

Field Measurement Options for Network Operators

Nir Laufer , ITSF 2013, Lisbon Portugal



Agenda



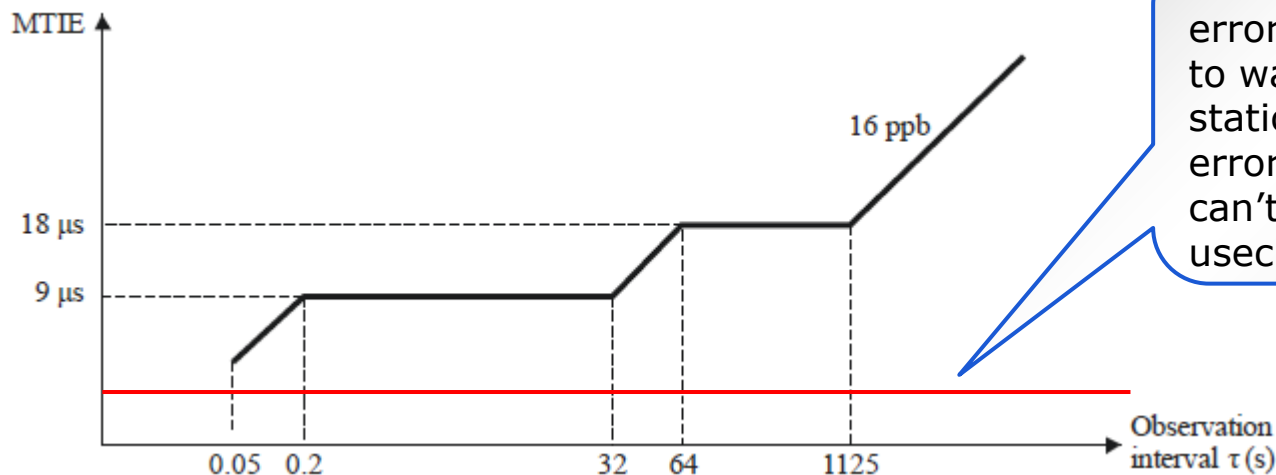
- New requirements – new challenges
- Sync SLA – Examples
- Probing Slave Clock
- Probing Boundary Clock
- Probing the Network
- Summary



New Requirement – New Challenges!

- Time/Phase requirement for NGN are much more stringent!

Frequency G.8261.1	16ppb
Phase G.8271	+/- 1.5/1.1usec



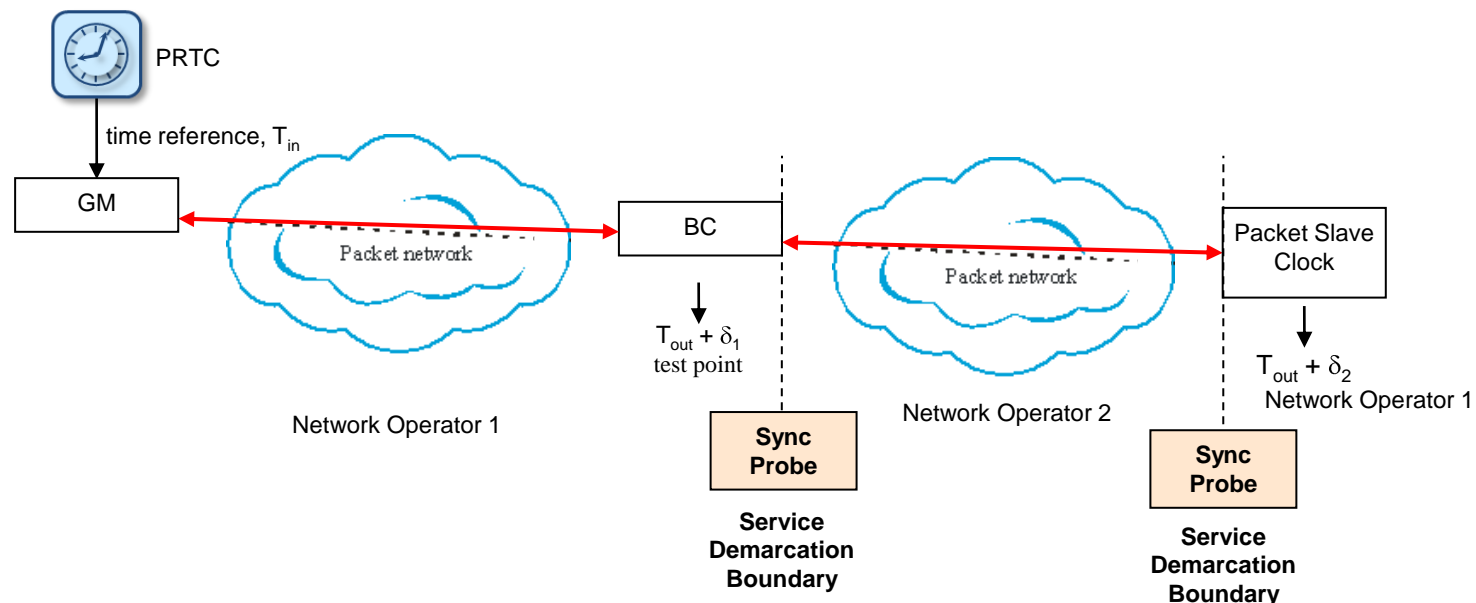
Why „In Service“ Sync Assurance is needed ?



- Making sure synchronization is working as designed is not trivial task
- Network PDV, asymmetry and environmental conditions can effect the Synchronization quality
- Some way to ensure proper synchronization should be integrated into Sync distribution/delivery functions or accompanied by cost effective Sync assurance tools
- Lab test equipment is too expansive for “in service” installation in multiple locations
- Other aspects such as power consumption and OSS should also be taken into consideration

Example #1 - Partitioning across Multiple Administrative Domains (G.8275 Appendix I)

- Operators may purchase service from other operators in order to provide access to remote equipment or networks.
- A boundary clock can be used to ensure a clean hand-off point to the second network operator.



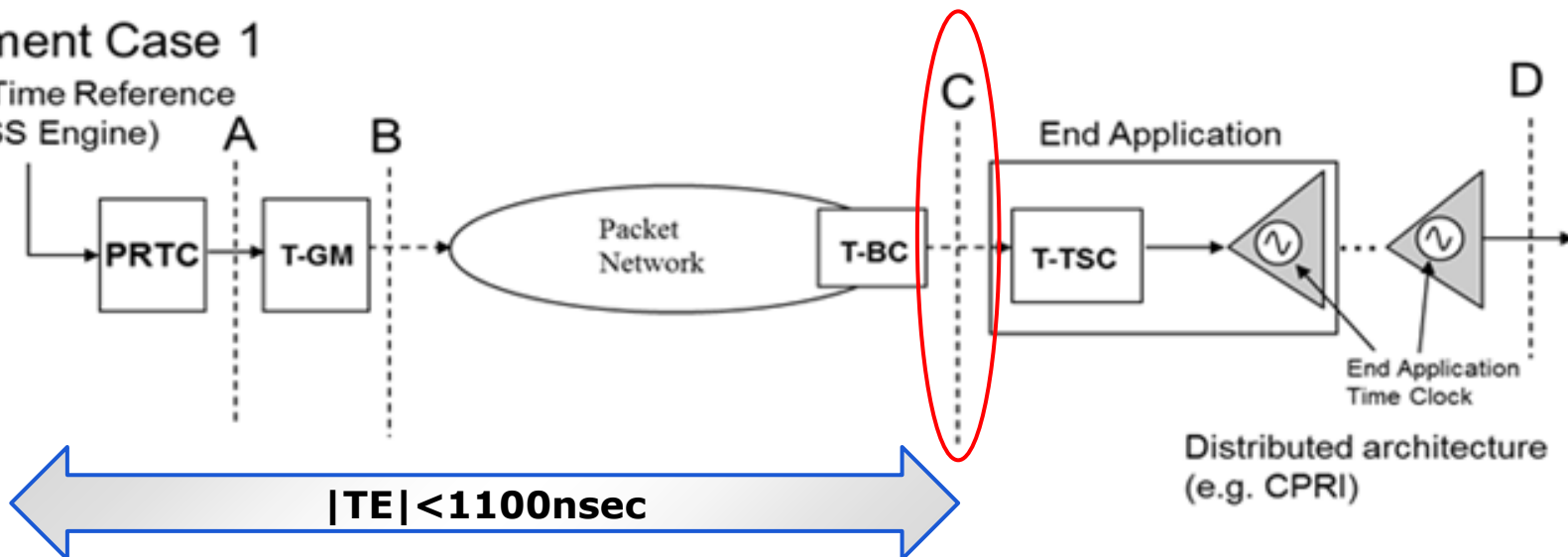
Example #2 - G.8271.1 Network Limits



- Maximum absolute time error network limit applicable at the reference point C:
 $\max |TE| \leq 1100 \text{ ns}$

Deployment Case 1

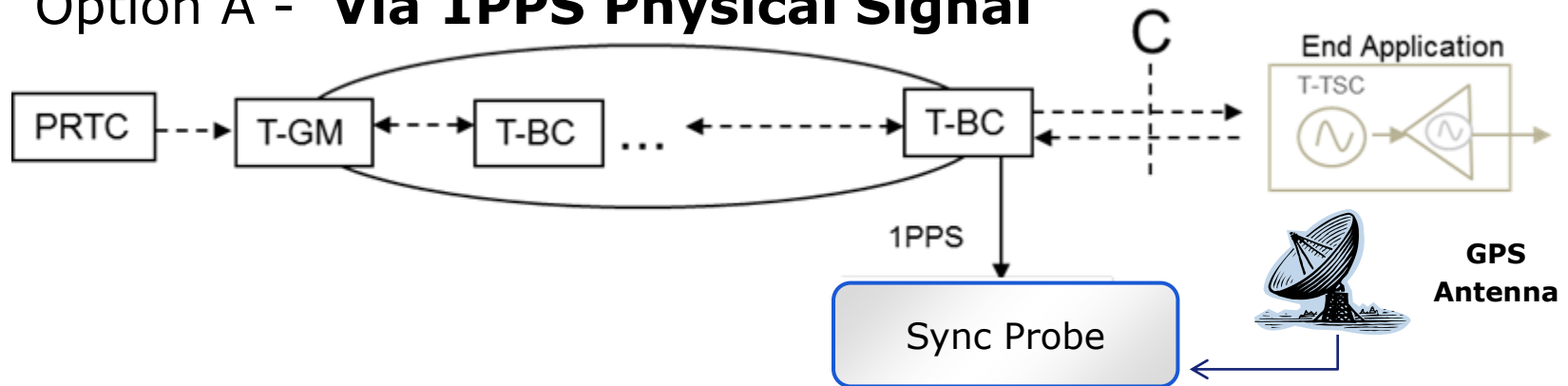
Network Time Reference
(e.g. GNSS Engine)



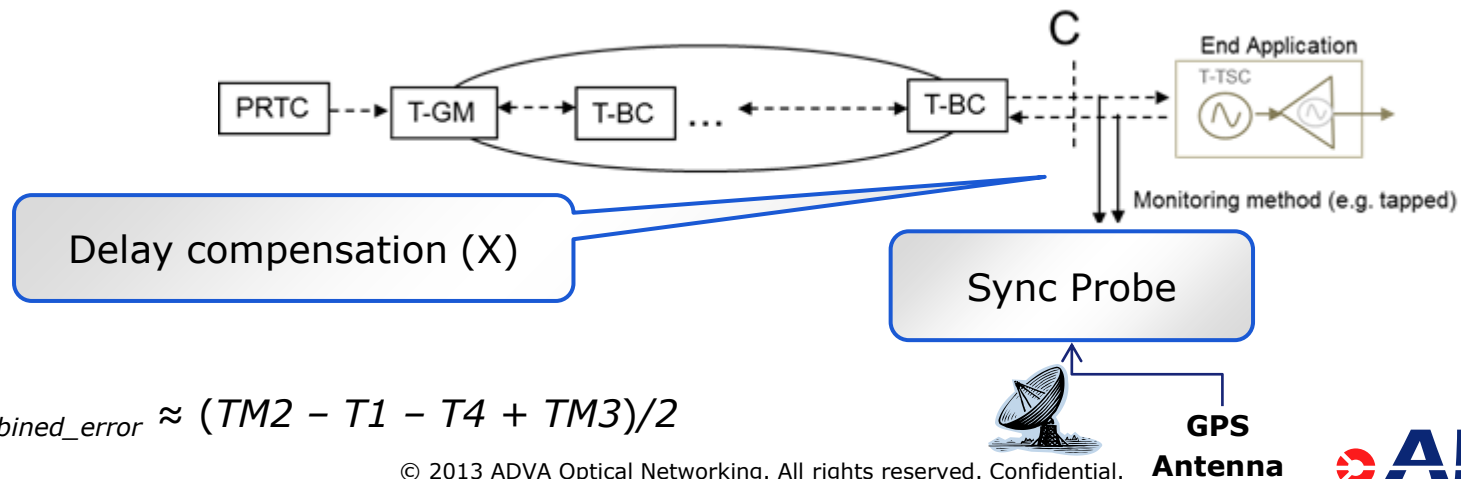
Example #2 - G.8271.1 Network Limits Deployment Case 1



- Option A - **Via 1PPS Physical Signal**



- Option B - from the two-way PTP flow via a **Passive PTP Probe**

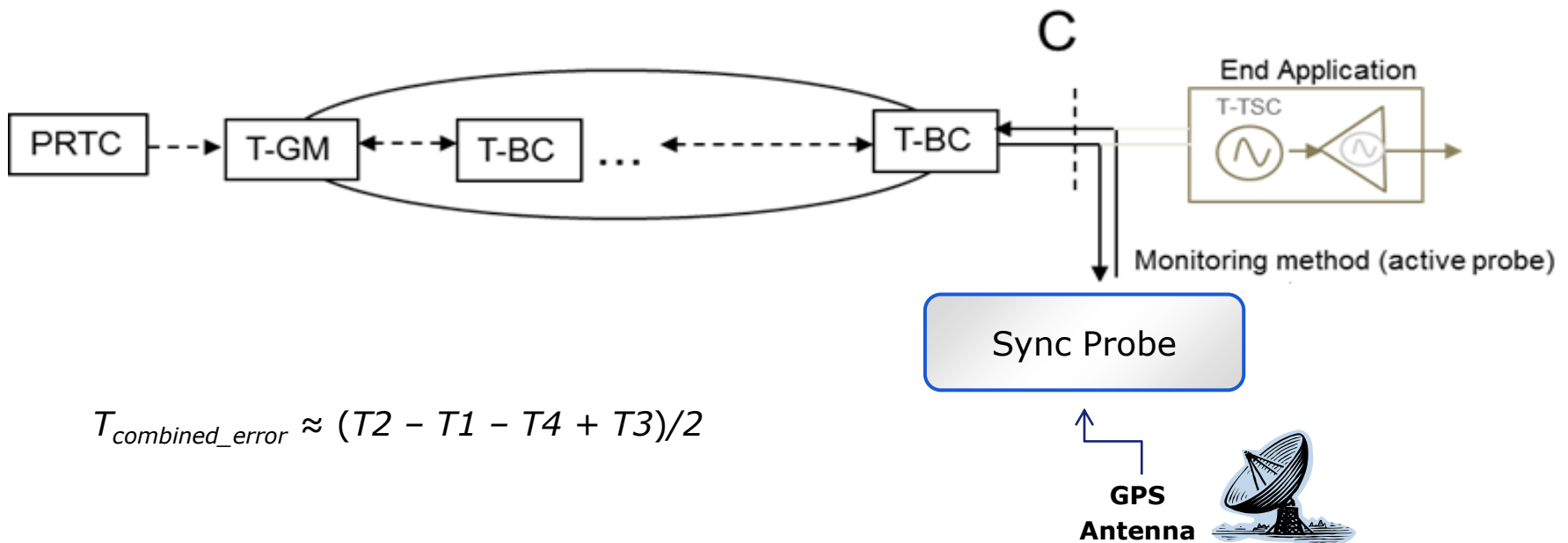


$$T_{combined_error} \approx (TM2 - T1 - T4 + TM3)/2$$

Example #2 - G.8271.1 Network Limits

Deployment Case 1 – Option C

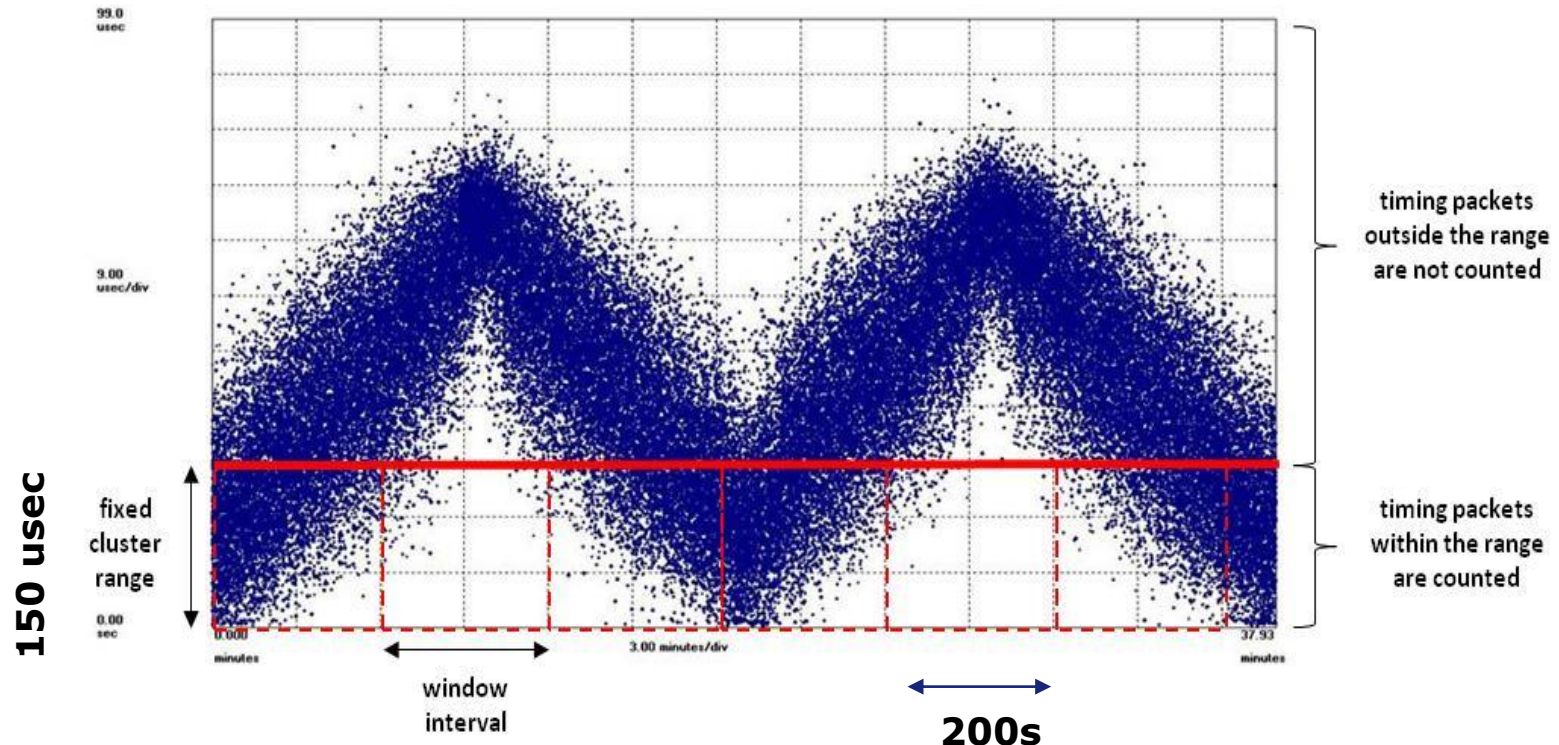
- Option C- From the two-way PTP flow via an **Active PTP Probe**



$$T_{combined_error} \approx (T2 - T1 - T4 + T3)/2$$

Example #3 - G.8261.1 Network Limit HMR1

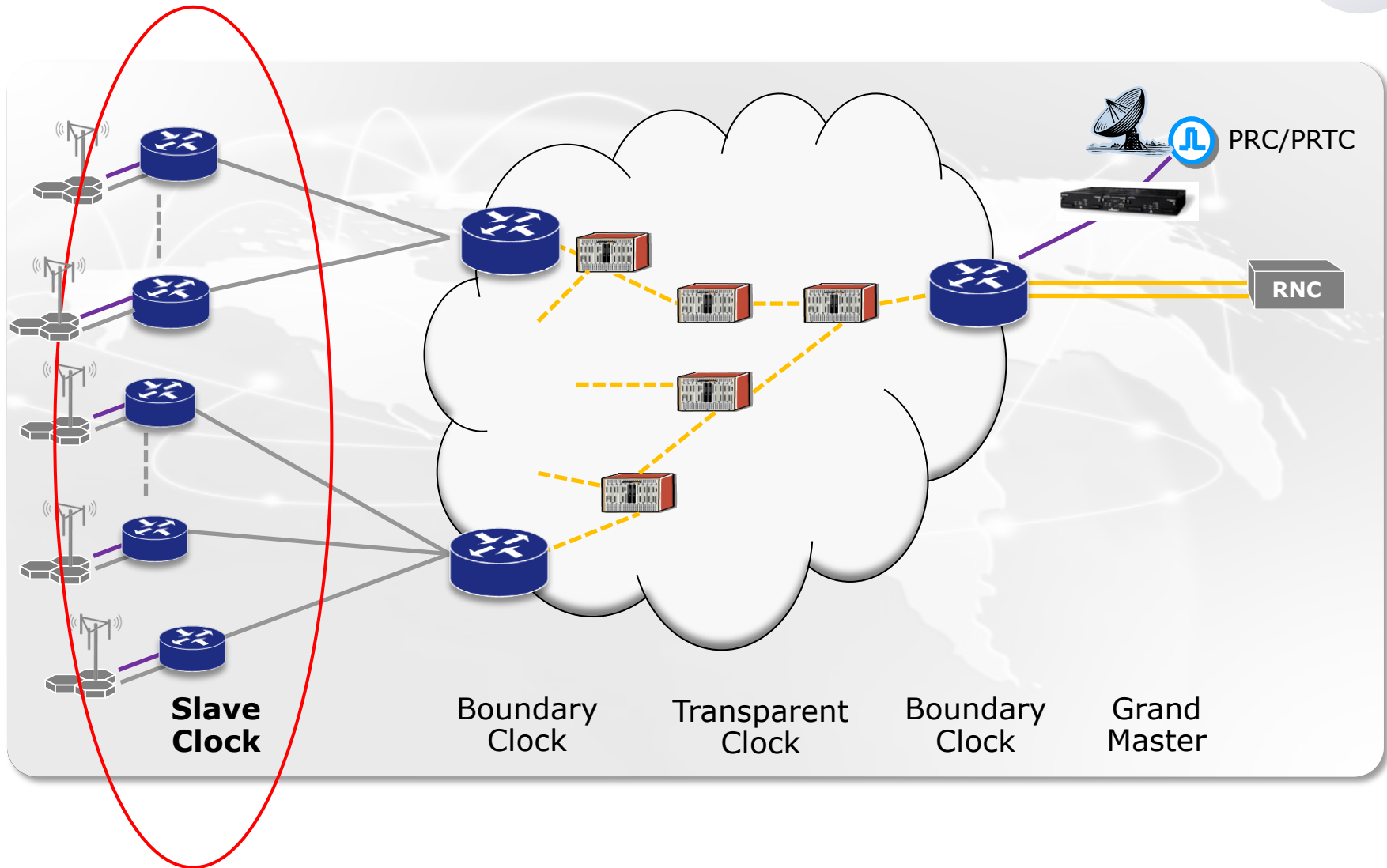
- **FPP** : For any window interval of 200 seconds at least 1% of transmitted timing packets will be received within a fixed cluster, starting at the observed floor delay, and having a range of 150 μ s (G.8260 floor delay packet population).



Probing and Monitoring Slave Clock



Probing Slave Clock



-
- The diagram illustrates the T-GM system architecture. At the top is a box labeled **T-GM**. Below it is a cloud labeled **Network**. At the bottom left is a **Slave Clock (DUT)** represented by a radio tower on a hexagonal grid. At the bottom right is a **Sync Probe** box. A **GPS** satellite is shown above the Sync Probe. Communication paths are indicated by blue arrows: T_1 and T_4 for downlink, and T_3 for uplink. A green arrow labeled **1PPS** points from the Slave Clock to the Sync Probe. A label **10MHz/BITS/Sync-E** is positioned between the Network and the Slave Clock. A world map with network connections serves as the background.

The screenshot shows the Vivado IDE interface with the 'Timing Summary' report open. The report is titled 'Timing Summary' and is divided into two main sections: 'Setup' and 'Hold'. The 'Setup' section shows a setup time of 1.00 ns for the 'Xilinx Spartan-6' device. The 'Hold' section shows a hold time of 0.00 ns for the 'Xilinx Spartan-6' device. The report also includes a table of timing constraints and a table of timing violations.

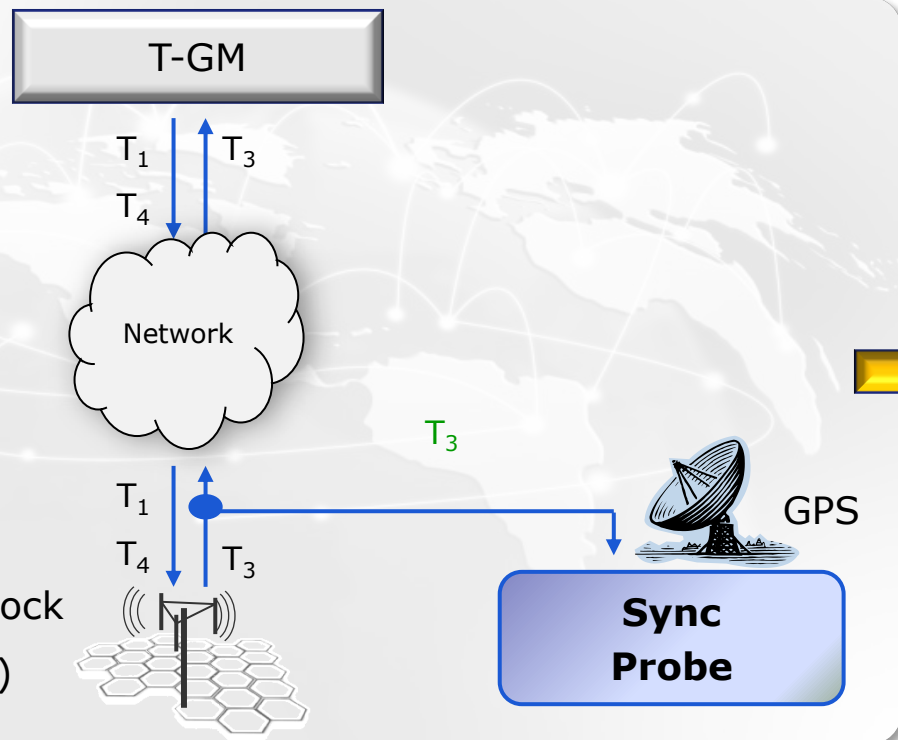
Constraint	Value	Unit
Setup	1.00	ns
Hold	0.00	ns

Constraint	Value	Unit
Setup	1.00	ns
Hold	0.00	ns

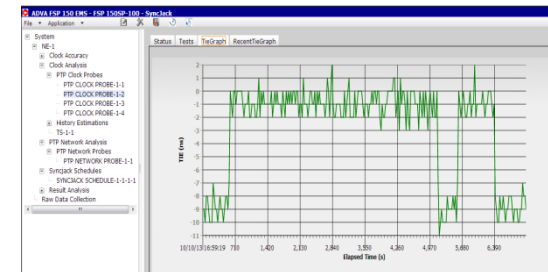
Probing an Third Party Slave Clock



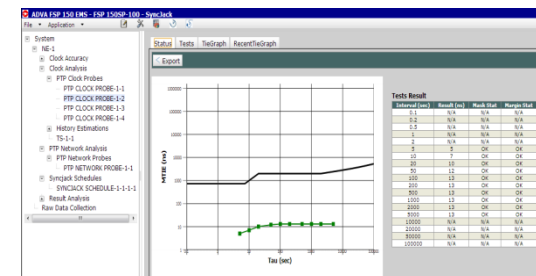
- Probing the **Slave Clock – Passive Probing**
 - A Sync Probe is placed at a calibrated distance from the Slave Clock (system under test)
 - The Sync Probe functions as passive PTP probe (fiber tapping or mirroring switch)
 - The Sync Probe measure packet TE/TIE/MTIE of the tapped Slave port against a reference measurement timing signal



Packet Time Error

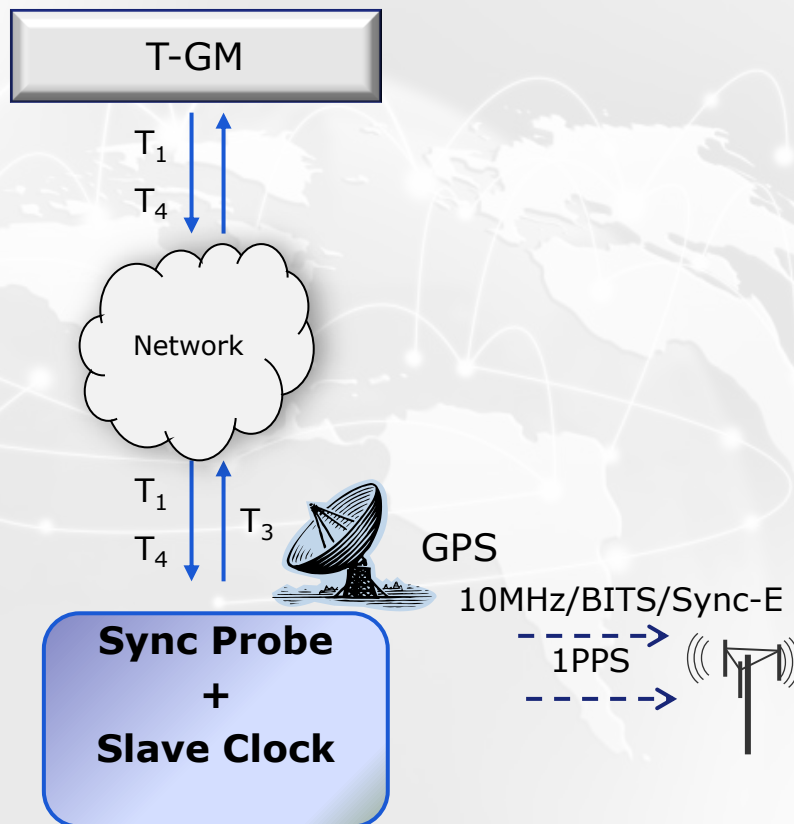


Packet MTIE

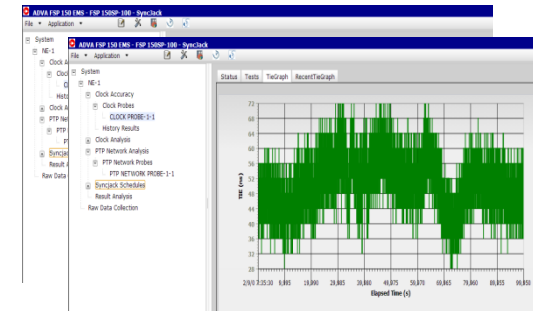


Slave Clock Self Monitoring

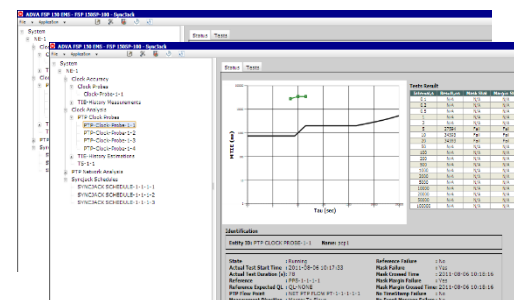
- ▶ The probing functions are integrated into the slave clock which deliver clock to the end application
- ▶ internal 1PPS and clock recovered from PTP can be self monitored Vs GPS/external reference as well as T3 generated by Slave Clock



CLK TIE and 1PPS Time Error



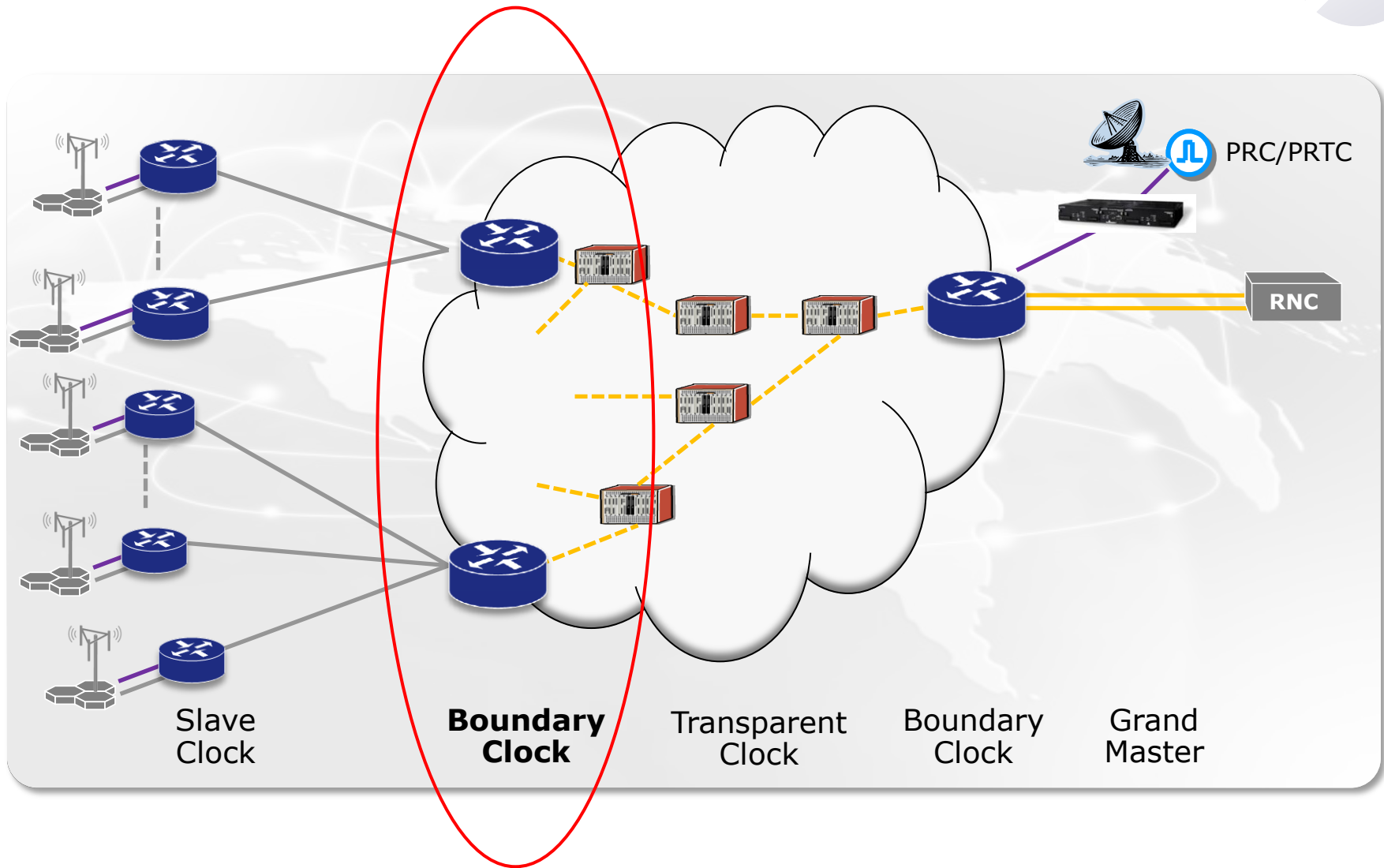
CLK and 1PPS MTIE



Probing and Monitoring Boundary Clock



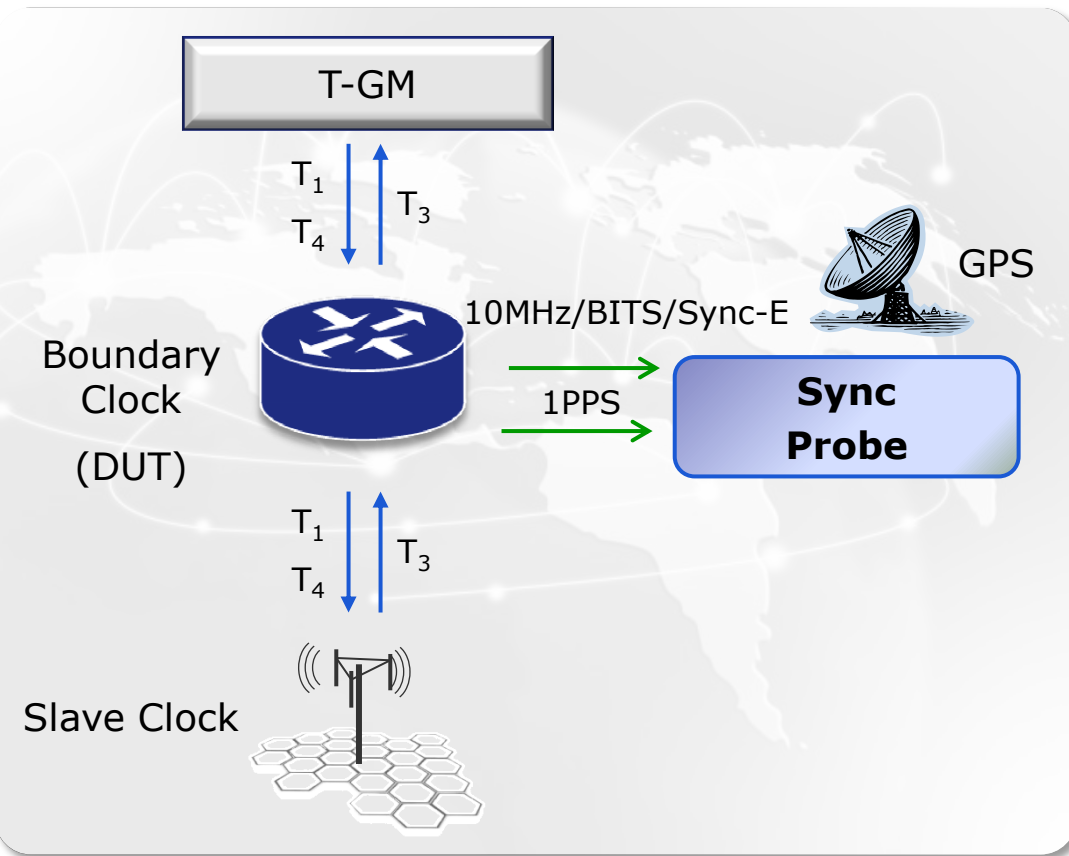
Probing Boundary Clock



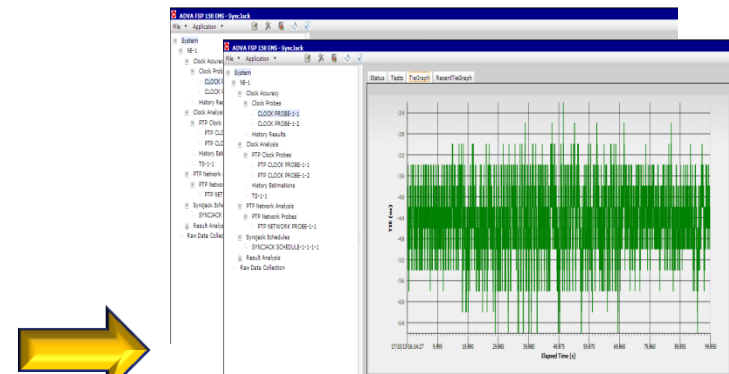
Probing Third Party Boundary Clock



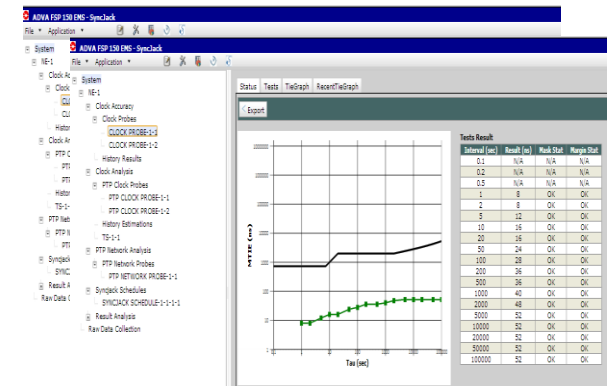
- ▶ A Sync Probe is used for assurance of third party Boundary Clock
- ▶ Boundary Clock 1PPS and clock outputs can be monitored Vs. GPS reference



CLK TIE and 1PPS Time Error

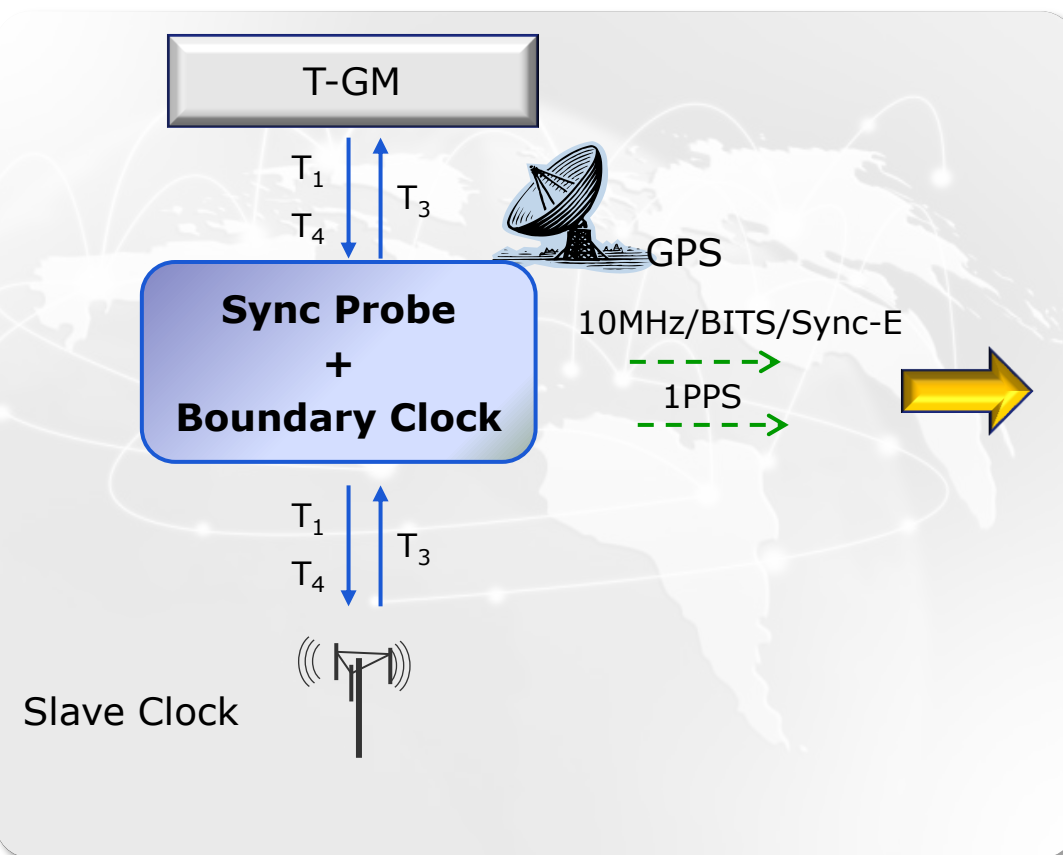


CLK and 1PPS MTIE

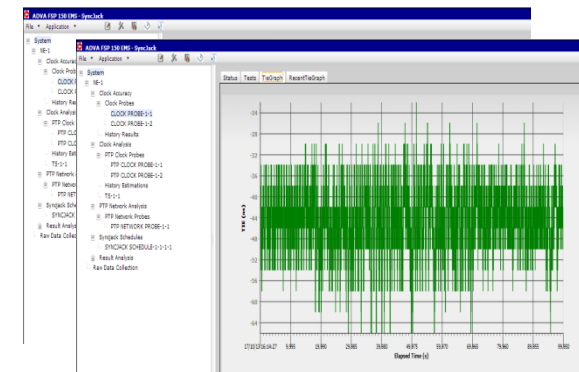


Boundary Clock Self Monitoring

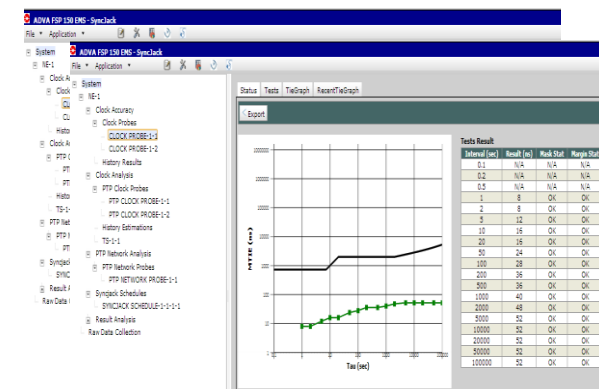
- ▶ The probing functions are integrated into the Boundary Clock
- ▶ The internal BC 1PPS and clock recovered from PTP can be self monitored simultaneously



CLK TIE and 1PPS Time Error

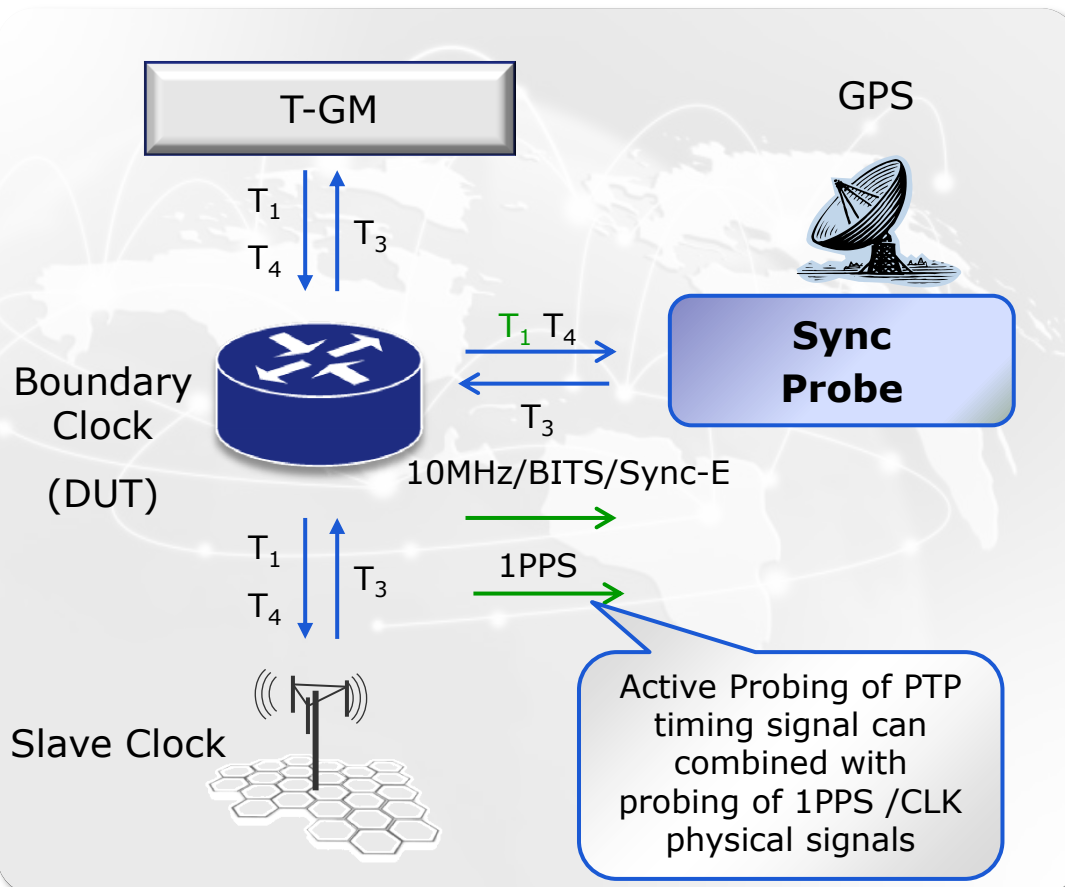


CLK and 1PPS MTIE

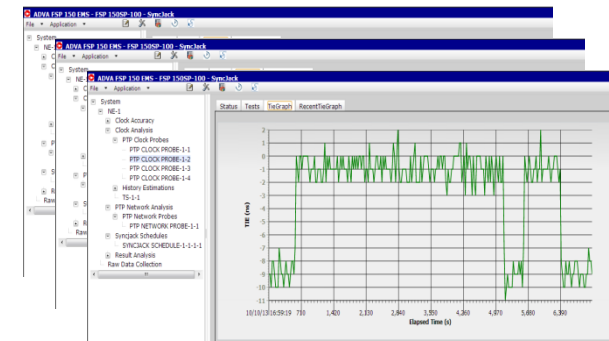


Probing an Third Party Boundary Clock

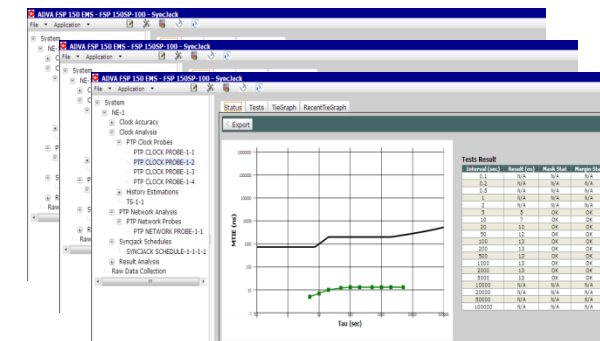
- Probing the Master side of a Boundary Clock – **Active Probing**
 - The Sync Probe is placed at a calibrated distance from the Master port of an Third Party Boundary Clock (system under test)
 - The Sync Probe functions as active probe



CLK TIE ,1PPS TE & Packet TE



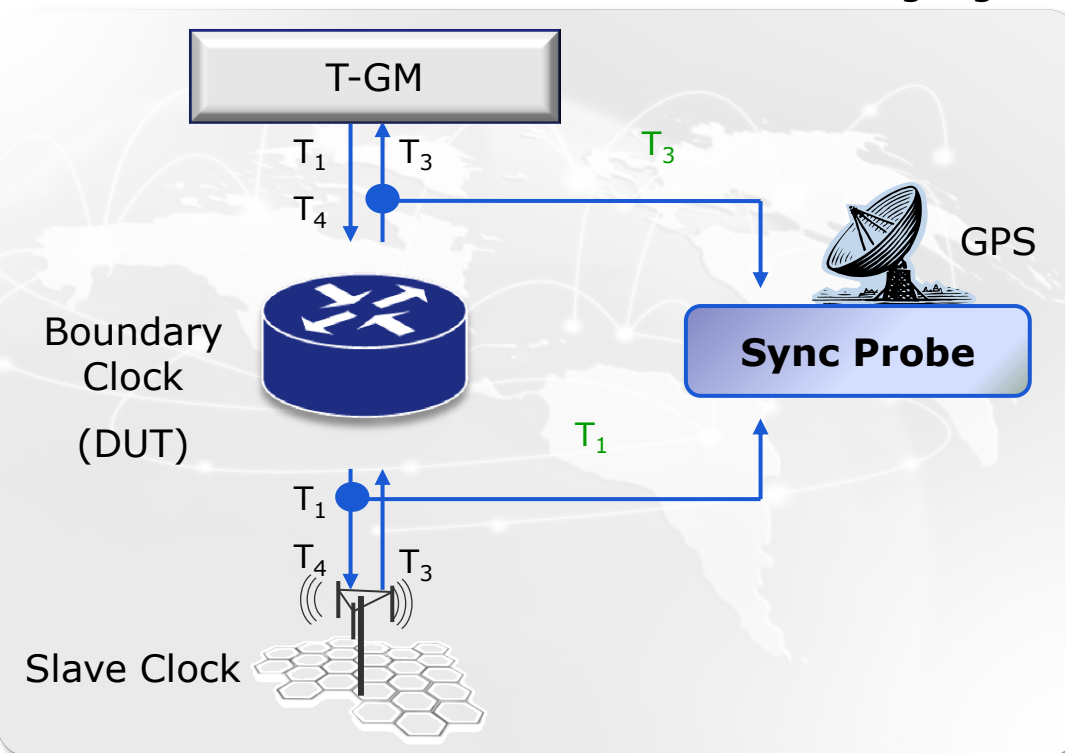
CLK ,1PPS MTIE & Packet MTIE



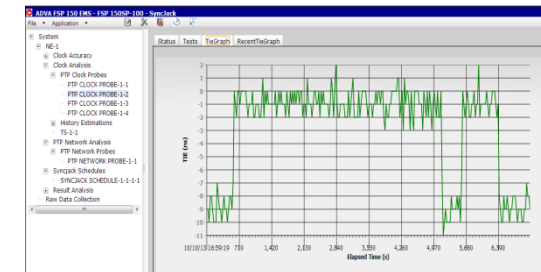
Probing an Third Party Boundary Clock

- Probing the **Master/Slave side** of a Boundary Clock – **Passive Probing**

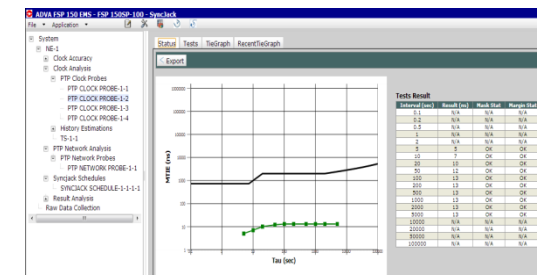
- The Sync Probe is placed at a calibrated distance from the Master/Slave port of a Third Party Boundary Clock (system under test)
- The Sync Probe functions as passive PTP probe (fiber tapping or mirroring switch)
- The Probe measure packet TE/TIE/MTIE of the tapped Master port against a reference measurement timing signal



Packet Time Error

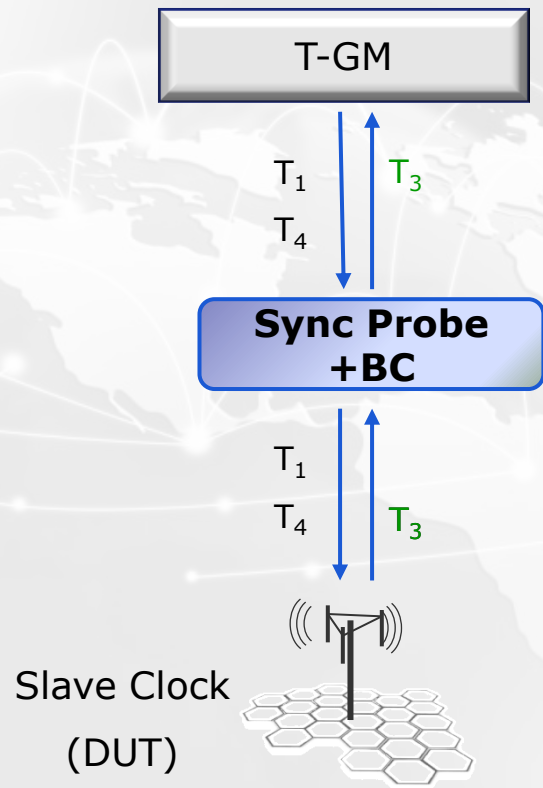


Packet MTIE

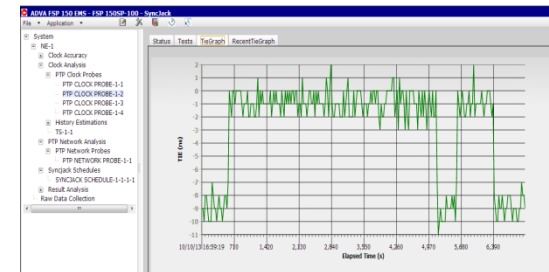


Self Monitoring Network

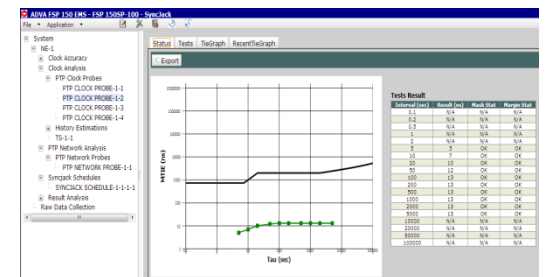
- ▶ No GPS or external reference is needed!
- ▶ Each BC can compare next hop recovered clock Vs. his own recovered clock by compering T3 received form next hop against his own recovered clock which is used as reference.



Packet Time Error



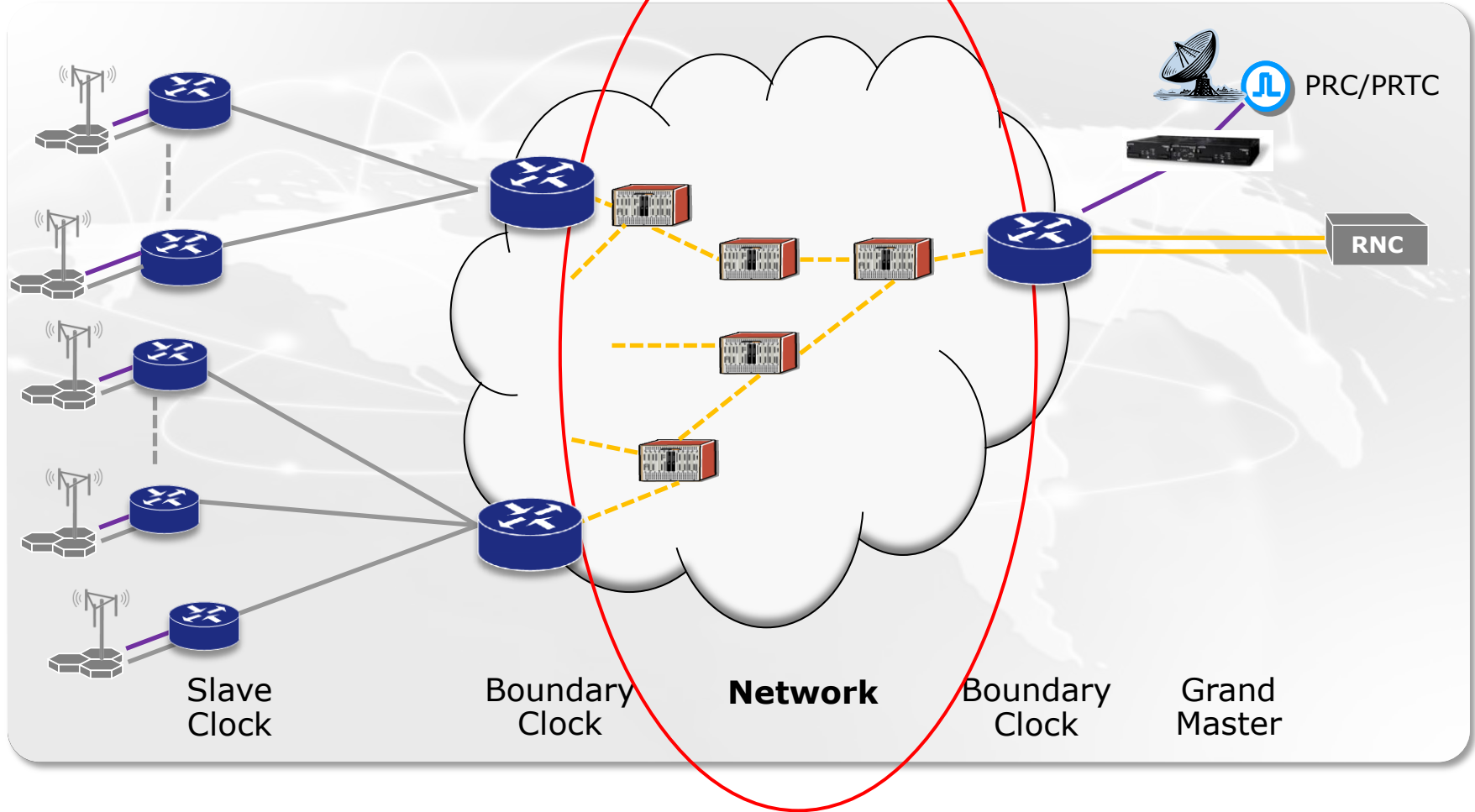
Packet MTIE



Probing and Monitoring the Network



Probing the Network



Probing the Network



- A Sync Probe can be used for testing the network connecting the master and Slave/BC
- ▶ Collect statistical information about the network (PDV, packet loss...) and can decide on network usability and KPI
 - **Packet Counters** (arrived, lost)
 - **PD** (Path Delay) , **MPD** (Mean Path Delay) , **Asymmetry**
 - **Network Usability** (i.e. based on G.8261.1 FPP)
- ▶ Calculate PM statistics (i.e. 15min ,24hours) and TCAs in order to validate Sync SLA performance

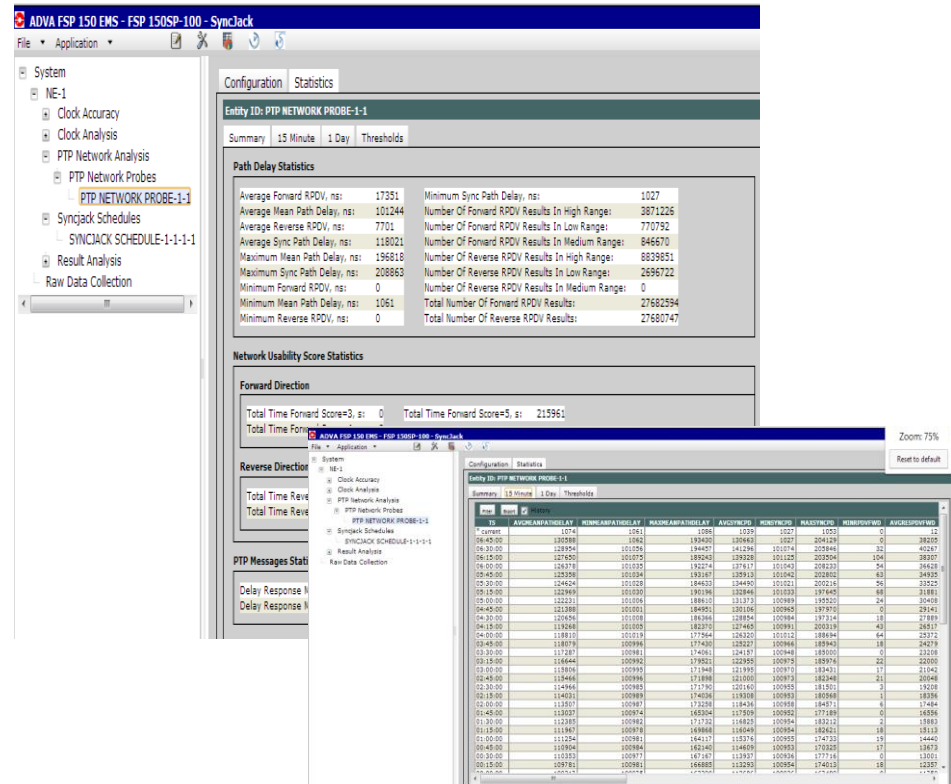
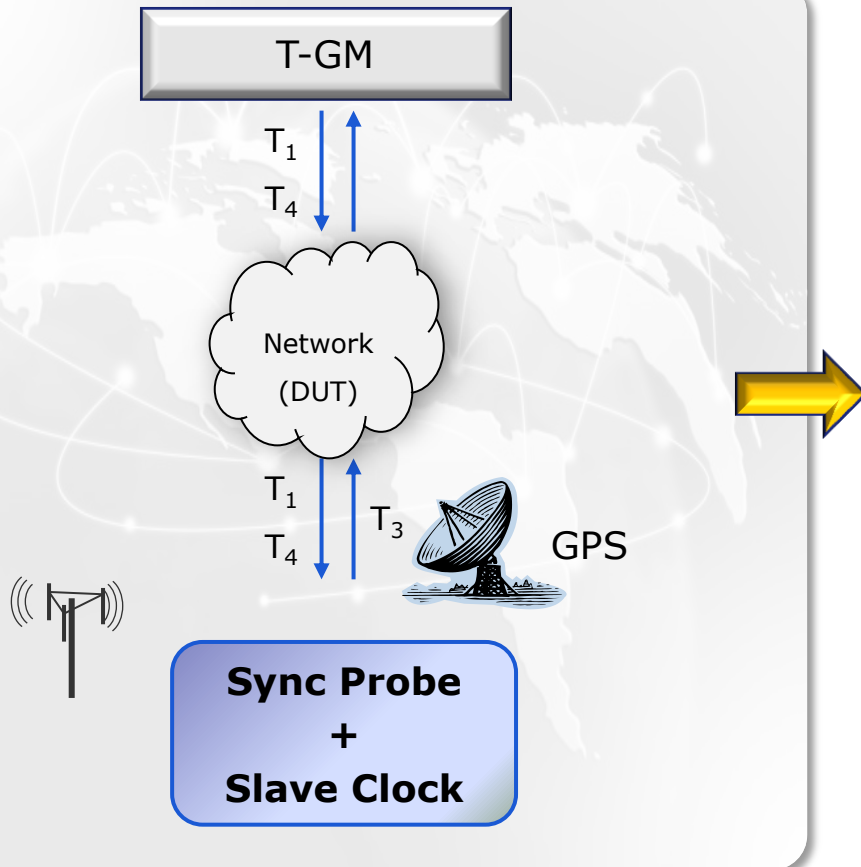


PTP Network Active Probe



- ▶ Active Probe uses the internal Telecom slave packets exchanged
- ▶ The Sync Probe can probe the network and recover the clock simultaneously

PTP network Probe Statistics and Usability Score

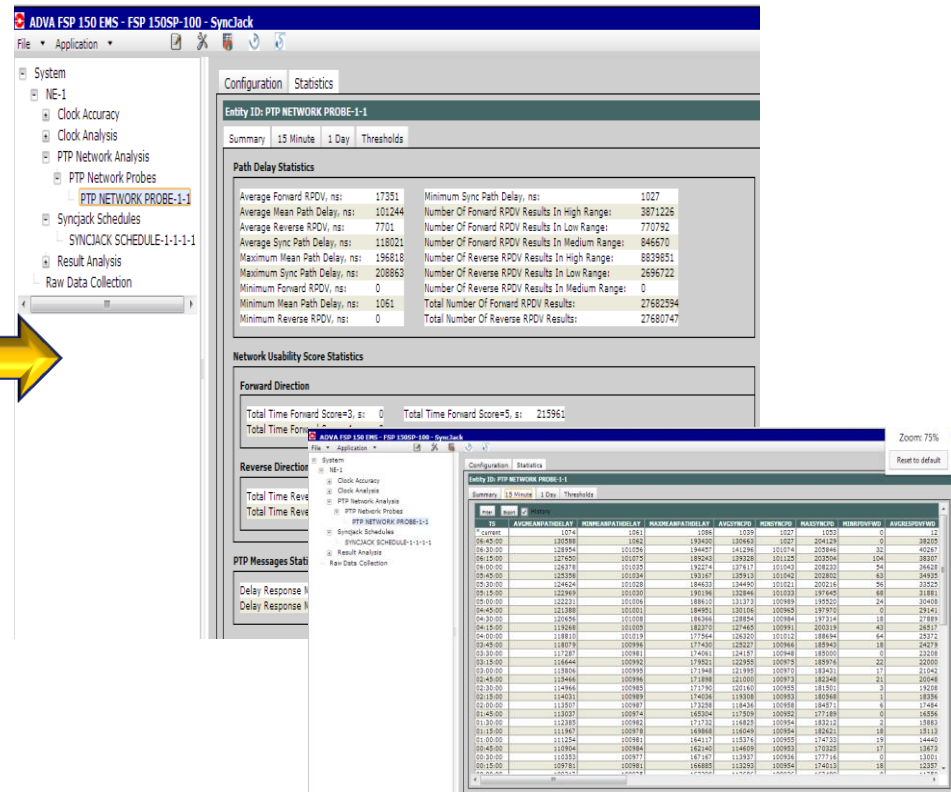
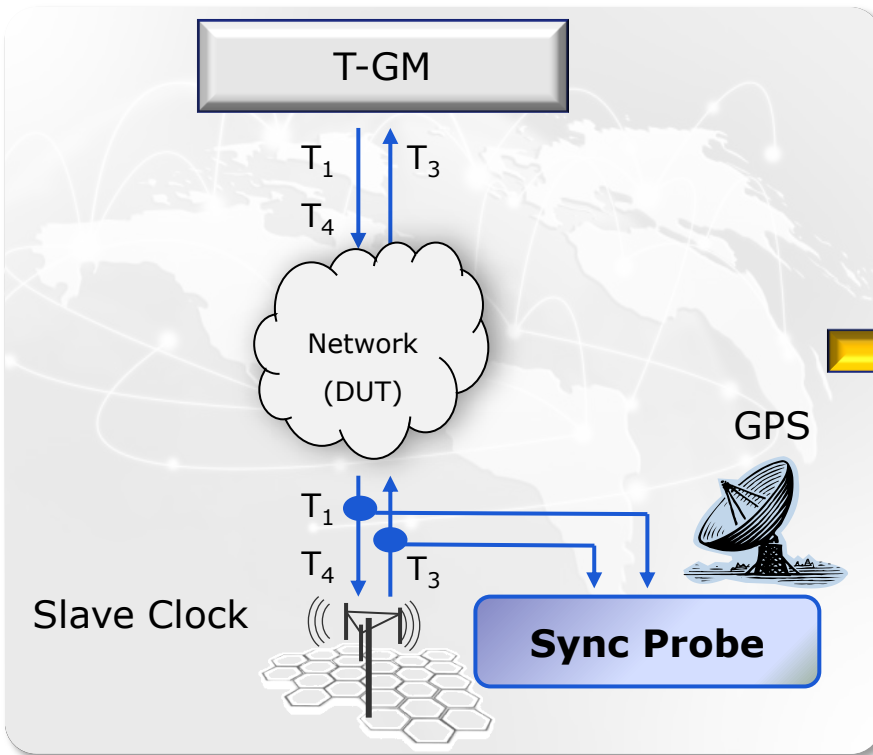


PTP Network Passive Probe



- Passive probe tap packet exchanged between master third party slave / boundary clock

PTP network Probe Statistics and Usability Score



Summary



- Time/Phase requirement for NGN are stringent
- In services probing is need in order to ensure proper synchronization
- Monitoring the accuracy of the Synchronization delivered is possible using Sync Probes which can be used for monitoring the Clocks and/or the Network



**FSP150
SP-100**



Thank you

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