· TIMING SUBCOMMITTEE ·
CAPITOL BALLROOM 567

Chair: Dr. Patricia Larkoski, Lead Sensor Engineer, The MITRE Corporation;
Deputy Chair: Dr. Bijunath Patla, National Institute of Standards and Technology (NIST)

> ▶ Watch livestream
> on zoomgov.com ➡

2:00 p.m. MDT	**Welcome Remarks / Introduction** *Dr. Patricia Larkoski, Chair; Dr. Bijunath Patla, Deputy Chair*
2:10	**USNO Report to the CGSIC Timing Subcommittee** *Dr. James Hanssen, Precise Time Department, US Naval Observatory (Virtual)*
2:30	**Time and Frequency Activities at the JHU Applied Physics Laboratory** *Mr. Stephen Mitchell, Johns Hopkins University, Applied Physics Laboratory*
2:50	**A Layered Approach to Resilient PNT** *Mr. David Sohn, Orolia*
3:10	**A Cybersecurity Perspective to Addressing PNT Vulnerabilities** *Mr. Ernest Wong, Technical Manager, Science & Technology Directorate, U.S. Department of Homeland Security*
3:30	**Break**
3:40	**Report from NIST** *Dr. Bijunath Patla, National Institute of Science and Technology (NIST)*
4:00	**Clock and Timing Data Analysis for GNSS Products and Applications** *Dr. Michael Coleman, Naval Research Laboratory (NRL)*
4:20	**Industry Trends for Resilient Timing of Critical Infrastructure** *Greg Wolff, Senior Product Line Manager, Frequency & Time Systems, Microchip*
4:40	**Will We Have a Negative Leap Second?** *Dr. Demetrios Matsakis, Masterclock, Inc.*
5:00	**Questions and Discussion**
5:30	**Adjourn**

Summary

USNO specializes in real-time timekeeping

- UTC(USNO) is the official source of time for the DOD

- USNO continues to improve the master clock to support emerging timing requirements

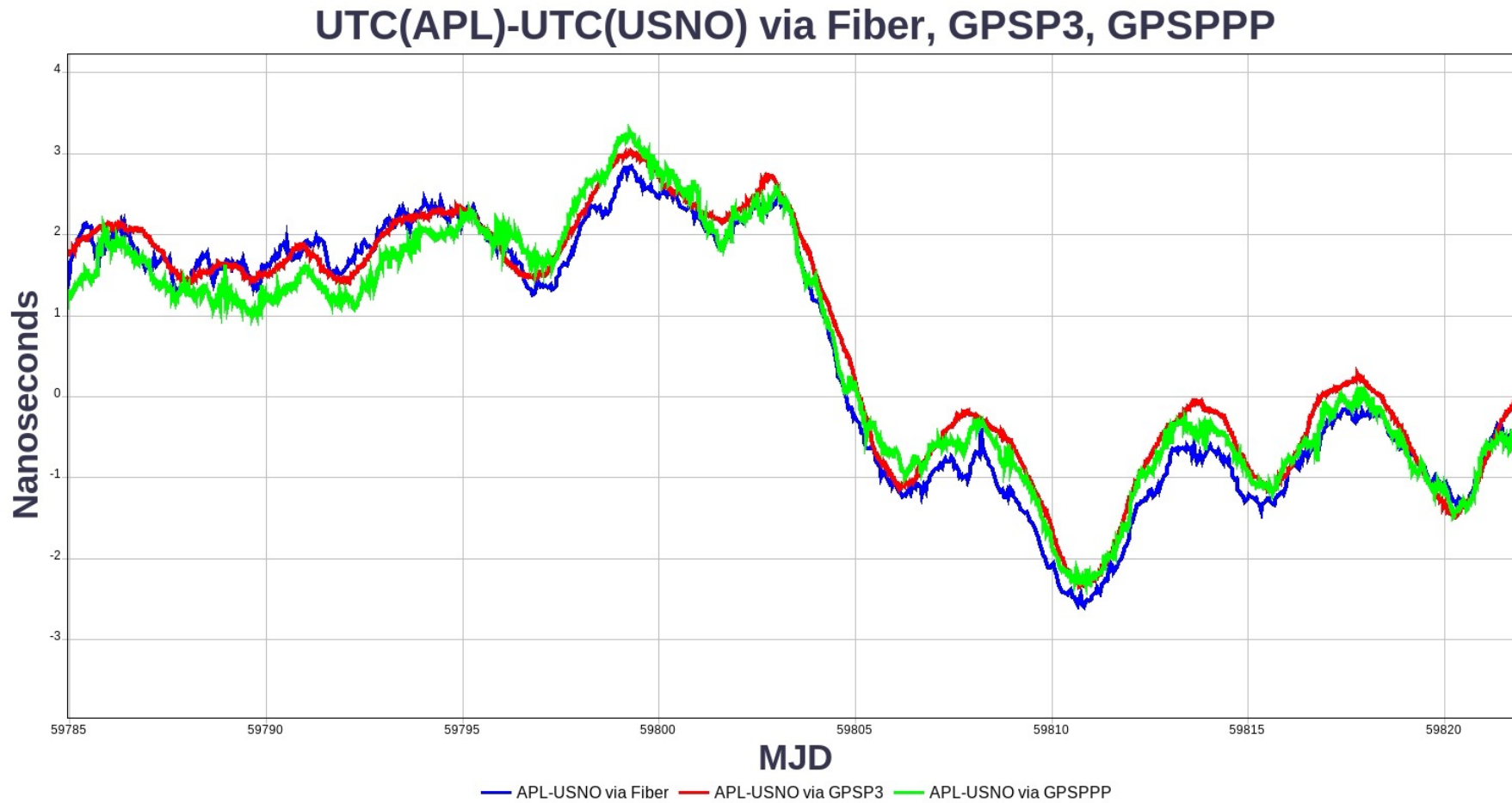- UTC(USNO) is disseminated to users via many methods, including GPS

USNO provides the timing reference for GPS

- Monitor and report the offset of GPS Time from UTC(USNO)

- Ensure the validity of reported numbers through receiver calibrations

USNO monitors other GNSS Time

- Will report GGTO data to GPS with OCX

Fiber Time Transfer with USNO

UTC(APL)-UTC(USNO) via Fiber, GPSP3, GPSPPP

— APL-USNO via Fiber — APL-USNO via GPSP3 — APL-USNO via GPSPPP
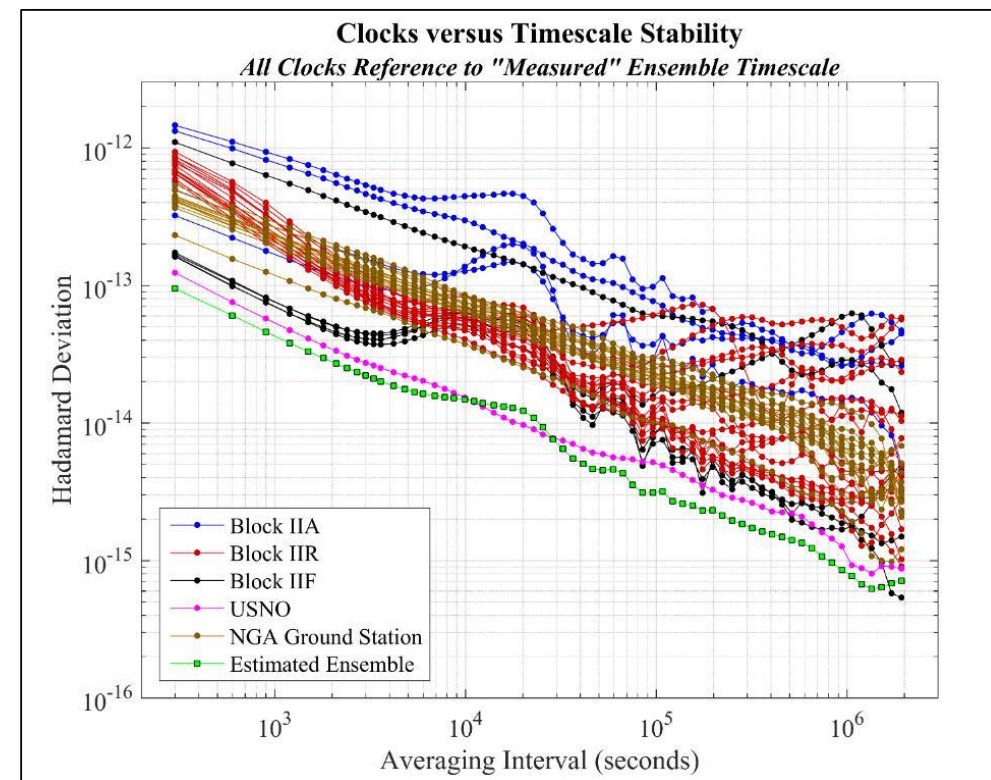
New GPS Timescale

Scope: Generate an ensemble reference time that: estimates phase, frequency and drift of member clocks, is not solely dependent on one clock as master, and is capable to steering to any identified source."

Completion Milestones

- Installation to OCX enterprise mostly complete as of 2020.

- First stage of testing has passed requirements.

- Several rounds of testing remain to exercise other capabilities.

Capabilities

- Multi-weighting (one set of clock weights for each noise process) yields a more stable ensemble over a wider range of averaging intervals.

- Autonomous break detection allows self correction of clock states for several types of clock anomalies.

- Independent measurement weight reduces impact of outliers or excessive noise on measurements.
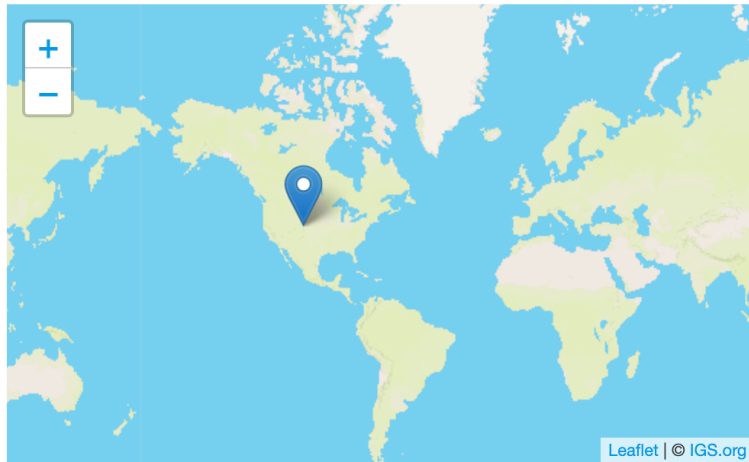
- Linear Quadratic Gaussian steering control parameters

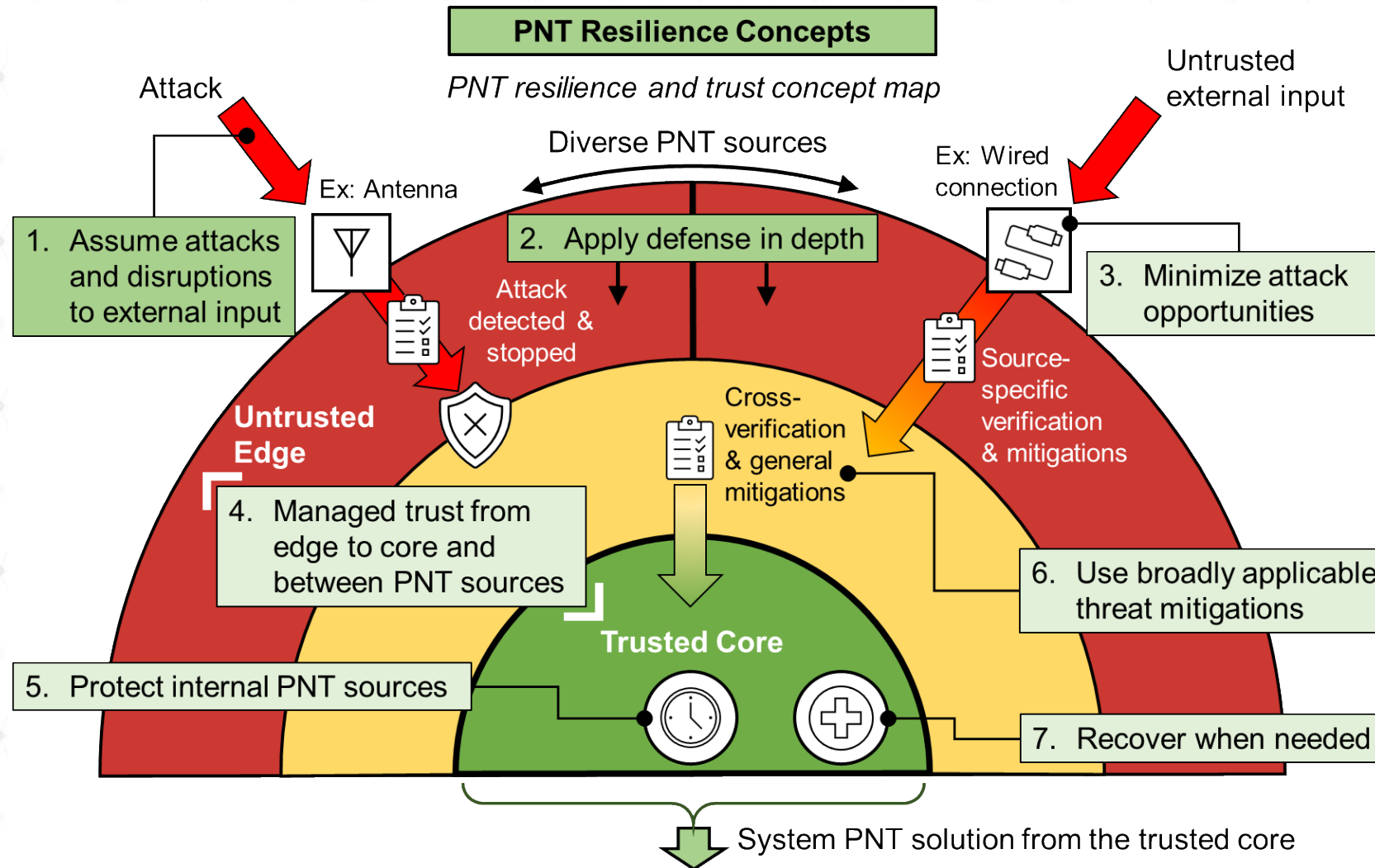# June 2022: NIST primary receiver and antenna upgrades

➢ June 15, 2022: Results of CAL_ID 1001-2020 implemented
➢ Internal delays 28.2 ns and 26.3 ns for GPS P1 and P2
➢ Ref. delay: 93.0 ns
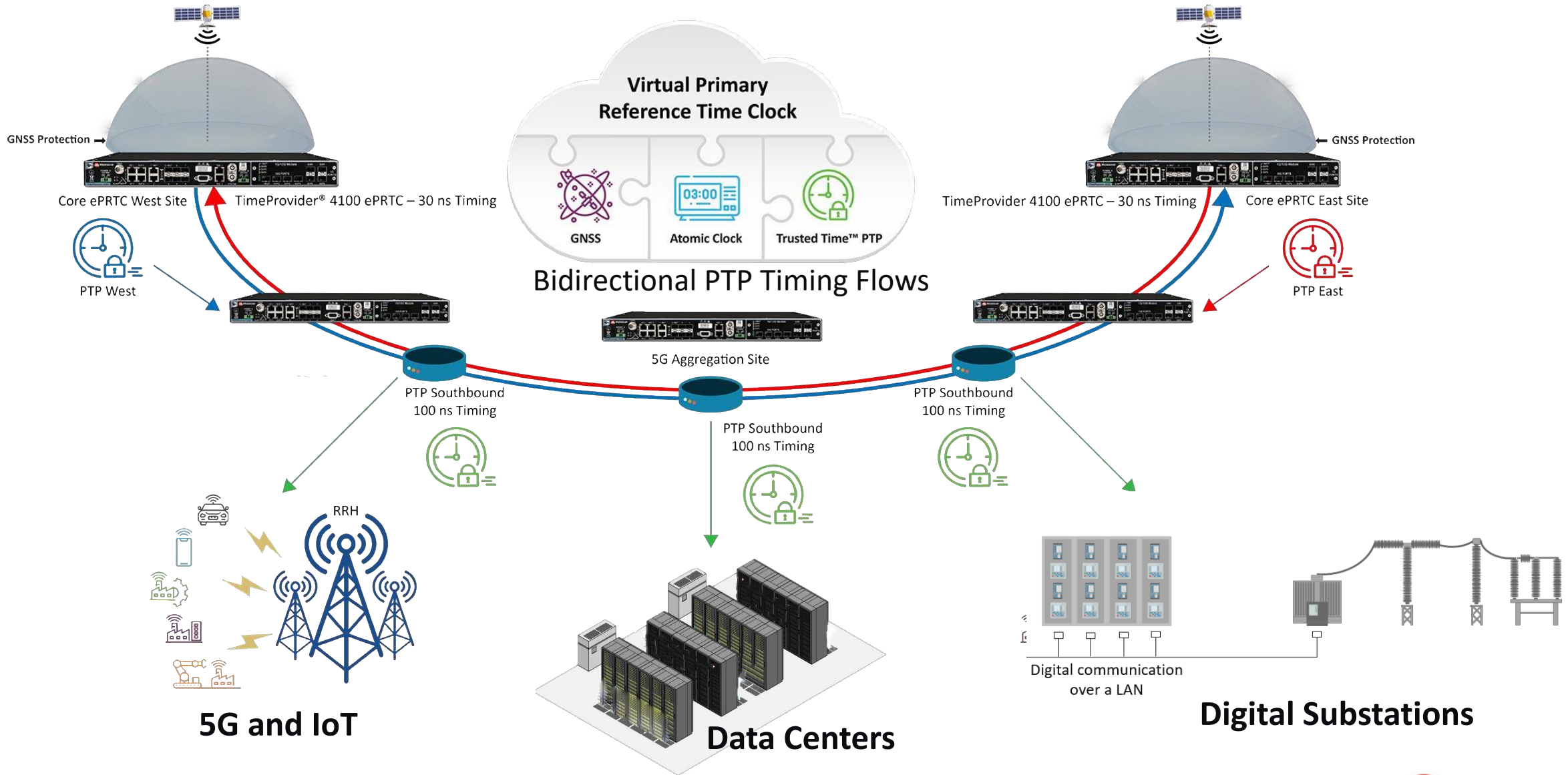
LAYERED APPROACH

- Layered solutions exist to retrofit existing systems

- Look for modular capabilities to scale based on risk and requirements

- Upgradeability is important (gradual investment in Resiliency possible)

- Evolving with new threats and new technologies

- Protecting past investments

Orolia Resilient Timing

Layers of Protection

External References
Antennas
In-Line Protections
Interference Detection
Internal PNT References
Internal Quality Detection
Cybersecurity
Simulation & Analysis
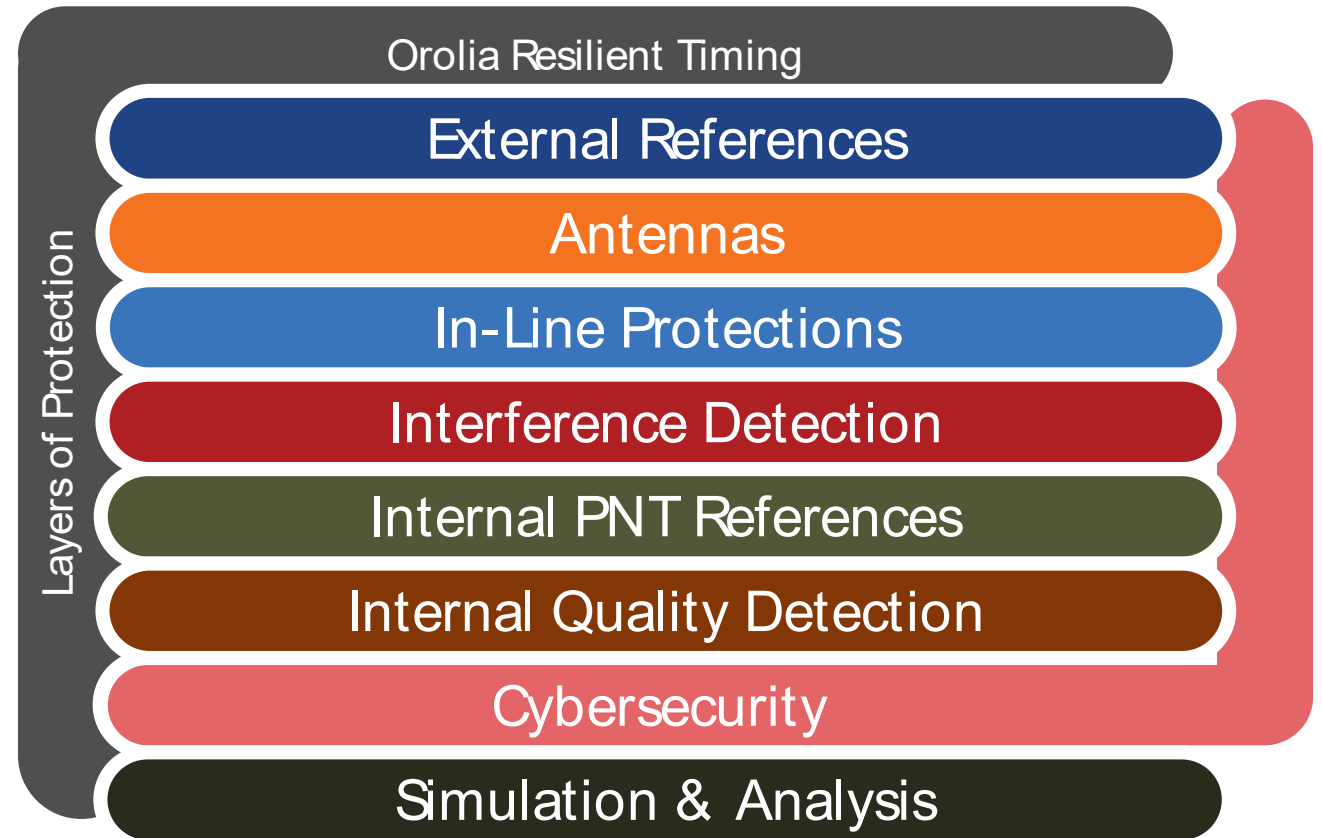
Applying Zero Trust Concepts to PNT

PNT Resilience Concepts

PNT resilience and trust concept map

Attack

Untrusted external input

Diverse PNT sources

Ex: Antenna

Ex: Wired connection

1. Assume attacks and disruptions to external input

2. Apply defense in depth

3. Minimize attack opportunities

Attack detected & stopped

Source-specific verification & mitigations

Untrusted Edge

Cross-verification & general mitigations

4. Managed trust from edge to core and between PNT sources

Trusted Core

6. Use broadly applicable threat mitigations

5. Protect internal PNT sources

7. Recover when needed

System PNT solution from the trusted core
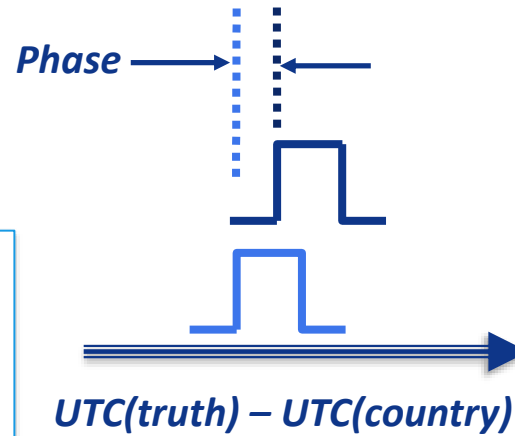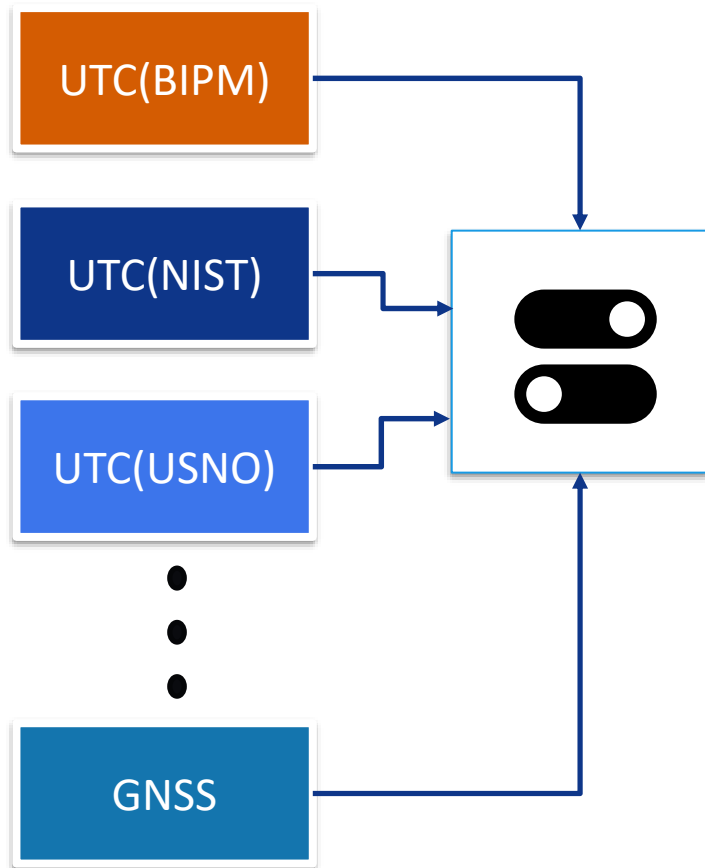
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Science and Technology

vPRTC for Resilient Timing

Time Scale Systems
National Timing Source for Critical Infrastructure

Truth Sources

UTC(BIPM)

UTC(NIST)

UTC(USNO)

GNSS

Phase

UTC(truth) – UTC(country)

UTC (country)
Traceable to truth source

Virtual Primary Reference Time Clock

GNSS   Atomic Clock   Trusted Time

Transportation

Power Utility

5G and IoT

Data Centers
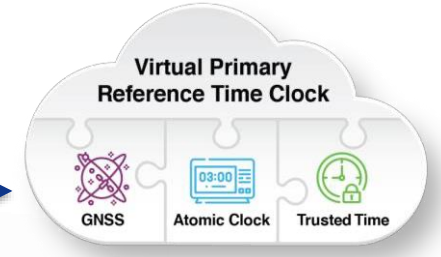
Local Time Scale (within country)

Microchip
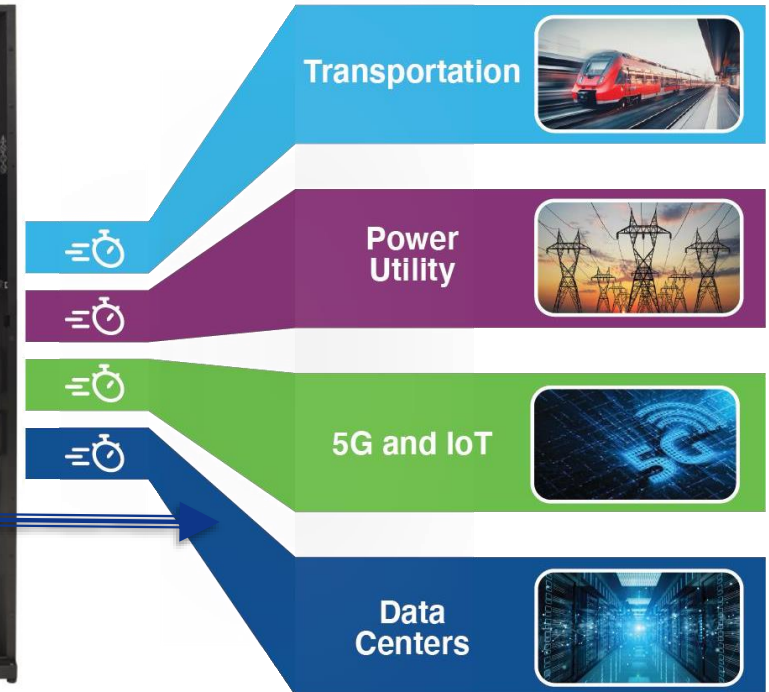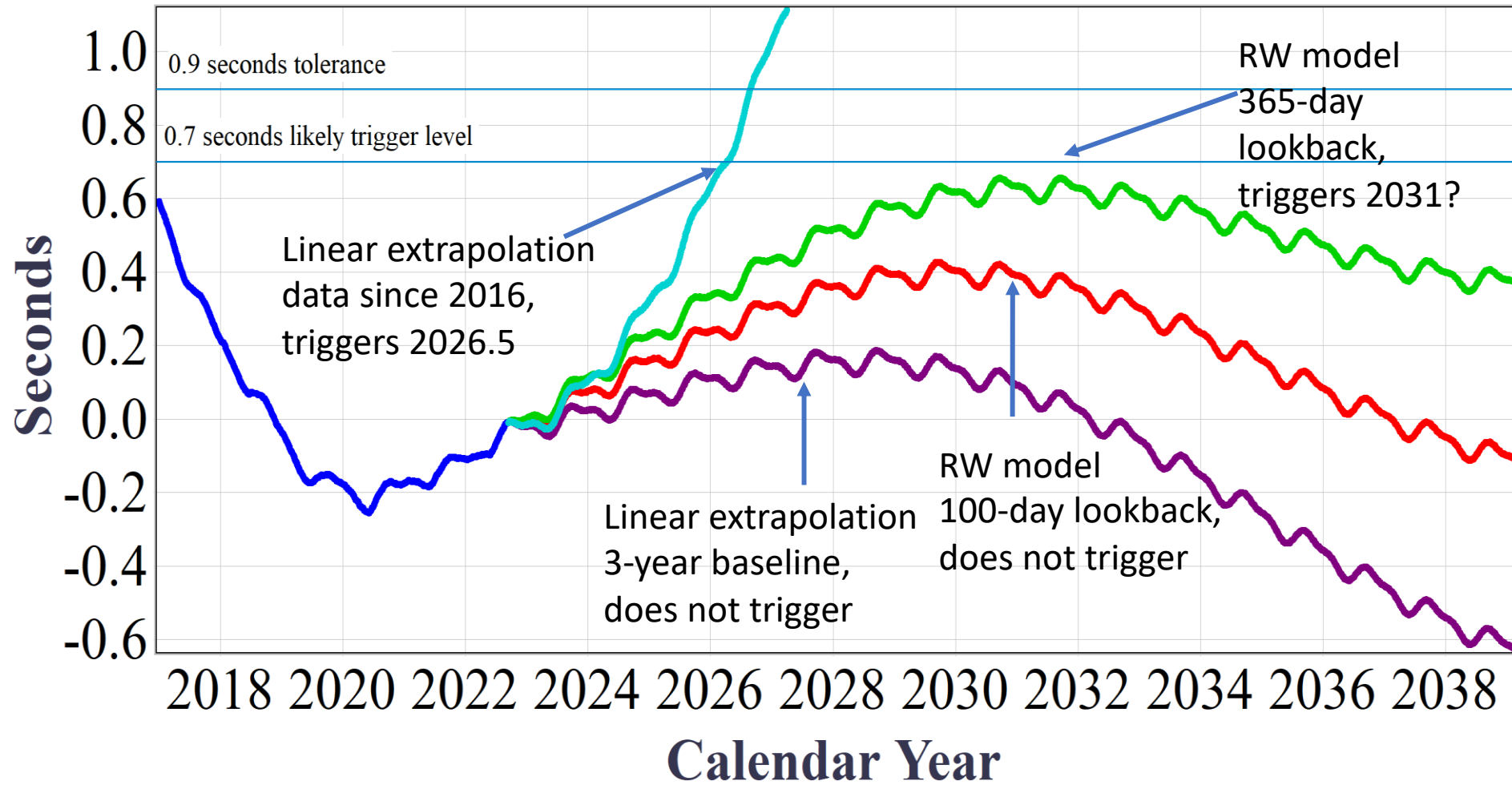
The largest source of error lies beneath our feet

Discussion topic

Would users benefit from a real-time GPS navigation message made available on a secure website?

Any strong objections?

Suggestions? Use cases?