



FS_5TRS_URLLC, KI #1: 5GS network timing synchronization status and reporting

Ericsson



Background

- Latest conclusion attempt for KI#1 in S2-2205514 (r08) was not agreed in SA2 #152e.
- Some open issues are still to be discussed
 - Editor's note: Whether both UE and AF need to be informed about the time synchronization status simultaneously, and in which cases only UE or only AF may receive it is FFS.
 - UEs in Idle determine based on information in SIB that the quality of the 5GS reference time has changed.
 - Editor's note: Whether, and if yes which existing, or potentially new SIB information is used by the UE e.g., UEs in Idle, to make this determination is FFS.

Background



TS 22.104 states:

5.6.0 Description

Clock synchronicity, or time synchronization precision, is defined between a sync master and a sync device. The requirement on the synchronicity budget for the 5G system is the time error contribution between ingress and egress of the 5G system on the path of clock synchronization messages.

Clock synchronisation requirements specific for direct device connection and indirect network connection are captured in section 7.2.3 and 8.2.3.

With “5GS network timing synchronization status” for the scope, we believe it must be interpreted as the total 5GS status i.e., including all components in the 5GS distribution path (5GS= 5G System and including also Uu and UE) if Stage 1 requirements are to be followed.



Problem Statement: Reporting a time synchronization status to UE/AF

- Applications behind UE(s) are the receivers of accurate time services
- Usually there is an Application Function (AF) that manages (e.g., activates/deactivates/modifies) these services for the UEs supporting these types of applications
- Time Synchronization services are controlled via User subscription (based on “Time Synchronization Subscription data” stored in UDM)
- There are two ways on how a time sync service may be provided/activated according to the current solutions in the study:
 1. Triggered by an AF request (in combination with “Time Synchronization Subscription data”, i.e., UE needs to have a valid subscription for the AF requested time sync service)
 2. Only based on UE subscription (stored in “Time Synchronization Subscription data” at UDM) in cases when there is no AF and therefore no AF requests can be made



Reporting the status to both UE and AF

- It has been proposed to report a time synchronization status to UE and AF, however:
 - Why does a status report need to be sent to UE(s) in cases when there is an AF (that made a time synchronization service request) and the status report is sent to that AF?
 - There is a risk of inconsistency by sending status reports to two different 3GPP entities. How to solve any conflict situation in case of faulty reporting etc.? Which entity has the latest and correct information?
 - If there is no AF as such and a time synchronization service is activated solely based on the Time Synchronization Subscription data retrieved from UDM, only then a status report is sent to UE (i.e., application behind the UE)
 - This can be decided by TSCTSF, which can then trigger reporting towards specific UEs (via AMF and NG-RAN)
- **Proposal 1:** whenever there is an AF and a service is activated based on the AF request, the status report is sent only to that AF; however, when there is no AF request, the status report is sent only to the UE based on whose subscription the service was activated.



Scenario: UEs in RRC_IDLE state

As discussed in the external CC:

- For the considered use cases (e.g., in a Bank), UEs providing time synchronization service (including timing resiliency) may only be receiving time from the network.
- In general, UEs will move into RRC_IDLE state as there is no other ongoing data exchange with the network.
 - There is no reason to keep UEs in RRC_CONNECTED state.
 - Time can be provided to UEs in RRC_IDLE state via SIB9.



Transferring time sync status to UE via SIB (1)

- Since there might be UE(s) in **RRC_IDLE state**, it has been proposed to deliver time synchronization information to the application behind the UE using SIB9 messages, however:
- SIB (due to its broadcast nature) contains characteristics common for all UEs in a cell. For instance, the (optional) uncertainty field in SIB9 reflects the time uncertainty at the gNB antenna and it does not consider the remaining error components, such as UE internal errors and Uu errors.
 - Therefore, SIB9 is not suitable for delivering individual time sync service information on per UE basis.
 - Applications behind UE are interested in “End-to-end” information about time synchronization.
 - Broadcasting this information makes it difficult, if possible at all, for operators to create a value chain; the information is broadcasted to all UEs regardless to their subscription and there is no possibility to differentiate service levels.
 - Operators are (likely) not keen on revealing the actual performance metrics which then could be used for (not always fair) comparisons between competitors.



Transferring time sync status to UE via SIB (2)

- Revealing Time synchronization information openly in our view is a **security concern exposing** valuable information to potential attackers.
 - Example, an aggressor launching an attack on a local GNSS synchronization source might get a direct feedback on whether and how (un-)successful a jamming attack has been, use it extract essential information before launching an attack, or even it to judge about the impact on the operation of certain end applications and network communication services as such.
 - Furthermore, SIB messages are unprotected and subject to modification attacks since they don't have any integrity protection. Therefore, an attacker can modify timing information transported in a SIB message using, e.g., a so-called false base-station approach.



Transferring time sync status to UE via SIB (3)

- How relevant is it really for UEs offering a time synchronization service to be updated in RRC_IDLE state? Considering that UE(s) in :
 - RRC_CONNECTED state receive a status report via dedicated RRC messages (no security concerns)
 - RRC_INACTIVE state may be paged if subscription and status indicates that the user is authorized for the service, once in RRC_CONNECTED state they are able to receive a status report via dedicated RRC messages.
 - RRC_IDLE state can receive information when connected again, when subscription allows/supports
- Ericsson proposes that providing time sync info to UEs in RRC_IDLE do not need to be supported or justified considering the security risk and failure to comply with subscription-based services requirement
- Proposal 2:** No need to provide status reports for UE(s) in RRC_IDLE state
 - Alternative: proposed solution for a new Annex (see slide 11)



Summary of proposals

Proposal 1: Delivery of status report/information:

- In case where there is an AF and a service is activated based on the AF request, the status report is sent only to that AF, for UEs that have subscription for the service;
- In case there is no AF request, the status report is sent only to the UE based on available subscription for the service activated
- Status report/information needs to be simply **Yes/No** or **not fulfilled/fulfilled**

Proposal 2: Do not need to send status reports for UE(s) in RRC_IDLE state

- Alternative: proposed solution for a new Annex (see slide 11)



An Alternative Solution for an Annex

🌿 SIB9 messages are used to trigger UEs in RRC_IDLE to move to RRC_CONNECTED so that a time synchronization status report could be send via dedicated RRC signalling. The main steps:

- Two new fields are included in SIB9 –a flag, indicating a new time sync status report is availbale, and flagSetTimeUTC field reflecting a timeInfoUTC value when the flag was updated
- The flag and flagSetTimeUTC fields shall be updated by the NG-RAN node only when there is a change in a time synchronization status that needs to be reported to a UE, for instance, when specific service requirements cannot be fulfilled or when these requirements can be fulfilled again
- The flag needs to be considered as System Information (SI).
- Once received SI update notification, the UEs re-acquires a SIB9 message and reads the flag and flagSetTimeUTC fields and determines whether a new time synchronization report is available.
- If the report is available, the UE initiates the procedure to move to RRC_CONNECTED state.
- The NG-RAN determines (based on the information provided by the AMF via the TSCTSF) that the latest time synchronization status report needs to be send to this UE, which is then done via dedicated RRC signaling

🌿 More detailed description of this solution is given in S2-2208403.