MEF

Amendment to MEF 22.2 - Time Synchronization

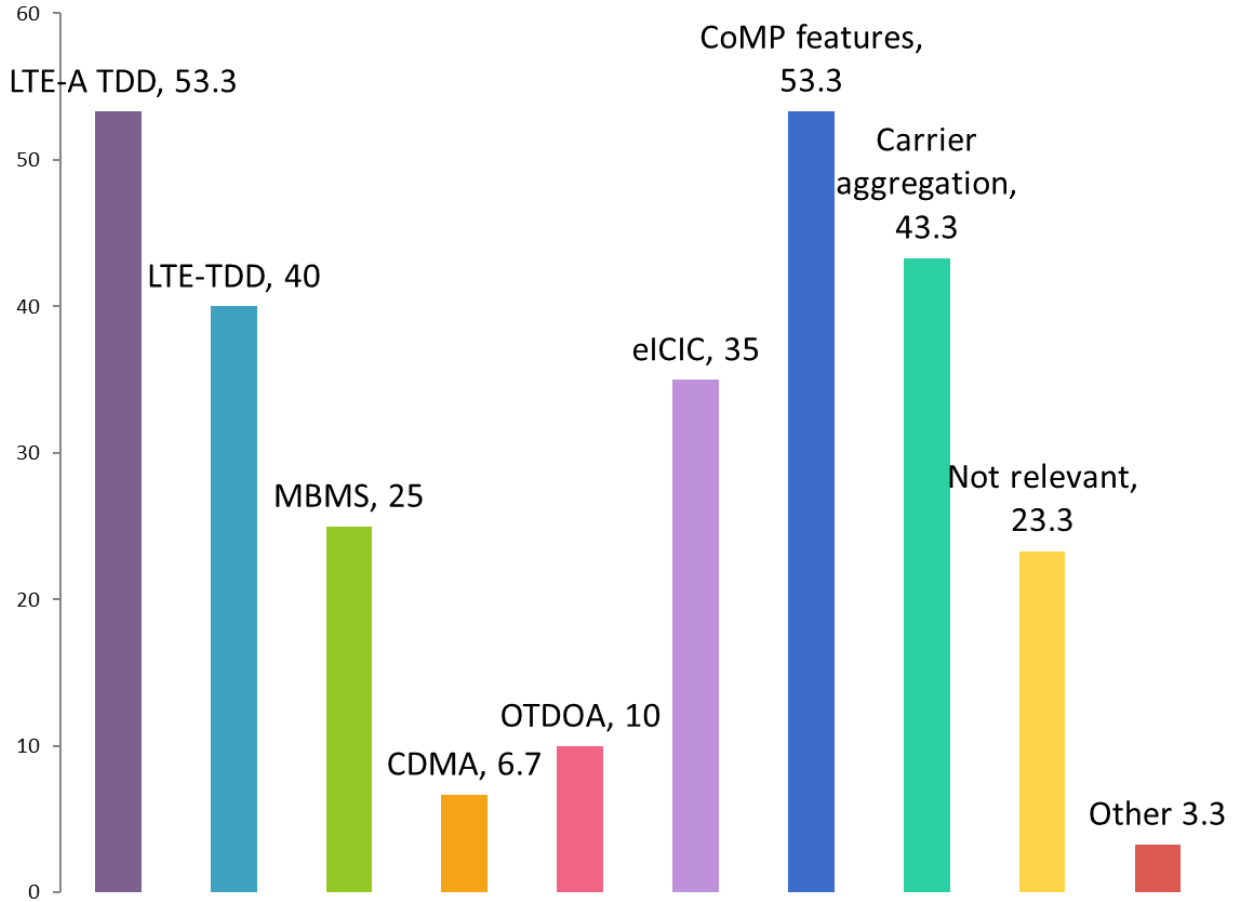
This Amendment (MEF 22.2.1) Summary

- This is an amendment to MEF 22.2 that addresses the addition of technical content on time and phase synchronization.
- Synchronization is a generic concept of distributing common time and frequency references to all nodes in a network to align their time and frequency scales. In this Implementation Agreement (IA) timing is used as a single term to refer to either time or frequency.
- Synchronization is a key component in mobile technologies and different mobile technologies have different synchronization requirements. This phase of the IA addresses both frequency synchronization, as well as time and phase synchronization.
- Synchronization is used to support mobile application and system requirements to minimize radio interference, facilitate handover between base stations, and to fulfill regulatory requirements. Various mobile technologies stipulate that the radio signal must be generated in strict compliance with frequency, phase and time accuracy requirements.

- MEF ran recently a survey to determine the usage of synchronization methods and the following three slides are the highlights of the results

MEF Synchronization Survey 2017

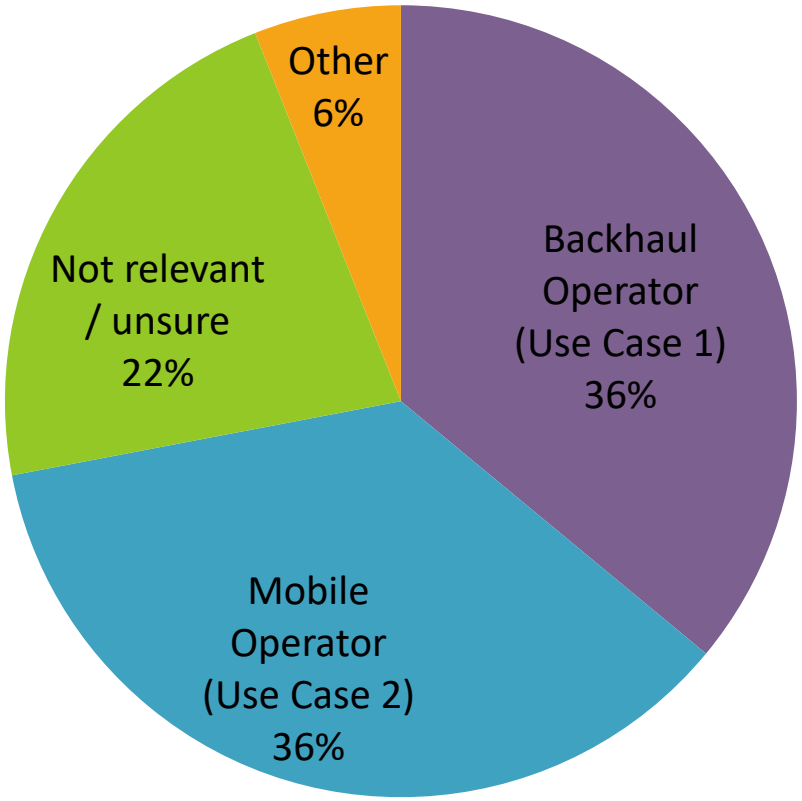
What applications/technologies will drive the accuracy requirement for time of day synchronization at RAN BS?



Value	Percent	Count
LTE-A TDD	53.3%	32
LTE-TDD	40.0%	24
MBMS	25.0%	15
CDMA	6.7%	4
OTDOA	10.0%	6
eICIC	35.0%	21
CoMP features	53.3%	32
Carrier aggregation	43.3%	26
Not relevant	23.3%	14
Other	3.3%	2

MEF Synchronization Survey 2017

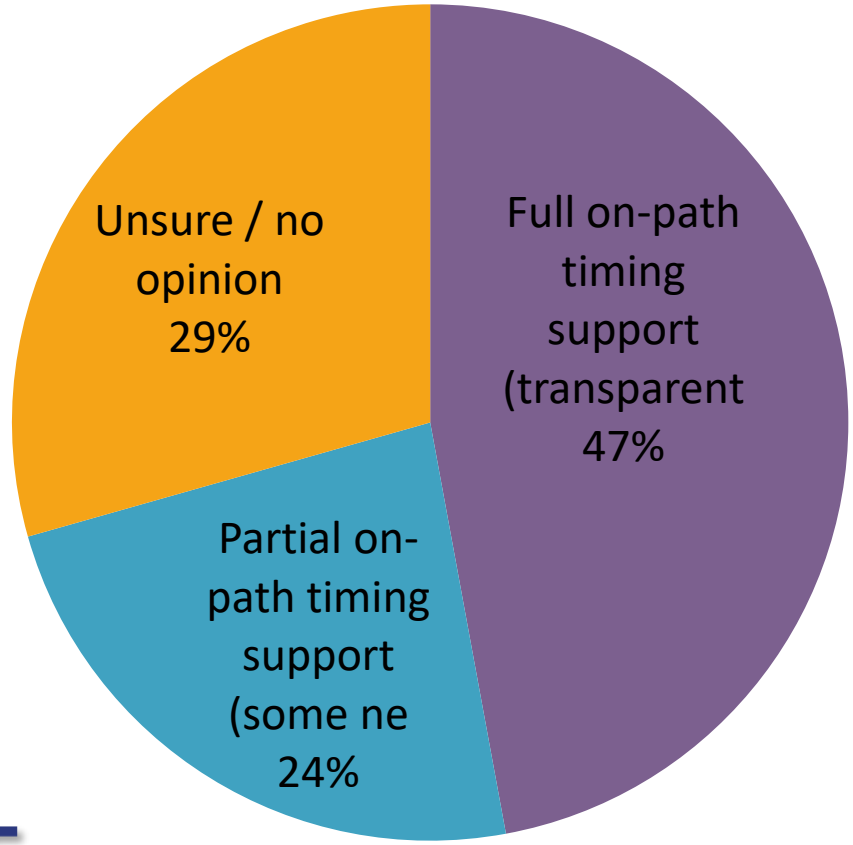
Who should own the grand master when providing time sync over the backhaul link?



Value	Percent	Count
Backhaul Operator (Use Case 1)	36.0%	18
Mobile Operator (Use Case 2)	36.0%	18
Not relevant / unsure	22.0%	11
Other (please specify)	6.0%	3
	Total	50

MEF Synchronization Survey 2017

In the case that a mobile operator owns the time sync master, do you expect the timing across a backhaul operator network to be handled with full on-path timing support or via partial on-path timing support?



Value	Percent	Count
Full on-path timing support (transparent	47.1%	8
Partial on-path timing support (some ne	23.5%	4
Unsure / no opinion	29.4%	5
	Total	17

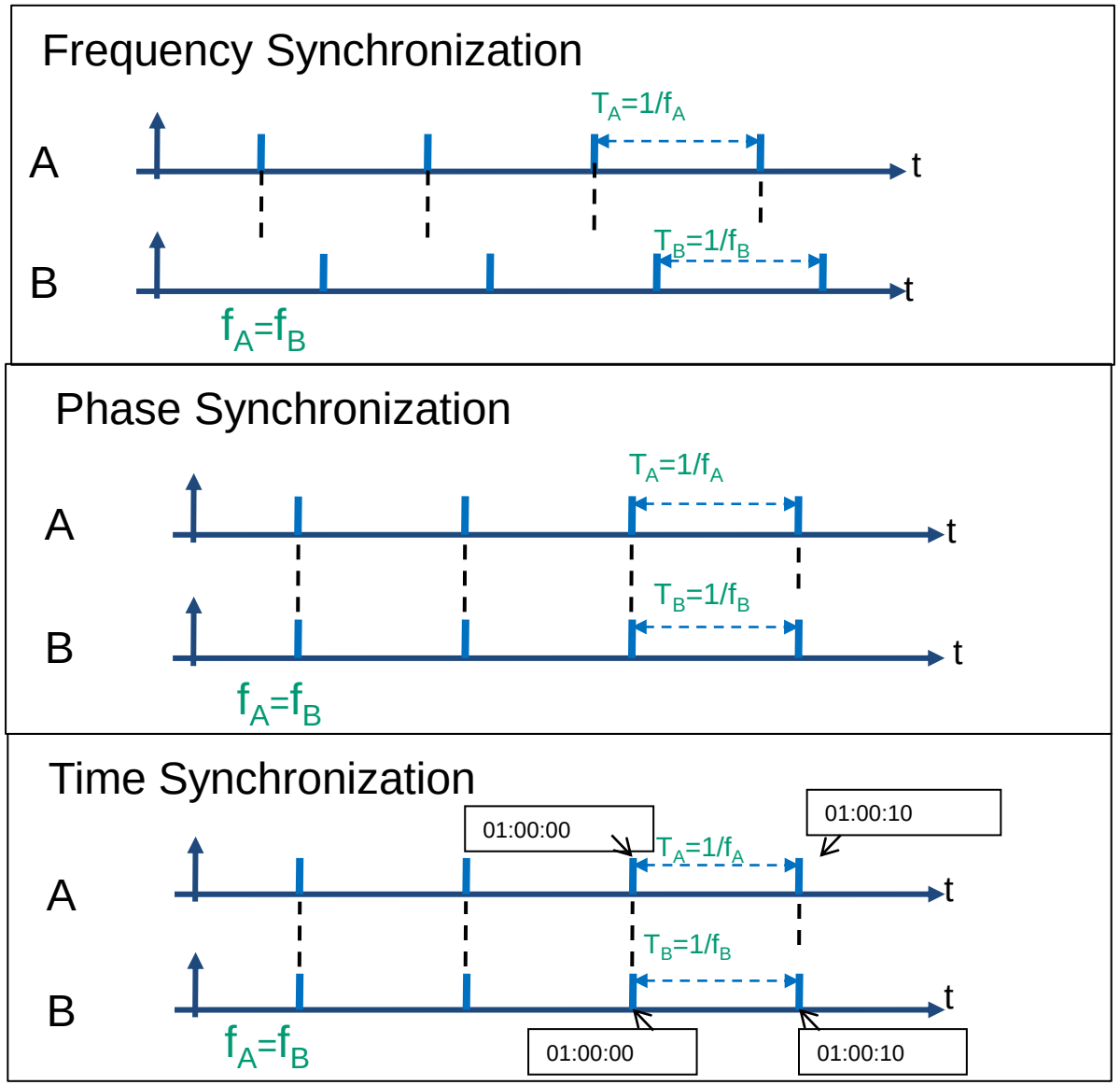
Time Synchronization - Amendment

- Two use cases for phase and time synchronization
- New service attributes for the first phase and time synchronization use case
- New requirements in support of phase and time synchronization
- Alignment of synchronization clause to distinguish between frequency and time synchronization
- Various editorial corrections, including alignment to current MEF style

MEF 22.2.1 Overview

- **1-7 – Introduction – Editorial**
- **11.4 – SyncE UNI – Editorial**
- **11.5 – Time Sync UNI – New section**
  - Time Synchronous Mode Service Attribute
  - Multicast address default value
- **13 – Synchronization – Editorial**
  - Existing text is “frequency sync” but often that was not indicated
- **13.4 – time synchronization – New**
  - Two uses cases
  - UNI-N interface limits
    - Use case 1 – PRTC in CEN - specified
    - Use case 2 – PRTC in mobile operator network – under study
- **14 – References – new ITU-T & ATIS**

Synchronization Requirements



Mobile Network Architecture	Frequency Sync	Time-of-day / Phase Sync
CDMA2000		✓
GSM	✓	
UMTS-FDD	✓	
LTE-FDD	✓	
UMTS-TDD	✓	✓
LTE-FDD with MBMS-Single Freq. Network	✓	✓
LTE-TDD	✓	✓
Mobile WiMAX	✓	✓
TD-SCDMA	✓	✓
LTE-A (COMP, eICIC)	✓	✓
"5G" - NR	✓	✓

Background on Time and Phase

- **Time and Phase Synchronization in focus in several standardization bodies**
  - Main reference, ITU-T SG15 Q13
- **ITU-T G.8271 summarizes the main motivations for phase and time sync, and related solutions**
- **Solutions are based on relevant PTP profiles and related clock specifications:**
  - Network Performance: G.8271.1
  - Clock Specification: G.8272.3 (G.8273.3, Transparent Clock under development)
  - Architecture: G.8275
  - PTP profiles: G.8275.1, G.8275.2

Time Synchronization Requirements - Details

Level of accuracy	Time error requirements (Note 1)	Typical applications (for information)
1	500 ms	Billing, alarms
2	100 µs	IP Delay monitoring
3	5 µs	LTE TDD (large cell)
4	1.5 µs	UTRA-TDD, LTE-TDD (small cell) WiMAX-TDD (some configurations)
5	1 µs	WiMAX-TDD (some configurations)
6	x ns (Note 3)	Various applications, including Location based services and some LTE-A features (Note 2)

NOTE 1 – The requirement is expressed in terms of error with respect to a common reference.

NOTE 2 – The performance requirements of the LTE-A features are under study. For information purposes only, values between 500 ns and 1.5 µs have been mentioned for some LTE-A features. Depending on the final specifications developed by 3GPP, LTE-A applications may be handled in a different level of accuracy.

NOTE 3 – For the value x, refer to Table II.2 of Appendix II.

Main Focus

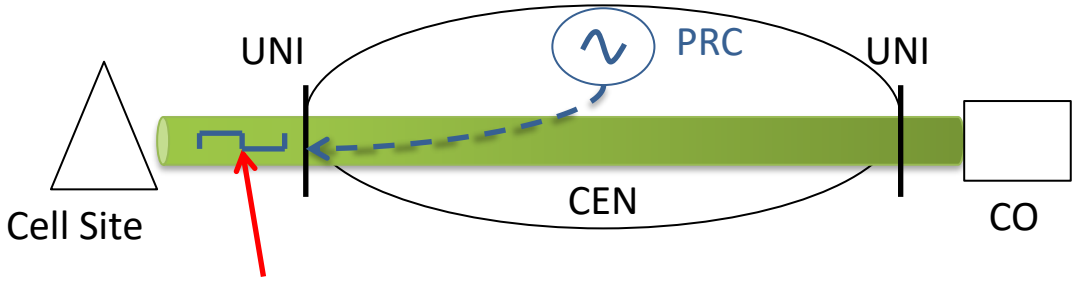
Table 1 from G.8271 (Time and phase requirement classes)

Current work in ITU-T addressing new and more stringent sync requirements (e.g., as applicable to fronthaul, and 5G applications)

2 Models for a Carrier Ethernet Sync Service

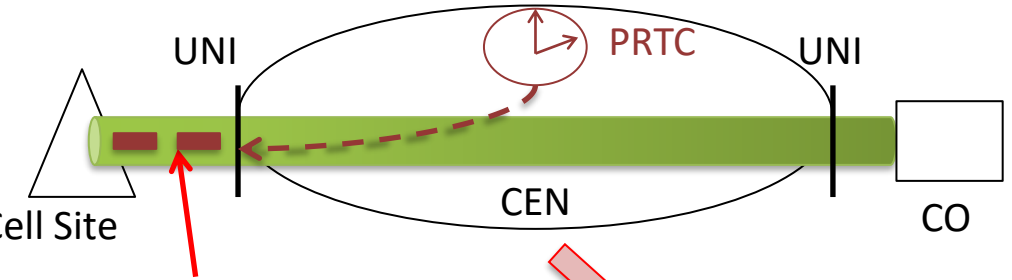
Model 1: synchronization reference provided by the CEN Service Provider

A- Frequency synchronization with SyncE



Provided as part of the CE service: Synchronous Ethernet link (physical layer) + ESMC frames (Ethernet layer) (existing synchronous mode attribute)

B- Phase/time synchronization with PTP G.8275.1

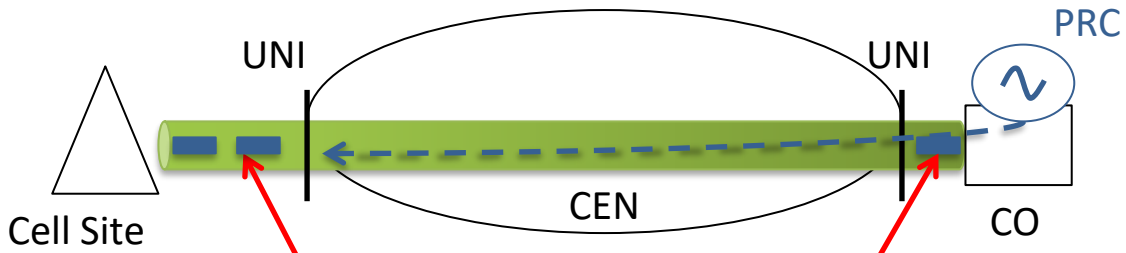


Provided as part of the CE service:
G.8275.1 PTP frames (Ethernet layer)

Time Synchronous Mode Service Attribute

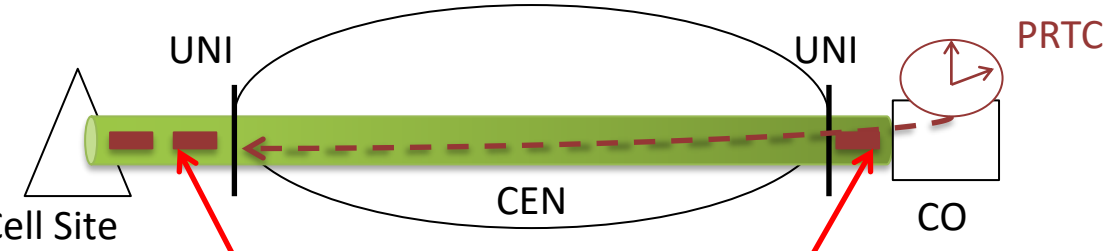
Model 2: synchronization reference carried transparently over the CEN

A- Frequency sync with PTP G.8265.1



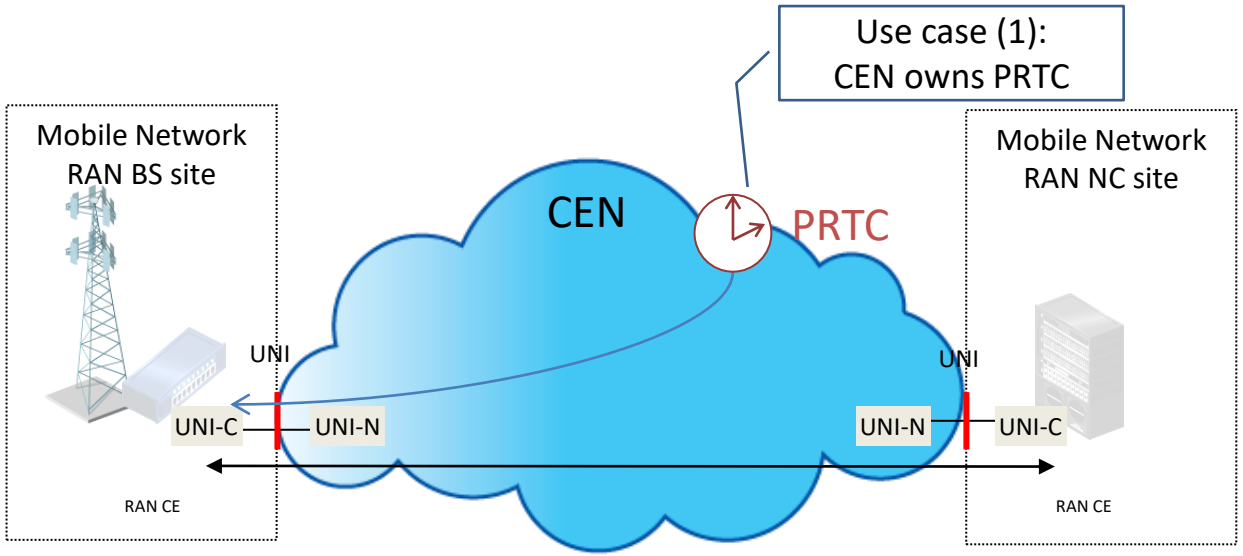
G.8265.1 PTP frames (IP mapping) are generated by the MNO and carried transparently over the CEN

B- Phase/time synchronization with PTP G.8275.2



G.8275.2 PTP frames (IP mapping) are generated by the MNO and carried transparently over the CEN
(there is no sync service attribute, the SP is not involved.
Note 2: A specific SLA for performance objectives and QoS is for further study. The related parameters are work in progress within ITU-T.

Use Case 1 – CEN owns PRTC



Related to Model 1, case B

Time Synchronization Service with PRTC in the CEN – ITU-T G.8275.1 Boundary Clock chain

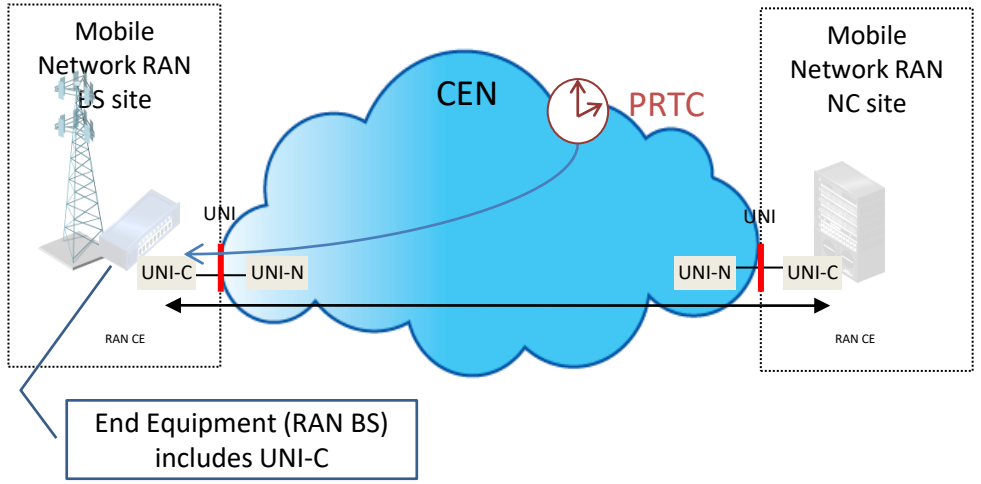
Note 1: Transparent Clock may also be used according to G.8275.1 (clock performance spec., G.8273.3 under study)

Note 2: How the reference is carried in the CEN is implementation-specific, as long as the network limits are met at the UNI

Network Limits – Use Case 1

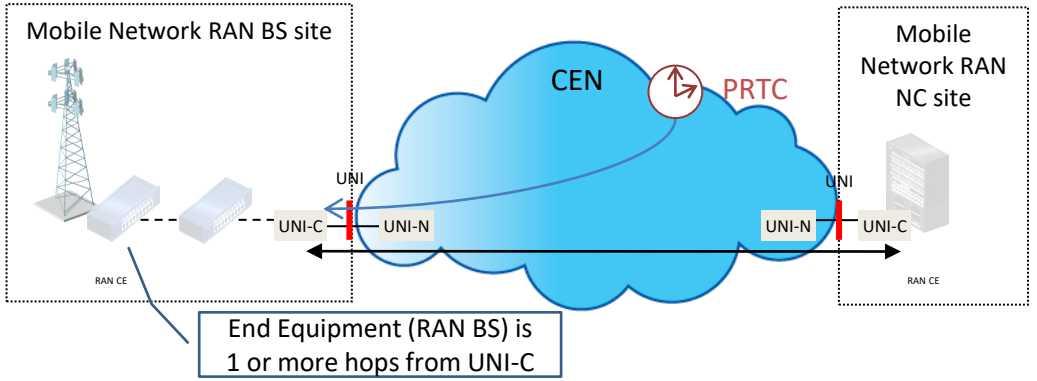
Network Limits Type I – at RAN BS site *(ITU-T G.8271.1 as-is)**

- peak-to-peak TE amplitude
- MTIE
- Maximum absolute time error



Network Limits Type II – at RAN BS site *(part of ITU-T G.8271.1)**

- peak-to-peak TE amplitude
- MTIE depends on the actual use case



* Currently focusing on +/-1.5 us at the output of the End Equipment. Other use cases under study

Network Limits – Use Case 1 - Details

Exchange of Liaisons with ITU-T Q13/15 reviewing the relevant text

Network Limits Type I:

-**A-R4**...**for any network limit Type**, the interface MUST meet the specification for the **dynamic time error** in terms of **peak-to-peak TE** amplitude as defined in clause 7.3 from ITU-T G.8271.1

> *..for frequency components higher than 0.1 Hz .. as measured over a 10'000 second interval:* ***peak-to-peak TE amplitude < 200 ns***

-**A-R5**... **for Type I network limits**, the interface MUST meet the specification for the **dynamic time error in terms of MTIE** as defined in clause 7.3 from ITU-T G.8271.1

-**A-R6**: the interface MUST meet the specification for **Maximum absolute time error** network limits defined in clause7.3 from ITU-T G.8271.1

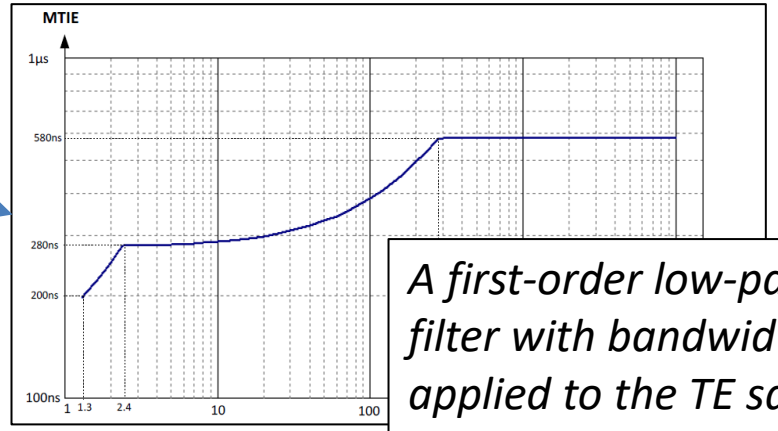
> ***Maximum absolute time error*** *network limit applicable at the reference point C: max \|TE\| ≤ 1'100 ns.*

Network Limits Type II:

-Same limit as for Type I for **dynamic time error in terms of peak-to-peak TE amplitude**

-The specification in terms of **MTIE** for other network limits type (e.g. Type II) in general **depends on the characteristics of the network segment between the UNI-C and the End Equipment**..

For small networks (e.g. 1 or 2 hops) the same specification as per type I could be assumed



A first-order low-pass measurement filter with bandwidth of 0.1 Hz is applied to the TE samples measured at the packet timing interface prior to evaluating the max \|TE\|, MTIE and TDEV

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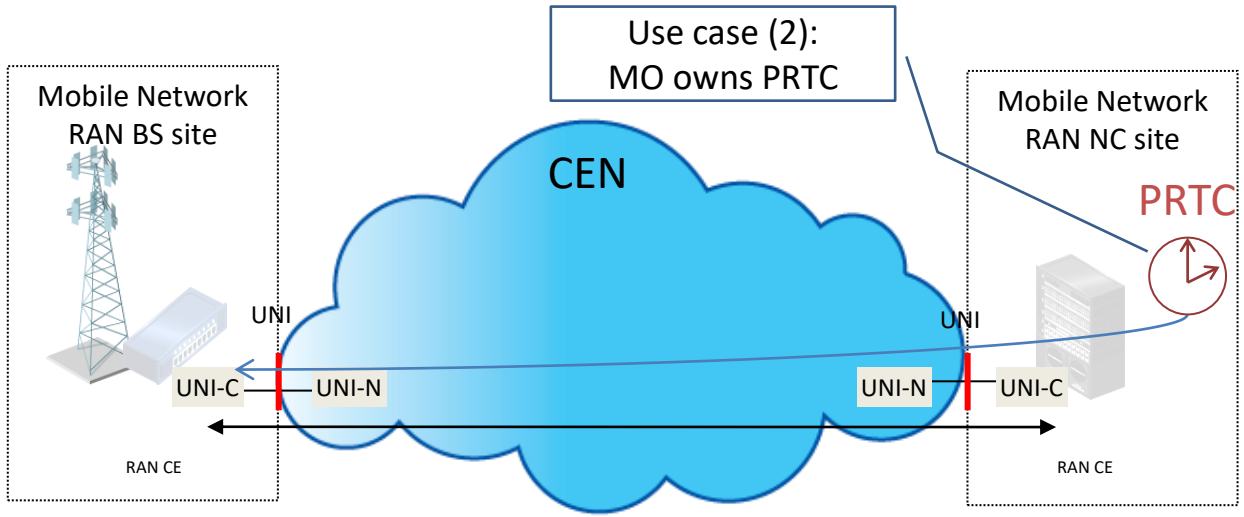
Use Case 2 – MO owns PRTC

Related to Model 2, case B



Synchronization Service with PRTC in the MO network – Partial timing support as per ITU-T G.8275.2

Note 1: There is no sync service attribute, the CEN is not involved
Note 2: A specific SLA for performance objectives and QoS is for further study. The related parameters are work in progress within ITU-T.