ADVA™ Optical Networking

# Mobile Backhaul Synchronization

## In Service Timing SLA Tools for Mobile Networks

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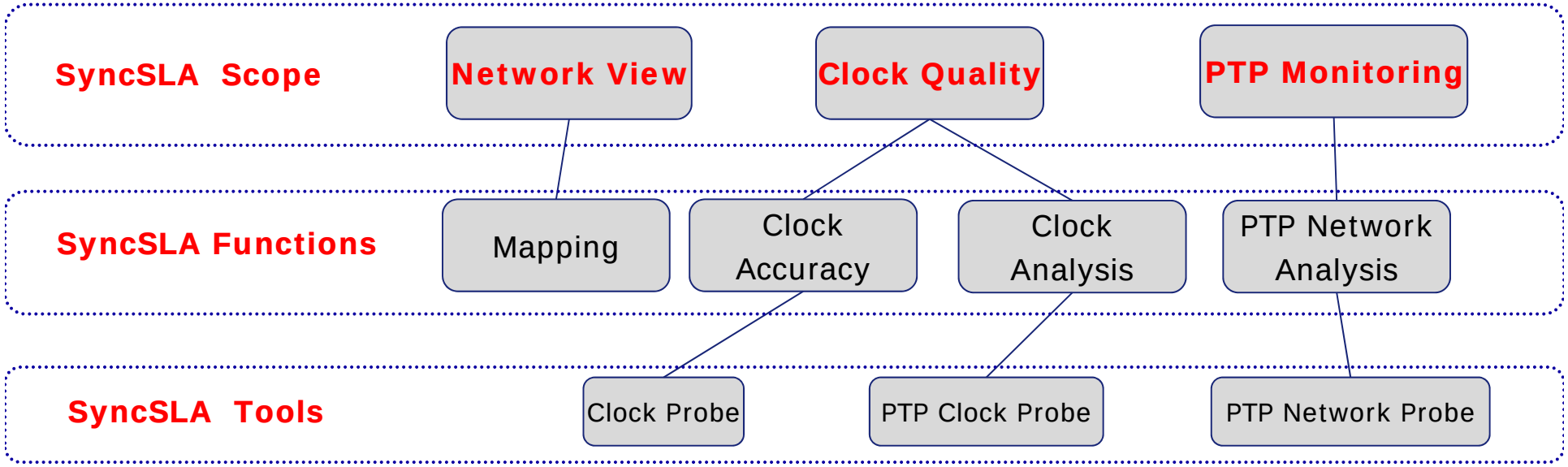
Syncjack™

# Agenda

- Synchronization SLA tool requirements
- Description of Synchronization SLA tools in different “In Service” modes of operation
- Test Cases for use of Sync Probe SLA tools
- Summery

# Synchronization SLA tool requirements

# SyncSLA Scope, functions and tools



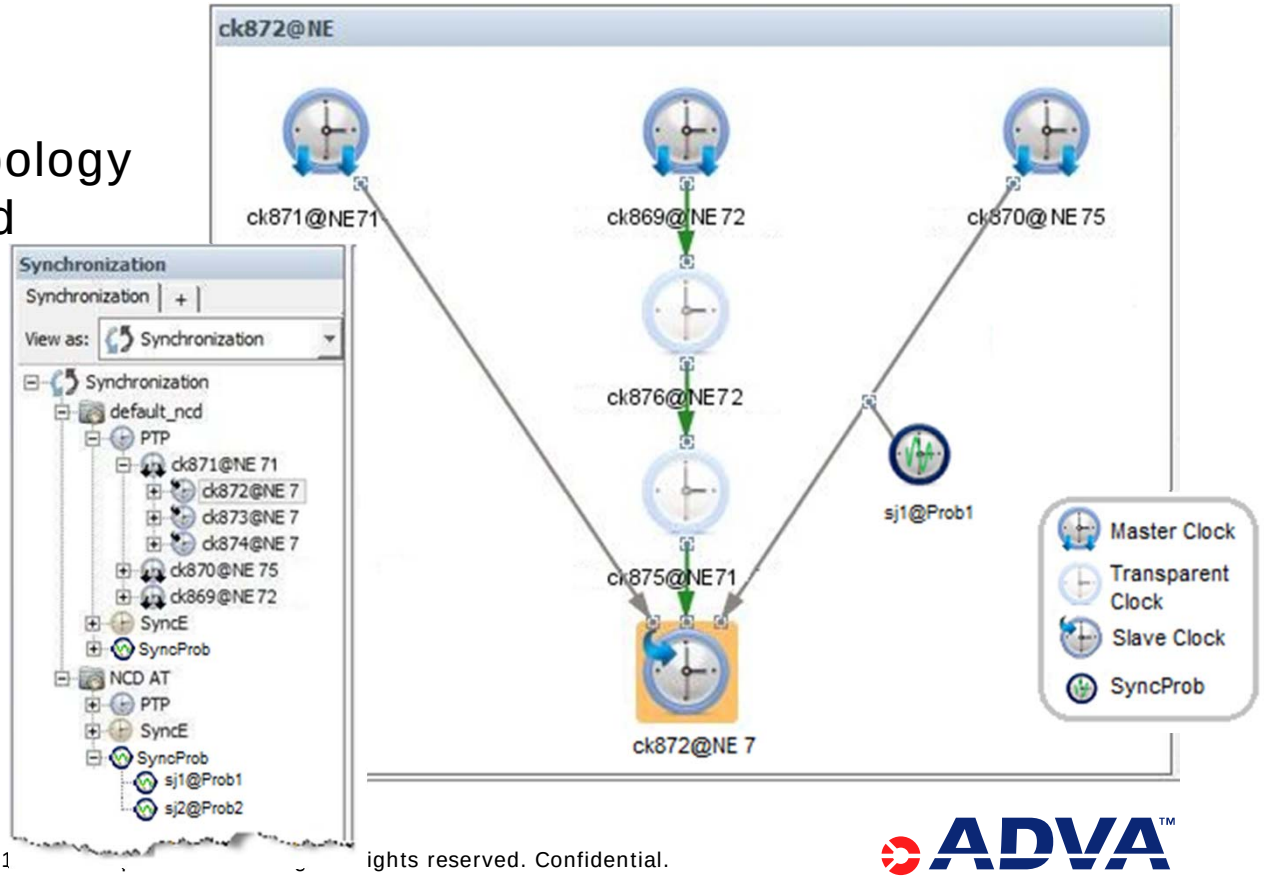

**Network View** – Topological and status visualization of the synchronization network.

**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

# Mapping Requirements (PTP Map Case)

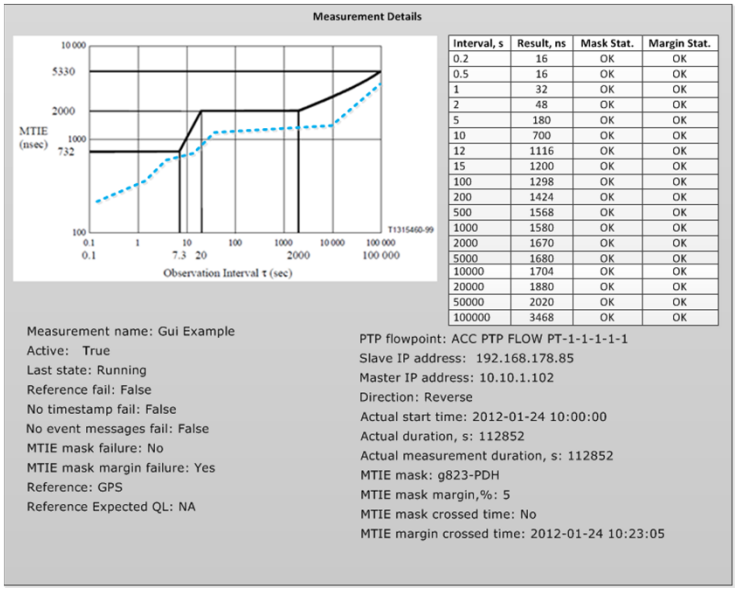
- To adds a layer of PTP and SyncE over a topology map of the network
- To display Sync Routes and clock distribution based on the user point of interest
- To monitor synchronization topology changes, status and synchronization distribution capabilities
- To display Sync Probe attachment points




NCD: Network Clock Domain

# 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

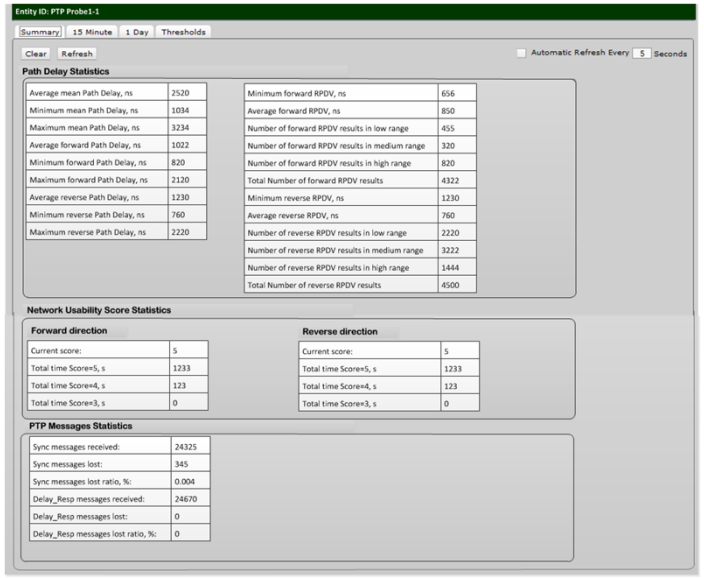



| Interval, s | Result, ns | Mask Stat. | Margin Stat. |
|---|---|---|---|
| 0.2 | 16 | OK | OK |
| 0.5 | 16 | OK | OK |
| 1 | 32 | OK | OK |
| 2 | 48 | OK | OK |
| 5 | 180 | OK | OK |
| 10 | 700 | OK | OK |
| 12 | 1116 | OK | OK |
| 15 | 1200 | OK | OK |
| 100 | 1298 | OK | OK |
| 200 | 1424 | OK | 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 |

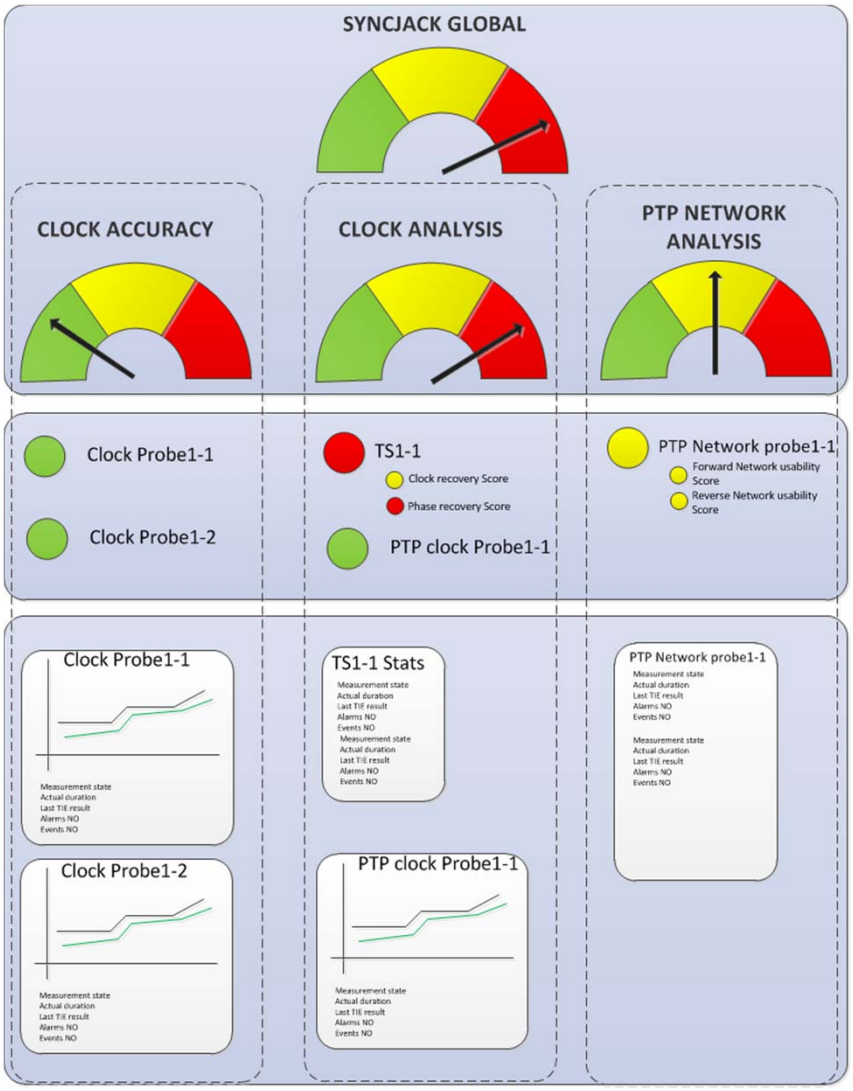
# PTP Network Analysis Requirements

- 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



# 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

# Description of Synchronization SLA tools in different “In Service” modes of operation

# In Service Sync Probing Value Proposition

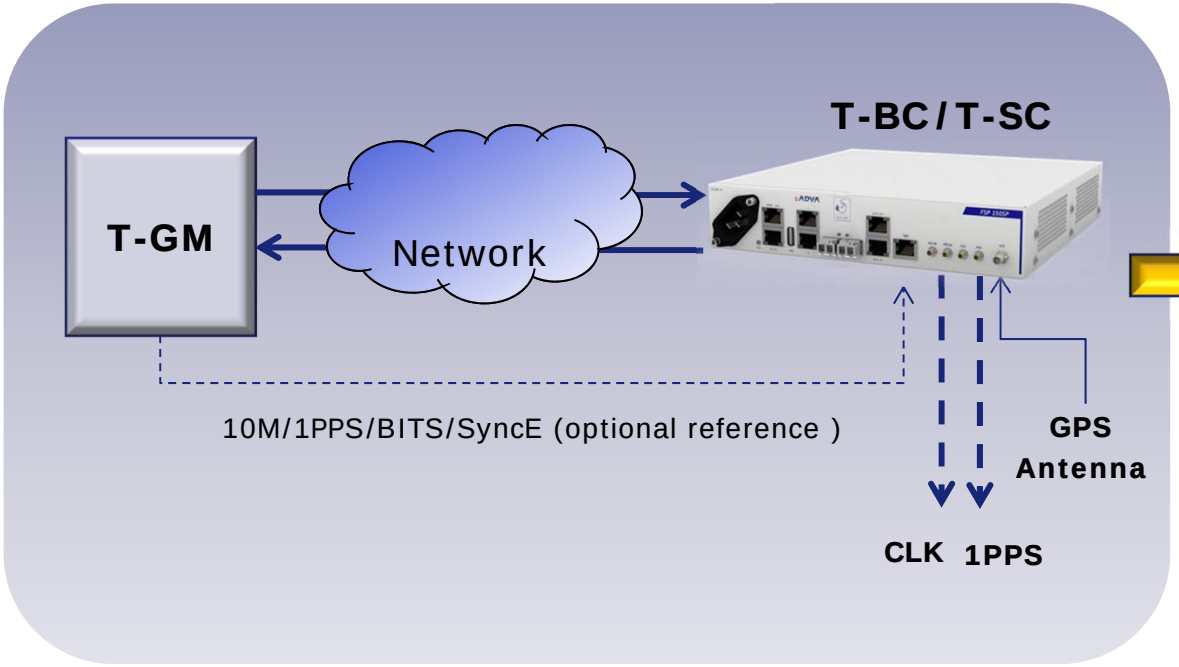
- Active /Passive Probing and monitoring of multiple telecom physical signals as well as multiple packet timing signals
- Probing of physical signals, packet timing signals and the network PDV can be done simultaneously
  - Ease finding correlation between network impairments and clock performance
- Bi-directional Probing of network PDV Behavior
  - Impact Frequency Delivery Performance
- Measurement of PTP network asymmetry
  - Impact Phase and ToD Delivery Performance
- In-service Probing enable Synchronization as a Service with Guaranteed SLA

# Type of Probing Tools for Sync SLA

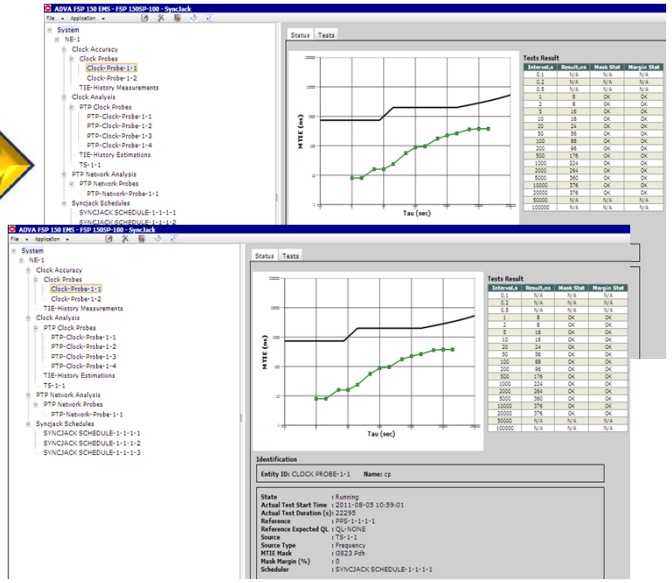
- **Clock Accuracy - 2 x Clock Probe:**
  - Calculate MTIE between physical source and reference signals
  - Programmable Source and reference signals
- **Clock Analysis**
  - **4 x PTP Clock Probe**
    - Calculate packet MTIE between Physical reference signal and packet flow
    - Probe Master to Slave or Slave to master traffic
    - Support parallel and tapping modes
  - **T-SC score –** simple score of internal slave clock
- **PTP Network Analysis - 1 x PTP Network Probe**
  - Delay and delay variation performance statistics, Network usability statistics, Packet loss statistics

# T-SC and T-BC Self Monitoring

- Internal T-SC and T-BC 1PPS and clock outputs can ne monitored simultaneously using Two Clock Probes and GPS/external reference
- The network delay asymmetry can be measured using the PTP network probe statistics (Sync Min Path Delay and Mean Min Path Delay)

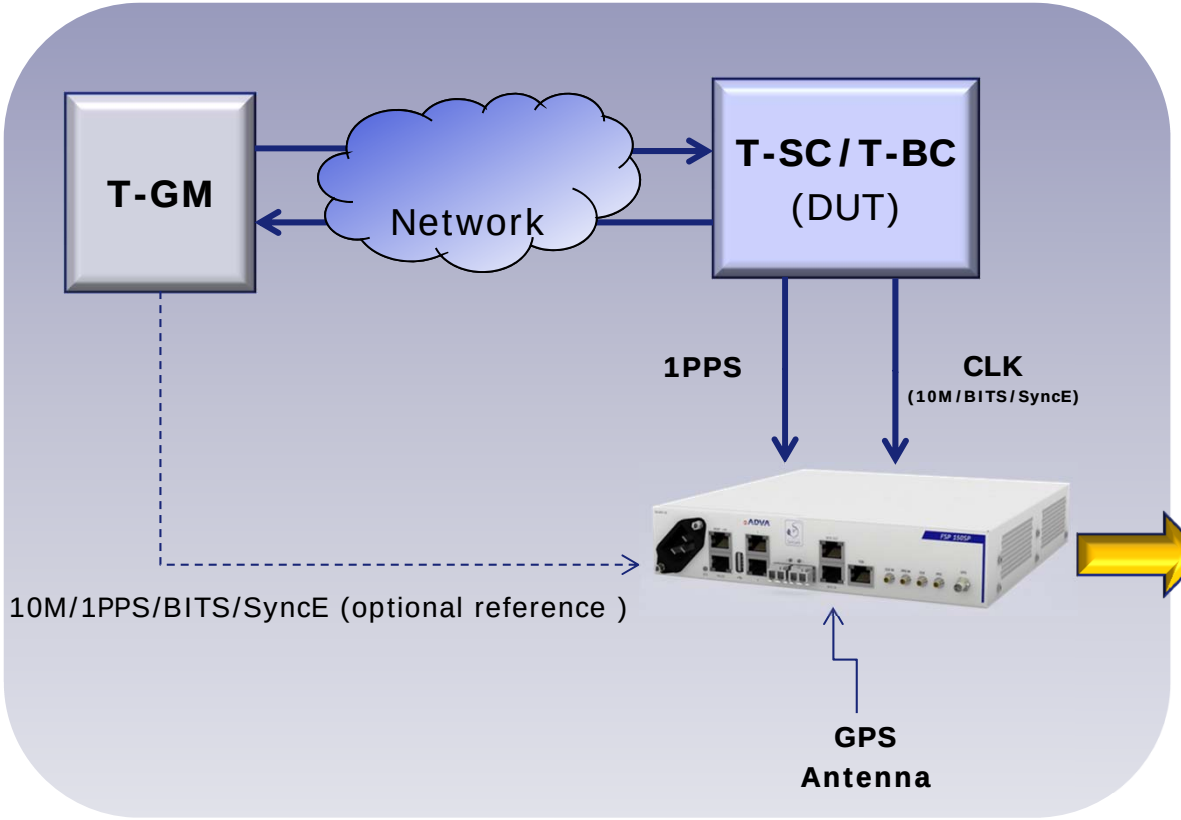



**1PPS and CLK MTIE**

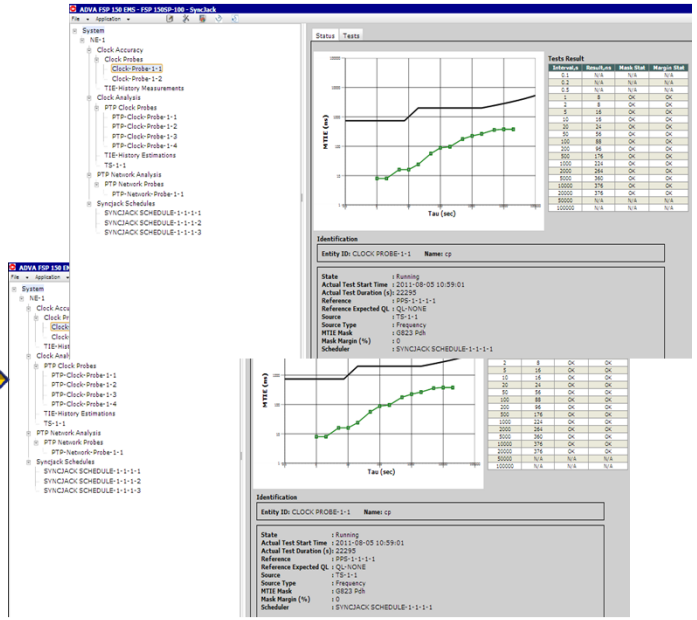


# Testing T-SC and T-BC

- T-SC and T-BC 1PPS and clock outputs can be monitored simultaneously using Two Clock Probes

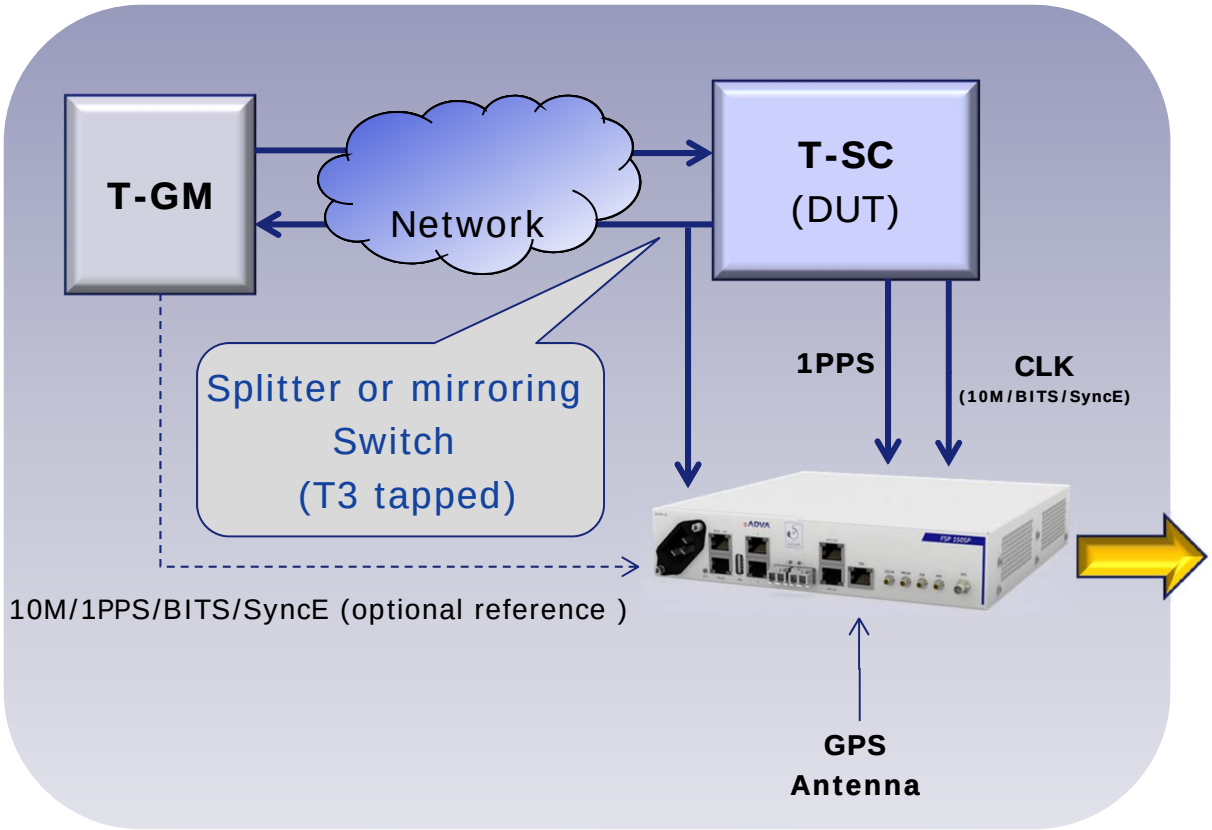



**1PPS and CLK MTIE**

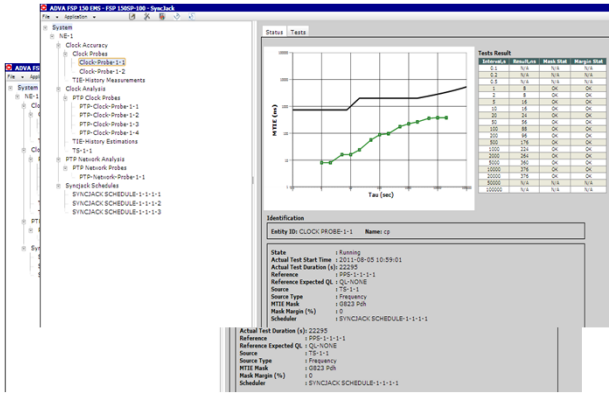


# Probing T-SC

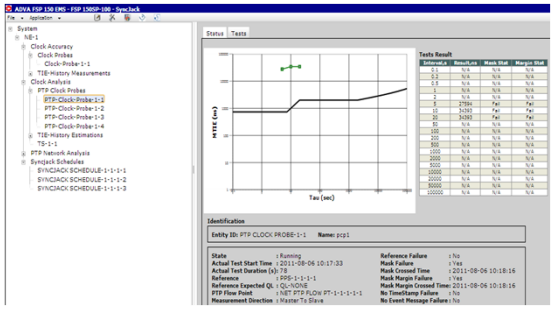
- T-SC packet timing signal (T3), 1PPS and clock outputs can be monitored simultaneously using Two Clock Probes and One PTP clock Probe




**1PPS and CLK MTIE**

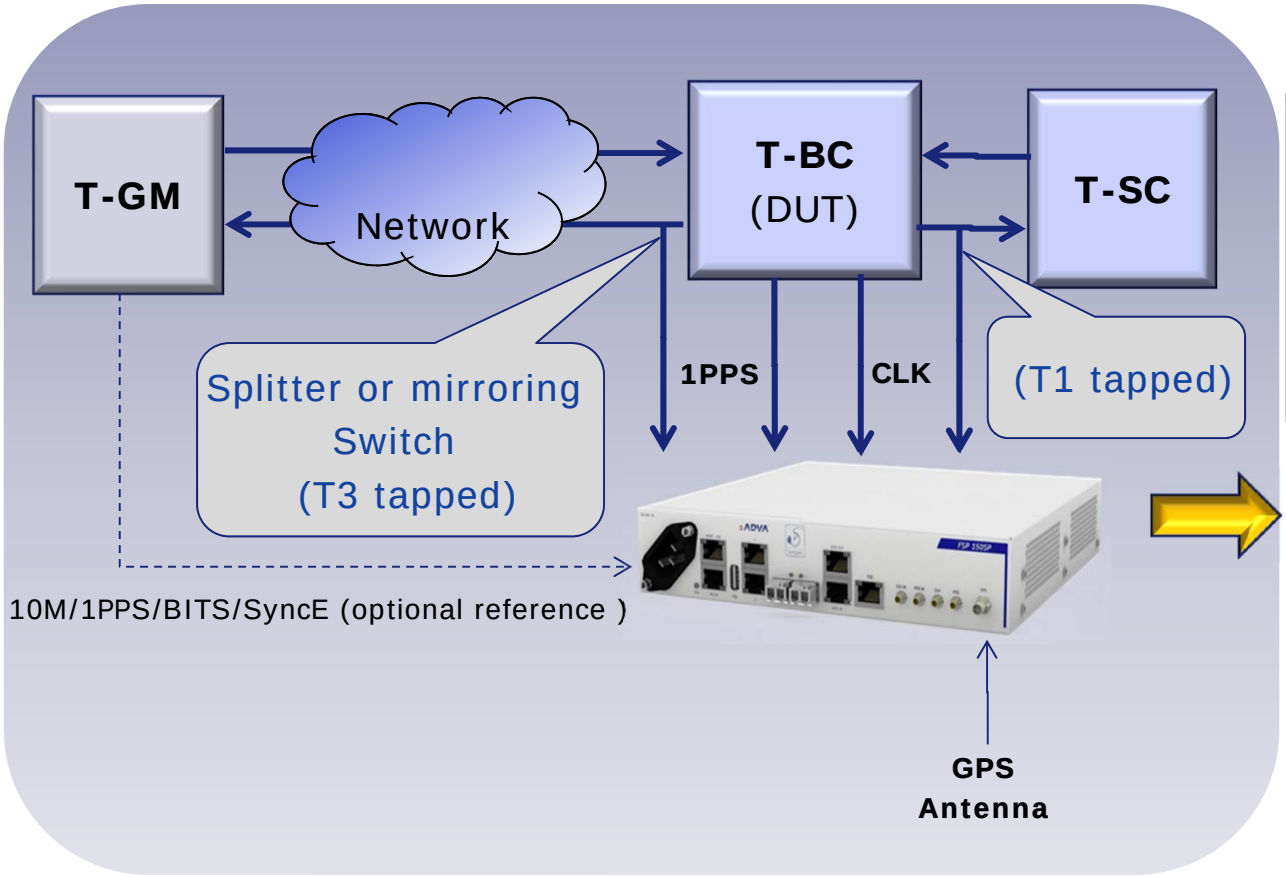


**Packet MTIE based on T3**

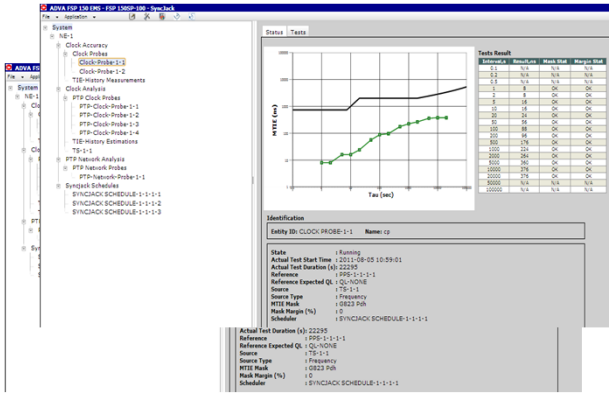


# Probing T-BC

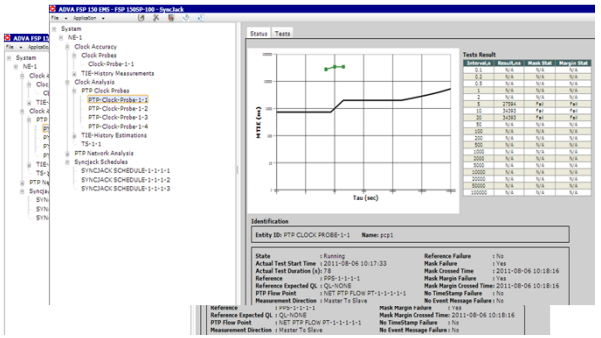
- 1PPS and clock outputs together with T-BC slave & master packet timing signal (T3 and T1), can be monitored simultaneously using Two Clock Probes and Two PTP clock Probes




**1PPS and CLK MTIE**



**Packet MTIE based on T3,T1**







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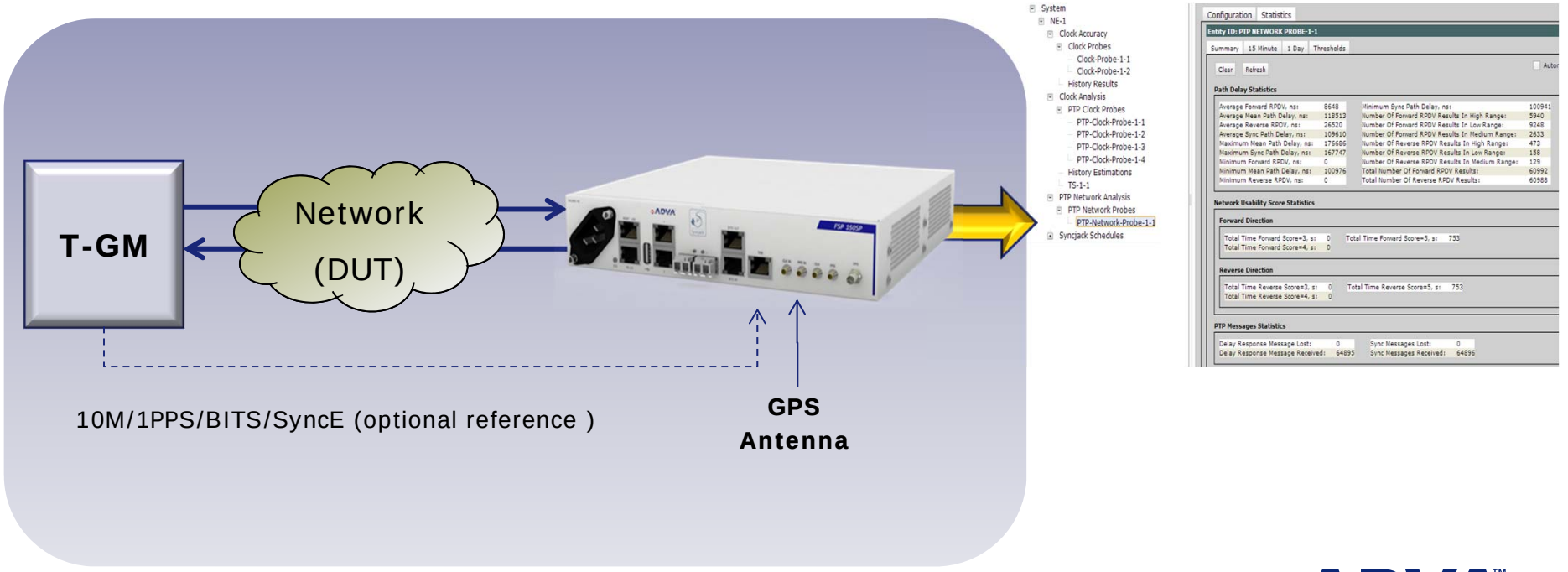
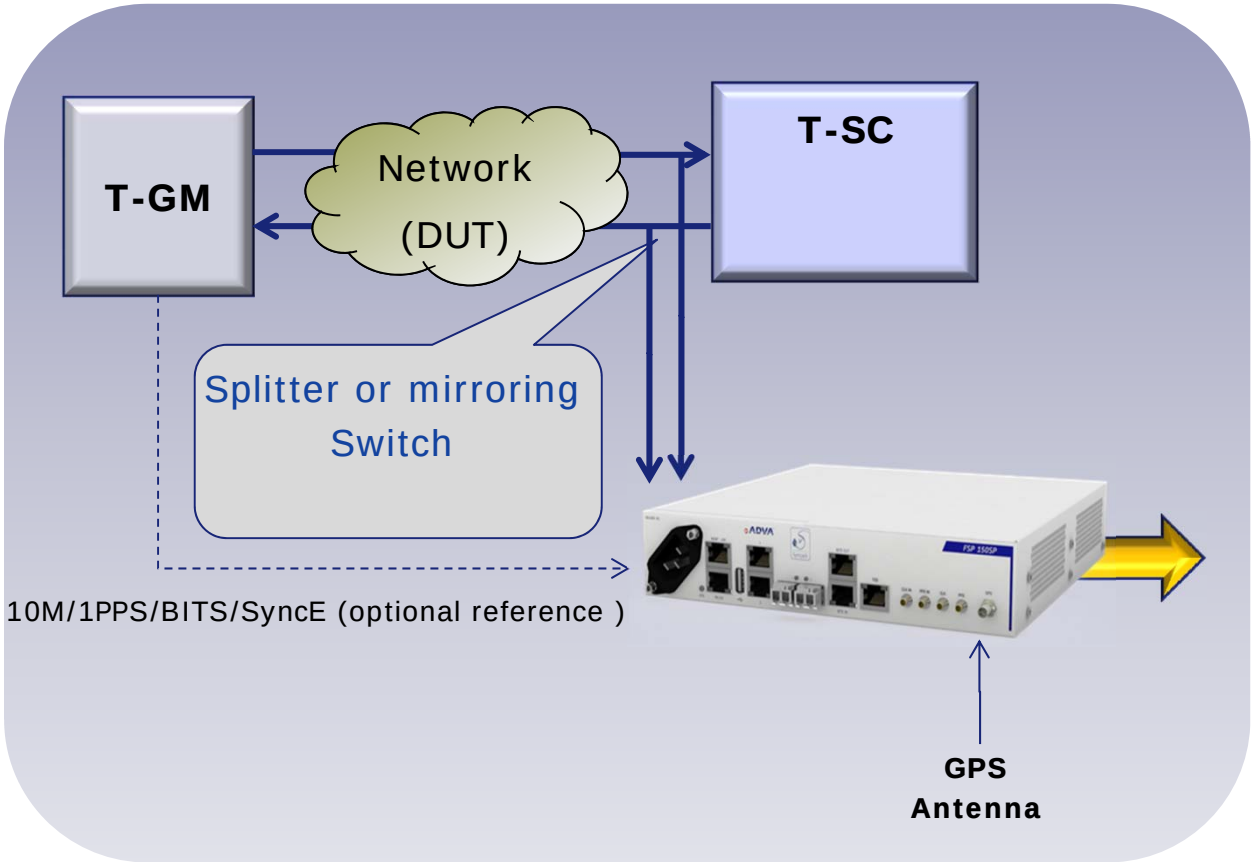
# PTP Network Active Probe

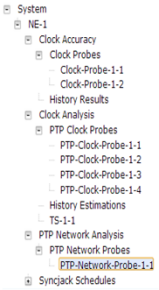
- Active probe uses the internal Telecom slave packets exchanged
- The Sync Probe can probe the network and recover the clock simultaneously
  - Can be used as Sync Interface Demarcation (SID) device
  - Can be used also as Mini GM for indoor small cell deployment
- Provides PTP network Probe Statistics and Network Usability Score

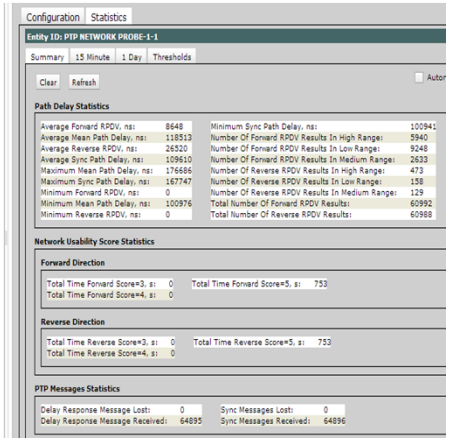


# PTP Network Passive Probe

- Provides PTP network Probe Statistics and Network Usability Score based on  T1, T2, T3 and T4 information

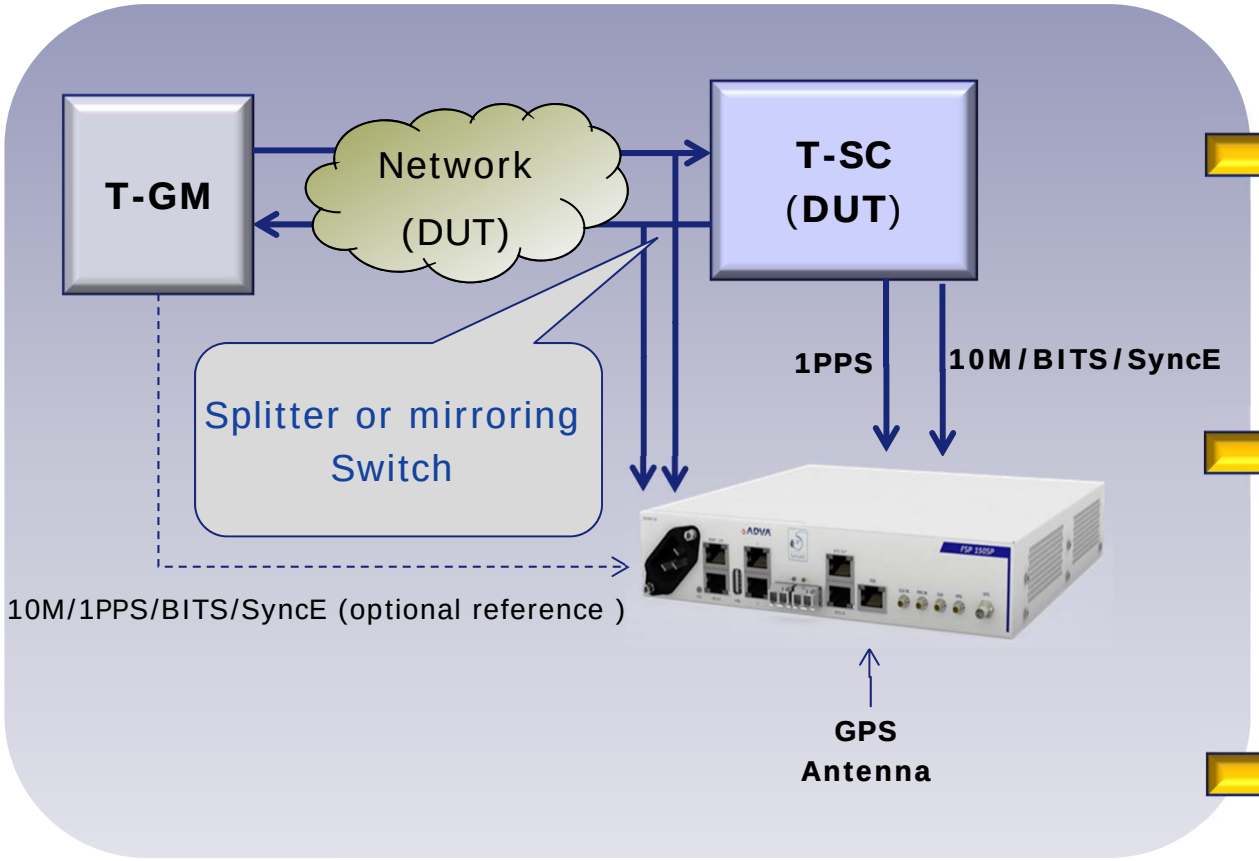


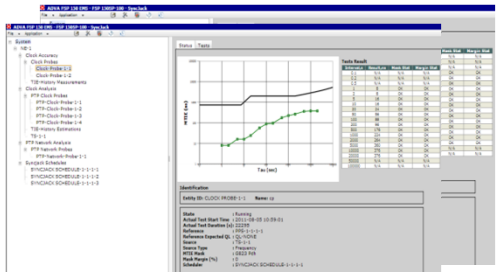



# Probing Clock and Network Simultaneously

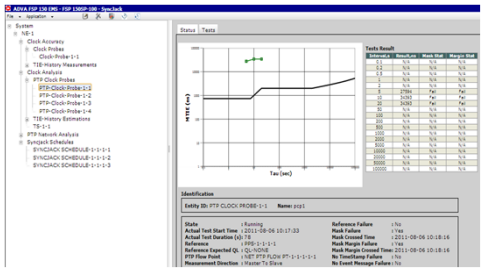
- Clock probes, PTP Clock probes and PTP network probe can work simultaneously, therefore both T-SC and network can be monitored at the same time



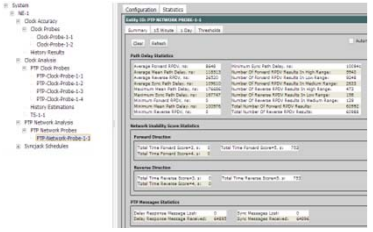

**1PPS and CLK MTIE**



**Packet MTIE based on T3**



**PTP network Probe Statistics and Network Usability Score**







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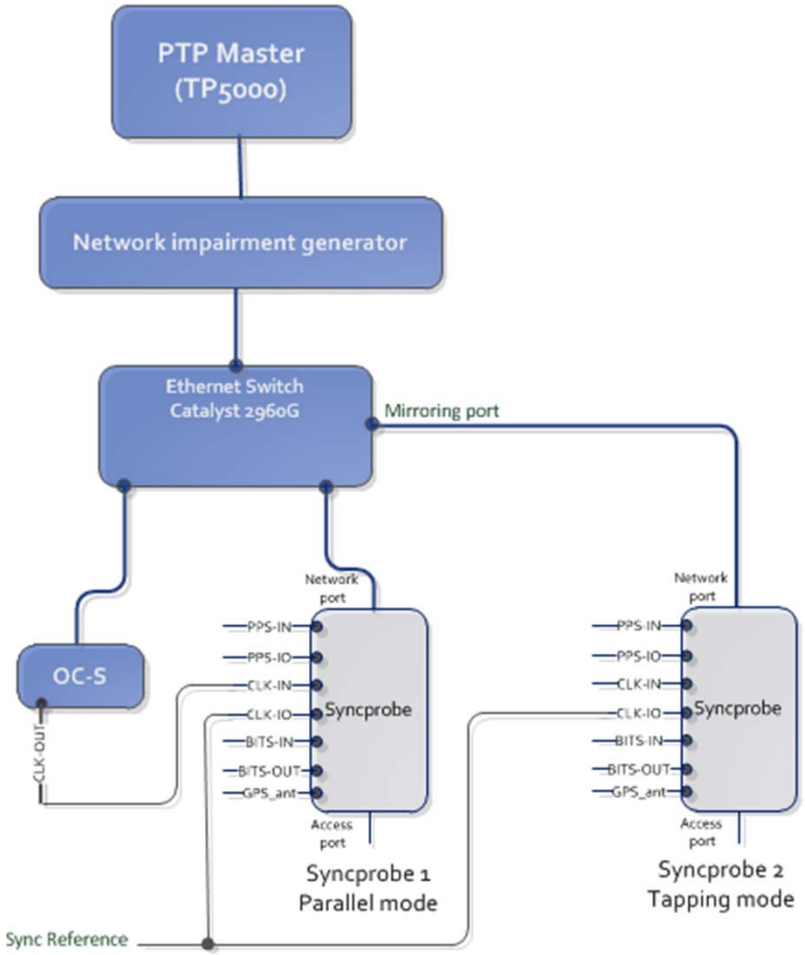
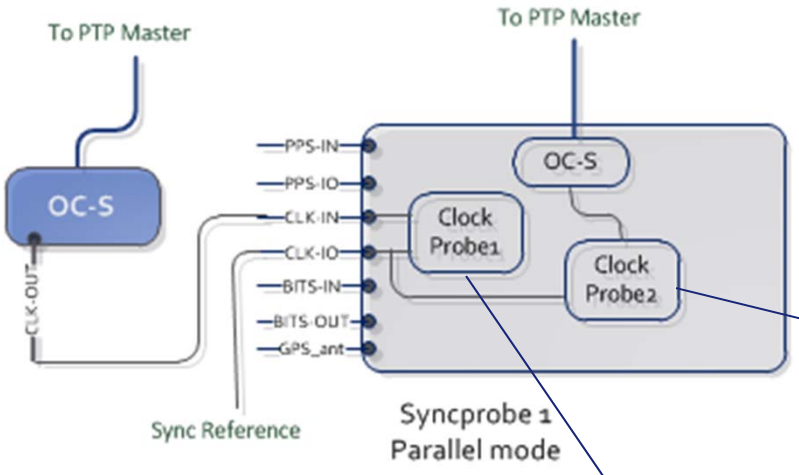
# Test Cases for use of Sync Probe SLA tools

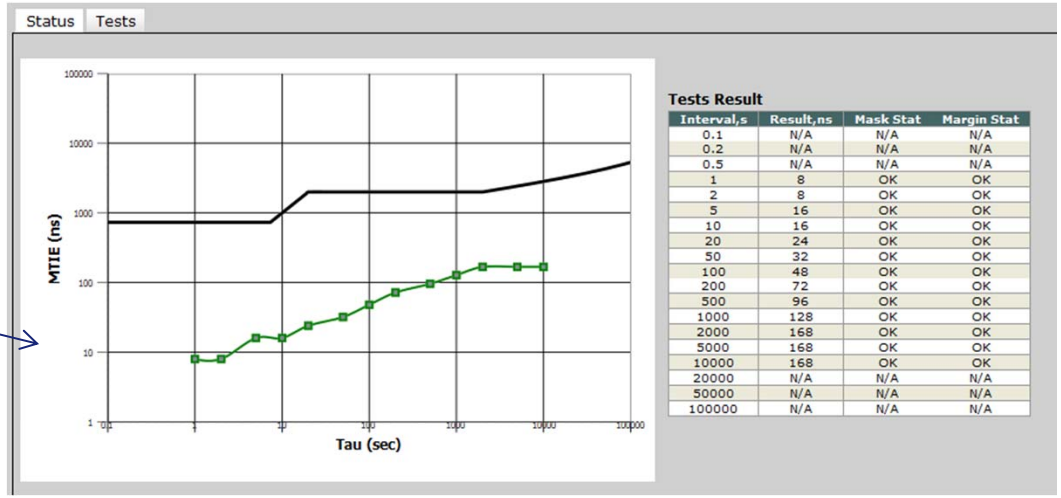
# Set-up description for Sync Probe test cases results

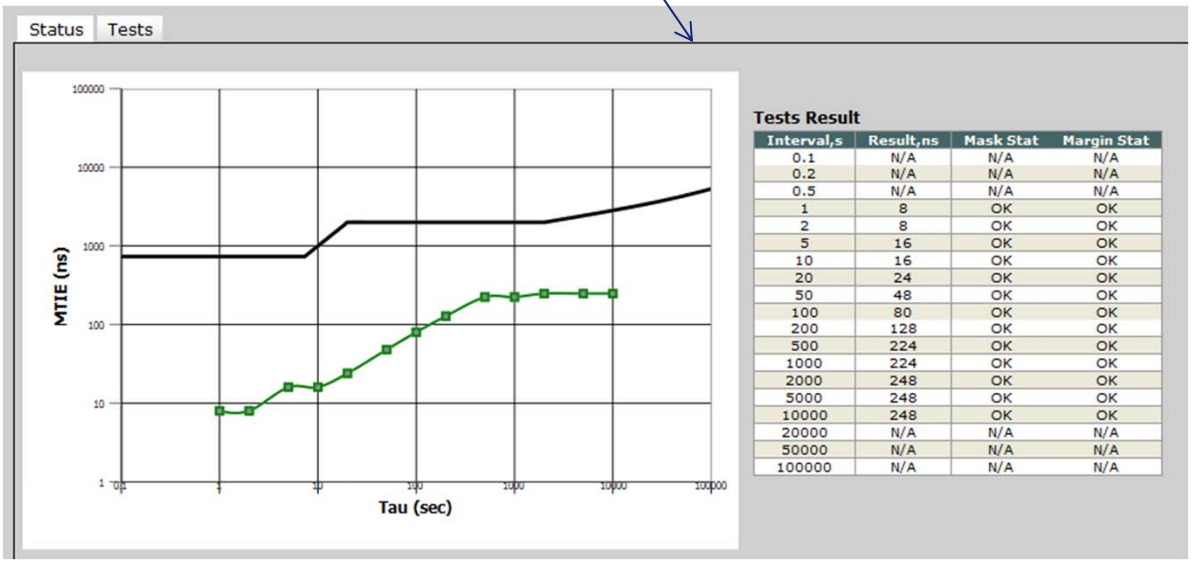


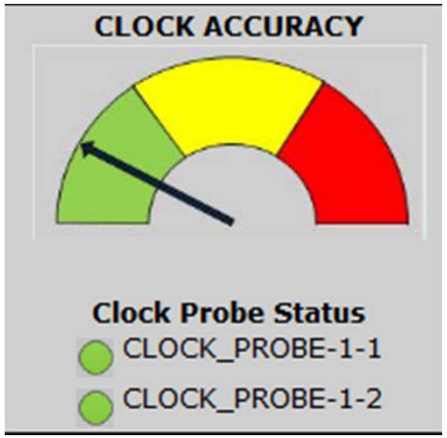

- PTP Master – Symmetricom TP5000
- OC-S – Tested device with IEEE1588v2 Ordinary Clock-Slave (OC-S) functionality
- Sync Probe-1 operates OC-S and runs SyncSLA tools
- Sync Probe-2 runs only SyncSLA tools
- Impairment generator runs test case 12 ITU-T G.8261 – Calnex Paragon-X
- The Ethernet switch 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

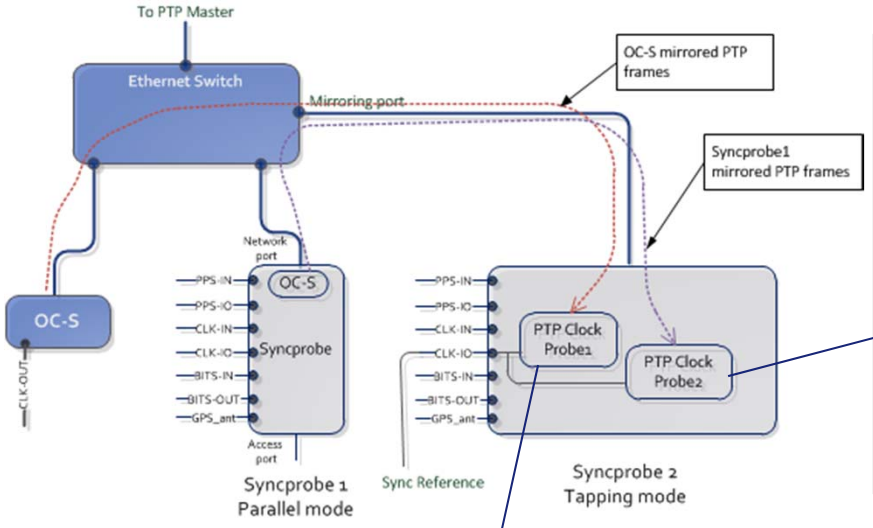


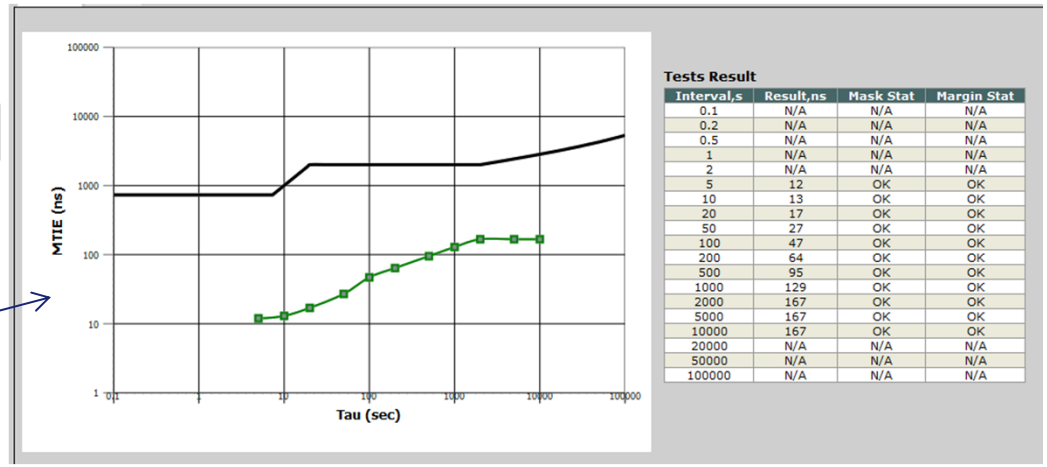



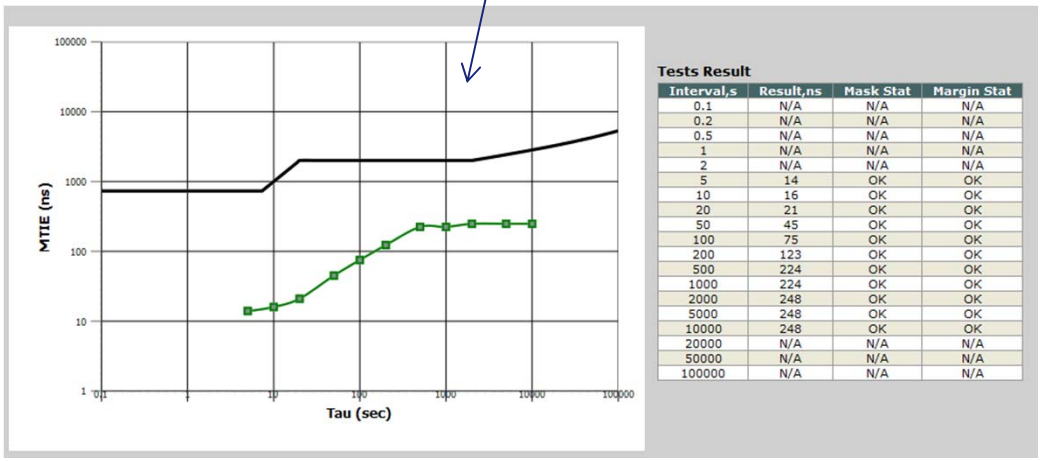
# Simultaneous MTIE measurements of multiple remote OC-S nodes – Clock Analysis




**Tests Result**

| 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**

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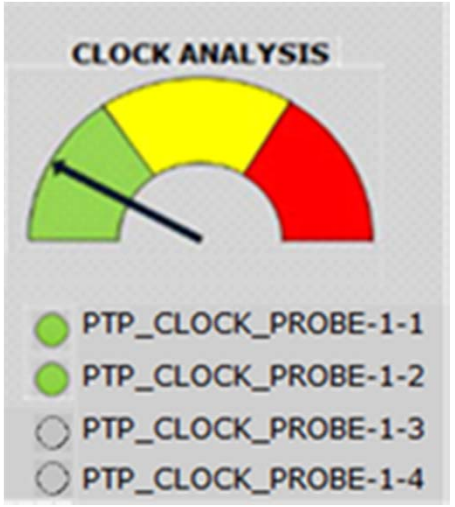
|---|---|---|---|
| 0.1 | N/A | N/A | N/A |
| 0.2 | N/A | N/A | N/A |
| 0.5 | N/A | N/A | N/A |
| 1 | N/A | N/A | N/A |
| 2 | N/A | N/A | N/A |
| 5 | 14 | OK | OK |
| 10 | 16 | OK | OK |
| 20 | 21 | OK | OK |
| 50 | 45 | OK | OK |
| 100 | 75 | OK | OK |
| 200 | 123 | OK | OK |
| 500 | 224 | OK | OK |
| 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 |





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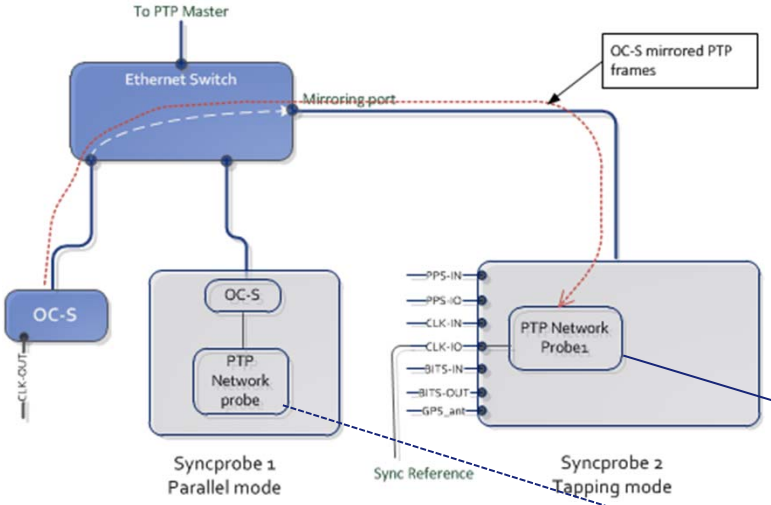
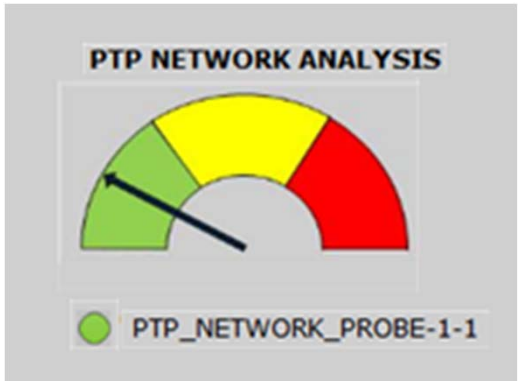
# PTP communication path PM and statistics
# PTP Network Analysis




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 mean Path Delay, ns | 1034 |
| Maximum mean Path Delay, ns | 3234 |
| Average forward Path Delay, ns | 1022 |
| Minimum forward Path Delay, ns | 820 |
| Maximum forward Path Delay, ns | 2120 |
| Average reverse Path Delay, ns | 1230 |
| Minimum reverse Path Delay, ns | 760 |
| Maximum reverse Path Delay, ns | 2220 |

| | |
|---|---|
| Minimum forward RPDV, ns | 656 |
| Average forward RPDV, ns | 850 |
| Number of forward RPDV results in low range | 455 |
| Number of forward RPDV results in medium range | 320 |
| Number of forward RPDV results in high range | 820 |
| Total Number of forward RPDV results | 4322 |
| Minimum reverse RPDV, ns | 1230 |
| Average reverse RPDV, ns | 760 |
| 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**

| | |
|---|---|
| Current score: | 5 |
| Total time Score=5, s | 1233 |
| Total time Score=4, s | 123 |
| Total time Score=3, s | 0 |

**Reverse direction**

| | |
|---|---|
| Current score: | 5 |
| Total time Score=5, s | 1233 |
| Total time Score=4, s | 123 |
| 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 |

- 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-A deployment





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# Thank you

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