Network Synchronization Test Applications

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Agenda

- Introduction
- Time Alignment Error and Time Error
- Synchronization Test Applications
- Synchronization Tester
- Challenges
- Q&A

Introduction

- 5G and LTE advanced services pose new challenges for synchronization networks:
  - 3gpp technical specs such as 36.104/38.104
  - SLAs derived from Time Alignment Error TAE
    - TAE relative: Largest timing difference between two antenna
  - Different categories dependent on wireless service needs.

3GPP feature	RAN	
	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

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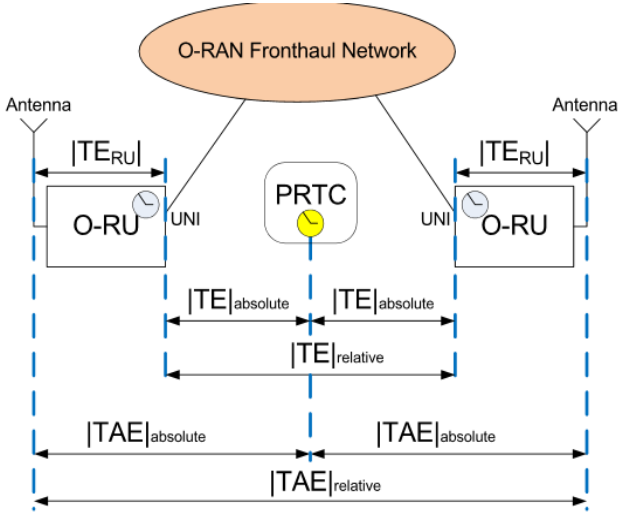
Time Alignment Error and Time Error

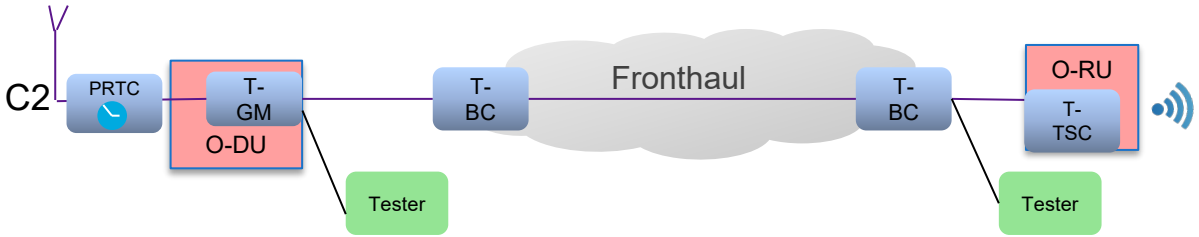
- 3gpp Time Alignment Error metrics are composed of $|TAE|_{relative}$ and $|TAE|_{absolute}$
- Time Error TE is defined as the time differences at a UNI compared to another UNI or PRTC
- $|TAE|_{absolute} = |TE|_{absolute} + |TE|_{RU}$
- $|TE|_{absolute}$ limits are smaller than $|TAE|_{absolute}$ listed 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

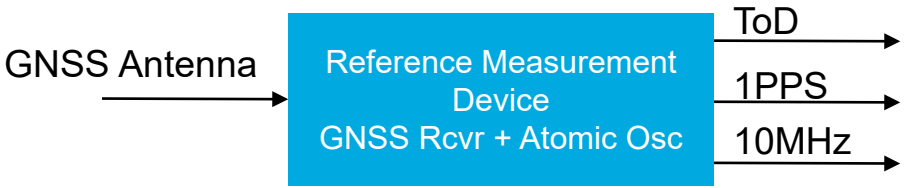
5G Synchronization Test Application

- Verify Time Error at various intermediate points of the network
- Constant Time Error, Dynamic Time Error (MTIE/TDEV)
- Measurement limits defined in ITU-T G.827x documents
- Required measurement accuracy in nano second range



5G Synchronization Test Equipment

- Performing time error measurements in nano sec. range demand highly accurate timing/synchronization reference devices synchronized to GNSS
- Line of sight to GNSS is not always available therefore a holdover function is essential for field applications -> Highly stable oscillator
- Measurement reference device interfaces:
  - Multiband GNSS Antenna input
  - ToD, 1PPS, and 10MHz outputs



Challenges

- Field deployment environments pose several challenges for a proper operation of measurement reference devices:
  - Temperature change as users go between indoor and outdoor settings
  - Mechanical/magnetic stress due to transportation/movement
  - Proper time reference performance necessitates an accurate location survey (especially challenging in an urban canyon location) and fine tuning of the oscillator; they can be time consuming
  - Accurate accounting for delay in all measurement cables and antenna systems
  - Users expect adequate data sheets with details of the performance characteristics (e.g. holdover time), although the performance highly depends on factors mentioned above

THANK YOU

Q & A

Backup Material

5G Fronthaul Synchronization Architectures