

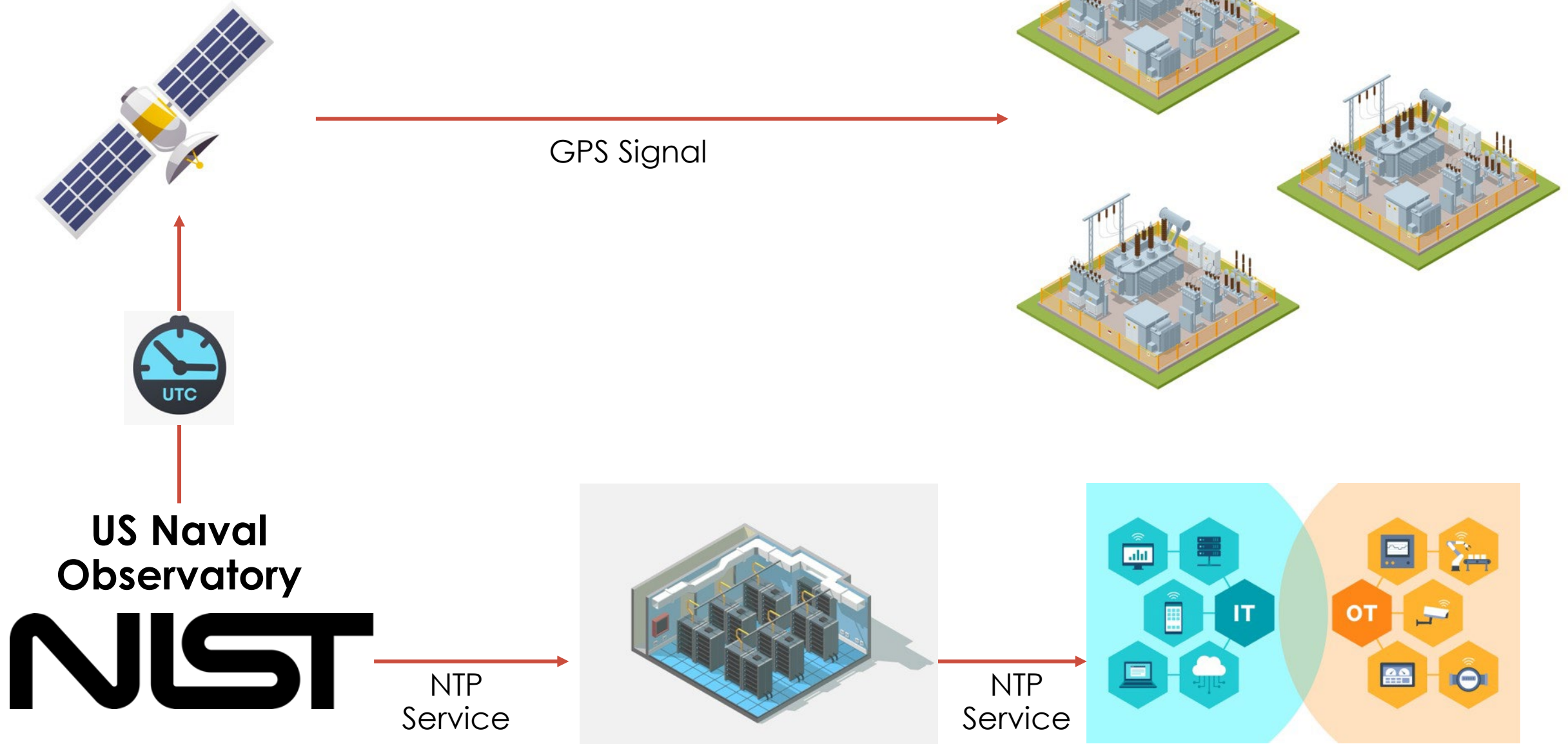
Novel Grid-Specific Approaches to Synchronization and Time Distribution

Carter Christopher, PhD
Center for Alternative Synchronization and Timing
Oak Ridge National Laboratory

Sponsored by the US Department of Energy,
Office of Electricity



Basic Concept - Today



Risk and Vulnerabilities

SPACE NEWS
BUSINESS | POLITICS | PERSPECTIVE

News AI Civil Commercial Launch Military Opinion Policy & Politics

Military

The race to ba

The Space Force wants to harness c

Sandra Erwin February 20, 2024

📧 📱 📺 📄 📧 📄

WIRED SECURITY POLITICS GEAR BACKCHANNEL BUSINESS SCIENCE CULTURE IDEAS MERCH

SIGN IN SUBSCRIBE

BY MATT BURGESS SECURITY APR 30, 2024 1:16 PM

The Dangerous Rise of GPS Attacks

Thousands of planes and ships are facing GPS jamming and spoofing. Experts warn these attacks could potentially impact critical , and more.

SUPPORT REFERENCE LIBRARY DOCUMENTATION SUPPORT NTP DONATE TODAY!

Search...

Report / Security

Security

<h3>Notification Policy</h3> <p>When we discover a security vulnerability in NTP we follow our Phased Vulnerability Process which includes first notifying Institutional members of the NTP Consortium at Network Time Foundation, then CERT, and finally making a public announcement.</p> <p>Institutional Members receive advanced notification of security vulnerabilities.</p>	<h3>Security Patch Policy</h3> <p>When security patches are ready, they are first given to Premier and Partner Institutional members of the NTP Consortium at Network Time Foundation, then access instructions are provided to CERT, and finally the public release is made on the embargo date.</p> <p>Premier and Partner Members receive early access to security patches.</p>	<h3>Reporting Security Issues</h3> <p>If you find a security vulnerability in the NTP codebase, please report it by PGP-encrypted email to the NTF Security Officer Team. You can use our NTF Security Officer PGP Key. Please refrain from discussing potential security issues in any mailing lists or public forums.</p> <p>NOTE: Non-code vulnerabilities (such as a website issue) should instead be reported to webmaster. Issues for subdomains of "pool.ntp.org" should be reported to the NTP Pool Project.</p>
---	--	---

Known Vulnerabilities by Release Version

The following releases provided fixes for at least one security vulnerability. The table for each release provides an entry for each security issue (click its hyperlink to read the details for the vulnerability), indicates the issue's severity, and provides the dates of advance notification to institutional members, advance release to premier and partner institutional members, and public release.

Refer to the [Release Timeline](#) for a complete list of all releases, their public release dates, release announcements, and changelogs.

▼ Release Version:

- 4.2.8o18

The Register

...os up modded switch to secure ...id against Russian cyberattacks

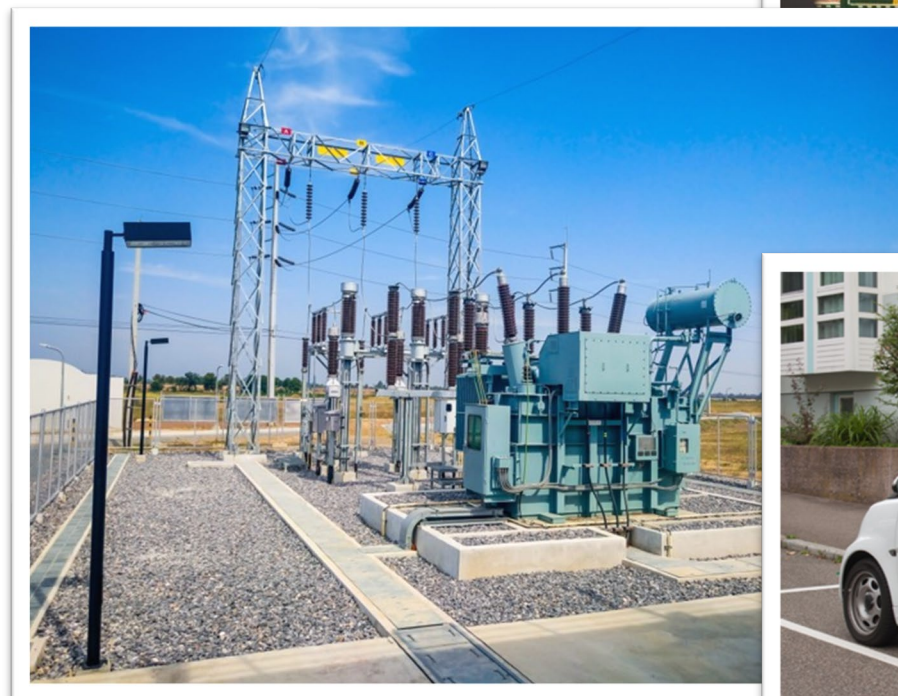
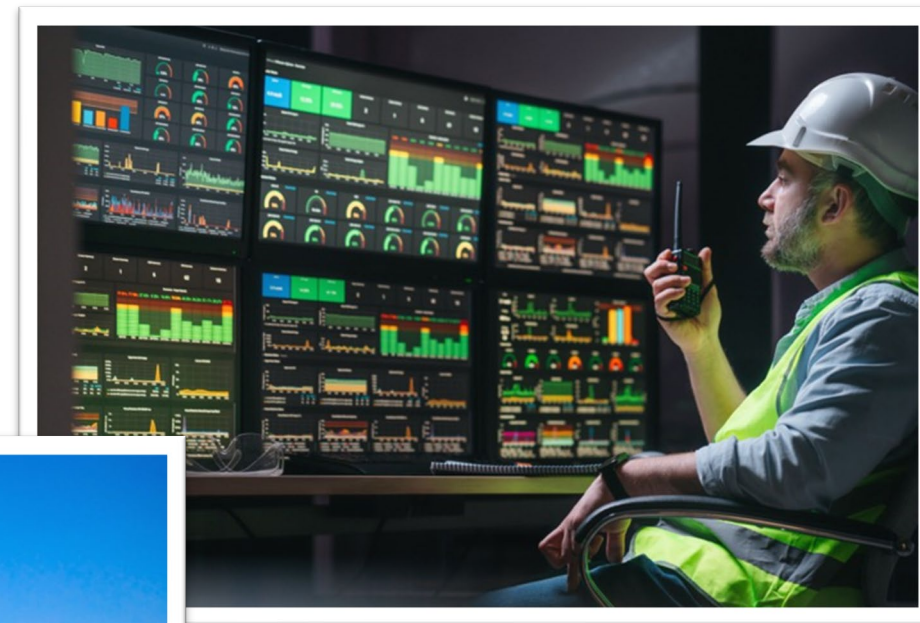
...s were doing much more than simply scrambling missile guidance

Connor Jones

Wed 22 Nov 2023 18:33 UTC

Proliferation of GPS and NTP on the Grid

- Tens of thousands of devices on the grid require microsecond or better synchronization
 - PMUs
 - Substations
 - SCADA
 - Control Centers
 - Data Centers



Developing Wide-Area Time Synchronization Solutions to Augment GPS for US Critical Infrastructure

National Security & Modernization Imperative

- GPS is an amazing capability but is vulnerable to spoofing and other cyber threats
- Executive Order 13905 (2020): National Resilience through PNT
- PTP timing necessary for a smart grid

One-of-a-Kind Testbed with Dozens of Commercial Partners

- Leveraging COTS capabilities to evaluate against strict accuracy & cyber requirements of the grid
- Partnerships to improve, refine, and adapt OEM capabilities

R&D and T&E of Novel Timing Architectures for the Grid

- Developing nanosecond-scale secure timing solutions
- Testing across a variety of terrestrial and space-based comms links
- Evaluating integrations with existing utility equipment baselines

Established Capacity for Transition to Utilities

- CAST collaborates with PMAs and utilities to demonstrate and implement new synchronization capabilities
- Team is documenting best practices for sharing with and supporting utilities



— Center for Alternative —
Synchronization and Timing



ORNL Timing & Synchronization Test-Bed: Industry-Leading Technologies and Nationwide Partnerships

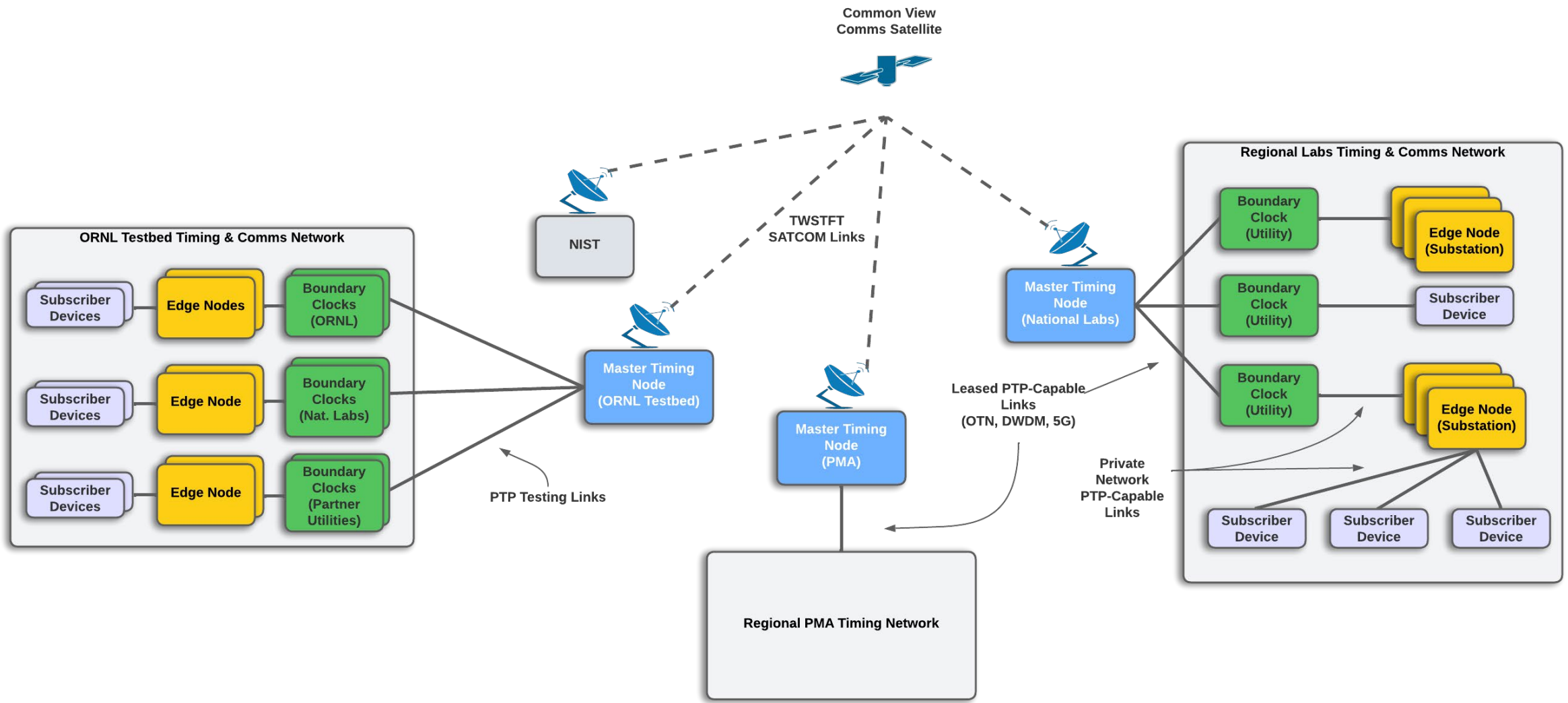
One-of-a-Kind Technology Baseline

- Multiple **atomic clocks**
 - One optical cesium clocks
 - Two magnetic cesium clock
 - Two rubidium clocks
- **Cyber** accredited, industry leading firewall and signal **encryption**
- Multiple **communications networks** integrated to the lab
 - Dark fiber
 - DWDM
 - Carrier Ethernet
 - OTN
 - DOE ESN
 - Cellular/5G
 - Dedicated SATCOM
 - Satellite Internet

Industry and Lab Partnerships for Testing and Development

- Hardware
 - Adtran/Oscilloquartz
 - Microchip
 - Palo Alto
 - Juniper
 - Arista
 - Nokia
 - Orolia
- R&D and Testing
 - Idaho National Lab
 - Sandia National Lab
 - Savannah River National Lab
 - National Institute of Standards of Technology (NIST)
 - Electric Power Board (EPB) of Chattanooga
 - Public Service Company of New Mexico (PNM)
 - Dominion Energy
 - Western Area Power Administration (WAPA)
- Communications
 - ESN
 - AT&T, Verizon
 - InMarSat
 - SES Government

Tomorrow - Multi-Tier Timing Architecture for Resilient PNT



Timing Nodes and Pathways

Stratum 0 – UTC

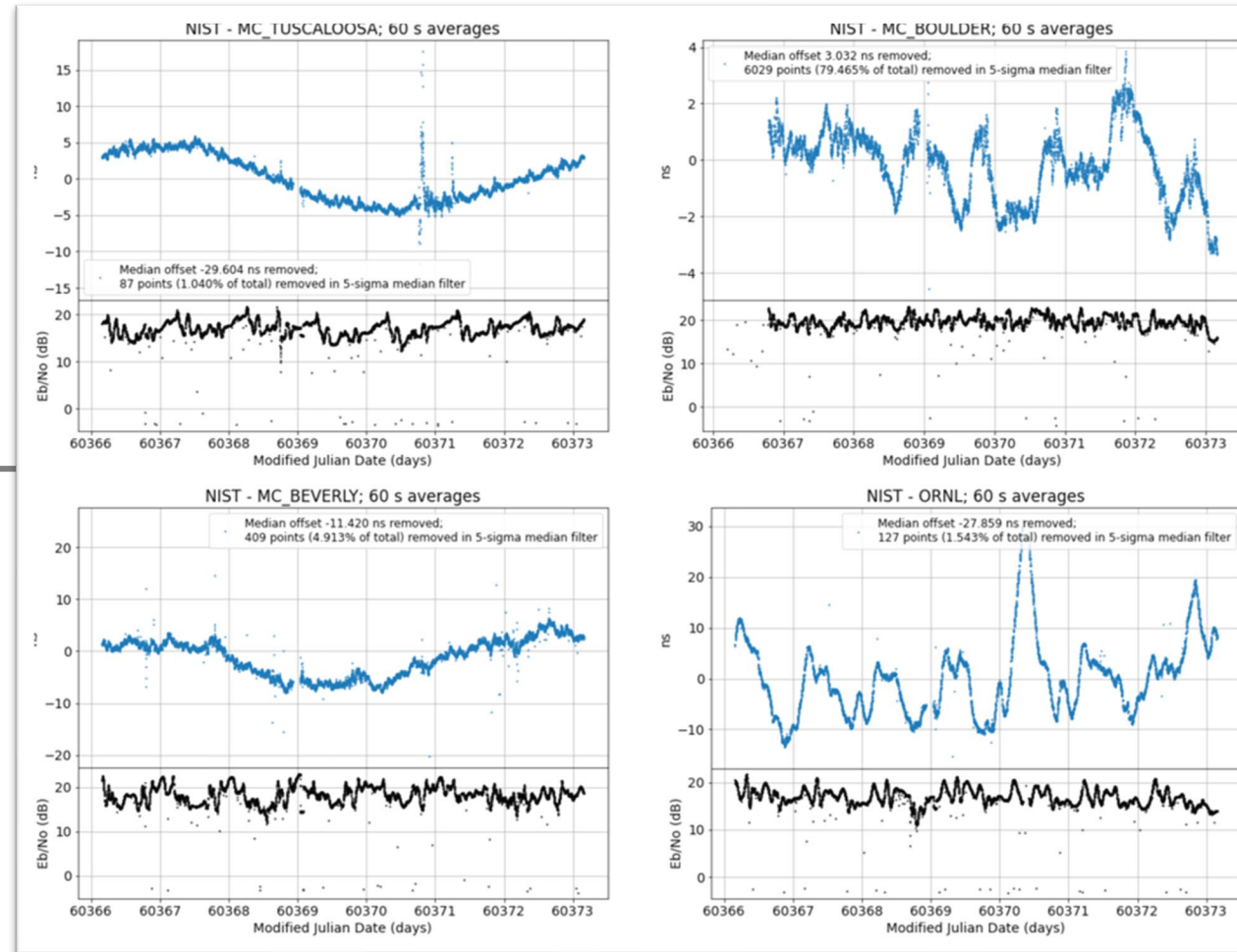
- USNO – GPS
- NIST – NTP

Investigating novel methods for time transfer from authoritative sources

- Collaboration with NIST
- TWSTT as a service
- Future investigations of LEO offerings

Stratum 1 –
Master Clock

- Cesium Reference
- Disciplined Oscillator



Stratum 3 –
Secondary Clock

Disciplined
Oscillator

Timing Nodes and Pathways

Stratum 0 – UTC

- USNO – GPS
- NIST – NTP

Benchmarking commercial master clock systems for power grid accuracy, precision, and holdover performance

- Collaboration with Oscilloquartz and Microchip
- 14-day, 30-day, indefinite ePRTC holdover tests

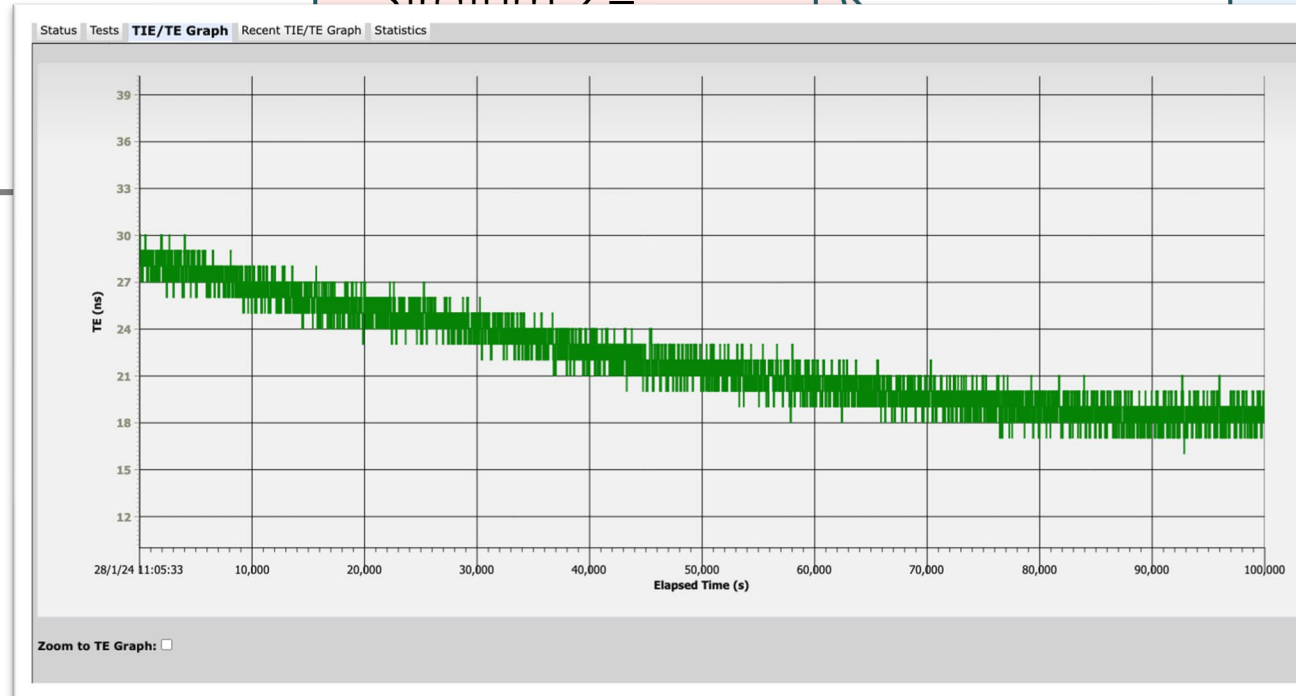
Stratum 1 –
Master Clock

- Cesium Reference
- Disciplined Oscillator

Stratum 2 –

Stratum 3 –
Boundary Clock

Disciplined
Oscillator



Timing Nodes and Pathways

Stratum 0 – UTC

- USNO – GPS
- NIST – NTP

Evaluating performance of different network mediums for time delivery and synchronization

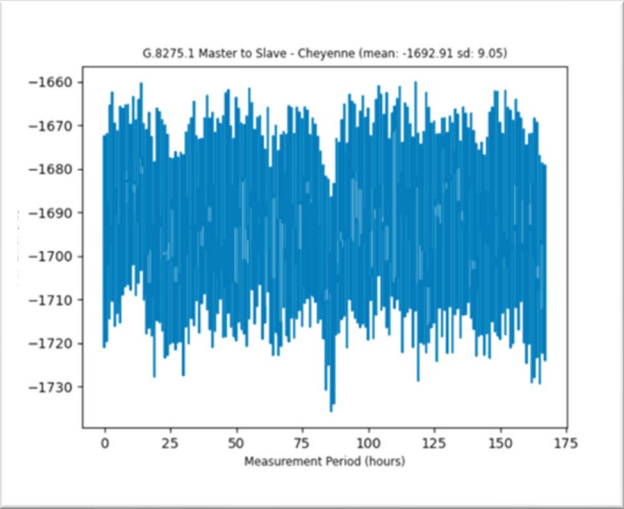
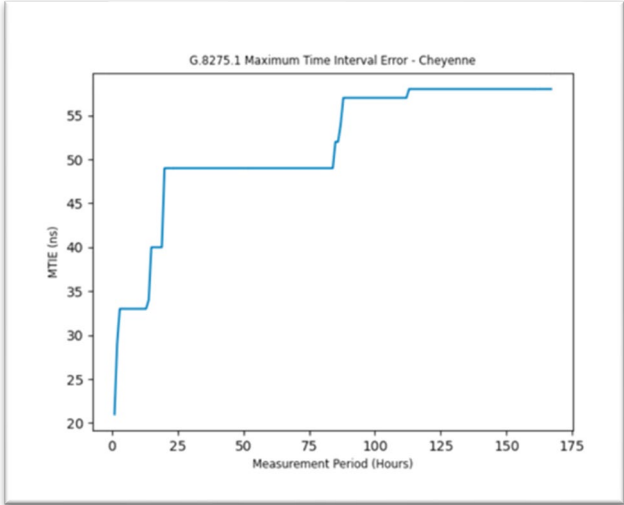
- DOE ESNET for Federal entities
- Dark fiber, OTN, DWDM, SONET/SDH, Commercial/Carrier Ethernet, MPLS
- Precision Time Protocol (IEEE 1588-2008/2019), Network Time Protocol

Stratum 1 – Master Clock

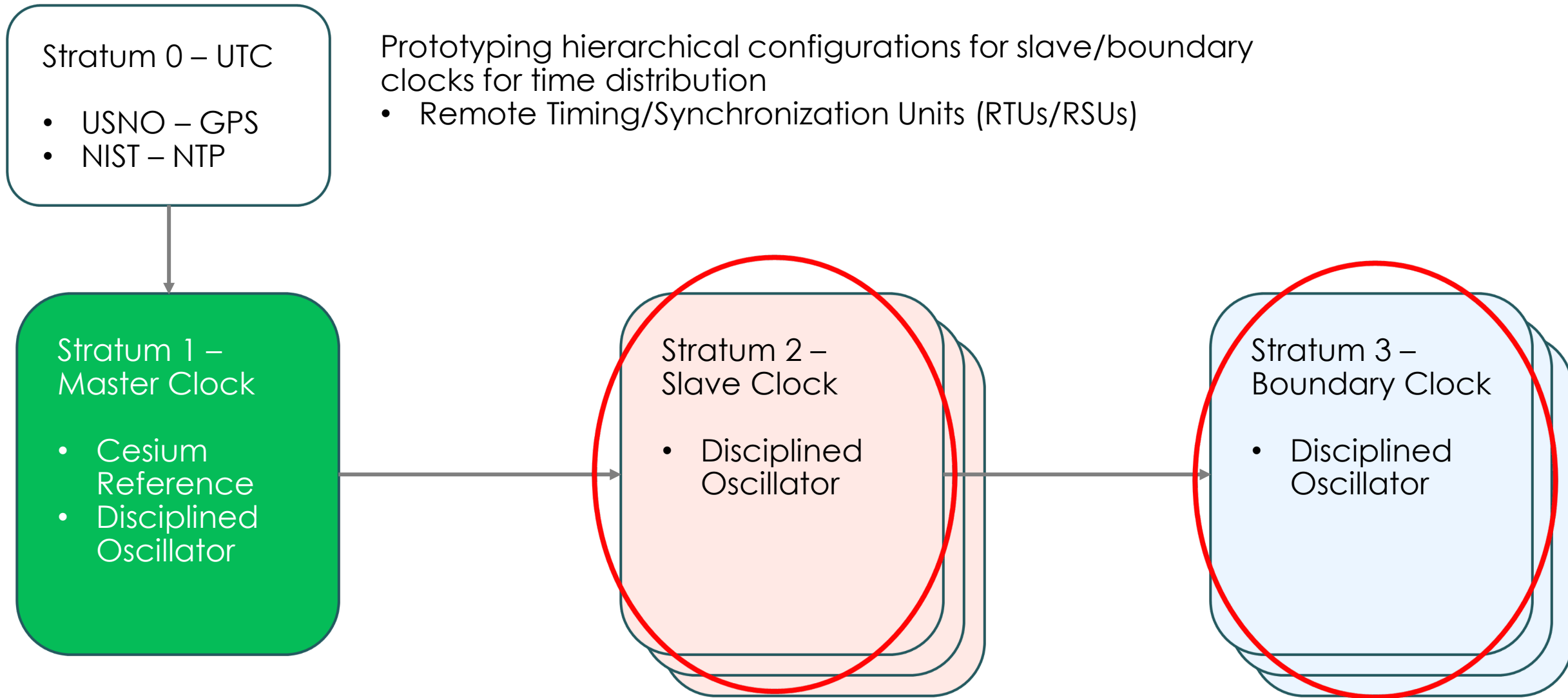
- Cesium Reference
- Disciplined Oscillator

Stratum 2 – Slave Clock

- Disciplined Oscillator

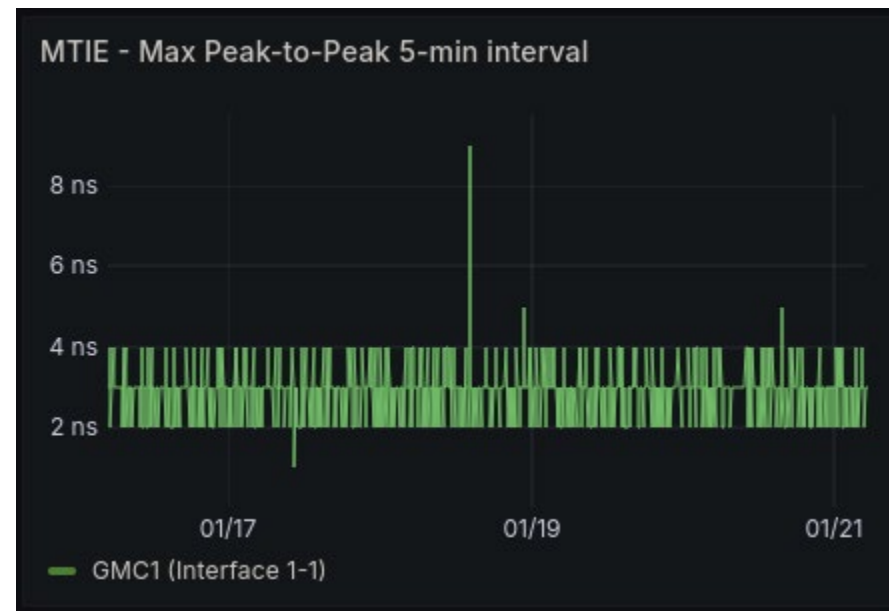
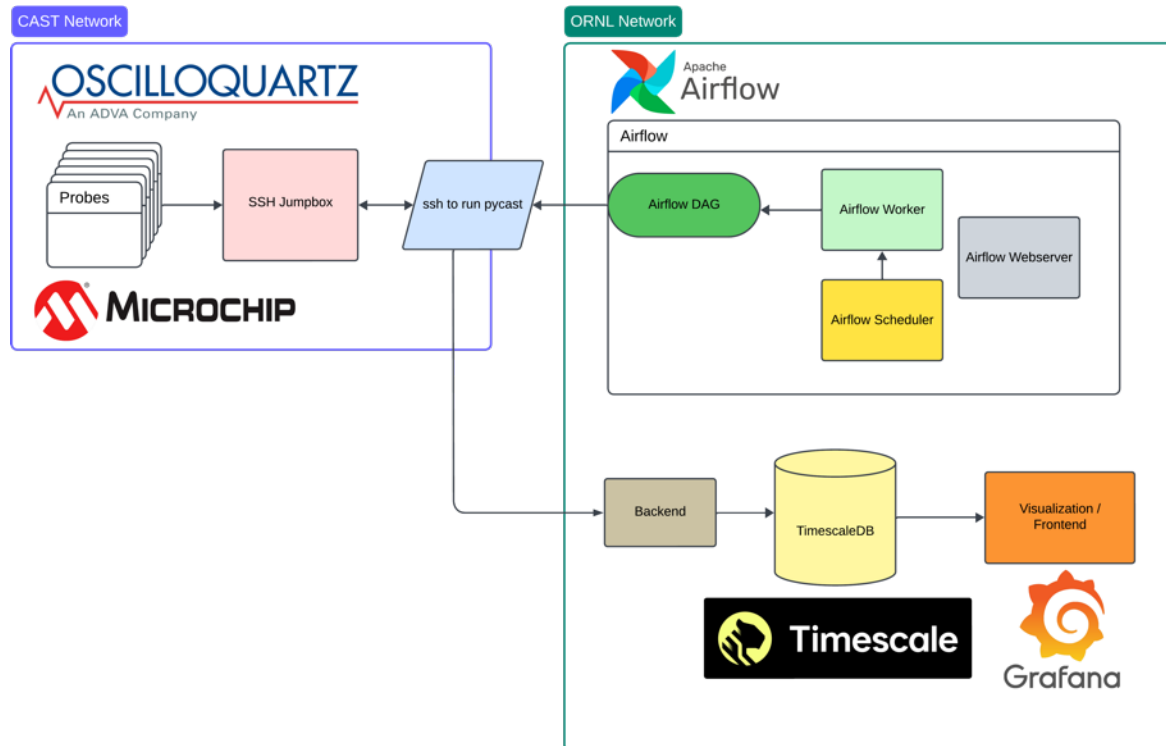


Timing Nodes and Pathways



Monitoring

Developing a real-time monitoring and analytics platform for automated data collection, visualization, and anomaly detection



CAST Web Page



[Home](#) [News](#) [Technical Resources](#) [Events](#) [Data](#) [About CAST](#) [Contact Us](#)



<https://cast.ornl.gov>



THANK YOU