Mobile Backhaul Synchronization

In Service Timing SLA Tools for Mobile Networks

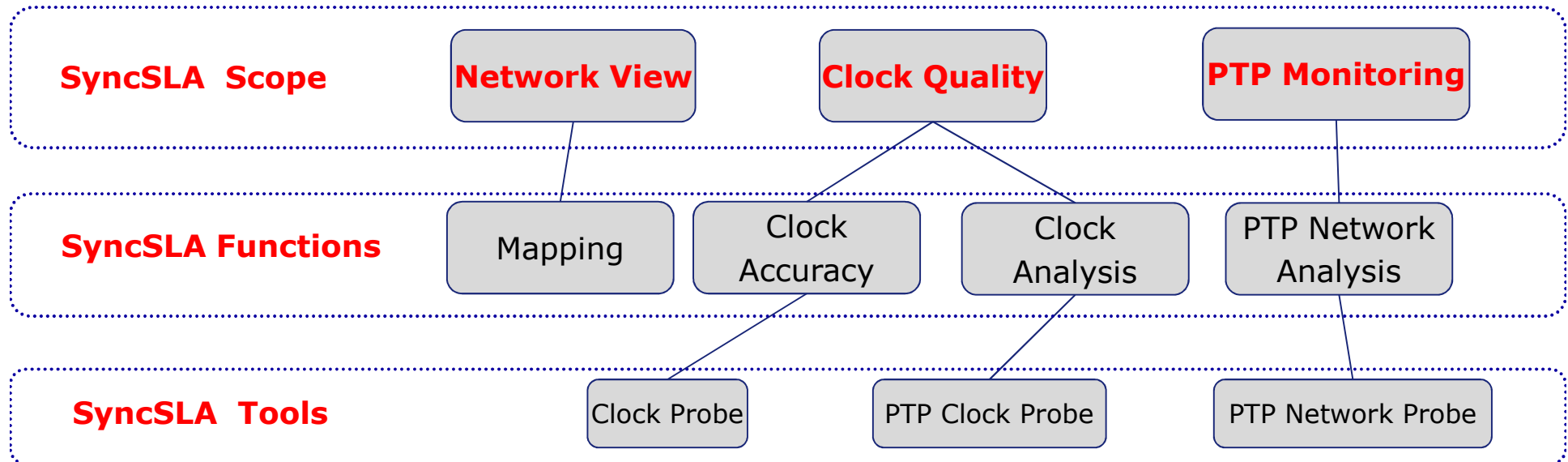Gil Biran, ITSF 2012, Nice France

Agenda

- Synchronization SLA tool requirements

- Description of Synchronization SLA tools

- Detailed Deployment modes for "In Service" Sync Probe

- Test Cases for use of Sync Probe SLA tools

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Synchronization SLA tool requirements

SyncSLA Scope, functions and tools

SyncSLA Scope	Network View	Clock Quality	PTP Monitoring

SyncSLA Functions	Mapping	Clock Accuracy	Clock Analysis	PTP Network Analysis

SyncSLA Tools	Clock Probe	PTP Clock Probe	PTP Network Probe

**Network View** – Topological and status visualization of the synchronization network.

Clock Quality – A set of functions intended to monitor test and analyze the quality of the slave clock

PTP Monitoring – A set of functions intended to monitor test and analyze the end to end PTP routes

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Mapping Requirements (PTP Map Case)

- To adds a layer of PTP and SyncE over a topology map of the network

- To display Sync Routes and clock distribution based on the user point of interest

- To monitor synchronization topology changes, status and synchronization distribution capabilities
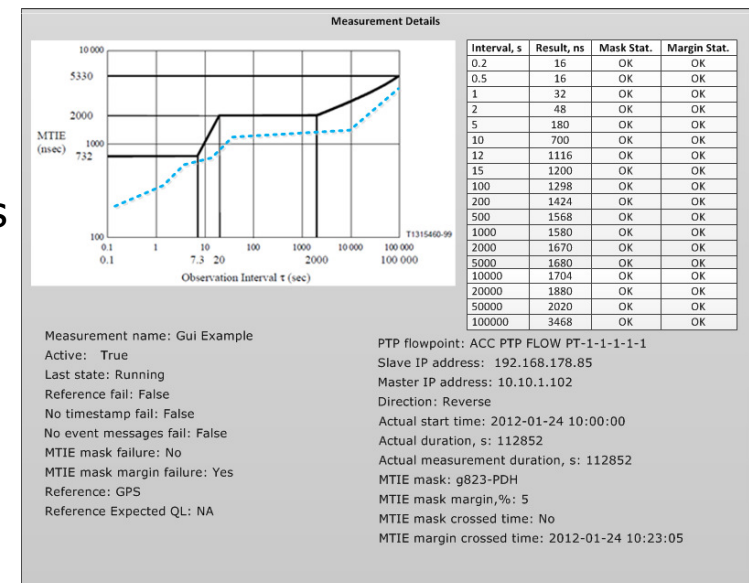
- To display Sync Probe attachment points

NCD: Network Clock Domain

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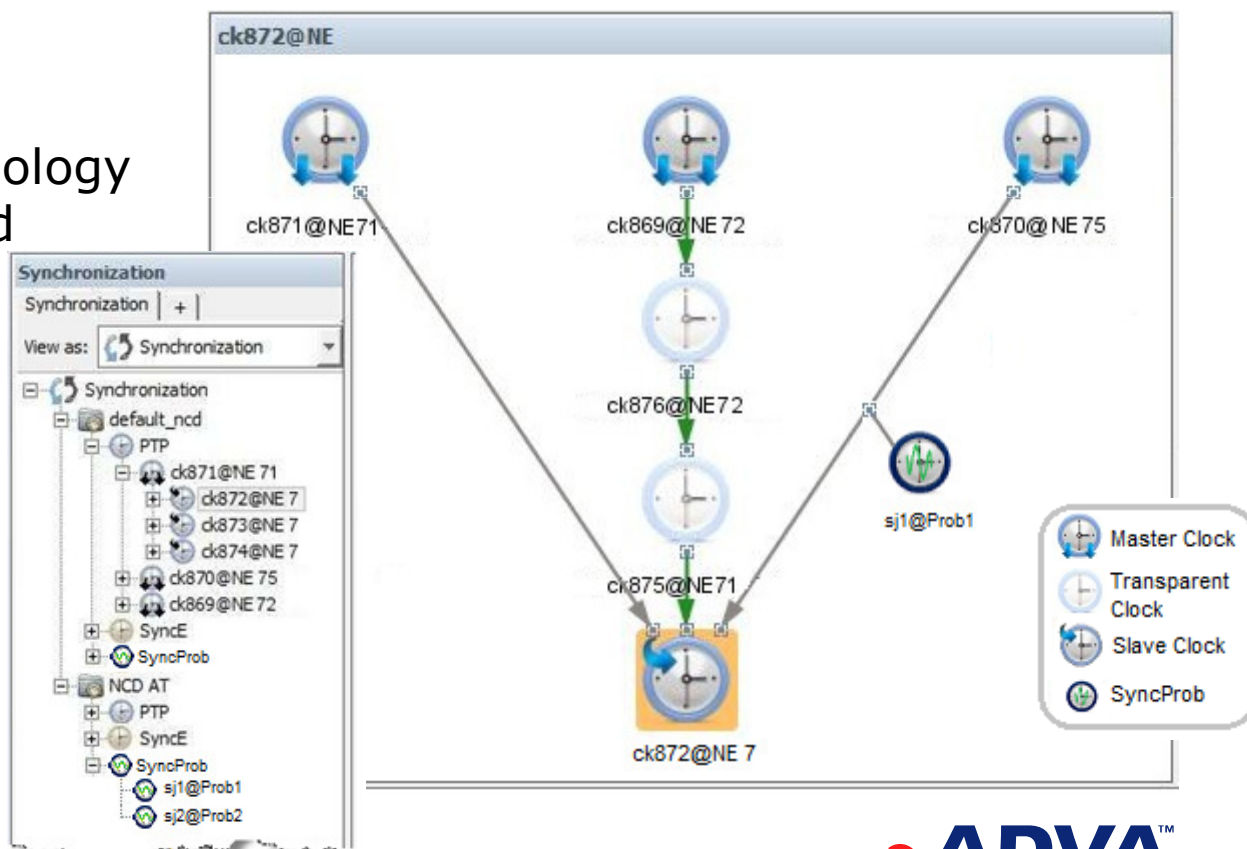
Clock Analysis Requirements
(PTP Clock Probe Case)

- To monitor selected clock source based on collected PTP messages timestamps

- To run multiple concurrent tests per Sync Probe

- To define MTIE Mask and Mask Margin to receive Mask crossing notifications.

- To run the test using NM test framework as option
  - Define tests schedule
  - Monitor the Sync Probe and the on going tests
  - View and export results of historical tests

- To collect Performance Monitoring
  - Clock recovery performance statistics
  - Phase Recovery performance statistics
  - Offset from master statistics
  - TS statuses

Measurement Details

Interval, s	Result, ns	Mask Stat.	Margin Stat.
0.2	16	OK	OK
0.5	16	OK	OK
1	32	OK	OK
2	48	OK	OK
5	180	OK	OK
10	700	OK	OK
12	1116	OK	OK
15	1200	OK	OK
100	1298	OK	OK
200	1424	OK	OK
500	1568	OK	OK
1000	1580	OK	OK
2000	1670	OK	OK
5000	1680	OK	OK
10000	1704	OK	OK
20000	1880	OK	OK
50000	2020	OK	OK
100000	3468	OK	OK

Measurement name: Gui Example
Active: True
Last state: Running
Reference fail: False
No timestamp fail: False
No event messages fail: False
MTIE mask failure: No
MTIE mask margin failure: Yes
Reference: GPS
Reference Expected QL: NA

PTP flowpoint: ACC PTP FLOW PT-1-1-1-1-1
Slave IP address: 192.168.178.85
Master IP address: 10.10.1.102
Direction: Reverse
Actual start time: 2012-01-24 10:00:00
Actual duration, s: 112852
Actual measurement duration, s: 112852
MTIE mask: g823-PDH
MTIE mask margin,%: 5
MTIE mask crossed time: No
MTIE margin crossed time: 2012-01-24 10:23:05

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PTP Network Analysis Requirements

- To collect and display end to end PTP communication path performance monitoring for PD, PDV, Frame loss and availability.
  - Collect basic info from Grand master
  - Collect Transparent Clock residence time Performance statistics
  - Collect and display PTP Performance statistics from Boundary Clock
  - Collect and display Performance statistics from Slave clock

- To display different statistics and metrics for PTP
  - PD statistics
  - PDV metrics in different network loads

Entity ID: PTP Probe1-1

Summary | 15 Minute | 1 Day | Thresholds

Clear | Refresh   ☐ Automatic Refresh Every [5] Seconds

Path Delay Statistics

|			
Average mean Path Delay, ns	2520	Minimum forward RPDV, ns	656
Minimum mean Path Delay, ns	1034	Average forward RPDV, ns	850
Maximum mean Path Delay, ns	3234	Number of forward RPDV results in low range	455
Average forward Path Delay, ns	1022	Number of forward RPDV results in medium range	320
Minimum forward Path Delay, ns	820	Number of forward RPDV results in high range	820
Maximum forward Path Delay, ns	2120	Total Number of forward RPDV results	4322
Average reverse Path Delay, ns	1230	Minimum reverse RPDV, ns	1230
Minimum reverse Path Delay, ns	760	Average reverse RPDV, ns	760
Maximum reverse Path Delay, ns	2220	Number of reverse RPDV results in low range	2220
		Number of reverse RPDV results in medium range	3222
		Number of reverse RPDV results in high range	1444
		Total Number of reverse RPDV results	4500

Network Usability Score Statistics

Forward direction		Reverse direction	
Current score:	5	Current score:	5
Total time Score=5, s	1233	Total time Score=5, s	1233
Total time Score=4, s	123	Total time Score=4, s	123
Total time Score=3, s	0	Total time Score=3, s	0

PTP Messages Statistics

Sync messages received:	24325
Sync messages lost:	345
Sync messages lost ratio, %:	0.004
Delay_Resp messages received:	24670
Delay_Resp messages lost:	0
Delay_Resp messages lost ratio, %:	0

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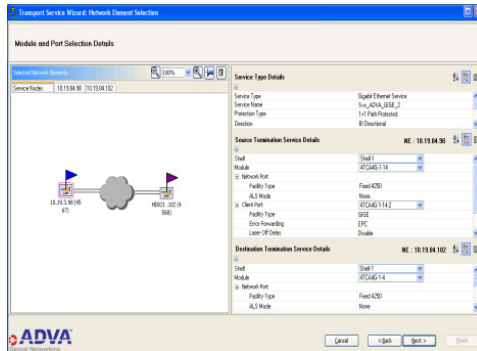
SyncSLA Status Display Requirements
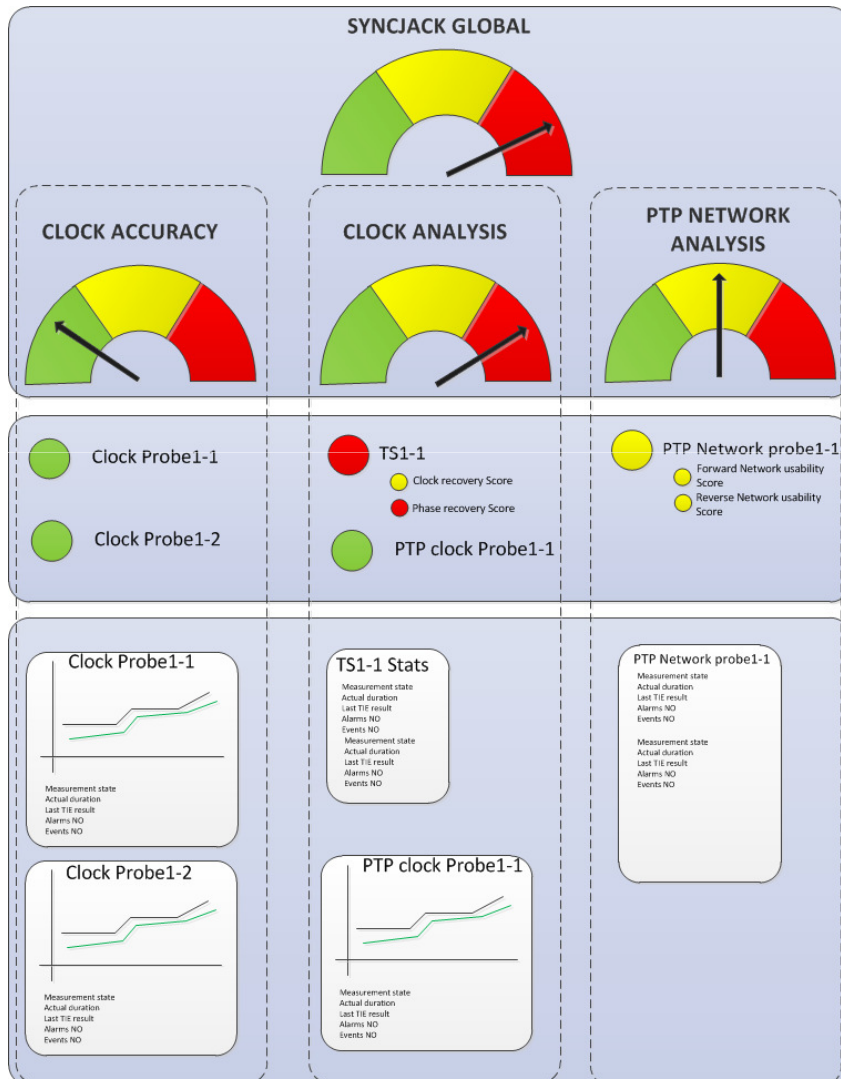
- To support several levels of details for step by step troubleshooting
  - Peeling the onion approach
  - Based on the engineer knowhow

- First level to provide overall Sync Services health indication

- Second level to provide high level health indication of each tool report

- Third level to provide sufficient information for fault localization of each and every test

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Detailed description of Synchronization SLA tools

Synchronization SLA Functions Requirements

Clock recovery score statistics

Phase recovery score statistics

Time and frequency traceability status

PTP Clock Probe results

Mapping

Clock Analysis

> **Mapping**
>> Sync distribution topology and status presentation

> **Clock Accuracy**
>> Frequency and phase accuracy measurement relative to sync ref

> **Clock Analysis**
>> Clock performance monitoring and measurement of slave with and without local external sync ref

> **PTP Network Analysis**
>> PTP path monitoring / testing

Traceable Reference Clock

PRC

FSP
150
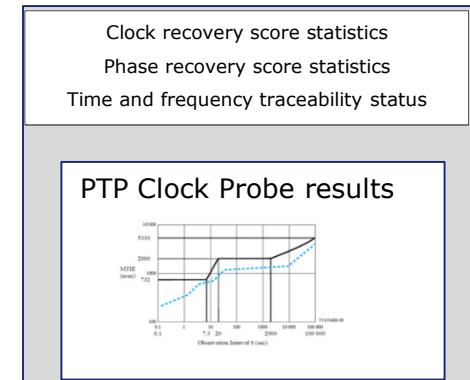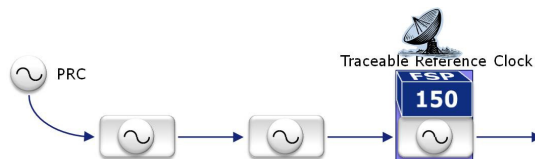
Clock Accuracy

PTP Network Analysis

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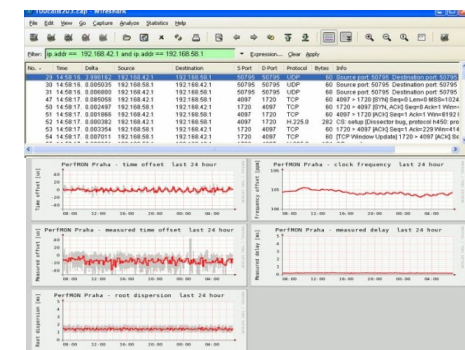
Clock Accuracy Function

- Clock Accuracy is using Clock Probe tool in order to measure frequency and phase accuracy against a reference clock

- Frequency and Time comparisons over observation windows

- Provide standards based mask test plots
  - TIE, MTIE, TDEV
  - PDV, MATIE, MAFE
  - Catering for ITU-T G.8262 performance Masks, and FDD/TDD base station specs

- Metrics Calculation (e.g. MTIE) can be used in 2 ways
  - In the NE with less resolution (18 points) or NM with higher resolution

PRC

Sync Probe

Clock Probe results

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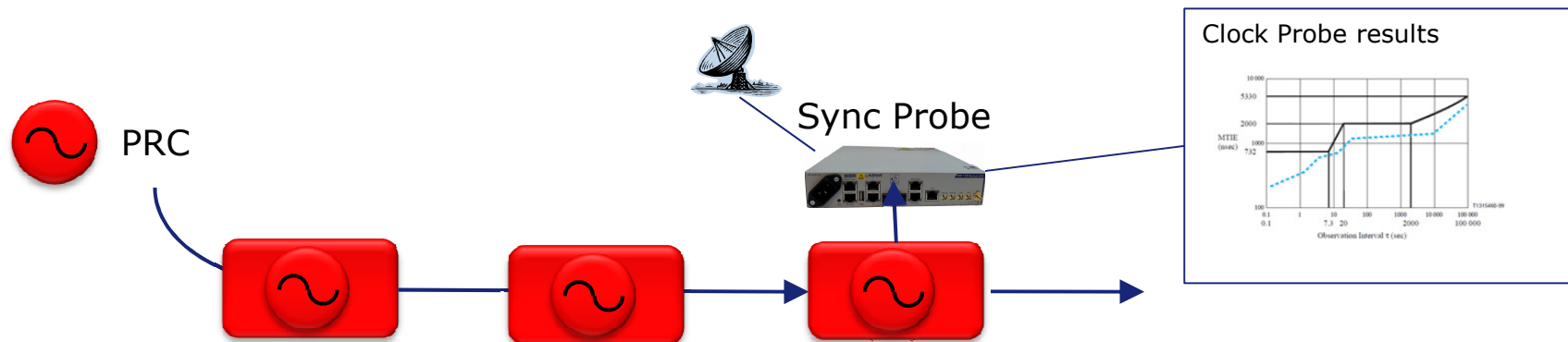
Clock Analysis Function

- Clock Analysis – Proactive in every node – aggregation/demarcation

- Clock Analysis is using PTP Clock Probe tool which is using PTP messages timestamps

- On-demand PTP Clock Probe allows TIE measurements of the Slave clock without need for on-site synchronization reference

- Network wide view using NMS allows comparison of each node performance and problem localization
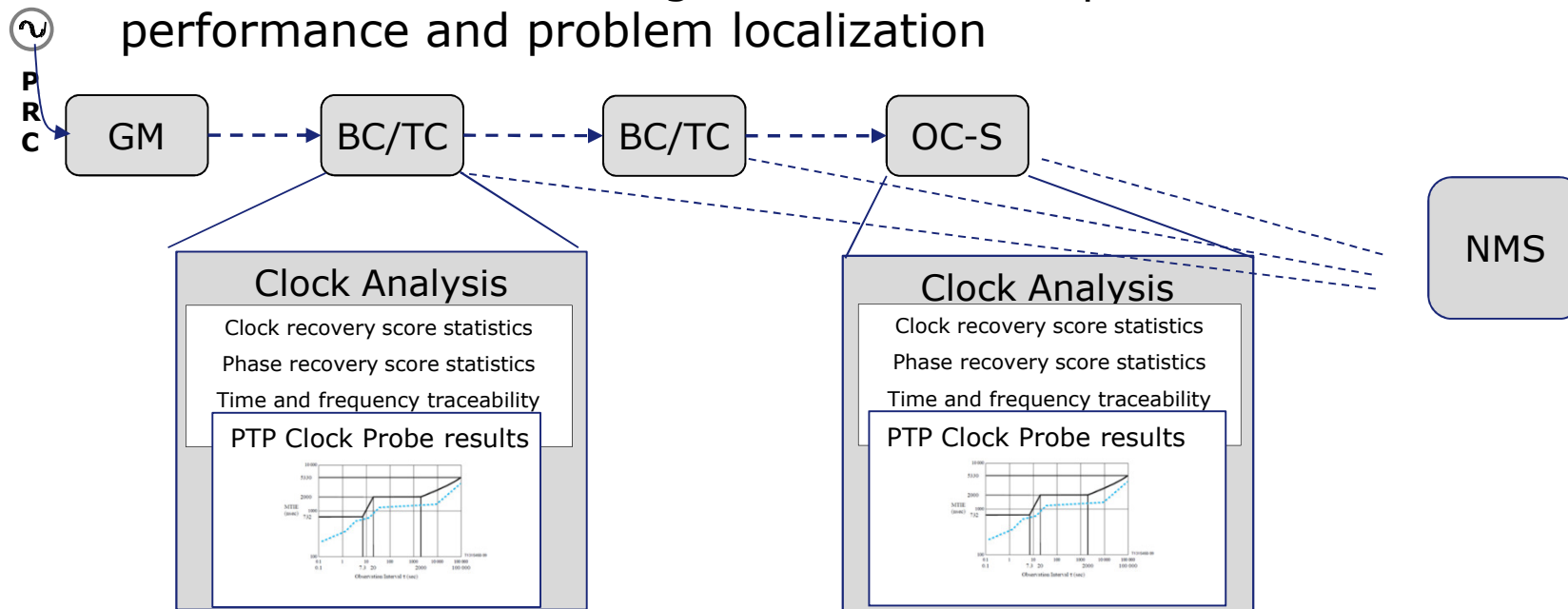
PTP Network Analysis Function

- PTP Network Analysis is using PTP Network Probe for Performance Monitoring of PTP messages Delay, Delay Variation, Network Usability and Packet loss with and without reference clock depending on the mode of Operation
  - Can provide metrics like MAFE (Maximum Average Frequency Error) and MinTDEV (Minimum Time Deviation)

Path delay statistics
PDV statistics
Network usability statistics
Delay floor stability statistics
Delay row results import to NMS

Path delay statistics
PDV statistics
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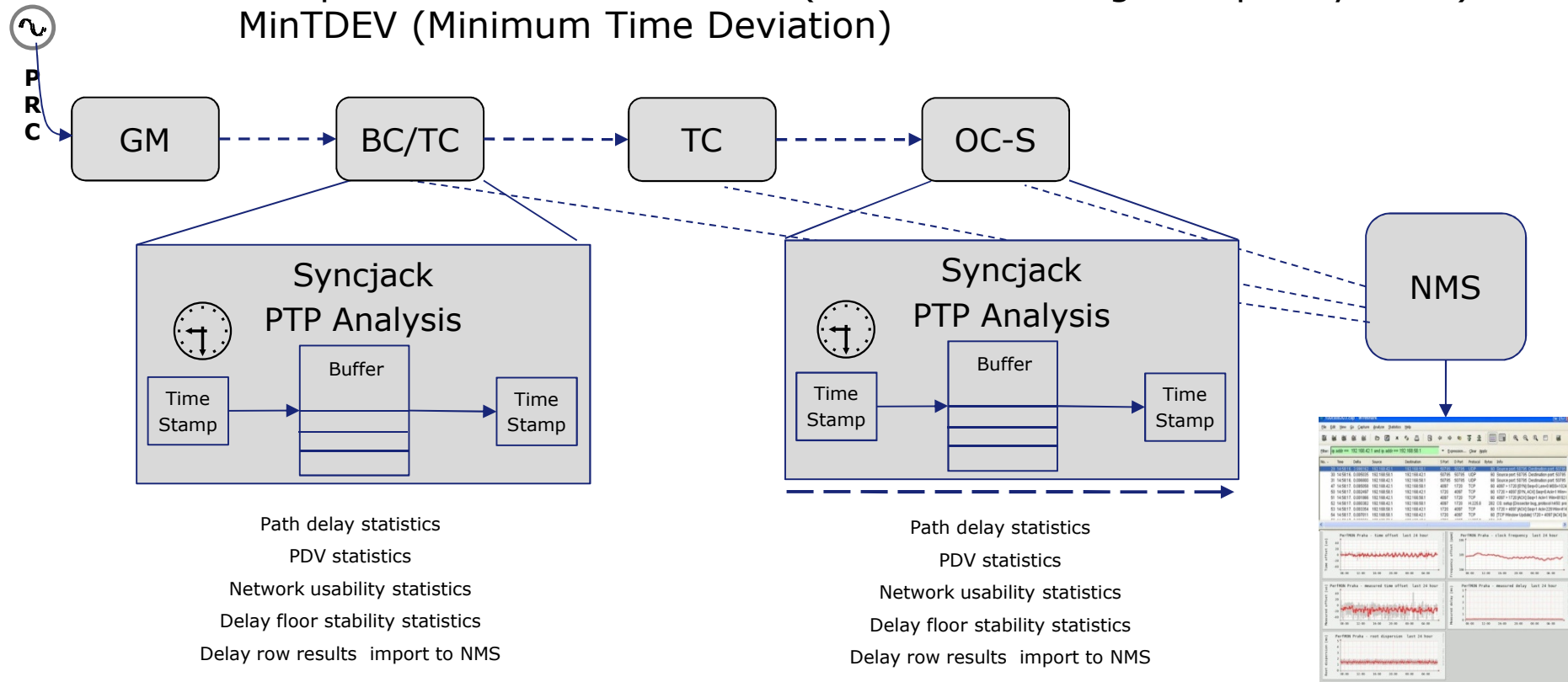
Sync Probe Standard Activity in ITU

- PTP Probe high level Definition will be included in G.8260

- PTP Probe definition: a device capable of measuring and recording the sending times and arrival times of PTP event messages relative to a reference time (e.g. as generated by a PRTC)

  - An **active** PTP probe may function as a PTP ordinary clock port from the protocol point of view, enabling it to exchange PTP event messages with a system under test while recording their event times

  - It (**active** PTP probe) is not required to perform the synchronization functions of a PTP ordinary clock

  - A passive PTP probe may monitor the passing of PTP event messages on a link, without participating in the protocol

Sync Probe Standard Activity in ITU

- Active measurement setup for systems with PTP time transfer

  - Equivalent to the described Parallel mode in Sync Probe
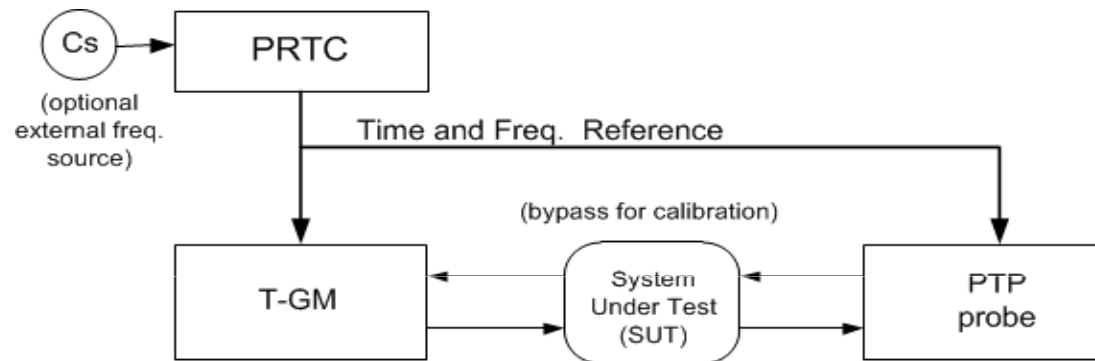
- Passive measurement setup for systems with PTP time transfer

  - Equivalent to the described Tapping mode in Sync Probe
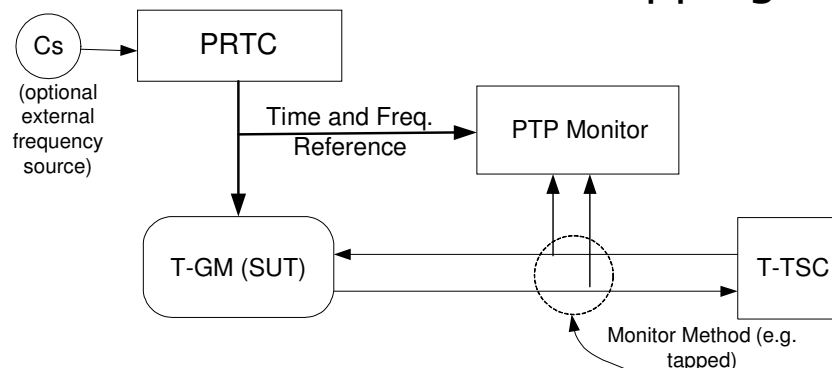
Deployment modes for "In Service" Sync Probe

# Deployment of Sync Probe in end to end Sync Network (PTP Case)

Customer Premise | Access | Aggregation | Core

10GE MEN

PRC

Grand Master

RNC

Head End

Slave Clock ---- Boundary Clock ---- Transparent Clock ---- Boundary Clock ---- Grand Master

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Sync Probe Tapping mode

Master

Sync Network

Mirrored Port/VLAN

Mirrored PTP packets

Mirroring Port/VLAN

NID

TOD
BITS_in

Eth2
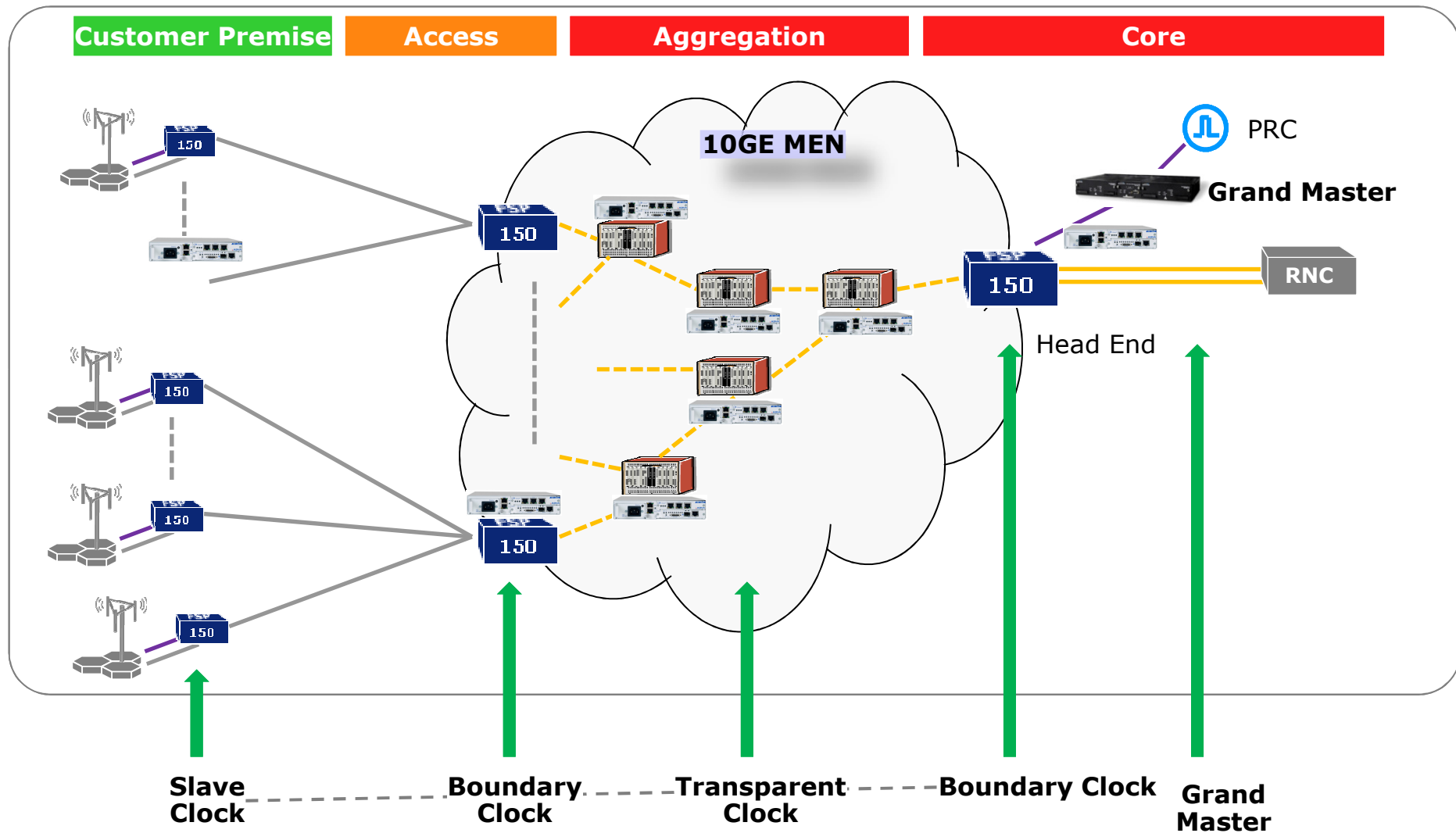
SyncProbe

Slave Clock

Cell Site
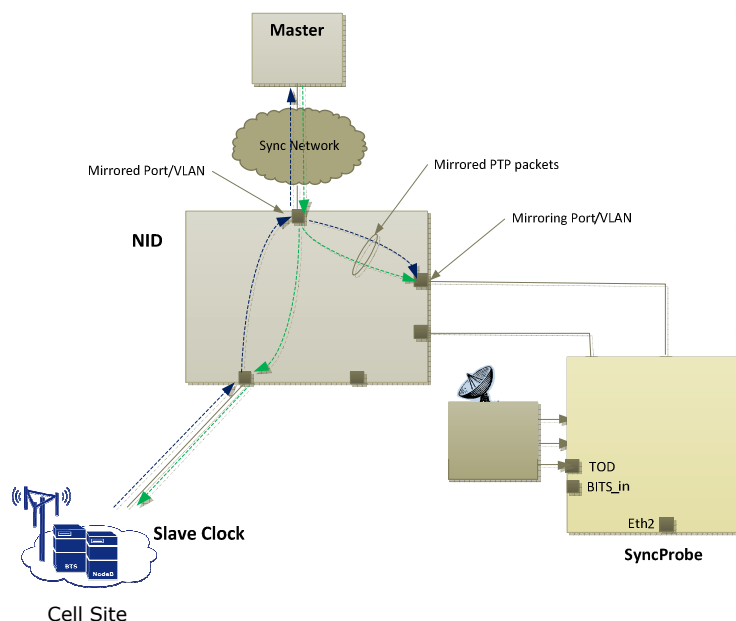
- Connection Highlights
  - NID mirrors PTP frames to the port with attached Syncprobe

- Clock Accuracy functions: Only for SyncE

- Clock analysis functions
  - Measurement of the Slave Clock and Master Clock TIE and phase offset accuracy based on the PTP event messages timestamps

- PTP Network analysis functions
  - PTP Communication Path PM
  - PDV measurement of communication path segments

- Mapping functions
  - Monitoring of the Sync-E QL, the Master(s) status and the Slave status and events

Sync Probe Parallel mode
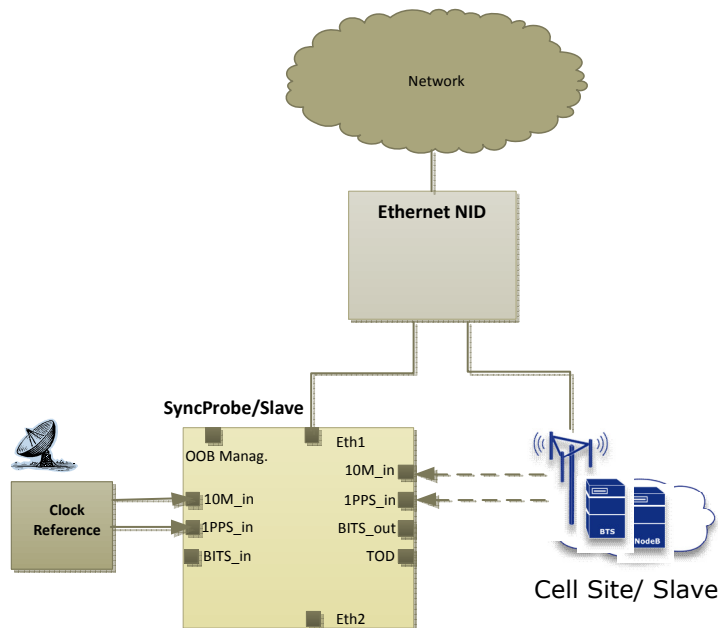
- Sync Probe operates Slave clock and also runs TIE test for external timing signals
  - Clock accuracy using two internal Clock Probes
- Clock accuracy functions
  - TIE measurements of PTP recovered clock and external timing signals
  - Sync-E accuracy testing
- Clock analysis functions
  - Clock recovery and phase accuracy performance estimation
  - Slave clock extended statistics and statuses
- PTP Network analysis functions
  - PTP Communication Path PM
  - PDV measurement of communication path segments
- Mapping functions
  - Monitoring of the Sync-E QL, the Master(s) status and monitoring of the Slave status and events

Sync Probe PTP Image and Enabling modes
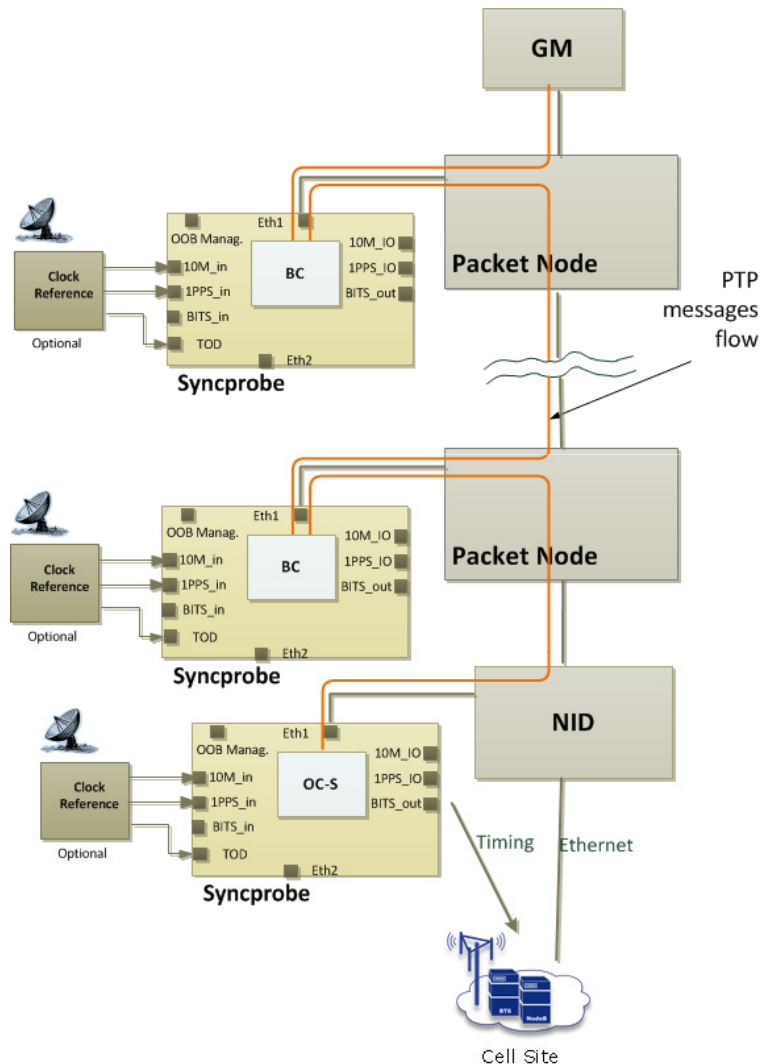
- Sync Probe as add on "plug in boundary clock" or "plug in transparent clock"

- Add PTP support to a legacy network with NE that doesn't support PTP

- Convert a none SyncSLA mobile backhaul network to full end to end SyncSLA PTP overlay network

- Provide SyncSLA functions to every node in the Sync network

- Allow end to end managing, monitoring and testing of Sync networks

  - Networks that doesn't support SyncSLA (Image)

  - Networks that doesn't support Sync at all (Enabling)

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Test Cases for use of Sync Probe SLA tools

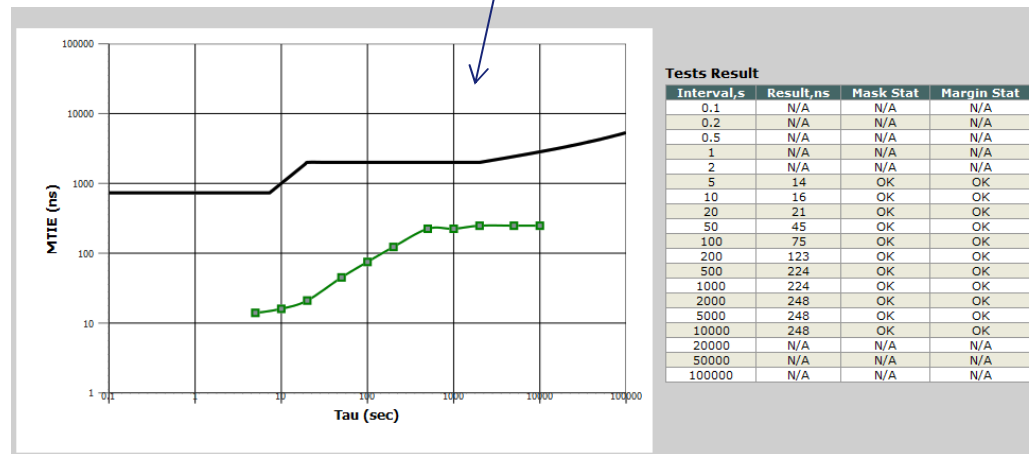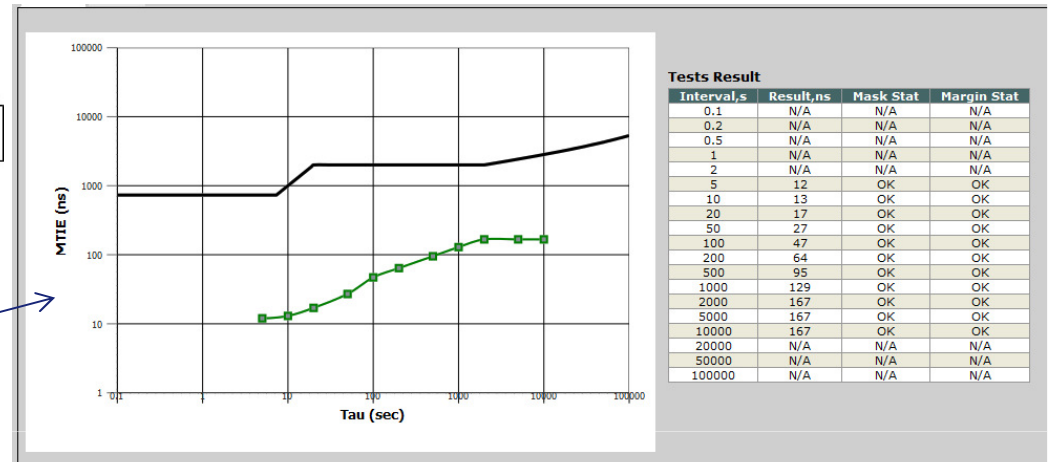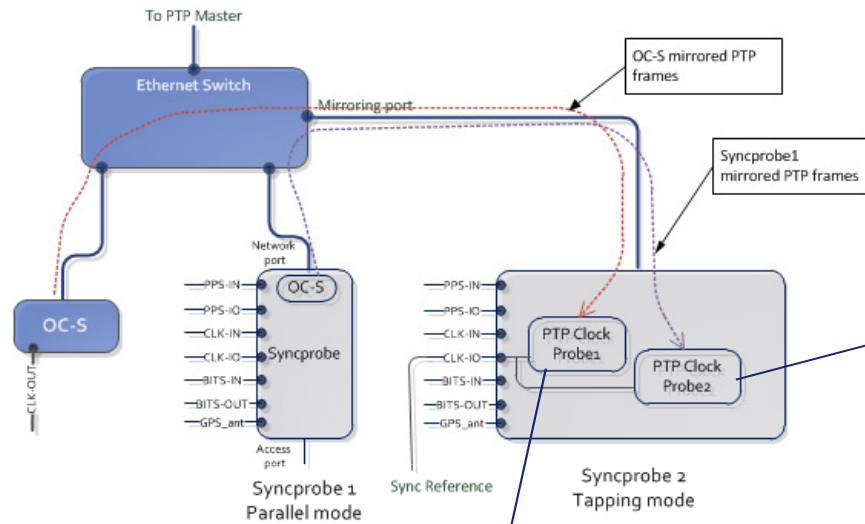# Set-up description for Sync Probe test cases results
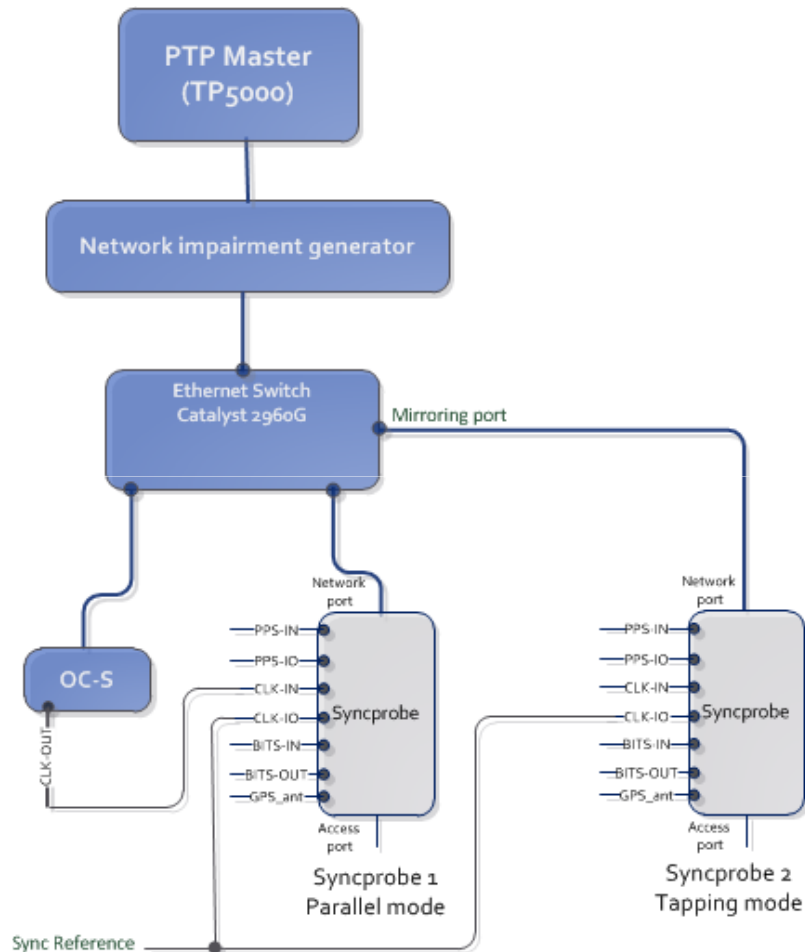
- PTP Master – Symmetricom TP5000

- OC-S – Tested device with IEEE1588v2 Ordinary Clock-Slave (OC-S) functionality

- Sync Probe-1 operates OC-S and runs SyncSLA tools

- Sync Probe-2 runs only SyncSLA tools

- Impairment generator runs test case 12 ITU-T G.8261

- The Ethernet switch is configured with mirroring mode to copy PTP frames to the Mirroring Port (in the real deployment optical splitter may be used instead)

- Sync reference is always connected to the Sync Probe-2 and in some test cases connected to the Sync Probe-1 (PPS, 10MHz, BITS, Sync-E and GPS antenna)

MTIE measurements of OC-S under test Vs. OC-S in Sync Probe – Clock Accuracy
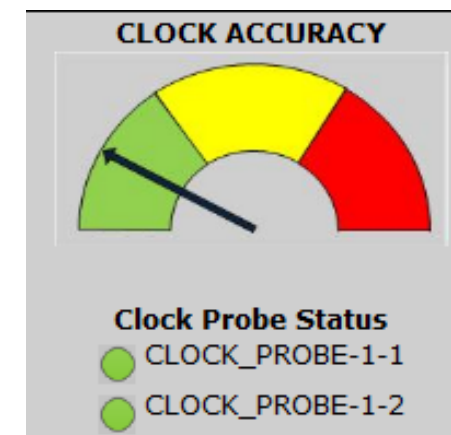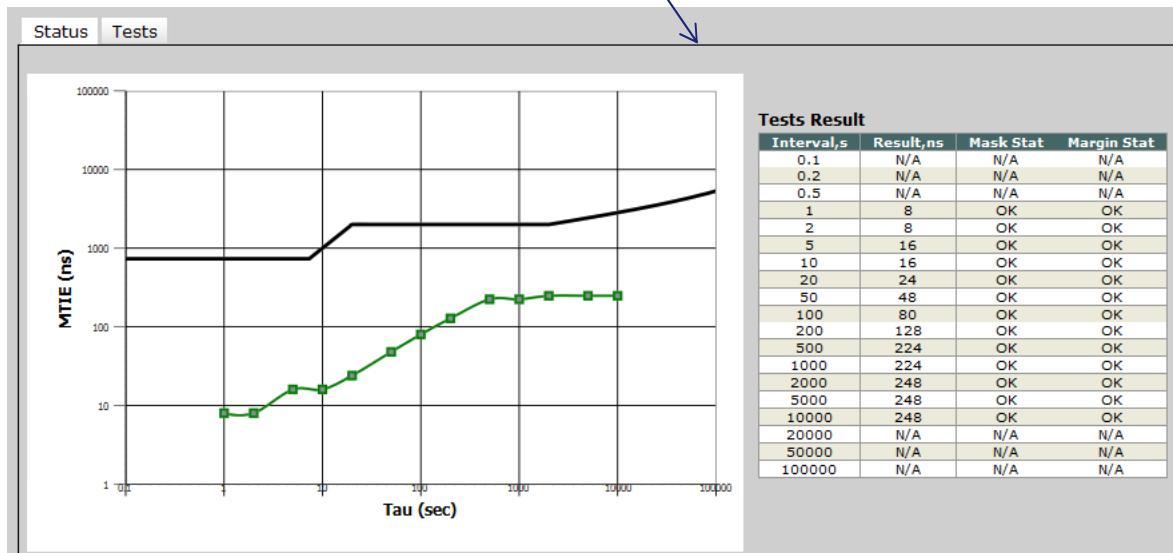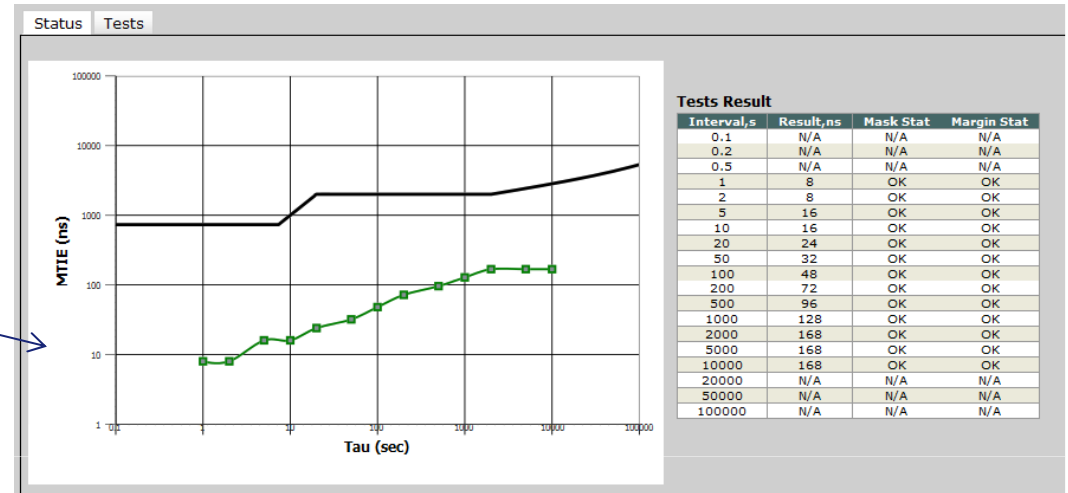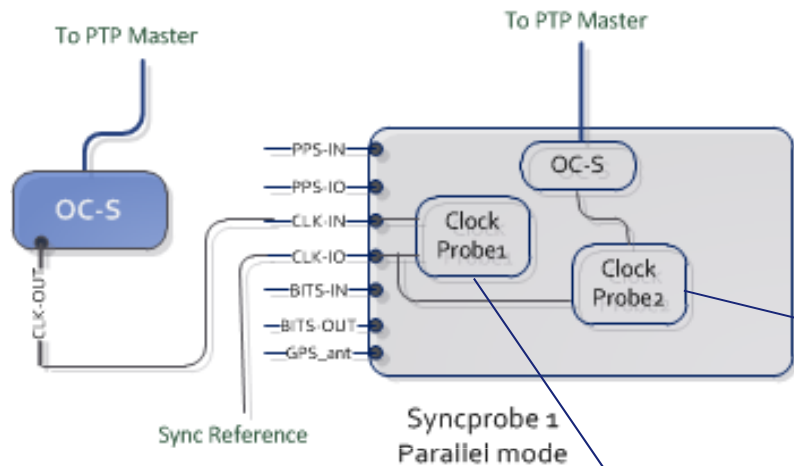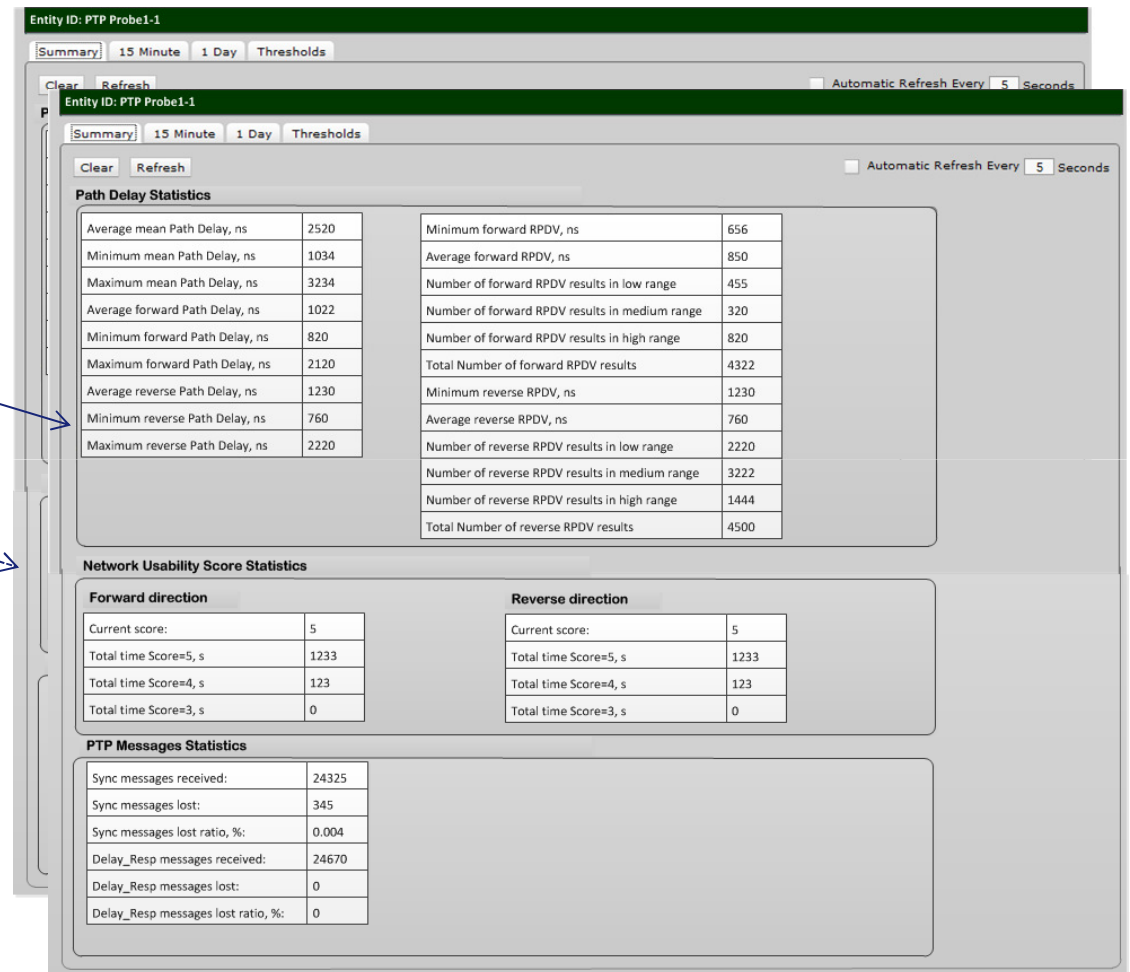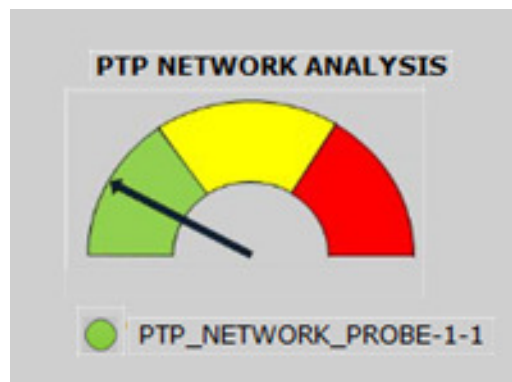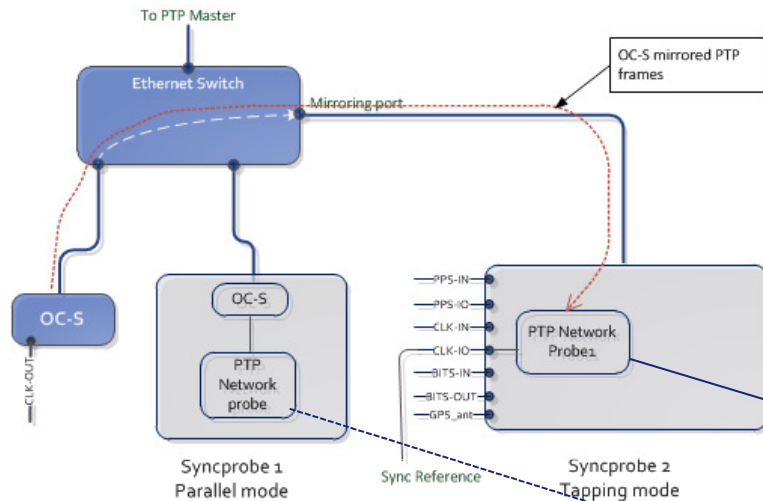
Simultaneous MTIE measurements of multiple remote OC-S nodes – Clock Analysis

Tests Result (upper right)

Interval,s	Result,ns	Mask Stat	Margin Stat
0.1	N/A	N/A	N/A
0.2	N/A	N/A	N/A
0.5	N/A	N/A	N/A
1	N/A	N/A	N/A
2	N/A	N/A	N/A
5	12	OK	OK
10	13	OK	OK
20	17	OK	OK
50	27	OK	OK
100	47	OK	OK
200	64	OK	OK
500	95	OK	OK
1000	129	OK	OK
2000	167	OK	OK
5000	167	OK	OK
10000	167	OK	OK
20000	N/A	N/A	N/A
50000	N/A	N/A	N/A
100000	N/A	N/A	N/A

Tests Result (lower left)

Interval,s	Result,ns	Mask Stat	Margin Stat
0.1	N/A	N/A	N/A
0.2	N/A	N/A	N/A
0.5	N/A	N/A	N/A
1	N/A	N/A	N/A
2	N/A	N/A	N/A
5	14	OK	OK
10	16	OK	OK
20	21	OK	OK
50	45	OK	OK
100	75	OK	OK
200	123	OK	OK
500	224	OK	OK
1000	224	OK	OK
2000	248	OK	OK
5000	248	OK	OK
10000	248	OK	OK
20000	N/A	N/A	N/A
50000	N/A	N/A	N/A
100000	N/A	N/A	N/A

CLOCK ANALYSIS

- ● PTP_CLOCK_PROBE-1-1
- ● PTP_CLOCK_PROBE-1-2
- ○ PTP_CLOCK_PROBE-1-3
- ○ PTP_CLOCK_PROBE-1-4

PTP communication path PM and statistics
PTP Network Analysis

- With and Without Reference Clock

Managing Synchronization Networks

Network View

Visibility of Sync Routes and clock distribution

Clock Analysis & Accuracy

Monitor in service clock performance

PTP Network Analysis

Monitor in service PTP performance for SLA Assurance

Synchronization as integrated part of mobile backhaul service

Sync SLA should be provided and managed like any L2/L3 service

Sync SLA is mandatory for successful LTE deployment

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Thank you

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