OSCILLOQUARTZ
An ADVA Optical Networking Company

70 YEARS
TIMING EXCELLENCE

What is the Future of Traditional SSUs and TSGs?

Chuck Perry

cperry@oscilloquartz.com

WSTS - March 2019

Existing Deployments for TDM Synchronization

Cs PRS

Free-running self-contained stratum 1 frequency Source
E1/T1 10Mhz Outputs

GPS PRS

GPS Based stratum 1 frequency Source
E1/T1 10Mhz Outputs
Possible NTP / TOD

BITS Clocks

Redundant Frequency Distribution shelf with holdover protection
DS1/E1, CC
Possibly Integrated GPS
Possible NTP / PTP

What is the BITS concept?

"Building Integrated Timing Supply"

Following the BITS concept means that all "Network Elements" within an office be timed from a single common clock source.

TSGs and SSUs fill this role

Traditional TSG/SSU architecture - Employs dual clock modules within a common shelf, dual feeding a bank of output modules (E1,DS1 or CC)

Network Elements are designed accept primary and secondary timing inputs from diverse output modules creating a "No Single Point of Failure" scenario

10s of Thousands of SSU/TSGs Deployed in NA

ANSI Clock Standards

Stratum-1	1×10^{-11}	Not Defined	Not Defined
Stratum-2	1.6×10^{-8}	1×10^{-10} per day, 1st 24 hrs.	1.6×10^{-8}
Stratum-3E	4.6×10^{-6}	1×10^{-8} per day, 1st 24 hrs.	4.6×10^{-6}
Stratum-3	4.6×10^{-6}	$\leq$ 255 DS1 slips, 1st 24 hrs.	4.6×10^{-6}
SMC	2.0×10^{-5}	4.6×10^{-6}	2.0×10^{-5}
Stratum-4	3.2×10^{-5}	Not Defined	3.2×10^{-5}

The maximum MTIE during a reference rearrangement for SONET interfaces is 1 μs or 20 ns in any 14 ms.

Where are all these clocks today?

Many of these clocks are still in place with many serving mission critical applications in the Federal, Telco, Cable and Utilities markets.

- **Providing DS1 Timing to SONET and TDM Transport gear**
- **Providing "Composite Clock" Timing to Channel Banks and Signaling gear as required for the critical applications like emergency "911" service**

Important Note!

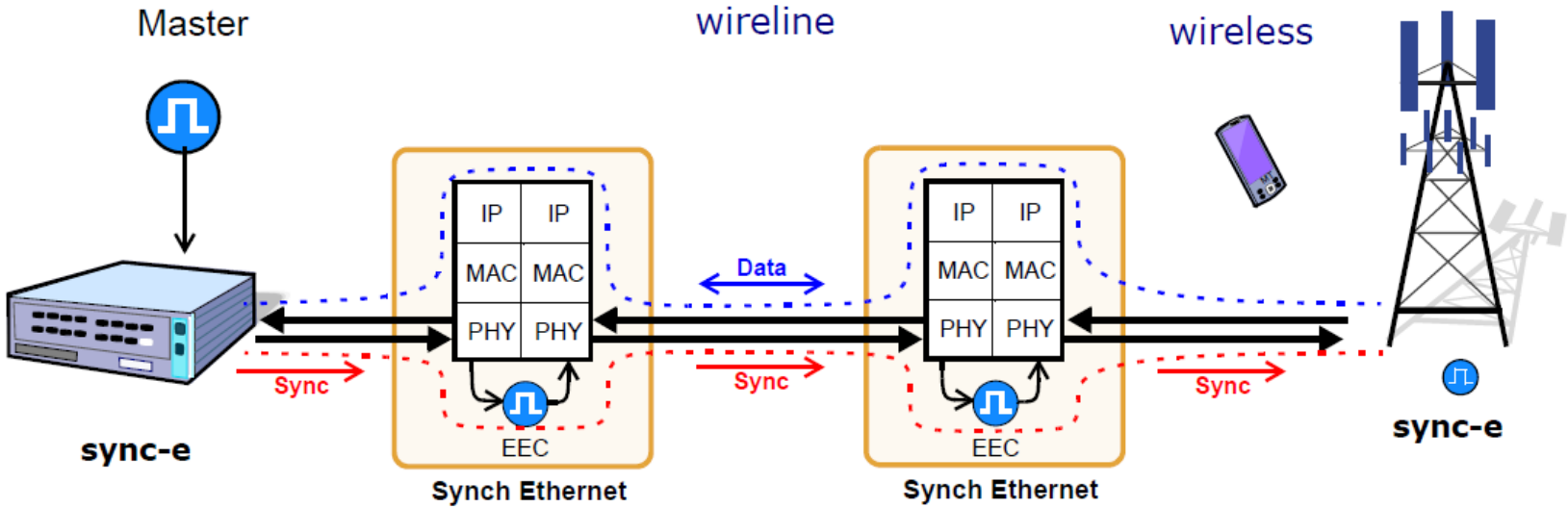
- **Maintaining legacy SSUs/TSGs has forced operators to "abandon the BITS concept" because these clocks are not capable of providing all of the synchronization needs of modern offices and networks!**

Synchronization Needs for Modern Network Clocks

1) Sync-E Inputs and Outputs
2) PTP Grandmaster, Slave and Boundary Clock Functionality
3) PTP to NTP translation
4) Using PTP Inputs for Protection against Local GNSS Jamming
5) Inservice PTP probing for Sync-Assurance and Advanced Spoofing Detection
6) NTP/PTP/Sync-E service port expansion capabilities with faster Interfaces
7) ePRTC – Enhanced Primary Reference Time Clock
8) Maintaining Legacy TDM Sync Network using Traditional TSG Architecture

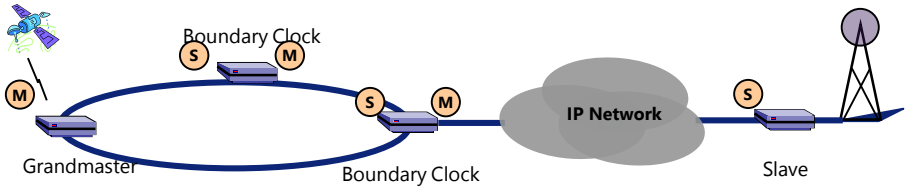
OSCILLOQUARTZ
An ADVA Optical Networking Company

Synchronous Ethernet

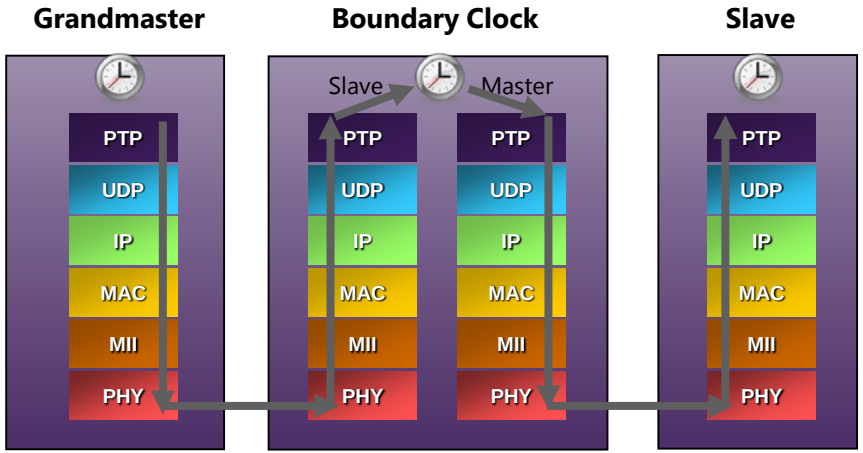


Also referred as **Sync-E**, is an ITU-T standard for computer networking that facilitates the transference of frequency reference signals over the Ethernet physical layer. This signal can then be made traceable to an external clock.

What is a Modern Boundary clock?



A Boundary Clock has an internal oscillator and can extend the reach, and/or offload slave capacity from the PTP Grandmaster.

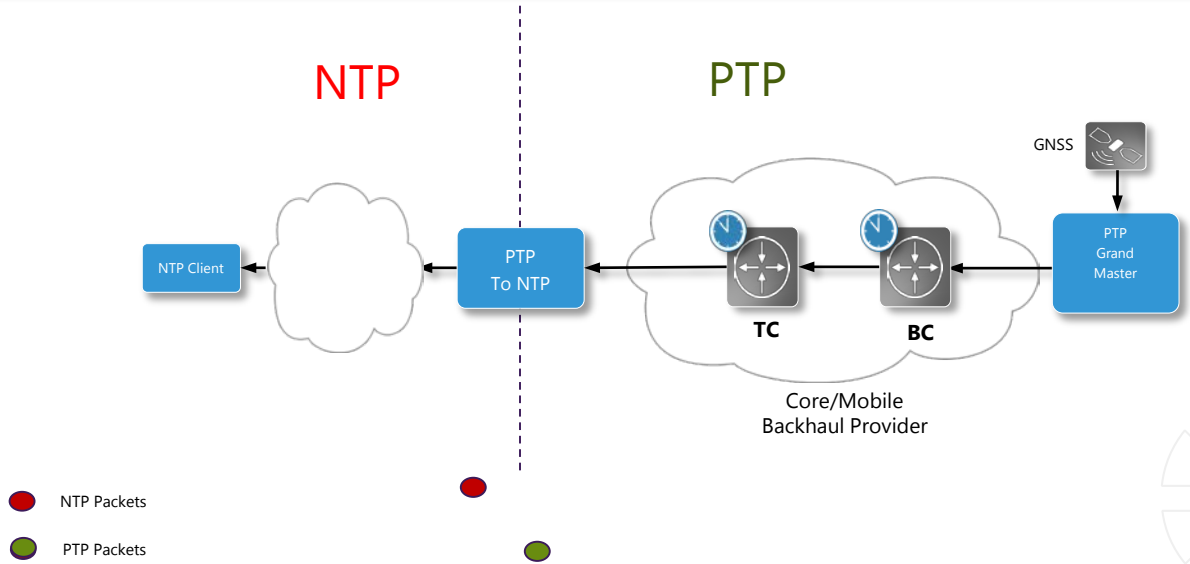


- **Modern clocks can use Boundary Clock functionality as a backup or alternative to GNSS for UTC traceable reference**
- **Why limit downstream service to PTP? Once the clock is set it can be used for BITS, Sync-E, PTP profile conversion, PTP/NTP translation etc…**

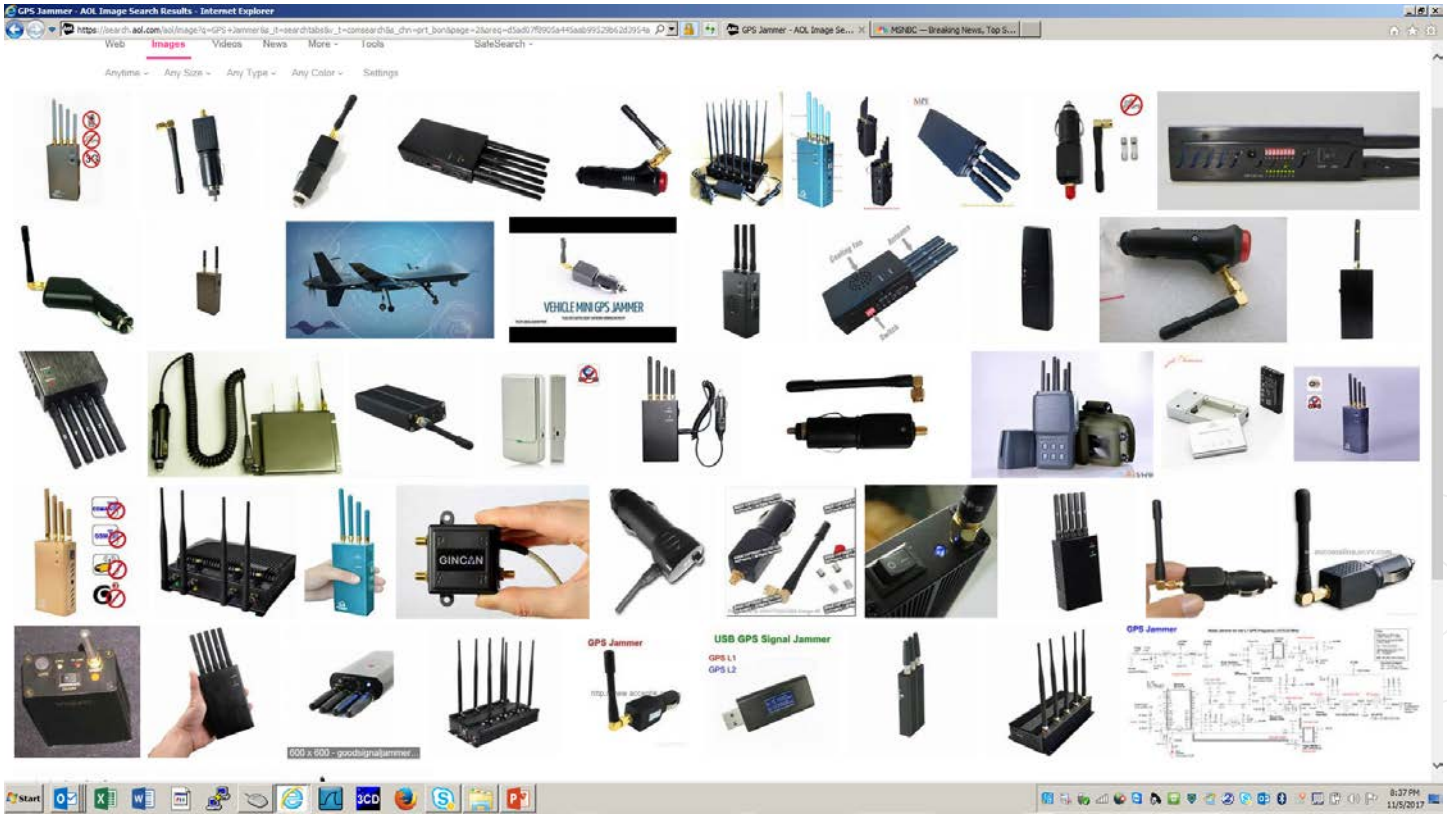
9

PTP to NTP Translation

Rather than sending NTP across the network, Much better results can be achieved by sending PTP across the network, then translating to NTP at the end office the NTP service is required

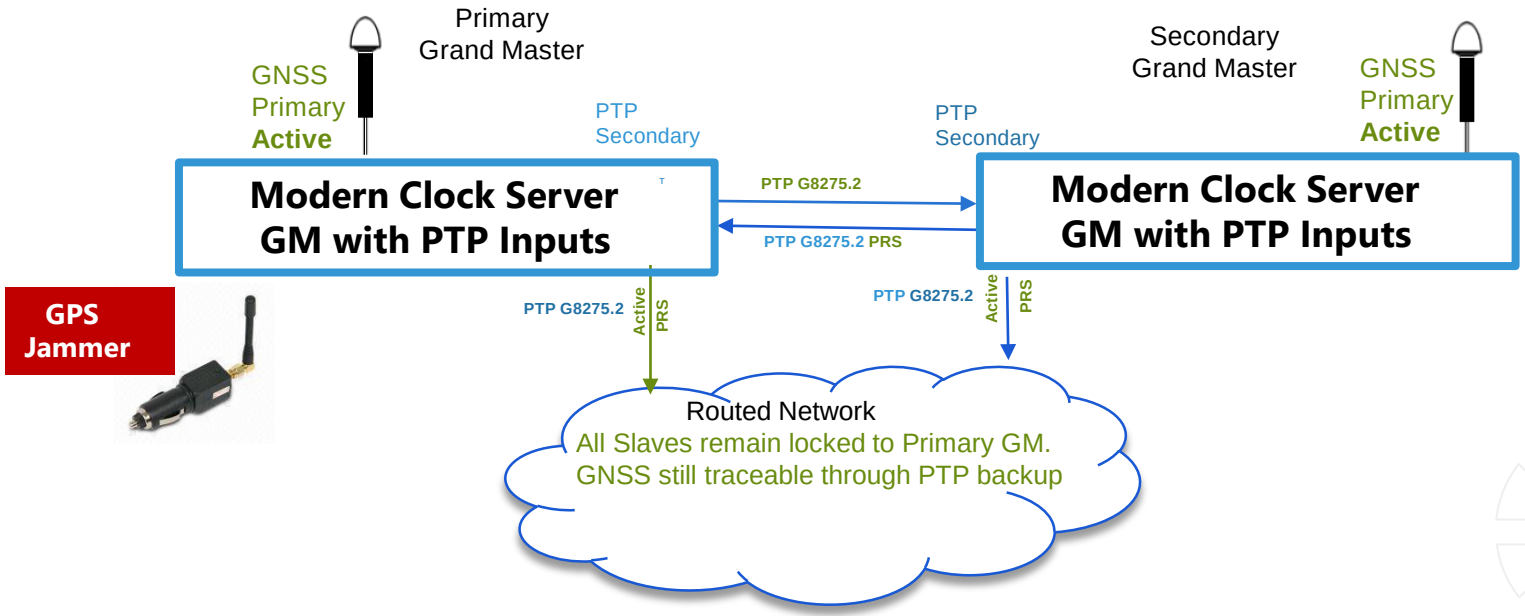


Local GNSS Jamming is a Real Threat!

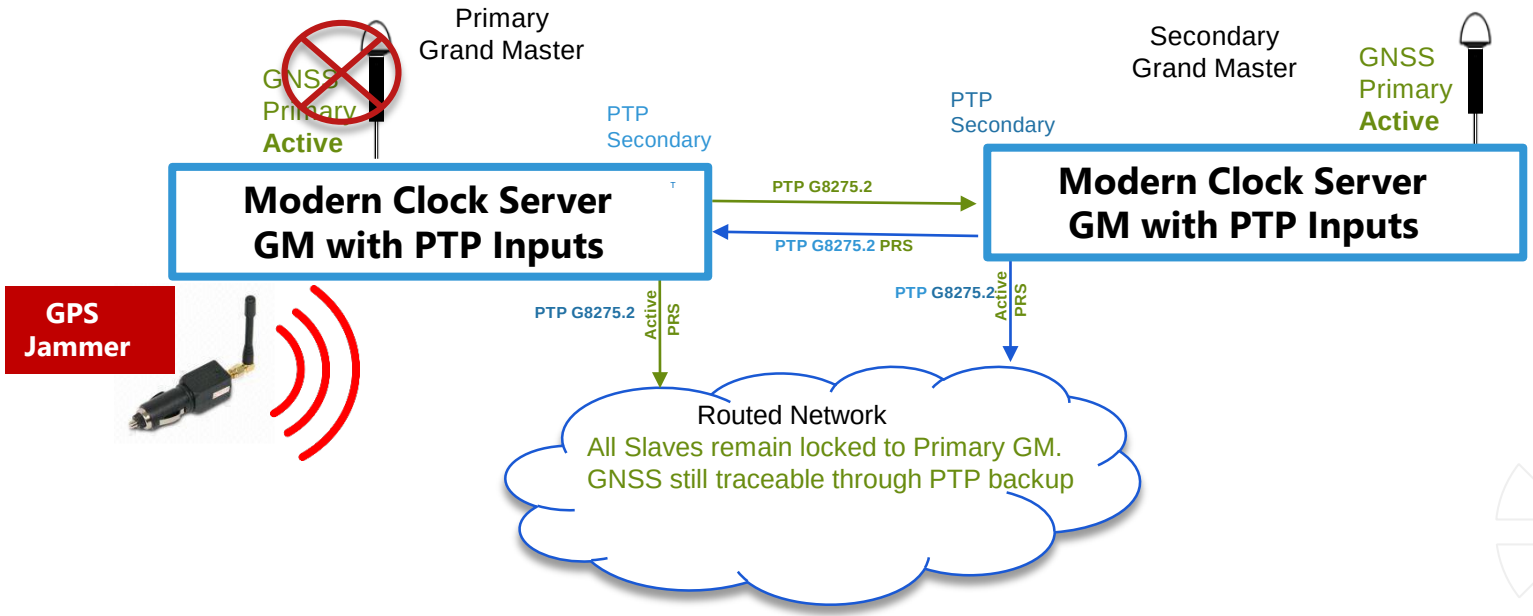


11

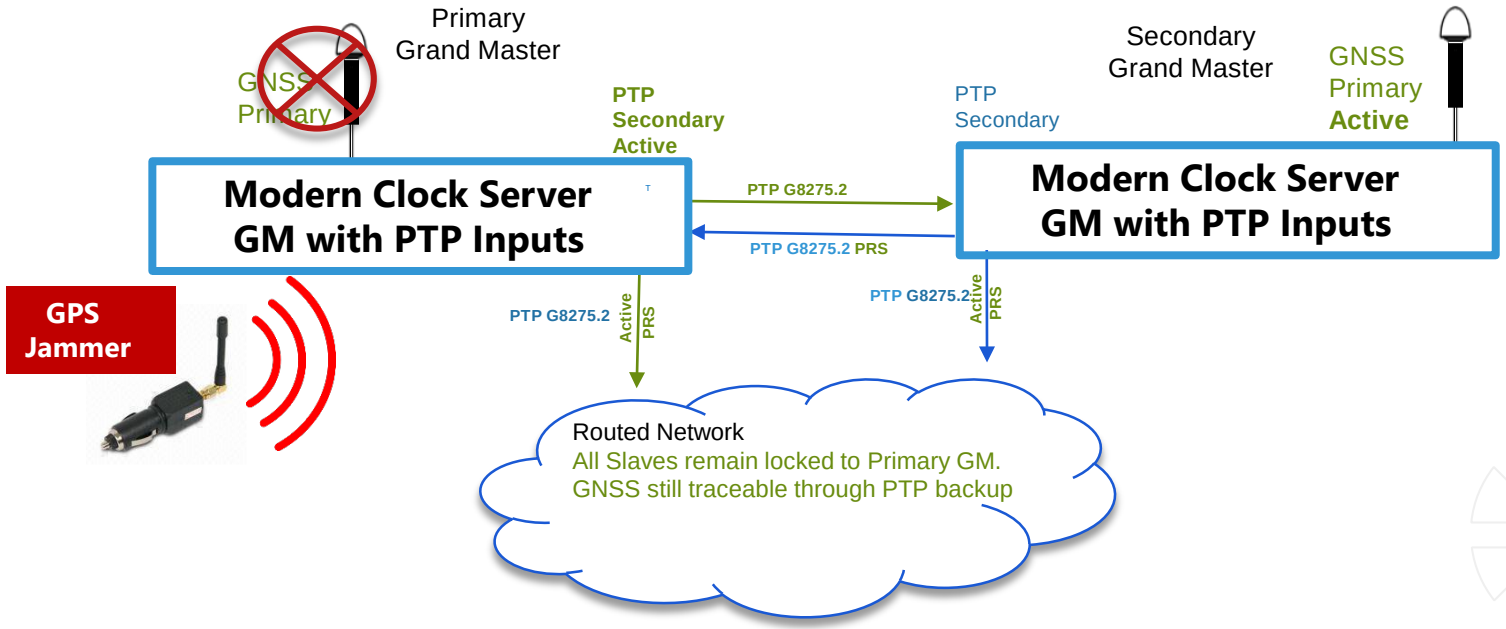
Using PTP for Protection Against local GNSS Jamming



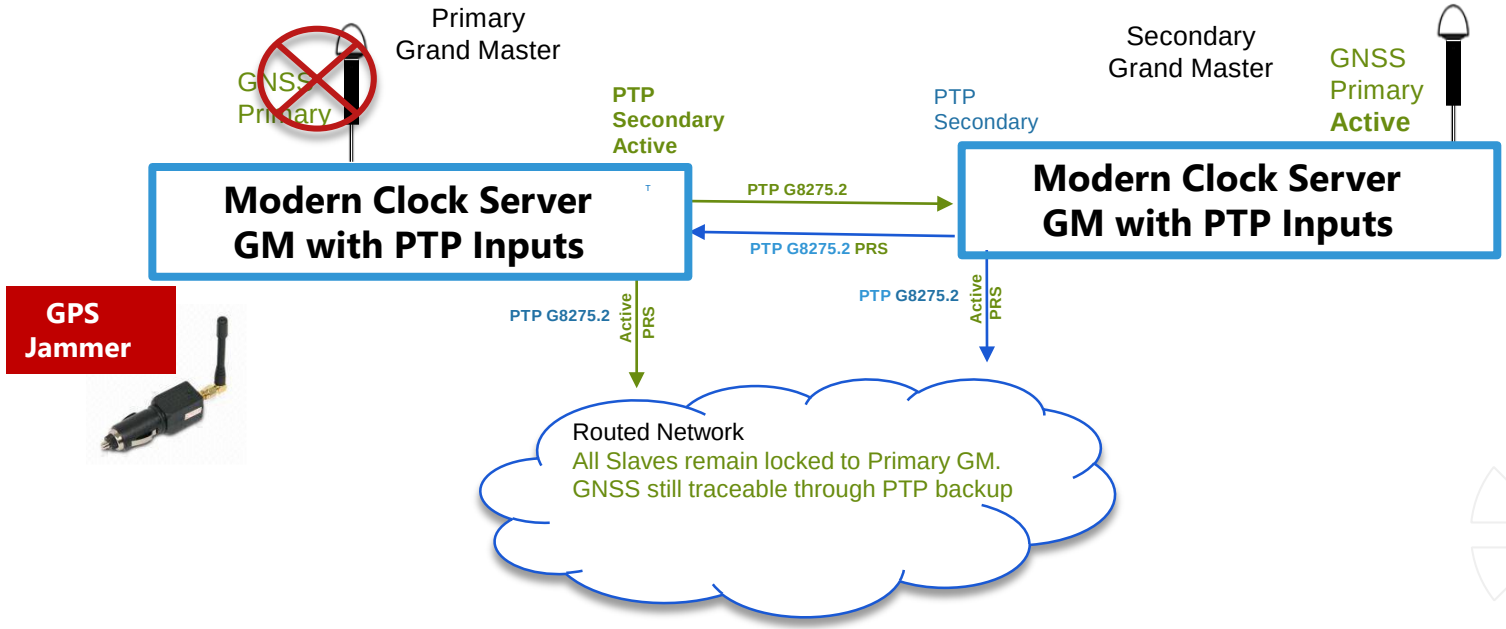
Using PTP for Protection Against local GNSS Jamming



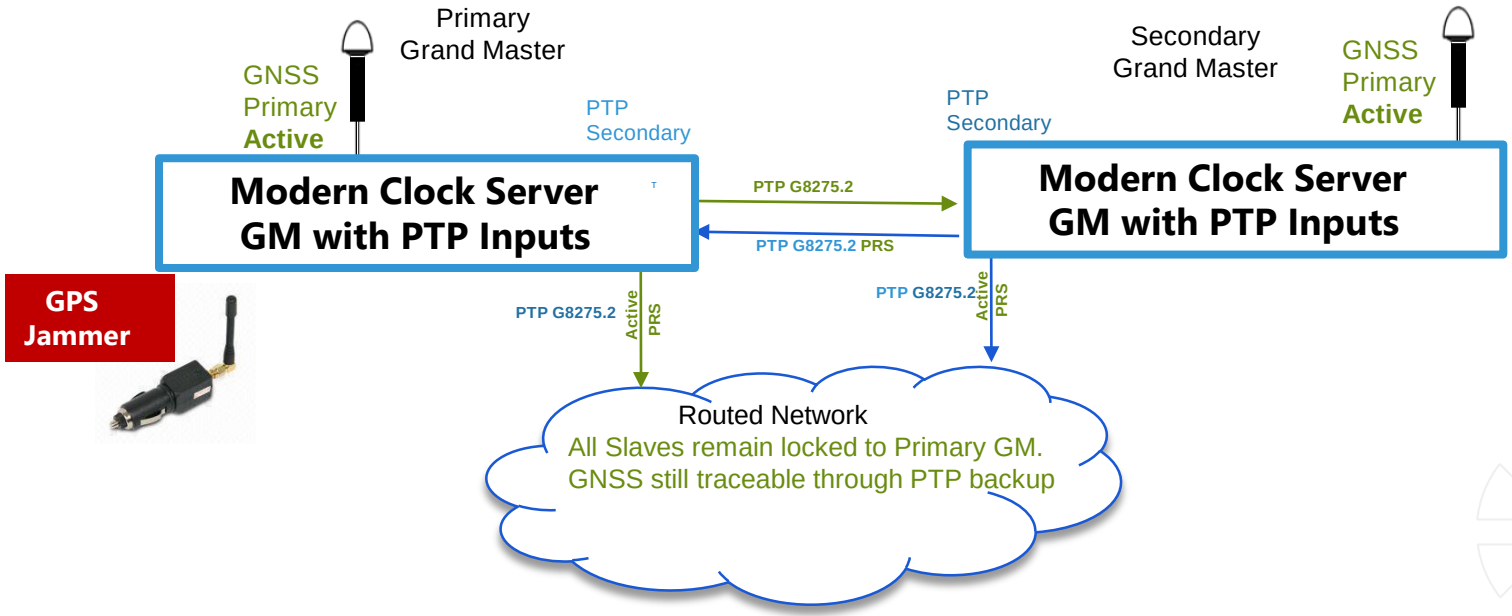
Using PTP for Protection Against local GNSS Jamming



Using PTP for Protection Against local GNSS Jamming

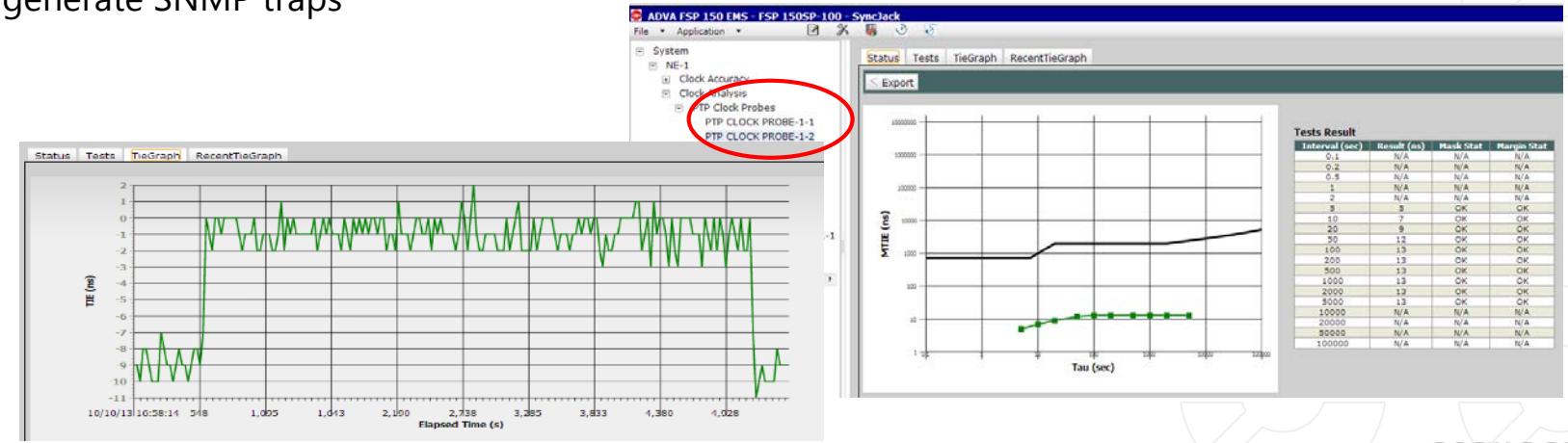


Using PTP for Protection Against local GNSS Jamming



In-Service PTP Clock Probing

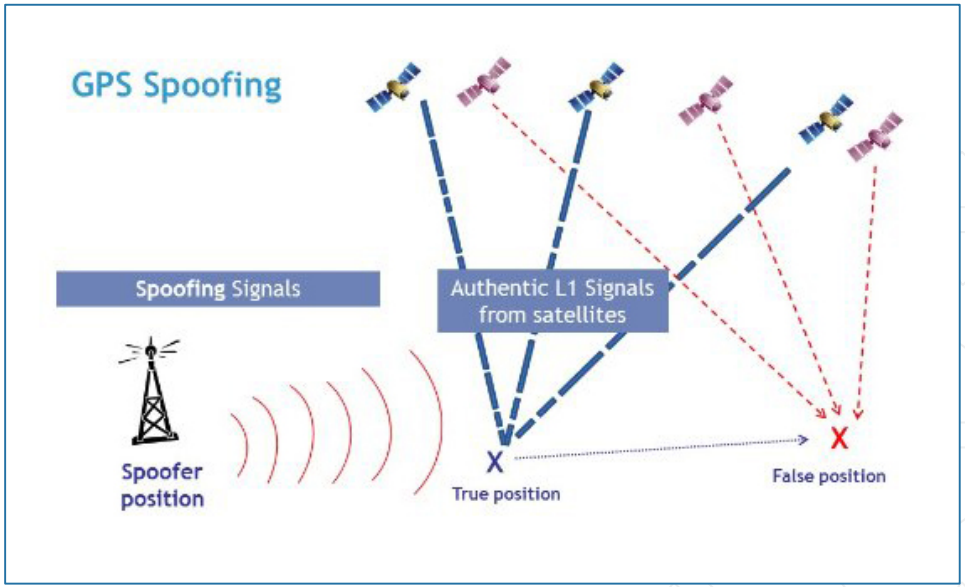
- PTP Clock probes can be used for probing of PTP Packet timing signals for sync-assurance and slave clock recovery validation
- The Clock Analysis is done based on the timestamps embedded in the PTP packets , compared to a reference signal (i.e. GPS)
- Packet TE/TIE/MTIE can computed for multiple in-service probes
- In case of Packets/reference failure or in case MTIE mask crossed, in-service probing can raise alarms and generate SNMP traps



Detecting Clock Drift Caused by Spoofing

Requires Majority Voting and comparison of 3 independent sources minimum. Any 3 of the following:

1) **Cesium**
2) **GPS**
3) **GLONASS**
4) **Galileo**
5) **BEIDOU**

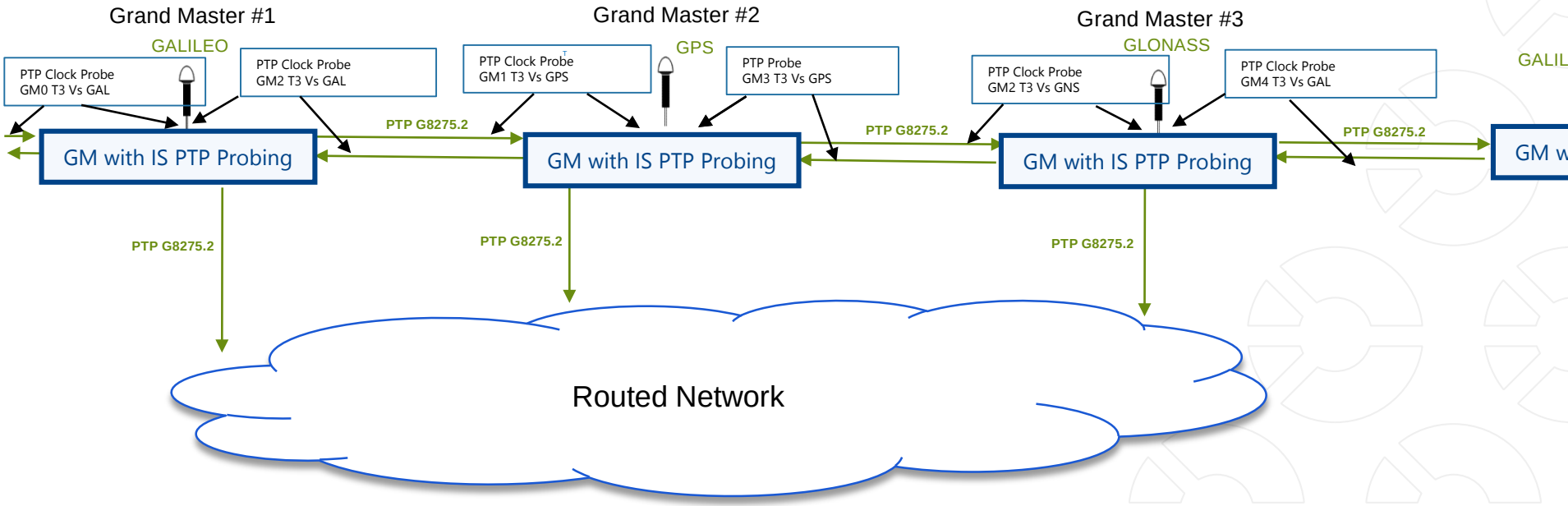


18

Using PTP Probing for Advanced Spoofing Detection

Use PTP Clock Probing and Majority Voting to detect clock drift between Adjacent GMs

Alternate GNSS constellations can be used (GPS, GLONASS, GALILEO or BEIDOU)



NTP/PTP/Sync-E Port Expansion and Faster Interfaces

Time is Money $$$!

Operators are upgrading their networks to be PTP capable in order to deliver accurate phase required for RAN applications (LTE-A/LTE-TDD)

TAAS - Accurate time/frequency delivered via PTP can be a profitable service offering for the Mobility, Financial and other markets

Core routing equipment no longer supports 1G interfaces – 10G clock interfaces are now required from core clocks to minimize PTP hop counts and enable efficient PTP distribution from the core.

Timing as a Service is a new potential source of revenue for many operators $$$

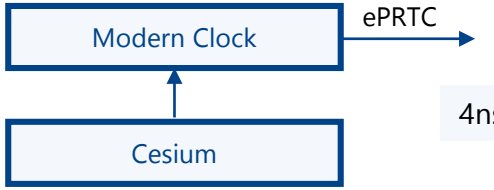
ePRTC: enhanced PRTC (ITU-T G.8272.1)

What is Needed?

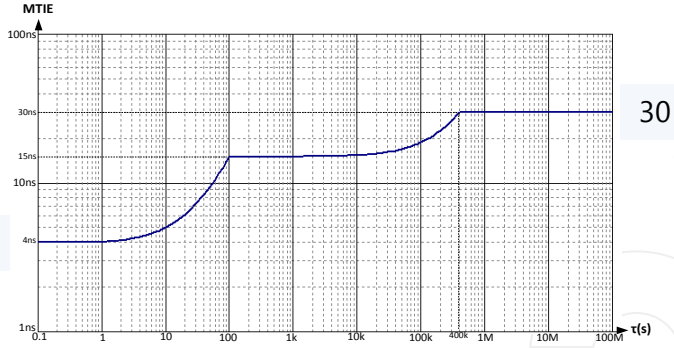
A Modern Clock that can offer "Single Shelf Solution" to combine with Cesium to Achieve ePRTC performance?

Cesium Clock to filter GNSS instabilities:

- atmospheric interference
- solar storms
- Equatorial diurnal Ionospheric variation



4ns



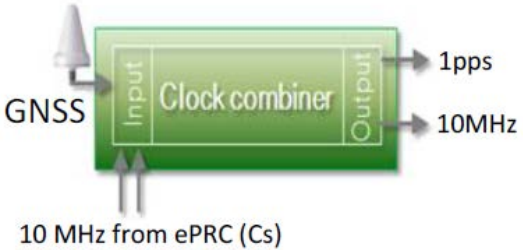
30 ns

→ 30ns MTIE in GNSS locked mode

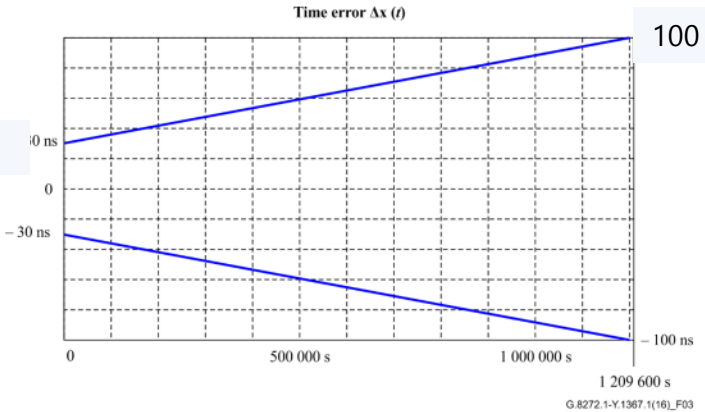
Cesium Clock: Resiliency against GNSS outage

→ 100ns MTIE over 14 days in Holdover mode (Class-A)

→ 100ns MTIE over 80 days in Holdover mode (Class-B)



30 ns



100 ns

OSCILLOQUARTZ
An ADVA Optical Networking Company

Summary – The problems our customers are facing

Traditional SSU/TSG architecture for Mission Critical TDM applications will be required for many more years to come

Operators have been forced to abandon the BITS concept due to the slow evolution of clocks capable of doing everything in a common shelf

Combining all synchronization technologies in a common clock shelf is an important need for operators

The industry is ready for a clock capable of enabling seamless evolution from TDM sync, to the highest precision PTP-based phase synchronization solutions

Maintaining the BITS concept requires new modern core clocks capable of delivering legacy and all latest synchronization technologies for packet networks in a common shelf

Thank you

Chuck Perry

cperry@oscilloquartz.com