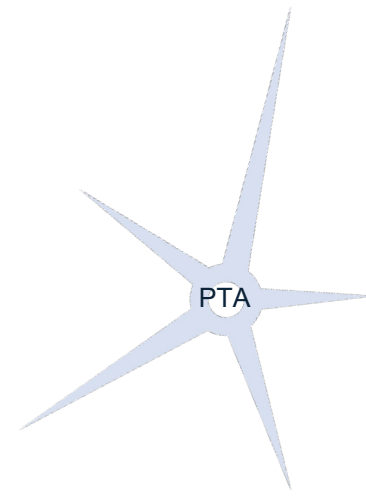




SPACE-BASED POSITIONING  
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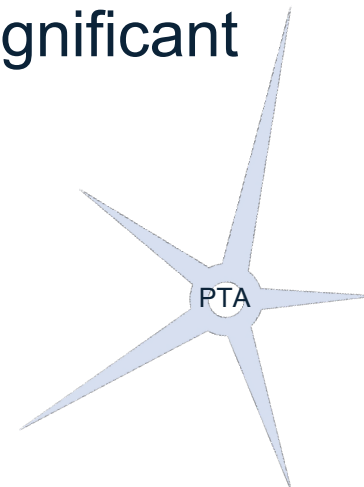
# Wrapup of “PTA Day”

24 April 2024



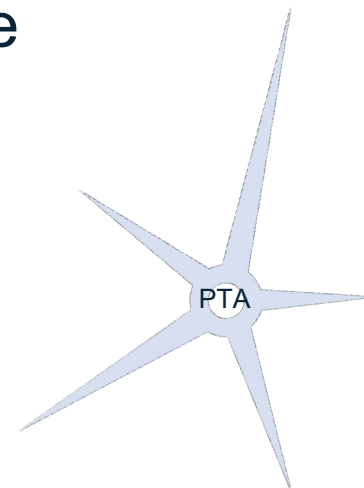
# Protect Takeaways

- DoT should establish a set of metrics for developing national interference monitoring, with numerical targets, then accelerate development and fielding of this essential operational capability
  - DoT should present the metrics and numerical targets, along with a schedule through fielding, at the Fall 2024 PNTAB meeting
- DoT, DHS, and FCC should collaborate to modernize removal of significant interference sources
  - Should no longer rely only on a few skilled individuals.
- DoT, DHS, and FCC need to commit to a maximum time before a significant interference source is removed
  - 72 hours as an initial goal



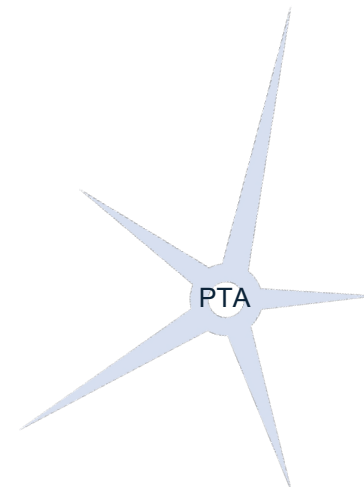
# Toughen Takeaways

- DoS should complete updating the ITAR to remove unnecessary obstacles to critical infrastructure use of controlled reception pattern antennas (CRPAs)
- DHS should publish a list of existing antijam antenna products (e.g., horizon nullers for timing receivers, two-element CRPAs) that are not ITAR restricted and could be rapidly installed to toughen against interference
- There are many practical techniques for receivers to defend against spoofing
- DHS should establish a forum where receiver and simulator manufacturers can collaborate to establish interference/spoofing Toughen Test Suites that can readily be used to evaluate receiver robustness and competence
- Meanwhile, each simulator manufacturer can proceed individually



# User Device Toughness: Robustness, Competence, Resilience

- Robustness (withstands challenges) and competence (handles situations as expected):
  - Thoroughly implements signal interface documents and other GPS documentation, reacting properly even to rare events such as leap seconds, week rollovers, clock/ephemeris cutovers
  - Withstands in-band jamming and interference as well as powerful out-of-band interference
  - Recognizes and resists errors due to natural phenomena (e.g., multipath), false inputs (e.g., measurement spoofing and data spoofing), and faulted signals whether accidental or malicious
  - Reports anomalous inputs to the user or host system, and may even archive these inputs
  - Does not output erroneous information if overwhelmed with faulty inputs or in a faulty state
- Resilience (recovers from challenges):
  - Seamlessly recovers to a known good state from faulty states and faulty inputs
  - Adeptly hands over to a backup source of PNT when it cannot use GPS
- In summary, the ideal Tough user device implements the Six R's:
  - Recognize challenges and threats
  - Reject challenges and threats when possible
  - Resist challenges and threats not rejected
  - Report challenges and threats
  - Replace GPS with other source of PNT when necessary
  - Recover from challenges and threats



# Testing Toughness (1 of 2)

- Simulator manufacturers could offer a Toughness Toolkit of standard tests to assess and report the robustness and competence of different GPS civil user devices
- Test full compliance with applicable Interface Specifications and other relevant GPS documentation, including for rare events such as leap seconds, week rollovers, clock and ephemeris cutovers
- Evaluate ability to tolerate in-band and out-of-band interference
  - Received power
  - Waveforms
  - Frequency content
- Evaluate the ability to recognize, reject, resist, report, recover from spoofing
  - Different measurement spoofing techniques
  - Different data spoofing techniques
- Evaluate ability to replace PNT from GPS with PNT from another source when needed
- Not exhaustive, but representative of common stresses and attacks
- Technical challenges need to be addressed
  - Designing tests to prevent simple workarounds in user devices (e.g., use randomization)
  - Designing user devices to counter spoofing yet be testable on simulators



# Testing Toughness (2 of 2)

- Civil user device manufacturers could report results (e.g., “passed XY% of ABC Simulator Corporation’s Toughness Tests”)
- Federal CIOs should establish or adopt Toughness Tests, setting standards for Federal acquisition of user devices
- Critical infrastructure owners/operators could select civil devices based on Toughest Test results
  - Reported by user device manufacturers
  - Performed as a service by a third party
- Volunteers/hobbyists would likely crosscheck reported results
- Informal survey of simulator manufacturers did not identify current marketing of any such Toughness Toolkit for civil receivers
  - Some simulator products only record and replay
  - Some simulator products enable users to develop toughness tests
    - Detailed capabilities need to be explored
    - Simulator manufacturers could support user development of tests or develop tests for users
- Once many receivers have “raised the bar” with defenses against common attacks, the critical infrastructure community begins to achieve “herd immunity”

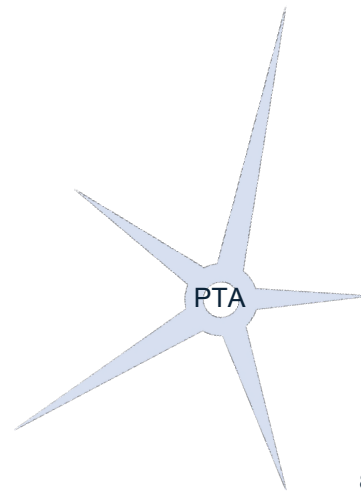


# Augment Takeaways

- DoT should work with NASA to operationalize the PNTAB's proposed GPS High Accuracy and Robustness Service (HARS)
- There are multiple promising alternate sources of time
- With Tough receivers and prompt interference removal, Galileo is a useful alternate source of PNT for almost all Critical Infrastructure Use Cases
  - Receiver manufacturers should develop robust and competent dual-system, dual-frequency (DSDF) GPS/Galileo L1/L5 receivers
  - Use Toughen Test Suites to demonstrate robustness and competence
- DHS should encourage CI owner/operators to acquire and install Tough DSDF receivers
  - Add appropriate backups for timing applications
  - Add anti-jam antennas where appropriate
- DoT and DHS should validate or adjust, if needed, the PTA SC's assumptions:
  - Very high probability that any GPS outage will last less than three days
  - Significant interference will be removed within three days
- DoT should adapt, if necessary, then use the PTA SC's critical infrastructure use cases to downselect alternate PN technologies being addressed in the Complementary PNT effort
  - Which alternate PN sources could meet use case criteria (accuracy, service region, ...) if matured?



**Thank You for  
Participating in PTA Day!**





# Today's PTA Agenda

- 10:30 to 11:30 PTA Overview
- 11:30 to 12:30 Lunch
- 12:30 to 1:45 Protect, with Board Discussion
- 1:45 to 2:00 Break
- 2:00 to 3:15 Toughen, with Board Discussion
- 3:15 to 3:30 Break
- 3:30 to 4:45 Augment, with Board Discussion
- 4:45 to 5:00 PTA Summary
- ➔ 5:00 to 6:00 Board Deliberations
- 6:00 Adjourn

