OSCILLOQUARTZ
A division of Adtran

75 YEARS
TIMING EXCELLENCE

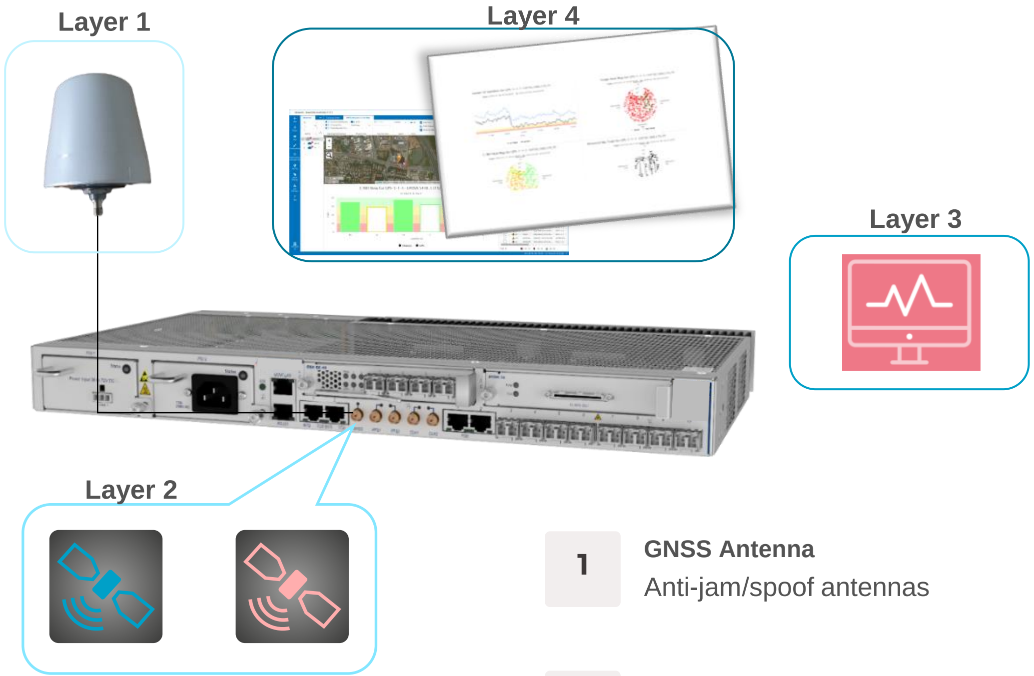
Pushing the boundaries of holdover performance.

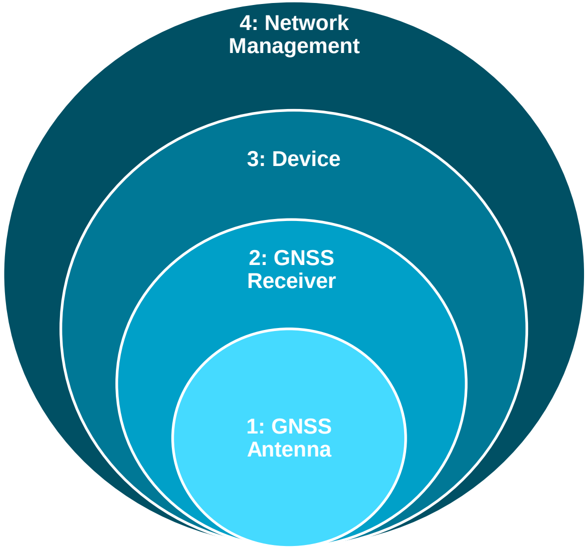
Ensuring robust, precise timing in increasingly complex environments.

Dr. Alon Stern, Senior Manager of Technology, Oscilloquartz

WSTS 2025

Multilayer threat detection





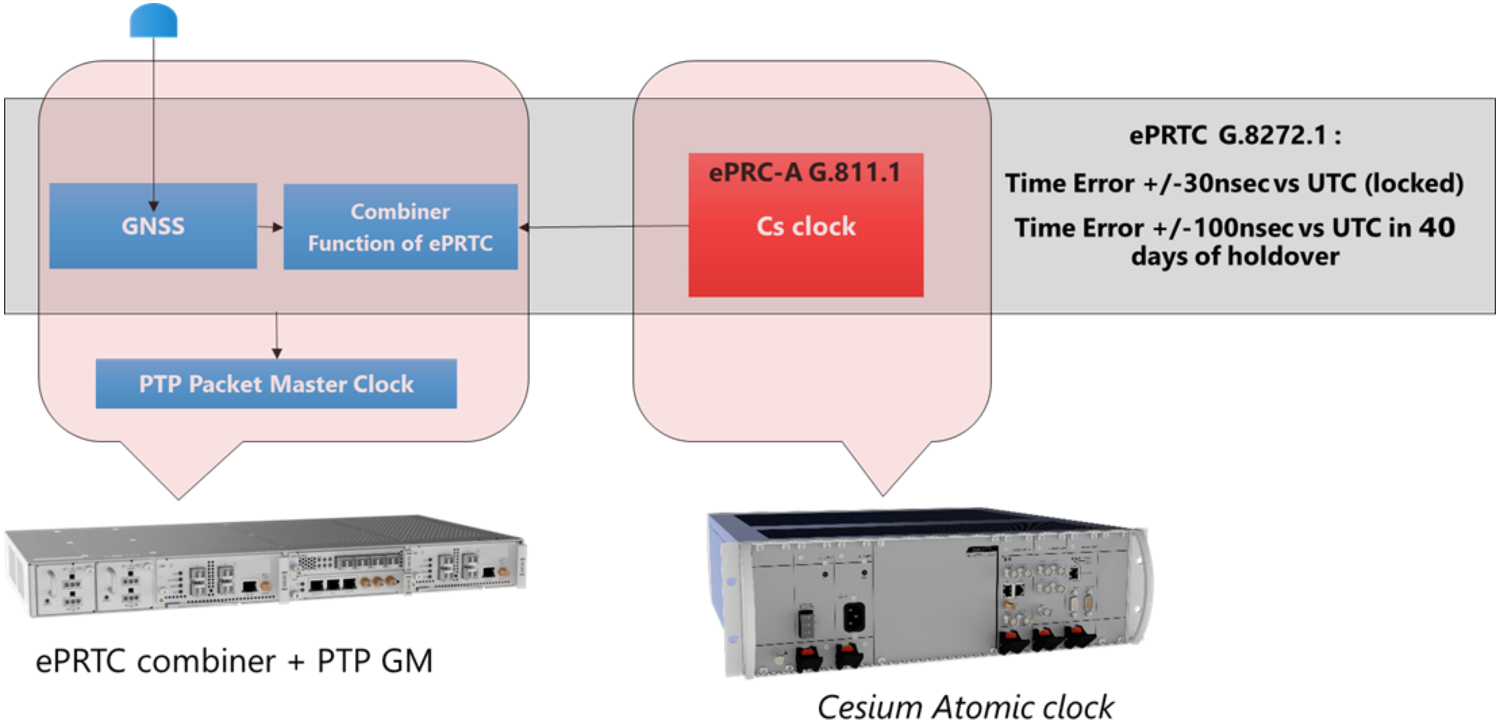
1 **GNSS Antenna**
Anti-jam/spoof antennas

2 **GNSS Receiver**
Multi-constellation / multi-band receivers with jam/spoof detection

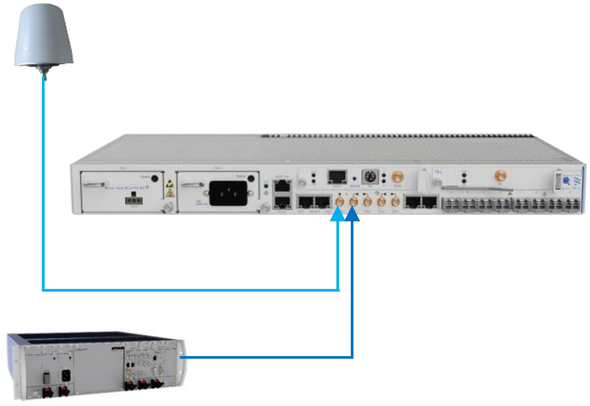
3 **Device Level**
Continuous monitoring to mitigate spoofed GNSS vs PTP signals

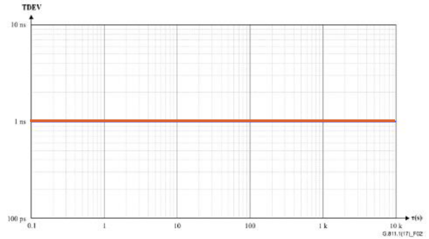
4 **Network Management**
Monitor all network clocks (GNSS/PTP/ etc.)

Solution: Mitigation using ePRTC implementation

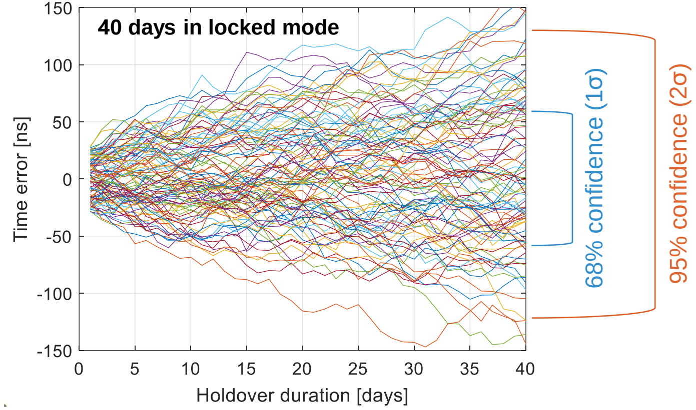


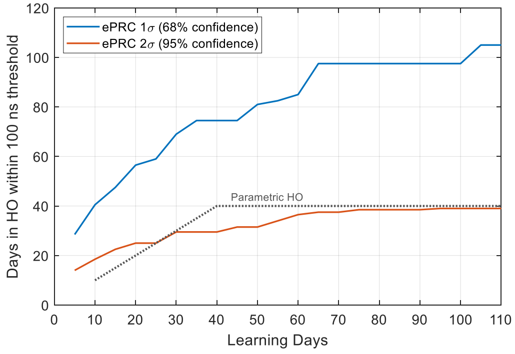
ePRTC holdover performance is starting from the ePRC's stability





ePRC's TDEV as a function of an observation (integration) period τ (source: G.811.1)





Enhancing ePRTC resiliency with advanced holdover solutions

Super high-performance Cesium clock

- Ultra-stable, long-term frequency stability
- Minimize time error over extended GNSS outages

Multiple Cesium clocks

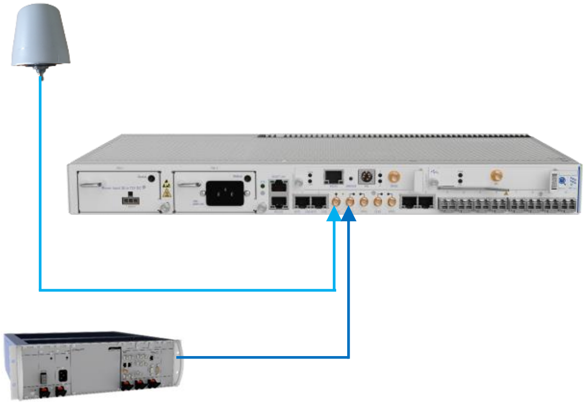
- Redundant reference clocks
- Improved stability for enhanced holdover performance

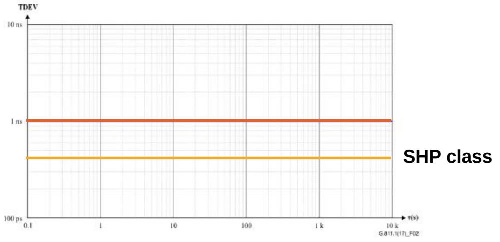
Immediate holdover capability during intermittent GNSS disruptions

GNSS & LEO

- Resistant to GNSS jamming/spoofing
- Additional layer for holdover when both fail

Exceeding holdover standard limits
100nsec holdover over 100 days with super high-performance Cesium clock





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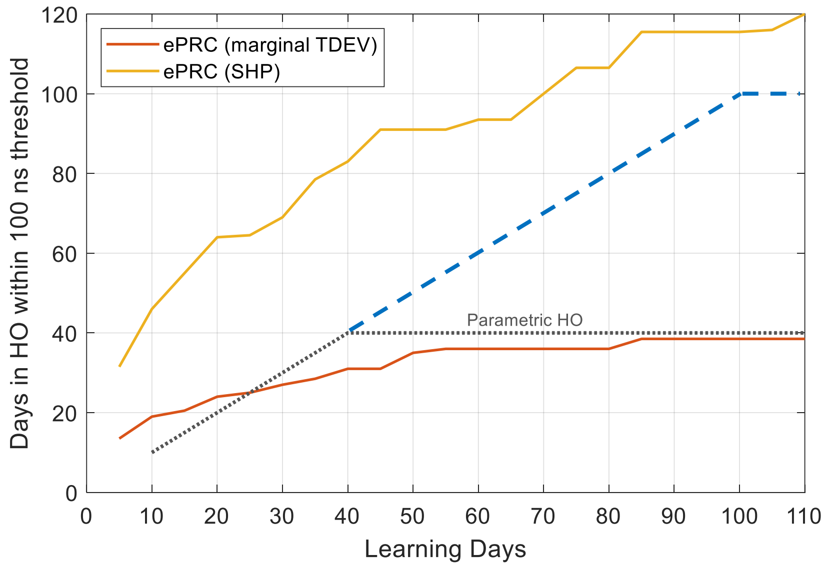

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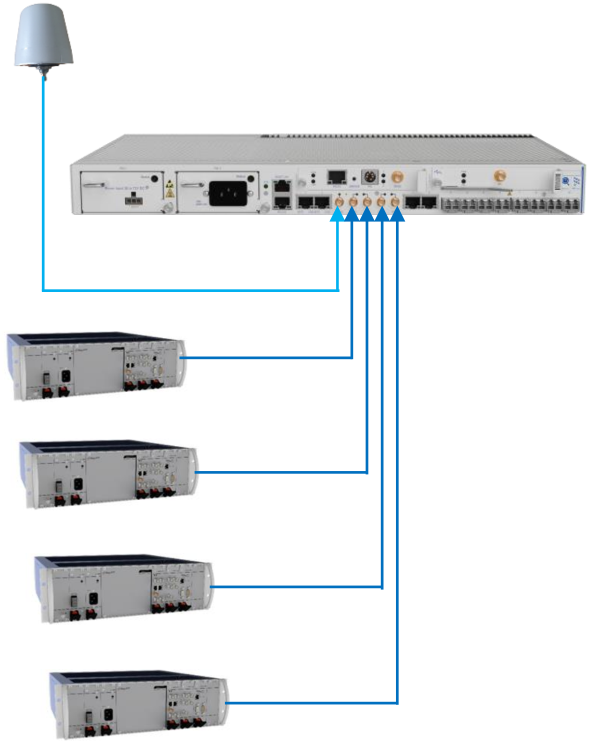
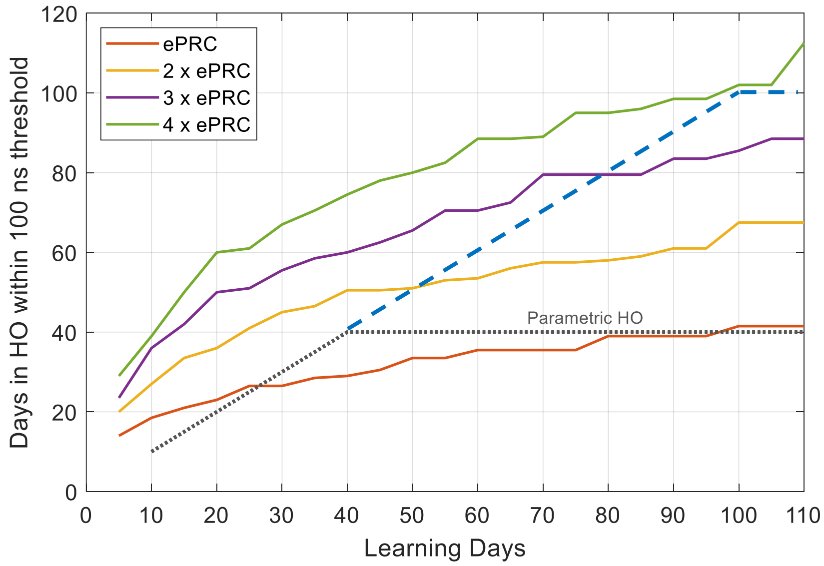
Two clocks are better than one

Exceeding holdover standard limits with multiple Cesium clocks



Multiple Cesium clocks

- Redundant reference clocks
- Improved stability for enhanced holdover performance



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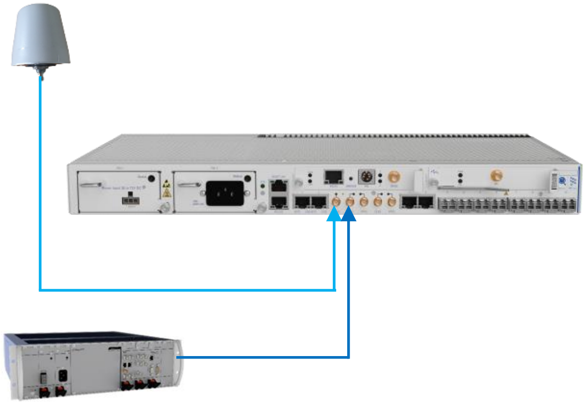
Unstable GNSS – intermittent outages still provide strong holdover readiness



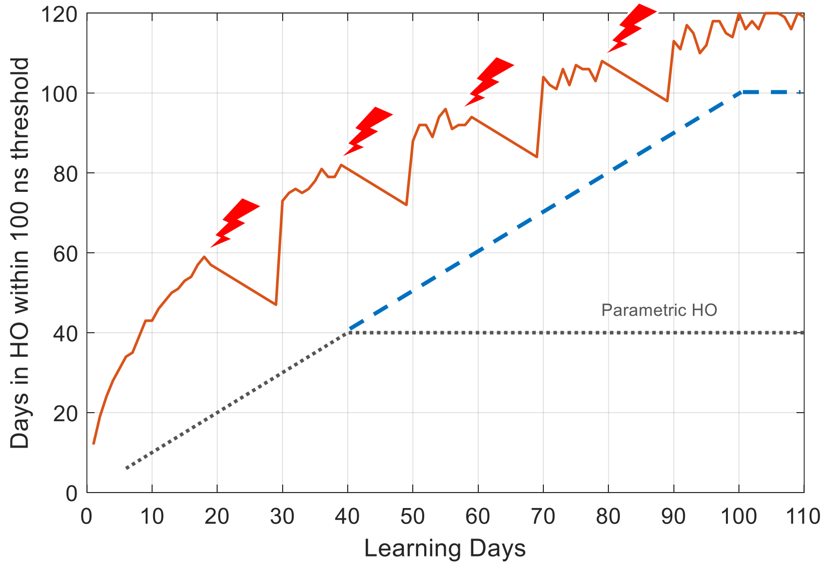
8.2.1 Time error in holdover mode

For the ePRTC-A, the holdover requirements for time error are as follows:

– From the start of phase/time holdover, after a period of continuous normal (locked mode) operation of *L* days, the time output of the ePRTC should be accurate, when verified against the applicable primary time standard (e.g., UTC), to within a value increasing linearly from 30 ns to 100 ns over a holdover period of *H* days, as defined in Table 3. These are the three cases from Table 3:

(source: G.8272.1)

Immediate holdover capability during intermittent GNSS disruptions



General Business

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Enhancing ePRTC resiliency with advanced holdover solutions

Super high-performance Cesium clock

- ➢ Ultra-stable, long-term frequency stability
- ➢ Minimize time error over extended GNSS outages

Multiple Cesium clocks

- ➢ Redundant reference clocks
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Immediate holdover capability during intermittent GNSS disruptions

GNSS & LEO

- ➢ Resistant to GNSS jamming/spoofing
- ➢ Additional layer for holdover when both fail

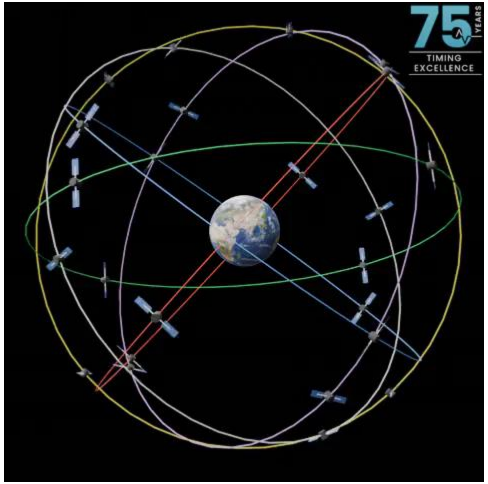
LEO provides additional layer of resiliency as an independent time distribution system

Image: Spirent Federal

Trusting the output of a GNSS receiver without question is no longer acceptable in safety- or liability-critical applications

GPS

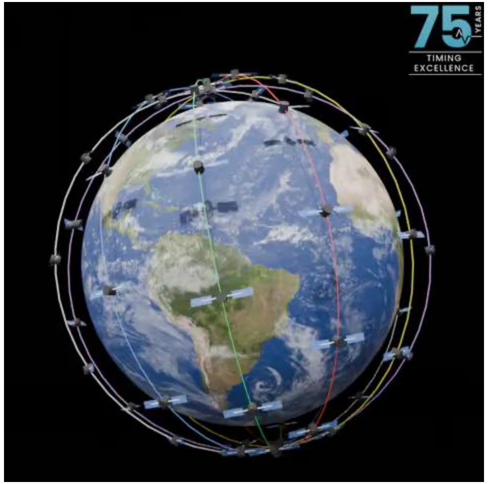
24+ satellites in 6 orbital planes.
Orbiting at 20,200 km altitude



STL IRIDIUM

66+ satellites in 6 polar orbits.
Orbiting at 780 km altitude

26x closer



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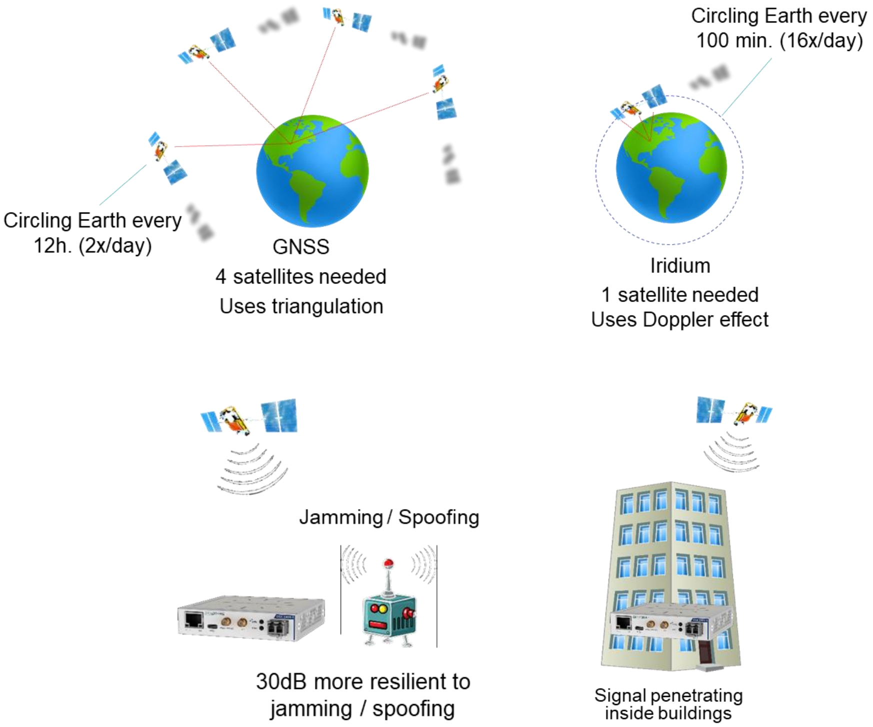
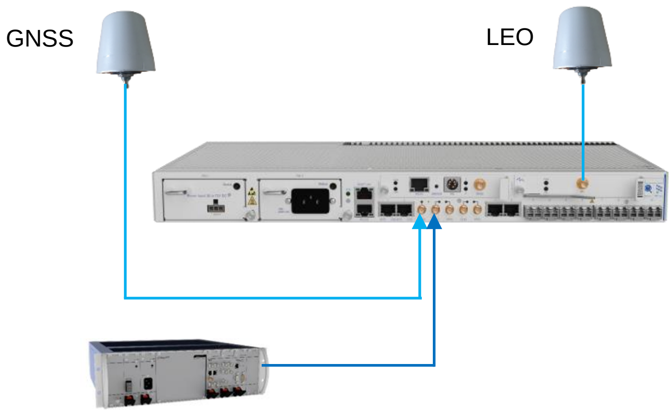
LEO provides additional layer of resiliency as an independent time distribution system

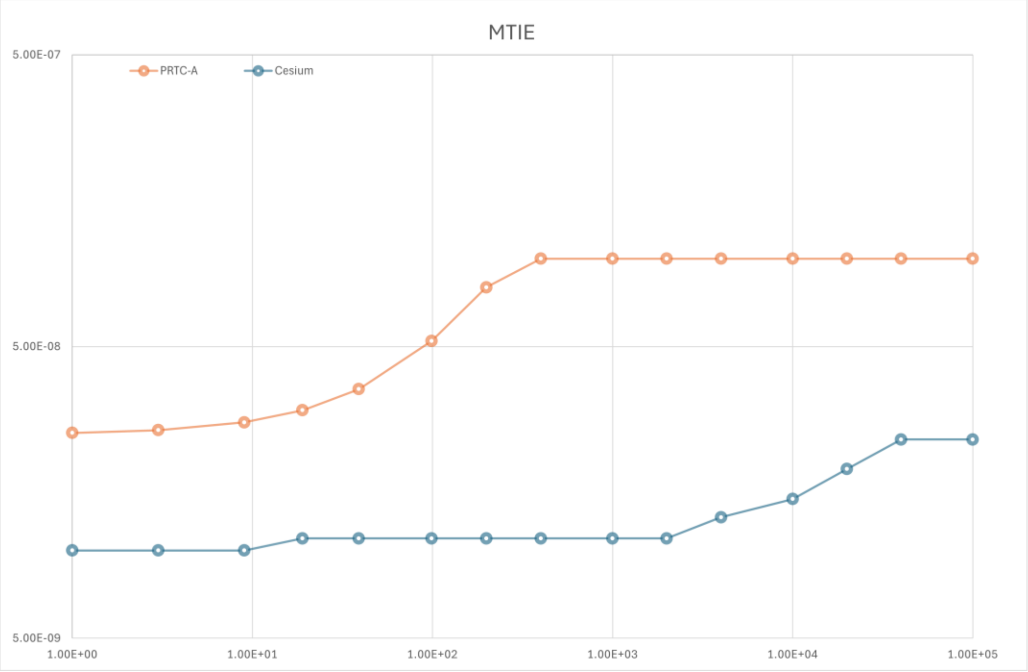
LEO's lower orbit results in higher relative velocity, allowing receivers to extract positioning and timing data from a single satellite, unlike GNSS which requires four

LEO's low-earth orbit places it 26x closer to Earth, making its signal approximately 30dB (or 1,000x) stronger than GNSS



Enhanced ePRTC resiliency with LEO: complementary, independent time distribution for GNSS





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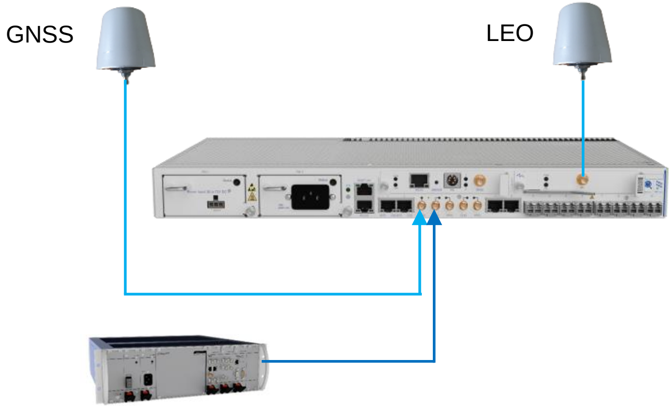
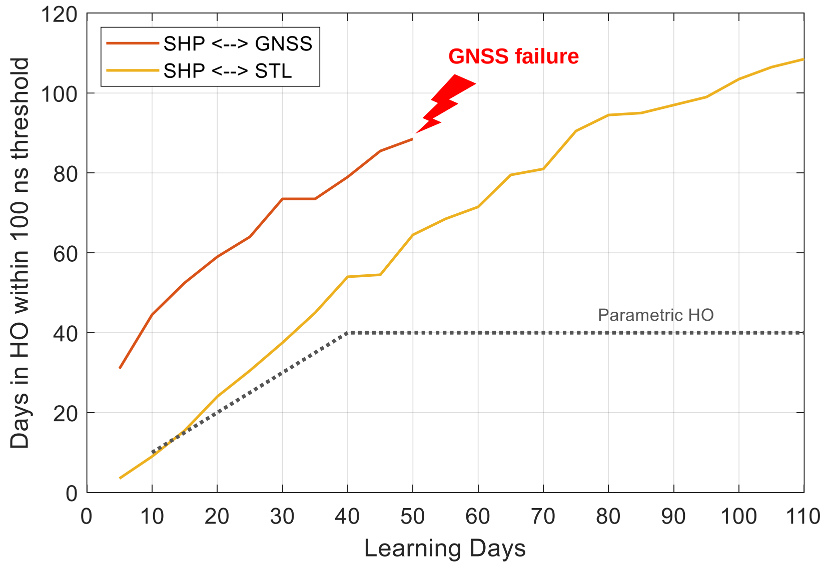
Enhanced ePRTC resiliency with LEO: provides additional layer for holdover when both fail





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Summary

- GNSS provides 100nsec high time accuracy, but faces significant vulnerabilities
- ePRTC (G.8272.1) maintains timing for up to 40 days during GNSS outages (based on learning period)
- Resiliency during long outages can be improved with:
  - Super-high performance Cesium clock – ultra-stable long-term frequency stability
  - Multiple Cesium clocks – for redundancy and enhanced stability
  - Normal timing performance during intermittent GNSS outages
  - LEO – complementary, independent time source

Thank you

Please contact me in case you have any comments or questions : alon.stern@adtran.com

oscilloquartz.com