Building a PMU that withstands spoofing using an internal atomic clock

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http://www.swri.org/4org/d10/comm/NetCent.htm

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- 1,200 acre facility
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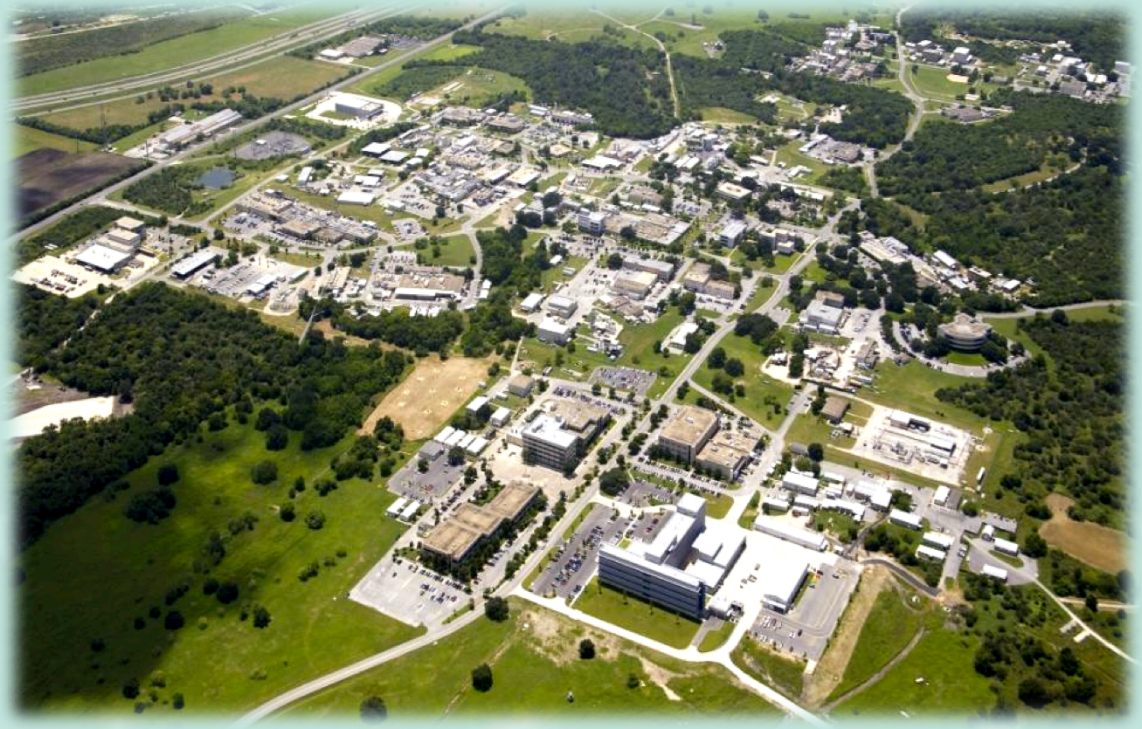
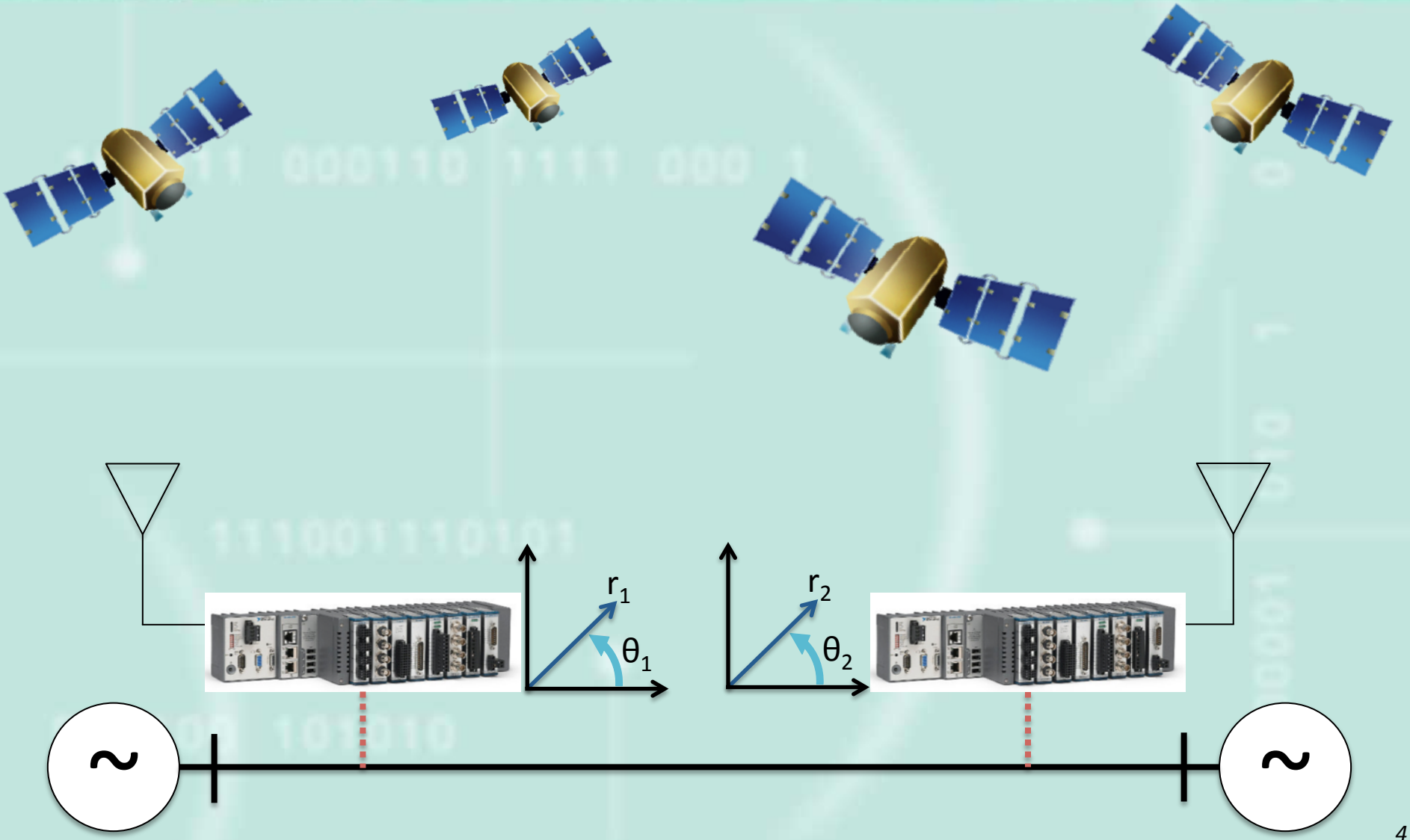


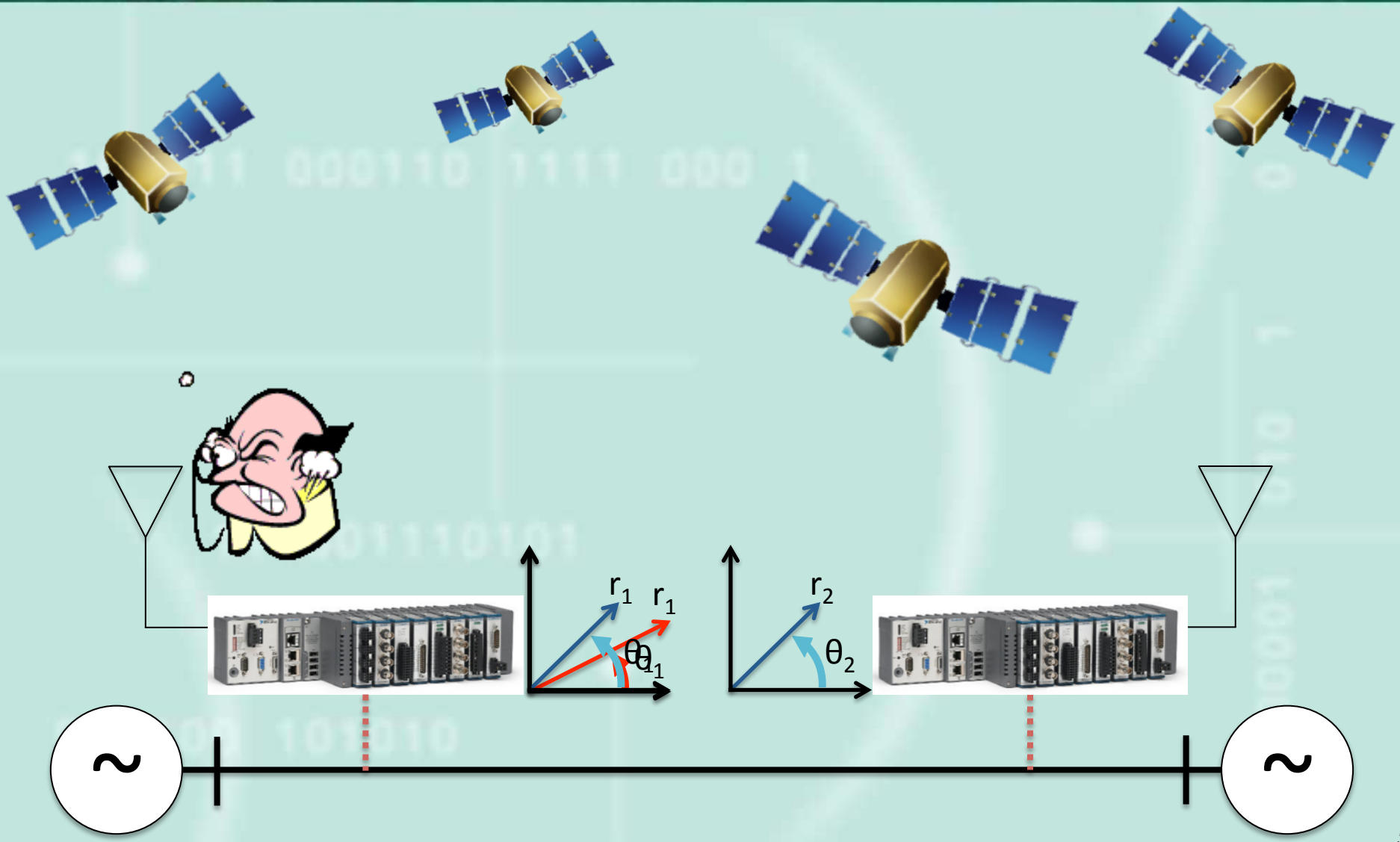
Agenda

1. PMU Overview
   - Clock Synchronization
   - GPS Vulnerabilities
2. PMU Hardware Setup
   - Test Results
3. Solutions
   - Test Results

Clock Synchronization



GPS Vulnerabilities

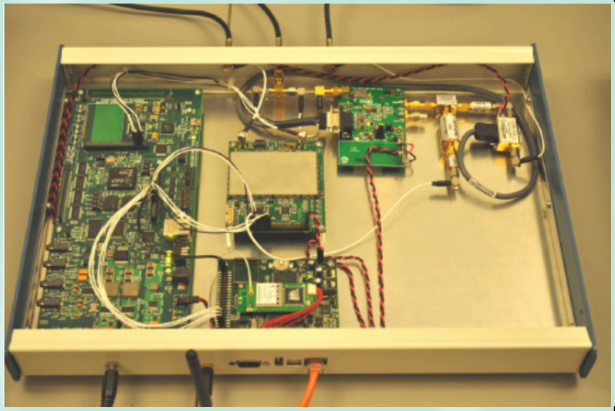


What Does This Mean?

- Jamming/Spoofing GPS is EASY
- GPS is not likely to change
- We want to Protect GPS
  - But,
    - Protecting RF is an **EXPENSIVE** option
    - The RF Attack Surface is **LARGE**
    - Many attacks have not been shown **YET**

➔ ***We've tested an alternative method***

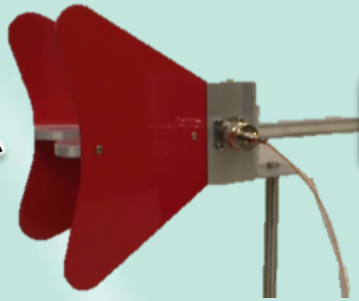
[1]


[2]

[1] Fox News. http://www.foxnews.com/tech/2013/07/26/exclusive-gps-flaw-could-let-terrorists-hijack-ships-planes/
[2] Shepard et al. "Evaluation of the Vulnerability of Phasor Measurement Units to GPS Spoofing Attacks"

SwRI PMU Test Setup

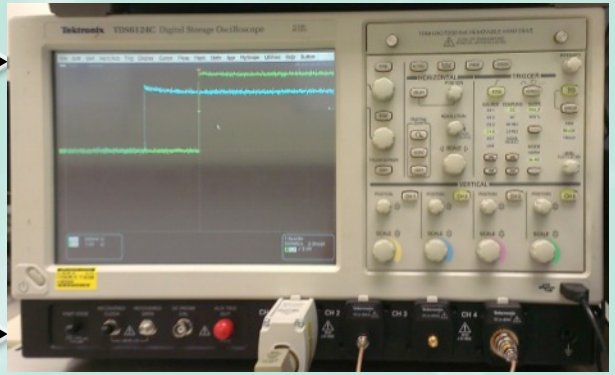
- Jitter
- Fast Spoofing Drift
- Slow Spoofing Drift



- Jamming

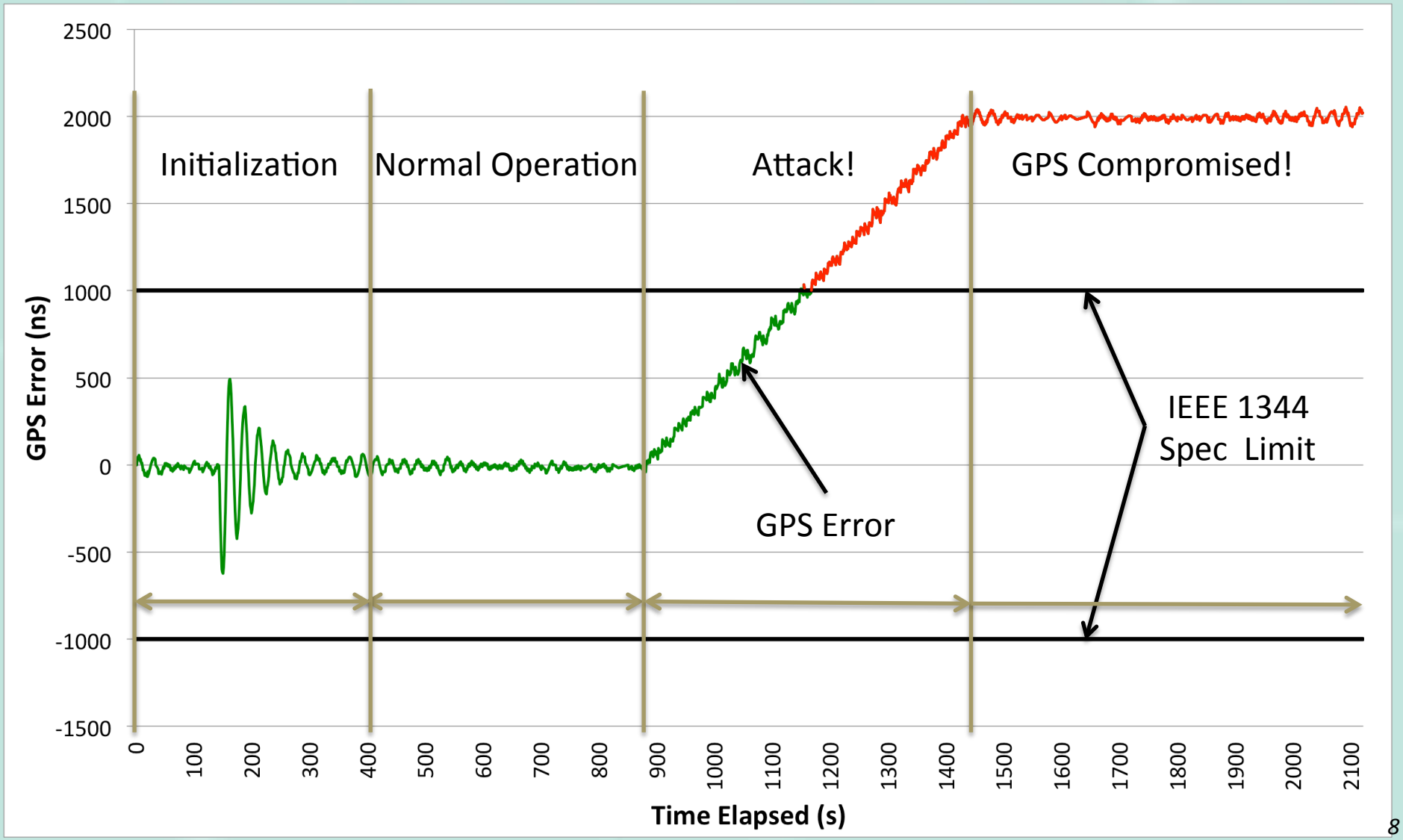
GPS Signal

PPS



Reference Clock

Attack Test Results



What We Have Done

- Options: Algorithms and/or Hardware

	Spoof Detection	Max Withstand (Hold-off)	Cost
Option 1: Anomaly Detection Algorithm	Some fast attacks	10's of Seconds	$
Option 2: Standard Clock Reference	All attacks	Minutes	$$
Option 3: Precise Clock Reference	All attacks	Days	$$$
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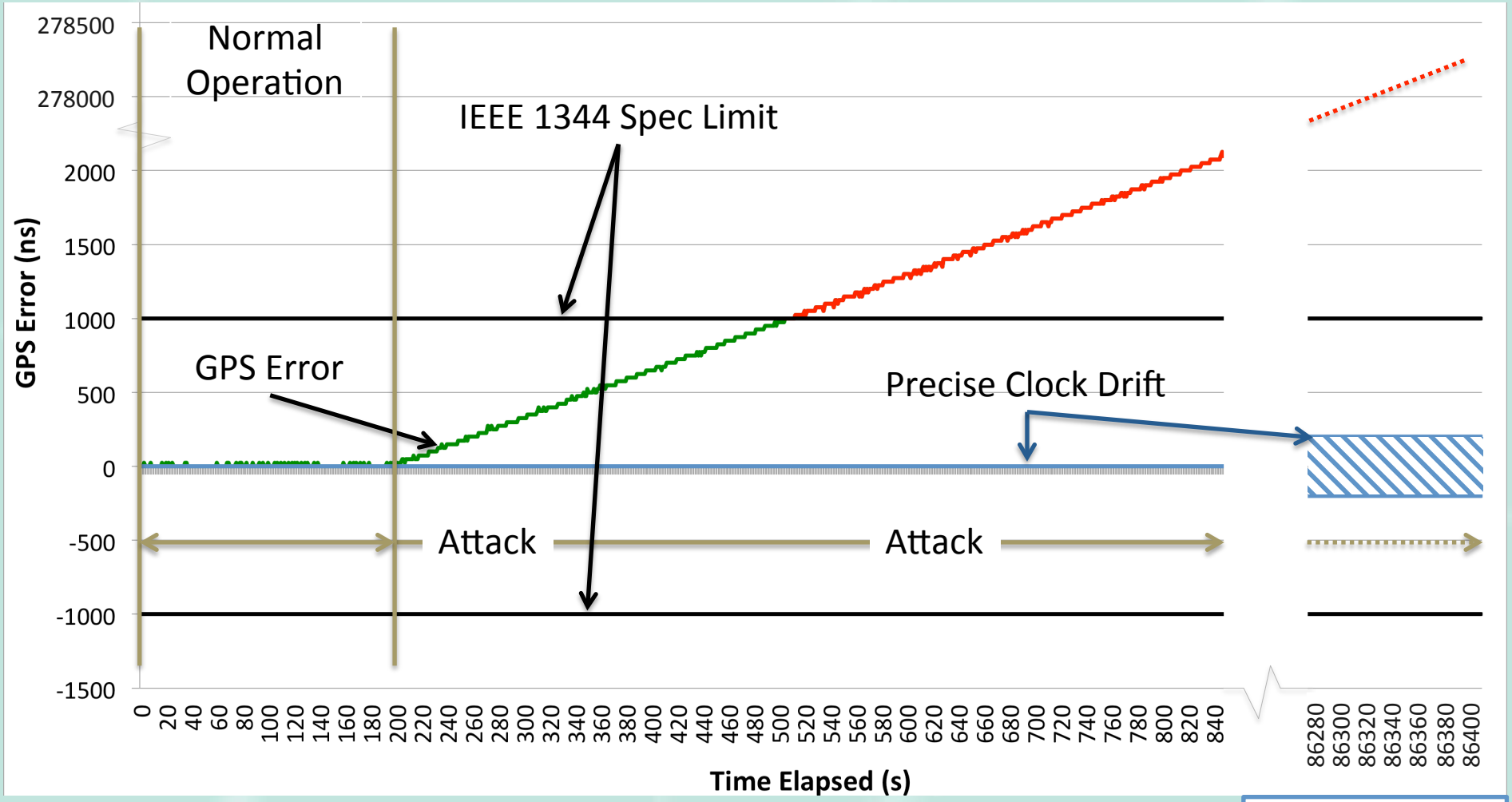
Slow Spoof vs. Option 3



86400 = 24 hrs

Key Takeaways

- **No silver bullet to defend from GPS attacks**
- **GPS is widely used** from financial institutions to global navigation and time synchronization, **and it is unlikely to change in the near future ($$$$).**
- Detecting attacks solely based on RF analysis (time averaging, etc.) has limited utility.
- FPGA Technology can be used to constantly **monitor in real-time the "Quality" of various time sources** and select the one that is most appropriate at any given time.

THANK YOU!

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