A PTA program

and

Specific Challenges to PNT

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Supported by FAA, NASA, AND Aerospace Corp.

(All opinions are my own)

The National, Space-Based, Positioning, Navigation, and Timing (PNT) Advisory Board (**PNTAB**)

- Reports directly to the the ExCom (Deputy Secretaries of Defense, Transportation, Commerce, Interior, etc)
- Our ***Fundamental Purpose***:
  Assured PNT **(At required availability, accuracy and integrity)**

◆ PNTAB Generally meets 1 to 2 times per year.

PNTAB Actions to Assure PNT for all users

- **First** – Increase National Awareness of Value of GPS (and GNSS)

"Develop a Formal National Threat Model for PNT Applications in Critical Infrastructure:

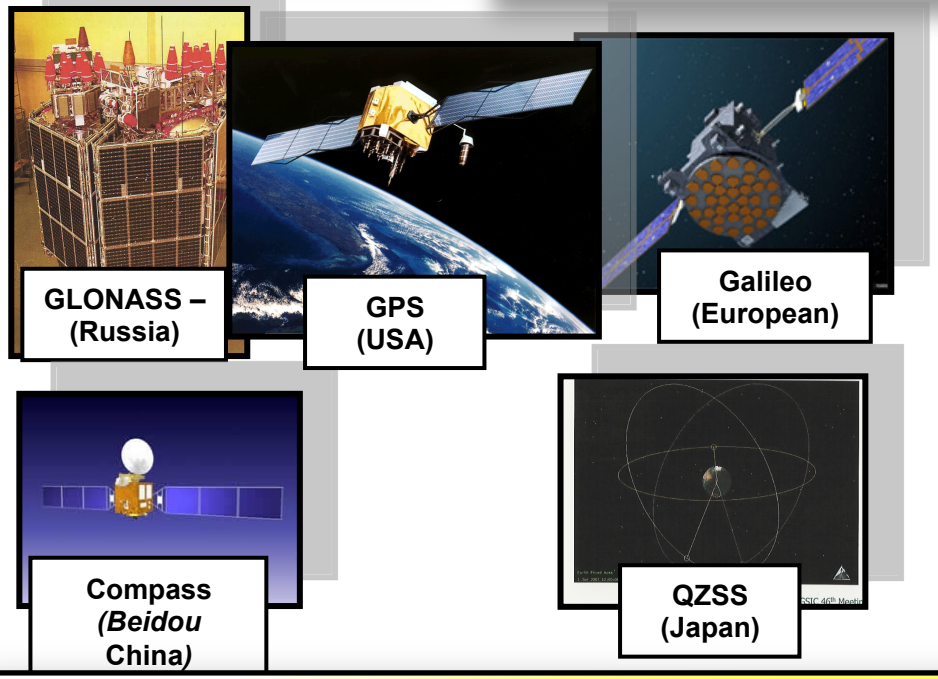
- **Second** – Implement specific steps to:
  - **Protect** Clear and Truthful Reception –
  - **Toughen User's Receivers**
  - **Augment** or substitute PNT sources

Assured Availability of PNT - "PTA"

Highlights in **Red** are PNTAB recommendations or Actions

Assured Availability of PNT - "PTA"

Augment or substitute PNT Sources



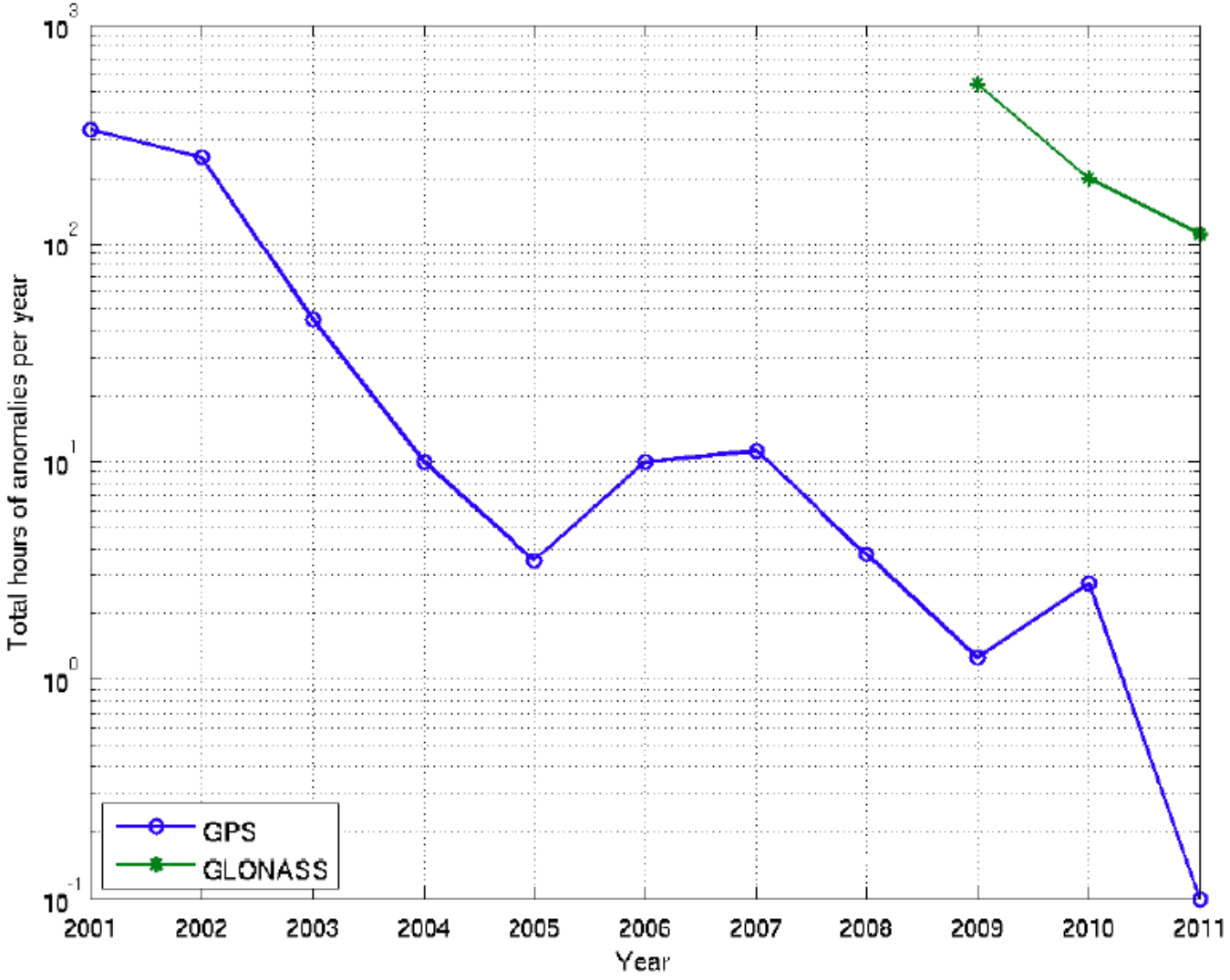
GNSS Community – both Toughen and Augment PNT

Two valuable consequences of using all GNSS:

- **Diversify (for GPS signal denied) and**
- **Densify (for sky-impaired)**

Effectiveness driven by # of operational constellations, constellation size, *AND their Integrity*

Bathtub Challenge (from Liang Heng)

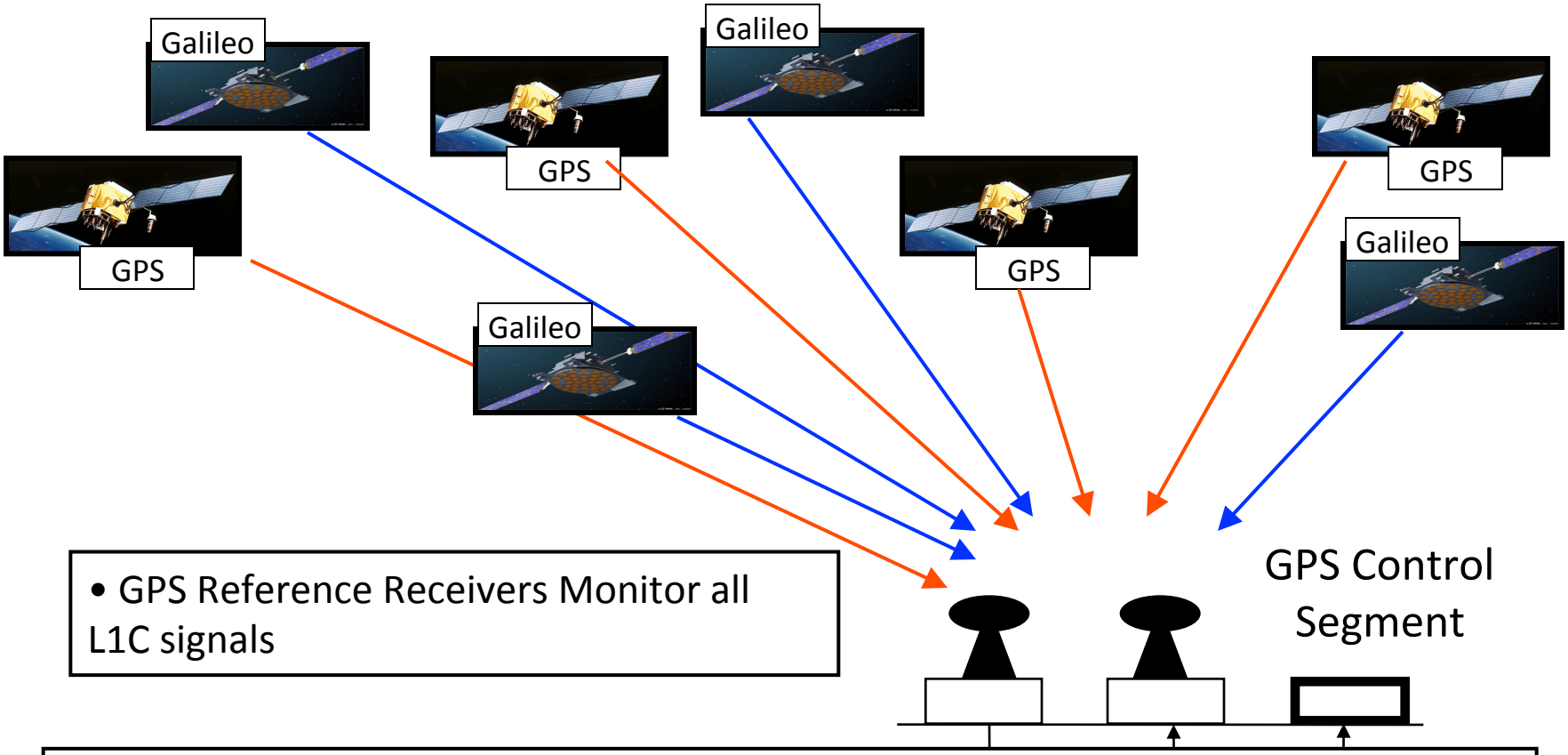


Major Barriers to Use of All GNSS

1. Establishing Integrity – major techniques
   - Inherent GNSS integrity
     - Requires knowledge of system failure modes and history
   - Self Integrity Monitoring – (RAIM/ARIM)
   - External Monitoring and Timely Alerts to users
     - WAAS, EGNOS, MSAS, GDGPS …
2. Permissions to use (Licensing)
   - US is working on this issue

A New Proposal - CARS : GPS/Galileo Example

First Step: Monitor the "*other*" constellation signals



- GPS Reference Receivers Monitor all L1C signals

- GPS Master Control Calculates a WAAS/EGNOS correction and integrity assessment for each GPS satellite –***for operation in the Galileo Constellation***
- ***Galileo Does the same***

Emphasizing – *For many uses* *(e.g.* ***Aircraft and Safety of Life)***

Availability and Accuracy of the signals is insufficient

Integrity is also required for ***adoption***

- Availability of PNT with both:
  - *Required Accuracy*
    - PNT 2σ accuracy + Inaccuracy "bound" (3 or 4σ)

      and
  - ***and Required Integrity:***
- **Probability that expected accuracy is not exceeded**

– "Continue to implement ARAIM & inertial for Integrity (+WAAS/EGNOS/MSAS + …)"