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Field Measurement Options for Network Operators

Nir Laufer , WSTS 2014, San Jose California

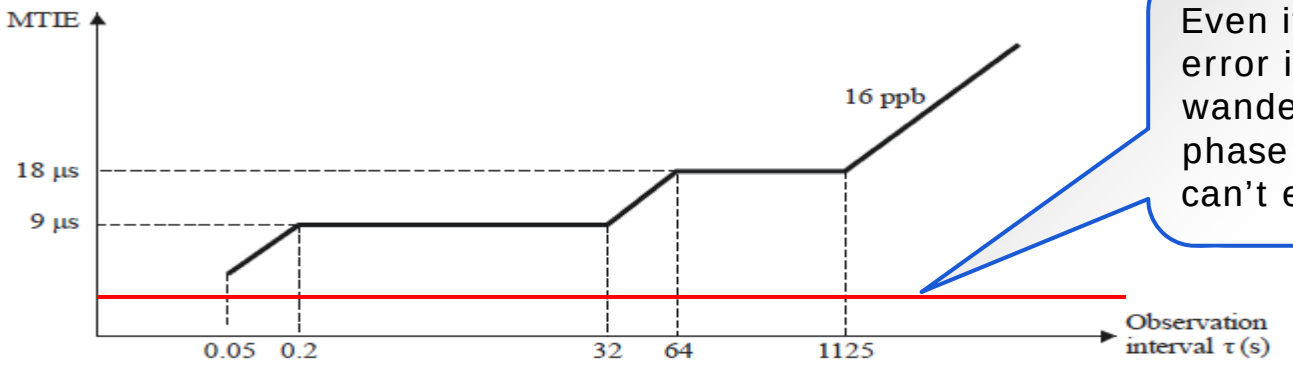
Agenda

- 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!

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

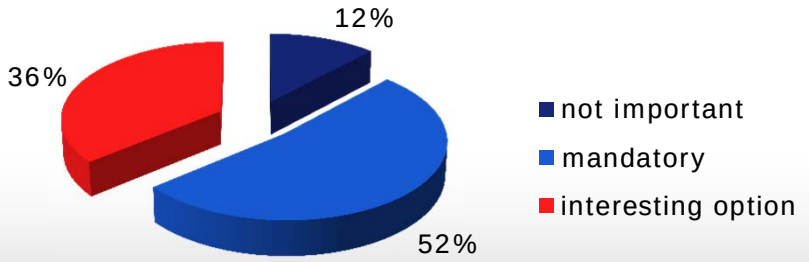


Even if all phase error is allocated to wander (no static phase error) , MTIE can't exceed 3 usec

Operators Survey - Synchronization Assurance

- Synchronization assurance is a highly relevant feature
- **Conclusion:** Mobile operators want to see such capability with their synchronization delivery solution

Do you rate synchronization service assurance as an important tool for delivering mobile backhaul services?

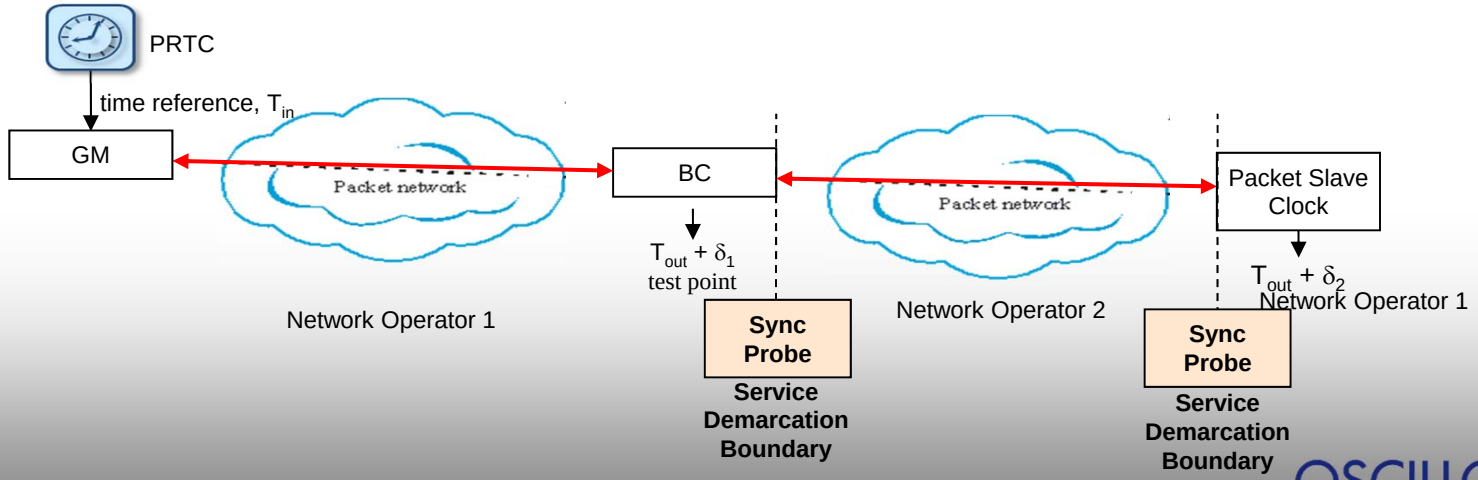


Why „In Service“ Sync Assurance is needed ?

- 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.

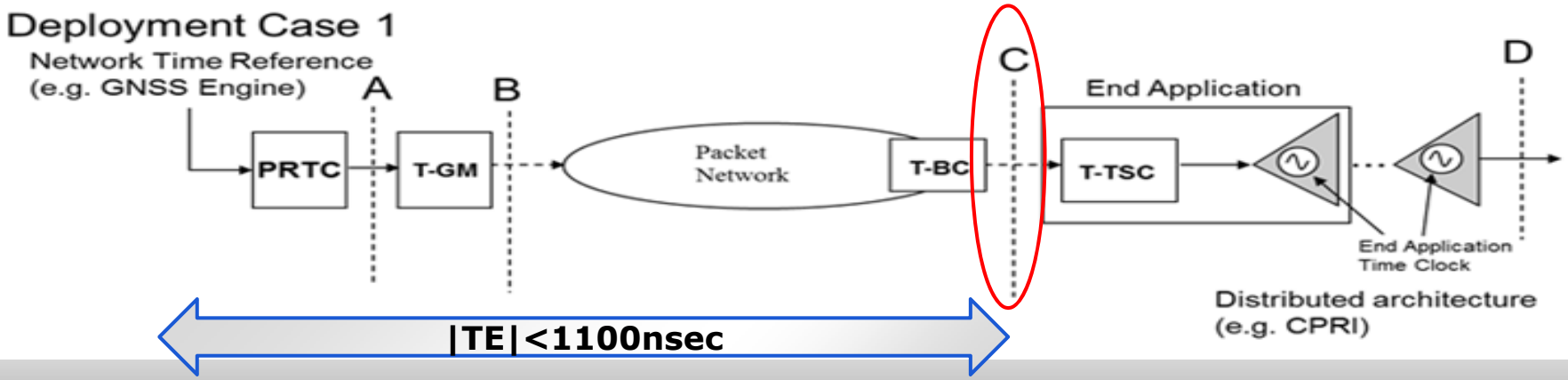
Example #1 - Partitioning across Multiple Administrative Domains (G.8275 Appendix I)

- 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.



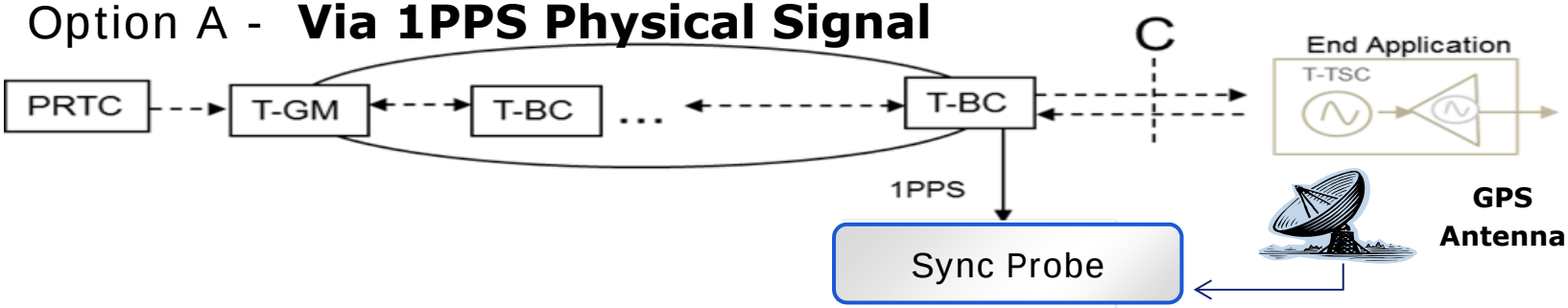
Example #2 – Time and Phase Delivery G.8271.1 Network Limits

- Maximum absolute time error network limit applicable at the reference point C:
  max |TE| ≤ 1100 ns



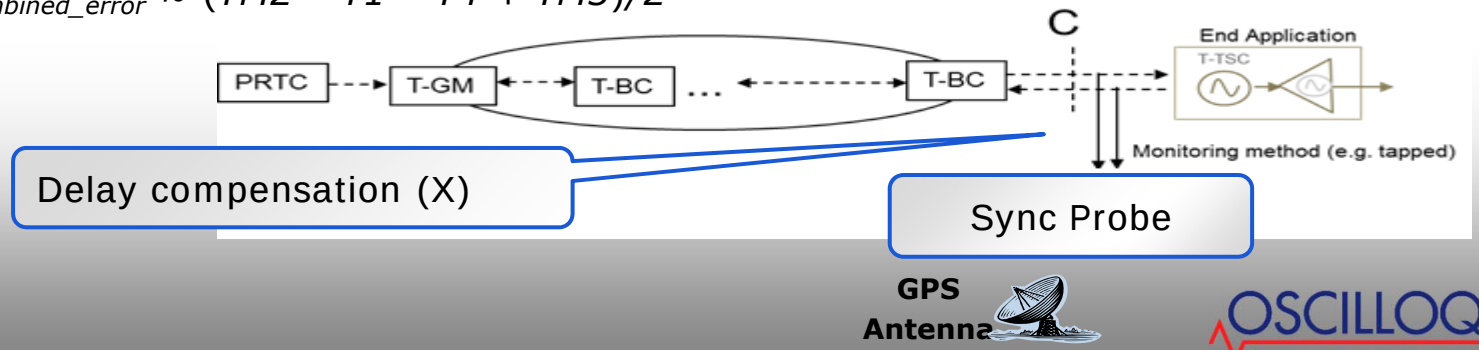
Example #2 - G.8271.1 Network Limits Deployment Case 1

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



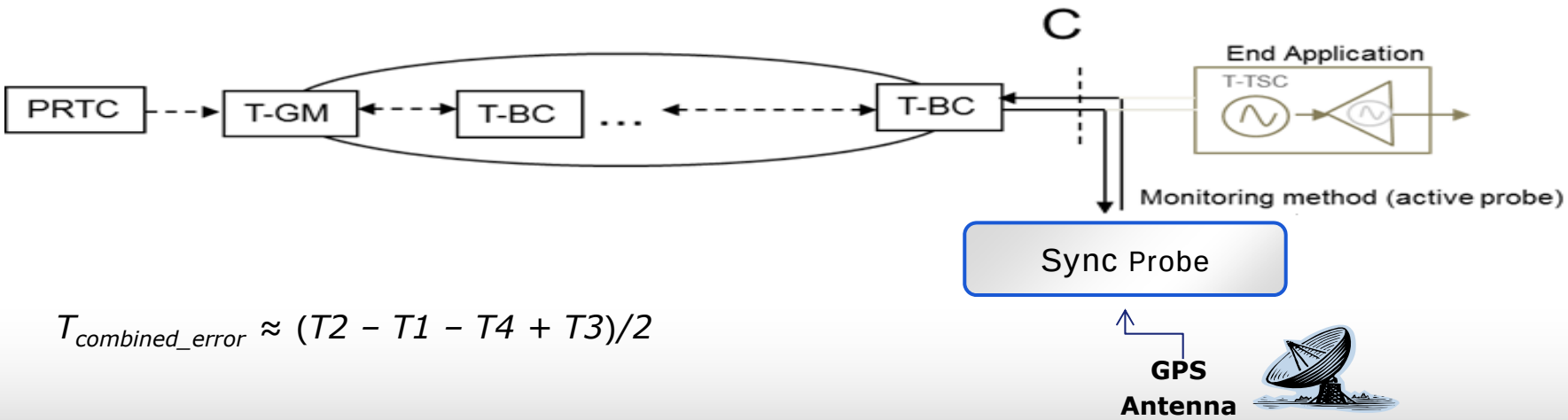
- Option B - from the two-way PTP flow via a **Passive PTP Probe**

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



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

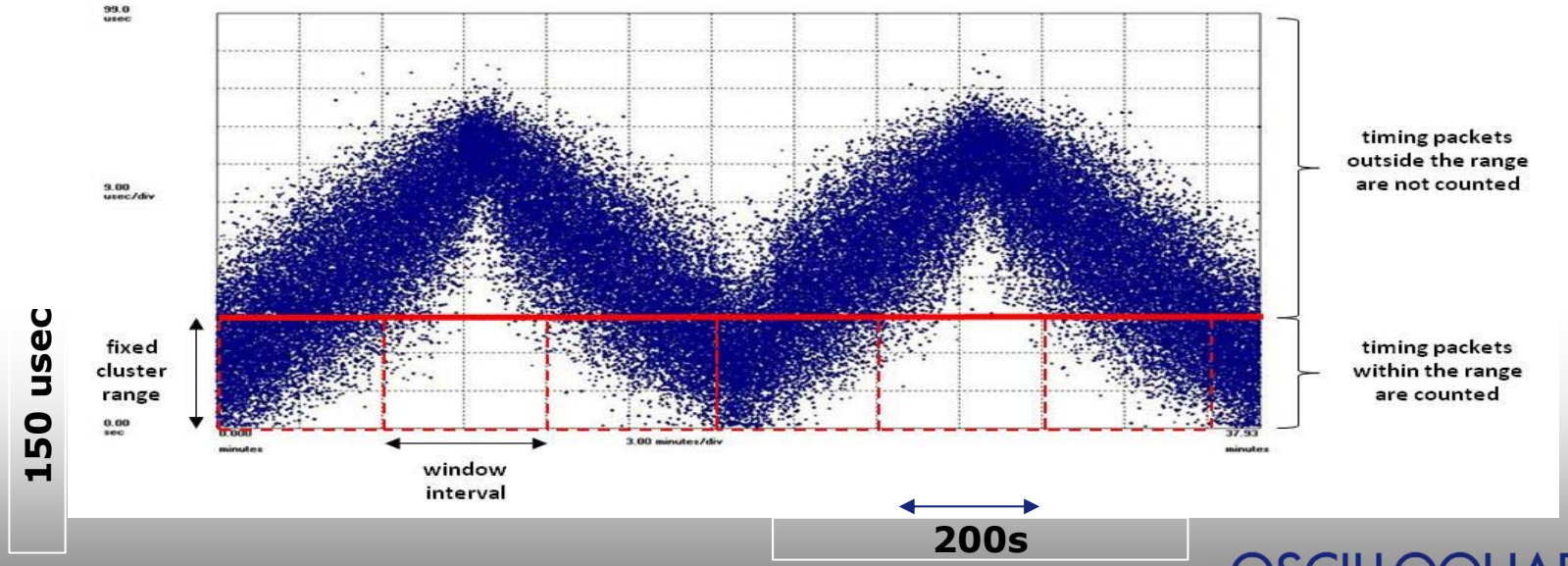
- Option C- From the two-way PTP flow via an **Active PTP Probe**



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

Example #3 – Frequency Delivery 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 µs (G.8260 floor delay packet population).



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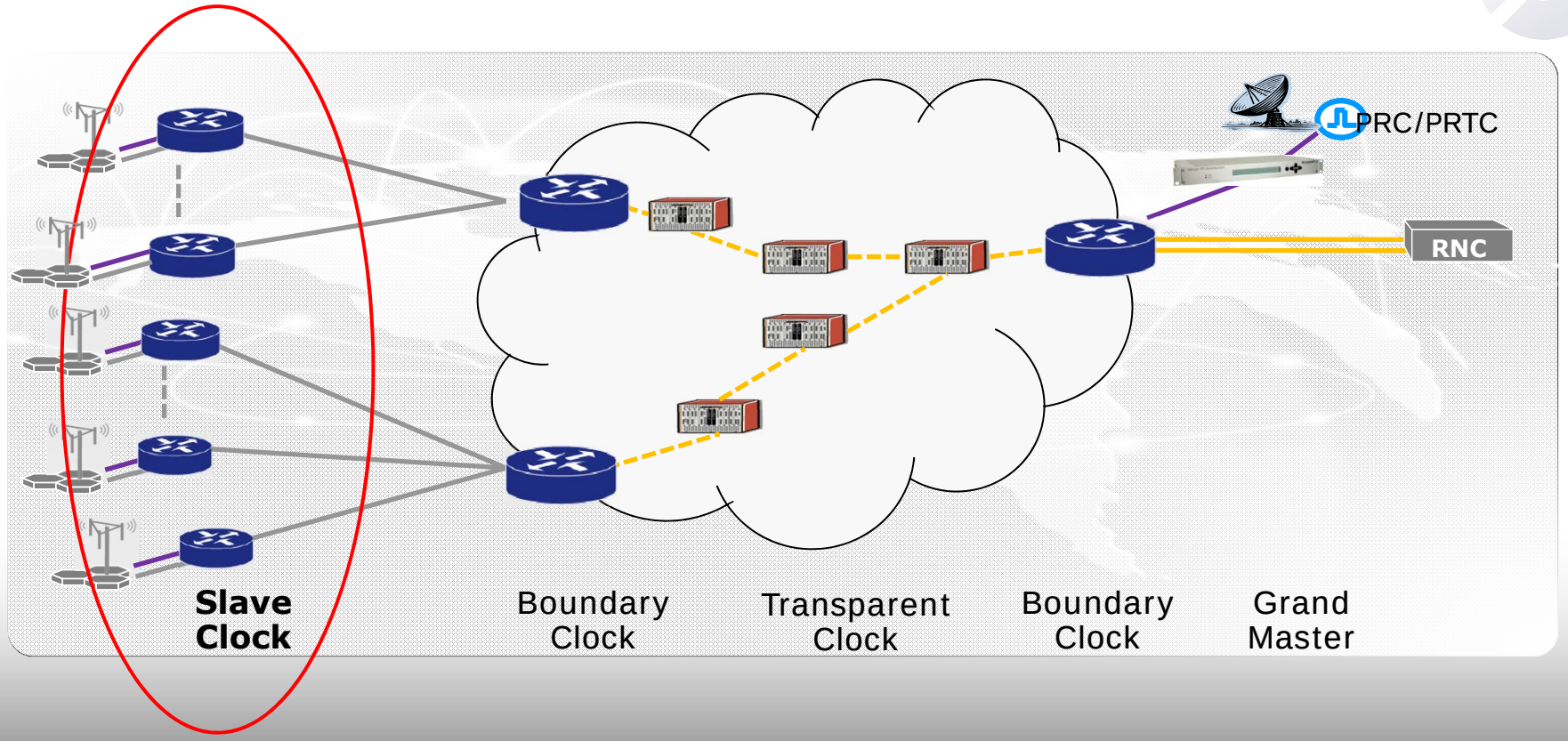
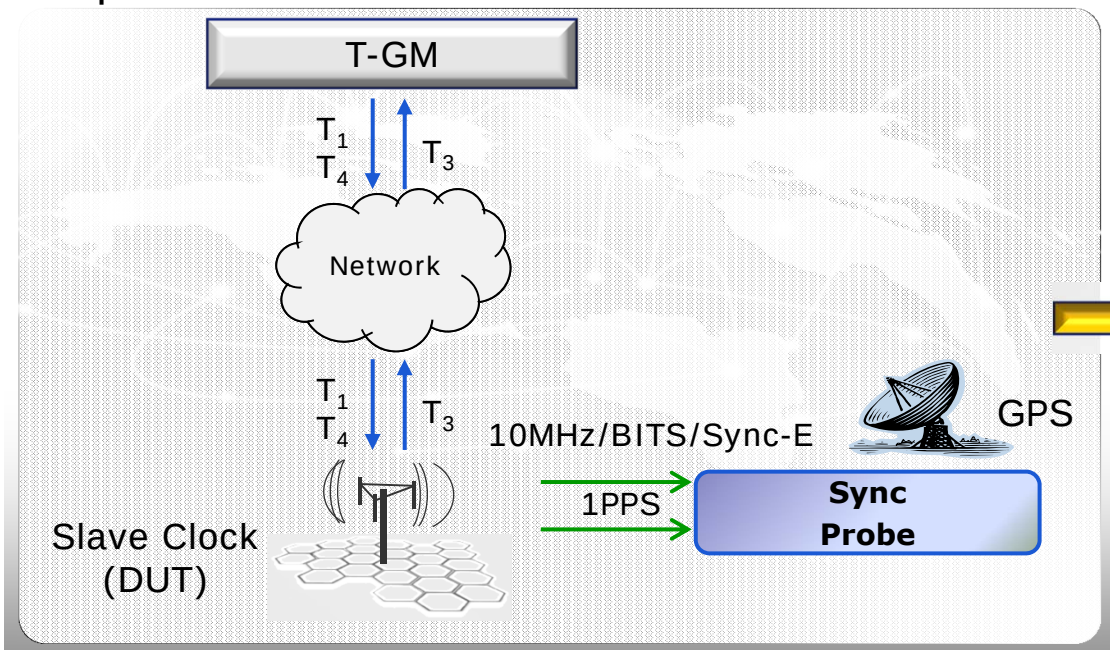
Probing and Monitoring Slave Clock

Probing Slave Clock

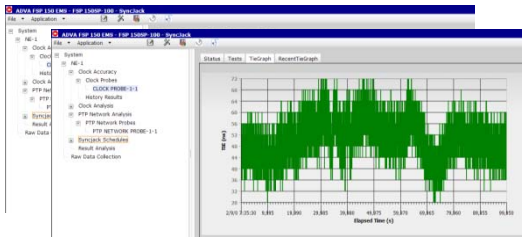


Probing Third Party Slave Clock

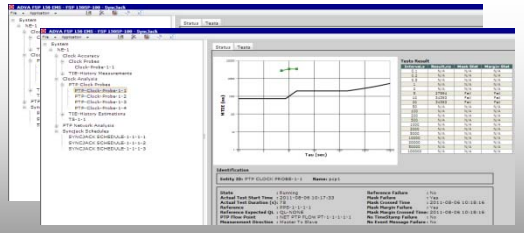
- Slave 1PPS and clock outputs can be monitored Vs. GPS/external reference
- Time Error , TIE and MTIE can be calculated and compared against target performance masks / metrics



CLK TIE & 1PPS Time Error

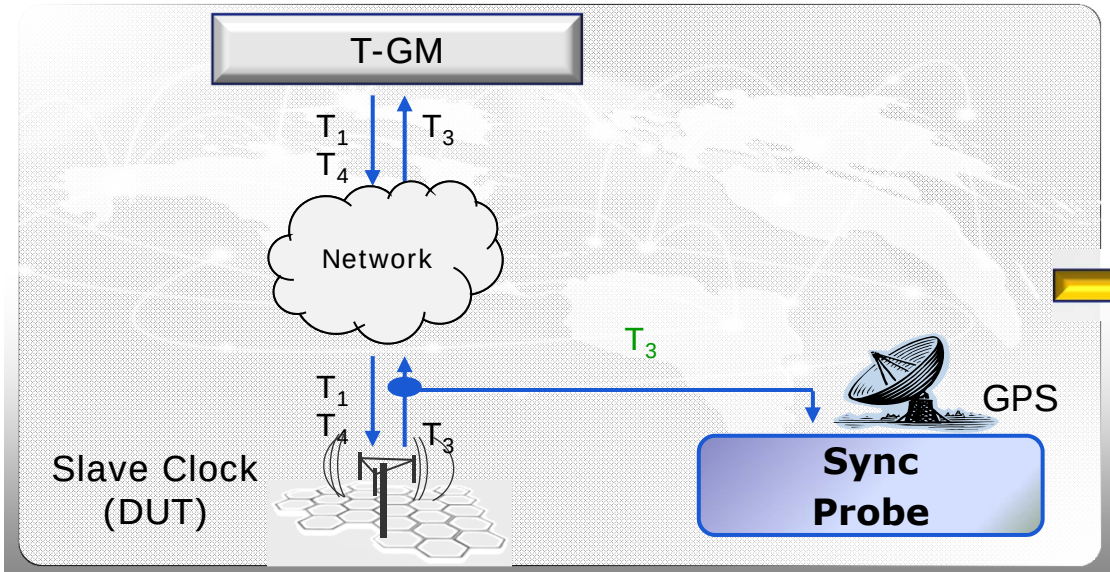


CLK & 1 PPS MTIE

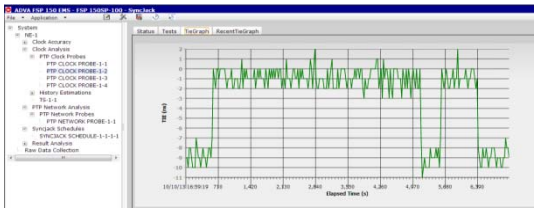


Probing an Third Party Slave Clock

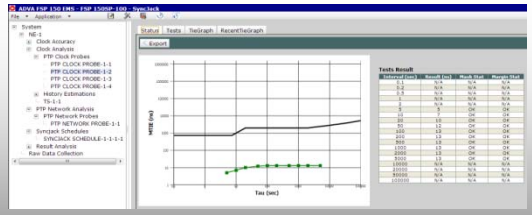
- Probing the **Slave Clock** – **Passive Probing**
  - A Sync Probe is placed at a calibrated distance from the Slave Clock (system under test)
  - The Sync Probe functions as passive PTP probe (fiber tapping or mirroring switch)
  - The Sync Probe measure packet TE/TIE/MTIE of the tapped Slave port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



Packet Time Error



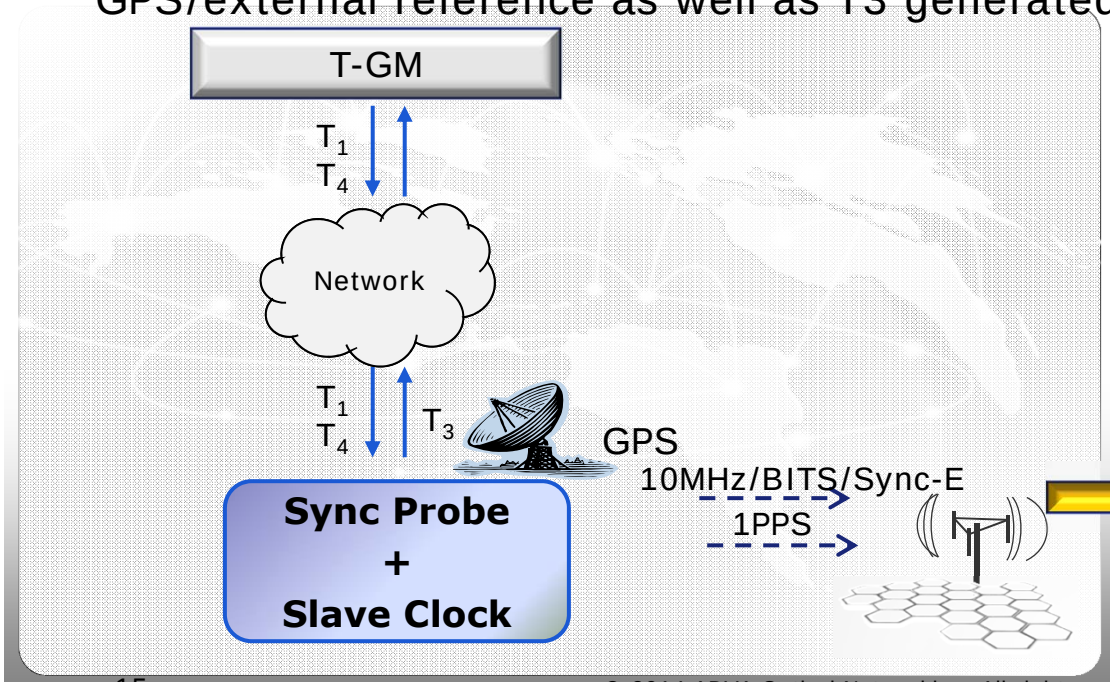
Packet MTIE



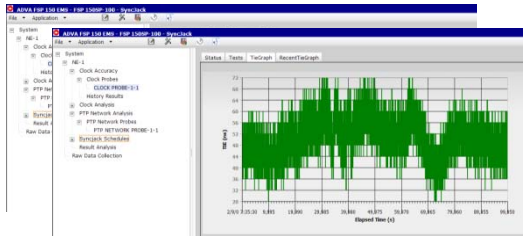
Slave Clock Self Monitoring

- The probing functions are integrated into the slave clock which deliver clock to the end application

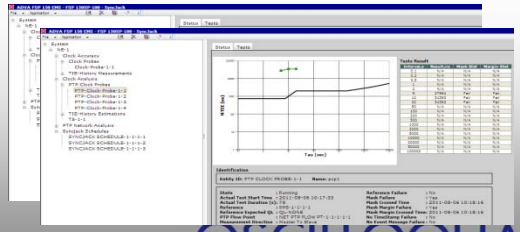
- internal 1PPS and clock recovered from PTP can be self monitored Vs. GPS/external reference as well as T3 generated by Slave Clock



CLK TIE and 1PPS Time Error



CLK and 1PPS MTIE



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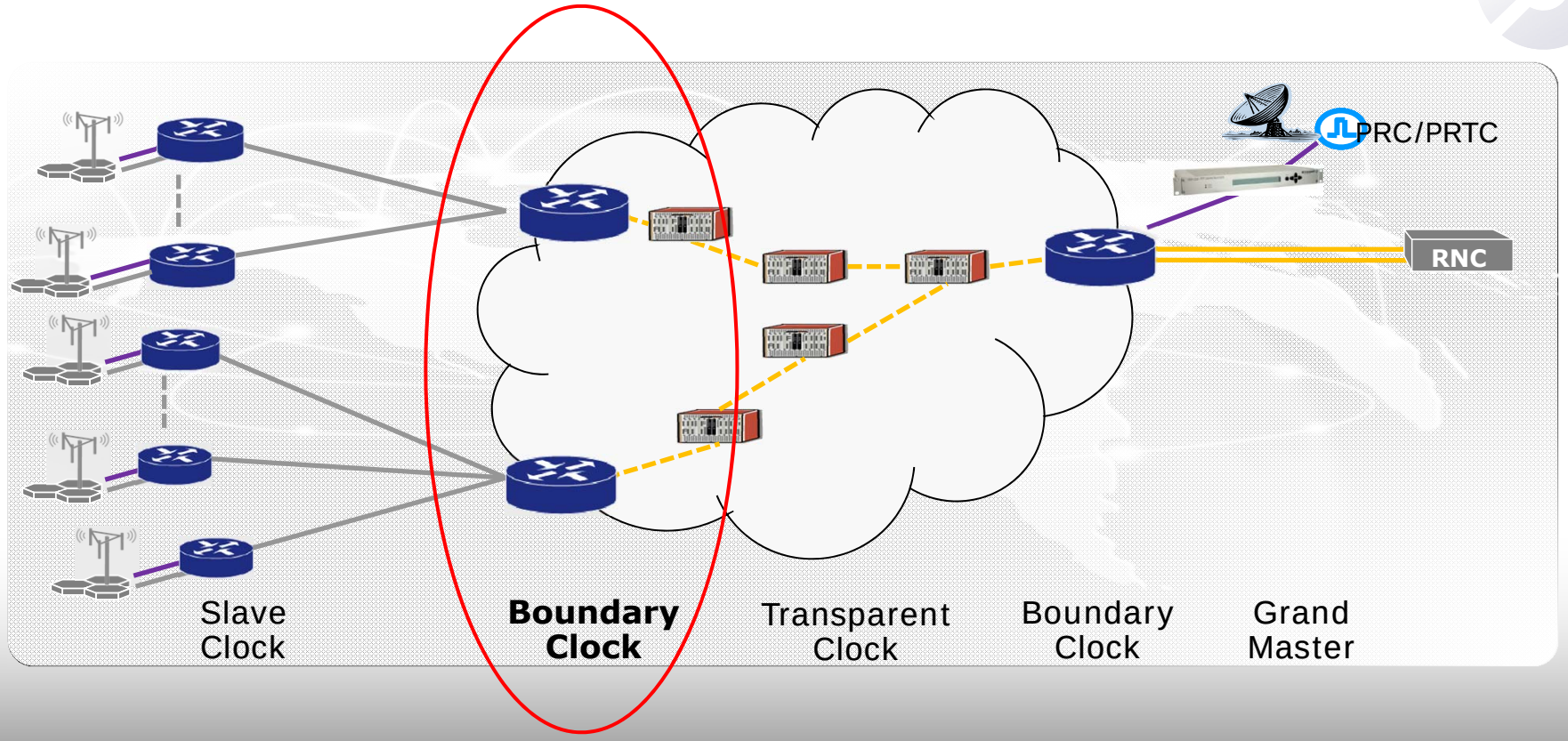
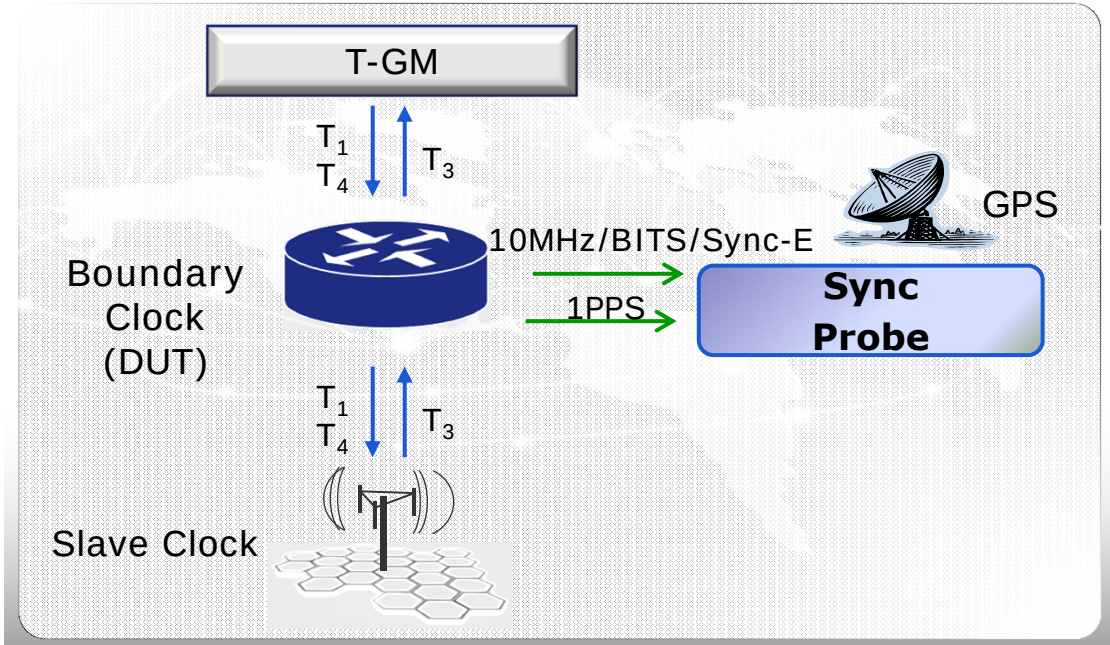
Probing and Monitoring Boundary Clock

Probing Boundary Clock

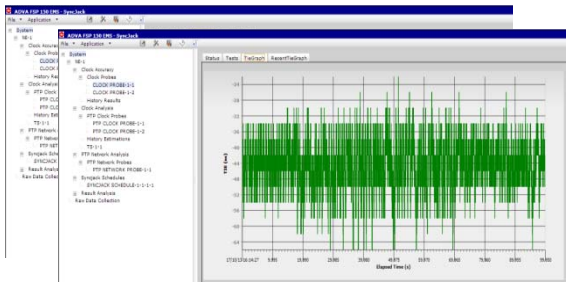


Probing Third Party Boundary Clock

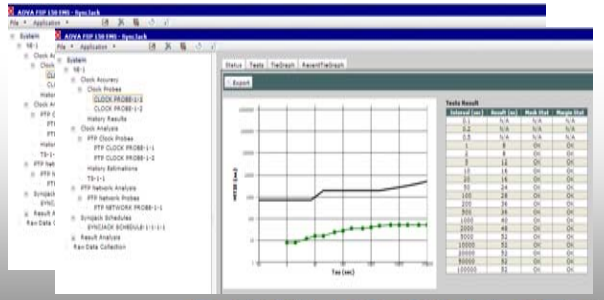
- A Sync Probe is used for assurance of third party Boundary Clock
- Boundary Clock 1PPS and clock outputs can be monitored Vs. GPS reference



CLK TIE & 1PPS Time Error



CLK & 1PPS MTIE



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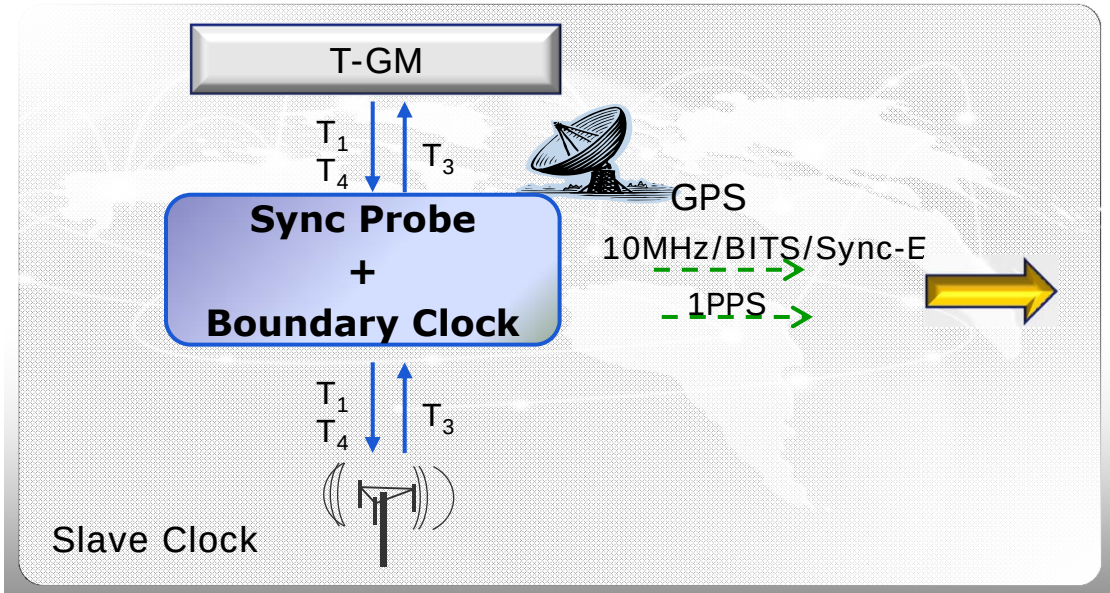
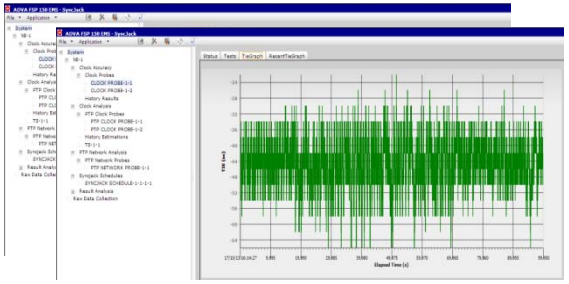
Boundary Clock Self Monitoring

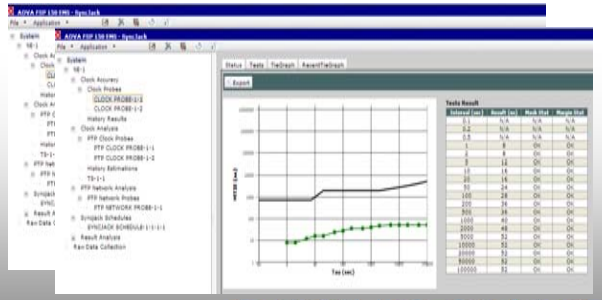
- The probing functions are integrated into the Boundary Clock
- The internal BC 1PPS and clock recovered from PTP can be self monitored simultaneously



CLK TIE and 1PPS Time Error



CLK and 1PPS MTIE



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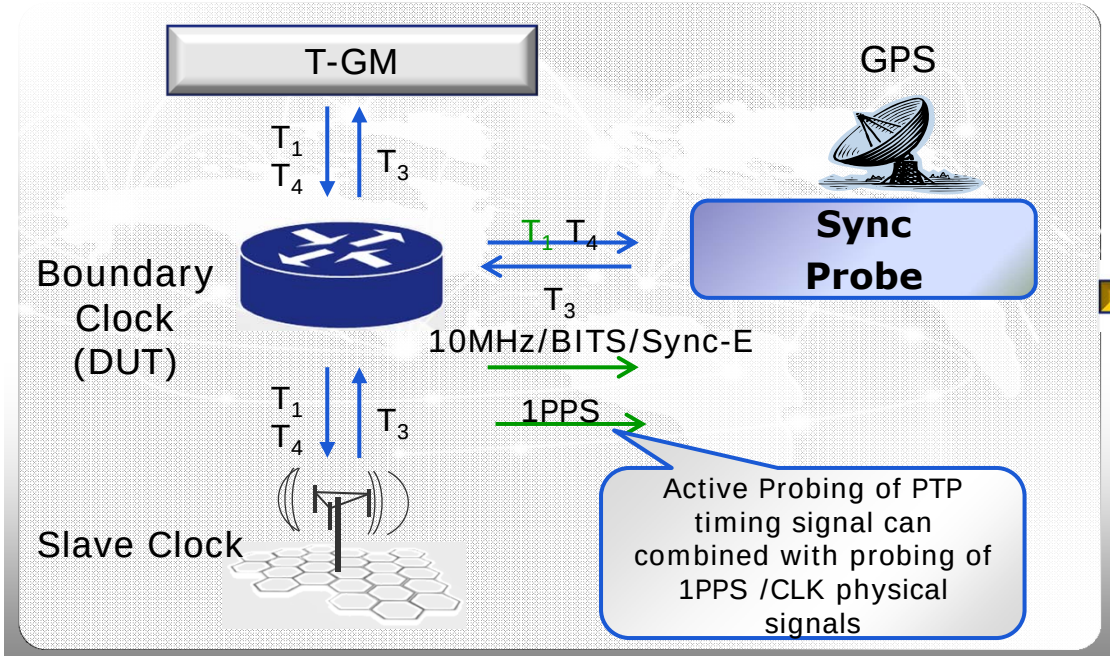
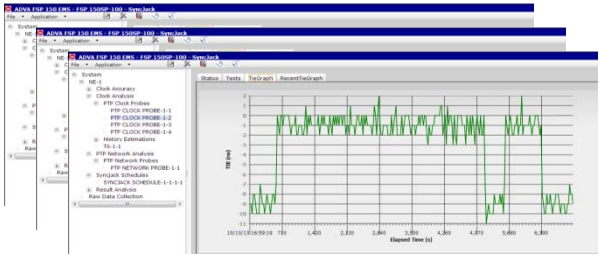
Probing an Third Party Boundary Clock

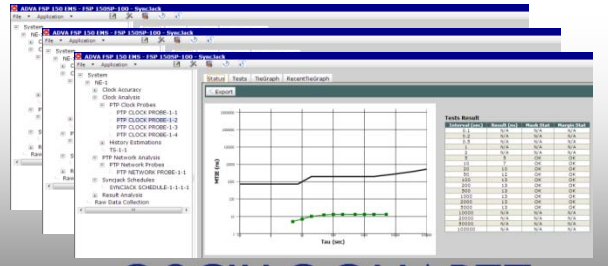
- Probing the Master side of a Boundary Clock – **Active Probing**
  - The Sync Probe is placed at a calibrated distance from the Master port of an Third Party Boundary Clock (system under test)
  - The Sync Probe functions as active probe



CLK TIE ,1PPS TE & Packet TE



CLK ,1PPS MTIE & Packet MTIE



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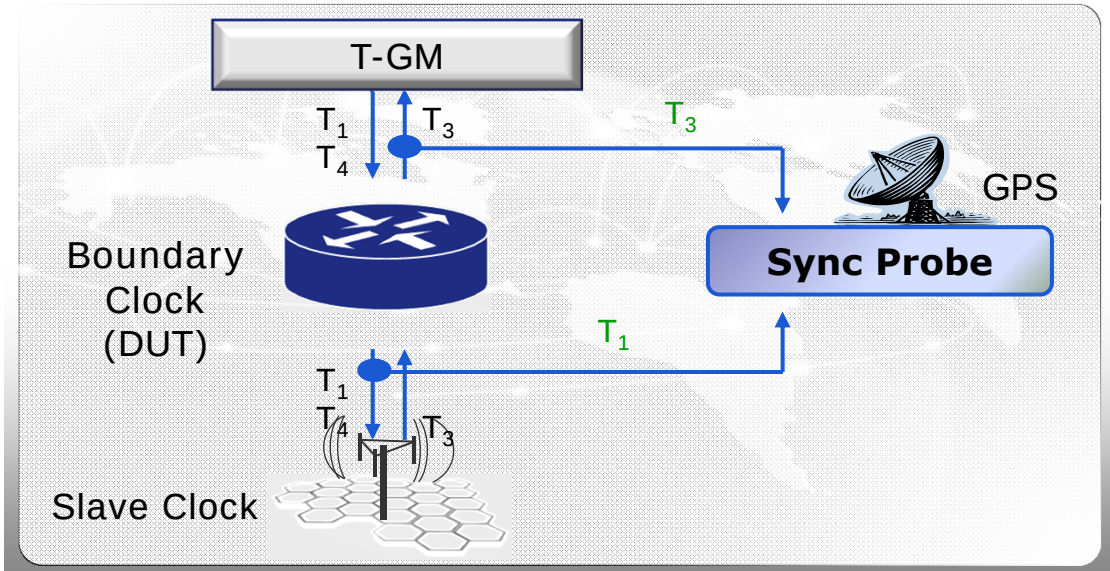
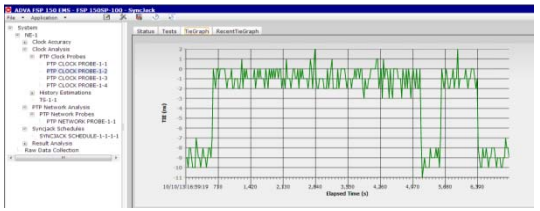
Probing an Third Party Boundary Clock

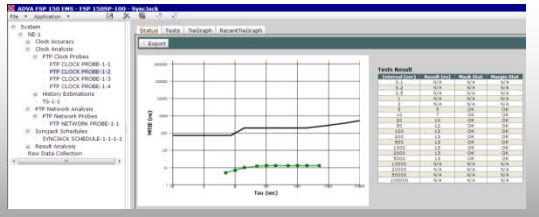
- Probing the **Master/Slave side** of a Boundary Clock – **Passive Probing**
  - The Sync Probe is placed at a calibrated distance from the Master/Slave port of a Third Party Boundary Clock (system under test)
  - The Sync Probe functions as passive PTP probe (fiber tapping or mirroring switch)
  -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



Packet Time Error



Packet MTIE



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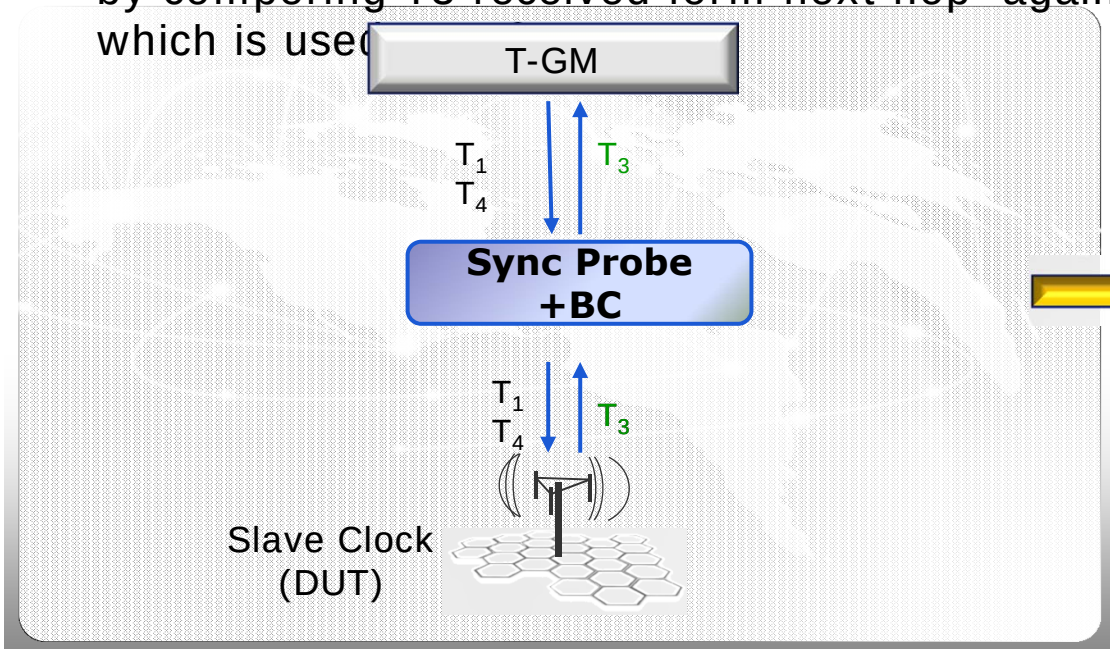
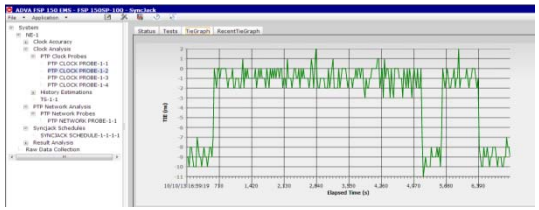
Self Monitoring Network

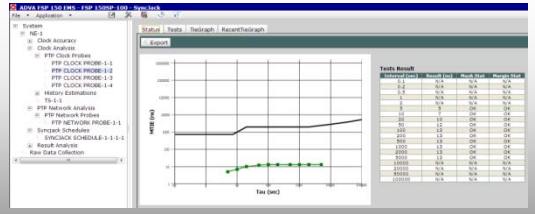
- No GPS or external reference is needed!
- Each BC can compare next hope recovered clock Vs. his own recovered clock by compering T3 received form next hop against his own recovered clock which is used



Packet Time Error



Packet MTIE



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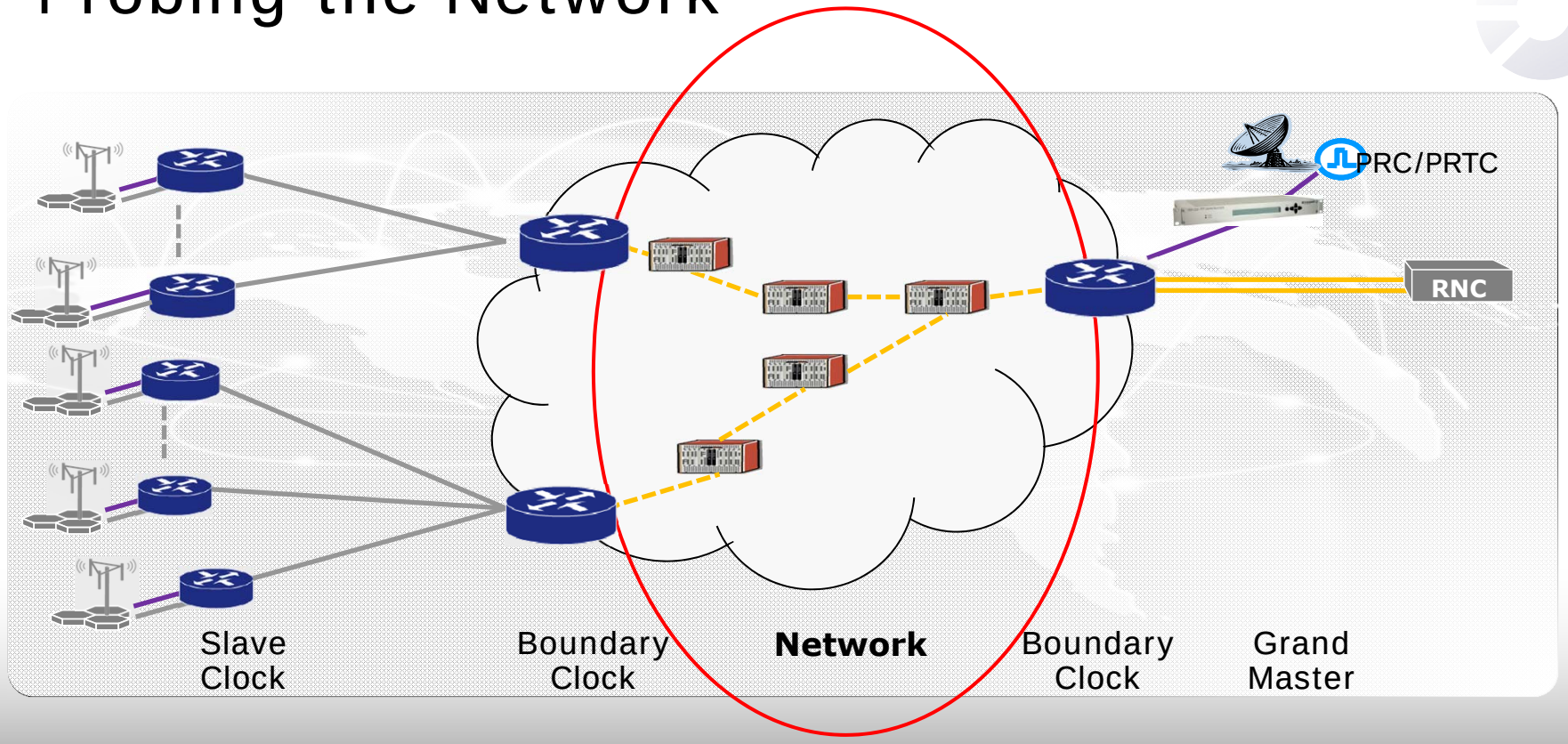
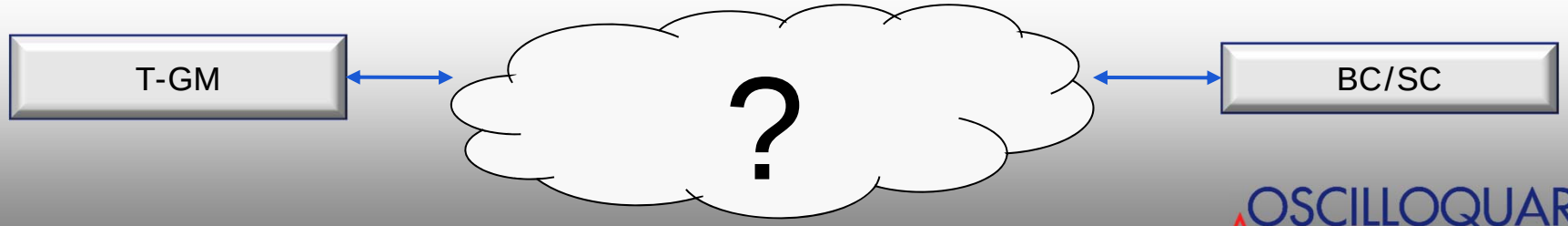
Probing and Monitoring the Network

Probing the Network



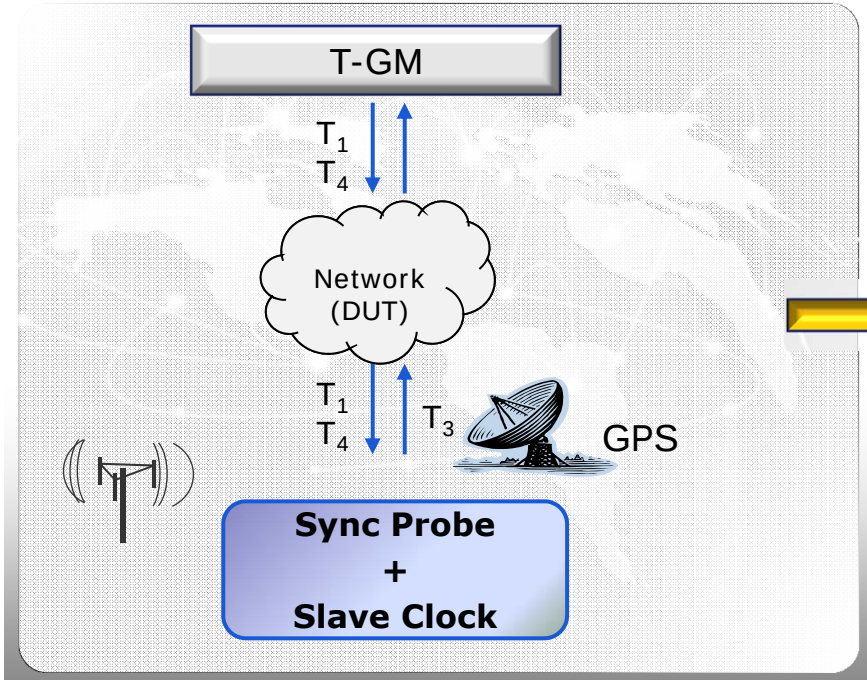
Probing the Network

- 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

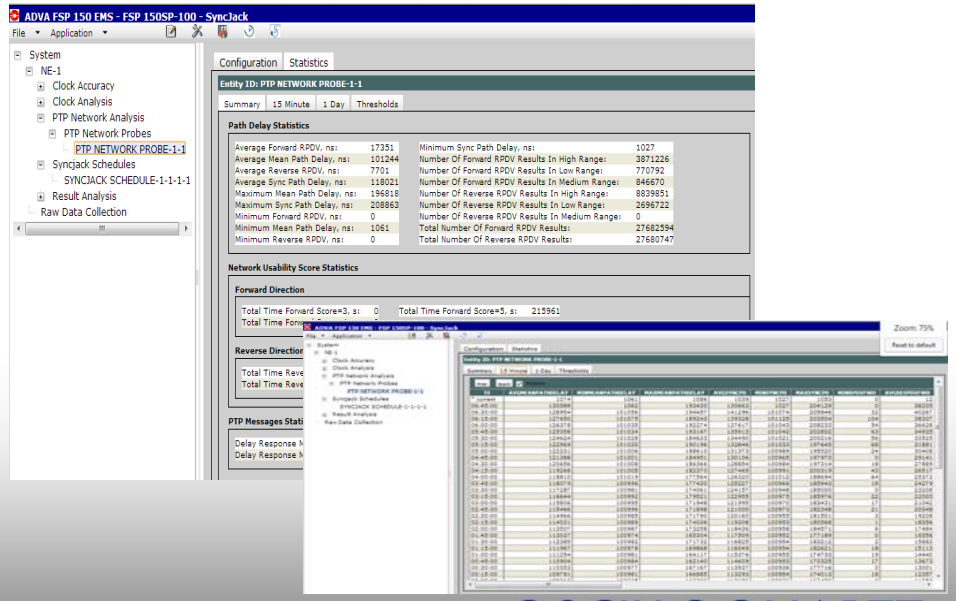


PTP Network Active Probe

- 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



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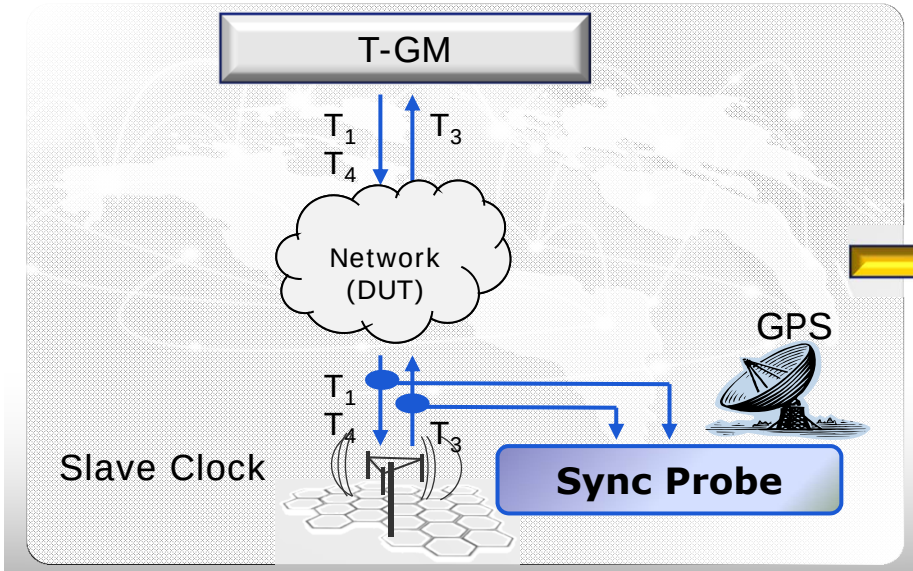
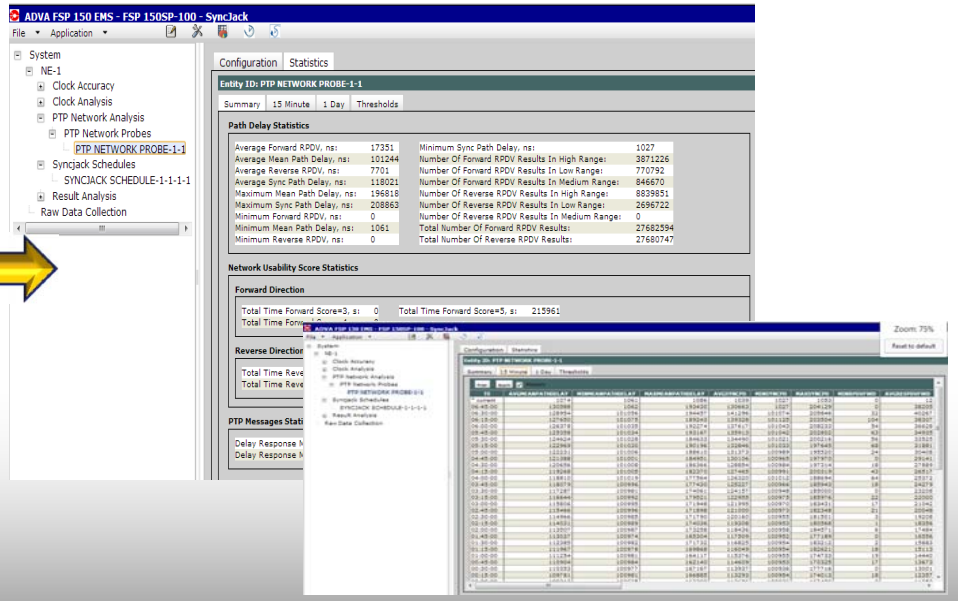
PTP Network Passive Probe

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



PTP network Probe Statistics and Usability Score



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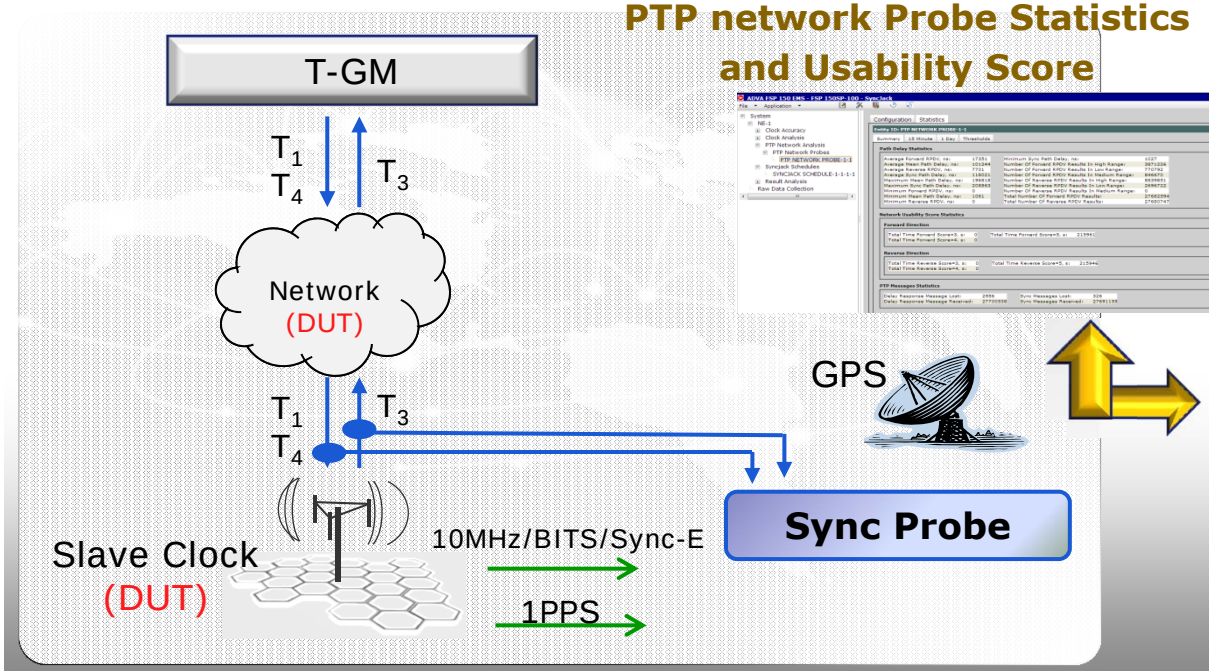
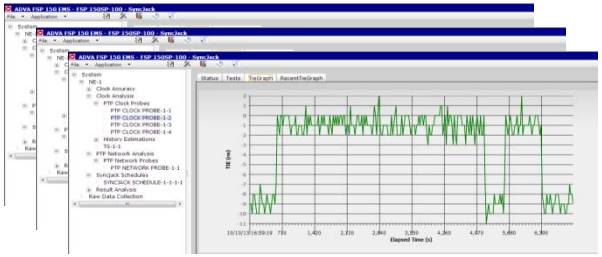
Simultaneous Testing

- Simultaneously probing of the Clock and the Network can help in troubleshooting problems

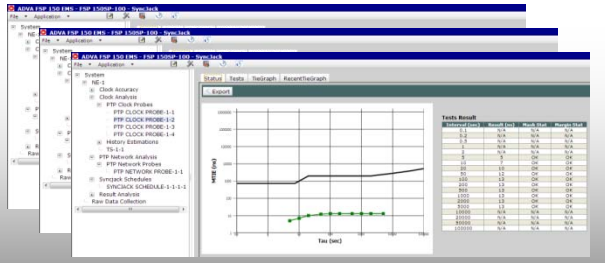


PTP network Probe Statistics and Usability Score

CLK TIE ,1PPS TE & Packet TE



CLK ,1PPS MTIE & Packet MTIE



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Summary

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

OSA 5410

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Thank you

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