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Advancements in PTP Slave Technology Enable PRS Level Performance

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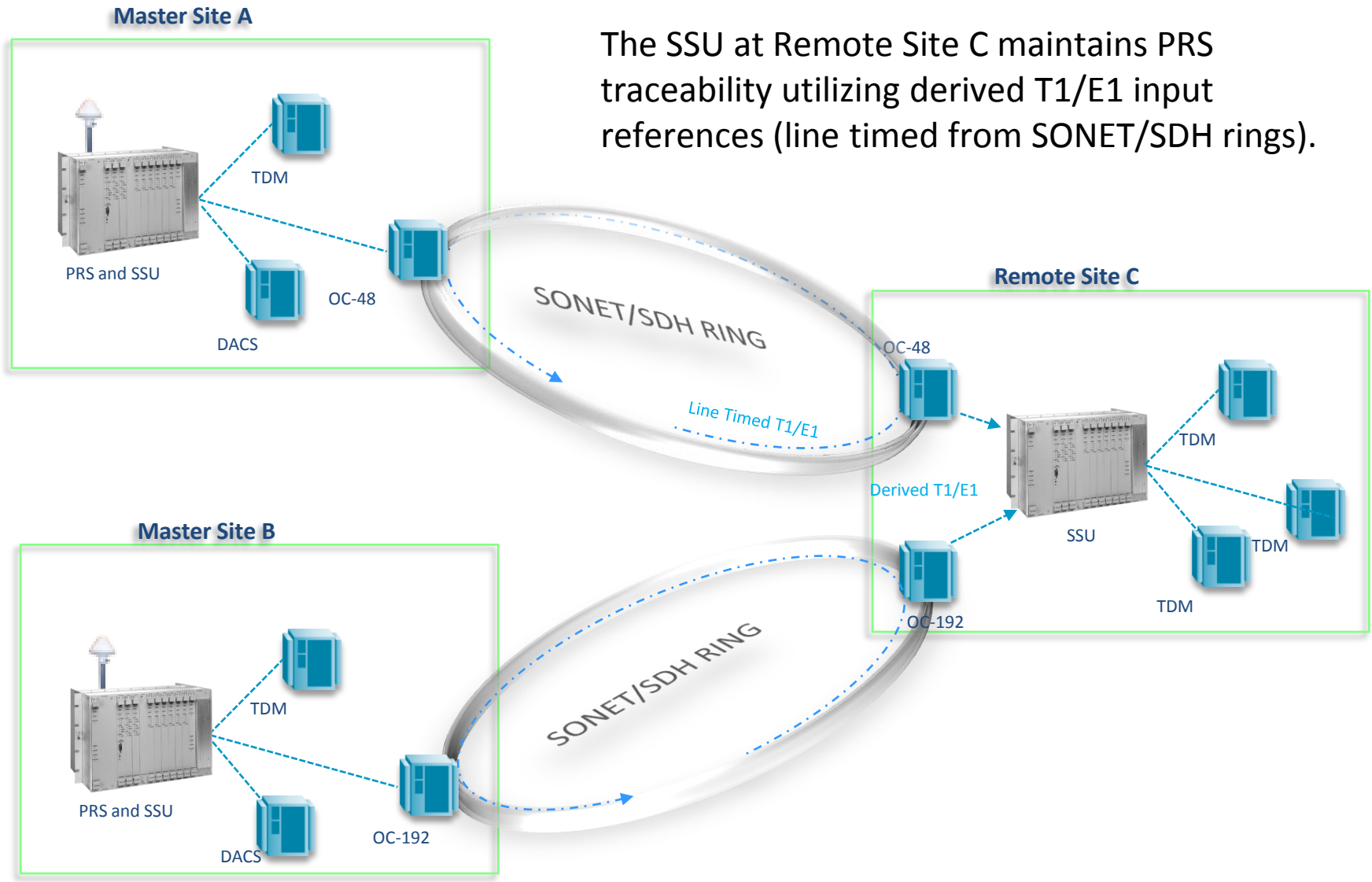
Agenda

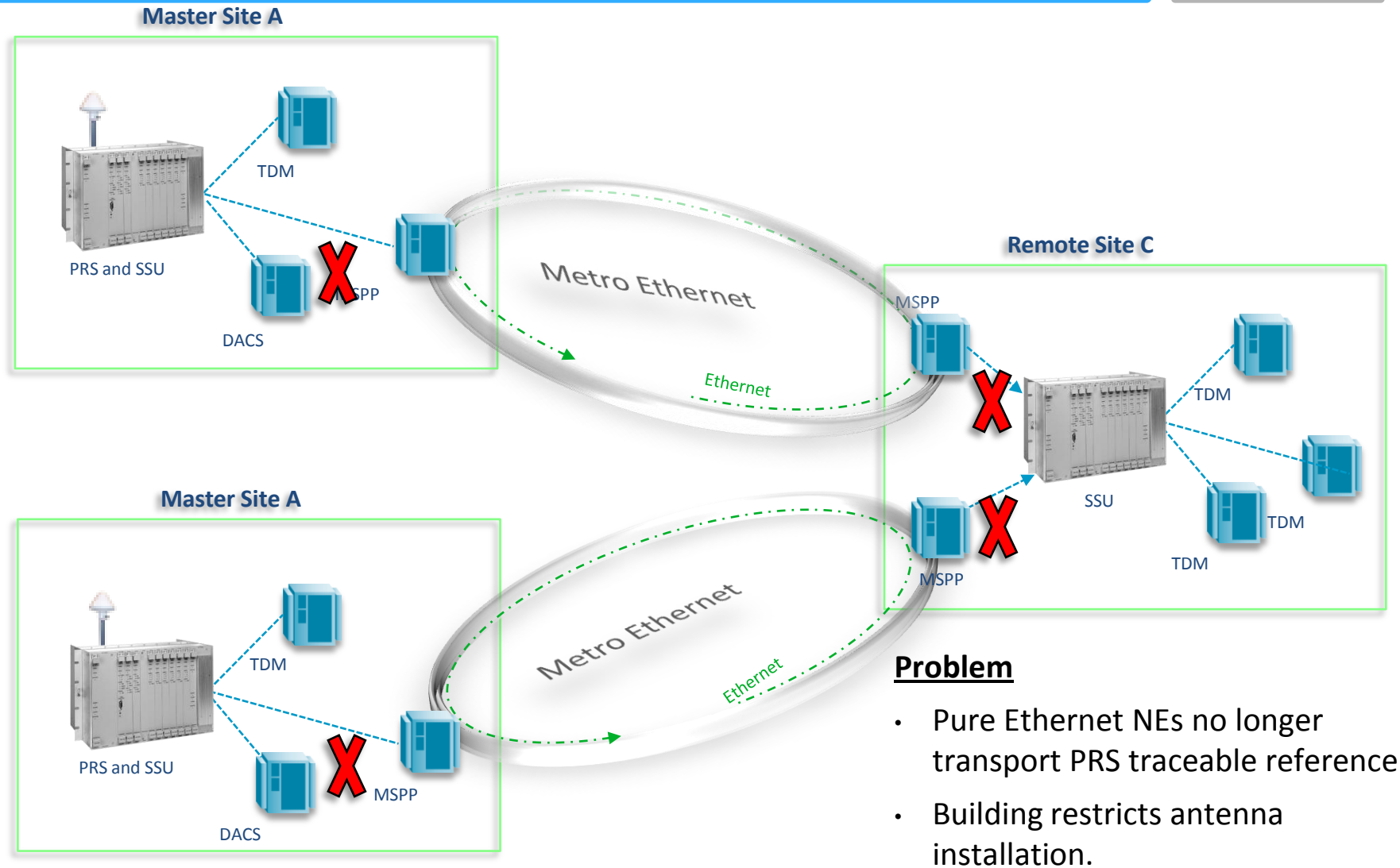
- PRS Distribution in TDM Networks Today
- The Ethernet Challenge
- PRS Distribution using IEEE 1588 PTP
- Performance Results
- Conclusion

Current TDM Network

The SSU at Remote Site C maintains PRS traceability utilizing derived T1/E1 input references (line timed from SONET/SDH rings).



New Ethernet Network



Problem

- Pure Ethernet NEs no longer transport PRS traceable reference
- Building restricts antenna installation.
- Cesium too expensive

A New Class of Packet PRS

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Cesium

$$$

- Standalone Atomic Clock
- Fully autonomous
- Core Sites - Pinnacle of sync hierarchy
- Frequency Accuracy 1 x 10-12

Primary Reference Sources

IEEE 1588 PTP

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Packet PRS

GNSS

$$

- IEEE 1588 PTP based PRS
- Standalone PRS or backup to GNSS
- No external GNSS antenna
- Requires PTP Grand Master
- Frequency Accuracy 1 x 10-12

- Flatten sync hierarchy
- Distribution nodes in the core and edge
- Requires GNSS antenna installation
- Frequency Accuracy 1 x 10-12

It Takes Two!

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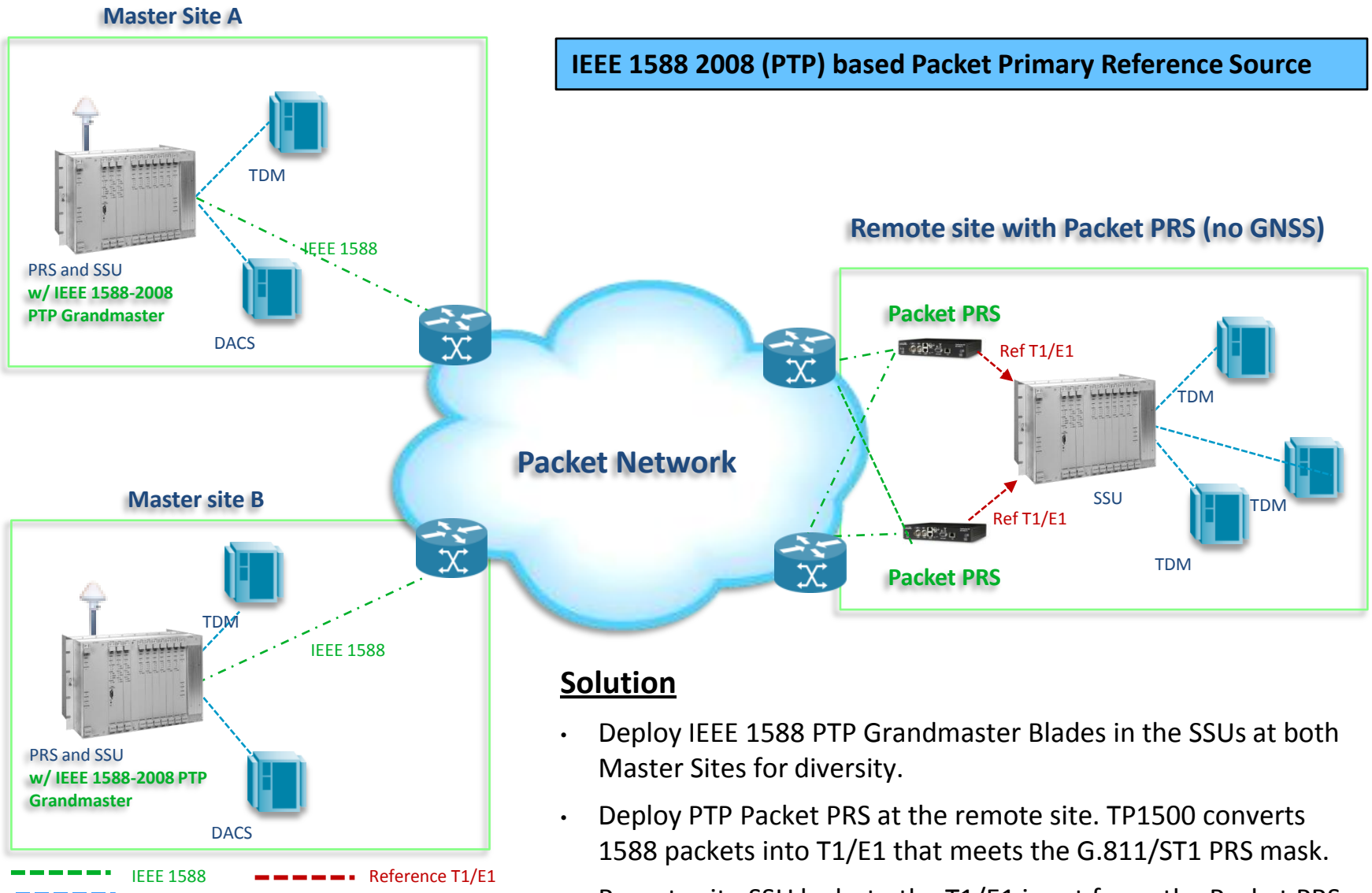
Packet PRS

Rubidium Atomic Oscillator

State of the art IEEE 1588 PTP Slave Algorithm

Rubidium is required to meet PRS mask requirements, and to ensure flawless performance

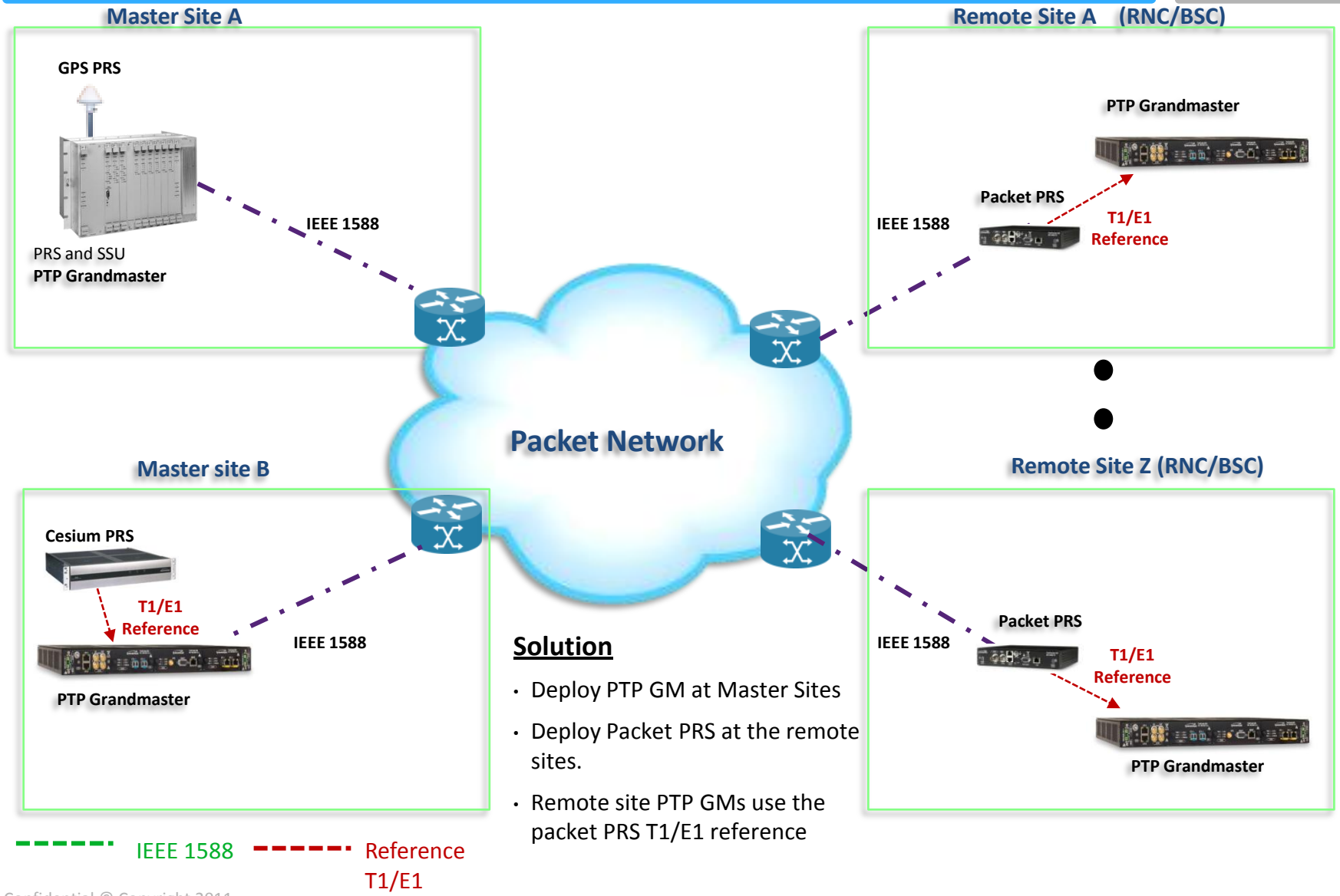
PRS distribution in Packet Networks



Solution

- Deploy IEEE 1588 PTP Grandmaster Blades in the SSUs at both Master Sites for diversity.
- Deploy PTP Packet PRS at the remote site. TP1500 converts 1588 packets into T1/E1 that meets the G.811/ST1 PRS mask.
- Remote site SSU locks to the T1/E1 input from the Packet PRS.

Alternative to GNSS at Mobile Edge



Solution

- Deploy PTP GM at Master Sites
- Deploy Packet PRS at the remote sites.
- Remote site PTP GMs use the packet PRS T1/E1 reference

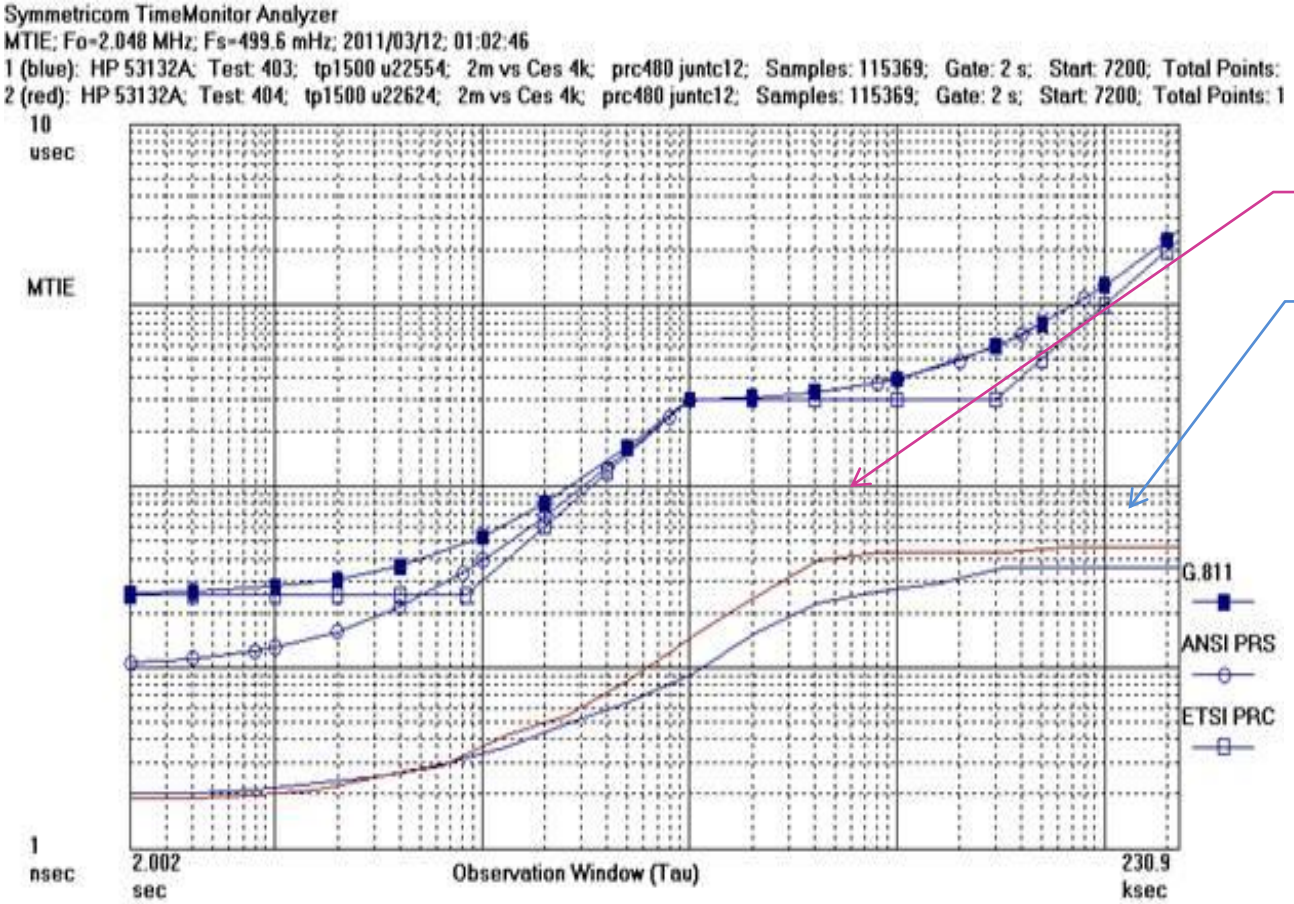
SLA for PTP Flow

Bandwidth Capacity	Maximum Loading	Intermittent Congestion	QoS	Recommended Hop Count
Minimum 1GigE	80% Average	100% load for less than 100s	Highest Priority	Frequency (10 hops) Time (5 hops)

The TimeProvider 1500 Packet PRS meets all requirements under full dynamic loading and impairments as specified in G.8261 – ”Timing and Synchronization aspects in Packet Networks” - Appendix VI Test Cases 12 to 17

MTIE Performance

Two Packet Primary Reference Sources operating over 10 node network.
G.8261 TC12 two way stress test at 80% loading (64 hour test period).

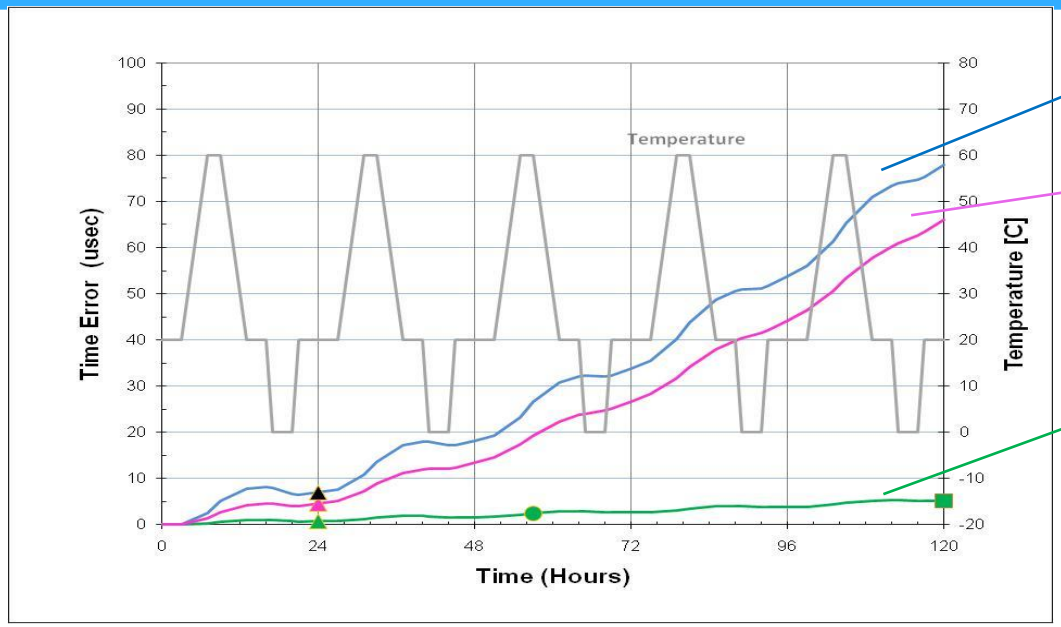


Packet PRS ser #22554

Packet PRS ser #22624

The Packet PRS complies with ETSI PRC and ANSI PRS masks with frequency accuracy better than 6e-13 with respect to house Cesium

Rubidium and Advanced PTP Slave Clock



OCXO 8 µs /day

Optimized OCXO < 4 µs/day

Rb <1.0 µs for 1.0 days Rb <5.0 µs for 5.0 days

Ageing ≤ $2X10^{-11}$/month

Rb performance is 5 - 8x better than Qz

- Rubidium coupled with state of the art PTP Slave algorithms provide a PRS quality clock
- Rubidium assures Holdover and Bridging specs per G.811/GR.2830
  - After losing PTP reference, the system shall be able to maintain PRS performance up to 6 hours
  - Unacceptable region of MTIE mask should not be entered for the first 48 hours after the allowed impairment

Packet PRS Contribution

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Requirements

- 1588 PTP Packet-based PRS
- Powered by Rubidium Atomic Oscillator
- T1/E1 outputs compliant with ITU-T G.811 Stratum 1 and Telcordia GR-2830
- 10MHz and 1PPS auxiliary outputs

Benefits

- No costly GNSS antenna installation and maintenance
- Reduces dependency on GNSS
- Smooth migration from TDM to packet networks
- Accurate and precise distribution of sync over packet networks

Applications

- “GNSS Difficult Sites” with no roof access
- Unreliable GNSS signal as in Urban Canyons or Tunnels
- Sites vulnerable to GNSS interferences due to jamming and spoofing
- Back-up to GNSS supporting frequency and time services

Thank You

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GLOSSARY

- ITU-T G.811: Timing Characteristics of Primary Reference Clocks
- Telcordia GR.2830 CORE : Primary Reference Sources – Generic Characteristics
- ITU-T 8261: Timing and Synchronization aspects in Packet Networks