A POSITIONING NAVIGATION AND TIMING (PNT) THREAT ENVIRONMENT MODEL FOR MILITARY AND CIVILIAN USE

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THE PNT ENVIRONMENT IS CONTESTED

ENVIRONMENT - PNT THREATS ARE REAL & GROWING MORE PREVALENT

Aug ‘2013
“Truck driver has GPS jammer, accidentally jams Newark airport”
(CNET)

Sep ‘11 – N. Korean Jammer Forces Down U.S. Plane

Army RDECOM ARL

South Korea issues warning over suspected North Korean GPS disruption March 31, 2016 (GPS World)

South Korea issued a warning Thursday after detecting satellite signal disruptions that appeared to be coming from North […]

Oct ‘17 – “ Spoofing in the Black Sea?” (GPS World)

Apr ‘18 – Russian military exercises disrupt GPS service in northern Norway...& disrupt cell phone service in portions of Latvia, Sweden & Norway (Resilient Nav & Timing Foundation)
APNT FOR CONTESTED ENVIRONMENTS

WHAT’S THE PROBLEM?

- Modern world has become highly dependent on Precision Absolute PNT
  - Civil Airspace & Transportation, Military Operations, Timing for internet, banking & commerce…

- The PNT threat environment has become more sophisticated
  - Forcing us to multi-sensor solutions with a mix of technologies that varies based on use case

- There are few, and inconsistent, definitions of the problem and threat conditions – making analysis of requirements and solution development difficult
**WHY DO WE NEED ASSURED PNT?**

**WHAT IS APNT’S JOB? – MAINTAINING ASSURED PRECISION ABSOLUTE PNT**

- ILS Precision Landings
- RADAR Approach
- Optical Surveying
- Point to Point Timing Sync

- Non-precision Landings
- Following Sequential Directions to Navigate
- Timer/Stopwatch

- GNSS Precision Landings
- Precision Agriculture
- Surveying & Construction
- Network Timing Sync
- Banking
- Network-dependent Commerce

- VFR flight
- Map
- Watch
- Sundial

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**RELATIVE PNT**  
locally referenced

**NON-PRECISION**

**Military**

**TOTAL COST OF OPERATIONS (TCO)**

**Civilian**

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**WHAT IS APNT’S JOB?**

**– MAINTAINING ASSURED PRECISION ABSOLUTE PNT**

**WHY DO WE NEED ASSURED PNT?**

- **TCO** = Total Cost of Operations
- **Precision Line of Sight Warfare & Operational Networked Communications**
  - Precision Weapons With Terminal Guidance
  - Terminal Navigation
  - Time Synchrony within Network (Link 16)
  - High Mission Effectiveness
  - Increased Risk to Mission Success
  - High Cost / Low Volume = High TCO

- **Non-Precision Line of Sight Warfare & Operational Networked Communications**
  - Dismounted Weapons
  - Mounted Weapons
  - Troop Communications
  - Low Effectiveness
  - Low Cost / Low Volume = Low TCO

- **Precision Absolute PNT**
  - Precision Warfare & Strategic Networked Communications
    - Low-Cost Precision Weapons
    - Net-enabled Weapons (LRASM, JASSM)
    - Autonomous Navigation
    - Communication In/Out of Theatre
    - Highest Mission Effectiveness
    - Lowest Risk
    - Low Cost / Low Volume = Lowest TCO

- **Non-Precision Absolute PNT**
  - Non-Precision Maneuver, Area Weapons & Non-Networked Communications
    - Enroute Navigation
    - Indirect Fire Weapons (high volume)
    - Point to Point Communications
    - Increased Risk to Mission Success
    - Low Cost / High Volume = Highest TCO

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A PNT THREAT ENVIRONMENT MODEL

ASSURED PRECISION ABSOLUTE PNT THREAT ENVIRONMENT – SEVEN THREAT CONDITIONS EMERGE

Analysis of Missions & Platforms in this model reveals Requirements
A MULTI-SENSOR APPROACH TO APNT

ASSURED PNT – APPLICABLE TECHNOLOGIES & SOLUTION SPACE

Technologies available today to address threat conditions 1-5; in the works for conditions 6-7

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AJ Reduces Jammer Threats to Local Threats

Without CRPA AJ – 1KW jammer effective to >1,000 Km

With CRPA AJ – 1KW jammer only effective at <1 Km

J/S (TRACKING) VS RANGE

J/S vs. Jammer Power and Range

Tracking w/ CRPA AJ

Tracking w/ FRPA
SPECTRUM OF THREATS TO PNT

Impact Severity

Catastrophic

Very High

Probability

Very Low

Impact

Mission Impact

(relative to unprotected GPS)

Unprotected

Protected

No PNT

Prec PNT

Add AJ & AS

Add Inertial/Time

Other SATNAV with AJ/AS

Other Nav

Adversaries Working to Increase Probability - Augmentation Reduces Impact
SUMMARY

MAINTAINING ASSURED PRECISION ABSOLUTE PNT

• Modern world is dependent on Assured Precision Absolute PNT
• Threats to PNT are real and becoming more prevalent
• There is a strong need for a consistent threat model and definitions to enable analysis and requirements development
• There are technologies available today to solve the majority of threat conditions – GPS remains foundational to these solutions
• There are technologies in development to solve the threat conditions in which GPS is not available

Adoption of a Consistent Threat Model Enables Analysis of Requirements and Accelerates Development of APNT Solutions