Augmenting GPS Use with the High Accuracy and Robustness Service (HARS)

John Betz
Frank van Diggelen
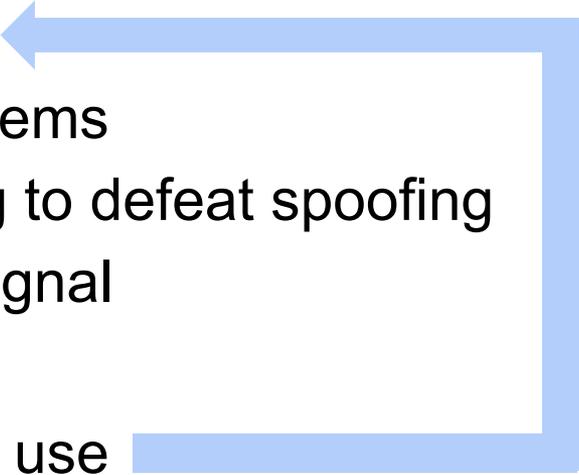
9 September 2025

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Civil PNT in the U.S. Needs "PTA"

- **P**rotecting GPS use
  - Preventing or promptly removing significant interference sources
- **T**oughening GPS use
  - Antijam antenna systems
  - Logic and processing to defeat spoofing
  - Use of the GPS L5 signal
- **A**ugmenting GPS use
  - Aids to improve GPS use
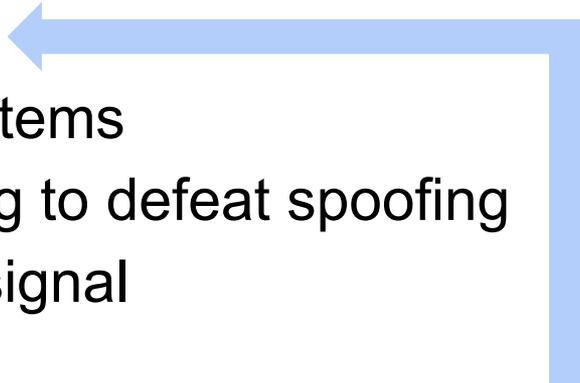 - Robust and capable backups

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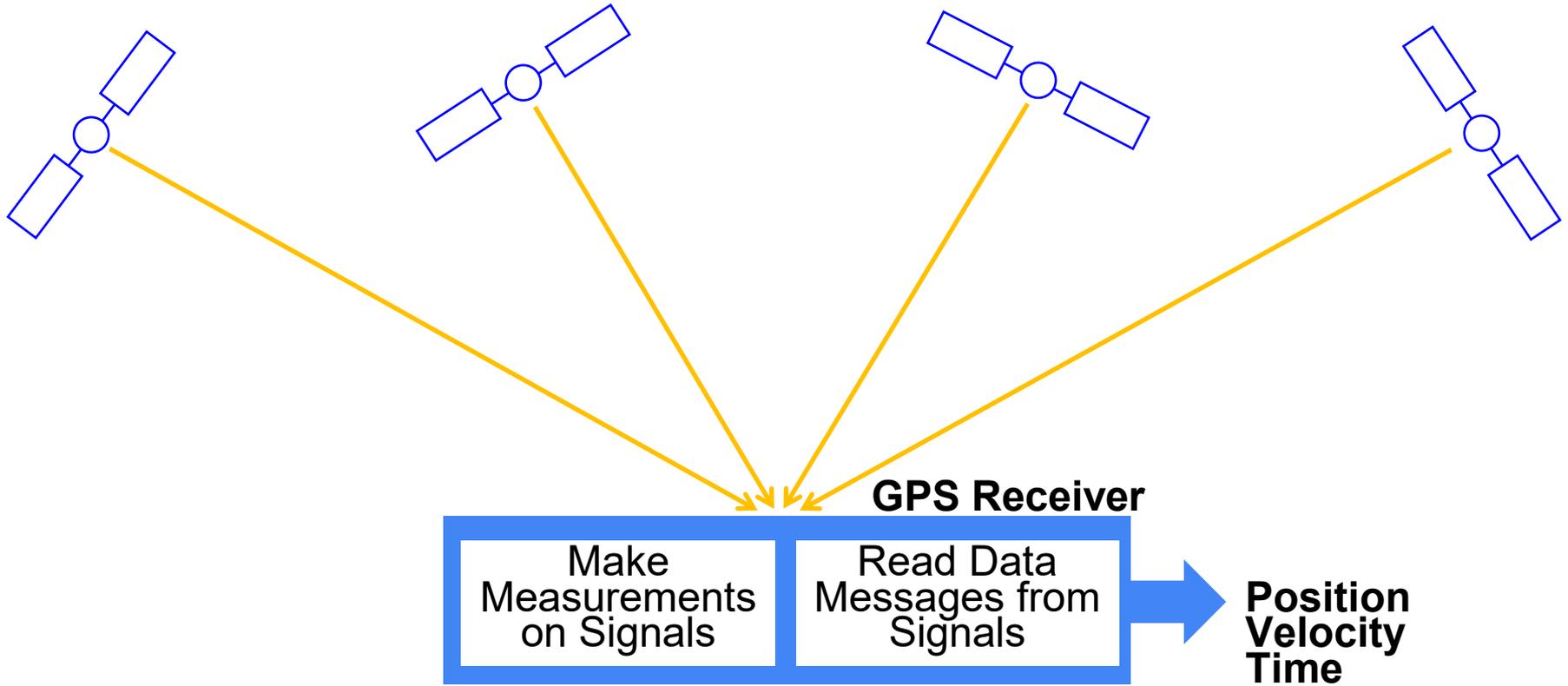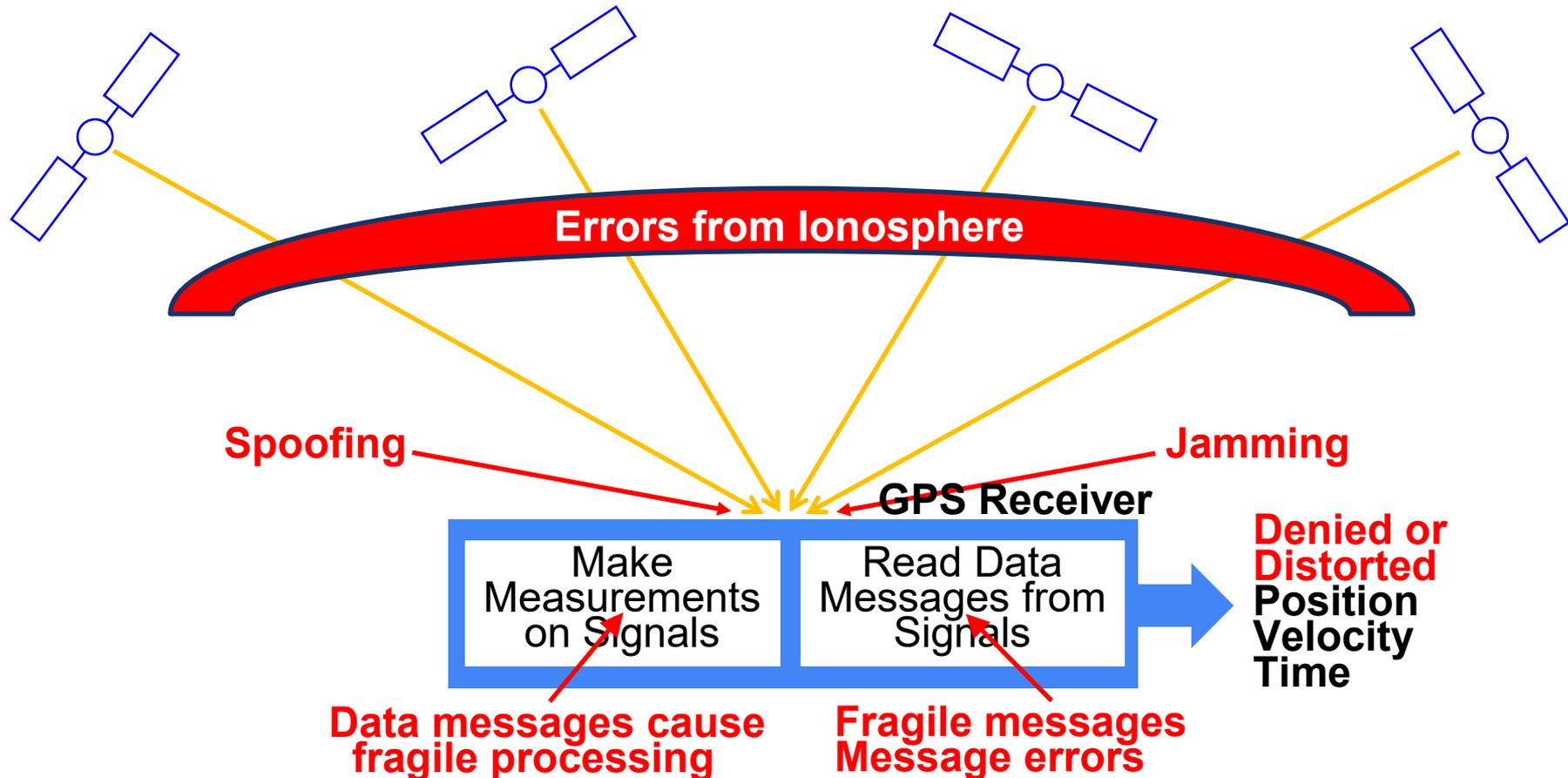
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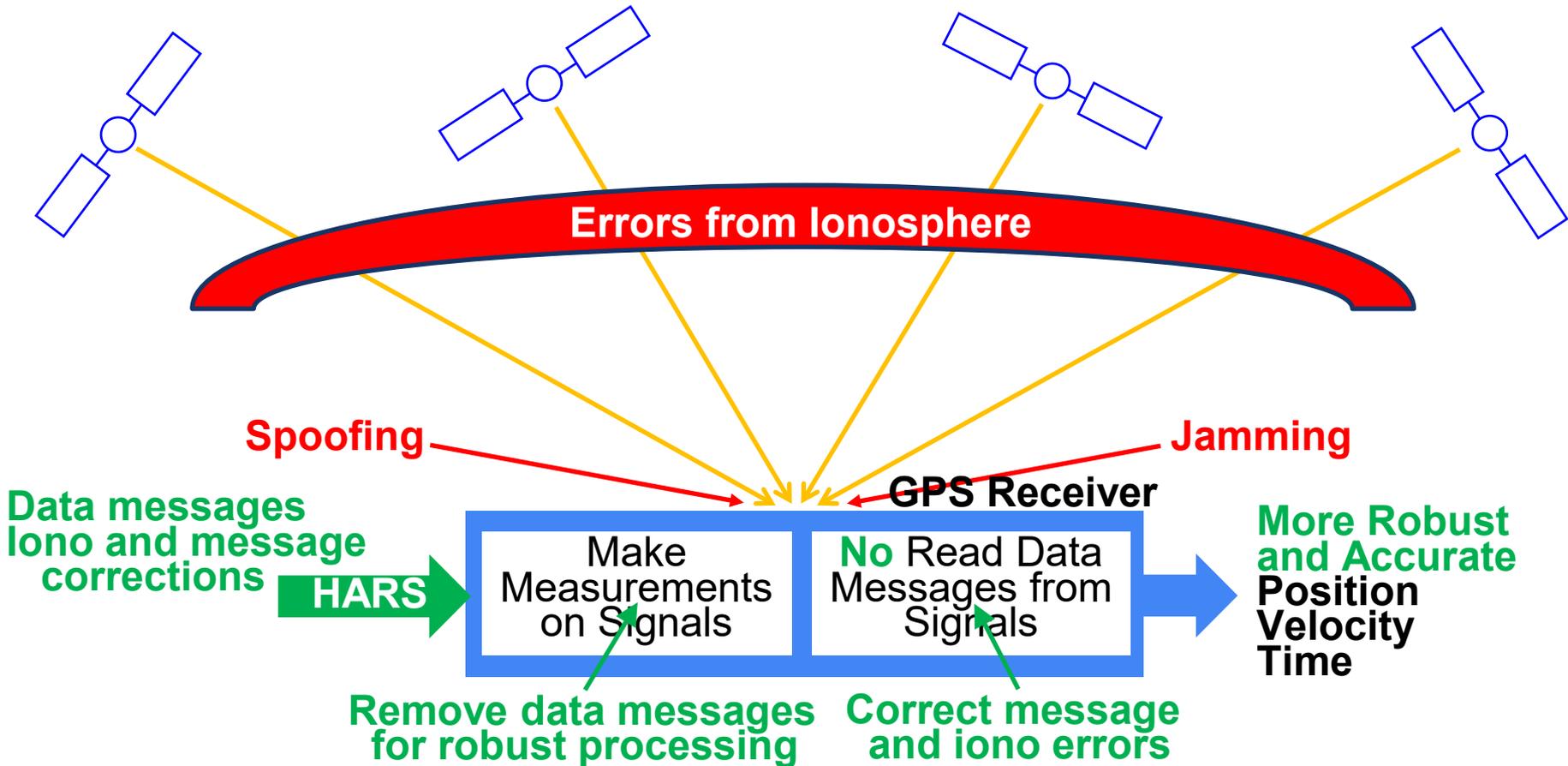
High Accuracy and Robustness Service (HARS)

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Receivers Process Signals Broadcast by GPS Satellites

GPS Receiver

| Make Measurements on Signals | Read Data Messages from Signals |

→ **Position Velocity Time**

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Limitations and Degradations to Receiver Performance

Errors from Ionosphere

Spoofing

Jamming

GPS Receiver

Make Measurements on Signals

Read Data Messages from Signals

Denied or Distorted Position Velocity Time

Data messages cause fragile processing

Fragile messages Message errors

HARS Mitigates Limitations and Degradations

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What's Needed for HARS?
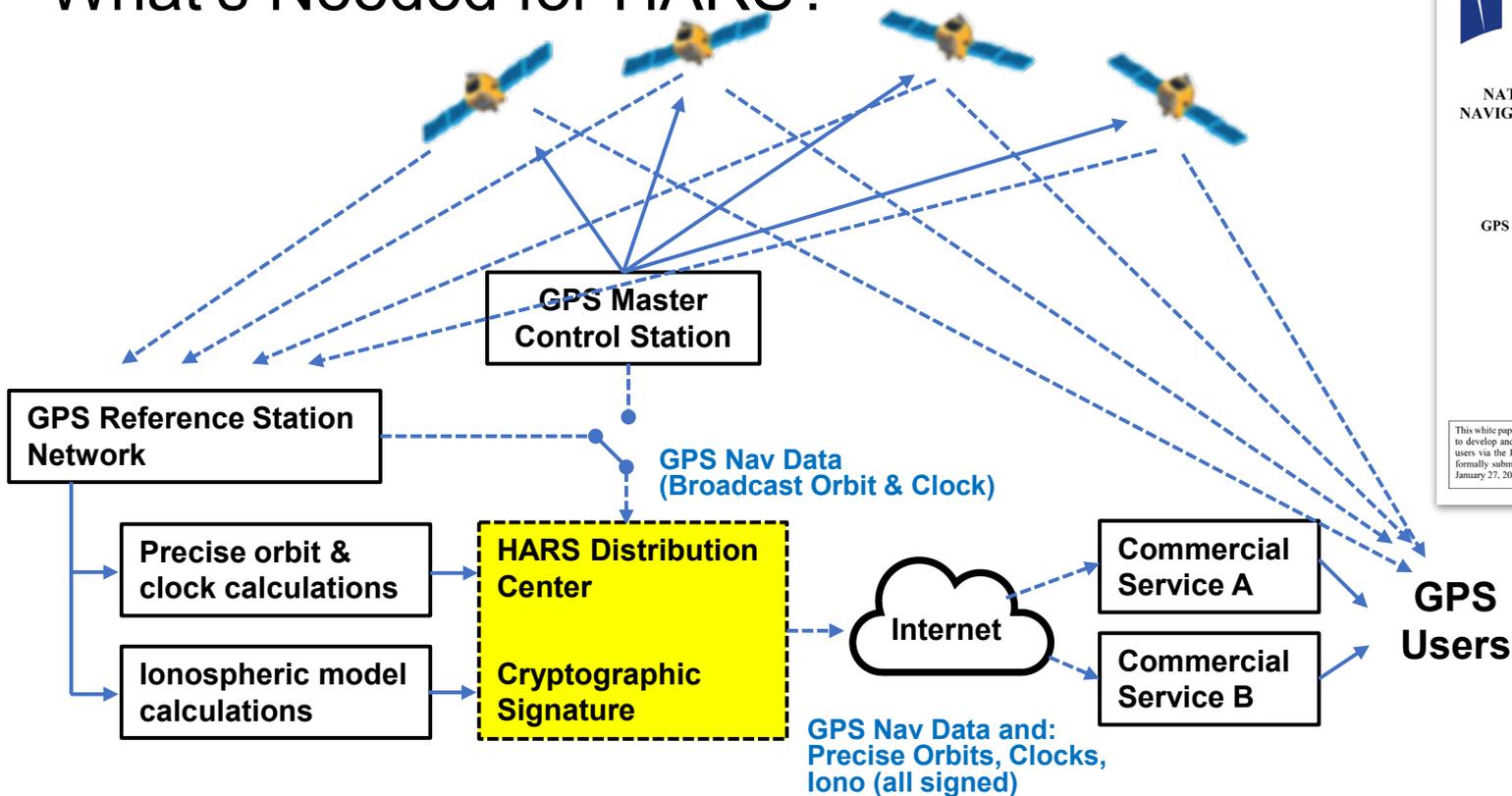
- **Government provides portal with cryptographically signed information**
  - Reference stations and facilities performing calculations already exist
- **Commercial services provide information to receivers**

HARS Fundamentally Improves GPS

- Enables receivers to increase robustness of measurements
  - Fourfold improvement for legacy GPS C/A signal
  - Eightfold improvement for GPS L1 signals
  - Twofold improvement for most other signals
- Averts data spoofing with cryptographically protected data message
- Improves accuracy, cutting positioning errors in half
  - Example application: lane-by-lane driving instructions
- Enhances GPS's competitiviness with Galileo and BeiDou, which already provide high accuracy corrections
  - No changes to satellites or broadcast signals
- Consumer receiver manufacturers eager for HARS

What part of the U.S. Government will develop, operate, and sustain HARS?

Source: *Nav data bits for increasing sensitivity and robustness,* van Diggelen, Murphy, Betz, ION GNSS+ Conference, 2024.

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