Emerging Capabilities, Applications, and Sectors Subcommittee report

PNT Advisory Board

Annapolis, MD
3 May 2023

Contents

ECAS Subcommittee

Members	Role/ Study Areas:
Frank van Diggelen, Chair Penny Axelrad, 1st Vice-Chair Scott Burgett, 2nd Vice-Chair Renato Filjar Dorota Greiner-Brzezinska Matt Higgins Vahid Madani Terry Moore Jade Morton Tim Murphy Tom Powell Eileen Reilly Russ Shields Todd Walter	• *GNSS High Accuracy Services* • *Inter satellite comms* • *Cislunar Service Volume* • *Intelligent Transportation Systems* • *Unmanned Aerial Systems* • *MEOSAR (Medium Earth Orbit Search & Rescue)* • *Integrated Energy Grid Concept* • *Comm. Networks* • *Positive Train Control*

Areas of current interest

- HARS (High Accuracy and Robustness Service)
  active work
- PPP for ITS, Unmanned aerial systems, and Train Control
  see work by International Engagement Committee
- Inter satellite comms
  future area of interest
- Expanded GPS service volume
  GEO (current) to Cislunar (future)

Invited speakers

	• Strategy, Policy, & Governance (SPG)	• Mr. Jeff Shane
12:30-1:30 (1 hr)	**LUNCH *(Queen Anne Ballroom)***	
	Theme 2: Emerging GNSS Capabilities & Alternative PNT – Synergies with GPS?	
1:30-2:00 (30 min)	Galileo High Accuracy Service (HAS) & Open Service Navigation Authentication (OSNMA) – *virtual briefer*	Ms. Fiammetta Diani, *Head, Market Development, European Agency for Space Programme (EUSPA), Prague, Czechia*
2:00-2:30 (30 min)	China's Strategic Approach to the Leveraging of its BeiDou System – *virtual briefer*	Dr. Sarah Sewall, *Executive Vice President, Strategic Issues, InQTel*
2:30-3:00 (30 min)	PNT as a Service (PNTaaS) Solution Benefits	Dr. Alison Brown, *President & CEO, NAVSYS Corporation*
3:00-3:15 (15 min)	**BREAK**	

GPS HARS
High Accuracy & Robustness Service

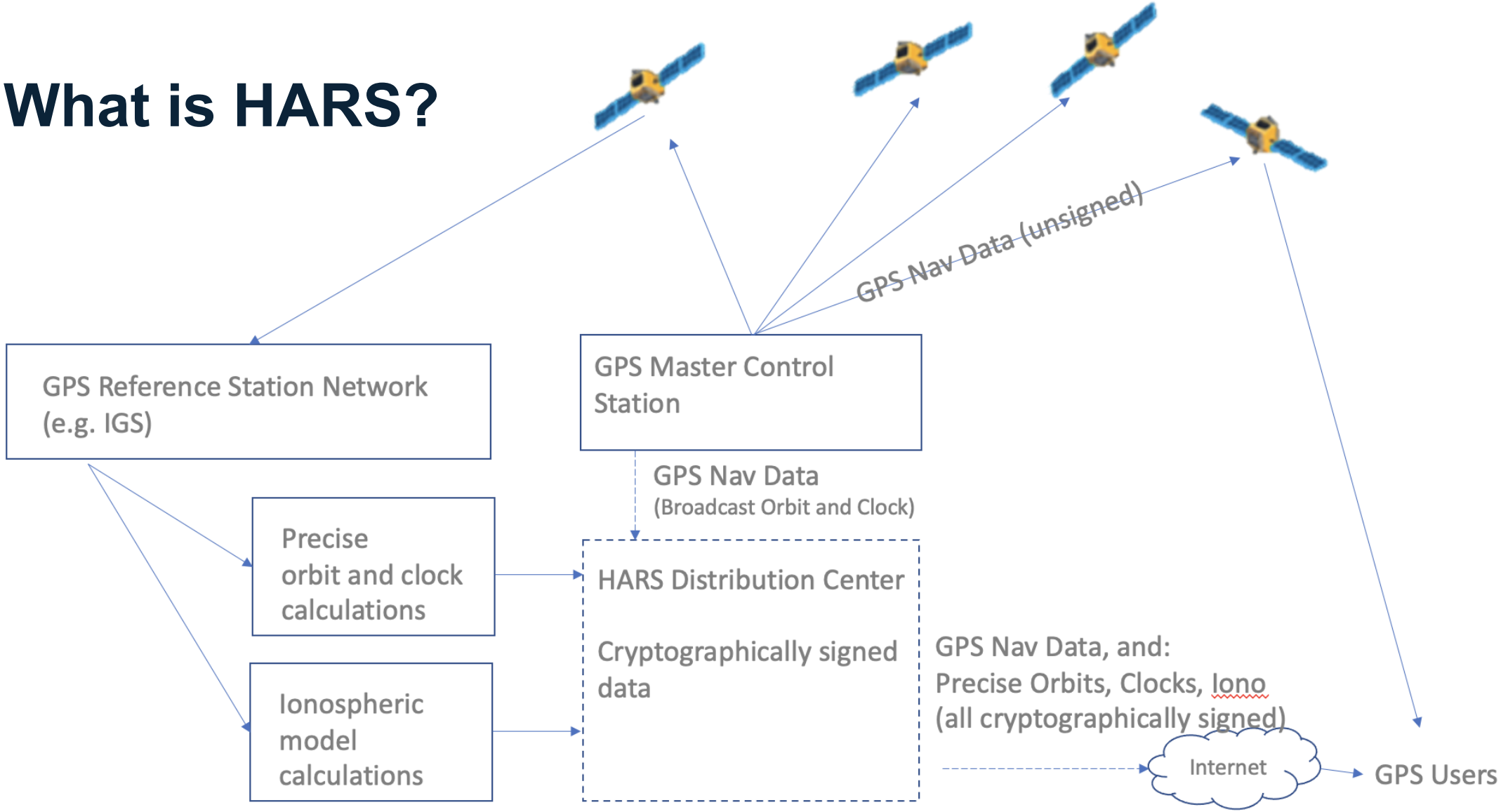
PNT Advisory Board

V1.0
3 May 2023

Contents

1. What is HARS?
2. Benefits: Accuracy, Robustness, National
3. Other GNSS
4. Internet vs Satellite Based data
5. Who can do this?
6. What is needed next.

1. What is HARS?



Satellite orbit & clock, ionosphere corrections,
and Nav data bits, cryptographically signed, over the Internet .

Accuracy Benefits

- Better accuracy benefits almost all user applications
- Specifically: accuracy in phones and cars, improves from ~3m to <1m

⇒ Good enough for lane-level accuracy

⇒ Lane-level traffic

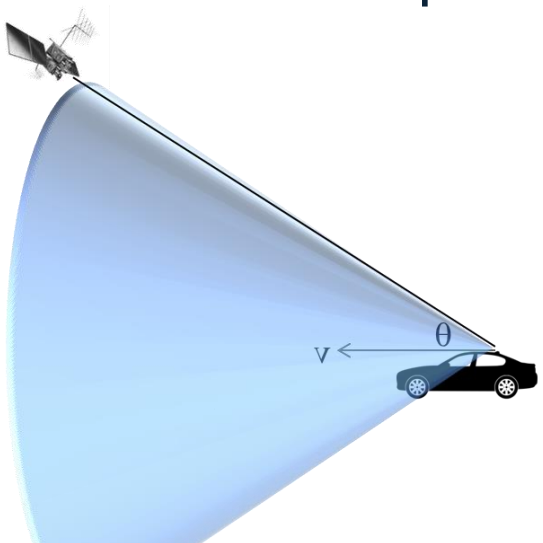
⇒ Improved traffic flow from:

  - Better navigation in apps
  - Real-time knowledge of blocked/closed lanes
  - Better dispatch of emergency vehicles

Robustness Benefits

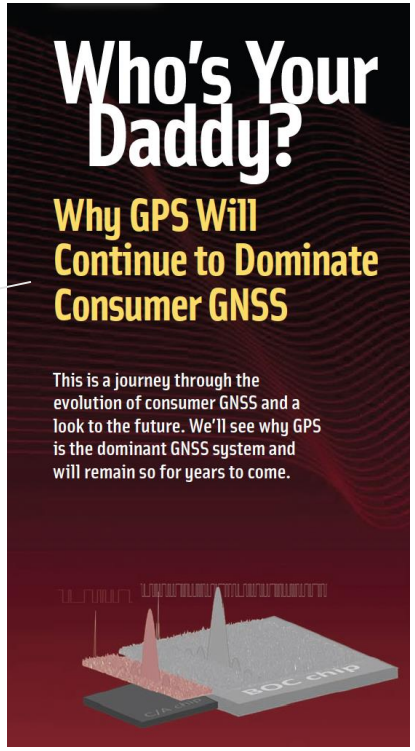
- GPS is vulnerable to spoofing
  - Encrypted digital signatures fix this for data-spoofing
- GPS is weak
  - NAV data bits enable signal processing to boost weak signals

  (through longer coherent integration)
  - Long coherent integration enables “super-correlation” which provides directional gain from antennas. And adds robustness to spoofing.



National Benefits

- GPS has been the premier satnav system to date
  i.e. all consumer GNSS chips depend primarily on GPS,
  other constellations are secondary
- This will change if GPS falls behind in features and performance



"*Who's Your Daddy?, Why GPS will continue to dominate consumer GNSS*", Frank van Diggelen, Stanford PNT Symposium 2013. And: Inside GNSS Magazine Mar-Apr 2014.

3. Other systems: accuracy and robustness services for consumers

- Galileo
  - HAS (High Accuracy Service), incl Internet
  - Nav message authentication
- BeiDou
  - GAS (Ground Augmentation Service) via Internet
  - PPP B2b (Broadcast PPP signals on B2 == L5)
- SBAS (WAAS, EGNOS, etc)
  - Broadcast satellite data not useful to phones in cars, because data bits cannot be decoded.
  - But: very useful if distributed via Internet

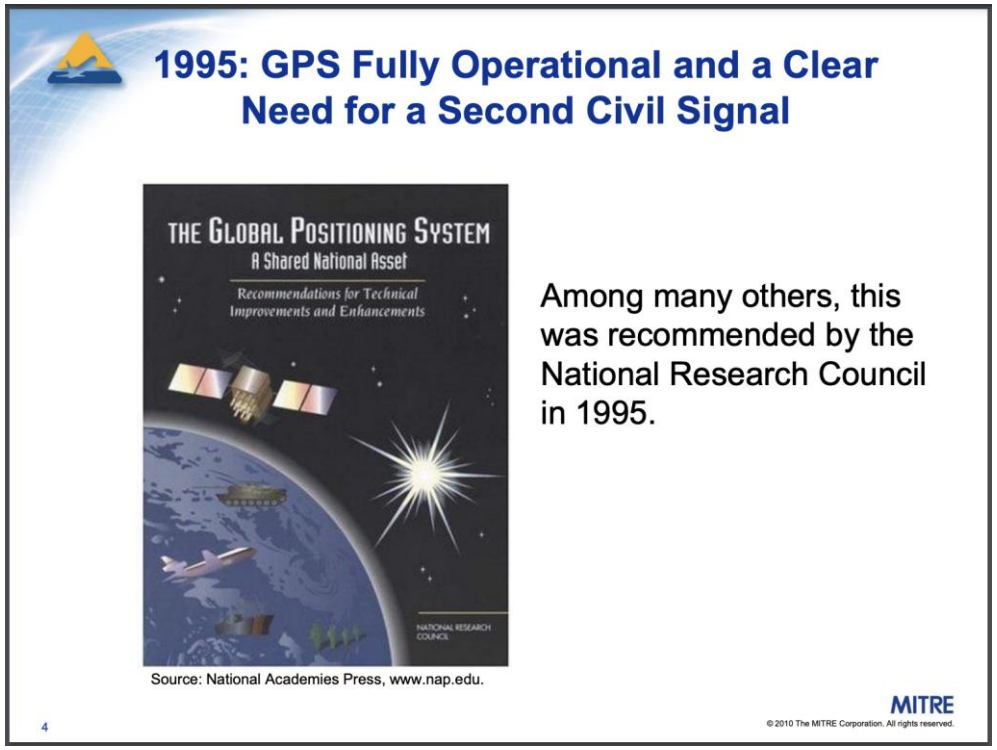
Table 1 The BDS Service Plan

Service Types		Signal(s)/Band(s)	Broadcast Satellites
Worldwide	Positioning, Navigation and Timing (RNSS)	B1I, B3I	3GEO+3IGSO+24MEO
		B1C, B2a, B2b	3IGSO+24MEO
	Global Short Message Communication (GSMC)	Uplink: L Downlink: GSMC-B2b	Uplink: 14MEO Downlink: 3IGSO+24MEO
	International Search And Rescue (SAR)	Uplink: UHF Downlink: SAR-B2b	Uplink: 6MEO Downlink: 3IGSO+24MEO
China and Surrounding Areas	Satellite-based Augmentation System (SBAS)	BDSBAS-B1C, BDSBAS-B2a	3GEO
	Ground Augmentation System (GAS)	2G, 3G, 4G, 5G	Mobile communication networks, Internet
	Precise Point Positioning (PPP)	PPP-B2b	3GEO
	Regional Short Message Communication (RSMC)	Uplink: L Downlink: S	3GEO

Note: China and surrounding areas means 75°E to 135 °E, 10°N to 55°N

4. Internet based vs Satellite Based

- 2-3 years vs 20-30 years
- Stronger encryption via Internet



L5 was proposed in 1995.
28 years later, we have 18 (of 31) GPS satellites with L5.

"*A Brief History of GPS L5*" Chris Hegarty, Stanford PNT Symposium, Nov 2010.
L5 proposed 1995, Signal Specification published 2000, first launch 2010.

5. Who can do this?

- DOT is already pursuing Out Of Band navigation message authentication.
- WAAS already has corrections for improved accuracy
- The GDGPS study from the PNT Advisory Board showed that the JPL GDGPS service is one example of how HARS corrections for orbits and clocks can be computed.

6. What is needed next

- We need an owner, such as DOT or DOD, who can fund and implement the High Accuracy and Robustness Service for GPS.