**3GPP TSG CT WG3 134 *C3-242309***

**Changsha, China, 15 - 19 April, 2024 (revision of C3-242xyz)**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **29.513** | **CR** | **0545** | **rev** | **-** | **Current version:** | **18.5.0** |  |
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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:*** | Clean up of subscription control and time synchronization services status monitoring | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Ericsson | | | | | | | | | |
| ***Source to TSG:*** | C3 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | TRS\_URLLC | | | | |  | ***Date:*** | | | 2024-03-24 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | The following issues are found in the current version of the specification:   * Missing references to the monitor of the time synchronization service status in 5GS * Missing information about the subscription-based authorization procedure: Checking of the Time Synchronization Subscription data, validation of the temporal conditions, validation of the spatial conditions, and validation of the clock quality detail level and clock quality acceptance criteria.   For ASTI service, additionally, missing information about whether the UE registers or deregisters after the AF provided the time synchronization information. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | * Completion of the references to the monitoring of time synchronization service status. * Completion of the subscription checking procedure, including the procedures if the time synchronization data changes. * For ASTI, additionally, including the behavior in case the UE registers or deregisters after the AF provided the ASTI service information. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Subscription based control of Time Synchronization and ASTI service is incorrect. Time Synchronization Status monitoring is incomplete. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 5.5.11.1, 5.5.11.2, 5.5.11.3, 5.5.11.4, 5.5.11.5 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

\* \* \* \* Start of Changes \* \* \* \*

#### 5.5.11.1 General

Time synchronization exposure allows an AF to configure time synchronization service(s) in 5GS and to monitor the time synchronization service status in 5GS.

For (g)PTP operations, the Time synchronization service allows an AF to subscribe to the UE and 5GC capabilities and availability for time synchronization services as described in clause 5.5.11.2, to configure the (g)PTP instance in 5GS as described in clause 5.5.11.3, and to monitor the service status as described in clause 5.5.11.5.

For the 5G access stratum time distribution, the AF can influence the 5G access stratum time distribution as described in clause 5.5.11.4 and monitor the service status as described in clause 5.5.11.5.

The time synchronization exposure is provided by the NEF, which uses the services provided by the TSCTSF. The AF that is part of the operator's trust domain may invoke the services directly with the TSCTSF; in such case, the TSCTSF directly responds/notifies the AF, accordingly.

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

#### 5.5.11.2 Exposure of UE availability and capabilities for Time Synchronization service

The procedure is used by the AF to subscribe to notifications and to explicitly cancel a previous subscription for UE availability for time synchronization service.



Figure 5.5.11.2-1: Exposure of UE availability and capabilities for Time Synchronization service

0. During SM Policy Association establishment, the PCF determines if the PDU Session is potentially impacted by time synchronization service (based on local configuration) and provides the "TSN\_BRIDGE\_INFO" policy control request trigger to the SMF as described in figure 5.2.1-1, step 11. During SM Policy Association modification (triggered during PDU session establishment), the SMF may report it to the PCF to provide TSC user plane node information (device side port number, DS-TT MAC address (to identify the PDU session), if applicable, TSC user plane node Id and UE-DS-TT residence time, if available), and, if available, a UMIC and/or one or more PMIC(s), as described in figure 5.2.2.3-1, step 2. For IP PDU sessions, the PCF uses the UE IP address to identify the PDU session. The PCF invokes the Npcf\_PolicyAuthorization\_Notify service operation to notify to the TSCTSF the received TSC user plane node information for the PDU session, and, if available, the received UMIC/PMIC(s), as described in figure 5.2.2.3-1, step 5.

The TSCTSF retrieves the UE SUPI from the BSF using the UE IP address, and may get from UDM Time Synchronization Subscription Data, that may contain either one or more subscribed time synchronization service Id(s) (that map to a PTP instance configuration in the TSCTSF for the DNN/S-NSSAI) or an indication that an AF-requested (g)PTP time synchronization service is allowed for the given UE and DNN/S-NSSAI.

If an AF-requested (g)PTP time synchronization service is allowed for the UE and DNN/S-NSSAI, the TSCTSF then invokes the Npcf\_PolicyAuthorization\_Create request message to the PCF as described in clause 5.2.2.2.2.1 to create an AF-session. The TSCTSF may subscribe with the PCF to the "TSN\_BRIDGE\_INFO" event, to get notifications abut PMIC/UMIC updates as specified in 3GPP TS 29.514 [10]. For IP PDU sessions, the TSCTSF stores the DNN, S-NSSAI and IP address as received from PCF and SUPI as received from BSF and associates them with the AF-session, as described in 3GPP TS 29.565 [60].

The received PMIC(s)/UMIC, if available, may contain (g)PTP instance configuration for the reported DS-TT/NW-TT.

If the TSCTSF retrieves from UDM one or more time synchronization service Id(s) matching PTP instance configuration for the DNN/S-NSSAI, the TSCTSF distributes the PTP instance configuration as described in clause 5.5.11.3.

1. To subscribe to notifications of the UE availability for time synchronization service, the AF invokes the Nnef\_TimeSynchronization\_CapsSubscribe service operation to the NEF by sending the HTTP POST request to the "Time Synchronization Exposure Subscriptions" resource as defined in 3GPP TS 29.522 [24].

To unsubscribe to the UE availability for time synchronization for a list of UE(s), the AF invokes Nnef\_TimeSynchronization\_CapsUnsubscribe service operation to the NEF by sending the HTTP DELETE request to the "Individual Time Synchronization Exposure Subscription" resource as defined in 3GPP TS 29.522 [24].

2. The NEF selects the TSCTSF and maps the received parameters to 5GC parameters, if applicable, as described in 3GPP TS 29.522 [24] and invokes the Ntsctsf\_TimeSynchronization\_CapsSubscribe service operation by sending the HTTP POST request to the "Time Synchronization Exposure" resource as described in 3GPP TS 29.565 [60].

In the case of Ntsctsf\_TimeSynchronization\_CapsUnsubscribe, the NEF interacts with the TSCTSF by sending an HTTP DELETE request to the "Individual Time Synchronization Exposure Subscription" resource as described in 3GPP TS 29.565 [60].

The AF that is part of operator's trust domain may invoke the requests directly to the TSCTSF.

3. If the request includes GPSI(s), an External Group Identifier or an Internal Group Identifier, the TSCTSF uses the Nudm\_SDM\_Get request as described in 3GPP TS 29.503 [61] to retrieve the subscription information for the target Ues (i.e., to retrieve the SUPI(s)) from the UDM, using each GPSI or the External Group Identifier as received from the NEF, or an Internal Group Identifier as provided directly by the AF).

For the retrieved SUPI(s), the TSCTSF requests the Time Synchronization Subscription Data from the UDM if not previously retrieved in step 0, to validate whether the AF request for (g)PTP-based time distribution for the DNN and S-NSSAI is allowed by the UE subscription.

4. The TSCTSF uses the parameters received in step 2 and step 3 (i.e. DNN, S-NSSAI and SUPI(s)) to find matching AF-session(s) as described in 3GPP TS 29.565 [60].

If the subscription data for the UE indicates that the AF is not allowed to request (g)PTP-based time synchronization for this UE, DNN and S-NSSAI combination, the corresponding AF-session is excluded from the list of matching AF-sessions.

For any AF-session in the list of matching AF-session(s), the TSCTSF interacts with the PCF by triggering a Npcf\_PolicyAuthorization\_Update request message as specified in 3GPP TS 29.514 [10], to provide/retrieve UMIC/PMIC information, if not available in the TSCTSF, from the NW-TT/DS-TT to read the (g)PTP capabilities as specified in 3GPP TS 23.501 [2], K.2.2.1

In the case of Ntsctsf\_TimeSynchronization\_CapsUnsubscribe, the TSCTSF, for the AF-session(s) in the list of matching AF-session(s), triggers a Npcf\_PolicyAuthorization\_Delete request message as specified in 3GPP TS 29.514 [10], deletes the corresponding "Individual Time Synchronization Exposure Subscription" resource and responds to the NEF (or AF) with a "204 No Content" status code. Steps 4-5 and 8-16 are skipped.

5. The PCF responds with a "200 OK" or "204 No Content" status code to the received PATCH request.

6. The TSCTSF acknowledges the execution of Ntsctsf\_TimeSynchronization\_CapsSubscribe to the requester that initiated the request (NEF or AF) by sending a "201 Created" status code.

When the request was to unsubscribe to the UE availability for time synchronization, the TSCTSF deletes the corresponding "Individual Time Synchronization Exposure Subscription" resource and responds to the NEF with a "204 No Content" status code.

7. The NEF acknowledges the execution of Nnef\_TimeSynchronization\_CapsSubscribe to the AF by sending a "201 Created" status code.

When the request was to unsubscribe to the UE availability for time synchronization, the NEF deletes the corresponding "Individual Time Synchronization Exposure Subscription" resource and responds to the AF with a "204 No Content" status code.

8 For each AF-session for which the TSCTSF triggered the Npcf\_PolicyAuthorization\_Update request as described in step 4, the PCF provides to the SMF the UMIC/PMIC information received from the TSCTSF and for the concerned PDU session as described in clause 5.2.2.2.2.2.

9 When the SMF detects UMIC/PMIC changes for the NW-TT/DS-TT for each concerned PDU sessions, the SMF provides the updated UMIC/PMIC information to the PCF as described in clause 5.2.2.3.

10. The TSCTSF receives UMIC/PMIC information from NW-TT/DS-TT ports from the PCF, with the notification of BRIDGE\_INFO events as specified in 3GPP TS 29.514 [10]. The PCF invokes the Npcf\_PolicyAuthorization\_Notify service operation by sending an HTTP POST request to the callback URI as specified in clause 5.2.2.3.

11. The TSCTSF responds to the PCF with a "204 No Content" status code.

12. The TSCTSF uses the procedures described in clause K.2.1 of TS 23.501 [2] to determine the (g)PTP capabilities from the DS-TT and, if not previously determined, the (g)PTP capabilities from the NW-TT.

The TSCTSF composes the time synchronization capabilities for the DS-TT/UE(s) connected to the NW-TT based on the capability information received from the DS-TT(s) and NW-TT for each AF-session. If the Ntsctsf\_TimeSynchronization\_CapsSubscribe request included an Event Filter with one or more of the requested PTP instance type, requested transport protocol for PTP, or requested PTP Profile, the TSCTSF considers only the DS-TT(s) and NW-TT(s) with these capabilities as part of the time synchronization capability set that is reported to the NEF (or AF).

The TSCTSF maintains, for the "Individual Time Synchronization Exposure Subscription" resource, the association between the user-plane Node ID, the time synchronization capabilities, the Event Filter(s) (if available), the NEF or AF Notification Target Address and list of the matching AF-sessions with PCFs with this user-plane Node ID.

13. The TSCTSF sends Ntsctsf\_TimeSynchronization\_CapsNotify to the NEF by invoking the HTTP POST request, as described in 3GPP TS 29.565 [60]. The message includes the time synchronization capabilities as composed for all the matching AF-sessions in step 12. The message contains one or more user-plane Node ID(s), a list of UE identities associated to each user-plane Node ID and time synchronization capabilities for each set of DS-TTs (Ues) connected to given user-plane Node ID. The user-plane Node ID identifies the NW-TT to where the UE/DS-TT(s) are connected to.

14. The NEF responds to the PCF with a "204 No Content" status code.

15. The NEF forwards the Nnef\_TimeSynchronization\_CapsNotify with Time Synchronization capability event to the AF by invoking the HTTP POST request as described in 3GPP TS 29.522 [24].

16. The AF responds the NEF with a "204 No Content" status code.

At PDU Session Establishment as defined is step 0, steps 3-5 and steps 8-16 are repeated for the new PDU Session/AF-session and the TSCTSF may notify the NEF (or AF) for the Time Synchronization capability event, optionally with the updated time synchronization capabilities.

Upon PDU Session release indication from a PCF, the TSCTSF removes the corresponding AF-session from the list of AF-sessions associated with the time synchronization exposure subscription resource, once the corresponding AF-session is removed from the list of AF-sessions associated with the time synchronization configuration, as described in clause 5.5.11.3. The changes in the set of capabilities are notified to the NEF and AF as described in steps 13 to 16.

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

#### 5.5.11.3 Time Synchronization service activation, modification, and deactivation

The AF may use Nnef\_TimeSynchronization\_CapsSubscribe service operation as described in clause 5.5.11.2 to learn the UE capabilities for time synchronization service for a list of UE identities. The Nnef\_TimeSynchronization\_CapsNotify service operation indicates the list of UE identities per User-plane Node ID that match the provided time synchronization capabilities.

The AF can use the user-plane node ID received in the Nnef\_TimeSynchronization\_CapsNotify service operation as a target of the configuration of a PTP instance in the Nnef\_TimeSynchronization\_ConfigCreate request. The Nnef\_TimeSynchronization\_ConfigCreate/ConfigUpdate request create/update a time synchronization configuration per user plane node ID based on the parameters indicated in the request for the NW-TT(s) and DS-TT(s). The AF may subscribe to time synchronization status reports via Nnef\_TimeSynchronization\_ConfigCreate/ConfigUpdate service operation(s) and may receive a time synchronization service status report via Nnef\_TimeSynchronization\_UpdateNotify service operation.



Figure 5.5.11.3-1: Time Synchronization service activation, modification and deactivation

1. To create a time synchronization service configuration for a PTP instance and user-plane node ID, the AF invokes the Nnef\_TimeSynchronization\_ConfigCreate service operation to the NEF by sending the HTTP POST request to the "Time Synchronization Exposure Configurations" resource as specified in 3GPP TS 29.522 [24].

To update an existing time synchronization service configuration for a PTP instance and user-plane node ID, the AF invokes the Nnef\_TimeSynchronization\_ConfigUpdate service operation by sending the HTTP PUT request to the "Individual Time Synchronization Exposure Configuration" resource.

To remove an existing time synchronization service configuration for a PTP instance and user-plane node ID, the AF invokes the Nnef\_TimeSynchronization\_ConfigDelete service operation by sending the HTTP DELETE request to the "Individual Time Synchronization Exposure Configuration" resource.

The NEF authorizes the AF request. The request contains user-plane node ID as reference to the target of Ues and AF-sessions held in the TSCTSF in the "Individual Time Synchronization Exposure Subscription" resource for the indicated user-plane node ID.

The Nnef\_TimeSynchronization\_ConfigCreate/Update request creates/updates also a subscription to notifications for the changes in the time synchronization service configuration.

The AF may also subscribe to time synchronization status report by including (optionally) the clock quality detail level set to "acceptable/not acceptable indication" and providing clock quality acceptance criteria.

NOTE 1: The AF request for PTP service activation, modification cannot indicate that the clock quality detail level to provide is "metrics", i.e. if the AF includes the clock quality detail level, its value needs to set to "acceptable/not acceptable indication" and accompanied with "clock quality acceptance criteria". The UE/DS-TT retrieves detailed information (timing synchronization metrics) from Announce messages sent for (g)PTP services.

2 The NEF authorizes the AF request and translates the received parameters into 5GC parameters as described in 3GPP TS 29.522 [24] before invoking the TSCTSF services (e.g., if the AF request includes a time synchronization coverage area formulated using a geographical description of the area(e.g., civic addresses or shapes), the NEF transforms this information into 3GPP identifiers (e.g. TA(s)) based on pre-configuration).

When the NEF receives the Nnef\_TimeSynchronization\_ConfigCreate request, the NEF invokes the Ntsctsf\_TimeSynchronization\_ConfigCreate service operation to create time synchronization service configuration for a PTP instance and a user-plane node ID in an "Individual Time Synchronization Exposure Subscription" resource in the TSCTSF by sending the HTTP POST request to the "Time Synchronization Exposure Configurations" resource as specified in 3GPP TS 29.565 [60]. If the "CoverageAreaSupport" feature is supported, the NEF may include the coverage area where the indicated service configuration applies.

When the NEF receives the Nnef\_TimeSynchronization\_ConfigUpdate request, the NEF invokes the Ntsctsf\_TimeSynchronization\_ConfigUpdate service operation to update time synchronization service configuration for a PTP instance and a user-plane node ID in an "Individual Time Synchronization Exposure Subscription" resource in the TSCTSF by sending the HTTP PUT request to the "Individual Time Synchronization Exposure Configuration" resource as specified in 3GPP TS 29.565 [60]. If the "CoverageAreaSupport" feature is supported, the NEF may include the coverage area where the indicated service configuration applies.

When the NEF receives the Nnef\_TimeSynchronization\_ConfigDelete request, the NEF invokes the Ntsctsf\_TimeSynchronization\_ConfigDelete service operation to delete time synchronization service configuration for a PTP instance and a user-plane node ID in an "Individual Time Synchronization Exposure Subscription" resource in the TSCTSF by sending the HTTP DELETE request to the "Individual Time Synchronization Exposure Configuration" resource as specified in 3GPP TS 29.565 [60]. The TSCTSF sends a "204 No Content" response.

An AF that is part of operator's trust domain may invoke the TSCTSF services directly with TSCTSF.

3. The TSCTSF acknowledges the NEF request including:

- For a creation request response, a "201 Created" status code, including a reference to the time synchronization service configuration created (PTP instance created) represented by the "Individual Time Synchronization Exposure Configuration" resource.

- For an update request response, a "200 OK" or a "204 No Content" status code.

- For a delete request response, a "204 No Content" status code.

4. The NEF sends the HTTP response message to the AF correspondingly.

5. The TSCTSF checks with the UDM if the concerned UE(s) are allowed to receive the time sync service configuration.

The TSCTSF uses user-plane node ID and the PTP instance information (PTP instance type, transport protocol and PTP profile) of the request and the related "Individual Time Synchronization Exposure Subscription" resource, to determine the target UEs (SUPI(s)) and checks whether the AF requested parameters comply with the stored Time Synchronization Subscription Data retrieved from the UDM as described in clause 5.5.11.2.

If the "AF request Authorization" in the Time Synchronization Subscription Data for the affected SUPI indicates that the AF is allowed to request PTP instance configuration, the TSCTSF proceeds with the configuration. Otherwise (i.e., the "AF request Authorization" is not allowed), steps 6-19 are skipped for this UE.

NOTE 2: The AF-sessions that are not associated with a time synchronization configuration (for a user-plane node Id, specific PTP instance information, and the related "Individual Time Synchronization Exposure Subscription" resource), are available to be selected as suitable AF-sessions in another Ntsctsf\_TimeSynchronization\_ConfigCreate/Update request.

If the Time Synchronization Subscription Data contains periods of authorized start and stop times, the TSCTSF checks whether the temporal validity condition contained in the Ntsctsf\_TimeSynchronization\_ConfigCreate request satisfies (i.e. within) any of the periods of authorized start and stop times. The TSCTSF then maintains the start-time and stop-time for the time synchronization service for the corresponding time synchronization configuration. If the start-time is in the past, the TSCTSF treats the request as if the time synchronization service is activated immediately. When the start-time is reached, the TSCTSF proceeds with the activation of the service while the current time is within an authorized time period. When the stop-time is reached for an active time synchronization service configuration, the TSCTSF proceeds as if an Ntsctsf\_TimeSynchronization\_ConfigDelete request is received.

6. If the "CoverageAreaSupport" feature is supported, the NEF may include in step 2 the coverage area where the indicated service configuration applies. The TSCTSF determines the authorized Time Synchronization Coverage Area by selecting the TA(s) that are part of both, the list of TA(s) provided by the NEF and the list of TA(s) stored in the Time Synchronization Subscription Data. Then, the TSCTSF performs the following operations:

- The TSCTSF subscribes with the AMF(s) for UE presence in Area of Interest composed by the TA(s) as specified in 3GPP TS 29.565 [60].

- Based on the received notification from the AMF and the authorized Time Synchronization Coverage Area, the TSCTSF determines whether to activate time synchronization service for this UE:

a. If the UE presence is within any of the TAs from the authorized time synchronization coverage area, the TSCTSF determines to activate the received PTP instance configuration for the authorized UE.

b. If the UE presence is not within any of the TAs from the authorized time synchronization coverage area, the TSCTSF determines to set to inactive the received PTP instance configuration for the authorized UE.

7. For each authorized UE (in step 5 and step 6) and matched AF-session, the TSCTSF uses the procedures described in clause K.2.2 of 3GPP TS 23.501 [2] to configure and initialize the PTP instance in the DS-TT(s) and NW-TT according to the parameters received in step 2. The TSCTSF constructs a PMIC to each DS-TT/UE to activate the time synchronization service in DS-TT and constructs PMIC(s) and UMIC to NW-TT to activate the time synchronization service in NW-TT.

If in step 1 the AF subscribes to time synchronization status report, the TSCTSF may subscribe for notifications about changes in NG-RAN and UPF/NW-TT (if applicable) timing synchronization status as described in clause 5.5.11.5.

8. For each authorized UE and matched AF-session, the TSCTSF delivers the PMIC(s) and UMIC to NW-TT and the PMIC(s) to DS-TT/UE by invoking the Npcf\_PolicyAuthorization\_Update service procedure as specified in clause 5.2.2.2.2.2.

9. The PCF acknowledges the request with a "200 OK" or a "204 No Content" status code.

10. For each AF-session for which the TSCTSF triggered the Npcf\_PolicyAuthorization\_Update request, the PCF provides the UMIC/PMIC information for the concerned PDU session as described in clause 5.2.2.2.2.2.

11 The DS-TT(s) and the NW-TT response is encoded in the corresponding PMIC(s)/UMIC containers which are delivered by the SMF to the PCF in an SM Policy Association modification initiated by the SMF procedure, as described in clause 5.2.2.3.

12. The TSCTSF receives UMIC/PMIC information from NW-TT/DS-TT ports from the PCF with the notification about BRIDGE\_INFO events for each AF-session, as specified in 3GPP TS 29.514 [10]. The PCF invokes the Npcf\_PolicyAuthorization\_Notify service operation by sending an HTTP POST request to the callback URI as specified in clause 5.2.2.3.

13. The TSCTSF responds to the PCF with a "204 No Content" status code.

14. Upon reception of responses from each DS-TT and the NW-TT (for all affected AF sessions), the TSCTSF determines the state of the time synchronization configuration for the indicated PTP instance and user-plane node ID.

15. The TSCTSF uses the procedure in clause 5.5.11.4, steps 5-9, to activate or modify the 5G access stratum time distribution for the UEs that are part of the indicated PTP instance.

16. For an active PTP instance, the TSCTSF notifies the NEF (or AF), with the Ntsctsf\_TimeSynchronization\_ConfigUpdateNotify service operation, by sending to the NEF (or AF) callback URI the HTTP POST request containing notification correlation identifer and the current state of the time synchronization service configuration for the NW-TT and DS-TTs (of the indicated PTP instance and user-plane node ID) as specified in 3GPP TS 29.565 [60].

If the TSCTSF determines an authorized spatial validity condition in step 6, the TSCTSF may indicate to the AF whether a PTP port of the PTP instance is activated or deactivated whenever the UE moves in or out of the authorized Time Synchronization Coverage Area.

If the feature "NetTimeSynchStatus" is supported and the state of the time synchronization service configuration for the NW-TT and/or DS-TT changes because the TSCTSF detects failure, degradation or improvement in the status of the time synchronization service, the TSCTSF may indicate to the AF/NEF whether the PTP port of the PTP instance is activated or deactivated together with the acceptable/not-acceptable time synchronization service status of the PTP port of the PTP instance.

17. The NEF (or AF) acknowledges the notification request by replying with a "204 No Content" status code.

18. The NEF forwards to the AF in the Nnef\_TimeSynchronization\_ConfigUpdateNotify service operation the current state of the time synchronization service configuration for the NW-TT and DS-TT (for the active PTP instance and user-plane node ID) by invoking the HTTP POST request to the AF callback URI.

19. The AF acknowledges the notification request by replying with a "204 No Content" status code.

20. If TSCTSF receives a time synchronization coverage area as part of the Ntsctsf\_TimeSynchronization\_ConfigCreate request in step 2 and determines an authorized Time Synchronization Coverage Area, upon the reception of a change in the UE presence in Area of Interest notification, the TSCTSF determines whether the authorized time synchronization coverage area condition shall trigger an activation or deactivation of the PTP instance configuration:

- If the UE moves within any of the TAs from the authorized time synchronization coverage area, then the TSCTSF adds the UE/DS-TT port to the PTP instance.

- If the UE moves outside all of the TAs from the authorized time synchronization coverage area, then the TSCTSF removes the UE/DS-TT port rom the PTP instance.

The TSCTSF configures the Grandmaster functionality, as applicable, as specified in 3GPP TS 29.565 [60]. The TSCTSF delivers the PMIC and/or UMIC as described in steps 8-15. The TSCTSF updates the state of the time synchronization configuration and may notify the NEF (or AF) as described in step 16-19.

21. For an active PTP instance, the TSCTSF notifies the NEF (or AF), with the Ntsctsf\_TimeSynchronization\_ConfigUpdateNotify service operation as specified in 3GPP TS 29.565 [60].

22. The NEF (or AF) acknowledges the notification request by replying with a "204 No Content" status code.

23. The NEF forwards to the AF in the Nnef\_TimeSynchronization\_ConfigUpdateNotify service operation.

24. The AF acknowledges the notification request by replying with a "204 No Content" status code.

NOTE 3: If the AF receives a clock quality acceptance criteria result (acceptable/not acceptable), the AF decides whether to modify the service configured for the UE of a PTP instance or whether to deactivate it (deleting the PTP instance configuration).

A change in the PTP instance in the DS-TT or NW-TT triggers a notification of PMIC/UMIC change towards the TSCTSF as described in clause 5.2.2.3 and steps 11-14. The change of PTP instance is notified to the NEF and AF as described in steps 16 to 19.

Upon PDU Session release indication from a PCF, the TSCTSF removes the corresponding AF-session from the list of AF-sessions associated with the time synchronization configuration. The TSCTSF uses the procedure in clause 5.5.11.4 to remove the 5G access stratum time distribution parameters for the UE that is removed from the impacted PTP instance. The changes in the configured PTP instance are notified to the NEF and AF as described in steps 16 to 19.

At PDU Session Establishment step 0, step 5, and steps 8-11 of figure 5.5.11.2-1 are repeated for a new PDU Session and AF-session. The NEF (or AF) may use the Ntsctsf\_TimeSynchronization\_ConfigUpdate service operation as described in figure 5.5.11.3-1 to add the DS-TT/UE to the existing PTP instance and corresponding time synchronization service configuration.

If the TSCTSF received a temporal validity condition, the TSCTSF checks the activation or deactivation of the time synchronization service as specified in 3GPP TS 29.565 [60].

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

#### 5.5.11.4 Management of 5G Access Stratum Time distribution

The AF can use the procedure to activate, update or delete the 5G access stratum time distribution for one UE or a group of UE(s). The AF may also use this procedure to indicate a clock quality detail level to provide to the UE or group of UE(s) and, optionally, to subscribe for time synchronization status reports.

The AF may query the status of the 5G access stratum time distribution using Nnef\_ASTI\_Get service operation. The Nnef\_ASTI service is specified in 3GPP TS 29.52265 [2460].



Figure 5.5.11.4-1: Management of 5G Access Stratum Time distribution

0. AM Policy Association establishment as described in clause 5.1.1.

1. To provide access stratum time distribution parameters to the NEF, the AF invokes the Nnef\_ASTI\_Create service operation to the NEF by sending the HTTP POST request to the "ASTI Configurations" resource as specified in 3GPP TS 29.522 [24].

To update previously provided access stratum time distribution parameters, the AF invokes an Nnef\_ASTI\_Update by sending the HTTP PUT request to the "Individual ASTI Configuration" resource.

To remove previously provided access stratum time distribution parameters, the AF invokes the Nnef\_ASTI\_Delete service operation by sending the HTTP DELETE request to the "Individual ASTI Configuration" resource.

To query the status of the access stratum time distribution, the AF invokes Nnef\_ASTI\_Get service operation by sending the by sending the "retrieve" custom operation (HTTP POST request) to the "ASTI Configurations" resource.

If the feature "NetTimeSynchStatus" is supported, the AF request may indicate the clock quality detail level of the information to provide to the UE and, if required, include the clock quality acceptance criteria for the UE.

NOTE: If the AF requests clock quality detail level to be "acceptable/not acceptable indication", the AF needs to provide the clock quality acceptance criteria.

By including the clock quality acceptance criteria in a Nnef\_ASTI request, the AF indicates to the TSCTSF (via the NEF) to create a subscription at the TSCTSF to get notified about the changes in 5G access stratum time distribution status.

2. The NEF authorizes the request and maps the received parameters to 5GC parameters as specified in 3GPP TS 29.522 [24] (e.g., the NEF transforms a geographical area description provided as a spatial validity condition into 3GPP identifiers (e.g. TAIs) based on configuration). After successful authorization, the NEF invokes:

- The Ntsctsf\_ASTI\_Create service operation by sending the HTTP POST request to the "ASTI Configurations" resource as specified in 3GPP TS 29.565 [60].

- The Ntsctsf\_ASTI\_Update service operation by sending the HTTP PUT request to the "Individual ASTI Configuration" resource as specified in 3GPP TS 29.565 [60].

- The Ntsctsf\_ASTI\_Delete service operation by sending the HTTP DELETE request to the "Individual ASTI Configuration" resource as specified in 3GPP TS 29.565 [60].

- The Ntsctsf\_ASTI\_Get service operation by sending the "retrieve" custom operation (HTTP POST request) to the "ASTI Configurations" resource as specified in 3GPP TS 29.565 [60].

If the TSCTSF determines the targeted UE is part of a PTP instance in 5GS (see clause 5.5.11.3), the TSCTSF rejects the request (steps 3 to 9 are skipped).

The AF that is part of operator's trust domain may invoke the services directly with the TSCTSF and identifies the targeted UE(s) using SUPI(s) or an Internal Group Identifier.

3. If the targeted UE(s) are identified by GPSI(s) or External/Internal Group Identifier, the TSCTSF interacts with UDM by invoking the Nudm\_SDM\_Get request as specified in 3GPP TS 29.503 [61] to retrieve the Time Synchronization Subscription Data for each affected SUPI.

If the "AF request Authorization" in the Time Synchronization Subscription Data for the affected SUPI indicates that the AF is allowed to request 5G access stratum-based time distribution, the TSCTSF proceeds with ASTI service configuration. Otherwise, if the AF is not authorized, steps 4-9 are skipped for this UE.

Then, the TSCTSF compares the AF request with the stored Time Synchronization Subscription Data to determine if the requested ASTI configuration (e.g. Uu time synchronization error budget) and, if available, the provided ASTI clock quality reporting control information is allowed. If the request is not authorized, steps 5 to 9 are skipped.

If the Time Synchronization Subscription Data contains periods of authorized start and stop times, the TSCTSF checks whether the temporal validity condition included in the Ntsctsf\_ASTI\_Create request in step 2 satisfies (i.e. within) any of the periods of authorized start and stop times.. The TSCTSF then maintains the start-time and stop-time for the ASTI service configuration and proceeds to enable the ASTI service while the current time is within an authorized time period. When the stop-time is reached for active ASTI service configuration, the TSCTSF proceeds as if an Nnef\_ASTI\_Delete request is received.

4. If the feature "CoverageAreaSupport" is supported, the Ntsctsf\_ASTI\_Create request in step 2 may contain the coverage area where the Access Stratum Time Distribution service applies. The TSCTSF determines the authorized Time Synchronization Coverage Area by selecting the TA(s) that are part of both, the list of TA(s) provided by the NEF and the list of TA(s) stored in the Time Synchronization Subscription Data. Then, the TSCTSF performs the following operations:

- The TSCTSF subscribes with the AMF(s) for UE presence in Area of Interest composed by the TA(s) in the time synchronization coverage area as specified in 3GPP TS 29.565 [60].

- Based on the received notification from the AMF and the authorized time synchronization coverage area, the TSCTSF determines whether to activate the ASTI service for this UE:

- If the UE location is within any of the TAs from the authorized time synchronization coverage area, the TSCTSF determines to enable access stratum time distribution for the UE.

- If the UE location is is not within any of the TAs from the authorized time synchronization coverage area, the TSCTSF determines to disable access stratum time distribution for the UE.

If the AF subscribes to time synchronization status reports (by providing a clock quality reporting control information indicating clock quality detail level "acceptable/not acceptable" and the clock quality acceptance criteria in step 1), the TSCTSF subscribes for notification about changes in NG-RAN and UPF/NW-TT timing synchronization status as described in clause 5.5.11.5.

5. To search for the PCF for the UE, the TSCTSF invokes the Nbsf\_Management\_Subscribe service operation by sending an HTTP POST request to the "Binding Subscriptions" resource as specified in 3GPP TS 29.521 [22] to subscribe to notifications of PCF\_UE\_BINDING\_REGISTRATION event for the indicated SUPI.

6. If matching entries already existed in the BSF when step 5 is performed, this entry is immediately reported to the TSCTSF in the "201 created" response.

6.b. If the matching entry does not exist, the BSF provides to the TSCTSF the identity of the PCF for the UE for the requested SUPI via an Nbsf\_Management\_Notify operation once the PCF is registered as described in clause 5.1.1.

7. If the AF requested Uu time synchronization error budget is authorized in step 3, the TSCTSF enables the Access Stratum Time Distribution service for the UE and calculates the Uu time synchronization error budget as described in clause 5.27.1.9 of 3GPP TS 23.501 [2]. .

When the procedure is triggered by PTP instance activation, modification, or deactivation in the TSCTSF as described in clause 5.5.11.3, the TSCTSF calculates the Uu time synchronization error budget as described in clause 5.27.1.9 of 3GPP TS 23.501 [2] for the SUPIs that are part of the PTP instance.

The TSCTSF sends to the PCF for the UE the access stratum time distribution request using Npcf\_AMPolicyAuthorization\_Create/Update request as described in 3GPP TS 29.534 [50], containing the 5G access stratum time distribution indication (enable, disable) and optionally the calculated Uu time synchronization error budget. If the feature "NetTimeSynchStatus" is supported, and the AF requested clock quality reporting control information is authorized in step 3, the TSCTSF provides to the PCF for the UE the authorized clock quality detail level and clock quality acceptance criteria, if available.

8. If the PCF receives multiple time synchronization error budgets for a given UE, then the PCF picks the most stringent budget. The PCF may initiate an AM Policy Association Modification procedure as described in clause 5.1.2.2 to provide the AMF with the 5G access stratum time distribution parameters. If the feature "NetTimeSynchStatus" is supported, the PCF for the UE provides the AMF the AF requested clock quality detail level and clock quality acceptance criteria, if available.

As part of this procedure, the AMF, if supported, stores the 5G access stratum time distribution indication (enable, disable), the Uu time synchronization error budget, the clock quality detail level and the clock quality acceptance criteria, if available, in the UE context in the AMF and sends the 5G access stratum time distribution indication (enable, disable), the Uu time synchronization error budget, the clock quality detail level and the clock quality acceptance criteria, when they are available, to NG-RAN (during mobility registration, AM policy modification, Service Request, N2 Handover and Xn handover) as specified in 3GPP TS 38.413 [62]. The NG-RAN node, if supported, stores the information in the UE Context. Based on this information, the NG-RAN node provides the 5GS access stratum time to the UE according to the Uu time synchronization error budget as provided by the TSCTSF (if supported by UE and NG-RAN) and timing synchronization status reports to the UE.

9. The PCF of the UE replies to the TSCTSF with a "201 Created" status code to the Npcf\_AMPolicyAuthorization\_Create service request and with a "200 OK" or "204 No Content" status code to the Npcf\_AMPolicyAuthorization\_Update service request.

10. The TSCTSF responds the AF/NEF with the Ntsctsf\_ASTI\_Create/Update/Delete/Get service operation response using the "201 Created"/"200 OK" or "204 No Content"/"204 No Content"/"200 OK" status code respectively.

11. The NEF informs the AF about the result of the Nnef\_ASTI\_Create/Update/Delete/Get service operation performed in step 2 using the "201 Created"/"200 OK" or "204 No Content"/"204 No Content"/"200 OK" status code respectively.

12. If the TSCTSF receives a time synchronization coverage area as part of the Ntsctsf\_ASTI\_Create request in step 2 or as part of the (g)PTP time synchronization service configuration, as described in clause 5.5.11.3 and determines the authorized Time Synchronization Coverage Area, upon the reception of a change in the UE presence in Area of Interest notification, the TSCTSF determines if the authorized time synchronization coverage area condition shall trigger an activation or deactivation of the access stratum time distribution:

- If the UE moves within any of the TAs from the authorized time synchronization coverage area, then the TSCTSF determines to enable access stratum time distribution for the UE.

- If the UE moves outside all of the TAs from the authorized time synchronization coverage area, then the TSCTSF determines to disable access stratum time distribution for the UE.

The TSCTSF updates the previously provided 5GS access stratum time distribution parameters as described in steps 7-9.

13. If the TSCTSF determines to update the enable/disable the 5G access stratum time distribution for the UE in step 12, and the TSCTSF received the time synchronization coverage area as part of the Ntsctsf\_ASTI\_Create/Update request in step 2, the TSCTSF notifies the update of the service status to AF/NEF by sending an HTTP POST to the received callback URI as specified in 3GPP TS 29.565 [60].

If the TSCTSF receives clock quality acceptance criteria as part of the Ntsctsf\_ASTI\_Create request in step 2 and the TSCTSF determines a change in the fulfillment of the clock quality acceptance criteria for the UE for which the AF has requested the access stratum time distribution as described in clause 5.5.11.5, the TSCTSF reports the clock quality acceptance criteria result (acceptable/not acceptable) to the AF/NEF. Based on this notification, the AF/NEF decides whether to modify the ASTI service configured for the UE using Ntsctsf\_ASTI\_Update service.

14. The NEF/AF replies with a "204 No Content" status code.

15. The NEF forwards the received notification to the AF by sending an HTTP POST to the received callback URI as specified in 3GPP TS 29.522 [24].

16. The NEF/AF replies with a "204 No Content" status code.

At UE registration in 5GS (step 0 occurs and in step 6b the BSF notifies of PCF for the UE registration), the TSCTSF may enable the ASTI service as described in steps 7 to 9 and may notify to the NEF and/or AF as described in steps 13 to 16.

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

#### 5.5.11.5 Management of network timing synchronization status monitoring

This procedure is used to notify the AF about the network time synchronization status monitoring for the time synchronization service offered in the (g)PTP based time distribution and in the 5G access stratum time distribution service described in clauses 5.5.11.3 and clause 5.5.11 correspondingly.



Figure 5.5.11.5-1: Management of network timing synchronization status monitoring

0. An AF requests creation or modification of a (g)PTP-based or an ASTI-based time synchronization service as described in clauses 5.5.11.3 and 5.5.11.4; and to subscribe to time synchronization status notification(s), the AF provides clock quality detail level and, if applicable, clock quality acceptance criteria in the request.

If network timing synchronization status reports are provisioned to the TSCTSF using node-level signalling via control plane, the TSCTSF determines the serving AMF(s) and the UPF/NW-TT nodes (in cases where UPF/NW-TT is involved in providing time information to DS-TT) for the UE(s) that needs to initiate network timing synchronization status monitoring.

1. For 5G access stratum time distribution or PTP instance activation, modification, if the UE/DS-TT obtains time information from NG-RAN and if network timing synchronization status reports are provisioned using node-level signalling via control plane:

- The TSCTSF subscribes with the determined AMF(s) to NG-RAN timing synchronization status updates at the NG-RAN nodes that may provision 5G access stratum time distribution information to the target UE.

NOTE 1: The provisioning of the NG-RAN timing synchronization status attributes can be configured via OAM or via TSCTSF and AMF with node-level signalling. The RAN node is pre-configured with the thresholds for each timing synchronization status attribute as described in clause 5.27.1.12 in 3GPP TS 23.501 [2]. When the network timing synchronization status exceeds or meets again any of the pre-configured thresholds, the NG-RAN node detects a change of its timing synchronization status (e.g., degradation, failure, improvement) and reports it.

2. For PTP instance activation, modification, if the UPF/NW-TT is involved in providing time information to DS-TT and if network timing synchronization status reports are provisioned using node-level signalling via control plane:

The TSCTSF subscribes to timing synchronization status updates with the UPF/NW-TT that may provision time information via PTP to the target UE.

NOTE 2: The UPF/NW-TT timing synchronization status updates provisioning can be configured via OAM or via UMIC.

3. When timing synchronization status reporting in NG-RAN is configured by the TSCTSF via the AMF in step 1, if the NG-RAN node detects a change on its timing synchronization, the TSCTSF receives an NG-RAN timing synchronization status update via the AMF. The update contains a scope of the timing synchronization status (as described in clause 5.27.1.12 in 3GPP TS 23.501 [2]) and some or all of the information elements listed in Table 5.27.1.12-1 of 3GPP TS 23.501 [2].

4. When timing synchronization status reporting in the UPF/NW-TT is configured by the TSCTSF via UMIC in step 2, if the UPF/NW-TT detects a change on its timing synchronization status, the TSCTSF receives a UPF/NW-TT timing synchronization status update from the UPF/NW-TT via UMIC. The update contains some or all of the information elements listed in Table 5.28.3.1-2 of 3GPP TS 23.501 [2].

5. Upon the reception of an update on the NG-RAN and/or NW-TT timing synchronization status, the TSCTSF determines the impacted UE(s) and, if applicable, whether the clock quality acceptance criteria can still be met.

NOTE 3: When the status update indicates degradation in the NG-RAN, the TSCTSF subscribes to notifications about UE presence in an Area of Interest for the gNB node ID(s) or Cell IDs that reported the timing synchronization status degradation/improvement in order to determine the affected UE(s).

NOTE 4: NG-RAN and/or UPF/NW-TT timing synchronization status update can be configured via OAM instead of node-level signalling via control plane.

For each affected UE, if the TSCTSF determines that the clock quality acceptance criteria can still be met, then TSCTSF may update, for (g)PTP, the clockQuality information sent in Announce messages for the PTP instance and/or may activate/deactivate the time synchronization service using PMIC/UMIC reporting, and for ASTI service, the TSCTSF notifies the service status to AF, as described in step 6, which based on this notification decides whether to modify the ASTI service configured for the UE.

NOTE 5: The handling of Announce messages follows existing procedures as described in 3GPP TS 23.501 [2].

6. If the clock quality acceptance criteria cannot be met or can be met again, then TSCTSF informs the NEF/AF about the acceptance criteria result (e.g., acceptable/not acceptable), for PTP based or ASTI time synchronization service as described in clauses 5.5.11.3 and 5.5.11.4.

\* \* \* \* End of change \* \* \* \*