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Time-Sensitive Networking (TSN) charging
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Foreword

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In the present document, modal verbs have the following meanings:

- shall** indicates a mandatory requirement to do something
- shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

- should** indicates a recommendation to do something
- should not** indicates a recommendation not to do something
- may** indicates permission to do something
- need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

- can** indicates that something is possible
- cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

- will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document is part of a series of documents that specify charging functionality and charging management in 3GPP networks. The 3GPP core network charging architecture and principles are specified in TS 32.240 [1].

The present document specifies the converged charging description for the time sensitive networking domain based on the functional stage 2 description in TS 23.501 [11], TS 23.502 [12] and TS 23.503 [13].

This charging description includes the converged charging architecture, principles, requirements and scenarios specific to the time sensitive networking, with focus on the following charging scenarios: .

- the TSN 5GS bridge configuration and management charging.
- the enabler for time sensitive communication and time synchronization charging.
- the time sensitive communication traffic charging.

It further specifies the structure and content of the CDRs and the charging events for converged charging.

All references, abbreviations, definitions, descriptions, principles and requirements, used in the present document, that are common across 3GPP TSs, are defined in TR 21.905 [8]. Those that are common across charging management in 3GPP networks/domains, services or subsystems are provided in the umbrella TS 32.240 [1] and are copied into clause 3 of the present document for ease of reading. Finally, those items that are specific to the present document are defined exclusively in the present document.

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*.

- [1] 3GPP TS 32.240: "Telecommunication management; Charging management; Charging architecture and principles".
- [2] 3GPP TS 32.254: "Telecommunication management; Charging management; Exposure function Northbound Application Program Interfaces (APIs) charging".
- [3] 3GPP TS 32.255: "Telecommunication management; Charging management; 5G Data connectivity domain charging; stage 2".
- [4] 3GPP TS 32.290: "Telecommunication management; Charging management; 5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".
- [5] 3GPP TS 32.291: "Telecommunication management; Charging management; 5G system; Charging service, stage 3".
- [6] 3GPP TS 32.297: "Telecommunication management; Charging management; Charging Data Record (CDR) file format and transfer".
- [7] 3GPP TS 32.298: "Telecommunication management; Charging management; Charging Data Record (CDR) parameter description".
- [8] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

- [9] 3GPP TS 22.104: "Service requirements for cyber-physical control applications in vertical domains".
- [10] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1".
- [11] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".
- [12] 3GPP TS 23.502: "Procedures for the 5G System".
- [13] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System; Stage 2".
- [14] 3GPP TS 24.519: "5G System (5GS); Time-Sensitive Networking (TSN) Application Function (AF) to Device-Side TSN Translator (DS-TT) and Network-Side TSN Translator (NW-TT) protocol aspects; Stage 3."
- [15] 3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [8] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [8].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

N104	Reference point between TSN AF and CHF
N105	Reference point between TSCTSF and CHF
N44	Reference point between the NEF and the CHF

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [8] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [8].

5GS	5G System
ASTI	Access Stratum Time
CNC	Centralized Network Configuration
DS-TT	Device-side TSN translator
NW-TT	Network-side TSN translator
TS	Time Synchronization
TSC	Time Sensitive Communications
TSCTSF	Time Sensitive Communication and Time Synchronization Function
TSN	Time Sensitive Networking
TSN AF	Time Sensitive Networking Application Function

4 Architecture considerations

4.1 High-level time sensitive networking architecture

The 5G system architecture references to support of integration with TSN and enablers for TSC and TS service are specified TS 23.501 [11] clause 5.27 and clause 5.28:

- 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 configuration of the 5GS Bridge can be provided by TSN AF and CNC.
- 5G System features that can be used independently or in combination to enable time-sensitive communication and time synchronization.

Figure 4.1.1 describes the architecture for 5GS appearing as TSN bridge, specified in clause 4.4.8.2 in TS 23.501 [11].

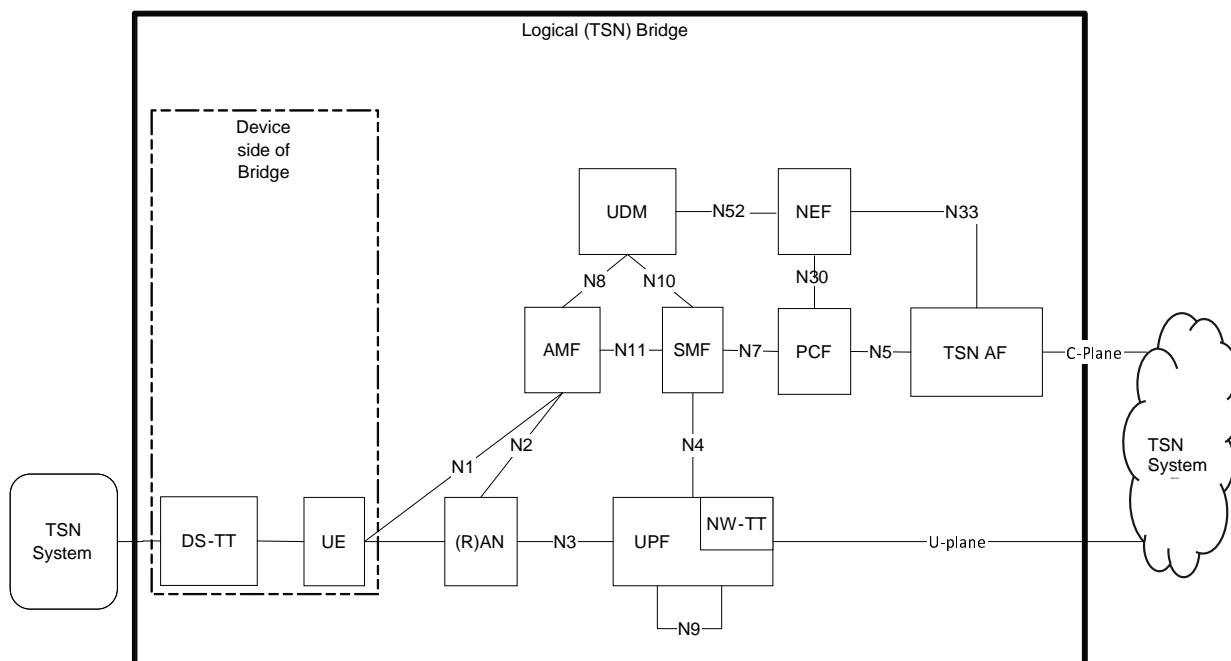


Figure 4.1.1: System architecture view with 5GS appearing as TSN bridge

Figure 4.1.2 describes the architecture for AF requested support of TSC and TS, specified in clause 4.4.8.3 in TS 23.501 [11].

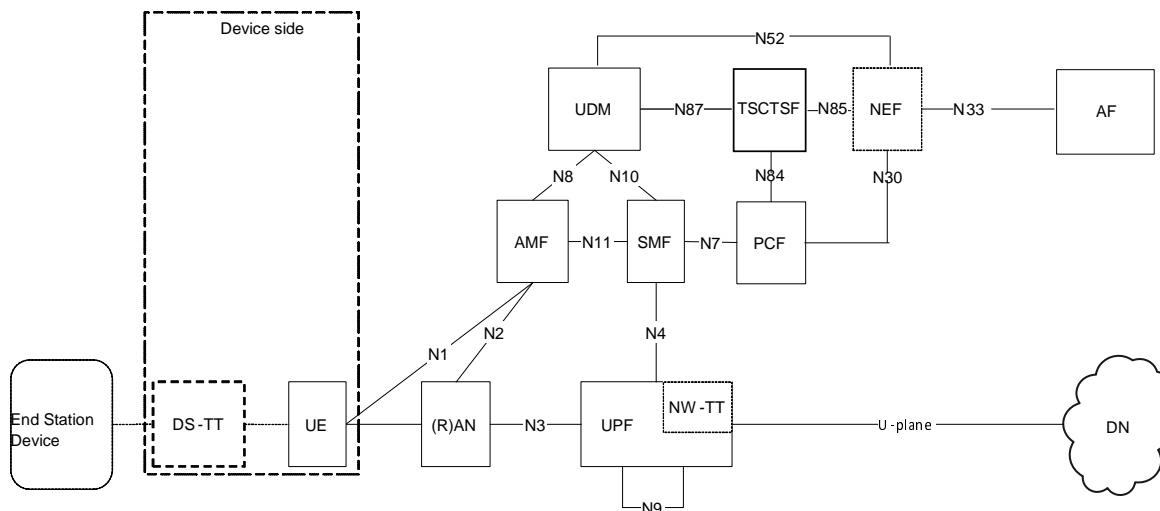


Figure 4.1.2: Architecture to enable Time Sensitive Communication and Time Synchronization services

4.2 Time sensitive networking converged charging architecture

Architectural options of Figure 4.2.1 apply to the TSN 5GS bridge configuration and management converged charging architectures.

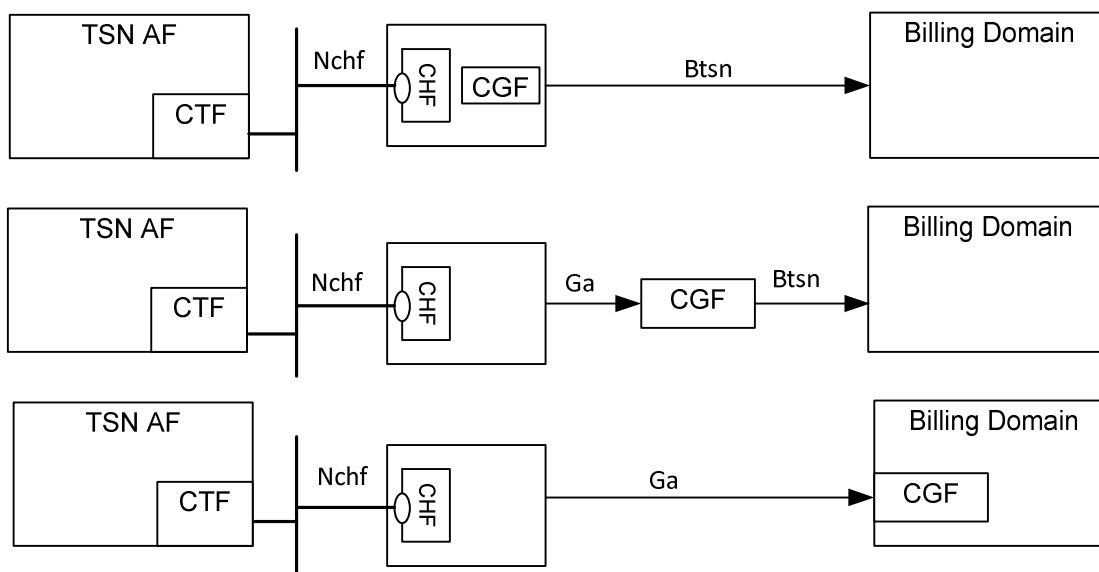


Figure 4.2.1: TSN 5GS bridge configuration and management converged charging architecture

Figure 4.2.2 depicts the TSN 5GS bridge configuration and management converged charging architecture in reference point representation for non-roaming. The N104 reference point is defined for the interactions between TSN AF and CHF.

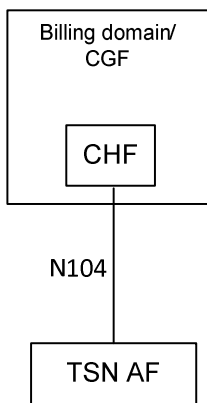


Figure 4.2.2: TSN 5GS bridge configuration and management converged charging architecture non-roaming reference point representation

Architectural options of Figure 4.2.3 apply to the enablers for TSC and TS converged charging architectures in this clause.

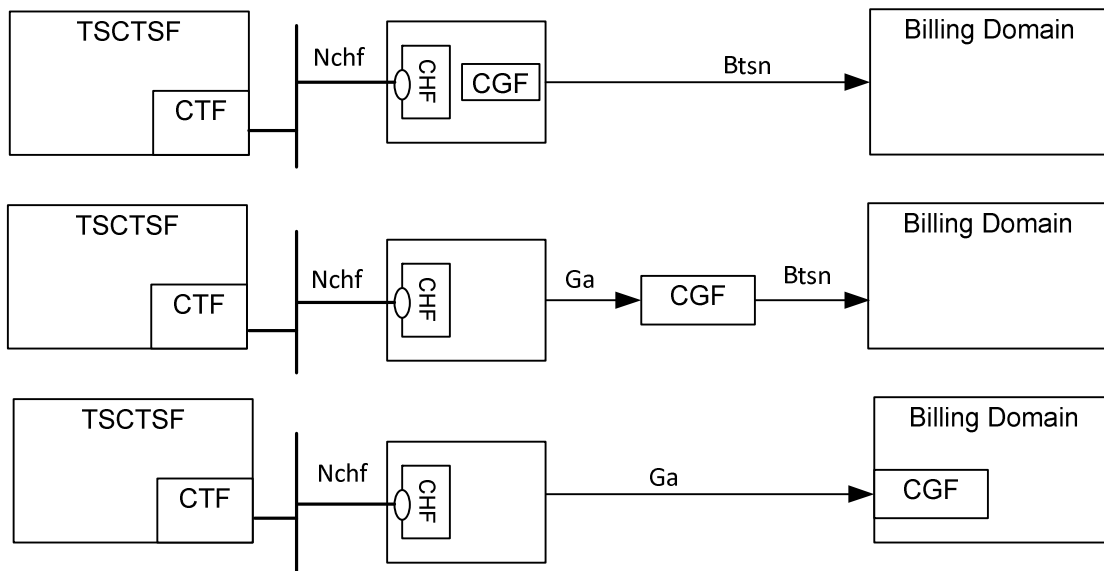


Figure 4.2.3: Enablers for TSC and TS converged charging architecture

Figure 4.2.4 depicts the enablers for TSC and TS converged charging architecture in reference point representation for non-roaming. The N105 reference point is defined for the interactions between TSCTSF and CHF.

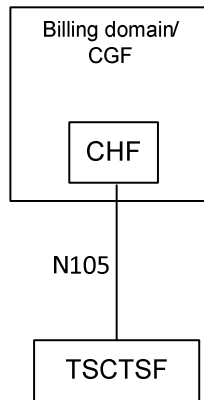


Figure 4.2.4: Enablers for TSC and TS converged charging architecture non-roaming reference point representation

The converged charging architecture specified in TS 32.254 [2] is applicable for the TSC and TS service exposure charging.

The converged charging architecture specified in TS 32.255 [3] is applicable for the TSC traffic charging. Ga is described in clause 5.2.4 and Btsn in clause 5.2.5 of the present document and Nchf is described in TS 32.290 [4].

5 Time sensitive networking charging principles and scenarios

5.1 Time sensitive networking charging principles

5.1.1 General

The charging functions specified for the TSN charging, are based on functionalities supported by TSN specified in TS 23.501 [11]:

- 5GS as TSN bridge, as specified in clause 5.28 in TS 23.501 [11].
- Enablers of TSC and TS service, as specified in clause 5.27 in TS 23.501 [11].

The charging functions specified for the TSN charging are:

- TSN 5GS bridge configuration and management charging.
- TSC and TS service enabler charging.
- TSC traffic charging.

5.1.2 Requirements

The following are high-level charging requirements specific to TSN domain, derived from requirements in TS 22.261 [10], TS 22.104 [9], TS 23.501 [11], TS 23.502 [12] and TS 23.503 [13].

- The TSN AF shall support converged charging.
- The TSN AF shall collect and report charging information for TSN 5GS bridge configuration and management.
- The TSCTSf shall support converged charging.
- The TSCTSf shall collect and report charging information for TSC and TS service enabler.

The requirements for SMF and NEF to support TSN charging are specified in the respective specifications, i.e. TS 32.255 [3] and TS 32.254 [2].

5.1.3 TSN charging information

The following is a non-exhaustive list related to one or more of the TSN information relevant to charging for TSN:

- 5GS bridge information as defined in clause 5.28 TS 23.501 [11].
- Time synchronization information as defined in clause 5.27 TS 23.501 [11].
- Time synchronization status information as defined in clause 5.27 TS 23.501 [11].
- QoS and TSC assistance information as defined in in clause 5.27 TS 23.501 [11].

5.1.4 CHF selection

The CHF selection by the TSN AF may be based on the following and with this priority order (highest to lowest):

- NRF based discovery.
- TSN AF locally provisioned charging characteristics.

The CHF selection by the TSCTSF may be based on the following and with this priority order (highest to lowest):

- NRF based discovery.
- TSCTSF locally provisioned charging characteristics.

The priority order for CHF selection may be changed by operator.

5.2 Time sensitive networking charging scenarios

5.2.1 Basic principles

5.2.1.0 General

5GS bridge configuration and management converged charging may be performed by TSN AF. The TSN AF shall be able to perform converged charging by interacting with CHF, for charging data related to 5GS bridge configuration and management, based on IEC, PEC or ECUR scenarios specified in TS 32.290 [4].

Service enablement of TSC and TS converged charging may be performed by TSCTSF. The TSCTSF shall be able to perform converged charging by interacting with CHF, for charging data related to TSC and TS service enabler, based on IEC, PEC or ECUR scenarios specified in TS 32.290 [4].

The contents and purpose of each charging event that triggers interaction with CHF, as well as the chargeable events that trigger them, are described in the following clauses.

A detailed formal description of the converged charging parameters defined in the present document is to be found in TS 32.291 [5].

A detailed formal description of the CDR parameters defined in the present document is to be found in TS 32.298 [7].

5.2.1.1 Applicable triggers in the TSN AF

Table 5.2.1.1.1 summarizes the set of default trigger conditions and their category which shall be supported by the TSN AF when charging is active for the corresponding 5GS bridge configuration and management (5GS BCM) functionality. For "immediate report" category, the table also provides the corresponding Charging Data Request message sent from TSN AF towards the CHF.

Table 5.2.1.1.1: Default Trigger conditions in TSN AF

Trigger Conditions	Trigger level	Default category	CHF allowed to change category	CHF allowed to enable and disable	Message when "immediate reporting" category
5GS BCM request received	-	Immediate	Not Applicable	Not Applicable	IEC/PEC: Charging Data Request [Event] ECUR: Charging Data Request [Initial]
5GS BCM response forwarded		Immediate	Not Applicable	Not Applicable	IEC/PEC: Charging Data Request [Event] ECUR: Charging Data Request [Termination]

5.2.1.2 Applicable triggers in the TSCTSF

Table 5.2.1.2.1 summarizes the set of default trigger conditions and their category which shall be supported by the TSCTSF when charging is active for the corresponding TSC and TS service enabler functionality. For "immediate report" category, the table also provides the corresponding Charging Data Request message sent from TSCTSF towards the CHF.

Table 5.2.1.2.1: Default Trigger conditions in TSCTSF

Trigger Conditions	Trigger level	Default category	CHF allowed to change category	CHF allowed to enable and disable	Message when "immediate reporting" category
AF request/subscribe received	-	Immediate	Not Applicable	Not Applicable	IEC/PEC: Charging Data Request [Event] ECUR: Charging Data Request [Initial]
Response to AF	-	Immediate	Not Applicable	Not Applicable	PEC: Charging Data Request [Event] ECUR: Charging Data Request [Termination]
Notification to AF		Immediate	Not Applicable	Not Applicable	IEC/PEC: Charging Data Request [Event] ECUR: Charging Data Request [Initial]
Notification acknowledgement		Immediate	Not Applicable	Not Applicable	PEC: Charging Data Request [Event] ECUR: Charging Data Request [Termination]

5.2.2 Message flows

5.2.2.1 General

The message flows in the present document specify the TSN charging functionality based on the TSN information from TSN AF and TSCTSF.

The message flows for SMF and NEF to support TSN charging functionality are specified in the respective specifications, i.e. TS 32.255 [3] and TS 32.254 [2].

5.2.2.2 TSN 5GS bridge configuration and management charging from TSN AF

5.2.2.2.1 General

This clause below describes the TSN 5GS bridge management and configuration charging from TSN AF.

5.2.2.2.2 TSN 5GS bridge configuration and management charging – IEC

The following figure 5.2.2.2.2-1 describes TSN 5GS bridge configuration and management charging from TSN AF in the IEC scenario.

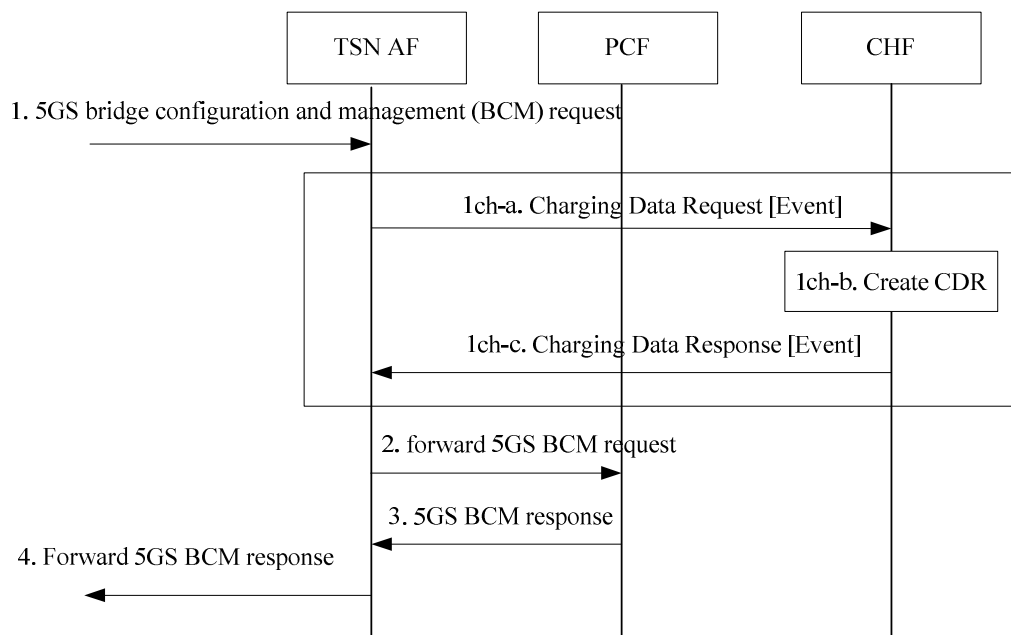


Figure 5.2.2.2.2-1: TSN 5GS bridge configuration and management charging from TSN AF --- IEC

1. Receive 5GS BCM request from CNC: TSN AF receives the information for 5GS bridge configuration and management from CNC, e.g. traffic forwarding information, port management information.

1ch-a. Charging Data Request [Event]: The TSN AF sends Charging Data Request [Event] to CHF, triggered by "5GS BCM request received.

1ch-b. Create CDR: The CHF creates a CDR for the 5GS bridge configuration and management charging.

1ch-c. Charging Data Response [Event]: The CHF acknowledges by sending Charging Data Response [Event] to the TSN AF.

2. Forward the 5GS BCM request to PCF: Based on the information received from CNC, TSN AF determines the TSC Assistance Container and TSN QoS information and sends them to the PCF, specified in clause 6.2.32 TS 23.501 [11] and clause 6.1.3.23 TS 23.503 [13].

3. Receive 5GS BCM response from PCF: TSN AF receives the event reporting from PCF with the 5GS bridge/router information that the PCF has received from the SMF, specified in clause 6.1.3.18 in TS 23.503 [13].

4. Forward 5GS BCM response to CNC: TSN AF constructs the above received information as 5GS bridge information and sends them to the CNC to register a new TSN bridge or update an existing TSN bridge.

5.2.2.2.3 TSN 5GS bridge configuration and management charging – PEC

The following figure 5.2.2.2.3-1 describes TSN 5GS bridge configuration and management charging from TSN AF in the PEC scenario.

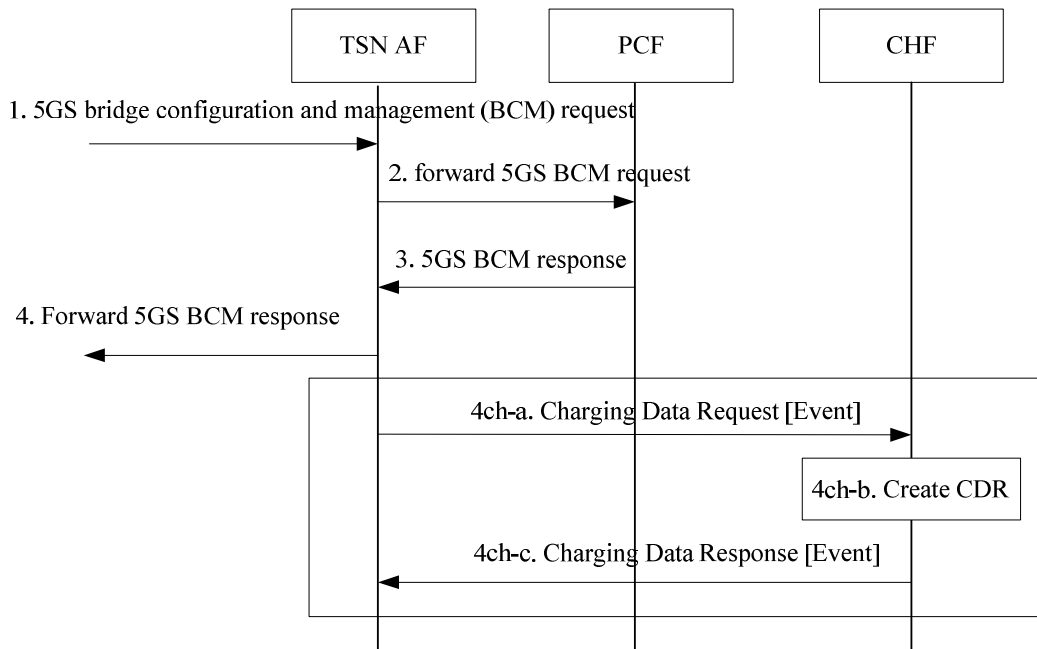


Figure 5.2.2.2.3-1: TSN 5GS bridge configuration and management charging from TSN AF --- PEC

- 1. Receive 5GS BCM request from CNC:** TSN AF receives the information for 5GS bridge configuration and management from CNC, e.g. traffic forwarding information, port management information.
- 2. Forward the 5GS BCM request to PCF:** Based on the information received from CNC, TSN AF determines the TSC Assistance Container and TSN QoS information and sends them to the PCF, specified in clause 6.2.32 TS 23.501 [11] and clause 6.1.3.23 TS 23.503 [13].
- 3. Receive 5GS BCM response from PCF:** TSN AF receives the event reporting from PCF with the 5GS bridge/router information that the PCF has received from the SMF, specified in clause 6.1.3.18 in TS 23.503 [13].
- 4. Forward 5GS BCM response to CNC:** TSN AF constructs the above received information as 5GS bridge information and sends them to the CNC to register a new TSN bridge or update an existing TSN bridge.
- 4ch-a. Charging Data Request [Event]:** The TSN AF sends Charging Data Request [Event] to CHF, triggered by "5GS BCM response forwarded".
- 4ch-b. Create CDR:** The CHF creates a CDR for the 5GS bridge configuration and management charging.
- 4ch-c. Charging Data Response [Event]:** The CHF acknowledges by sending Charging Data Response [Event] to the TSN AF.

5.2.2.2.4 TSN 5GS bridge configuration and management charging – ECUR

The following figure 5.2.2.2.4-1 describes TSN 5GS bridge configuration and management charging from TSN AF in the ECUR scenario.

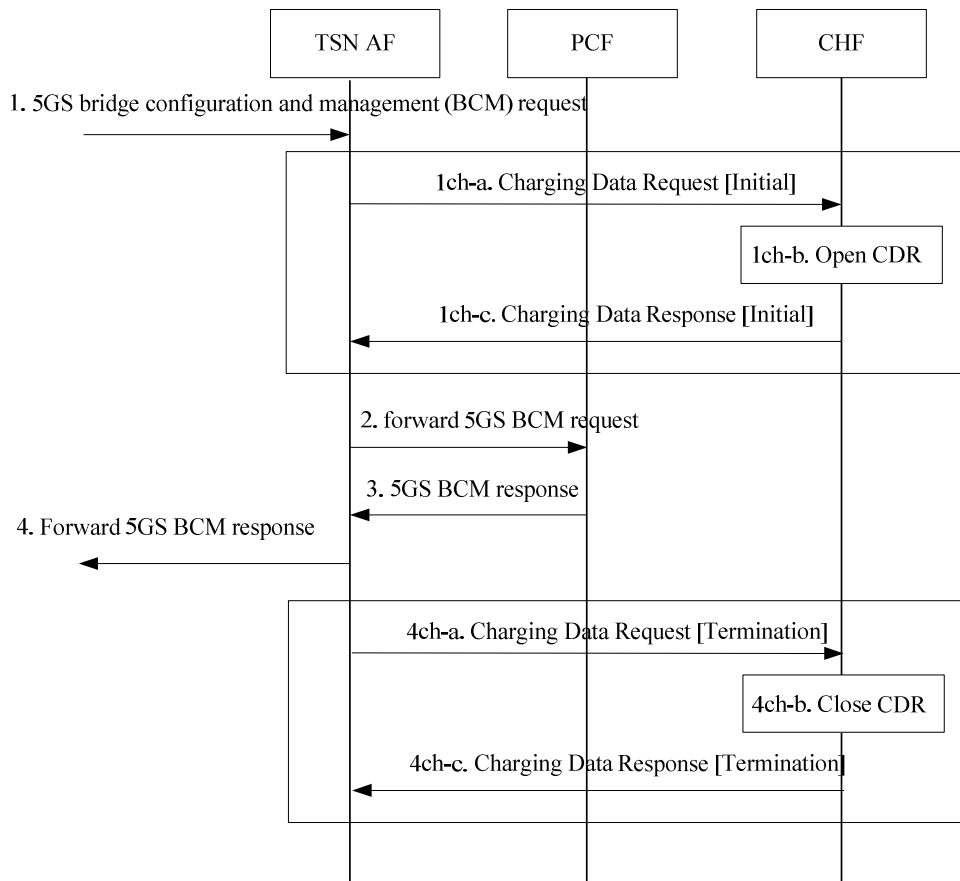


Figure 5.2.2.4-1: TSN 5GS bridge configuration and management charging from TSN AF --- ECUR

1. Receive 5GS BCM request from CNC: TSN AF receives the information for 5GS bridge configuration and management from CNC, e.g. traffic forwarding information, port management information.

1ch-a. Charging Data Request [Initial]: The TSN AF sends Charging Data Request [Initial] to CHF, triggered by "5GS BCM request received".

1ch-b. Open CDR: The CHF opens a CDR for the 5GS bridge configuration and management charging.

1ch-c. Charging Data Response [Initial]: The CHF acknowledges by sending Charging Data Response [Initial] to the TSN AF.

2. Forward the 5GS BCM request to PCF: Based on the information received from CNC, TSN AF determines the TSC Assistance Container and TSN QoS information and sends them to the PCF, specified in clause 6.2.32 TS 23.501 [11] and clause 6.1.3.23 TS 23.503 [13].

3. Receive 5GS BCM response from PCF: TSN AF receives the event reporting from PCF with the 5GS bridge/router information that the PCF has received from the SMF, specified in clause 6.1.3.18 in TS 23.503 [13].

4. Forward 5GS BCM response to CNC: TSN AF constructs the above received information as 5GS bridge information and sends them to the CNC to register a new TSN bridge or update an existing TSN bridge.

4ch-a. Charging Data Request [Termination]: The TSN AF sends Charging Data Request [Termination] to CHF, triggered by the "5GS BCM response forwarded".

4ch-b. Close CDR: The CHF close the CDR.

4ch-c. Charging Data Response [Termination]: The CHF acknowledges by sending Charging Data Response [Termination] to the TSN AF.

5.2.2.3 TSC and TS service enabler charging from TSCTSF

5.2.2.3.1 General

This clause below describes the message flow for TSC and TS service enabler charging from TSCTSF, when trusted AF interact with TSCTSF directly.

5.2.2.3.2 Time synchronization service charging – IEC

The following figure 5.2.2.3.2-1 describes time synchronization service charging from TSCTSF in the IEC scenario.

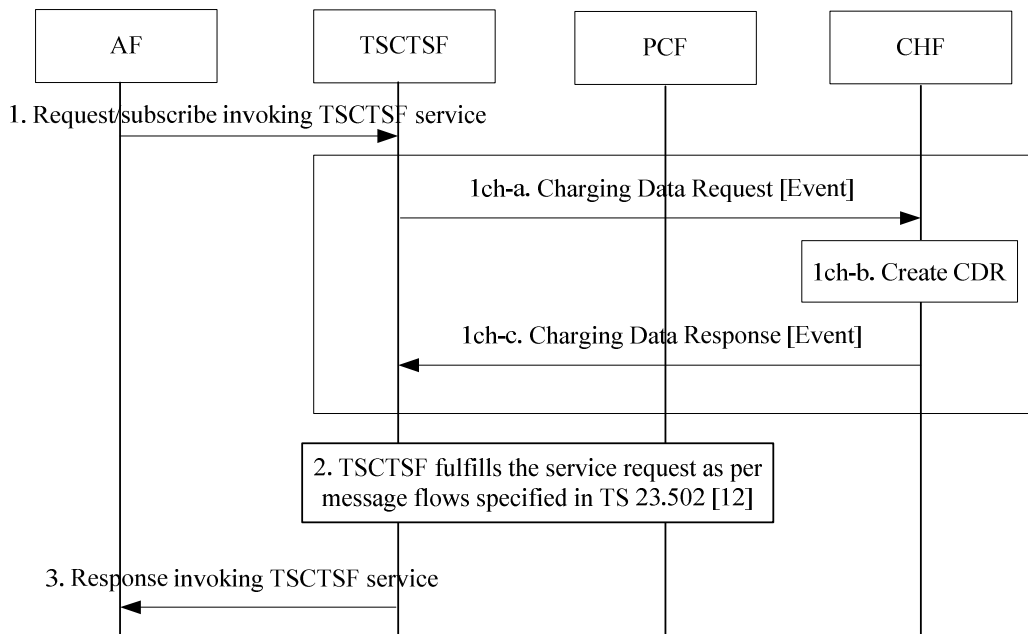


Figure 5.2.2.3.2-1: Time synchronization service charging from TSCTSF --- IEC

- 1. AF Request/Subscribe to TSCTSF service:** The TSCTSF receives a service request/subscribe message from an AF with the parameters as required by the NF service, e.g. time synchronization service (un)subscription, (de)activation, modification, defined in TS 23.502 [12] clause 4.15.9.
- 1ch-a. Charging Data Request [Event]:** The TSCTSF sends Charging Data Request [Event] to CHF, triggered by "AF request/subscribe received".
- 1ch-b. Create CDR:** The CHF creates a CDR for the request/subscribe of NF services provided by TSCTSF.
- 1ch-c. Charging Data Response [Event]:** The CHF acknowledges by sending Charging Data Response [Event] to the TSCTSF.
- 2. TSCTSF service fulfilment procedure:** TSCTSF performs the actions needed to fulfil the service request/subscribe, following the message flows for each scenario as specified in TS 23.502 [12].
- 3. Response to AF:** TSCTSF sends the service response message to inform AF.

5.2.2.3.3 Time synchronization service charging – PEC

The following figure 5.2.2.3.2-1 describes time synchronization service charging from TSCTSF in the PEC scenario.

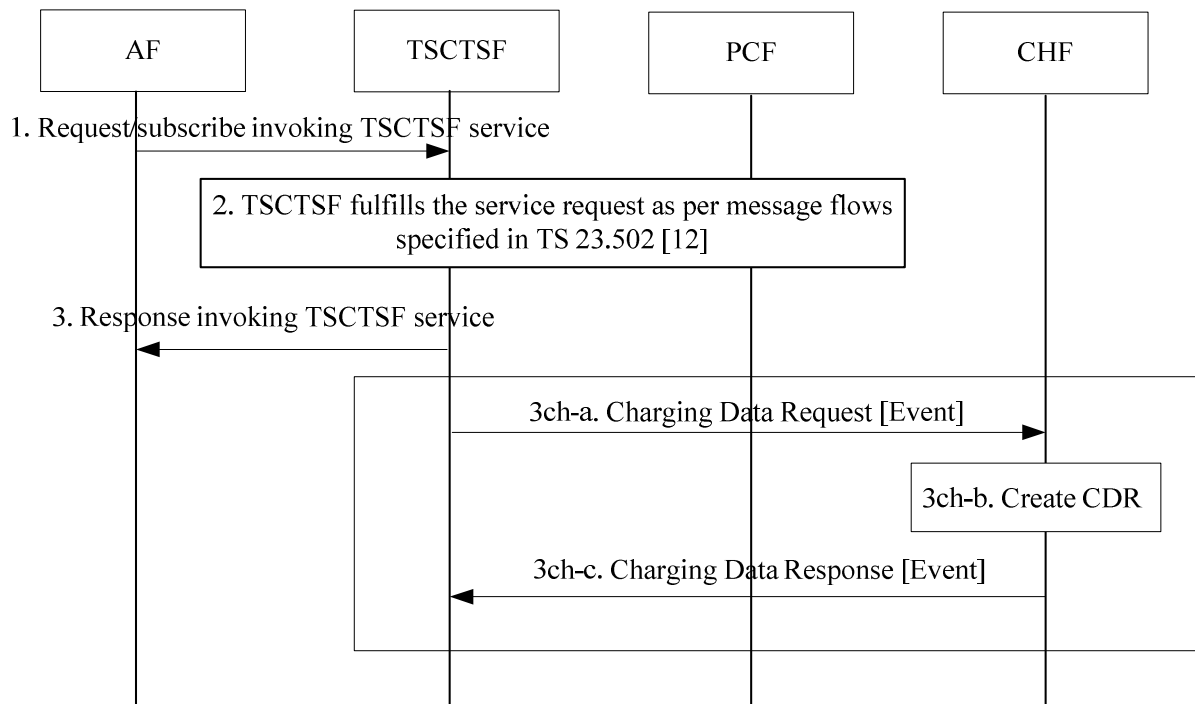


Figure 5.2.2.3.3-1: Time synchronization service charging from TSCTSF --- PCF

- 1. AF Request/Subscribe to TSCTSF service:** The TSCTSF receives a service request/subscribe message from an AF with the parameters as required by the NF service, e.g. time synchronization service (un)subscription, (de)activation, modification, defined in TS 23.502 [12] clause 4.15.9.
- 2. TSCTSF service fulfilment procedure:** TSCTSF performs the actions needed to fulfil the service request/subscribe, following the message flows for each scenario as specified in TS 23.502 [12].
- 3. Response to AF:** TSCTSF sends the service response message to inform AF.
- 3ch-a. Charging Data Request [Event]:** The TSCTSF sends Charging Data Request [Event] to CHF, triggered by "Response to AF".
- 3ch-b. Create CDR:** The CHF creates a CDR for the request/subscribe of NF services provided by TSCTSF.
- 3ch-c. Charging Data Response [Event]:** The CHF acknowledges by sending Charging Data Response [Event] to the TSCTSF.

5.2.2.3.4 Time synchronization service charging – ECUR

The following figure 5.2.2.3.2-1 describes time synchronization service charging from TSCTSF in the ECUR scenario.

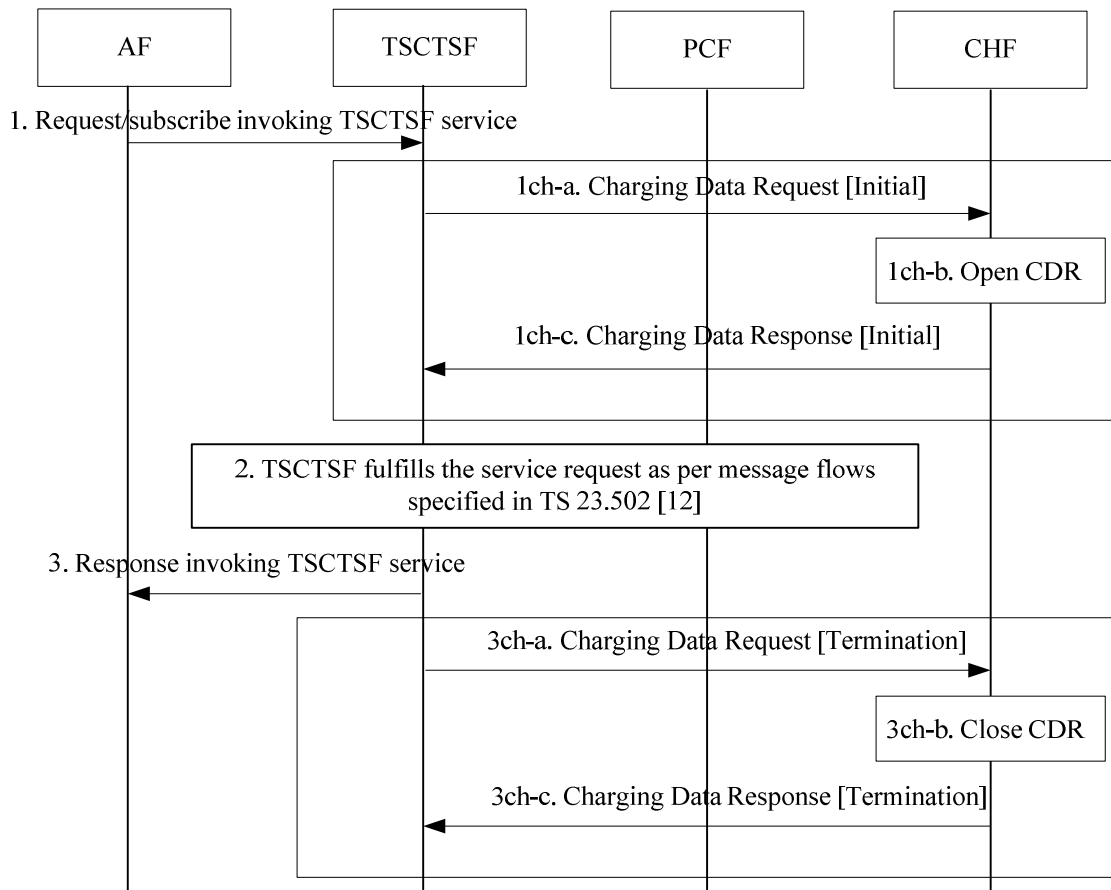


Figure 5.2.2.3.4-1: Time synchronization service charging from TSCTSF --- ECUR

- 1. AF Request/Subscribe to TSCTSF service:** The TSCTSF receives a service request/subscribe message from an AF with the parameters as required by the NF service, e.g. time synchronization service (un)subscription, (de)activation, modification, defined in TS 23.502 [12] clause 4.15.9.
- 1ch-a. Charging Data Request [Initial]:** The TSCTSF sends Charging Data Request [Initial] to CHF with requested unit, triggered by "AF request/subscribe received".
- 1ch-b. Open CDR:** The CHF opens a CDR for the request/subscribe of NF services provided by TSCTSF.
- 1ch-c. Charging Data Response [Initial]:** The CHF acknowledges by sending Charging Data Response [Initial] to the TSCTSF.
- 2. TSCTSF service fulfilment procedure:** TSCTSF performs the actions needed to fulfil the service request/subscribe, following the message flows for each scenario as specified in TS 23.502 [12].
- 3. Response to AF:** TSCTSF sends the service response message to inform AF.
- 4ch-a. Charging Data Request [Termination]:** The TSCTSF sends Charging Data Request [Termination] to CHF, triggered by "Response to AF".
- 4ch-b. Close CDR:** The CHF close the CDR.
- 4ch-c. Charging Data Response [Termination]:** The CHF acknowledges by sending Charging Data Response [Termination] to the TSCTSF.

5.2.2.3.5 QoS and TSC assistance service charging – IEC

The following figure 5.2.2.3.5-1 describes QoS and TSC assistance service charging from TSCTSF in the IEC scenario.

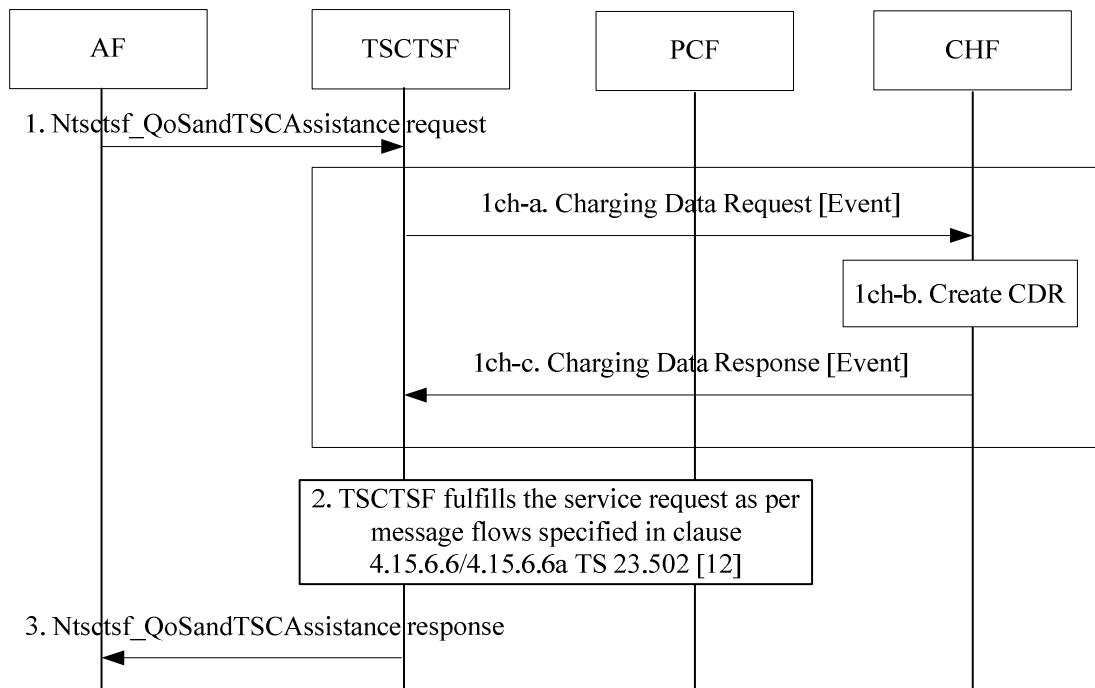


Figure 5.2.2.3.5-1: QoS and TSC assistance service charging from TSCTSF --- IEC

- 1. Ntsctsf_QoSandTSCAssistance request:** the TSCTSF receives a Ntsctsf_QoSandTSCAssistance service request/subscribe message from an AF with the parameters as required by the NF service, e.g. AF session with required QoS, defined in TS 23.502 [12] clause 4.15.6.6.
- 1ch-a. Charging Data Request [Event]:** The TSCTSF sends Charging Data Request [Event] to CHF, triggered by "AF request/subscribe received".
- 1ch-b. Create CDR:** The CHF creates a CDR for the request/subscribe of NF services provided by TSCTSF.
- 1ch-c. Charging Data Response [Event]:** The CHF acknowledges by sending Charging Data Response [Event] to the TSCTSF.
- 2. TSCTSF service fulfilment procedure:** TSCTSF performs the actions needed to fulfil the service request/subscribe, following the message flows for each scenario as specified in clause 4.15.6.6/4.15.6.6a TS 23.502 [12].
- 3. Ntsctsf_QoSandTSCAssistance response:** TSCTSF sends the Ntsctsf_QoSandTSCAssistance service response message to inform AF.

5.2.2.3.6 QoS and TSC assistance service charging – PEC

The following figure 5.2.2.3.6-1 describes QoS and TSC assistance service charging from TSCTSF in the PEC scenario.

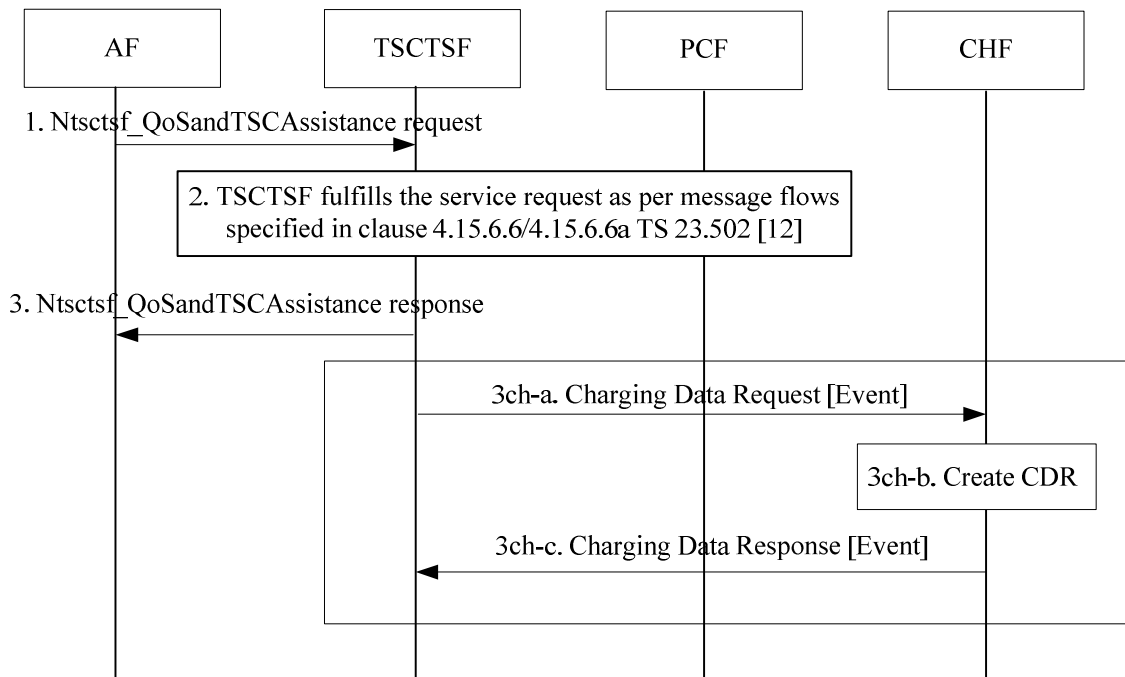


Figure 5.2.2.3.6-1: QoS and TSC assistance service charging from TSCTSF --- PEC

- 1. Ntsctsf_QoSandTSCAssistance request:** The TSCTSF receives a Ntsctsf_QoSandTSCAssistance service request/subscribe message from an AF with the parameters as required by the NF service, e.g. AF session with required QoS, defined in TS 23.502 [12] clause 4.15.6.6.
- 2. TSCTSF service fulfilment procedure:** TSCTSF performs the actions needed to fulfil the service request/subscribe, following the message flows for each scenario as specified in clause 4.15.6.6/4.15.6.6a TS 23.502 [12].
- 3. Ntsctsf_QoSandTSCAssistance response:** TSCTSF sends the Ntsctsf_QoSandTSCAssistance service response message to inform AF.
- 3ch-a. Charging Data Request [Event]:** The TSCTSF sends Charging Data Request [Event] to CHF, triggered by "Response to AF".
- 3ch-b. Create CDR:** The CHF creates a CDR for the request/subscribe of NF services provided by TSCTSF.
- 3ch-c. Charging Data Response [Event]:** The CHF acknowledges by sending Charging Data Response [Event] to the TSCTSF.

5.2.2.3.7 QoS and TSC assistance service charging – ECUR

The following figure 5.2.2.3.7-1 describes QoS and TSC assistance service charging from TSCTSF in the ECUR scenario.

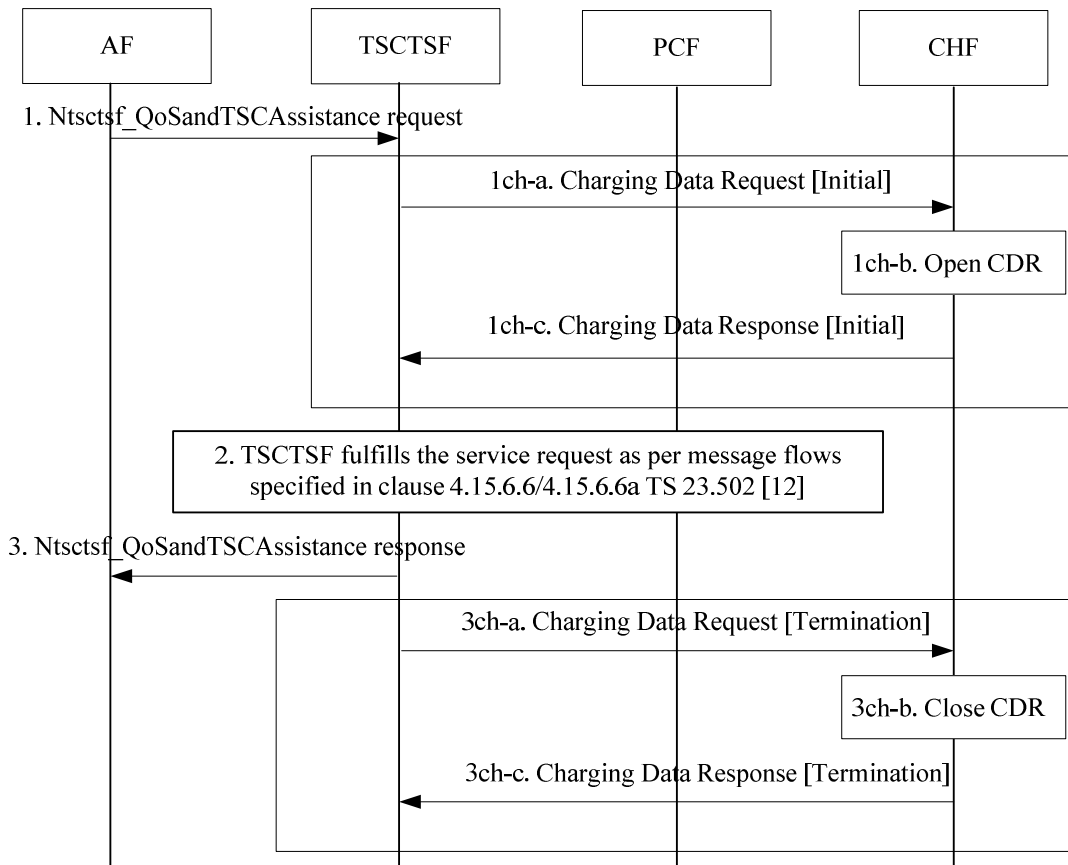


Figure 5.2.2.3.7-1: QoS and TSC assistance service charging from TSCTSF --- ECUR

- 1. Ntsctsf_QoSandTSCAssistance request:** The TSCTSF receives a Ntsctsf_QoSandTSCAssistance service request/subscribe message from an AF with the parameters as required by the NF service, e.g. AF session with required QoS, defined in TS 23.502 [12] clause 4.15.6.6.
- 1ch-a. Charging Data Request [Initial]:** The TSCTSF sends Charging Data Request [Initial] to CHF with requested unit, triggered by "AF request/subscribe received".
- 1ch-b. Open CDR:** The CHF opens a CDR for the request/subscribe of NF services provided by TSCTSF.
- 1ch-c. Charging Data Response [Initial]:** The CHF acknowledges by sending Charging Data Response [Initial] to the TSCTSF.
- 2. TSCTSF service fulfilment procedure:** TSCTSF performs the actions needed to fulfil the service request/subscribe, following the message flows for each scenario as specified in clause 4.15.6.6/4.15.6.6a TS 23.502 [12].
- 3. Ntsctsf_QoSandTSCAssistance response:** TSCTSF sends the Ntsctsf_QoSandTSCAssistance service response message to inform AF.
- 3ch-a. Charging Data Request [Termination]:** The TSCTSF sends Charging Data Request [Termination] to CHF, triggered by "Response to AF".
- 3ch-b. Close CDR:** The CHF close the CDR.
- 3ch-c. Charging Data Response [Termination]:** The CHF acknowledges by sending Charging Data Response [Termination] to the TSCTSF.

5.2.2.3.8 TSC and TS service notification charging – IEC

The following figure 5.2.2.3.8-1 describes TSC and TS service notification charging from TSCTSF in the IEC scenario.

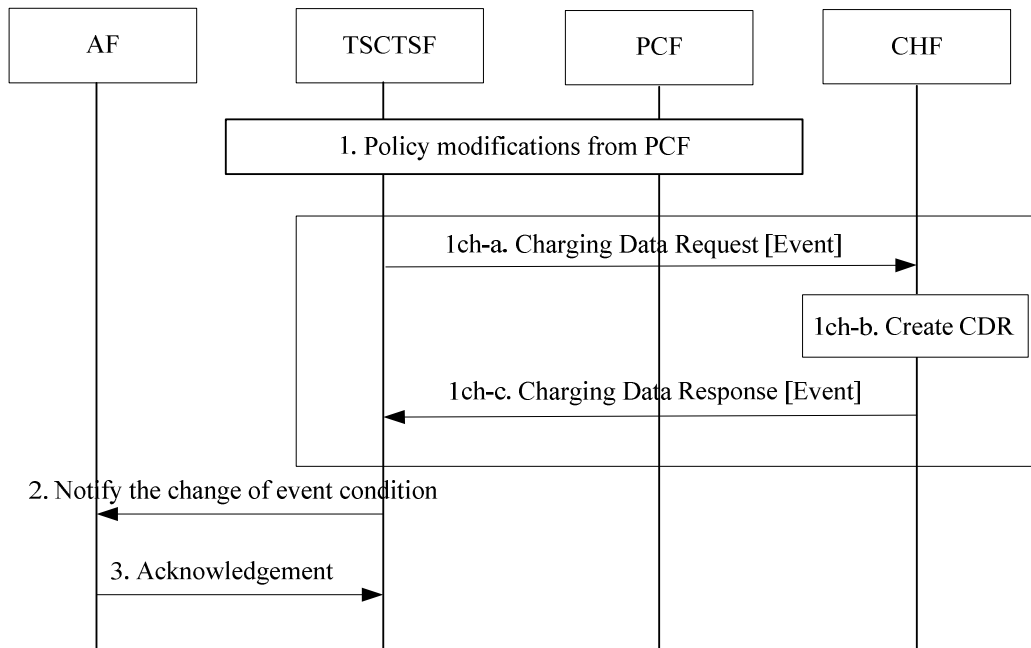


Figure 5.2.2.3.8-1: TSC and TS service notification charging from TSCTSF --- IEC

1. Policy modification: The TSCTSF keeps notify of the policy modifications from PCF.

1ch-a. Charging Data Request [Event]: The TSCTSF sends Charging Data Request [Event] to CHF, triggered by "Notification to AF".

1ch-b. Create CDR: The CHF creates a CDR for the notify message provided by TSCTSF.

1ch-c. Charging Data Response [Event]: The CHF acknowledges by sending Charging Data Response [Event] to the TSCTSF.

2. TSCTSF notify the change of event condition to AF: Upon the reception of a change in the NG-RAN and/or NW-TT timing synchronization status update, the TSCTSF shall determine if the UE is impacted for time synchronization service, if yes, the TSCTSF sends a notify message to the AF with the change of event condition.

In case of QoS and TSC assistance service, the change of event condition may be modification of the transmission resources corresponding to the QoS update succeeded or failed, an alternative service requirement is being applied, etc.

In case of time synchronization service, the change of event condition may be updated time synchronization capabilities based on the capability information received from the DS-TT(s) and NW-TT, UE moves in or out of the Area of Interest based on updated spatial validity condition, etc.

3. Acknowledgement: the AF acknowledges the reception of the notification.

5.2.2.3.9 TSC and TS service notification charging – PEC

The following figure 5.2.2.3.9-1 describes TSC and TS service notification charging from TSCTSF in the PEC scenario.

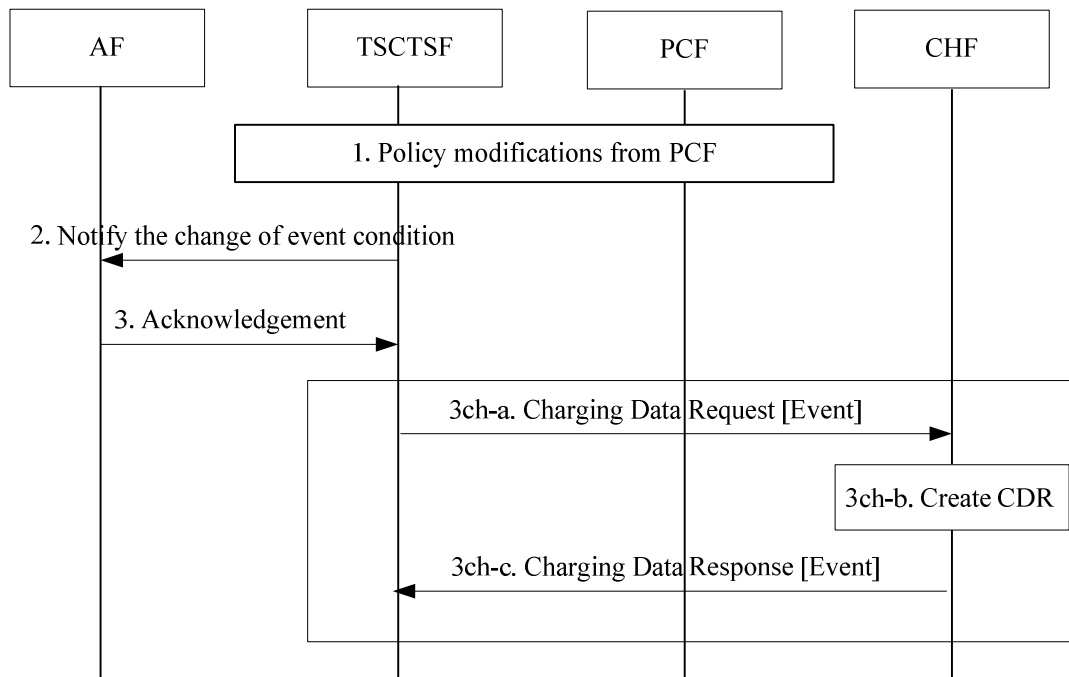


Figure 5.2.2.3.9-1: TSC and TS service notification charging from TSCTSF --- PEC

- 1. Policy modification:** The TSCTSF keeps notify of the policy modifications from PCF.
- 2. TSCTSF notify the change of event condition to AF:** Upon the reception of a change in the NG-RAN and/or NW-TT timing synchronization status update, the TSCTSF shall determine if the UE is impacted for time synchronization service, if yes, the TSCTSF sends a notify message to the AF with the change of event condition.

In case of QoS and TSC assistance service, the change of event condition may be modification of the transmission resources corresponding to the QoS update succeeded or failed, an alternative service requirement is being applied, etc.

In case of time synchronization service, the change of event condition may be updated time synchronization capabilities based on the capability information received from the DS-TT(s) and NW-TT, UE moves in or out of the Area of Interest based on updated spatial validity condition, etc.

- 3. Acknowledgement:** the AF acknowledges the reception of the notification.

3ch-a. Charging Data Request [Event]: The TSCTSF sends Charging Data Request [Event] to CHF, triggered by "Notification acknowledgement".

3ch-b. Create CDR: The CHF creates a CDR for the notify message provided by TSCTSF.

3ch-c. Charging Data Response [Event]: The CHF acknowledges by sending Charging Data Response [Event] to the TSCTSF.

5.2.2.3.10 TSC and TS service notification charging – ECUR

The following figure 5.2.2.3.10-1 describes TSC and TS service notification charging from TSCTSF in the ECUR scenario.

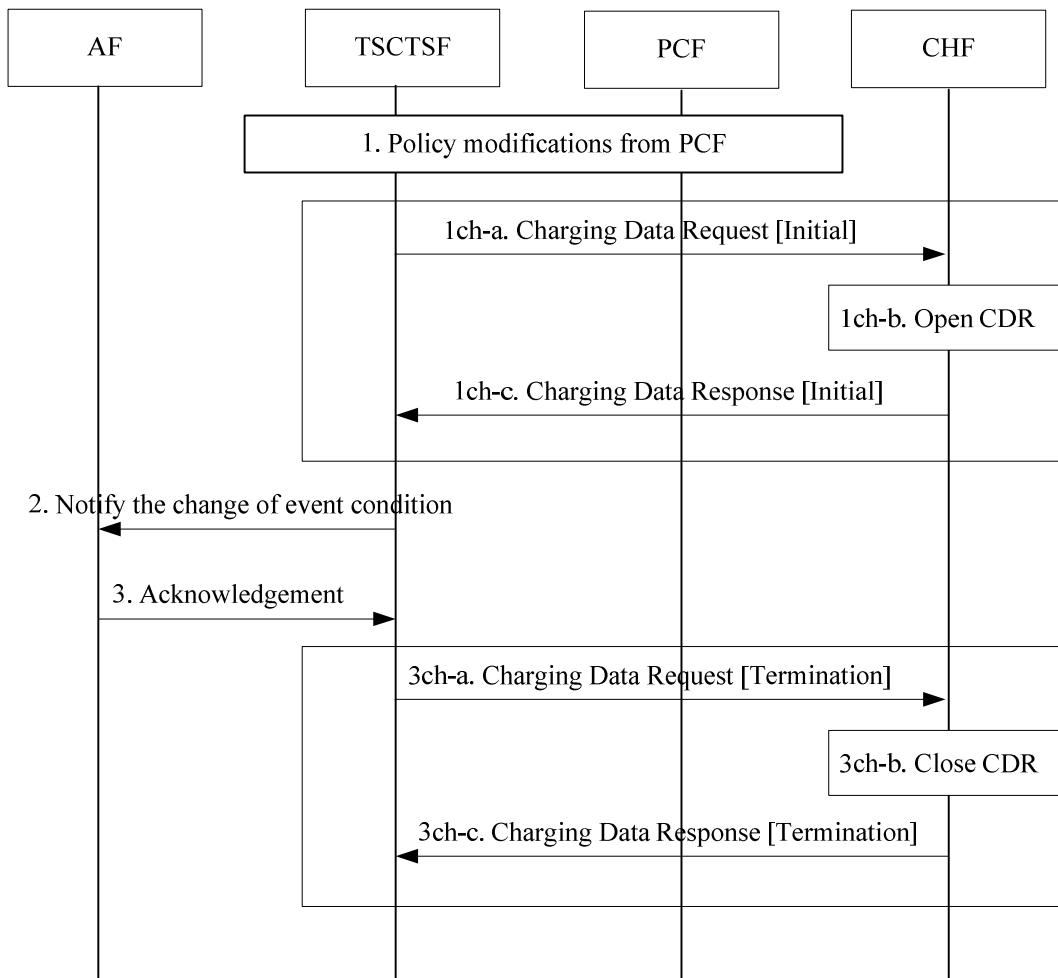


Figure 5.2.2.3.9-1: TSC and TS service notification charging from TSCTSF --- ECUR

1. Policy modification: The TSCTSF keeps notify of the policy modifications from PCF.

1ch-a. Charging Data Request [Initial]: The TSCTSF sends Charging Data Request [Initial] to CHF, triggered by "Notification to AF".

1ch-b. Open CDR: The CHF opens a CDR for the notify message provided by TSCTSF.

1ch-c. Charging Data Response [Initial]: The CHF acknowledges by sending Charging Data Response [Initial] to the TSCTSF.

2. TSCTSF notify the change of event condition to AF: Upon the reception of a change in the NG-RAN and/or NW-TT timing synchronization status update, the TSCTSF shall determine if the UE is impacted for time synchronization service, if yes, the TSCTSF sends a notify message to the AF with the change of event condition.

In case of QoS and TSC assistance service, the change of event condition may be modification of the transmission resources corresponding to the QoS update succeeded or failed, an alternative service requirement is being applied, etc.

In case of time synchronization service, the change of event condition may be updated time synchronization capabilities based on the capability information received from the DS-TT(s) and NW-TT, UE moves in or out of the Area of Interest based on updated spatial validity condition, etc.

3. Acknowledgement: The AF acknowledges the reception of the notification.

3ch-a. Charging Data Request [Termination]: The TSCTSF sends Charging Data Request [Termination] to CHF, triggered by "Notification acknowledgement".

3ch-b. Close CDR: The CHF closes a CDR for the notify message provided by TSCTSF.

3ch-c. Charging Data Response [Termination]: The CHF acknowledges by sending Charging Data Response [Termination] to the TSCTSF.

5.2.3 CDR generation

5.2.3.0 General

The CHF CDRs for TSN charging are generated by the CHF to collect charging information that they subsequently transfer to the Charging Gateway Function (CGF).

The CHF CDRs can be per individual subscriber or per TSN subscriber.

The following clauses describe in detail the conditions for generating the CHF CDR, which shall be supported by the CHF.

5.2.3.1 Triggers for CHF CDR

5.2.3.1.1 General

A TSN charging CHF CDR is used to capture charging information related to TSN chargeable events for PEC, IEC and ECUR scenarios.

5.2.3.1.2 Triggers for CHF CDR generation

A TSN charging CHF CDR is generated by the CHF for each received Charging Data Request [Event].

5.2.3.1.3 Triggers for CHF CDR opening

A CHF CDR shall be opened when the CHF receives Charging Data Request [Initial] with charging information added.

5.2.3.1.4 Triggers for CHF CDR closure

When the CHF receives Charging Data Request [Termination], the charging information shall be added in the CHF CDR and the CDR shall be closed.

5.2.4 Ga record transfer flows

Details of the Ga protocol application are specified in TS 32.295 [15].

5.2.5 Btsn CDR file transfer

Details of the Btsn protocol application are specified in TS 32.297 [6].

6 Definition of charging information

6.1 Data description for time sensitive networking charging

6.1.1 Message contents

6.1.1.1 General

The Charging Data Request and Charging Data Response are specified in subclause 5.1.2.2.1 of TS 32.290 [4].

Table 6.1.1.1-1 describes the use of these messages for time sensitive networking charging.

Table 6.1.1.1-1: Time sensitive networking charging messages reference table

Message	Source	Destination
Charging Data Request	TSCTSF, TSN AF	CHF
Charging Data Response	CHF	TSCTSF, TSN AF

NOTE: The SMF and NEF as source for TSN charging message is described in the respective specification.

The following clauses describe the different fields used in the Charging Data messages and the category in the tables is used according to the charging data configuration defined in clause 5.4 of TS 32.240 [1].

6.1.1.2 Charging Data Request message

Table 6.1.1.2-1 illustrates the basic structure of a Charging Data Request message from the TSN AF or TSCTSF as used for time sensitive networking charging.

Table 6.1.1.2-1: Charging Data Request message contents

Information Element	Converged Charging Category	Description
Session Identifier	O _C	Described in TS 32.290 [4].
Tenant Identifier	O _M	Described in TS 32.290 [4] and indicates AF identifier.
NF Consumer Identification	M	Described in TS 32.290 [4] and holds the identifier of the TSN AF or TSCTSF.
NF Functionality	M	Described in TS 32.290 [4].
NF Name	O _C	Described in TS 32.290 [4].
NF Address	O _C	Described in TS 32.290 [4].
NF PLMN ID	O _C	Described in TS 32.290 [4].
Charging Identifier	O _M	Described in TS 32.290 [4].
Invocation Timestamp	M	Described in TS 32.290 [4].
Invocation Sequence Number	M	Described in TS 32.290 [4].
Retransmission Indicator	O _C	Described in TS 32.290 [4].
One-time Event	O _C	Described in TS 32.290 [4].
One-time Event Type	O _C	Described in TS 32.290 [4].
Supported Features	O _C	Described in TS 32.290 [4].
Service Specification Information	O _C	Described in TS 32.290 [4].
TSN Charging Information	O _M	This field holds TSN specific information described in clause 6.2.1.2.

6.1.1.3 Charging Data Response message

Table 6.1.1.3-1 illustrates the basic structure of a Charging Data Response message from the CHF to the TSN AF or TSCTSF as used for time sensitive networking charging.

Table 6.1.1.3-1: Charging Data Response message contents

Information Element	Category for converged charging	Description
Session Identifier	O _C	Described in TS 32.290 [4].
Invocation Timestamp	M	Described in TS 32.290 [4].
Invocation Result	O _C	Described in TS 32.290 [4].
Invocation Result	O _C	Described in TS 32.290 [4].
Failed parameter	O _C	Described in TS 32.290 [4].
Failure Handling	O _C	Described in TS 32.290 [4].
Invocation Sequence Number	M	Described in TS 32.290 [4].
Session Failover	O _C	Described in TS 32.290 [4].
Supported Features	O _C	Described in TS 32.290 [4].

6.1.2 Ga message contents

Details of the Ga message contents are specified in TS 32.295 [15].

6.1.3 CDR description on the B_{tsn} interface

6.1.3.1 General

This clause describes the CDR content and format generated for time sensitive networking charging.

The following tables provide a brief description of each CDR parameter. The category in the tables is used according to the charging data configuration defined in clause 5.4 of TS 32.240 [1]. Full definitions of the CDR parameters, sorted by the name in alphabetical order, are provided in TS 32.298 [7].

6.1.3.2 Time sensitive networking charging CHF CDR data

If enabled, CHF CDRs for time sensitive networking charging shall be produced for each AF.

The fields of TSN charging CHF CDR are specified in table 6.1.3.2-1.

Table 6.1.3.2-1: Time sensitive networking charging CHF record data

Field	Category	Description
Record Type	M	Described in TS 32.298 [7].
Recording Network Function ID	O _M	Described in TS 32.298 [7].
Tenant Identifier	O _C	This field holds the AF Identifier.
NF Consumer Information	M	This field holds the information of the TSN AF or TSCTSF. that used the charging service.
NF Functionality	M	Described in TS 32.298 [7].
NF Name	O _C	Described in TS 32.298 [7].
NF Address	O _C	Described in TS 32.298 [7].
NF PLMN ID	O _C	Described in TS 32.298 [7].
Record Opening Time	M	Described in TS 32.298 [7].
Duration	M	Described in TS 32.298 [7].
Record Sequence Number	C	Described in TS 32.298 [7].
Cause for Record Closing	M	Described in TS 32.298 [7].
Local Record Sequence Number	O _M	Described in TS 32.298 [7].
Record Extensions	O _C	Described in TS 32.298 [7].
TSN Charging Information	O _M	This field holds the time sensitive networking charging information defined in clause 6.2.1.2.

6.2 Time sensitive networking charging specific parameters

6.2.1 Definition of time sensitive networking charging information

6.2.1.1 General

The Charging Information parameter used for time sensitive networking charging is provided in the following clauses.

6.2.1.2 Definition of TSN Charging Information

Specific charging information for TSN charging is provided within the TSN Charging Information.

The detailed structure of the TSN Charging Information can be found in table 6.2.1.2-1.

Table 6.2.1.2-1: Structure of TSN Charging Information

Information Element	Category	Description
DNN	O _C	This field holds data network name the AF belongs to.
S-NSSAI	O _C	This field holds network slice information the AF belongs to.
Internal Group Identifier	O _C	This field holds a group of UE represented by Internal Group Identifier(s) that the AF request is targeted for.
External Individual Id List	O _C	This field holds one or more individual UE(s) that the AF request is targeted for.
5GS Bridge Information	O _C	This parameter holds the information for TSN 5GS bridge, defined in clause 6.2.1.3.
TSN QoS Information	O _C	This parameter holds the information for TSN QoS, defined in clause 6.2.1.4.
TSC Assistance Information	O _C	This parameter holds the information for TSC Assistance, defined in clause 6.2.1.5.
Time Synchronization Information	O _C	This parameter holds the information for Time Synchronization, defined in clause 6.2.1.6.

6.2.1.3 Definition of 5GS Bridge Information

The detailed structure of the 5GS Bridge Information can be found in table 6.2.1.3-1.

Table 6.2.1.3-1: Structure of 5GS Bridge Information

Information Element	Category	Description
Bridge ID	M	This parameter holds the identifier of a TSN 5GS bridge.
NW-TT port numbers	O _M	This parameter holds the port number of NW-TT.
DS-TT port number	O _M	This parameter holds the port number of DS-TT.

6.2.1.4 Definition of TSN QoS Information

The detailed structure of TSN QoS Information can be found in table 6.2.1.4-1.

Table 6.2.1.4-1: Structure of TSN QoS Information

Information Element	Category	Description
Priority	O _M	This parameter indicates the priorities per port.
Bridge Delay	O _M	This parameter indicates 5GS independentDelayMin and independentDelayMax values for each port pair and for each traffic class using: UE-DS-TT Residence Time, and Per traffic class minimum and maximum delays between the UE and the UPF/NW-TT.

6.2.1.5 Definition of TSC Assistance Information

The detailed structure of TSC Assistance Information can be found in table 6.2.1.4-1.

Table 6.2.1.4-1: Structure of TSC Assistance Information

Information Element	Category	Description
Flow Direction	O _M	This parameter indicates the direction of the TSC flow, i.e. uplink or downlink.
Periodicity	O _M	This parameter indicates the time period between start of two data bursts.

6.2.1.6 Definition of Time Synchronization Information

The detailed structure of the Time Synchronization Information can be found in table 6.2.1.6-1.

Table 6.2.1.6-1: Structure of Time Synchronization Information

Information Element	Category	Description
Distribution method of timing information	O _M	This parameter indicates the distribution method of timing information, defined in clause 5.27.1.9 in TS 23.501 [11].
TSN time domain number	O _C	This parameter 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, defined in Annex K.1 in TS 23.501 [11].
Temporal validity information	O _C	This parameter indicates the duration when the time synchronization service is active for the targeted AF sessions, defined in clause 5.27.1.11 in TS 23.501 [11].
Spatial validity information	O _C	This parameter indicates the geographical area (e.g. a civic address or shapes) or a TA list in which time synchronization service is enabled for the targeted AF sessions, defined in clause 5.27.1.10 in TS 23.501 [11].
Time synchronization error budget	O _C	This parameter indicates the time synchronization budget for the time synchronization service, defined in clause 5.27.1.9 in TS 23.501 [11].
Synchronization state	O _C	This parameter indicates the state of the node synchronization, defined in clause 5.27.1.12 TS 23.501 [11].
Clock quality	O _C	This parameter holds the quality information of clock, including traceability to GNSS, traceability to UTC, frequency stability, clock accuracy, defined in clause 5.27.1.12 TS 23.501 [11].
Parent time source	O _C	This parameter indicates the primary source the node is currently using, defined in clause 5.27.1.12 TS 23.501 [11].

6.2.2 Formal time sensitive networking charging parameter description

6.2.2.1 Time sensitive networking CHF CDR parameters

The detailed definitions, abstract syntax and encoding of time sensitive networking CHF CDRs parameters are specified in TS 32.298 [7].

6.2.2.2 Time sensitive networking resources attributes

The detailed definitions of resources attributes used for time sensitive networking charging are specified in TS 32.291 [5].

6.2.3 Detailed message format for converged charging

The following clause specifies per Operation Type the charging data that are sent by CEF for time sensitive networking converged charging.

The Operation Types are listed in the following order: I (Initial)/T (Termination)/E (Event). Therefore, when all Operation Types are possible it is marked as ITE. If only some Operation Types are allowed for a node, only the appropriate letters are used (i.e. IT or E) as indicated in the table heading. The omission of an Operation Type for a particular field is marked with "-" (i.e. I-E). Also, when an entire field is not allowed in a node the entire cell is marked as "-".

Table 6.2.3-1 defines the basic structure of the supported fields in the *Charging Data Request* message for TSN AF or TSCTSF converged charging.

Table 6.2.3-1: Supported fields in *Charging Data Request* message

Information Element	Time Sensitive Networking	TSN AF	TSCTSF
	Supported Operation Types	I/T/E	I/T/E
Session Identifier		ITE	ITE
Tenant Identifier		ITE	ITE
NF Consumer Identification		ITE	ITE
NF Functionality		ITE	ITE
NF Name		ITE	ITE
NF Address		ITE	ITE
NF PLMN ID		ITE	ITE
Charging Identifier		ITE	ITE
Invocation Timestamp		ITE	ITE
Invocation Sequence Number		ITE	ITE
Retransmission Indicator		ITE	ITE
One-time Event		--E	--E
One-time Event Type		--E	--E
Supported Features		ITE	ITE
Service Specification Information		ITE	ITE
TSN Charging Information		ITE	ITE

Table 6.2.3-2 defines the basic structure of the supported fields in the *Charging Data Response* message for TSN or TSCTSF converged charging.

Table 6.2.3-2: Supported fields in *Charging Data Response* message

Information Element	Time Sensitive Networking	TSN AF	TSCTSF
	Supported Operation Types	ITE	ITE
Session Identifier		ITE	ITE
Invocation Timestamp		ITE	ITE
Invocation Result		ITE	ITE
Invocation Result		ITE	ITE
Failed parameter		ITE	ITE
Failure Handling		ITE	ITE
Invocation Sequence Number		ITE	ITE
Session Failover		ITE	ITE
Supported Features		ITE	ITE

6.3 Binding for time sensitive networking converged charging

This mapping between the Information Elements, resource attributes and CHF CDR parameters for time sensitive networking converged charging is described in clause 7 of TS 32.291 [5].

Annex A (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2023-10	SA5#151	S5-236894				Initial skeleton	0.0.0
		S5-236895				Update of skeleton	0.1.0
		S5-236971				Update scope, references and definitions	
		S5-236972				Update architecture considerations	
		S5-236973				Update charging principles	
		S5-236974				Update basic principles in charging scenarios	
2023-11	SA5#152	S5-238005				Add message flows for 5GS bridge configuration and management charging	0.2.0
		S5-238006				Add message flows for time synchronization service charging	
		S5-238007				Add message flows for QoS and TSC assistance service charging	
		S5-238008				Add message flows for TSC and TS service notification charging	
		S5-237863				Update CDR generation, record transfer and file transfer in charging scenarios	
		S5-238009				Add the charging data request and response message	
		S5-237865				Add the TSN charging CHF record data	
		S5-238010				Define the structure of TSN Charging Information	
		S5-238011				Define the information for 5GS bridge configuration and management	
		S5-238012				Define the information for time synchronization service	
S5-238013				Add the TSN charging parameter description, message format and binding			
		S5-237870				Update TSN charging information in charging principles	
2023-12	SA#102	SP-231521				Presented for information and approval	1.0.0
2023-12	SA#102					Upgrade to change control version	18.0.0
2024-03	SA#103	SP-240187	0001		B	Rel-18 CR 32.282 Resolve the EN on SMF and NEF	18.1.0
2024-06	SA#104	SP-240848	0002	1	F	Rel-18 CR 32.282 Correct charging information for TSN domain charging	18.2.0

History

Document history		
V18.1.0	May 2024	Publication
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