

Timing Resiliency for Rel-18

RAN Rel-18 Workshop

28th June – 2nd July 2021

RWS-210115

Nokia, Nokia Shanghai Bell

Motivation for 5G Timing Resiliency

5G Release-18 TRS objectives

5G wide area networks will serve critical infrastructure services in public and private domains

5G resilient to loss of GNSS

1

5G wide area networks offer attractive wireless and indoor-capable time synchronization service

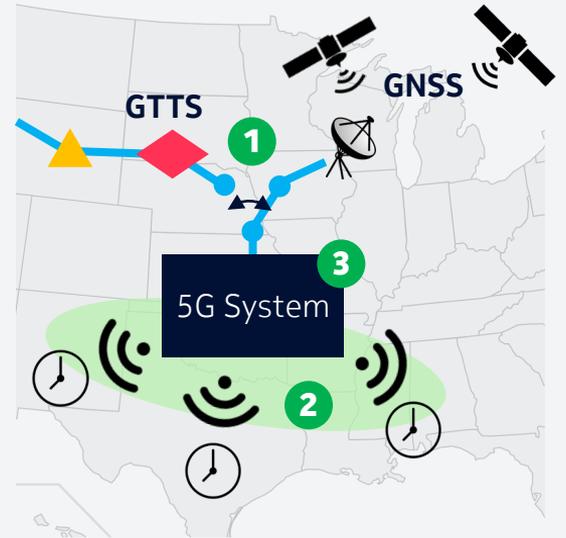
5G backup for GNSS timing

2

5G wide area networks maintain time synchronization accuracy under normal and challenging operation

5G maintains accurate timing

3



Expected outcome from Release-17

- Release-17 RAN WI is described in RP-201310 and focus on propagation delay compensation:

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| <ul style="list-style-type: none">4. Enhancements for support of time synchronization:<ul style="list-style-type: none">a. RAN impacts of SA2 work on uplink time synchronization, if any. [RAN2]b. Propagation delay compensation enhancements (including mobility issues, if any). [RAN2, RAN1, RAN3, RAN4] |
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- Standardize at **least one method for propagation delay compensation (PDC)**.
 - RAN1 has been asked by RAN2 to study methods of PDC. The methods are either based on timing advance based (based on either legacy Rel-15 and with enhancements), or an Rx-Tx based method known from positioning procedures. Two scenarios is studied, a smart grid scenario with 1 μ s E2E budget, and an indoor factory scenario with 900ns accuracy budget, where the latter is the most challenging from RAN perspective.
 - All companies agree that TA is sufficiently accurate for PDC to support the smart grid scenario. No additional overhead introduced. Activation signal to be standardized.
 - Rx-Tx based PDC is in competition to enhancing the TA procedure to be used for the indoor factory scenario. We prefer to supplement legacy TA PDC with Rx-Tx based PDC.
- NG-RAN to receive **time synchronization error budget available for the NG-RAN for Uu interface**.
 - RAN2 sees benefits having a Uu time synchronization budget at the gNB to assist PDC determination. There are still discussions on the specific format (e.g., flag, absolute value) and if the information can be provided by the CN.
- **Not all elements of the mobility enhancements** are being addressed in Release-17 to aid time synchronization.
 - Mobility issues has been discussed in both RAN2 and RAN3. The main challenge is RAN2 having agreed that no UE clock imperfections (or inter-gNB clock imperfections) are to be considered. We believe this assumption is too simplified. Clock inaccuracy contributions together with wide area support (e.g., service area of a time domain) may require further study in RAN2 and RAN3 in Rel-18. Mobility enhancements may strongly benefit from the provided NG-RAN time synchronization error budget.

Timing Resiliency: Motivation

- Access to a reliable timing source is a requirement to an increasing number of services, such as in the banking area, smart grid, and even the 5GS itself.
- While many of these services currently use GNSS to manage time-synchronization, concerns have been raised in multiple GNSS reports due to spoofing threats, low resistance against interference, availability for indoor/urban use, etc.
- Several initiatives exist around the world to reduce critical dependencies and provide a complement to and backup for the timing component of GPS (fibre-based backup solutions or other radio solutions).
- Resiliency towards losses/degradation of GNSS is essential to ensure trusty 5GS delivery of any critical data services in the future, including timing service as only one example.
- 5GS can be envisioned as a UTC global wireless backup/alternate for GNSS/GPS timing service.

Timing Resiliency: Objectives

- Study and specify propagation delay compensation enhancements to meet the new use cases in Release-18, e.g. specify Rx-Tx based propagation delay compensation enhancements as a supplement to TA based procedure.
- Study and specify potential propagation delay compensation procedure overhead optimizations.
- Study and specify the impact from asymmetry to propagation delay compensation and compensation techniques.
- Study and specify the signaling impact for supporting timing resiliency on NG-AP and Xn for detection, recovery and mitigation of GNSS loss/degradation.
- Study and specify mobility optimizations for maintaining the time synchronization accuracy at the UE in the new wide-area use case in Release-18.
- Study and specify potential optimizations based on RAN awareness of device time synchronization hold-over capability.

Envisioned roadmap for Time Synchronization in 5GS (SA2 scope)



Rel-16 Vertical_LAN

- Integration with IEEE TSN Centralized configuration model
- Ability to support gPTP time synchronization, distribution of external clock via 5GS
- Pre-configured best master clock

Rel-17 IIoT

- Ability to support AF activated time sync service for gPTP, PTP or 5G clock
- Distribution of external clock at device side (uplink sync, UE-UE sync)
- BMCA

Rel-18 SA2 Proposal

- 5G Timing Resilient System – 5G becomes resilient to loss of GNSS Terrestrial alternative for applications using GNSS
- Support for holdover capabilities within the 5G network

TRS R18 SA1 WID

KPIs for 5G Timing Resiliency

The 5G system shall be able to support a holdover time capability with timing resiliency performance requirements defined in table 7.8-1.

Table 7.8-1: Timing resiliency performance requirements for 5G System

Use case	Holdover time (note 3)	Sync target	Sync accuracy	Service area	Mobility	Remarks
Power grid (5G network)	Up to 24 hour	UTC (note 1)	<250 ns to 1000 ns (note2)	< 20 km ²	low	When 5G System provides direct PTP Grandmaster capability to sub-stations
Power grid (time synchronization device)	>5 s	UTC (note 1)	<250 ns to 1000 ns (note2)	< 20 km ²	low	When 5G sync modem is integrated into PTP grandmaster solution (with 24h holdover capability at sub-stations)
<p>NOTE 1: A different synchronization target is acceptable as long as the offset is preconfigured when an alternatively sourced time differs from GNSS. In this case, a 5G end device will provide PPS output which can be used for measuring the difference.</p> <p>NOTE 2: Different accuracy measurements are based on different configurations needed to support the underlying requirements from IEC 61850-9-3 [b]. The range is between 250 ns and 1000 ns. The actual requirement depends on the specific deployment.</p> <p>NOTE 3: This requirement will vary based on deployment options.</p>						

Table 7.8-2: Timing resiliency accuracy KPIs for members or participants of a trading venue [e]

Type of trading activity	Maximum divergence from UTC	Granularity of the timestamp (note 1)
Activity using high frequency algorithmic trading technique	100 µs	≤1 µs
Activity on voice trading systems	1 s	≤1 s
Activity on request for quote systems where the response requires human intervention or where the system does not allow algorithmic trading	1 s	≤1 s
Activity of concluding negotiated transactions	1 s	≤1 s
Any other trading activity	1 ms	≤1 ms
<p>NOTE 1: Only relevant for the case where the time synchronization assists in configuring the required granularity for the timestamp (for direct use), otherwise it will be configured separately as part of the financial transaction timestamp process.</p>		

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