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Metro & RF Test
5G Sync

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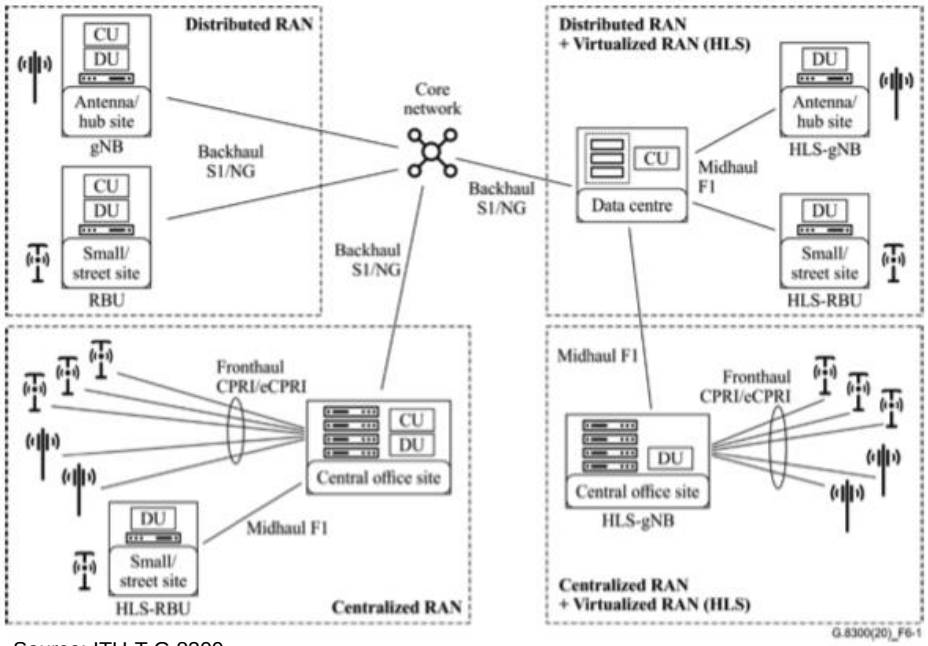
Regional Product Line Manager – Metro & RF
October 18th, 2022

VIAVI Solutions

5G Sync and Timing

Network Timing Requirements

5G Transport Network (ITU-T G.8300)

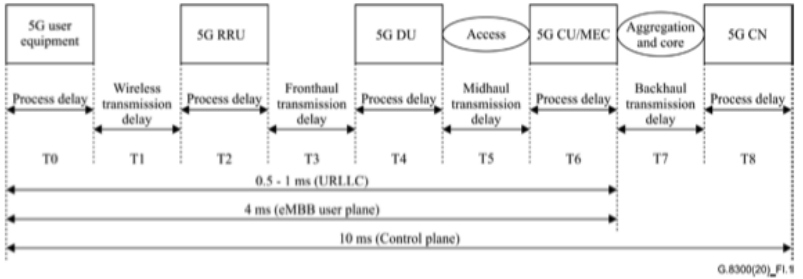


Source: ITU-T G.8300

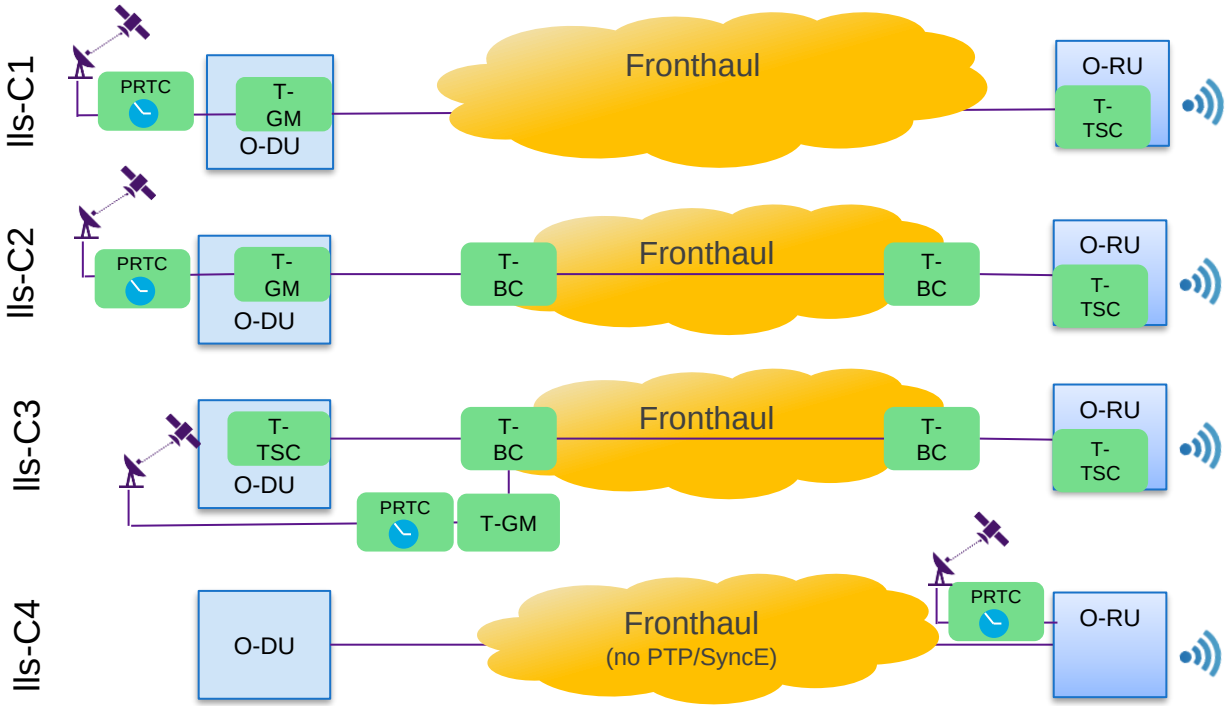
End-to-End Latency Requirements for Service Type

Service type		Latency requirement
eMBB	User plane (UE- CU/MEC)	4 ms
	Control plane (UE-CN)	10 ms
URLLC	User plane (UE-CU/MEC)	0.5 ms~1 ms
	Control plane (UE-CN)	10 ms

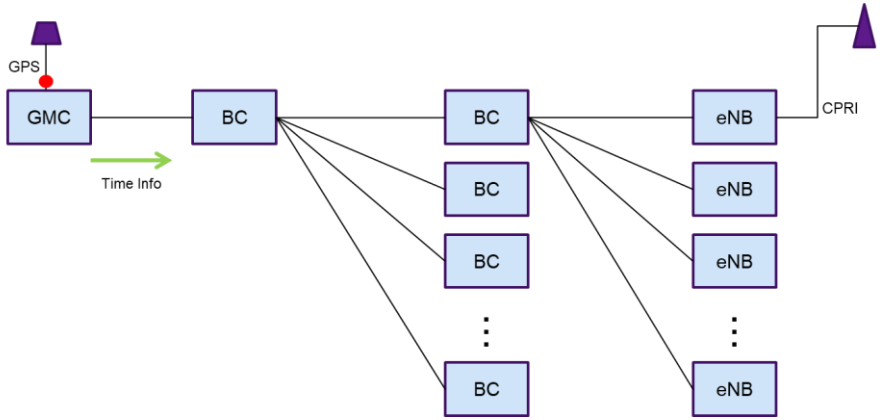
End-to-End Latency Allocation

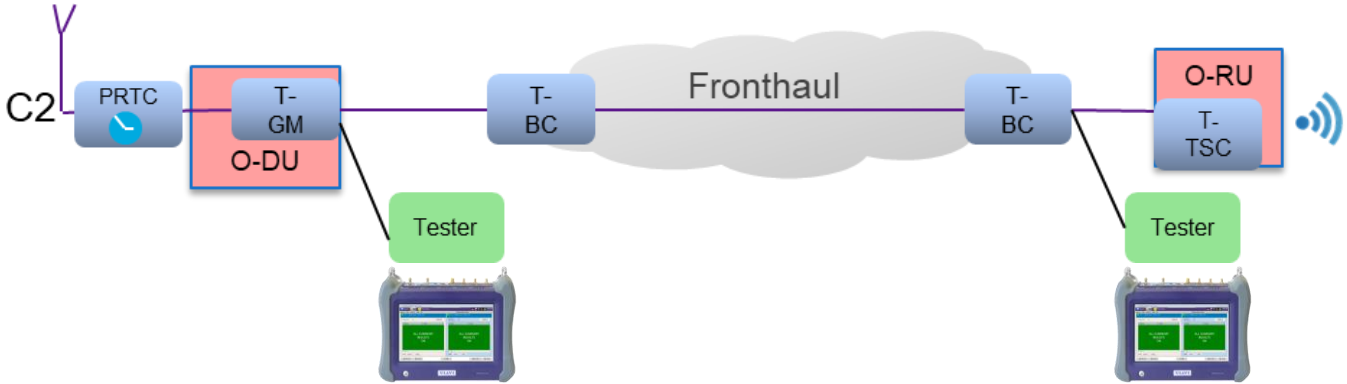


5G Fronthaul Sync Architecture



PTP Network Test





Synchronization Validation

Synchronization (PTP Application)

Validate Time Error measurement at various reference points

- → Constant and Dynamic Time Error cTE, dTE (MTIE/TDEV)
- → Maximum Time Error Max |TE|
- → Verify TE against limits set by ITU-T standards (ITU-T G.8271.1 (FTS)/G.8271.2 (PTS/APTS))
- → Verify connectivity to the Grand Master clock

Test Equipment

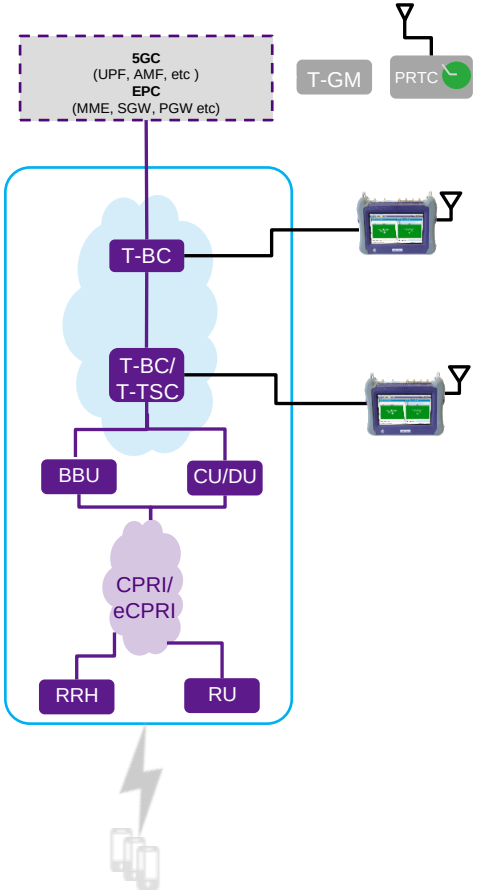
- → MTS-5800
- → TEM Module for MTS

Timing Error Requirements

Category	Time Error
A+ (relative)	20-32 ns
A (relative)	60-70 ns
B (relative)	100-200 ns
C (absolute)	1100 ns

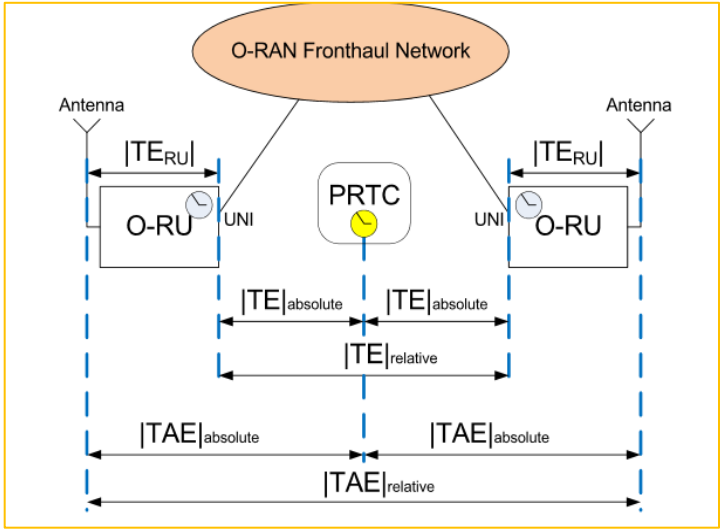
Timing Accuracy Categories

	RAN	
3GPP Feature	LTE	NR
MIMO or TX-diversity transmission	Category A+	Category A+
Intra-band contiguous carrier aggregation	Category A	BS Type 1: Category B BS Type 2: Category A
Intra-band non-contiguous carrier aggregation	Category B	Category C
Inter-band carrier aggregation	Category B	Category C
TDD	Category C	Category C
Dual Connectivity	Category C	Category C
COMP	Not specified in 3GPP	Not ready in 3GPP
Supplementary Uplink	Not applicable for LTE	Not ready in 3GPP
In-band Spectrum Sharing	Not ready in 3GPP	Not ready in 3GPP
Positioning	Not specified in 3GPP	Not ready in 3GPP
MBSFN	Not specified in 3GPP	Not ready in 3GPP



Synchronization Metrics

- **Synchronization essential for 5G cellular service (TDD, Carrier Aggregation)**
- 3gpp Time Alignment Error metrics are composed of $|TAE|_{relative}$ and $|TAE|_{absolute}$
- Time Error TE is defined as the time differences at a UNI compared to another UNI or PRTC
- $|TAE|_{absolute} = |TE|_{absolute} + |TE|_{RU}$
- $|TE|_{absolute}$ limits are smaller than $|TAE|_{absolute}$ listed below!



Category	|TAE|absolute	|TAE|relative	Application
A+	32.5ns	65ns	MIMO or TX diversity transmissions, at each carrier frequency.
A	65ns	130ns	E-UTRA intra-band contiguous carrier aggregation
B	130ns	260ns	NR intra & inter-band contiguous carrier aggregation; E-UTRA intra-band non-contiguous carrier aggregation
C	1.5µs	3µs	NR intra & inter-band non-contiguous carrier aggregation; TDD use cases

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Wireline Sync Test

New C5TEM-R2 – Timing Module Version 2

Common Functions

Miniature Rubidium Atomic Clock

Coax Cable Delay auto measurement

1 PPS Wander Analysis

1GE/10GE/25GE IEEE 1588-2008 (v2) (PTP)

- Master & Slave Operation
- Time/Phase and Frequency Profile Support (G.8265.1, G.8275.1, G.8275.2)

SyncE Support

SyncE and IEEE 1588-2008 (v2) (PTP) Wander Analysis

New v2 Functions

Multi-band satellite receiver

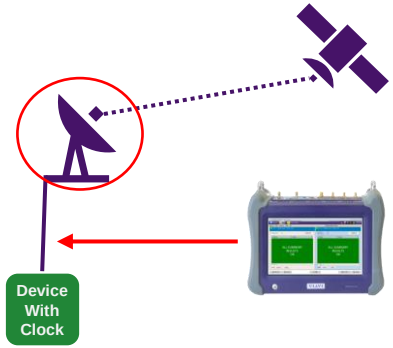
G.703 RJ-45 connector for 1PPS and Time of Day

GNSS 1 PPS pulse accuracy to +/- 5 ns (1-sigma)

BITS/SETS Clock input

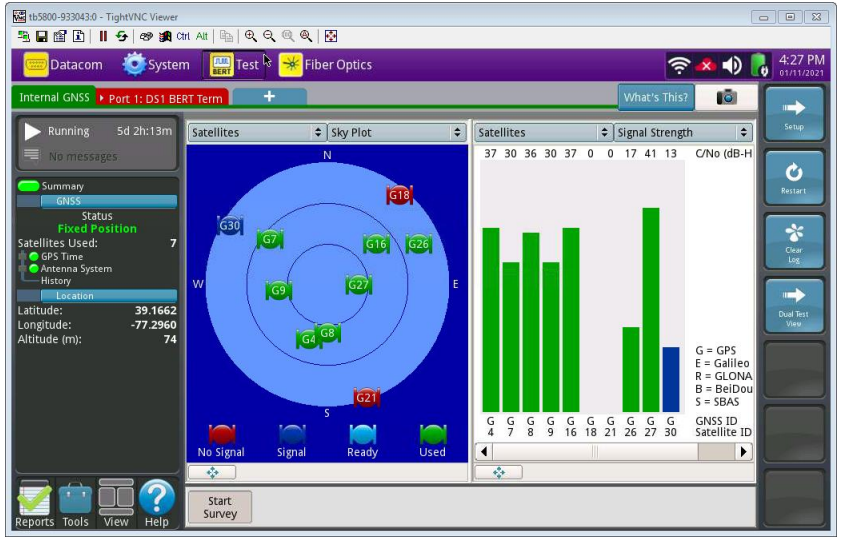
Best in class: Rubidium clock for holdover
RJ-45 G.703 connector

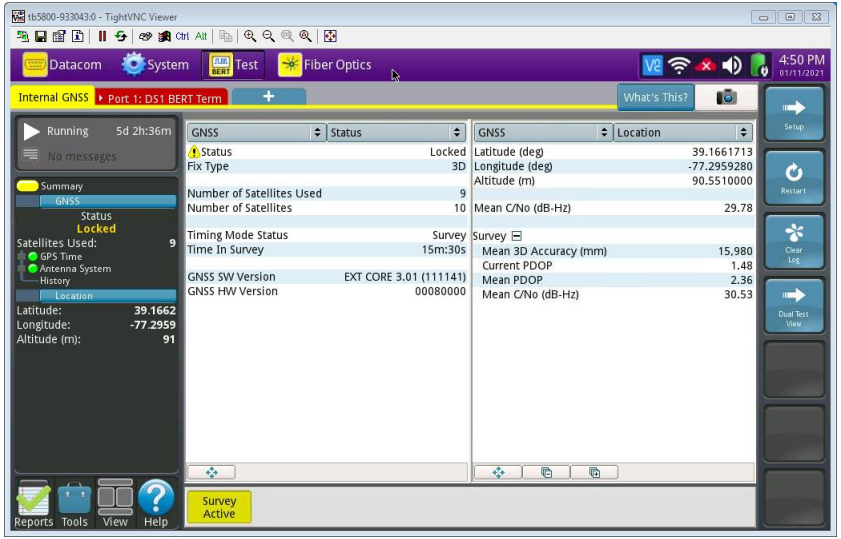
GNSS Antenna Test



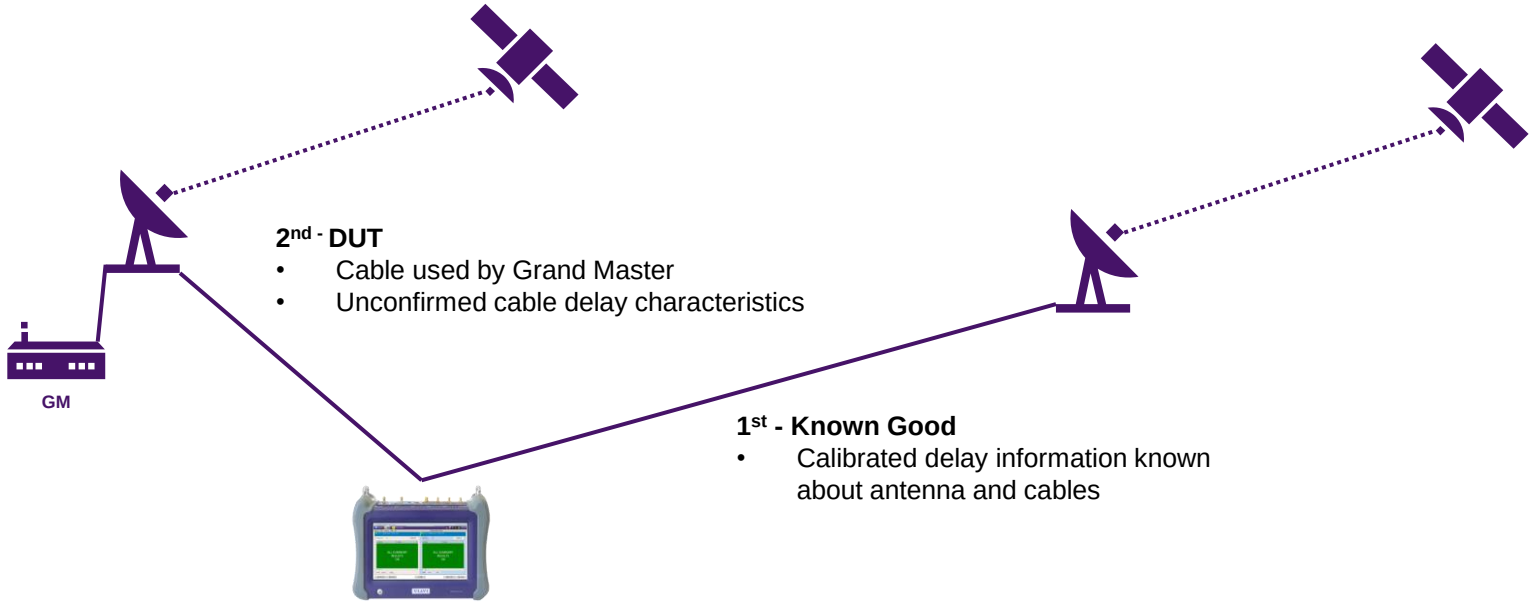
Recommended:

- At least 4 satellites usable
- C/No > 35 dB-Hz
- Mean 3D Accuracy < 5,000 mm





GNSS Antenna Cabling Delay Measurement

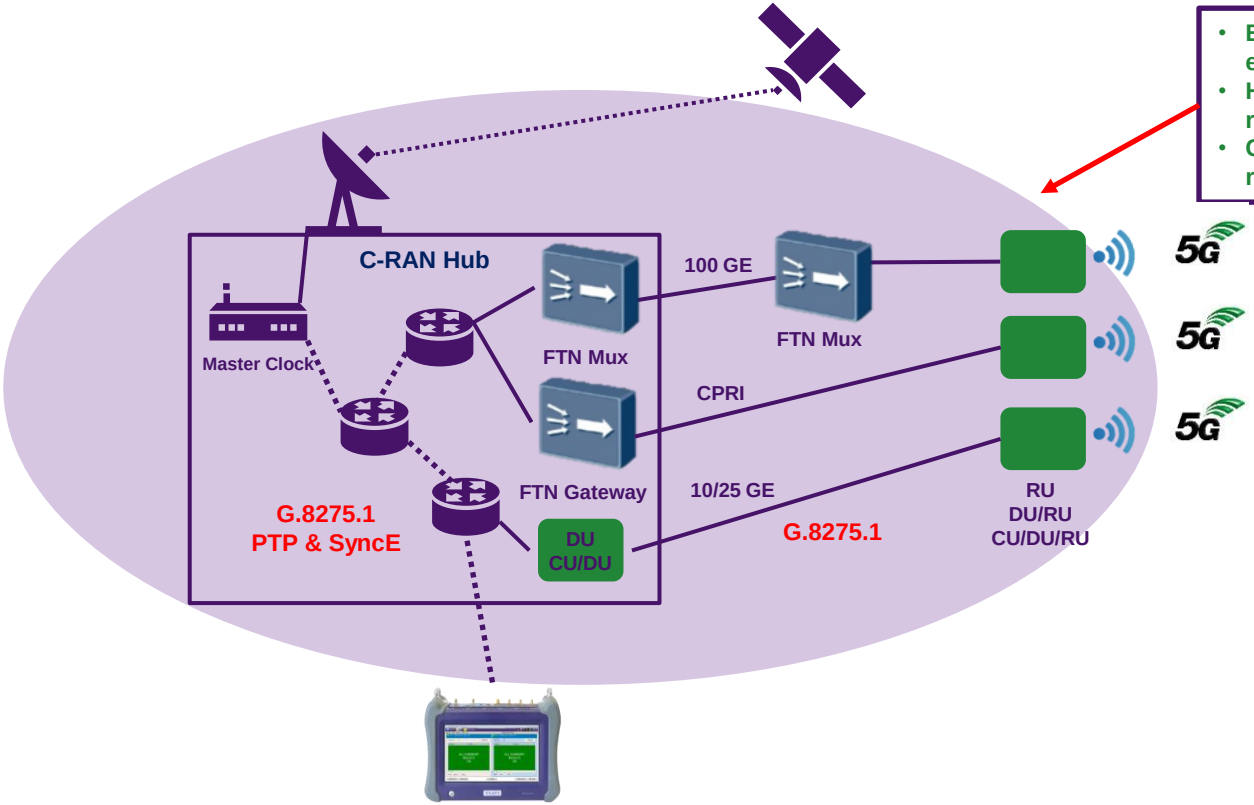


- Test confirms Antenna Cabling Delay
  - Frequency Delta (in ns) between Known Good and DUT indicates optimal cable delay for GM

Overview

- No need to perform a TDR on fiber or coaxial cable
- Delay includes any fiber to coax conversions
- Delay includes GNSS splitters and repeaters (if any)
- Delay includes surge arrestor delays (if any)

G.8275.1 C-RAN Hub Aggregation



- Extremely low time error needed
- Highest RF overlap & radio overlay
- Greatest risk of timing related interference

- Most important measurements
  - Max |TE|
  - cTE
  - Sync PDV
- Test at C-RAN Hub
  - Router interfaces
  - xWDM ports
  - Fiber demarc
  - Master clock
- Test at tower/pole/rooftop
  - xWDM ports
  - Fiber demarc

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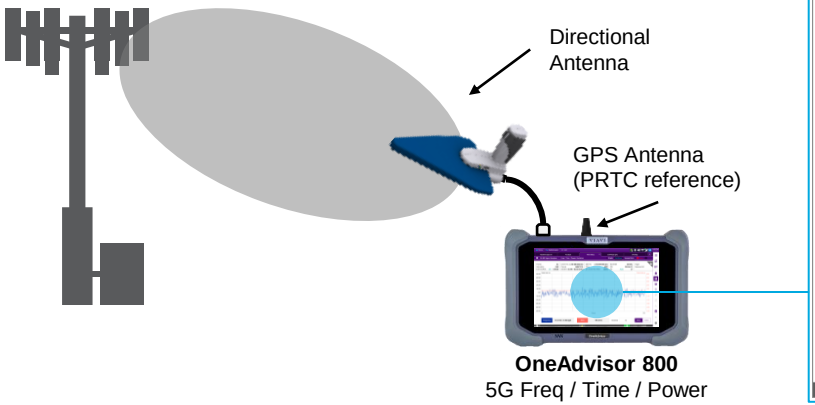
OTA Sync Test

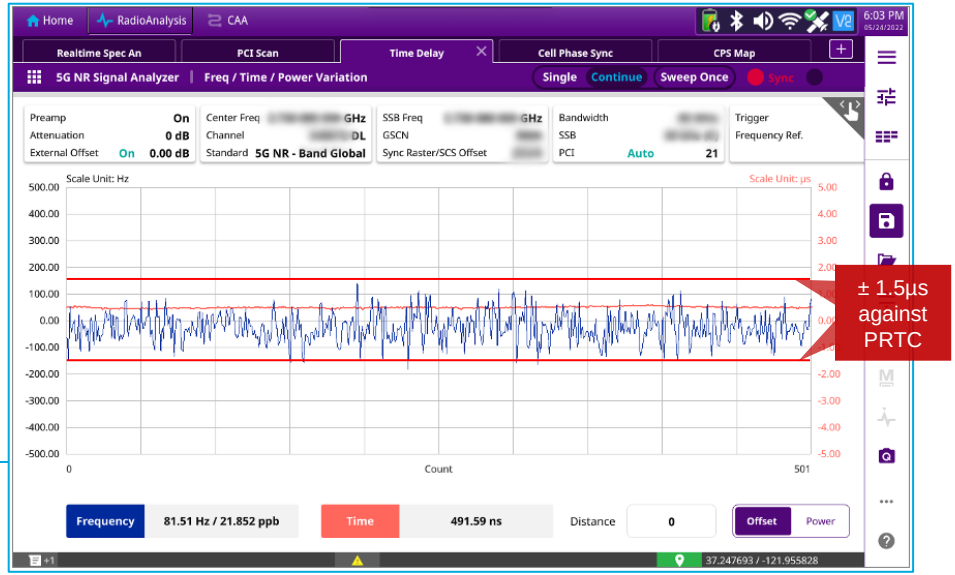
5G Sync and Timing

Air Interface: Time Error Requirements

5G Time Error Requirements (ITU G.8271 Class 4):

- UTRA-TDD, LTE-TDD (small cell), NR TDD, WiMAX-TDD (some configurations).
- Synchronous dual connectivity (for up to 9 km propagation difference between eNBs/gNBs in FR1).
- New radio (NR) intra-band non-contiguous and inter-band carrier aggregation, with or without multiple input multiple output (MIMO) or transmit (TX) diversity.



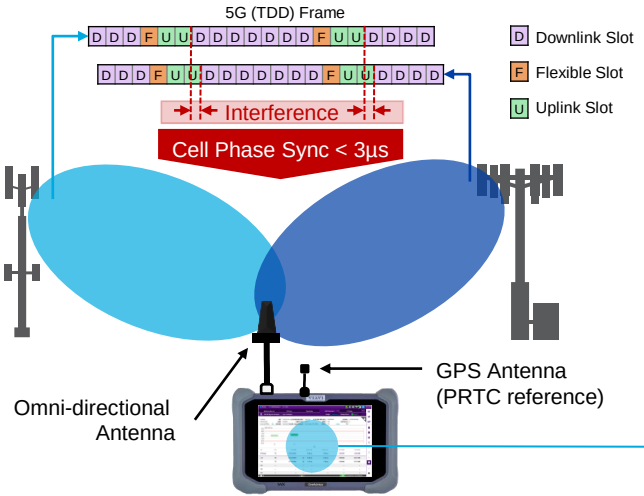


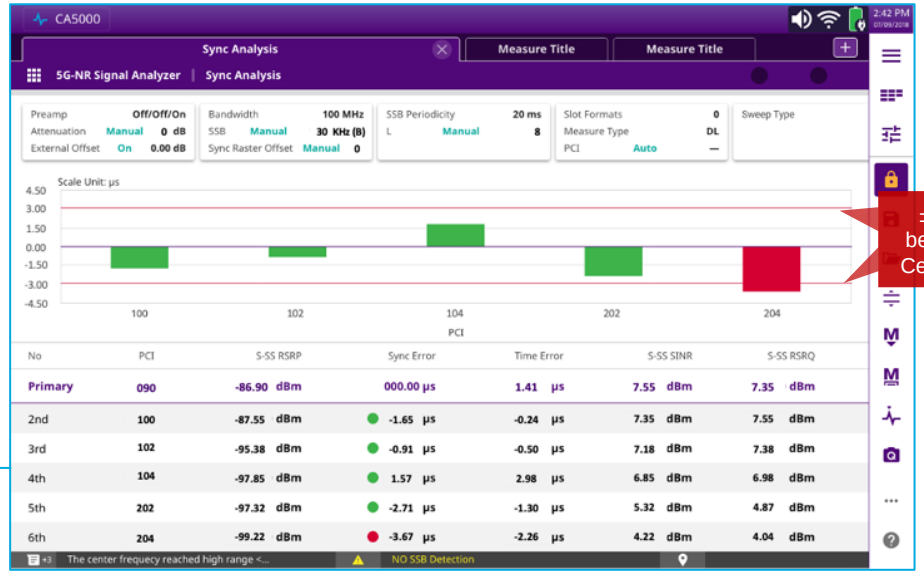
5G Sync and Timing

Air Interface: Cell Phase Synchronization Requirements

Cell Phase Synchronization Accuracy (3GPP 38.133)

- 7.4.1 Definition: Cell phase synchronization accuracy for TDD is defined as the maximum absolute deviation in frame start timing between any pair of cells on the same frequency that have overlapping coverage areas.
- 7.4.2 Minimum requirements: The cell phase synchronization accuracy measured at BS antenna connectors shall be better than 3 µs.





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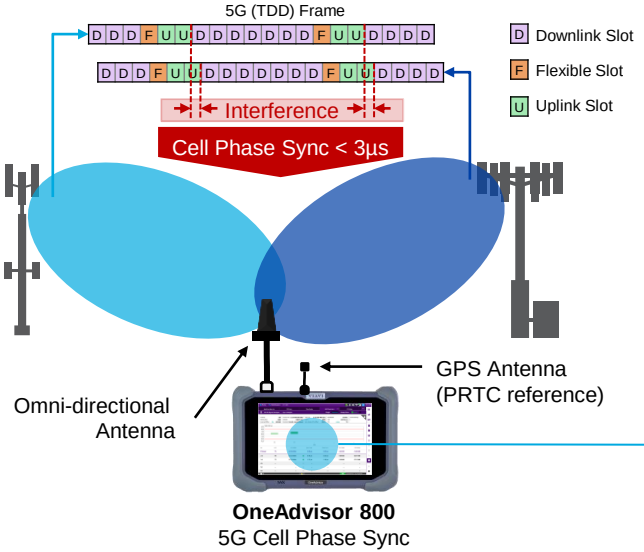
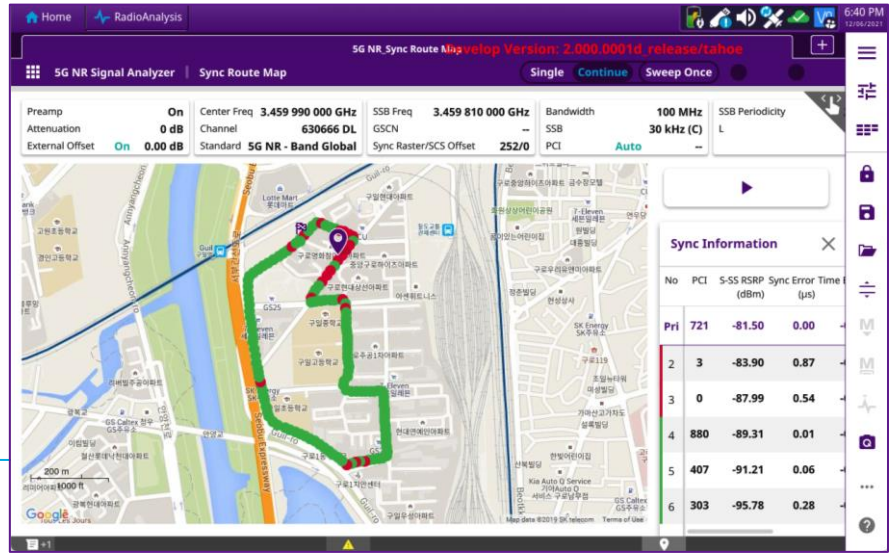
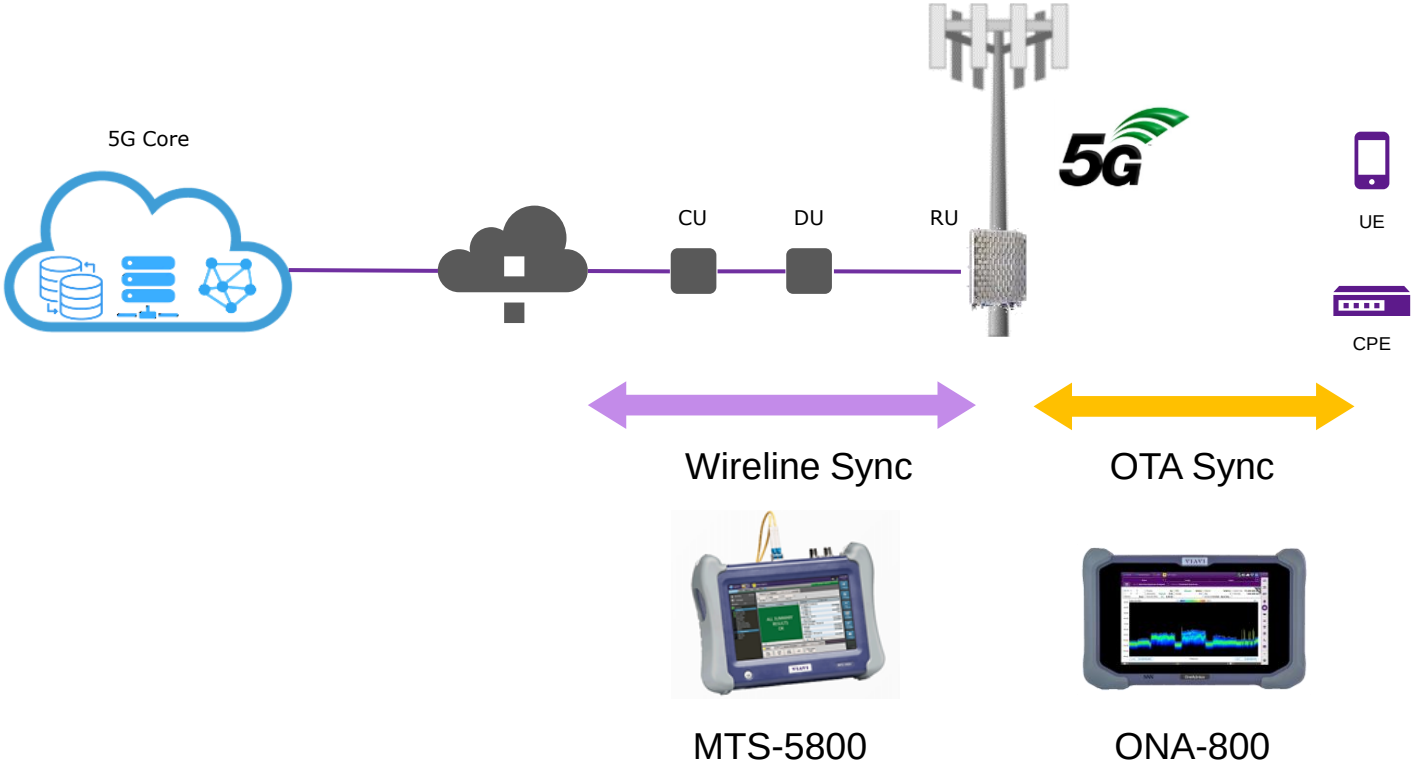




VIAVI test solution for 5G Sync

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