# Ticking Together: The Importance of Interoperability Testing in Clock Synchronization



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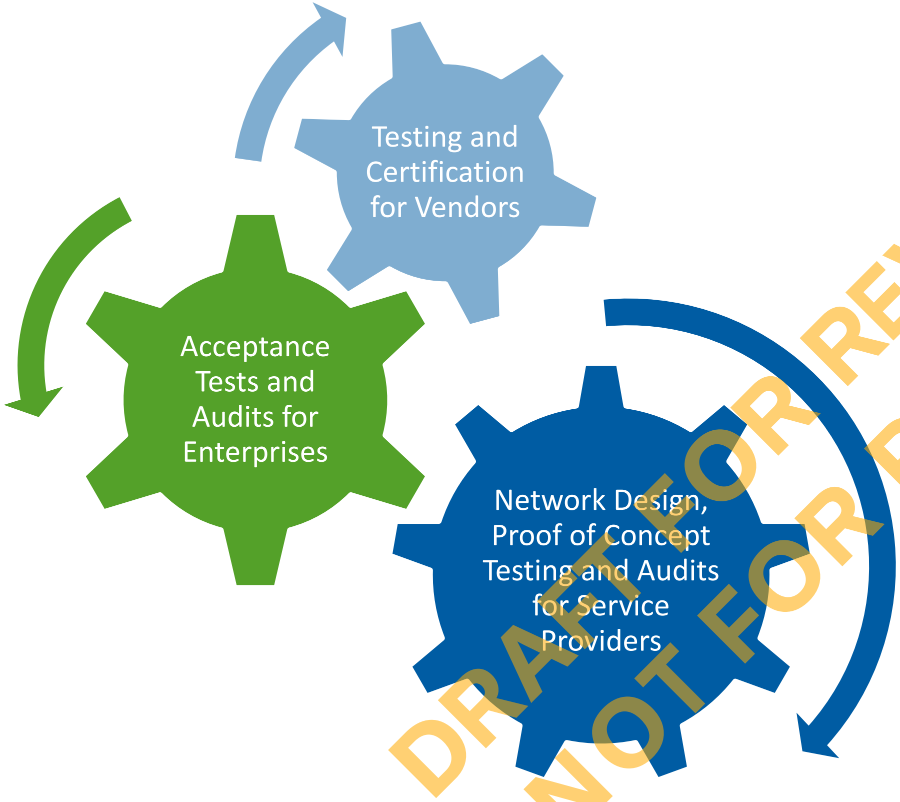
November 7, 2018

EUROPEAN ADVANCED NETWORKING TEST CENTER

# About the European Advanced Networking Test Center




- State of the art testing expertise focusing on innovative telecom technologies
- Emulating fully realistic scenarios representative for today’s production networks
- EANTC is 100% independent and vendor-neutral
- Adhering to highest quality standards and actively participating in test methods standardization

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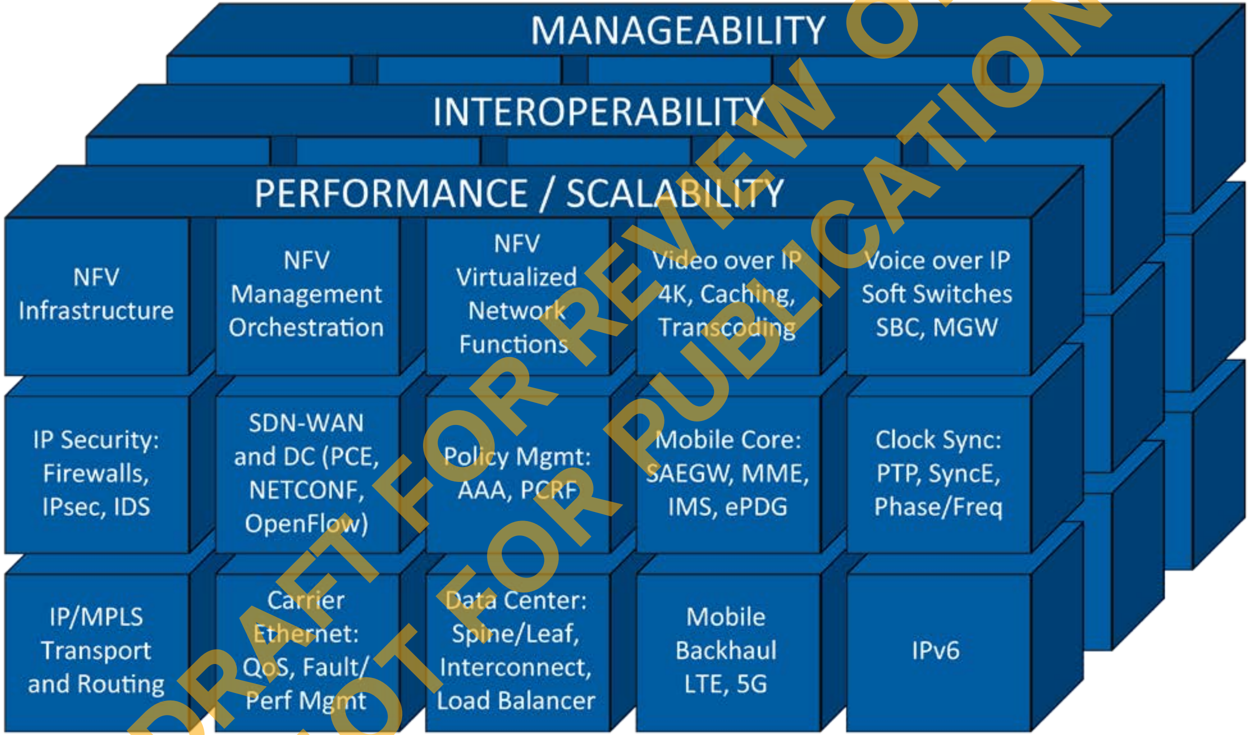
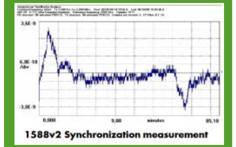
Tested by EANTC 2018

# Technology Areas – EANTC Strengths



# EANTC Interop Clock Synchronization Testing Milestones

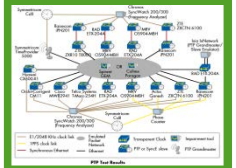
## 2008




IEEE 1588v2 based clock sync imple-mentations

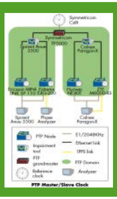
First EANTC Sync Interop

## 2010



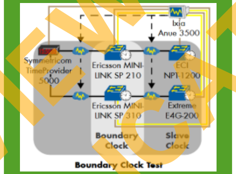

Multi-vendor interopera-bility of IEEE 1588-2008 for phase sync in end-to-end network

## 2012



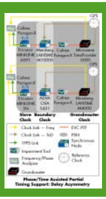

Complete chain (master, boundary, transparent , slave clock) as multi-vendor solution

## 2013




Boundary clock tests with multiple impairment locations

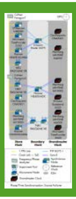
## 2016



Assisted Partial Timing Support

All tests are multi-vendor interop tests

## 2018



PTP over 100 GbE

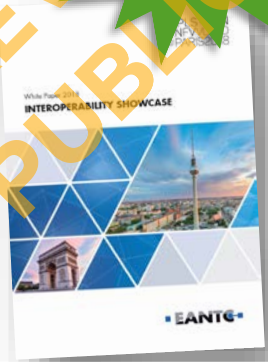
# MPLS + SDN + NFV Interoperability Testing & Showcase

Test Coverage:

- **Clock Synchronization**
- Ethernet Virtual Private Network
- Segment Routing
- Path Computation Element Protocol
- Microwave
- NETCONF/ YANG

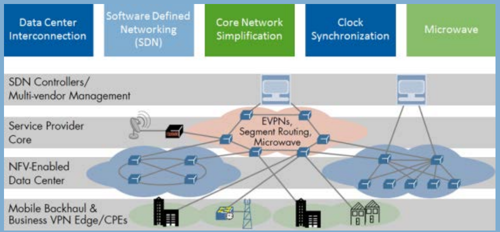
40-page public white paper available at
www.eantc.de/en/showcases/mpls_sdn_2018

7 pages of Sync results




Upcoming

MPLS+SDN
+NFVWORLD
PARIS 2019




April 9-12, 2019

upperside conferences

# Participating Vendors 2018

ADVA Optical Networking
ARISTA
BISDN
Calnex
cisco

DELTA
ECI
ERICSSON
HUAWEI
ipinfusion
ixia A Keysight Business

Juniper NETWORKS
MEINBERG
metaswitch
Microsemi a MICROCHIP company
NEC

NOKIA
OSCILLOQUARTZ An ADVA Optical Networking Company
UTSTARCOM
SPIRENT
ZTE

# Project Schedule

| Sep -Feb 2017/18 | March 5-16, 2018 | Mar 19- Apr 3, 2018 | April 10-13, 2018 |
|---|---|---|---|
| Preparation | Hot Staging | White Paper Editing | Congress |

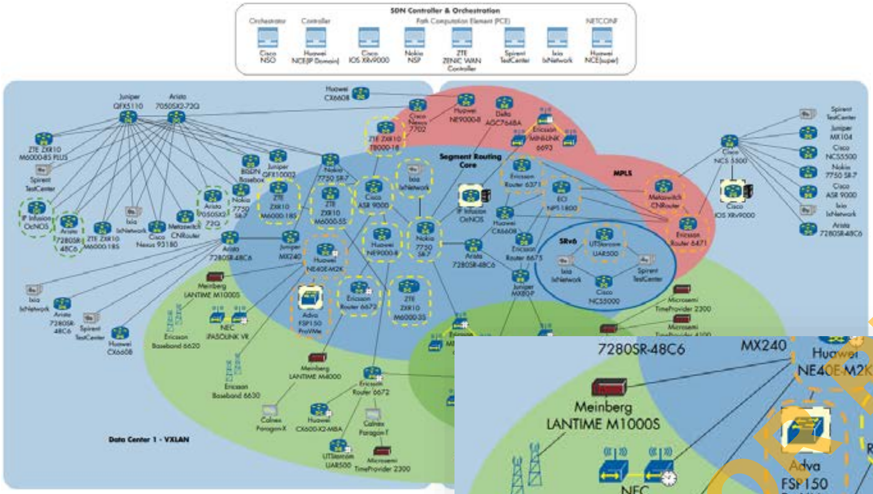
**Preparation**
- Conference calls
- Test plan and Config Guide creation
- Marketing planning

**Hot Staging**
- Interoperability testing
- Demonstrations creation
- Service Provider Day

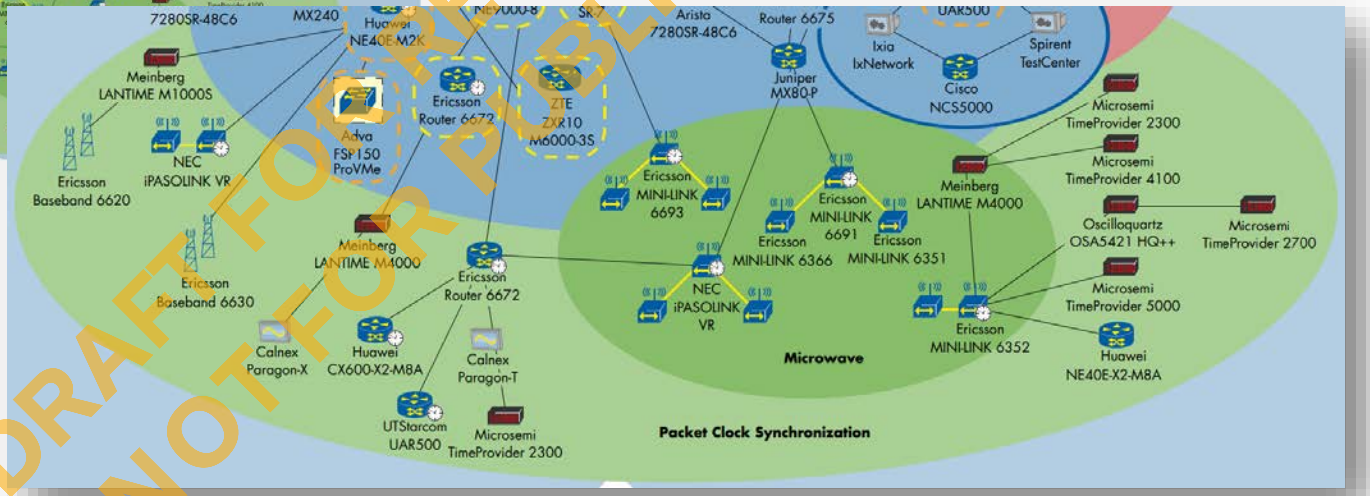
**White Paper Editing**
- Description of tested technologies, positive results, working demonstrations
- WP Approval
- WP Printing
- Press Releases

**Congress**
- Live demos
- Guided tours

# Topology 2018







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# Packet Clock Synchronization Tests Overview

Test Areas

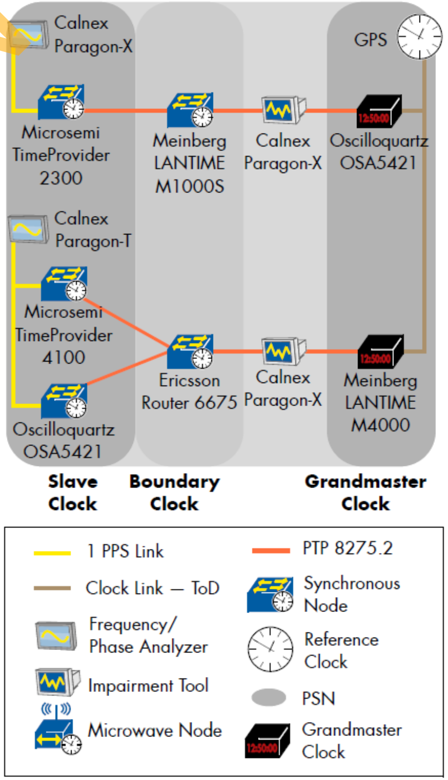
- Phase/Time Partial Timing Support
- Phase/Time Assisted Partial Timing Support & Delay Asymmetry
- Phase/Time Synchronization: Source Failover
- Phase/Time Synchronization with Full Timing Support: Microwave Transport
- Phase/Time Synchronization: Degradation of Primary Source
- Time/Phase Holdover with Sync-E support in the Core

# Phase/Time Partial Timing Support

Grandmaster clock provided with GPS input, while slave and boundary clock started from free running condition

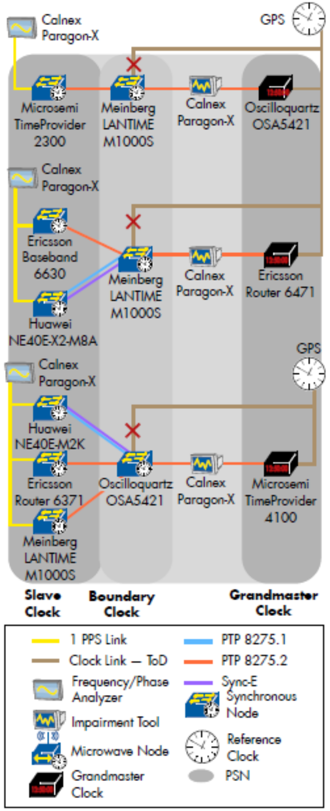
- We enabled PTP on the boundary clocks while the Calnex Paragon-X was emulating a PDV
- In the combination Meinberg LANTIME M4000 as T-GM and Ericsson Router 6675 as T-BC (as well as all the other occurrences of this combination in the current document), the boundary clock did not manage to lock to the grandmaster clock using this attenuation profile
- We agreed to use an attenuated version of this impairment, where all parameters were reduced by 50%
- After the boundary locked to the grandmaster clock, we let the slave clock also lock to the boundary clock via PTP and verified that the phase accuracy and frequency of the ITU-T G.823 SEC mask requirements were satisfied

In an additional setup, a transparent clock instead of the boundary clock was used, but slave did not to lock to grandmaster while using the impairment



Phase/Time Partial Timing Support

# Phase/Time Assisted Partial Timing Support



Phase/Time Assisted Partial Timing Support

ITU-T G.8275.2 profile between grandmaster and boundary clock, with choice of running G.8275.1 or G.8275.2 between boundary and slave clocks

- Grandmaster and boundary clocks were connected to GPS and the slave clock locked via PTP to the boundary clock
- The impairment emulated a PDV according to the profile defined in G.8261
- Some combinations used an attenuated version of this impairment, where parameters were reduced by 50%
- Upon disconnecting the GPS from the T-BC-P we verified that it switched to PTP and confirmed that the output met the phase accuracy requirement of ±1.1 µs and frequency requirements
- GPS antenna to the T-BC-P and repeated the measurement

In one combination we observed a problem with the boundary clock: the APTS backup path did not reach the ready/locked state while using both ITU G.8275.1 and 8275.2 profiles at the same time downstream towards different clients

In another combination the boundary clock was acting as T-GM and did not increment the steps (vendor explained that since the T-BC standardization process is still ongoing, feature not implemented yet)

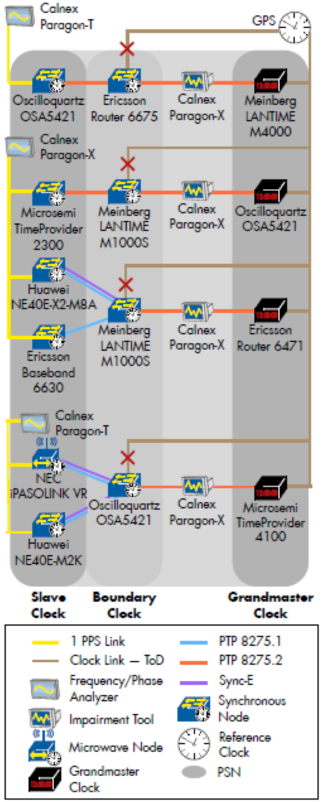
# Phase/Time Assisted Partial Timing Support: Delay Asymmetry

ITU-T G.8275.2 profile between grandmaster and boundary clock with choice of running G.8275.1 or G.8275.2 between boundary and slave clocks

- Grandmaster and boundary clocks were connected to GPS
- Impairment emulated a PDV according to the profile defined in G.8261
- Some combinations used an attenuated version of this impairment, where all parameters were reduced by 50%
- After disconnecting the GPS from the boundary clock, we used the Calnex Paragon-X to introduce an additional delay asymmetry of 125 µs and verified that the boundary could calculate and compensate the asymmetry introduced
- The Calnex Paragon-X was used to provide PTP impairments

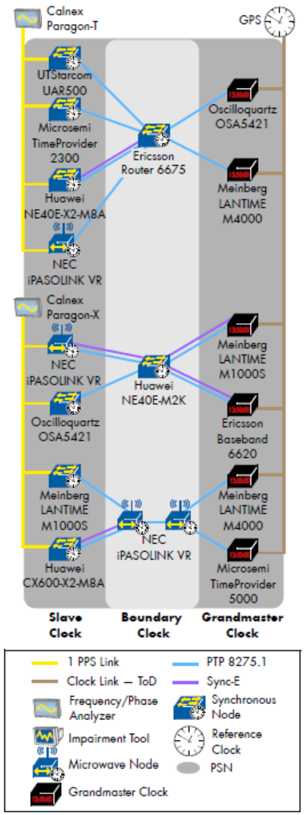
We observed different behaviors of the devices acting as boundary clock, depending on the internal oscillator quality

Upon inserting delay asymmetry, some T-BCs kept lock to grandmaster clock, while others went in holdover mode (ClockClass 160) while measuring asymmetry introduced, preferring internal oscillator time. As soon as calibration was performed, they reverted to ClockClass 6



Phase/Time Assisted Partial Timing Support: Delay Asymmetry

# Phase/Time Synchronization: Source Failover



Phase/Time Synchronization: Source Failover

Grandmasters were provided with GPS signal from a common GPS antenna

- Boundary clock locked to the primary grandmaster and then degraded the primary grandmaster's quality by disconnecting its GPS input
- Boundary clock switched over to the secondary grandmaster and measured the slave clock's transient response
- We also tested if the correct clockClass values are being signaled by the grandmasters according to the telecom profiles, which allows the alternate best master clock algorithm running on the boundary clock to correctly select the best grandmaster during each step of the tests

In a failed combination an issue related to ptpTimeScale flag set to TRUE, while currentUTCOffset was set to 36s and currentUTCOffsetValid was FALSE

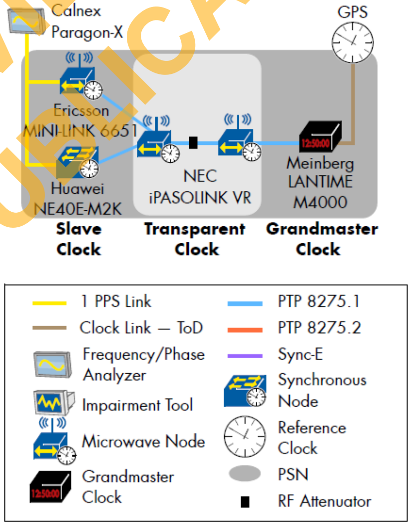
The PTP standard section 8.2.4.2 a) states that in case of ptpTimescale TRUE currentUTCOffset shall be obtained from the primary reference (GPS in this case)

We expected UTC offset to be 37s and valid flag set to TRUE, issue led the T-BC not to lock to grandmaster clock

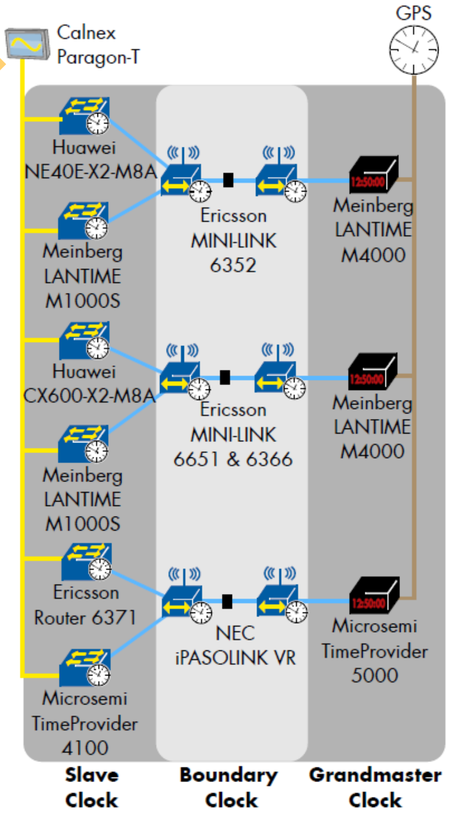
# Phase/Time Sync with Full Timing Support: Microwave Transport

Slave clock in free running mode generating constant bit rate at maximum line rate for maximum modulation scheme with no traffic loss

- After the slave clock locked, we performed baseline measurements
- To emulate severe weather conditions, we reduced the bandwidth between the two nodes of the microwave network using an RF attenuator
- As expected the nodes reacted by changing the modulation used
- PTP traffic was unaffected by the change of modulation, as it was prioritized over other data traffic and the slave clock output retains required quality level
- Bandwidth decreased accordingly, with data packets being dropped according to the available bandwidth
- In the first setup, the microwave stations acted as boundary clocks, in the second setup they were acting as transparent clocks




Phase/Time Synchronization with full Timing Support: Microwave Transport

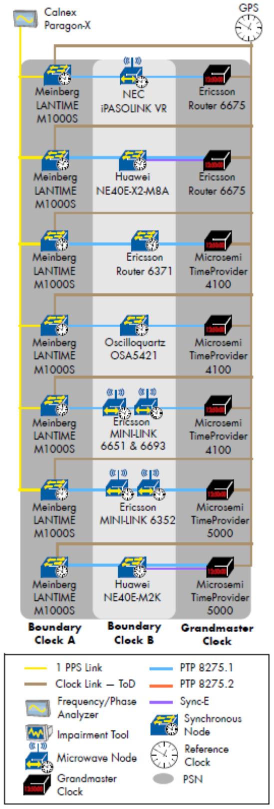


# Phase/Time Sync: Degradation of Primary Source

Capability to swap role of a boundary clock's port from master to slave and vice-versa

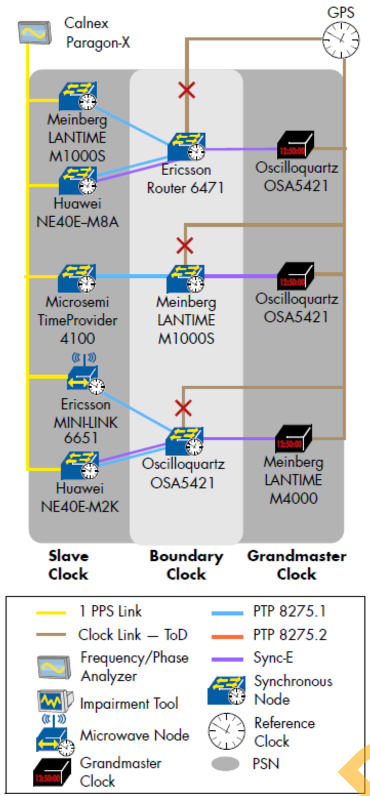
- This test was performed using the ITU-T G.8275.1 profile
- Both the grandmaster and one of the boundary clocks (BC-A) were provided with a GPS signal
- We allowed the grandmaster and the boundary clock A to lock to GPS input
- The boundary clock A acted as primary grandmaster for the upstream boundary clock (BC-B)
- Disconnected the antenna of the boundary clock A to emulate a GPS failure and verified that both boundary clocks locked via PTP to the central grandmaster
- We recovered the GPS of the boundary clock A and verified that the boundary clock B locked again to the downstream boundary clock A

In failed combinations devices acting as BC-A were not able to swap the operation mode of the port from Master to Slave, as this function was not implemented




Phase/Time Synchronization: Degradation of Primary Source

# Time/Phase Holdover with Sync-E support in the Core



Time/Phase Holdover with Sync-E Support in the Core

Holdover performance of boundary clock in relation to phase/time stability while GPS unavailable and Sync-E used as backup to GPS

- Both grandmaster and boundary clocks were provided with a GPS signal from a common GPS antenna
- In the upstream between the boundary and the grandmaster clock only Sync-E was available, while the ITU-T G.8275.1 was used in downstream link between boundary and slave clock
- First we allowed the slave clock to gain a stable lock, then we emulated a GPS failure of the antenna connected to the boundary clock
- We then measured that the phase accuracy requirement of ±1.1µs is fulfilled for at least 30 minutes while in hold-over

In one combination as GPS has been unplugged, the T-BC went into holdover-within-spec, clockClass 135 as expected, but after only 7 minutes changed to holdover-out-of-spec, clockClass 165

In this situation the slave clock lost it PTP lock to the boundary clock

# Outlook 2019

TBD

# Thank you for your interest!

For further information, please contact us:

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