceInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.15 |
| >> portDS.announceReceiptTimeout | RW | RW | IEEE Std 802.1AS [104] clause 14.8.16 |
| >> portDS.initialLogSyncInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.17 |
| >> portDS.currentLogSyncInterval | R | R | IEEE Std 802.1AS [104] clause 14.8.18 |
| >> portDS.useMgtSettableLogSyncInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.19 |
| >> portDS.mgtSettableLogSyncInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.20 |
| >> portDS.syncReceiptTimeout | RW | RW | IEEE Std 802.1AS [104] clause 14.8.21 |
| >> portDS.syncReceiptTimeoutTimeInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.22 |
| >> portDS.initialLogPdelayReqInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.23 |
| >> portDS.currentLogPdelayReqInterval | R | R | IEEE Std 802.1AS [104] clause 14.8.24 |
| >> portDS.useMgtSettableLogPdelayReqInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.25 |
| >> portDS.mgtSettableLogPdelayReqInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.26 |
| >> portDS.initialLogGptpCapableMessageInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.27 |
| >> portDS.currentLogGptpCapableMessageInterval | R | R | IEEE Std 802.1AS [104] clause 14.8.28 |
| >> portDS.useMgtSettableLogGptpCapableMessageInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.29 |
| >> portDS.mgtSettableLogGptpCapableMessageInterval | RW | RW | IEEE Std 802.1AS [104] clause 14.8.30 |
| >> portDS.initialComputeNeighborRateRatio | RW | RW | IEEE Std 802.1AS [104] clause 14.8.31 |
| >> portDS.currentComputeNeighborRateRatio | R | R | IEEE Std 802.1AS [104] clause 14.8.32 |
| >> portDS.useMgtSettableComputeNeighborRateRatio | RW | RW | IEEE Std 802.1AS [104] clause 14.8.33 |
| >> portDS.mgtSettableComputeNeighborRateRatio | RW | RW | IEEE Std 802.1AS [104] clause 14.8.34 |
| >> portDS.initialComputeMeanLinkDelay | RW | RW | IEEE Std 802.1AS [104] clause 14.8.35 |
| >> portDS.currentComputeMeanLinkDelay | R | R | IEEE Std 802.1AS [104] clause 14.8.36 |
| >> portDS.useMgtSettableComputeMeanLinkDelay | RW | RW | IEEE Std 802.1AS [104] clause 14.8.37 |
| >> portDS.mgtSettableComputeMeanLinkDelay | RW | RW | IEEE Std 802.1AS [104] clause 14.8.38 |
| >> portDS.allowedLostResponses | RW | RW | IEEE Std 802.1AS [104] clause 14.8.39 |
| >> portDS.allowedFaults | RW | RW | IEEE Std 802.1AS [104] clause 14.8.40 |
| >> portDS.gPtpCapableReceiptTimeout | RW | RW | IEEE Std 802.1AS [104] clause 14.8.41 |
| >> portDS.versionNumber | RW | RW | IEEE Std 802.1AS [104] clause 14.8.42 |
| >> portDS.nup | RW | RW | IEEE Std 802.1AS [104] clause 14.8.43 |
| >> portDS.ndown | RW | RW | IEEE Std 802.1AS [104] clause 14.8.44 |
| >> portDS.oneStepTxOper | R | R | IEEE Std 802.1AS [104] clause 14.8.45 |
| >> portDS.oneStepReceive | R | R | IEEE Std 802.1AS [104] clause 14.8.46 |
| >> portDS.oneStepTransmit | R | R | IEEE Std 802.1AS [104] clause 14.8.47 |
| >> portDS.initialOneStepTxOper | RW | RW | IEEE Std 802.1AS [104] clause 14.8.48 |
| >> portDS.currentOneStepTxOper | RW | RW | IEEE Std 802.1AS [104] clause 14.8.49 |
| >> portDS.useMgtSettableOneStepTxOper | RW | RW | IEEE Std 802.1AS [104] clause 14.8.50 |
| >> portDS.mgtSettableOneStepTxOper | RW | RW | IEEE Std 802.1AS [104] clause 14.8.51 |
| >> portDS.syncLocked | R | R | IEEE Std 802.1AS [104] clause 14.8.52 |
| >> portDS.pdelayTruncatedTimestampsArray | RW | RW | IEEE Std 802.1AS [104] clause 14.8.53 |
| >> portDS.minorVersionNumber | RW | RW | IEEE Std 802.1AS [104] clause 14.8.54 |
| >> externalPortConfigurationPortDS.desiredState | RW | RW | IEEE Std 802.1AS [104] clause 14.12.2 |
| NOTE 1: R = Read only access; RW = Read/Write access; ― = not supported.  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, UPF/NW-TT can use Static Filtering Entry information for forwarding TSC traffic, as specified in clause 5.8.2.5.3.  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. TSN AF indicates the discovered neighbor information for each DS-TT port to CNC.  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 6: Enumeration of supported PTP instance types. Allowed values as defined in clause 8.2.1.5.5 of IEEE Std 1588 [126].  NOTE 7: Enumeration of supported transport types. Allowed values: IPv4 (as defined in IEEE Std 1588 [126] Annex C), IPv6 (as defined in IEEE Std 1588 [126] Annex D), Ethernet (as defined in Annex E of IEEE Std 1588 [126]).  NOTE 8: Enumeration of supported PTP delay mechanisms. Allowed values as defined in clause 8.2.15.4.4 of IEEE Std 1588 [126].  NOTE 9: Indicates whether NW-TT supports acting as a PTP grandmaster.  NOTE 10: Indicates whether NW-TT supports acting as a gPTP grandmaster.  NOTE 11: Enumeration of supported PTP profiles, each identified by PTP profile ID, as defined in clause 20.3.3 of IEEE Std 1588 [126].  NOTE 12: PTP profile to apply, identified by PTP profile ID, as defined in clause 20.3.3 of IEEE Std 1588 [126].  NOTE 13: Transport type to use. Allowed values: IPv4 (as defined in Annex C of IEEE Std 1588 [126]), IPv6 (as defined in IEEE Std 1588 [126] Annex D), Ethernet (as defined in Annex E of IEEE Std 1588 [126]).  NOTE 14: Indicates whether to act as grandmaster on behalf of a DS-TT port or not if 5GS is determined to be the grandmaster clock, i.e. whether to send Announce, Sync and optionally Follow\_Up messages on behalf of DS-TT.  NOTE 15: The IEEE Std 802.1AS [104] data sets apply if the IEEE 802.1AS PTP profile is used; otherwise, the IEEE Std 1588 [126] data sets apply.  NOTE 16: Specifies the default data set for each PTP instance identified by PTP instance ID within the user plane node.  NOTE 17: PTP Instance ID uniquely identifies a PTP instance within the user plane node. | | | |

Exchange of port and user plane node management information between TSN AF or TSCTSF and NW-TT or between TSN AF or TSCTSF and DS-TT allows TSN AF or TSCTSF to:

1) retrieve port management information for a DS-TT or NW-TT port or user plane node management information;

2) send port management information for a DS-TT or NW-TT port or user plane node management information;

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

4) delete selected entries in the following data structures:

- "DS-TT port neighbour discovery configuration for DS-TT port" in UMIC using the DS-TT port number to reference the selected entry.

- "Stream Filter Instance Table" in PMIC using the Stream Filter Instance ID to reference the selected entry.

- "Stream Gate Instance Table" in PMIC using the Stream Gate Instance ID to reference the selected entry.

- "Static Filtering Entries table" in UMIC using the (MAC address, VLAN ID) pair to reference the selected entry.

5) delete PTP Instances in a DS-TT port or NW-TT port using the PTP Instance ID to reference the selected entry as described in clause K.2.2.1.

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

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

Exchange of user plane node management information between TSN AF or TSCTSF and NW-TT is initiated by NW-TT to:

- notify TSN AF or TSCTSF if user plane node management information has changed that TSN AF or TSCTSF 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 or TSCTSF indicates inside the Port Management Information Container or user plane node Management Information Container whether it wants to retrieve or send port or user plane node management information or intends to (un-)subscribe for notifications.

#### 5.28.3.2 Transfer of port or user plane node management information

Port management information is transferred transparently via 5GS between TSN AF or TSCTSF and DS-TT or NW-TT, respectively, inside a Port Management Information Container (PMIC). User plane node management information is transferred transparently via 5GS between TSN AF or TSCTSF and NW-TT inside a user plane node Management Information Container (UMIC). The transfer of port or user plane node management information is as follows:

- To convey port management information from DS-TT or NW-TT to TSN AF or TSCTSF:

- DS-TT provides a PMIC and the DS-TT port MAC address (if available) to the UE, which includes the PMIC as an optional Information Element of an N1 SM container and triggers the UE requested PDU Session Establishment procedure or PDU Session Modification procedure to forward the PMIC to the SMF. SMF forwards the PMIC and the port number of the related DS-TT port to TSN AF or TSCTSF as described in clauses 4.3.2.2 and 4.3.3.2 of TS 23.502 [3];

- NW-TT provides PMIC(s) and/or UMIC to the UPF, which triggers the N4 Session Level Reporting Procedure to forward the PMIC(s) and/or UMIC to SMF. UPF selects an N4 session corresponding to any of the N4 sessions for this NW-TT. SMF in turn forwards the PMIC(s) and the port number(s) of the related NW-TT port(s), or the UMIC, to TSN AF or TSCTSF as described in clause 4.16.5.1 of TS 23.502 [3].

NOTE 1: There has to be at least one established PDU session for DS-TT port before the UPF can report PMIC/UMIC information towards the TSN AF or TSCTSF.

- To convey port management information from TSN AF or TSCTSF to DS-TT:

- TSN AF or TSCTSF provides a PMIC, DS-TT port MAC address or UE IP address (applicable for TSCTSF only) reported for a PDU Session (i.e. MAC address of the DS-TT port or IP address related to the PDU session) and the port number of the DS-TT port to manage to the PCF by using the AF Session level Procedure, which forwards the information to SMF based on the MAC or IP address using the PCF initiated SM Policy Association Modification procedure as described in clause 4.16.5.2 of TS 23.502 [3]. SMF determines that the port number relates to a DS-TT port and based on this forwards the PMIC to DS-TT using the network requested PDU Session Modification procedure as described in clause 4.3.3.2 of TS 23.502 [3].

- To convey port or user plane node management information from TSN AF or TSCTSF to NW-TT:

- TSN AF or TSCTSF selects a PCF-AF session corresponding to any of the DS-TT MAC or IP addresses (applicable for TSCTSF only) for the related PDU sessions of this bridge and provides a PMIC(s) and the related NW-TT port number(s) and/or UMIC to the PCF. The PCF uses the PCF initiated SM Policy Association Modification procedure to forward the information received from TSN AF or TSCTSF to SMF as described in clause 4.16.5.2 of TS 23.502 [3]. SMF determines that the included information needs to be delivered to the NW-TT either by determining that the port number(s) relate(s) to a NW-TT port(s) or based on the presence of UMIC, and forwards the container(s) and/or related port number(s) to NW-TT using the N4 Session Modification procedure described in clause 4.4.1.3 of TS 23.502 [3].

#### 5.28.3.3 VLAN Configuration Information for TSN

The CNC obtains the 5GS bridge VLAN configuration from TSN AF according to clause 12.10.1.1 of IEEE Std 802.1Q [98]. The TSN AF and UPF/NW-TT are pre-configured with same 5GS bridge VLAN configuration.

NOTE: In this Release, the VLAN Configuration Information are pre-configured at the TSN AF and the NW-TT and is not exchanged between the TSN AF and the UPF/NW-TT.

### 5.28.4 QoS mapping tables for TSN

The mapping tables between the traffic class and 5GS QoS Profile is provisioned and further used to find suitable 5GS QoS profile to transfer TSN traffic over the PDU Session. QoS mapping procedures are performed in two phases: (1) QoS capability report phase as described in clause 5.28.1, and (2) QoS configuration phase as in clause 5.28.2

(1) The TSN AF shall be pre-configured (e.g. via OAM) with a mapping table. The mapping table contains TSN traffic classes, pre-configured bridge delays (i.e. the preconfigured delay between UE and UPF/NW-TT) and priority levels. Once the PDU session has been setup and after retrieving the information related to UE-DS-TT residence time, the TSN AF deduces the port pair(s) in the 5GS bridge and determines the bridge delay per port pair per traffic class based on the pre-configured bridge delay and the UE-DS-TT residence time as described in clause 5.27.5. The TSN AF updates bridge delays per port pair and traffic class and reports the bridge delays and other relevant TSN information such as the Traffic Class Table (clause 12.6.3 in IEEE Std 802.1Q [98]) for every port, according to the IEEE Std 802.1Q [98] and IEEE Std 802.1Qcc [95] to the CNC.

(2) CNC may distribute PSFP information and transmission gate scheduling parameters to 5GS Bridge via TSN AF, which can be mapped to TSN QoS requirements by the TSN AF.

The PCF mapping table provides a mapping from TSN QoS information (see clauses 6.2.1.2 and 6.1.3.23 of TS 23.503 [45]) to 5GS QoS profile. Based on trigger from TSN AF, the PCF may trigger PDU session modification procedure to establish a new 5G QoS Flow or use the pre-configured 5QI for 5G QoS Flow for the requested traffic class according to the selected QoS policies and the TSN AF traffic requirements.

Figure 5.28.4-1 illustrates the functional distribution of the mapping tables.



Figure 5.28.4-1: QoS Mapping Function distribution between PCF and TSN AF

The minimum set of TSN QoS-related parameters that are relevant for mapping the TSN QoS requirements are used by the TSN AF: traffic classes and their priorities per port, TSC Burst Size of TSN streams, 5GS bridge delays per port pair and traffic class (independentDelayMax, independentDelayMin, dependentDelayMax, dependentDelayMin), propagation delay per port (txPropagationDelay) and UE-DS-TT residence time.

Once the CNC retrieves the necessary information, it proceeds to calculate scheduling and paths. The configuration information is then set in the bridge as described in clauses 5.28.2 and 5.28.3. The most relevant information received is the PSFP information and the schedule of transmission gates for every traffic class and port of the bridge. At this point, it is possible to retrieve the TSN QoS requirements by identifying the traffic class of the TSN stream. The traffic class to TSN QoS and delay requirement (excluding the UE-DS-TT residence time) mapping can be performed using the QoS mapping table in the TSN AF as specified in TS 23.503 [45]. Subsequently in the PCF, the 5G QoS Flow can be configured by selecting a 5QI as specified in TS 23.503 [45]. This feedback approach uses the reported information to the CNC and the feedback of the configuration information coming from the CNC to perform the mapping and configuration in the 5GS.

If the Maximum Burst Size of the aggregated TSC streams in the traffic class is provided by CNC via TSN AF to PCF, PCF can derive the required MDBV taking the Maximum Burst Size as input. If the default MDBV associated with a standardized 5QI or a pre-configured 5QI in the QoS mapping table cannot satisfy the aggregated TSC Burst Size, the PCF provides the derived MDBV in the PCC rule and then the SMF performs QoS Flow binding as specified in clause 6.1.3.2.4 of TS 23.503 [45].

Maximum Flow Bit Rate is calculated over PSFPAdminCycleTime as described in Annex I and provided by the TSN AF to the PCF. The PCF sets the GBR and MBR values to the Maximum Flow Bitrate value.

The Maximum Flow Bit Rate is adjusted according to Averaging Window associated with a pre-configured 5QI in the QoS mapping table or another selected 5QI (as specified in TS 23.503 [45]) to obtain GBR of the 5GS QoS profile. GBR is then used by SMF to calculate the GFBR per QoS Flow. QoS mapping table in the PCF between TSN parameters and 5GS parameters should match the delay, aggregated TSC burst size and priority, while preserving the priorities in the 5GS. An operator enabling TSN services via 5GS can choose up to eight traffic classes to be mapped to 5GS QoS profiles.

Once the 5QIs to be used for TSN streams are identified by the PCF as specified in TS 23.503 [45], then it is possible to enumerate as many bridge port traffic classes as the number of selected 5QIs.

When PSFP information is not available to the TSN AF for a given TSN stream (e.g. because of lack of PSFP support in the DS-TTs or the NW-TTs, or exceeding the number of supported table entries for PSFP functions, or because CNC does not provide PSFP information), the 5GS can support the TSN streams using pre-configured mapping from stream priority (i.e. PCP as defined in IEEE Std 802.1Q [98]) to QoS Flows.

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

### 5.28.X Support of integration with IETF Deterministic Networking

#### 5.28.X.1 General

5GS acts as a DetNet Router according to the architecture defined in clause 4.4.8.X. When integrated with an IETF Deterministic Network, 5GS acts as one or more routers. A 5GS router is composed of the ports on a single UPF (i.e. PSA) side, the user plane tunnel between the UE and UPF, and the ports on the device side. For each 5GS router of a deterministic network, the ports on the network side and the ports on device side that are associated to the PDU Sessions support connectivity to the deterministic network.

The granularity of the 5GS DetNet node is per UPF for each network instance or DNN/S-NSSAI. The TSCTSF stores the binding relationship between a device side port and a PDU Session. The TSCTSF also stores information about ports on the UPF/NW-TT side.

The integration with IETF Deterministic Networking assumes the following.

* The existing 3GPP routing mechanisms are re-used for DetNet.
* The existing multicast capabilities can be re-used for DetNet communications.
* The 5GS integration to IETF DetNet is based on DetNet for IP; DetNet for MPLS is not supported.
* IP based DetNet traffic is carried in IP type PDU Sessions.
* 5GS functions realize the DetNet forwarding sub-layer. For the IP case according to RFC 8939 [S] clause 1, no service sub-layer function needs to be defined. The 5GS DetNet Router acts as a DetNet transit node as defined in RFC 8655 [X].

#### The interface between the TSCTSF and the DetNet controller uses protocols defined in IETF. The DetNet configuration is carried in YANG model [P] over Netconf [Q] or Restconf [R].5.28.X.2 5GS DetNet node reporting

The TSCTSF may provide exposure information to the DetNet controller using information collected from the 5GS entities. The exposure may be based on RFC 8343 [Y] and RFC 8344 [Z]. The exposure information can be used by the DetNet controller to build up the network topology information.

The TSCTSF collects the information from the UPF/NW-TT via parameters in PMIC as defined in clause 5.28.3.1 and the from the SMF (for the device ports) . For both the device and the network side ports, the TSCTSF may collect information on one or more IPv4 or IPv6 addresses and prefixes (with specific length) assigned to the ports, the MTU size and the type of the interface (defined in RFC 8343 [Y], with values defined in RFC 7244 [V]) associated with the port which can be used to determine whether it is a device or network side port.

For device side ports also information of IP addresses or IP prefixes not directly assigned to the port but reachable via the port may be provided. On the device side ports these are related to Framed Routes, i.e. a range of IPv4 addresses or IPv6 prefixes reachable over a single PDU Session, as defined in clause 5.6.14, or prefixes delegated by IPv6 prefix delegation as defined in clause 5.8.2.2. This additional information helps both the TSCTSF and the DetNet controller to map flows to correct source and destination interfaces. For the network side ports, the TSCTSF may also collect information on the MAC address and neighbor IP nodes. The ports are identified by the port number, which can also be used as interface identifiers towards the DetNet controller.

For network side ports, the information is transferred in PMIC between the NW-TT and the TSCTSF. For device side ports, the information is transferred without relying on PMIC, using additional parameters from the SMF via the PCF to the TSCTSF.

#### 5.28.X.3 DetNet node configuration mapping in 5GS

The TSCTSF maps the parameters in the DetNet YANG configuration to 5GS parameters as defined in TS 23.503 clause 6.1.3.23b.

The TSCTSF uses the identity of the incoming and outgoing interfaces to determine the affected PDU Session(s) and whether the flow is uplink or downlink. The TSCTSF also determines if the flow is from one UE to another UE (i.e., UE-to-UE) in which case two PDU Sessions will be affected for the flow and the TSCTSF breaks up the requirements to individual requirements for the PDU Sessions.

NOTE 1: The incoming interface is optional in the DetNet YANG configuration. If there is no incoming interface for UL traffic, the TSCTSF may determine the PDU session based on local configuration using information collected for the individual ports and the source IP address in the DetNet configuration. It is assumed that any IP prefix on the device side is reachable via at most a single device side interface, and thus if the flow source IP address belongs to a prefix associated with a device side interface, that interface can be uniquely determined as the source interface for the flow.

The TSCTSF provides a response to the DetNet controller regarding the success of the configuration setup. If the status of the flow changes later on for any reason, the TSCTSF notifies the DetNet controller. Upon release of a PDU Session that is part of the existing DetNet configuration, the PCF notifies the TSCTSF for the PDU Session release, and TSCTSF notifies the DetNet controller on status of the flow.

The 5GS routing is not modified by the configuration received from the DetNet controller, but the TSCTSF may verify whether the explicit routing information provided by the DetNet controller is in line with the 5GS mapping of IP addresses and prefixes to PDU sessions. The verification can be based on whether the IP address in the DetNet flow on the given port correspond to the IP address or prefix associated with the given PDU Session. Based on operator configuration, the TSCTSF may use other criteria (also not routing related) to determine whether to accept or reject a given DetNet configuration.

5GS DetNet Node can forward via its device side interface IP packets destined not only to the UE's IP address or prefix but also to a range of IPv4 addresses or IPv6 IP prefixes according to one or more Framed Routes or prefixes delegated to the UE by IPv6 prefix delegation. To facilitate this, the additional IP addresses used for framed routes and IPv6 prefix delegation are exposed by the SMF to the TSCTSF via the PCF and by TSCTSF to the DetNet controller as defined in clause 5.28.X.2.

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

### 6.2.29 TSCTSF

The Time Sensitive Communication and Time Synchronization Function (TSCTSF) supports the following functionality:

- Associating the time synchronization service request (see clause 5.27.1.8) from the NF consumer to the AF sessions with the PCF (the session between the PCF and TSCTSF).

- Controlling time synchronization service request from the NF consumer, (g)PTP-based time distribution and ASTI-based time distribution based on subscription data. The TSCTSF may be pre-configured with one or several PTP instance configurations. For each PTP instance configuration, it may contain:

- a reference to the PTP instance configuration.

- PTP profile.

- PTP domain.

- Managing the DS-TT and NW-TT via exchange of PMIC and UMIC as described in Annex K.

- Detecting availability of 5GS Bridge/Router information (including user plane node ID that applies also for IP type PDU Sessions) as reported by PCF for both Ethernet and IP type PDU Sessions (including the need to (un)subscribe 5GS Bridge/Router information Notification from PCF).

- Creating the TSC Assistance Container based on individual traffic pattern parameters from the NEF/AF or DetNet controller and providing it to the PCF.

- Determining the Requested PDB by subtracting the UE-DS-TT Residence Time from the Requested 5GS Delay provided by the NEF/AF or DetNet controller and providing the determined Requested PDB to the PCF.

- Discovering the AMFs serving the list of TA(s) that comprise the spatial validity condition from the NRF and subscribing to the discovered AMF(s) to receive notifications about presence of the UE in an Area of Interest events determined by the list of TA(s) served by the AMF.

- Determining the spatial validity condition from the requested coverage area by the NEF/AF and enforcing time synchronization service for the requested coverage area.

- In case of support of integration with IETF Deterministic Networking (as depicted in clause 4.4.8.X and 5.28.X), acting as a stateful translator function between a DetNet controller and 5G System Network Functions and Procedures, including the NW-TT. This includes exposing the information about the 5GS router to the DetNet controller and mapping 5GS router configuration parameters provided by the DetNet controller to 5G System parameters. The details are defined in clause 5.28.x.

\* \* \* End of Changes \* \* \*