Emerging Capabilities, Applications, and Sectors (ECAS) subcommittee

May 4, 2022

Members:	**Role/ Study Areas:**
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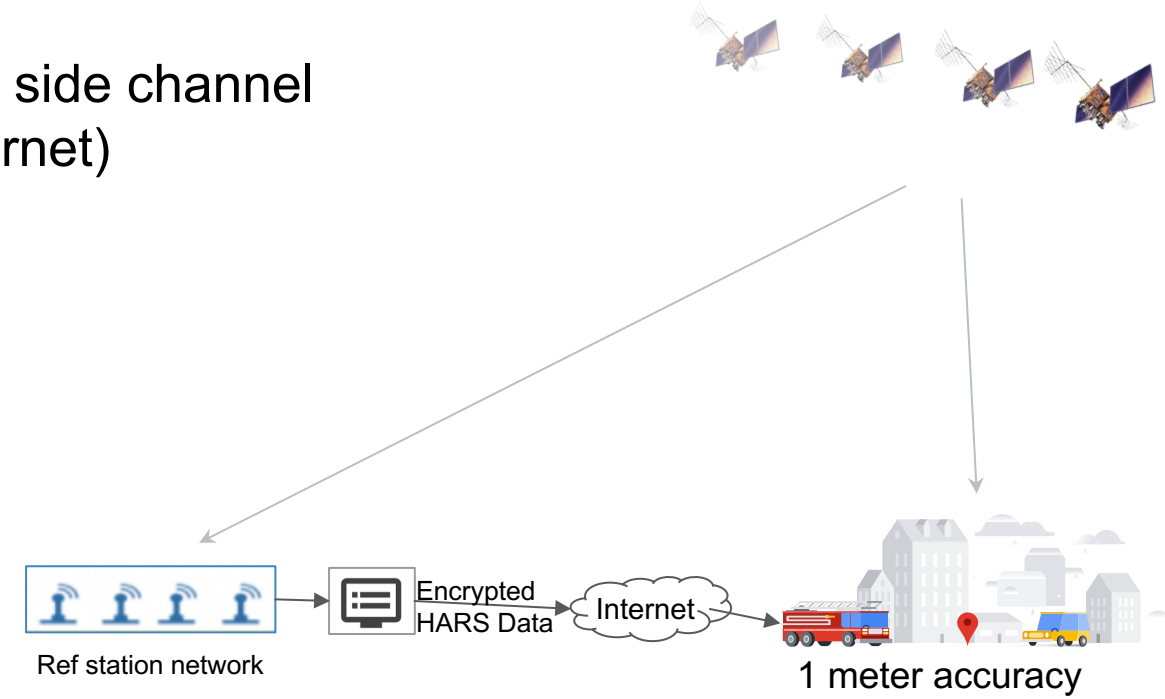
Last update: 2022/05/04

The need and benefits of GPS HARS (High Accuracy & Resilience Service)

Proposal: GPS HARS over a side channel (encrypted data over the Internet)

a) achievable in the near term
b) matches Galileo HAS



User accuracy with HARS: 1m, horizontal. 95% for patch antennas (e.g. cars), 50% for phones.

Maintaining GPS Leadership

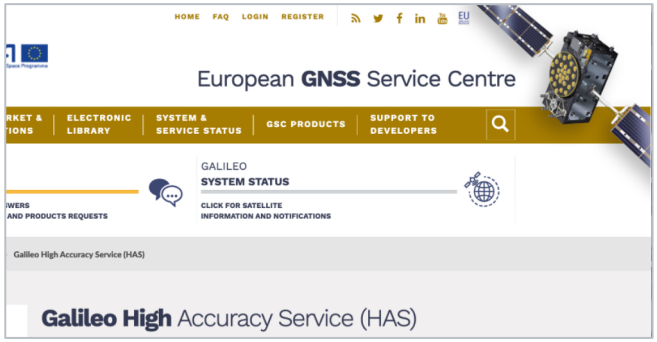
National Space Policy 9 December 2020:
"The U.S. must maintain its leadership in the service, provision, and responsible use of GNSS" [1]

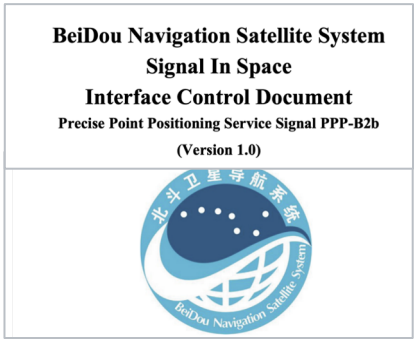
Galileo, QZSS, BeiDou: all now provide High Accuracy Services in their broadcast signals.

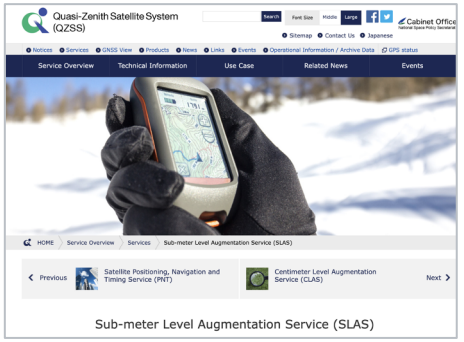
Galileo HAS will also be distributed over the internet.

GPS will provide corrections *and Nav data* (orbit & clock) as part of HA*R*S.

Keep GNSS chips manufactured as *GPS First* [2,3]







[1] U.S. Space-Based PNT Policy Update March 2022, H.W. Martin III, Director, National Coordination Office, link
[2] "*Who's your Daddy? Why GPS rules GNSS*", F. van Diggelen, Keynote. Stanford PNT Symposium, Nov 2013, link
[3] "*Who's Your Daddy? Why GPS will continue to dominate consumer GNSS",* F. van Diggelen, Inside GNSS, Mar/Apr 2014, link

Security and Robustness of GPS

Encrypted Nav data over the internet increases security and robustness of GPS.

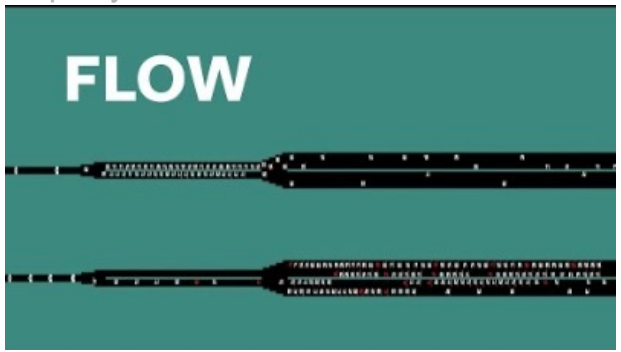
GPS HARS enhances and adds robustness: receivers don’t need to rely on the open data service broadcast from space.

Also, expands opportunities for energy efficient snapshot approaches, and long-coherent integration for more sensitivity.

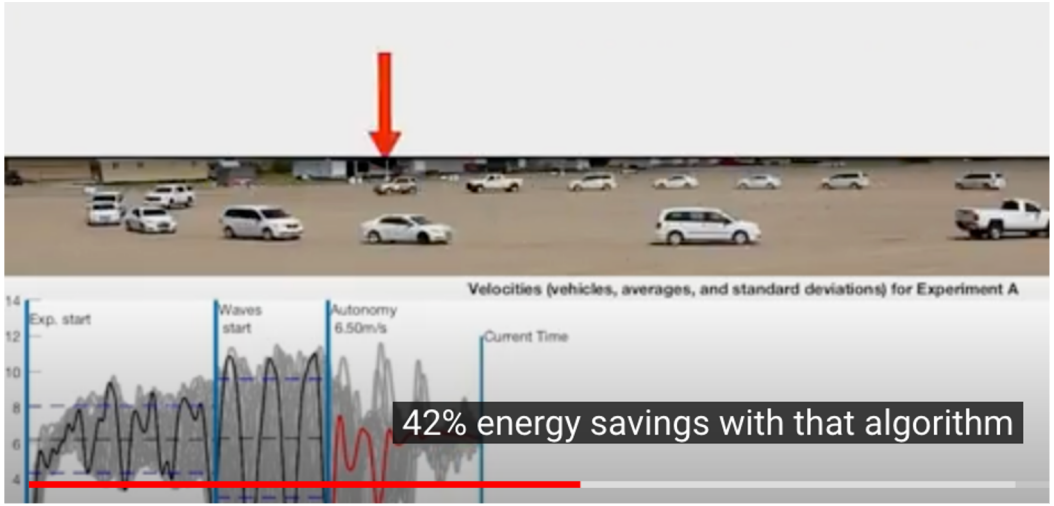
Enhancing driving efficiency and safety

GPS is infrastructure, it already directly benefits the US road system

Improved GPS accuracy (5m to 1m) enables traffic management systems
e.g. this 2 minute video
https://youtu.be/P7xx9uH2i7w



Energy savings →



Also, see keynote from ION ITM, Jan 2022: https://www.ion.org/itm/plenary.html

US Consumers

Almost all* consumer GPS products are now connected to the (wireless) internet.

All benefit seamlessly as applications (such as traffic management) are integrated.

GDGPS corrections can be generated by JPL, but distributed to the end uses through commercial companies that redistribute the data.

- This is how A-GPS has been implemented for every US smartphone user.
- Also opens commercial opportunities (see next slide*)

* not only phones: watches, cars, tablets, and many other GPS devices are now connected.

Why HARS belongs in the GPS itself

National Space Policy 9 December 2020:
“Provide continuous worldwide access for peaceful civil uses free of direct user fees” **

Private industry provides service for RTK, cm and decimeter apps (e.g Trimble, etc).
Only government has provided corrections for ~one meter accuracy:

- USCG DGPS service
- Galileo HAS

The HARS choice is not: Gov. vs Industry, it is Gov. vs Nothing

Also, the distribution of HARS provides commercial opportunities to industry: they can provide value add with their own distribution. (see prev slide*)

** Source: U.S. Space-Based PNT Policy Update March 2022, Harold W. Martin III, Director, National Coordination Office

Conclusion

GPS HARS:

- Can be implemented without any changes to the GPS satellites
- The pieces exist, and just need to be assembled and managed:
  - GDGPS
  - Mass distribution through commercial providers (Apple, Google, Cellular Carriers)
  - $M tens not $M hundreds
- Encrypted data over the internet adds accuracy *and* resilience
- Enhances safety and efficiency on US roads
- Keeps GPS as the lead system in GNSS

extra slides follow …

Further ideas for the future (beyond initial GPS HARS development)

● Two gov't sources providing estimates that could be cross-checked to protect against a failure or cyber issue with one	
● Future broadcast over the satellite signal itself. Maybe for GPS 4.	There is no current signal that has the data rate, and too difficult currently for the GPS infrastructure (monitoring and control, satellites, signals) to be changed do this.
● Different levels of accuracy, e.g. Decimeters	This is what QZSS does. Raises issues of competition with commercial companies. The need today is to match the 1m accuracy of Galileo HAS, keep GPS as primary GNSS, and provide the benefits to the US consumer.