Use-cases and Enablers for resilient time of day services in 5G-A and 6G

2023 Workshop on Synchronization and Timing Systems (WSTS)

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Outlook

1

Use-cases for provisioning time in wireless networks

2

Enablers and enhancements for time synchronization over the air in 5G/5G-A networks

3

Timing resiliency enablers in 5G-A networks

4

Outlook: challenges to be solved in 6G

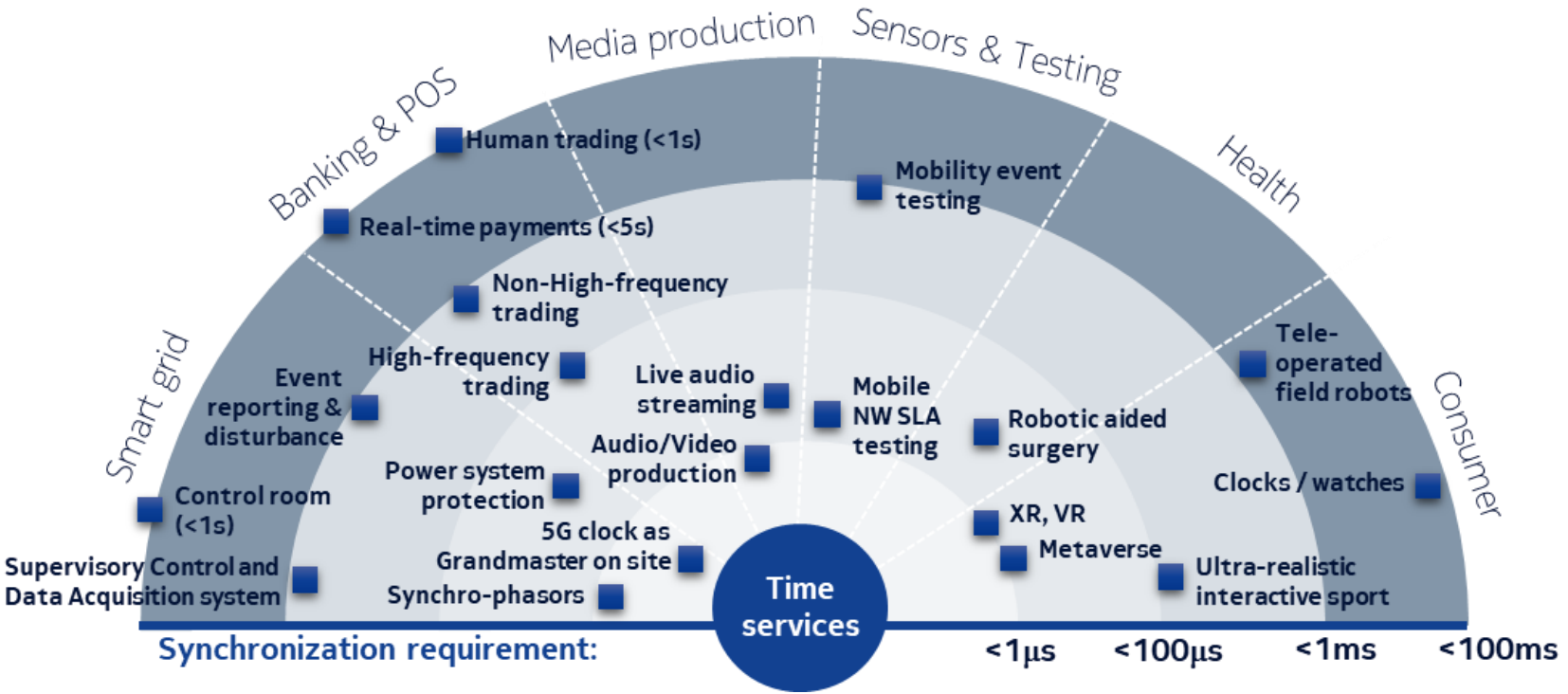
Access to time is a key enabler to humans and machines

5G offers a new wireless solution with excellent indoor coverage

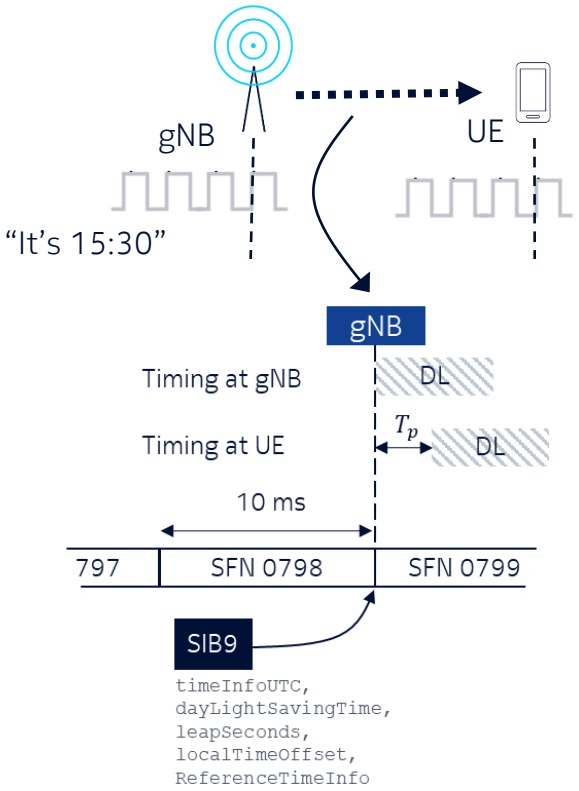
Time of Day service	**Telephone Time-of-Day incl. automated computer time**		**Radio station time service**	**GPS time transfer**	**Internet time service**	**5G time service**
Access method by user	Landline	VoIP, cell phone	Wireless receiver	Wireless receiver	Internet access, ex. PC or time device	Wireless receiver
Typical sync. accuracy	<30 ms	<150 ms	<50 ms	<100 ns	<100 ms	< 1 µs
Years of public operation	1933 - today		1945 - today	1973 - today	1990 - today	2021 onwards

Evolution of different methods available to acquire time-of-day synchronization (inspired by the content of [2])

Example use-cases for 5G wireless Time Service



How 5G device acquires UTC timing over air interface

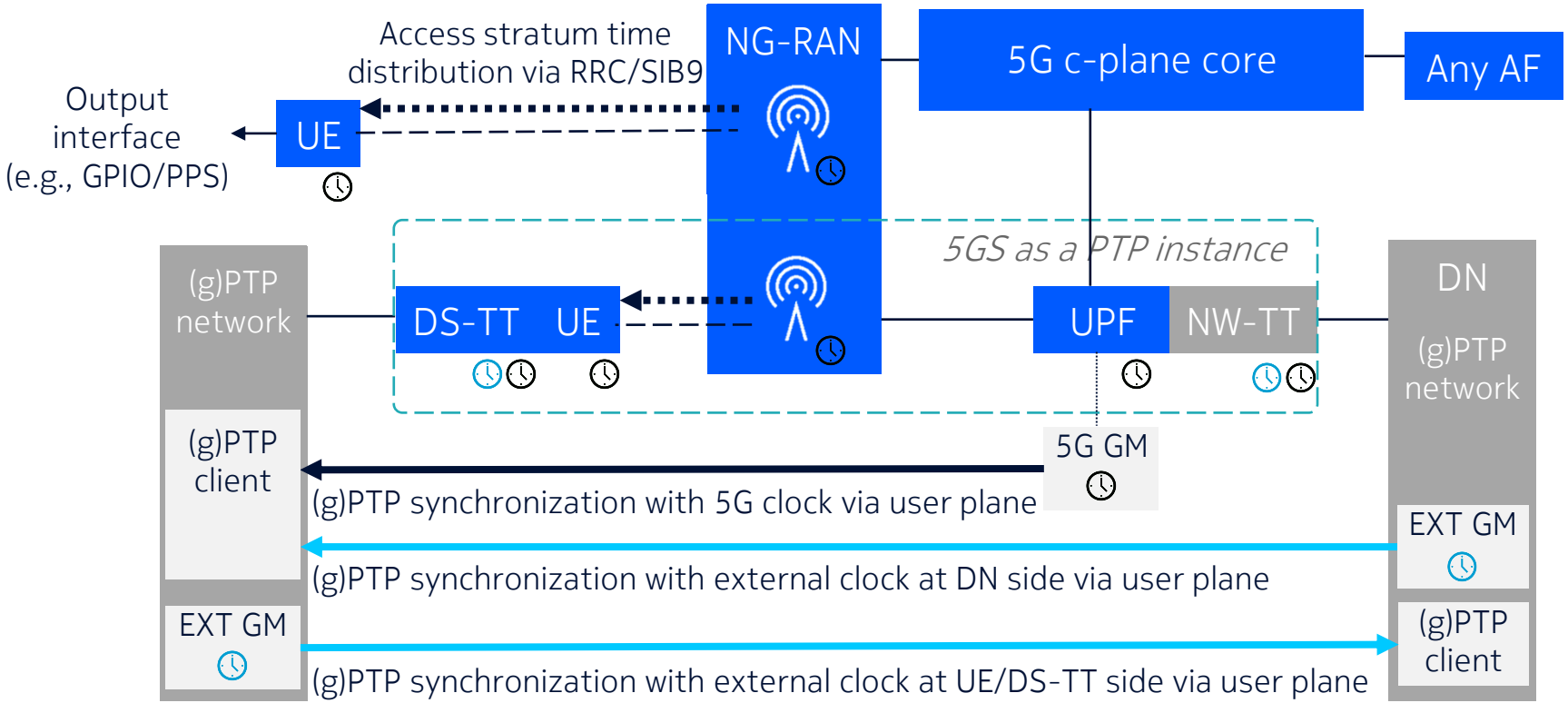


Procedure:

- 5G base stations are accurately synchronized to UTC
- 5G sends its timing relative to an event on the air interface identifiable by the device (SFN boundary)
- For larger cells (e.g., wide area coverage), the gNB and device estimate the propagation delay (Tp) and compensate the clock time by it
- This way, the device is synchronized to UTC by an accuracy that can be <1 microsecond (depending on implementation of base station and device)

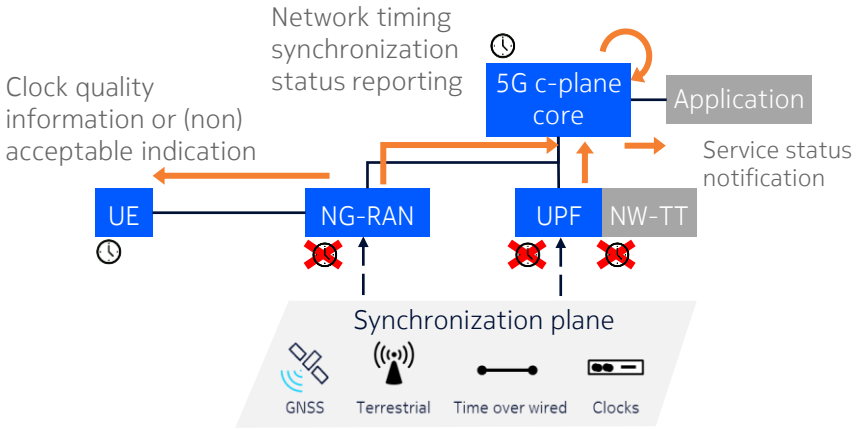
gNB = 5G Base Station
UE = 5G end-user device (e.g., phone, (I)IoT device, etc.)
SFN = System Frame Number
SIB = System Information Block

Advanced synchronization protocols supported by 5G



How to leverage 5G timing resiliency for critical use-cases?

- 5G depends largely on GNSS today for timing; one key objective in Release 18, is to enable resiliency of 5G system to survive the loss of GNSS
- 5G system has unique assets in checking and maintaining health of its own synchronization plane (ex. base station monitoring and holdover capabilities)



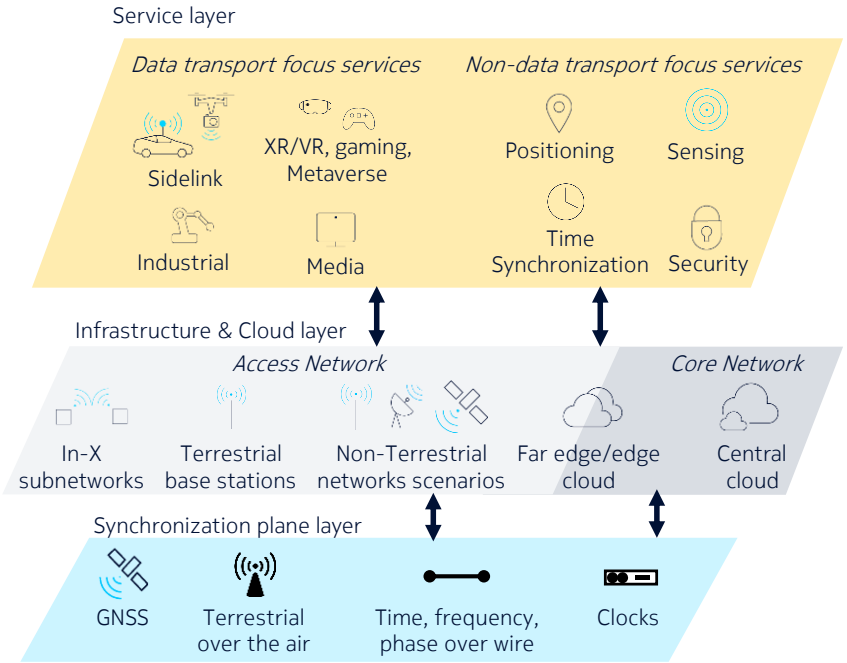
1

Integration of multiple external backup time sources, error detection, and mitigation by using proven industry standard protocols, techniques and practices already specified by other standardization bodies

2

Monitoring and reporting of the 5G network timing synchronization status to consumers (e.g., the devices and subscribed network applications)

Research needs for 6G time services



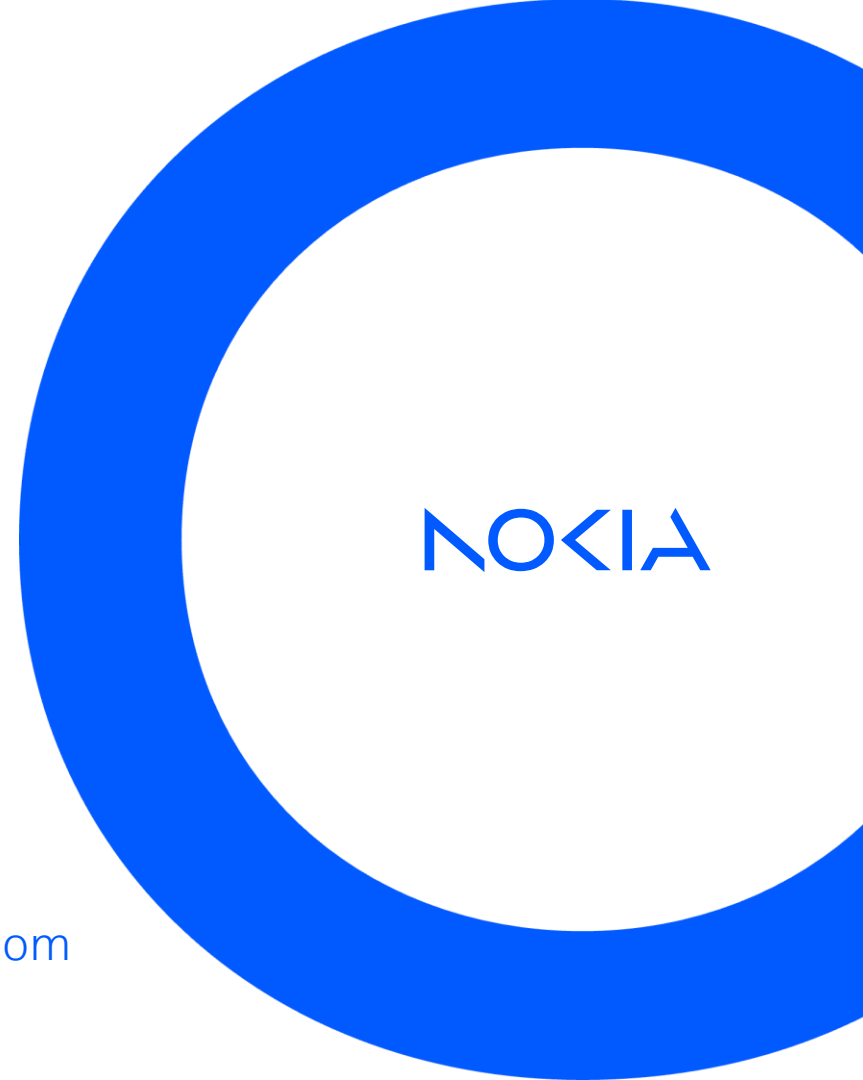
Enablers for low-complexity **nanosecond level** synchronization accuracy (reducing the gap to GNSS performance)

Enablers for **accurate time-redistribution** into 6G sub-networks, ex. local multi-device XR/holographic experiences, in-vehicle systems, etc.

Enablers for **further resiliency mechanisms**, leveraging the characteristics of base station implementation

Standardization enablers for improved **sync-plane services** in context of other advanced services such as sensing, positioning, etc.

Thank you!



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References

[1] 5G time service, Nokia white paper. [Online]. Available: https://onestore.nokia.com/asset/210965?_ga=2.135604849.1380031519.1675937032-717597119.1655193990

[2] National Institute of Standards & Technology (NIST), “Time Realization and Distribution,” 2021. [Online]. Available: https://www.nist.gov/time-distribution/radio-station-wwv/telephone-time-day-service.

[3] 3GPP TS 38.331, NR; Radio Resource Control (RRC); Protocol specification, v17.3.0

[4] 3GPP TS 23.501 System architecture for the 5G System (5GS), v18.0.0

[5] 3GPP TR 23.700-25, Study on timing resiliency and TSC and URLLC enhancements, v18.0.0

[6] 3GPP TR 22.878, Study on 5G timing resiliency system, v18.2.0


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