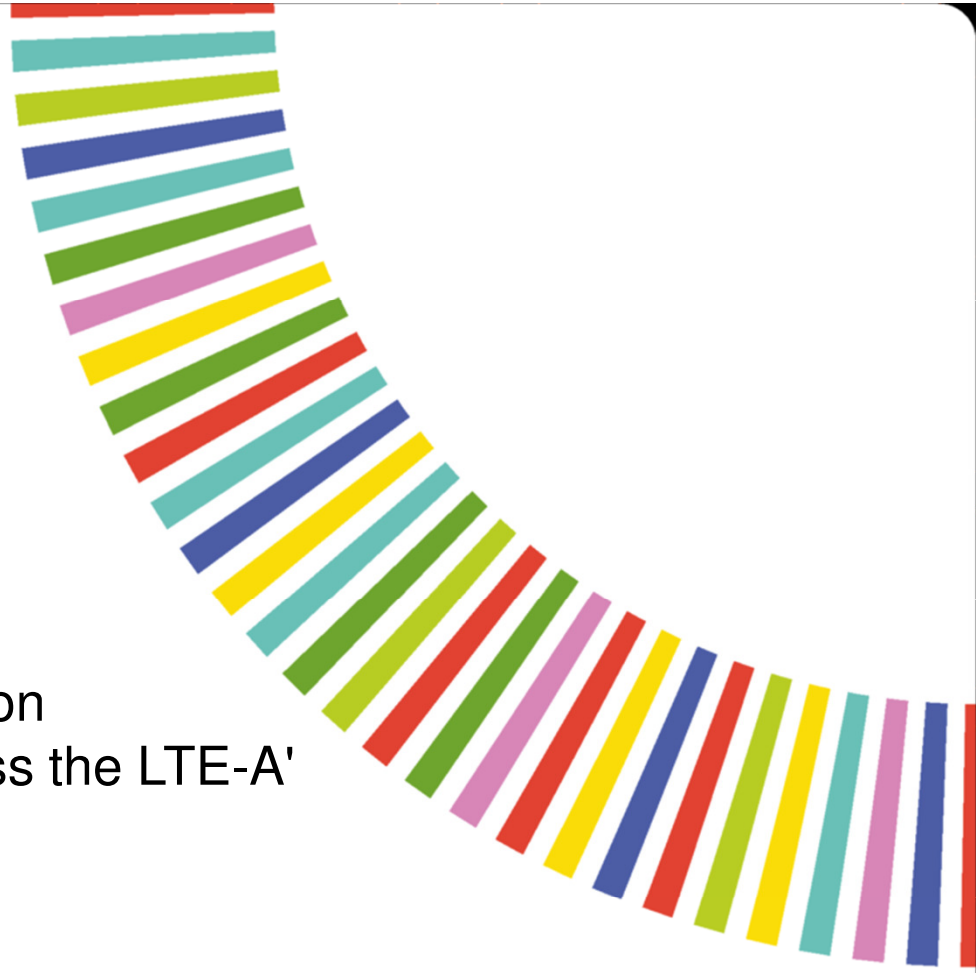


ITSF 2017

'The reality for Time and Phase synchronization
within the Mobile Network Operator to address the LTE-A'

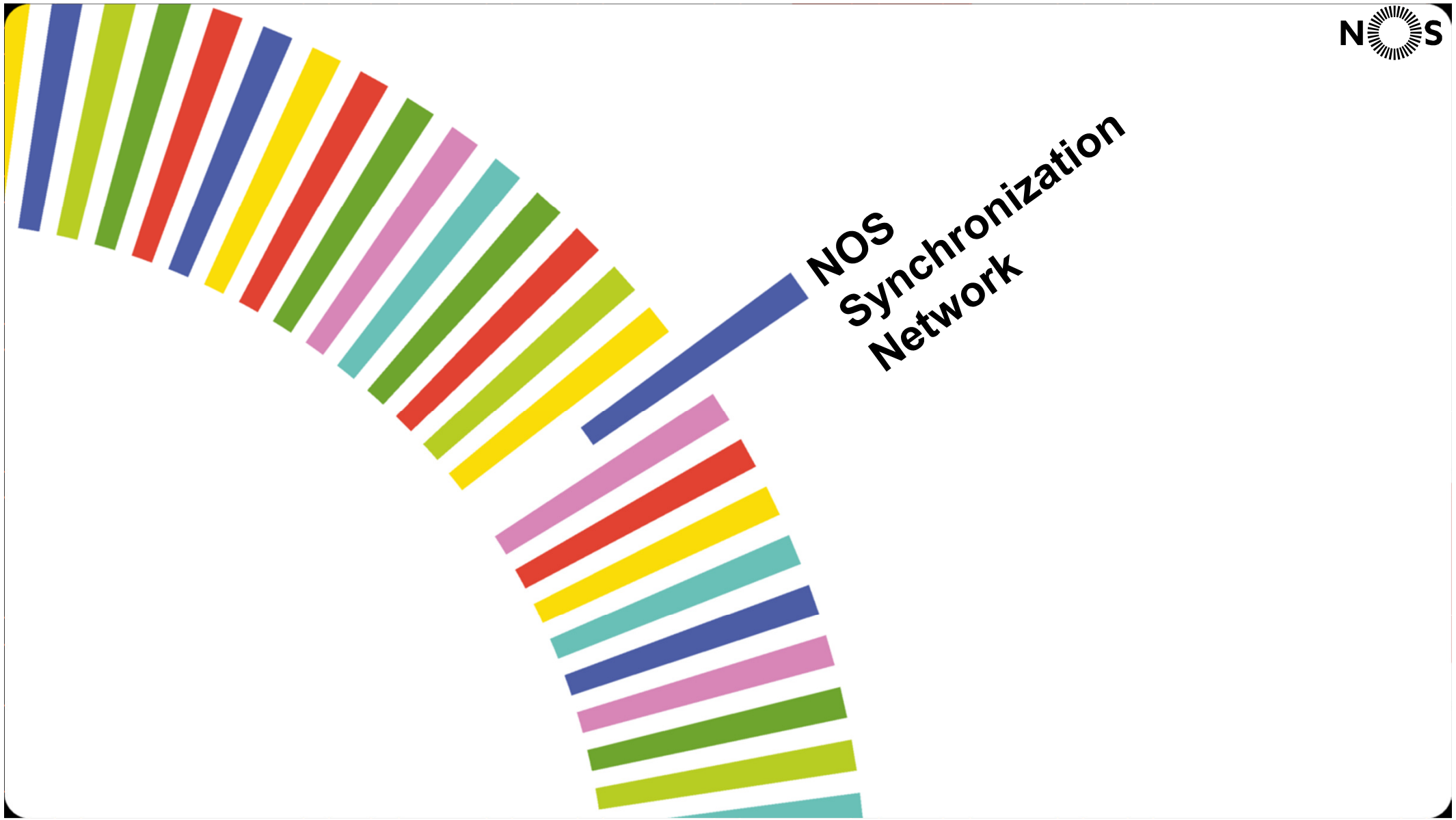
Pedro Antao | 7/NOV/2017

'The reality for Time and Phase synchronization within the Mobile Network Operator to address the LTE-A'

NOS Synchronization Network

Plans to address the LTE-A +/- 1.5us phase requirements

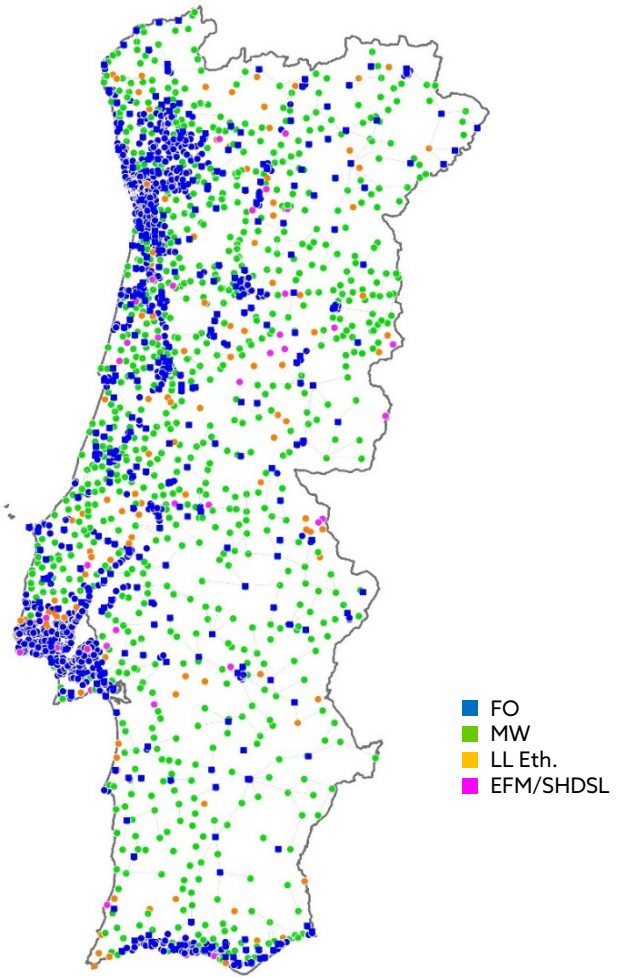
Ongoing trials and network developments


NOS
Synchronization
Network

NOS Radio Access Network footprint

3100 RAN sites (GSM, UMTS, LTE*)FDD

- 63% Gigabit-Ethernet
- 30% MW-Ethernet
- 5% leased ETH
- 2% EFM



… Fiber in major urban areas / MW in rural areas

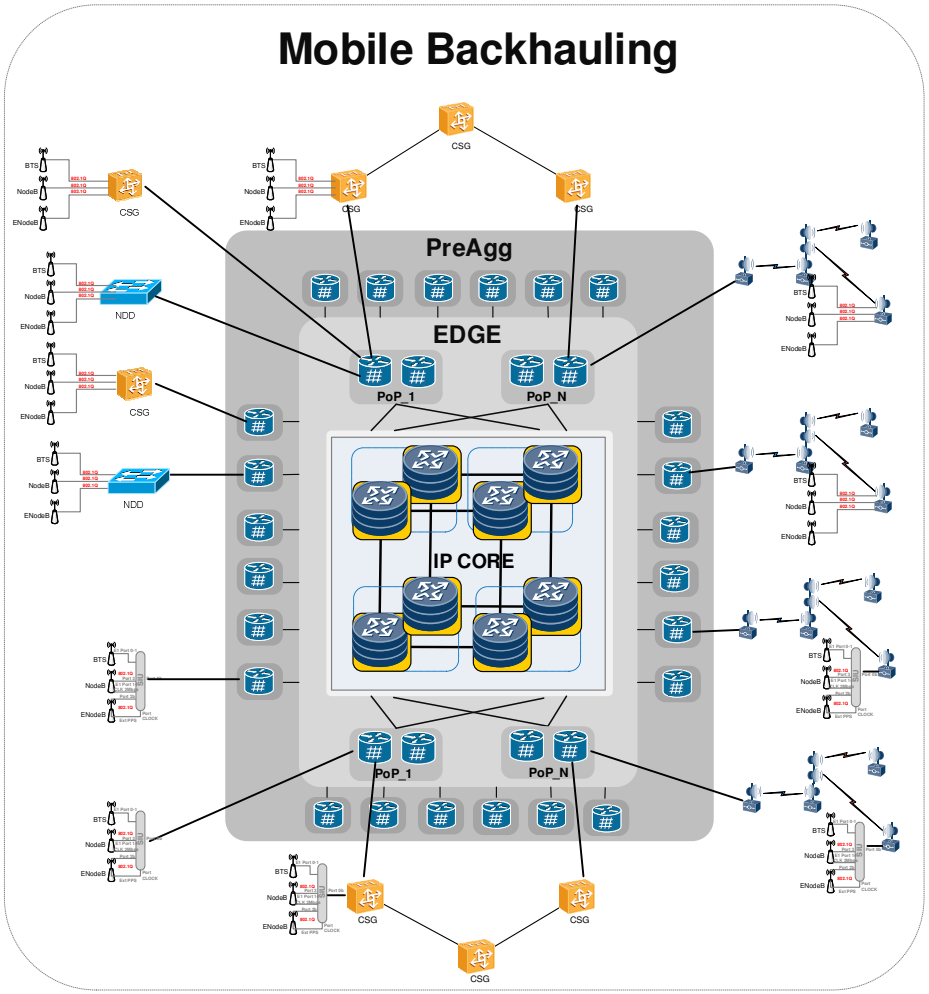
NOS Mobile Backhaul

RAN leverage on MBH for sync, no GPS

Wider variety of Backhaul solutions

- P2P ETH Fiber Gigabit
- P2P ETH Leased Ethernet
- CSG within ring topology
- MW-ETH tree topologies

Connected to a IP convergent network shared among Cable, FTTH, Mobile, Business, etc.



IP Network is the “Synchronization Distribution Network”

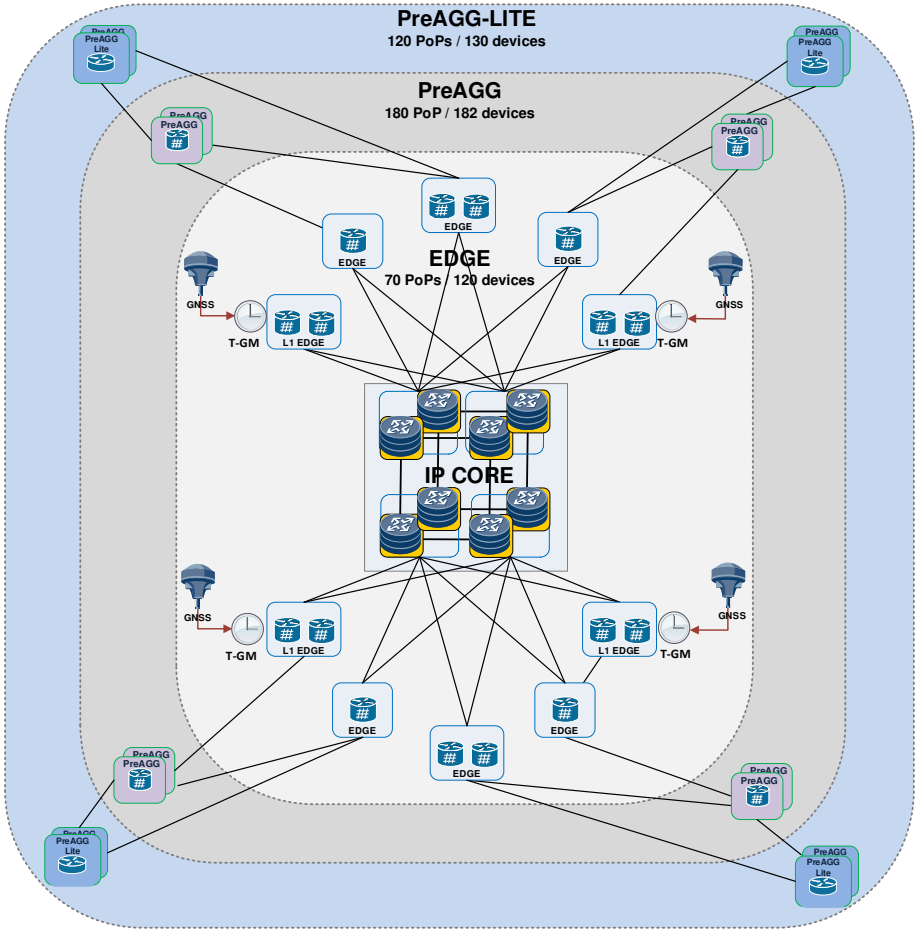
Convergent IP Network for Data & Sync

4 x L1 Centralized Synchronization POPs:

- GNSS GPS and Galileo
- SyncE references for IP Network
- PTP GMs G.8265.1; *T-GM G.8275.X*

SyncE distribution through IP network layers:

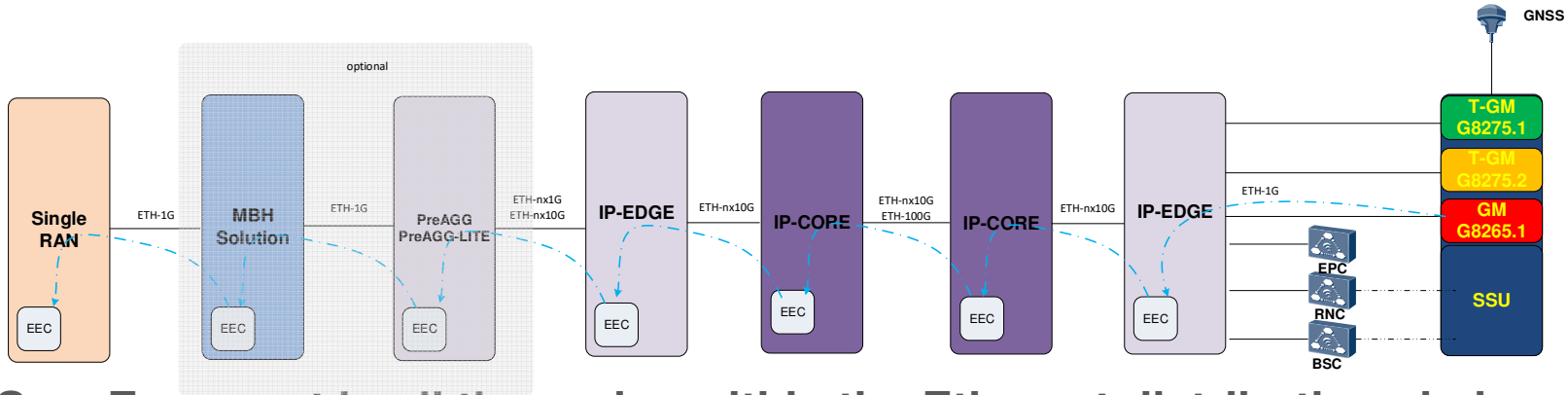
- IP CORE , IP EDGE, IP PreAgregation, and IP PreAGG-Lite, using Fiber or DWDM 100G, 10G, and 1G links



NOS Synchronization Network

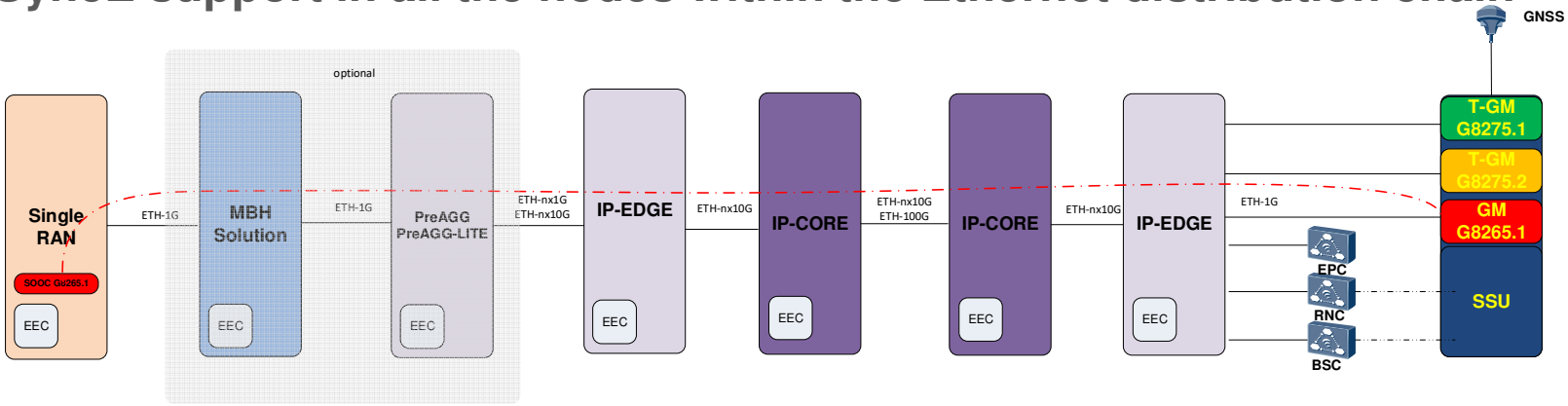
RAN devices are usually bellow 6 hops from the sync reference, except where MBH use Microwave Ethernet Radios Links.

SyncE

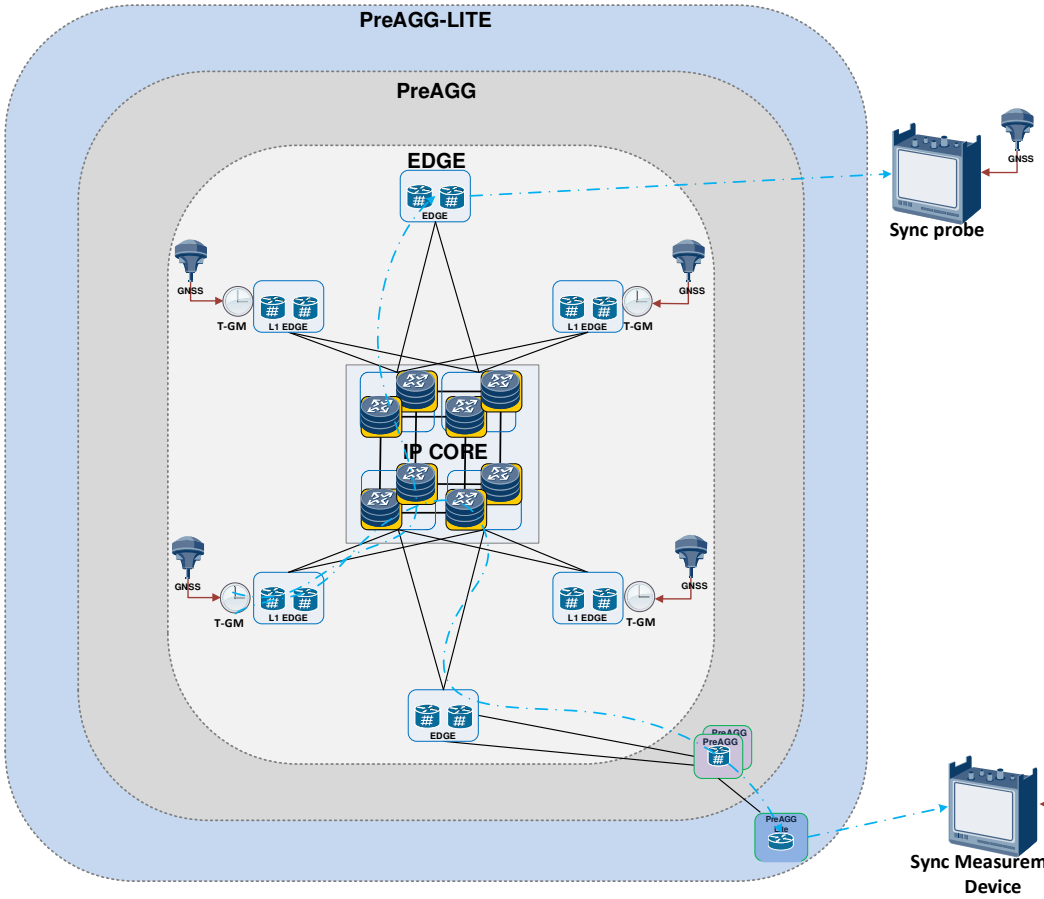


SyncE support in all the nodes within the Ethernet distribution chain

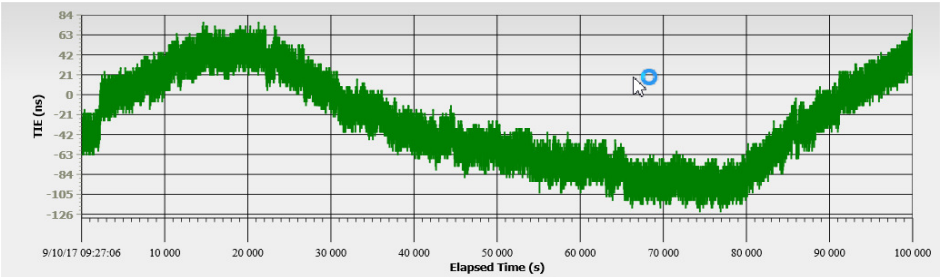
PTP G.8265.1



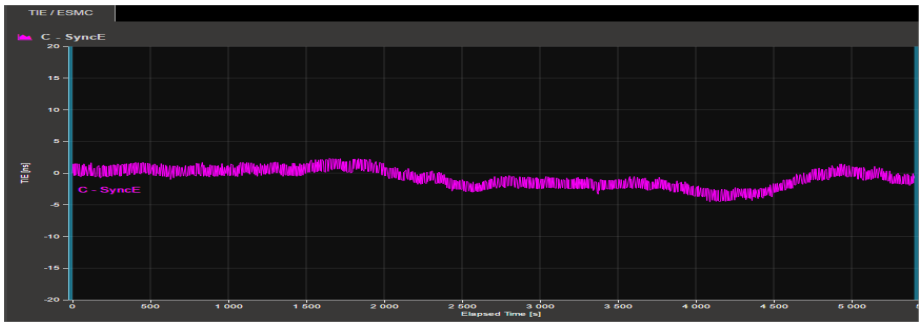
TIE measurements from live network using Synchronous Ethernet



Active probe in the EDGE (24h)

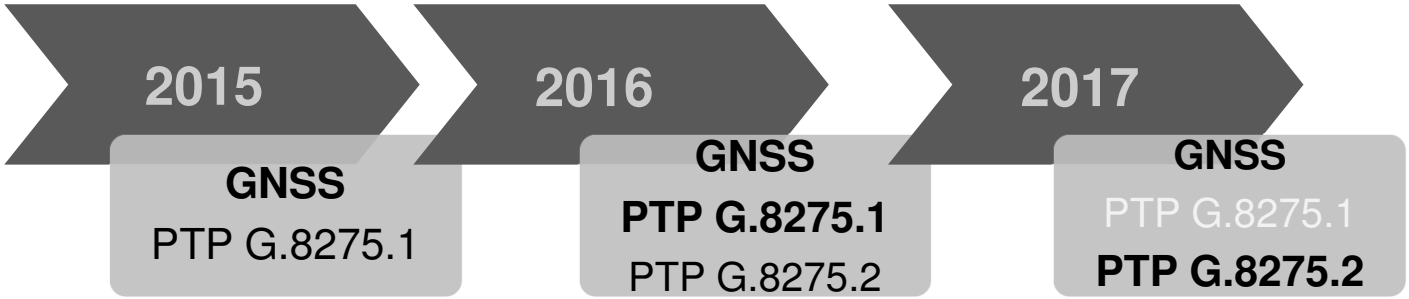


Field measurement in PreAGG-LITE 1,5h




Plans to address the
LTE-A +/- 1.5us phase
requirements

Solutions to enable phase & time being considered in the RAN

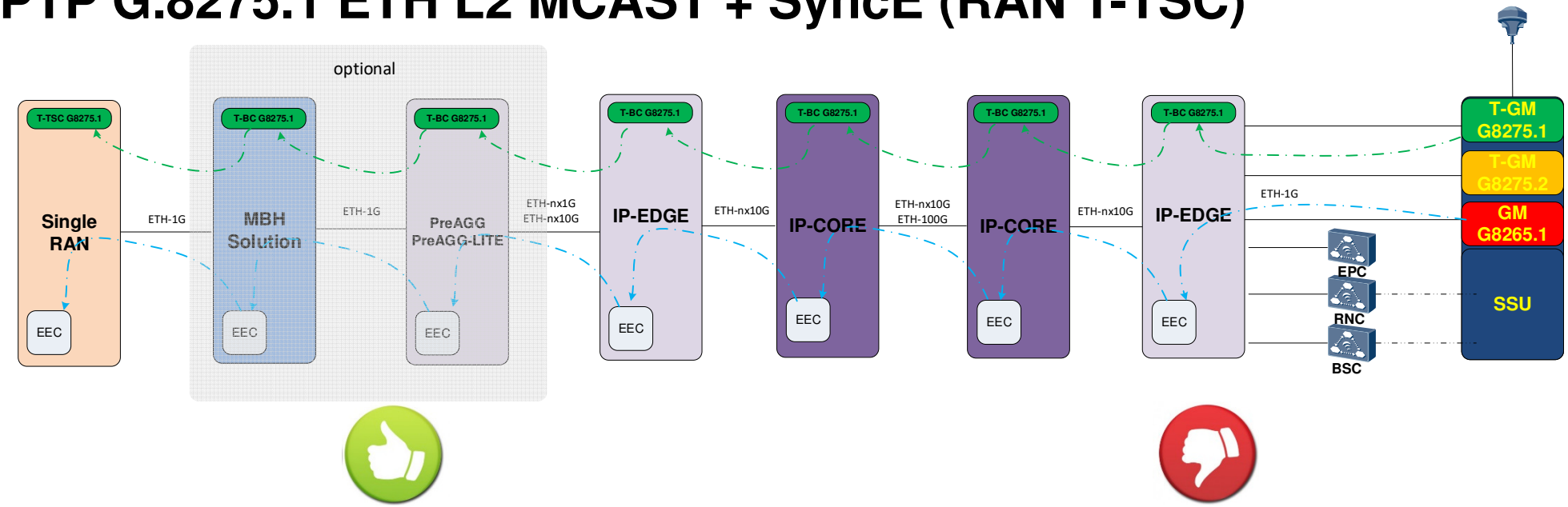


eNB (LTE-A)

- PTP G.8275.1 T-TSC + SyncE
- PTP G.8275.2 T-TSC-P
- GNSS + SyncE , *contingency.*

At the current being it is obviously that PTP ITU-T profile G.8275.2 is a seriously alternative to the GNSS in the cell site, in the counterpart the G.8275.1 is loosing attractivity.

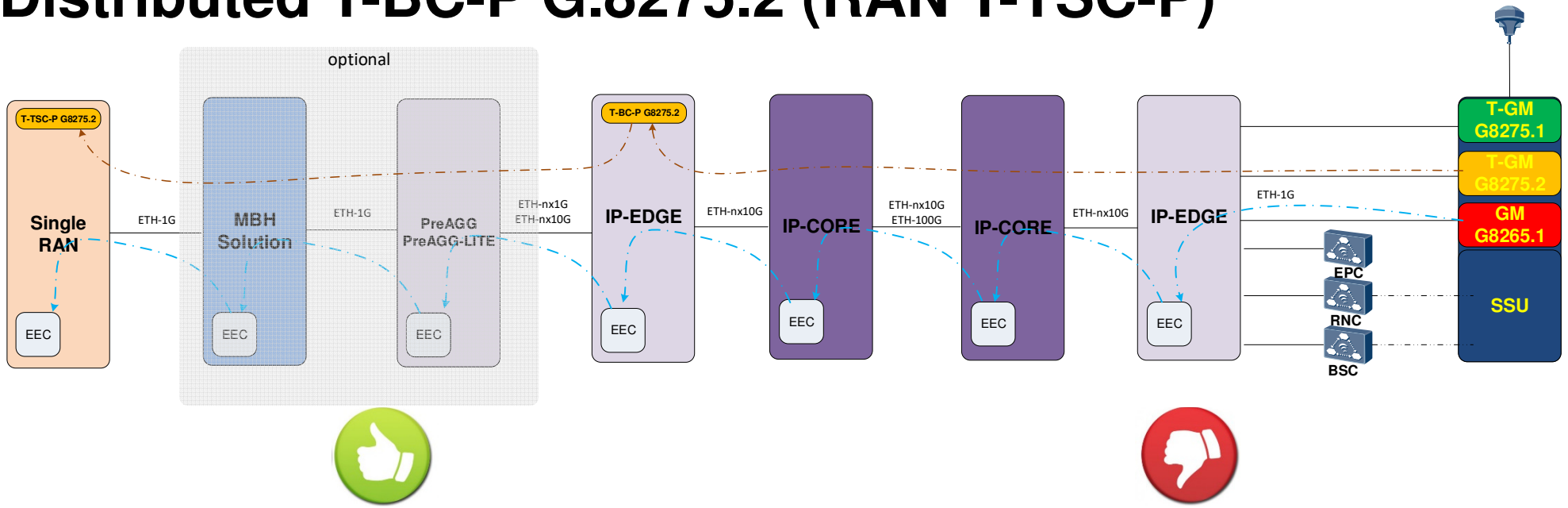
PTP G.8275.1 ETH L2 MCAST + SyncE (RAN T-TSC)



- Standards finish in 2014
- Feasible to leverage on centralized T-GM
- Widely accepted by RAN vendors
- Well defined metrics by the ITU-T

- Requires full path support, not easy to achieve due to HW/SW restrictions
- Legacy HW does not support
- Slow start to IP routers vendors to support this profile

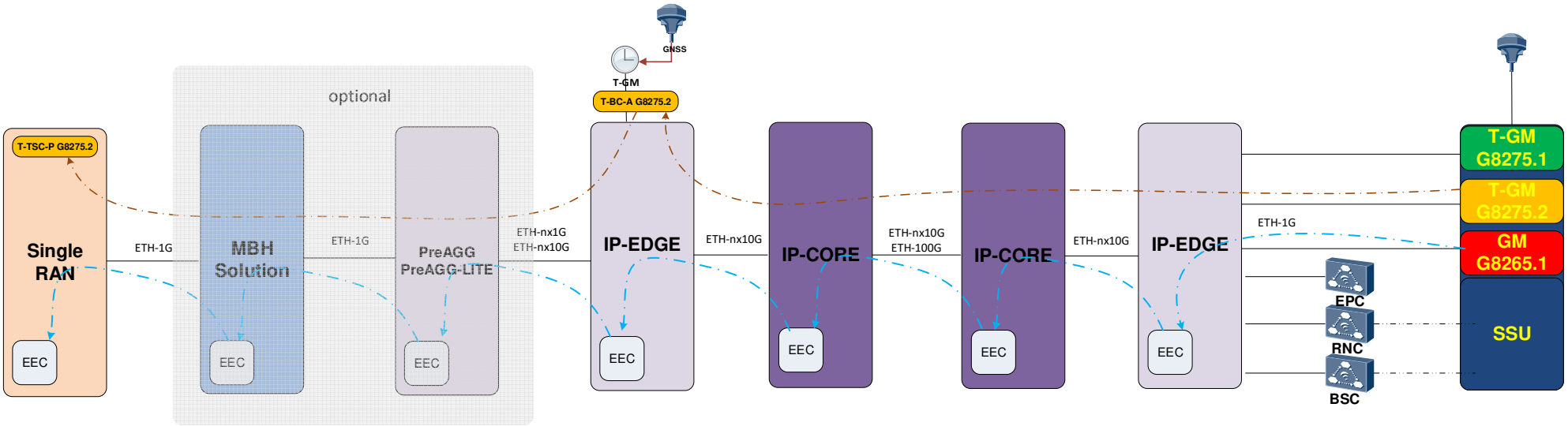
Distributed T-BC-P G.8275.2 (RAN T-TSC-P)



- Despite being standardized two years later than G.8275.1, it is already implemented and supported by a wider variety of equipment vendors
- Does not requires full time path support

- Asymmetry are more likely due to IP routing issues among parallel paths
- Metrics are not well defined yet
- More risky to leverage within centralized T-GM deployment

PTP G.8275.2 APTS (RAN T-TSC-P)

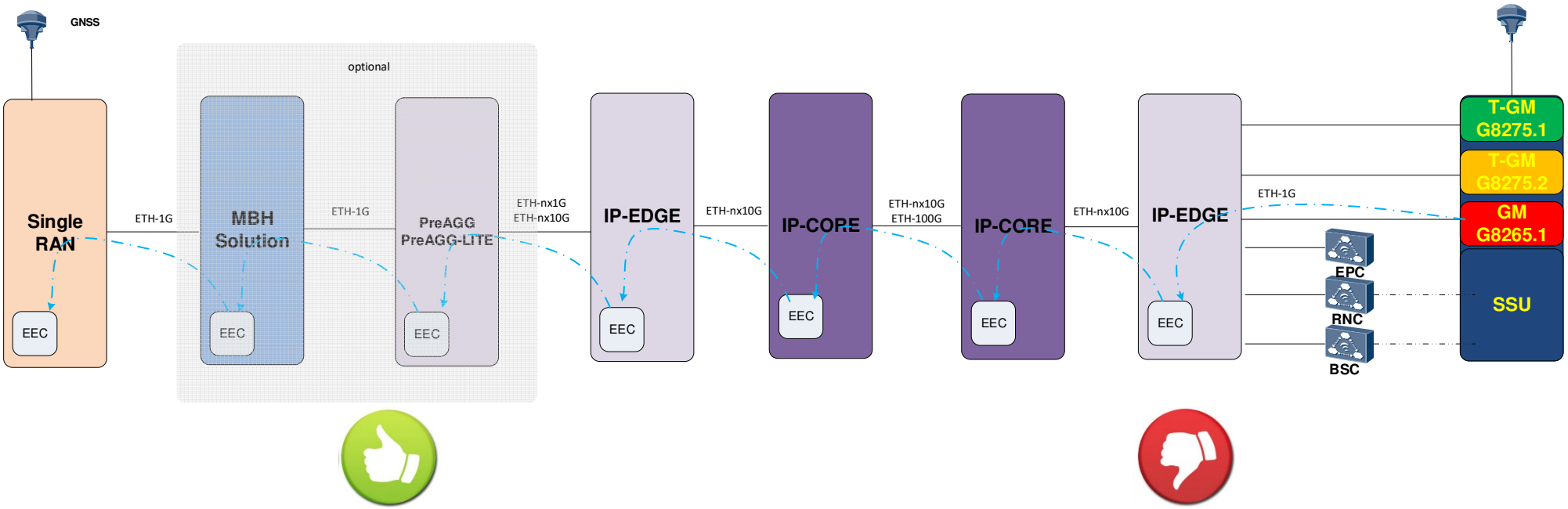


APTS

- Distributed Small/Mid size T-BC-A in the EDGE and/or Pre-AGG layers to provide higher scalability
- APTS use the distributed GNSS reference, and centralized T-GM for backup with real time asymmetry correction

Plans to address the LTE-A phase requirements (+/- 1.5us TE)

GNSS receiver in the RAN



- Does not require synchronization features from IP/Transport Network
- Easier to achieve +/- 1.5 us TE

- Risk of jamming
- Installation and maintenance costs

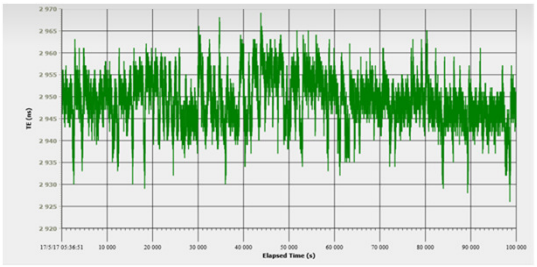

Ongoing trials and
network developments

PTP G.8275.1 trials, we have found a TE > +/- 1.5us versus GNSS, due to DWDM asymmetries

RAN site A and RAN Sites B,C,D have a 7us TE

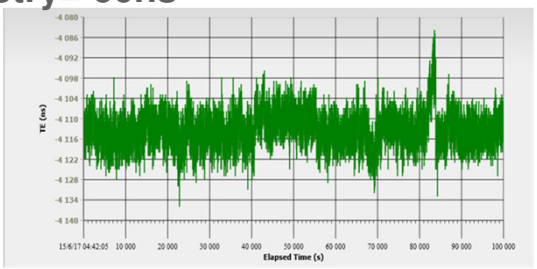
DWDW path T-GM#1<>COI2 TE=+2.9us

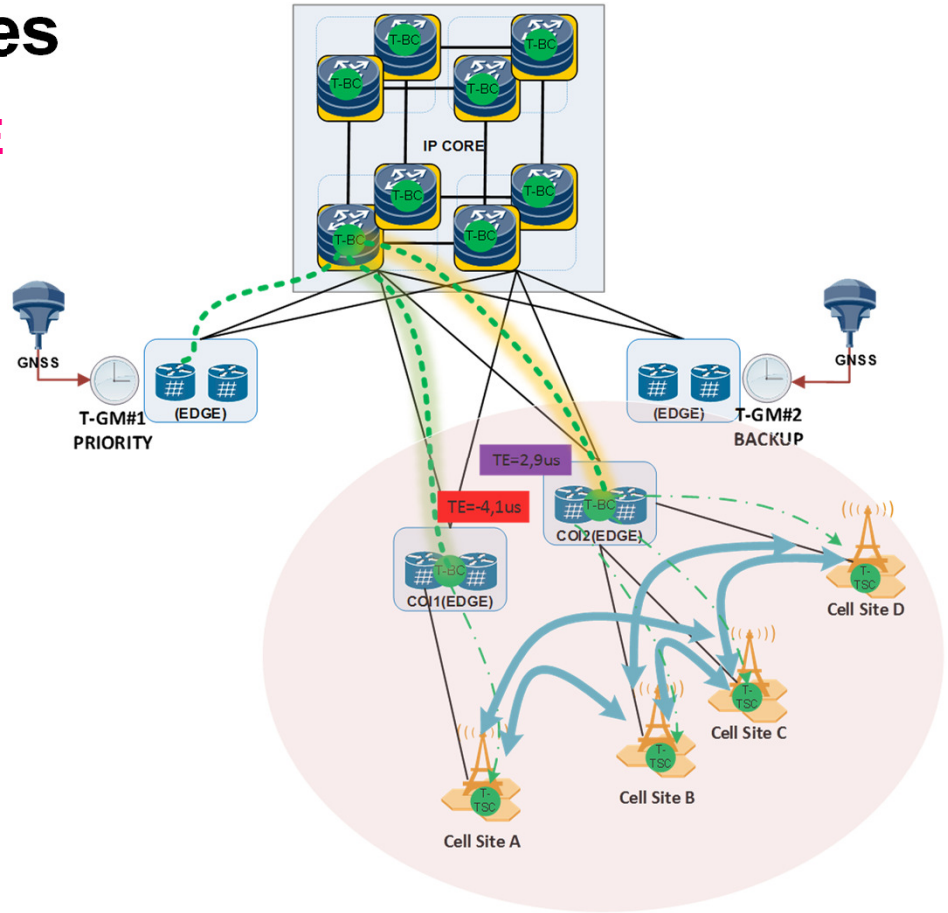
Dynamic asymmetry= 45ns



DWDW path T-GM#1<>COI1 TE=-4.1us

Dynamic asymmetry= 60ns





Challenges

How to minimize the asymmetries introduced by the DWDM

- Re-engineer the DWDM non-coherent to coherent network, and use HW with Sync Time-Stamp
  … to evaluate!
- Use asymmetry correction in the IP transport network , but requires asymmetry correction features within the T-BC
  … requires field measurement in every hop, does not scale!

To workaround the DWDM asymmetries, a good approach seems to be:

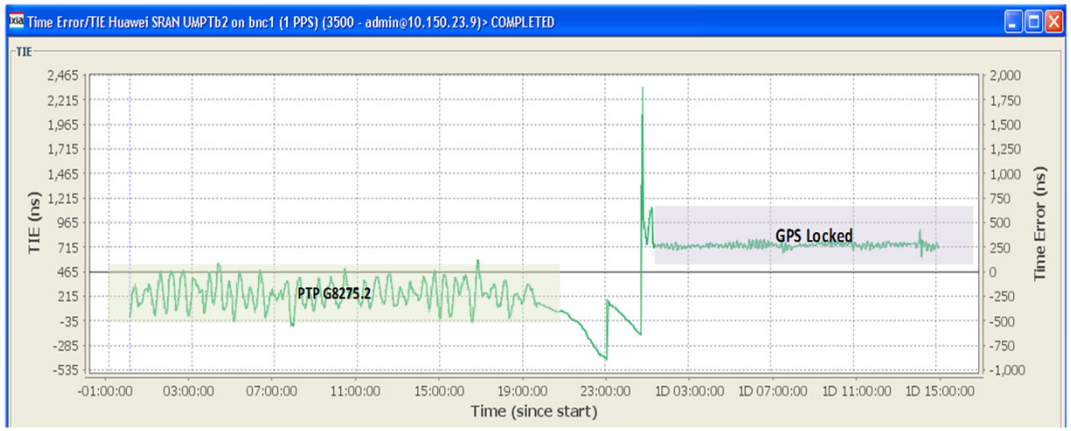
Deploy G.8275.2 T-BC-A where it is needed (when DWDM non-coherent links are used)

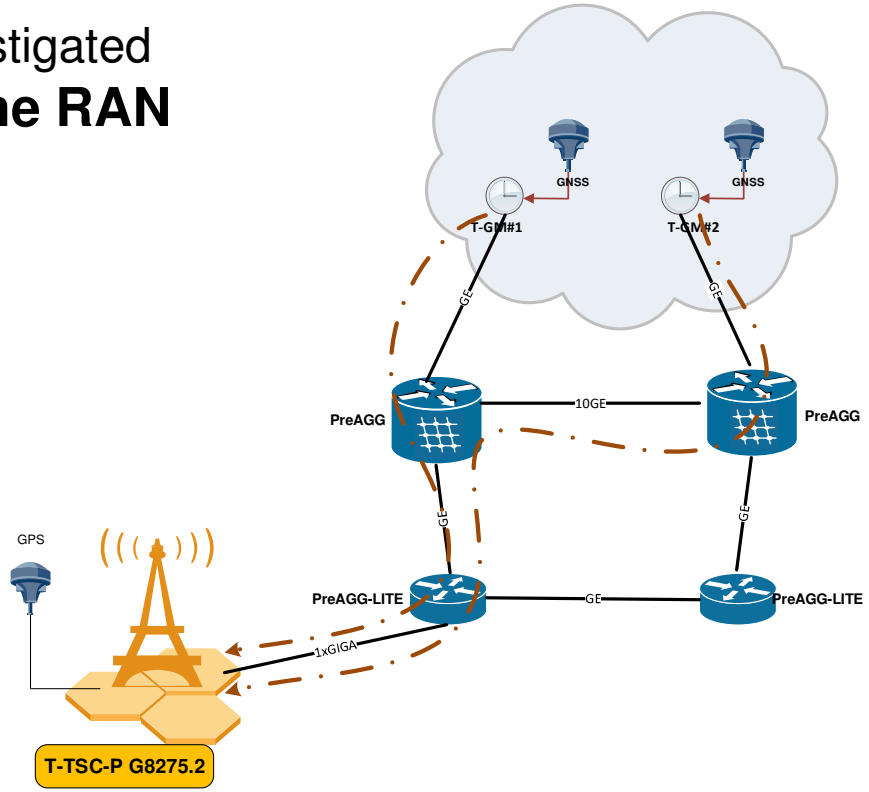
PTP G.8275.2 Lab trials

- **Good insights regarding the TE metrics achievement**

  Max TE -500ns , max dynamic TE to be investigated

- **Stability of the solutions implemented in the RAN**





PTP results achieved using 128pps Sync Message rate

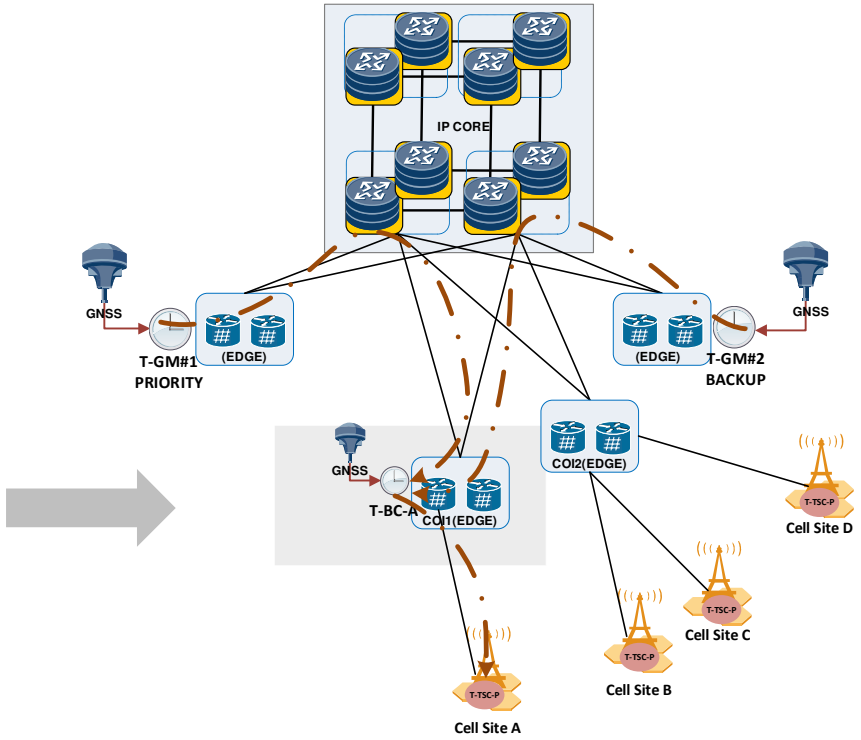
PTP G.8275.2 Next Steps

- **Live deployments using centralised T-GM**
- **Live deployments using distributed T-BC-A for asymmetry correction**

Distributed G.8275.2 T-BC provides

- Dynamic asymmetry correction to compensate DWDM or other existing asymmetries
- Enhance the PTP slave capacity within the network;

Leverage in the centralized L1 T-GM for GNSS redundancy



RESUME

Deploy Phase & Time without GNSS receiver in RAN sites requires:

- **Full understanding from the IP/Transport Network :** synchronization features, synchronization accuracy, topology

- **One solution does not fit all the use cases, example for NOS use cases:**
  - Centralized T-GM G.8275.2 without T-BC-P for Lisbon and Oporto (mainly fiber links without DWDM)
  - Centralized T-GM G.8275.2 plus T-BC-P for regions without DWDM asymmetries;
  - Centralized T-GM G.8275.2 plus T-BC-A for regions with DWDM asymmetries;
  - For the MW clusters, further analysis is required;

Thank You!