Calnex Solutions

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Synchronization in Fronthaul: status, challenges and next steps

Contents

- Introduction
- Ongoing Studies and Challenges
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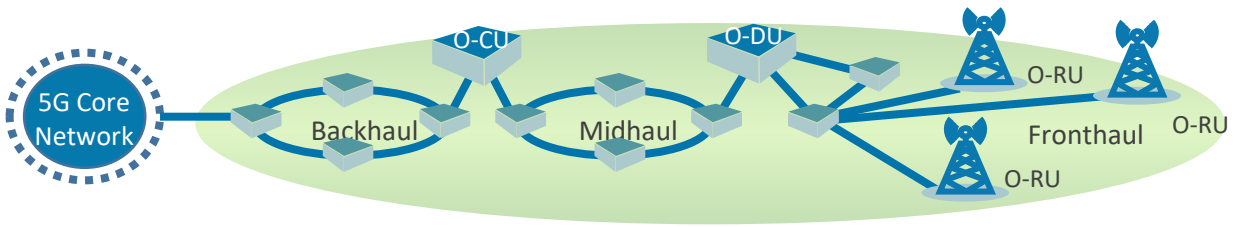
What is Open RAN?

An Open Radio Access Network (Open RAN) is a non-proprietary version of the Radio Access Network (RAN) system that allows interoperation between cellular network equipment provided by different vendors.

The concept behind Open RAN is that by standardizing the main elements of the network and defining interoperable interfaces between those elements, the network designer will have a greater choice of components to deploy.

"O-RAN" specifications enable the Telecom industry to implement open and intelligent Radio Access Networks.

O-RAN defines the performance and interface specifications for the component parts, ensuring interop and overall network behaviour.



O-CU O-RAN Central Unit
O-DU O-RAN Distributed Unit
O-RU O-RAN Radio Unit

The O-RAN Alliance is an open technical organization which was established to provide such standardization.

O-RAN vs. ITU-T and other SDOs for synchronization

IEEE 1588
IEEE 802.1AS
IEEE 802.1CM
…

PTP (IEEE 1588)

ORAN.WG4.CUS
ORAN.WG4.CONF
O-RAN.WG4.IOT
ORAN.WG9.XTRP-SYN
ORAN.WG9.XTRP-TST
…

PTP (IEEE 1588)

Network limits
Clocks

Network limits
Clocks
PTP Telecom Profiles

End application requirements

ITU-T G.826x
ITU-T G.827x

Applicable PTP Profiles
(TSC integration)

Testing Sync Requirements

- O-RAN provides a formal conformance specification (Conformance Test Specification)
- Need for a common procedure for testing. E.g., noise profiles, performance verification.
- ITU-T provides some of the fundamental specifications.
  - Including guidelines for testing the requirements
  - Direct contributions from Q13 members, or via liaisons
- Alignment between G.8271.1 and O-RAN CUS for LLS-C3
  - New MTIE mask in G.8271.1 to meet 50 ppb ?
- Testing of Complex arrangements (e.g., Shared cells) not fully specified yet
  - FHM (Fronthaul Multiplexer)
  - Cascaded O-RUs

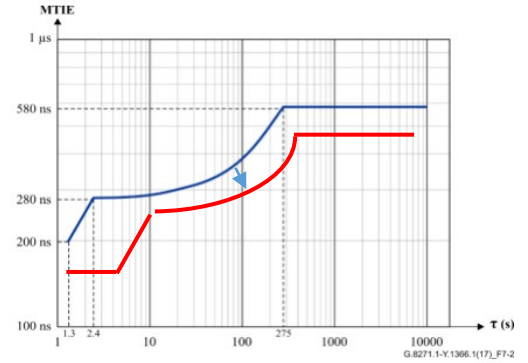
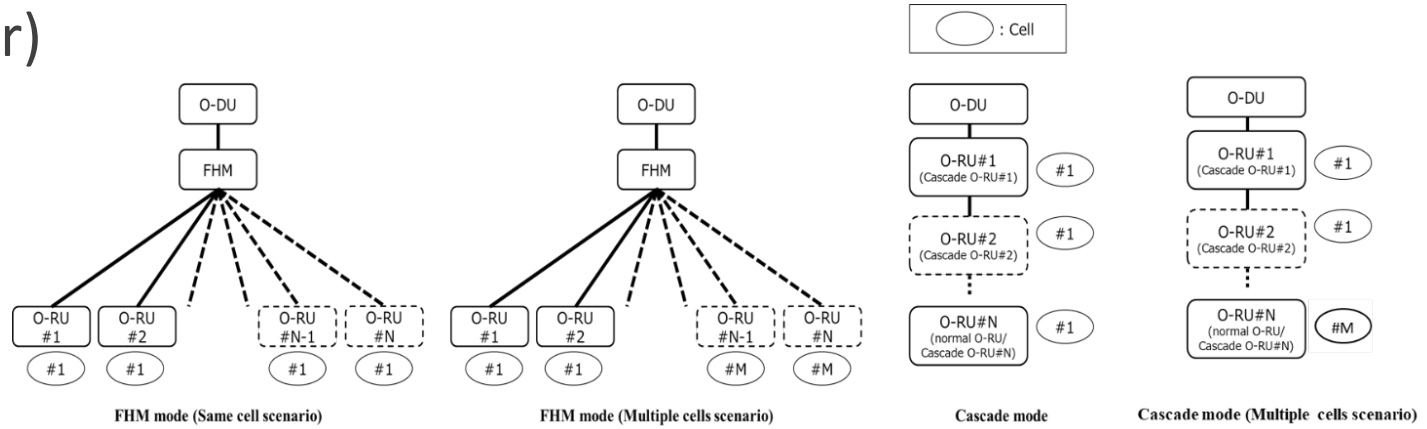


Figure 7-2 – Dynamic time error network limit (MTIE)



FHM mode (Same cell scenario)

FHM mode (Multiple cells scenario)

Cascade mode

Cascade mode (Multiple cells scenario)

From O-RAN Working Group 4,
Control, User and Synchronization Plane Specification

Example: O-RU tests clause **3.3.3**, LLS-C2/LLS-C1 recent additions

- Diagnostic test on 1PPS O-RU output when available

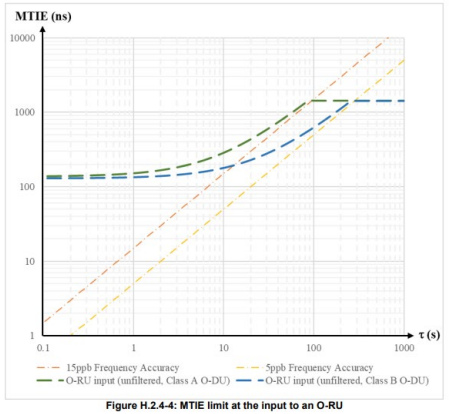
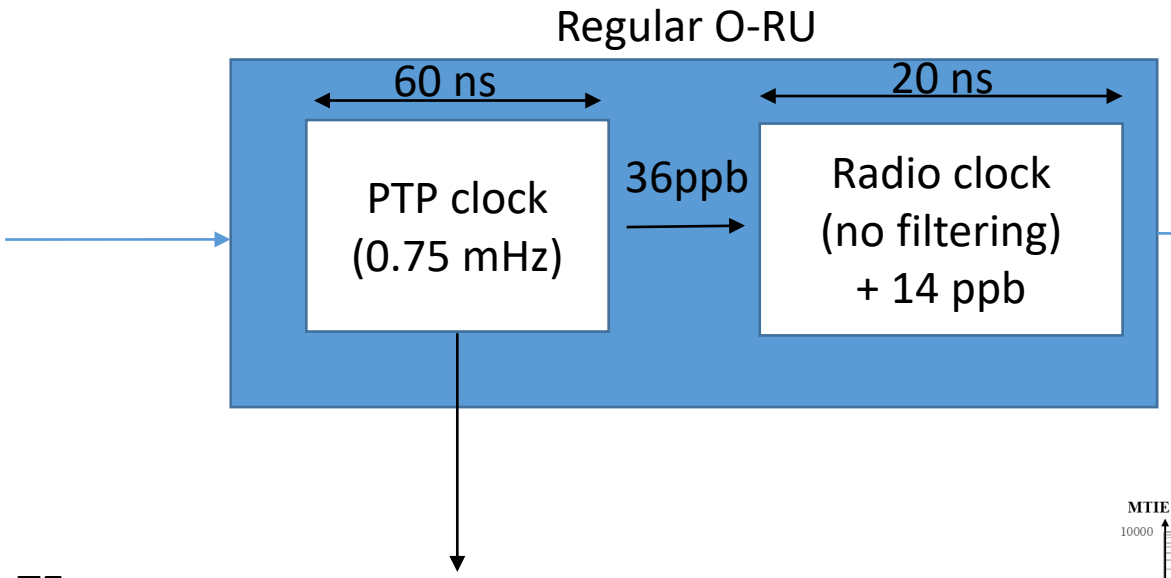
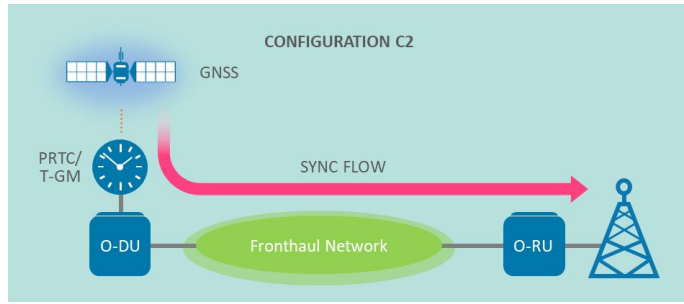


Figure H.2.4-4: MTIE limit at the input to an O-RU





Max TE =

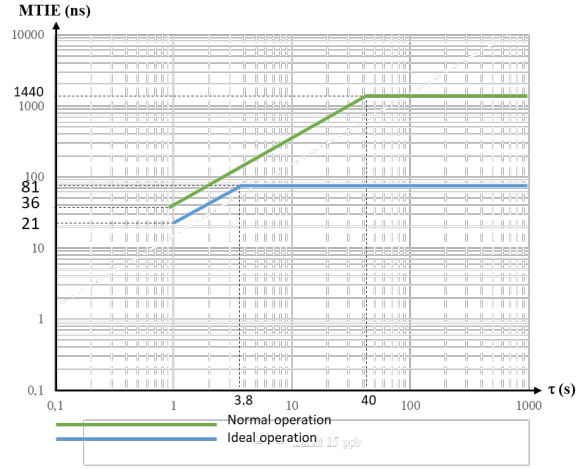
1420 ns + 60 ns = 1480 ns (normal operation);

60 ns (ideal operation)

Frequency Error:

15ppb + 21 ppb = 36 ppb (normal operation);

21 ppb (ideal operation)

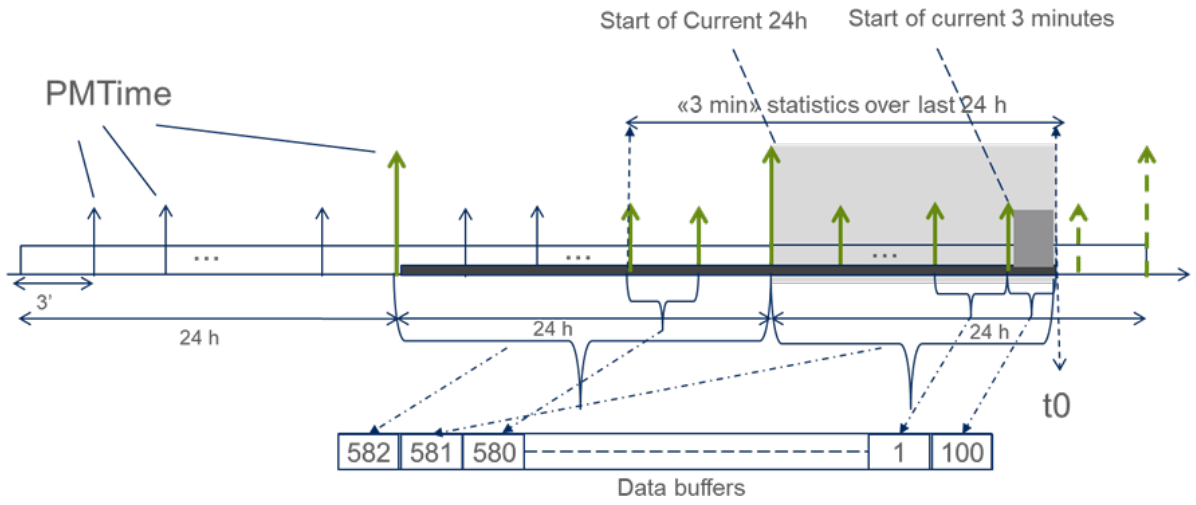


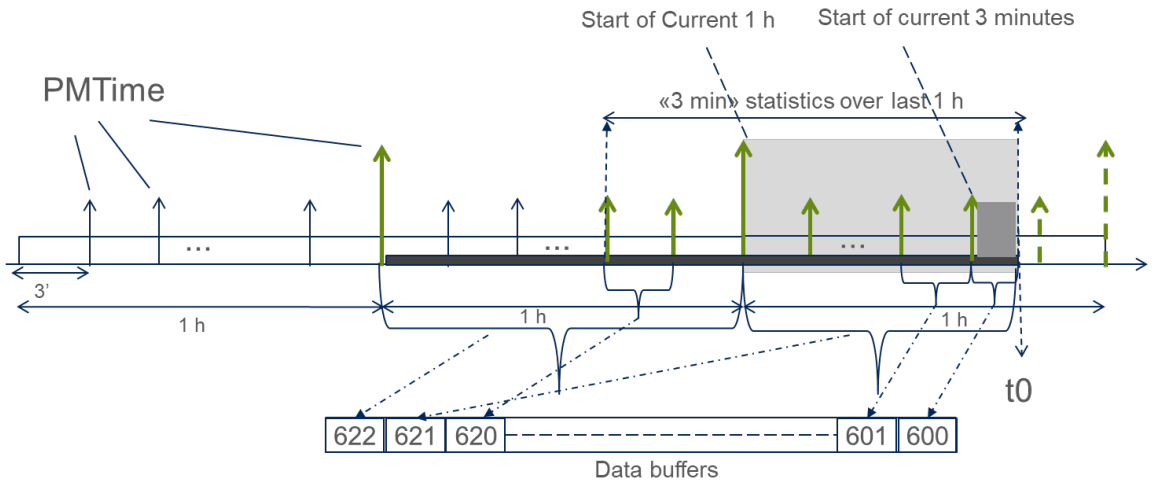
Synchronization Security

- O-RAN requirements for Security in “O-RAN.WG11.Security-Requirements-Specification”
- For PTP security, two categories of solutions have been identified:
  - **Synchronization Architecture Redundancy**
  - **Authentication and Authorization of PTP nodes**
- O-RAN has also studied the use of the IEEE P1588 PTP Integrated security mechanism (Security TLV) for integrity protection and authentication of PTP message
  - Liaisons exchanged with Q13 for inclusion in the PTP telecom profiles.
  - Limited to Announce messages to protect from Master spoofing and Rogue Master attacks
  - Options for managing the security key distribution are being considered (e.g., as per P1588d)
- Ongoing discussions on the use of MACsec for C-Plane and potential impact on PTP messages
  - Important to keep PTP outside the MACsec tunnel.
- Adding security to SyncE ESMC has also been proposed
- O-RAN security Test Specification will eventually also address S-Plane security

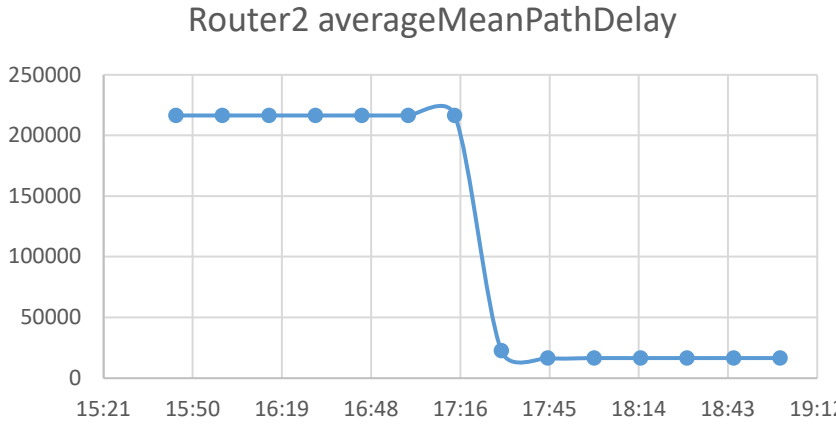
Performance Monitoring

- New architecture, with multiple vendors:
  - when deployed in the field problems may be found
- How to monitor performance of networks in operation?
- Discussion started in ITU-T:
  - Use of IEEE1588 Annex J (Performance Monitoring Option) has been proposed, with general support for a future integration as an option into the Telecom profiles

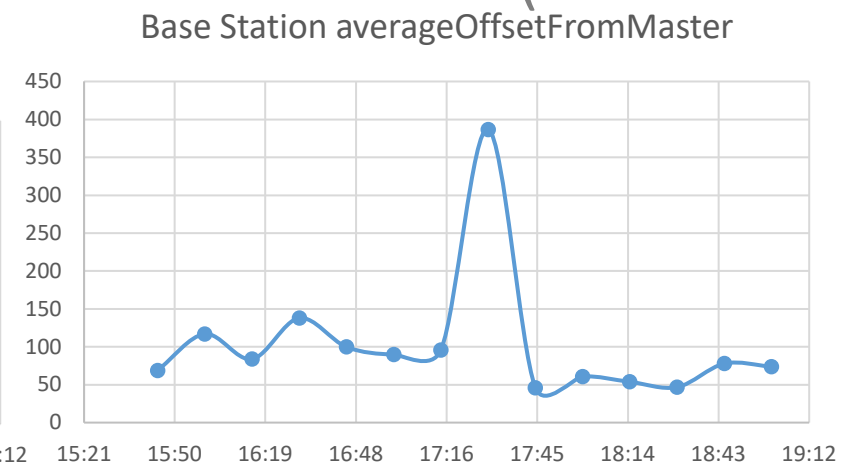




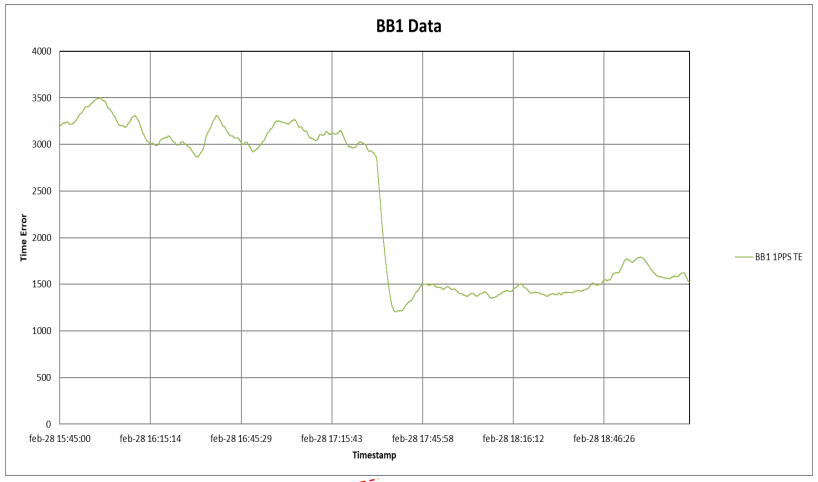
Example of use of Annex J PM data (G.8275.1)



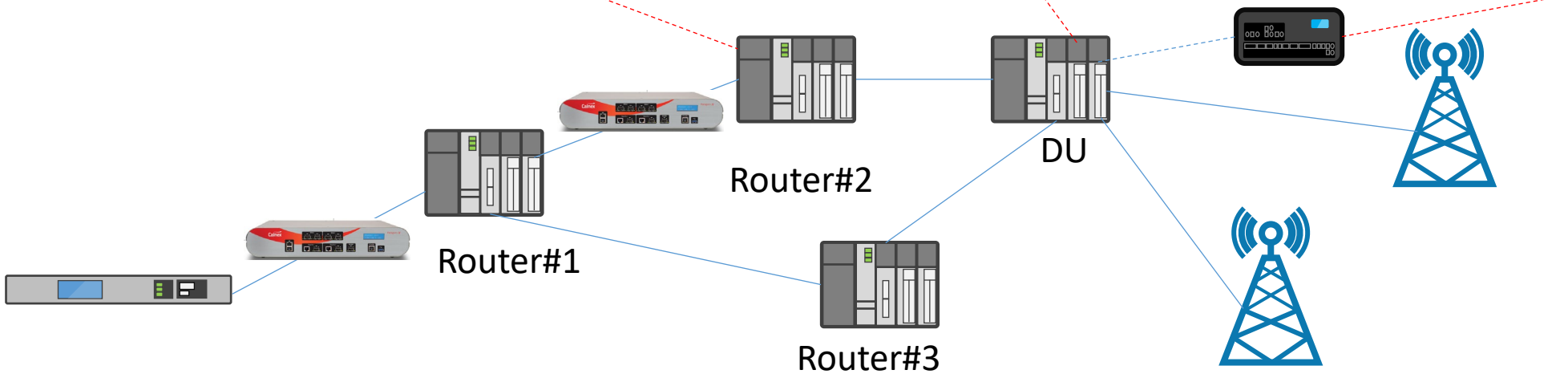
Router PM Data



DU PM Data



Measured performance

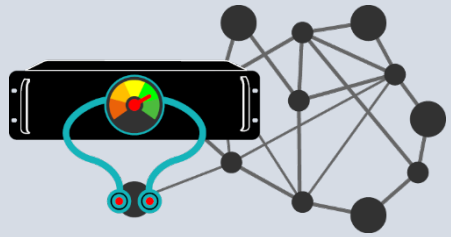


PM data can allow to identify in real-time the point in the network ultimately impacting End Application performance

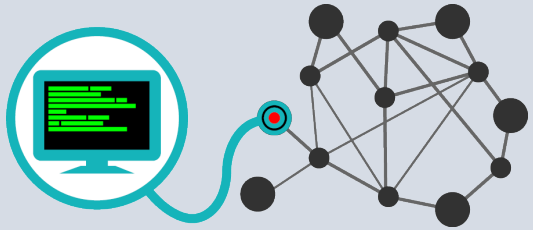
Sync Visibility – 3 Flavors

PTP NMS + Analytics

Direct measurement
Physical measurement using directly connected hardware with an external reference.



Device querying
Use APIs and/or network management protocols to read PTP and other data from the network device.



Network sniffing
Capture and analyze PTP traffic using probes or similar.

ACCURATE

FLEXIBLE

A hybrid scheme would consist of some or all test elements reporting back to a central site

Conclusions

- The cooperation between O-RAN and ITU-T is resulting in a number of consistent and solid specifications for the telecom industry
- Still a number of aspects need to be addressed (e.g., Sync Security, LLS-C3 testing, Shared Cells)
- Network Performance monitoring is an emerging need. Various flavours are possible.
  - Initiatives have started in ITU-T that eventually can bring benefits also to the O-RAN Alliance.

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Insight and Innovation