DHS SCIENCE AND TECHNOLOGY

Responsible Use of PNT for DLT in the Financial Services Sector

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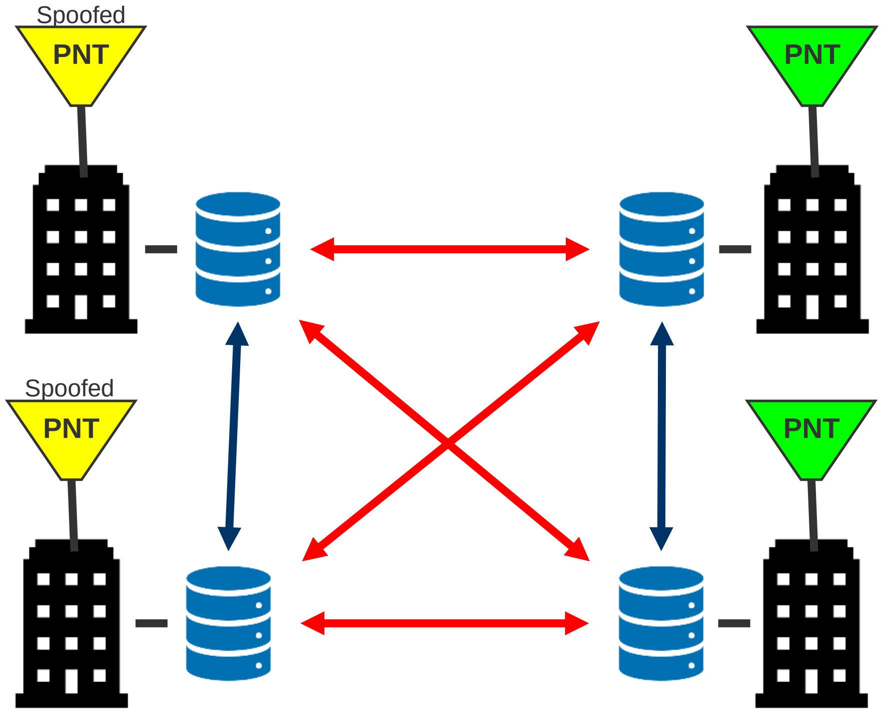
Presentation Outline

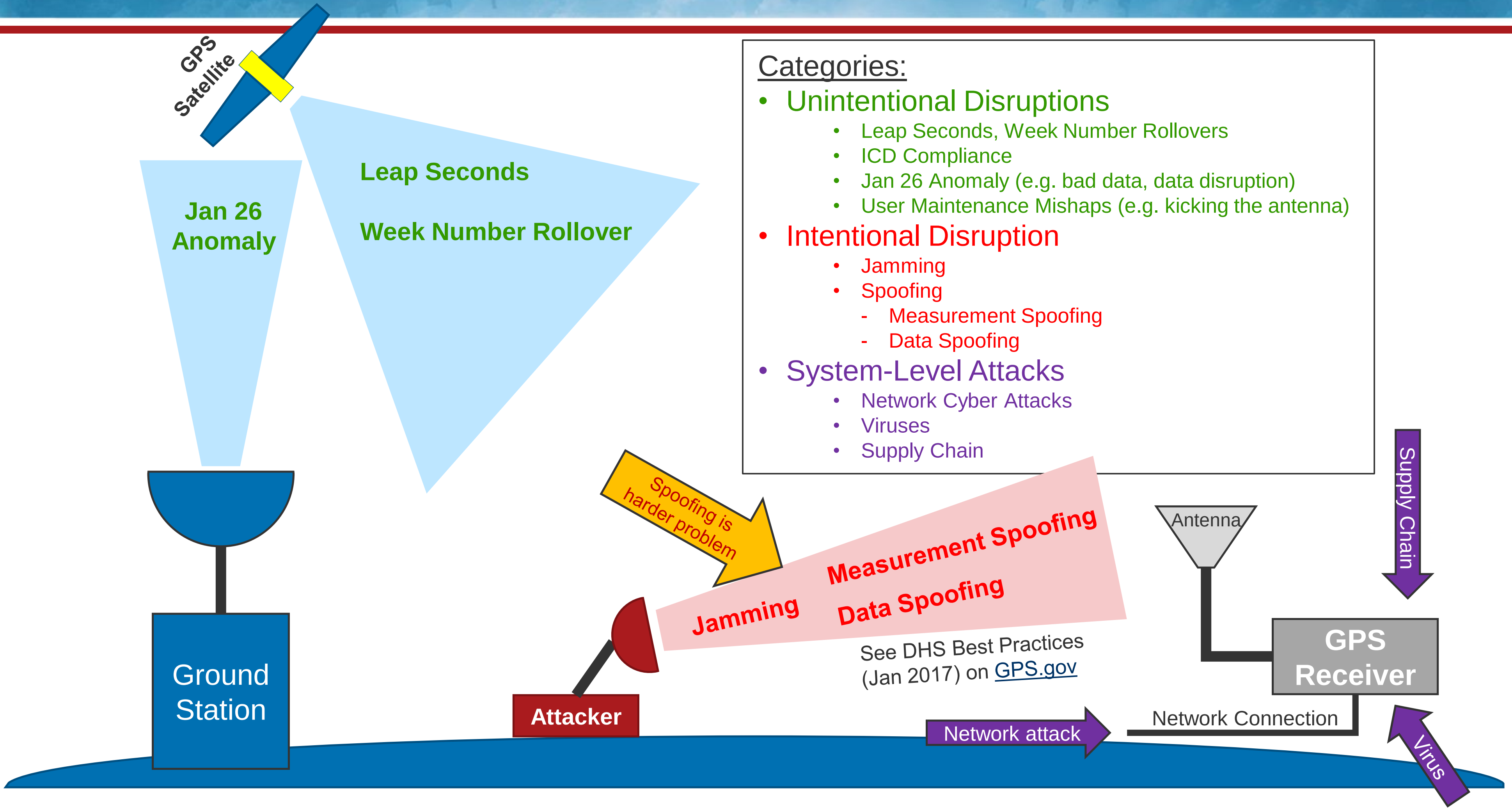
- Introduction Sections
  - Precision Timing in DLT: What could go wrong? (or right?)
  - Overview of Threats to GPS Timing
  - Role of DHS
- Protecting the Financial Services Sector against PNT Spoofing
  - Risk Assessment Spectrum
  - PNT Receivers and Attack Surfaces
  - Resilient PNT Conformance Framework
  - Mitigations: The Flip
  - Other Mitigations
  - Other Things Coming “Soon” from DHS

Precision Timing in DLT:
What Could Go Wrong?

- Potential Applications
  - Trading
  - Market Data
  - Clearance and Settlements
  - Timing Compliance
- Building the Case
  - A trade is a trade, regardless of underlying technology.
    - All (DLT) transactions will need to be time stamped (assumption).
  - Firms have to trace to sovereign time / UTC.
    - This generally means a GPS receiver.
  - GPS time can be spoofed.
  - What happens when the time stamps are wrong?
    - When would the discrepancy be noticed?
    - Would DLT help identify the discrepancy? (maybe not)
    - Would it hurt or help?



GPS/PNT Threat Classes



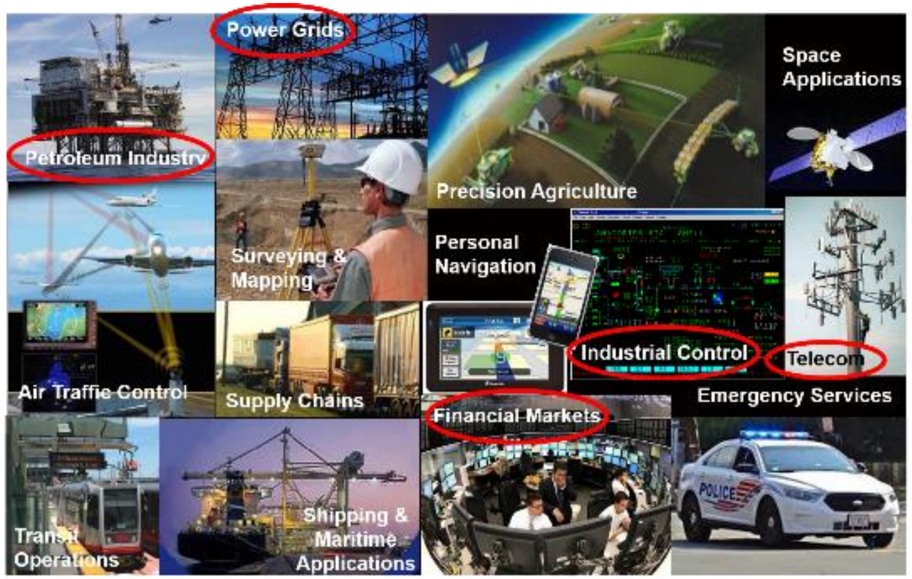
Categories:

- Unintentional Disruptions
  - Leap Seconds, Week Number Rollovers
  - ICD Compliance
  - Jan 26 Anomaly (e.g. bad data, data disruption)
  - User Maintenance Mishaps (e.g. kicking the antenna)
- Intentional Disruption
  - Jamming
  - Spoofing
    - Measurement Spoofing
    - Data Spoofing
- System-Level Attacks
  - Network Cyber Attacks
  - Viruses
  - Supply Chain

See DHS Best Practices (Jan 2017) on GPS.gov

DHS Role in Timing for Critical Infrastructure

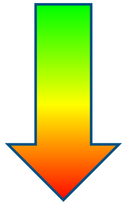
- **PNT in Critical Infrastructure**: Accurate position, navigation and timing (PNT) information is necessary for the functioning of many critical infrastructure sectors.
  - Precision timing is particularly important.
  - Primary source of distributed & accurate timing is currently through GPS.
- **Problem**: GPS susceptible to disruption (both intentional and unintentional)
  - Jamming (Newark I-95, North Korea, criminal activity)
  - Spoofing (Possible examples from recent open source media)
    - **Spoofing also becoming easier w/ low-cost SDRs & open source code**
- **DHS Role:**
  - Improve the resilience of critical infrastructure against PNT threats and disruptions via:
    - Engaging with industry for information sharing and risk management.
    - Developing technology and mitigations.



Protecting the Financial Services Sector Against PNT Spoofing

Risk Assessment Spectrum

- **Large-scale, high-speed, high-value operations with multiple Cesium atomic Clocks**
  - Operation: Trusting the atomic clock and keeping it on holdover during the weekday.
    - Significantly reduces risk due to the smaller attack window.
  - Remaining Risk: Attack Surface ≠ Attack Window. Attack surface open to data & measurement spoofing.



- **Traditional operations with low-cost GPS receiver**
  - Operation: Time is provided from a basic GPS receiver constantly listening through the RF port.
  - Risk: Susceptible to both measurement spoofing and data spoofing.
  - Options: There are mitigations you can employ that won’t cost as much as a Cs atomic clock.

PNT Receivers and Attack Surfaces

- PNT receivers should be treated like computers rather than radios.
  - The PNT antenna is like an open port.
  - There is data processing inside the receiver.
- When mitigating for PNT resilience, need to assess both the threat and the attack surface.

- **Caution when mitigating**: Adding more PNT sources does not automatically provide resilience.
  - More PNT sources = more attack surfaces.
  - When incorporating other PNT sources, they should also be examined from this perspective and hardened.

Resilient PNT Conformance Framework

Vision: Develop common language for defining resilient PNT equipment

- Accomplished through defining multiple levels of resilience.

- **Working Group:**
  - Industry working group consisting of most major system integrators (timing).
  - Looking for additional CI end-user representation and input.

Resilience Levels (Preview)

- **Level 1**: Robust Recovery
- **Level 4**: Operate through Threats

Levels apply to:

- GNSS Chipsets
- Integrated Receivers
- System of Systems

Key Concepts:

- Defense-in-Depth
- Resilience Levels
- Core Functions

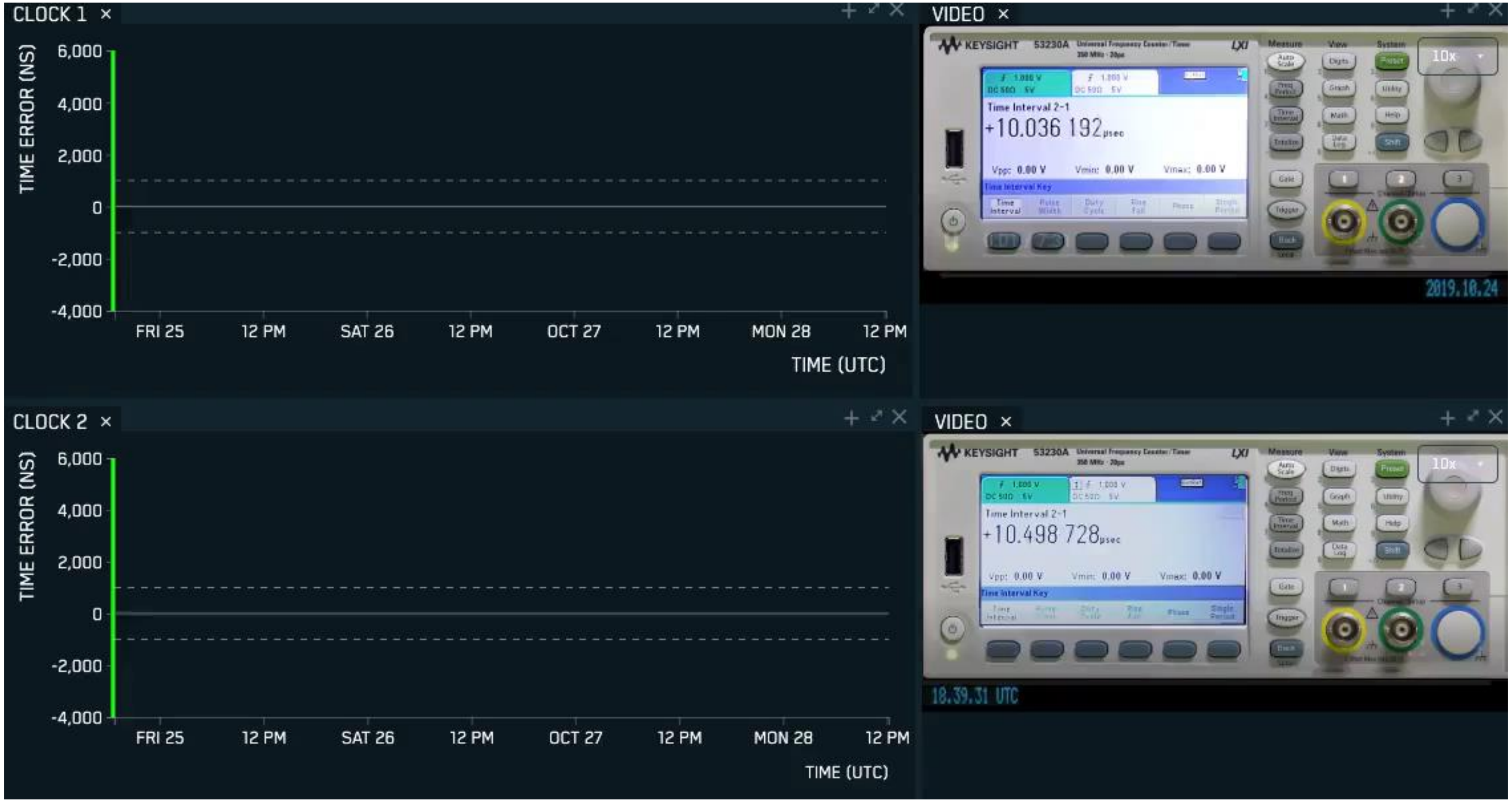
Will enable:

- Product differentiation for vendors
- Improved risk management and decision making by CI operators when acquiring new PNT equipment (or updating existing deployments).

- **Initial Focus**: GNSS-based timing equipment

Mitigations: The Flip

(Courtesy of HSSEDI)



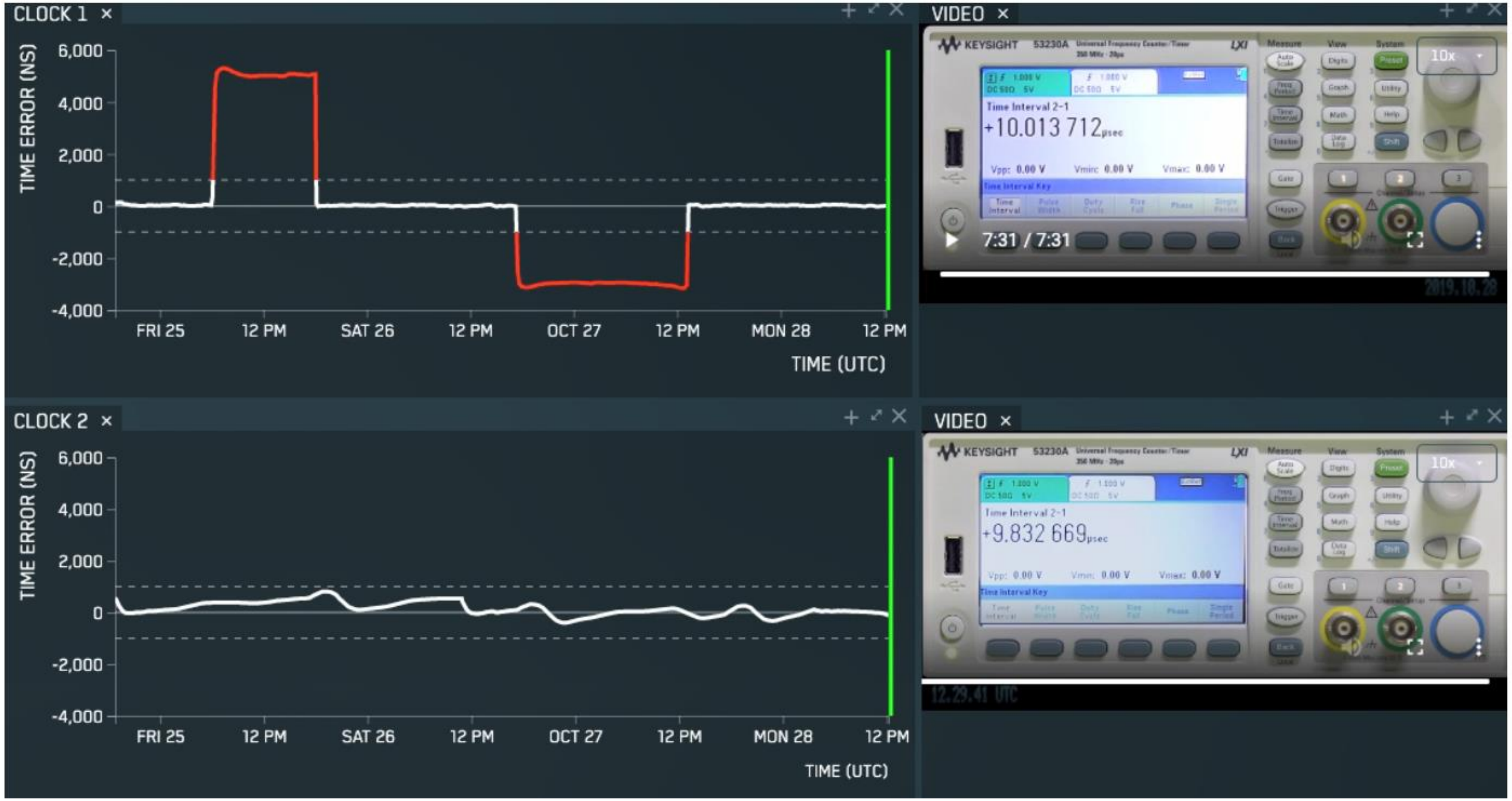
Time Interval 2-1
+10.036 192 psec
Vpp: 0.00 V Vmin: 0.00 V Vmax: 0.00 V

Time Interval 2-1
+10.498 728 psec
Vpp: 0.00 V Vmin: 0.00 V Vmax: 0.00 V

Credit: Homeland Security Systems Engineering and Development Institute (HSSEDI) FFRDC

Mitigations: The Flip

(Courtesy of HSSEDI)



Principle: Trust your clock

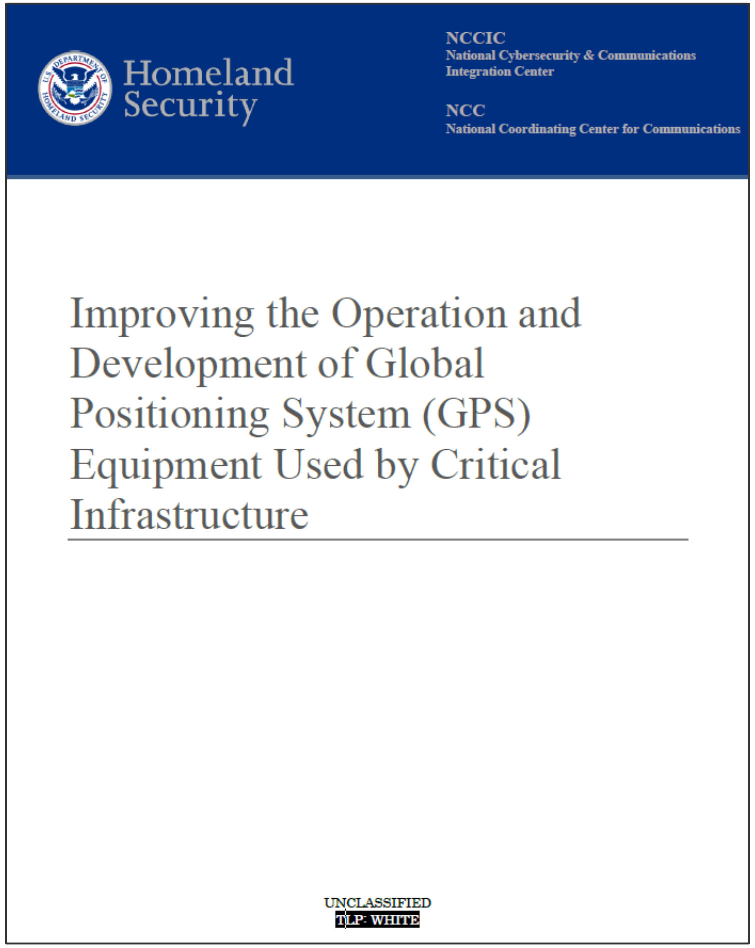
- Likely do not need the precision GPS provides (40ns).
- Therefore keep clock in holdover and perform intermittent disciplining as needed.
- Significantly reduces attack window.

Attacker can't spoof or jam a receiver if it isn't listening.

Credit: Homeland Security Systems Engineering and Development Institute (HSSEDI) FFRDC

Other User Mitigations & Considerations

- Horizon Nulling Antennas
- DHS Best Practices
  - User Deployment strategies
    - E.g. obscure view of antenna, decoys, placement
  - On GPS.gov (lower right-hand corner):
    - “Best Practices for Improving the Operation and Development of GPS Equipment Used by Critical Infrastructure - Jan 2017”
- “Resilient PNT Equipment”
  - Spoofing detection capabilities
    - Resilient PNT Conformance framework can help with this comparison.
  - Robust recovery capabilities
    - Ability to “return to a known good state” (DHS Best Practices, Jan 2017)
    - Essential since there’s no such thing as perfect security.
    - This is foundational capability for defense-in-depth approach.



Homeland Security

NCCIC
National Cybersecurity & Communications Integration Center

NCC
National Coordinating Center for Communications

Improving the Operation and Development of Global Positioning System (GPS) Equipment Used by Critical Infrastructure

UNCLASSIFIED
TLP: WHITE

Other Things Coming “Soon” from DHS

- **Epsilon Algorithms**
  - What: Spoofing detection algorithms focused on consistency checks using PVT data.
  - Who (Intended Use):
    - System Integrators: For integration into their products.
    - DIY End-user: Algorithms can utilize outputs from an existing GPS receiver.
  - When: By end of calendar year 2020

- **Spoofing Detection Toolkit**
  - What: API with a suite of spoofing detection algorithms for the full RF-processing chain.
  - Who (Intended Use):
    - System Integrators: For integration into their products. Algorithms for the full RF-processing chain requires sufficient data (either revised chipsets or a SDR)
    - DIY End-user : With DIY documentation, will be able to take the API and algorithms for use on an SDR and processor (e.g. SoC).
  - When: Targeting end of calendar year 2020

Other Things Coming “Soon” from DHS (con’t)

- **Best Practices for Financial Services Sector**
  - What: DHS best practices document tailored for financial services sector
    - Will likely include risk and mitigation information & recommendations on how to apply the Conformance Framework.
    - Will include suggestions for different scale operations and take into consideration tradeoffs of economic costs vs. risks.
  - For Who: Financial Sector End-users
  - When: TBD (likely Calendar Year 2021)

- **2020 GPS Equipment Testing for Critical Infrastructure (GET-CI 2020)**
  - What: Live-sky GPS spoofing event for industry to test and evaluate their equipment
  - For Who: Equipment manufacturers, critical infrastructure end-users
  - When: Expecting 2nd half of 2020
  - How to apply: RFI for participation will be posted on SAM.gov

Questions?

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DIVERSE PERSPECTIVES + SHARED GOALS = POWERFUL SOLUTIONS

Backup Slides

Conformance Framework Approach

Phases:

- Phase 1: Guidance documentation (targeting Spring 2020)
- Phase 2: Standards development (starting by 2021)

Reference Architecture:

- Reference Architecture documentation (FY20)
- Reference Implementation Demo (FY21)

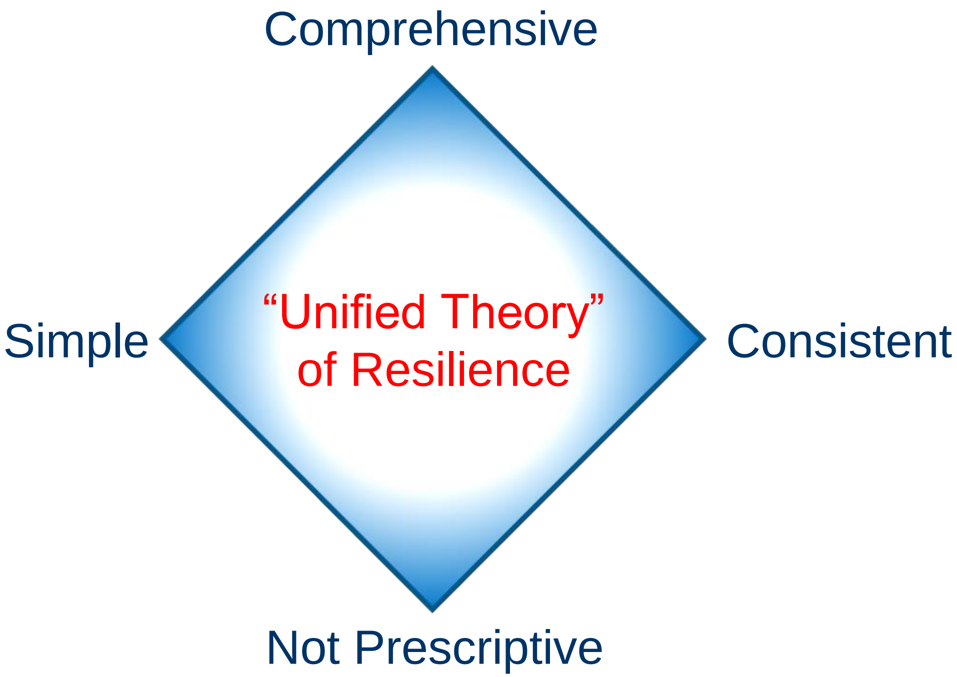
Industry Participation:

- Most major system integrators are part of working group (WG)
  - DOT and FAA also part of WG (to ensure extensibility to P/N)
- Looking for more end-user participation and input

Conformance Framework: Guiding Principles

- **Guiding Principles:**
    - Must be comprehensive
    - Must be simple
    - Must be consistent
    - Must NOT be prescriptive

- **Challenge**: Iterative process to distill framework into something that fits this “quadruple constraint.”



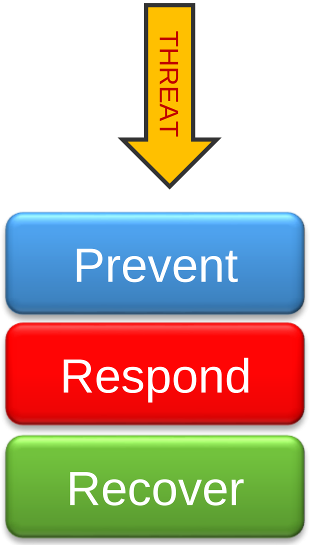
Conformance Framework: Key Concepts

Key Concepts:

- Defense-in-Depth *(2 dimensions)*
- Resilience Levels
- Core Functions

Core Functions

Blends NIST Cybersecurity Framework & PPD-21 National Preparedness System for Resilience



Resilience Levels (Preview)

- **Level 1**: Robust Recovery

Have working definitions, but needs some refinement to better satisfy the four guiding priorities.

- **Level 4**: Operate through Threats