# GNSS is an Incredible…

# …y Flawed Technology

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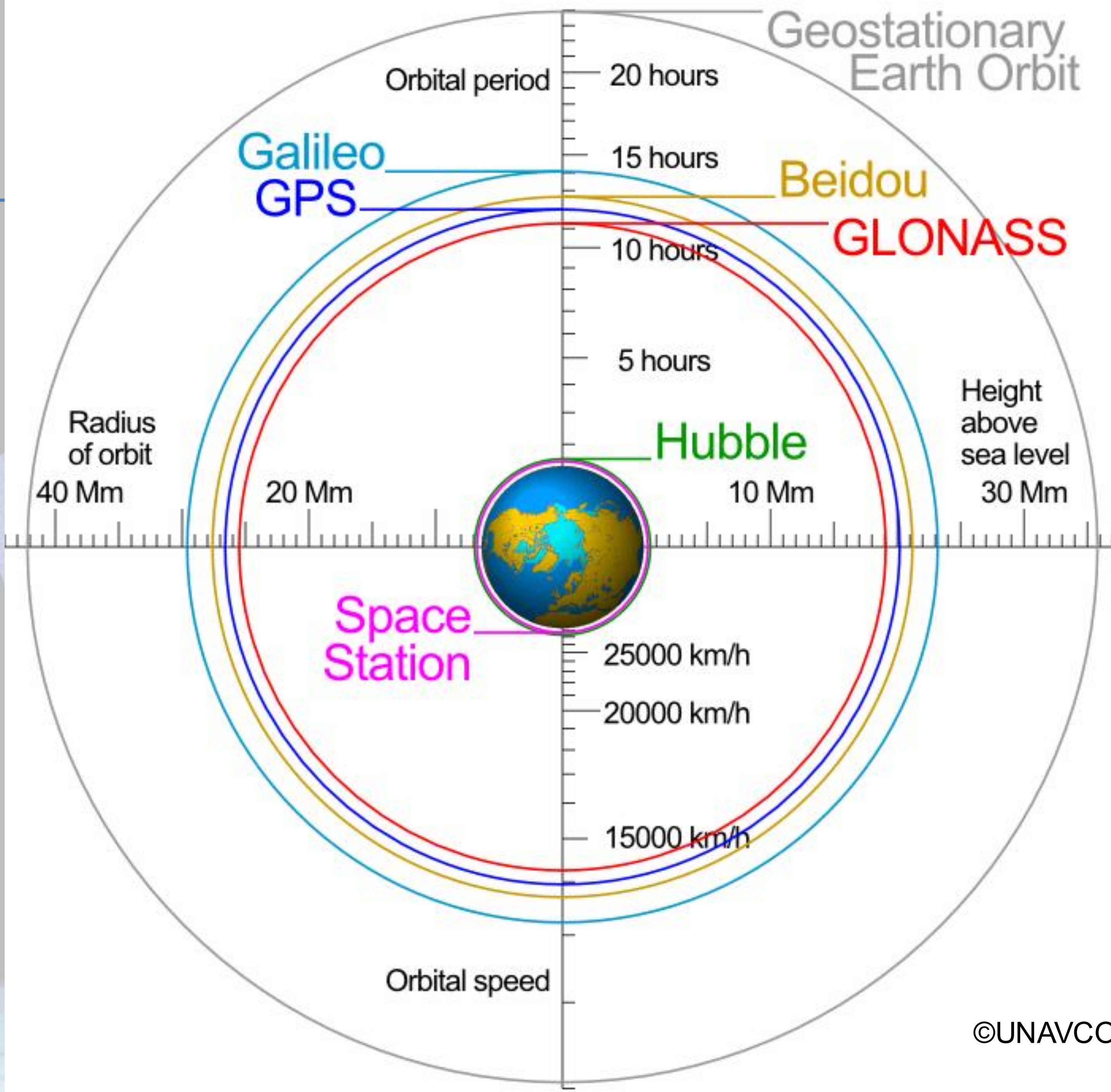
# GNSS

- **GPS:** US Space Force constellation of ~31 satellites.
- **Glonass:** Russian constellation of ~24 satellites.
- **Galileo:** European Union constellation of ~24 satellites.
- **BeiDou:** Chinese constellation of ~30 global satellites.

# Common GNSS Correction Types

- **SBAS:** Satellite-Based Augmentation System. Real-time sub-meter GNSS accuracy.
- **RTK:** Real-time Kinematic. Real-time, sub-inch GNSS accuracy.
- **RTK Base Station:** Sends RTK corrections to RTK users in the field, usually via internet.


Geostationary Earth Orbit
Orbital period
20 hours
15 hours
10 hours
5 hours
Galileo
GPS
Beidou
GLONASS
Hubble
Radius of orbit
40 Mm
20 Mm
10 Mm
Height above sea level
30 Mm
Space Station
25000 km/h
20000 km/h
15000 km/h
Orbital speed

# Look how far High-Accuracy GNSS has come!

- **1980's - Mission planning, post-processing. Meters of accuracy. GPS-only.**
  - **Midnight missions to collect hours of data. Meters of accuracy.**
- **1990's - GPS fully operational, and the dawn of GPS RTK**
  - **Commercial GPS receiver competition heats up.**
- **2000's – Glonass matures. SBAS, RTK Networks emerge**
  - **Glonass boosts RTK productivity. States begin deploying RTK networks. SBAS enables free and ubiquitous < 1 meter accuracy**
- **2010's – Beidou and Galileo step up.**
  - **GNSS satellite constellation size grows. Field productivity improved.**
- **2020's – Four constellations fully deployed. No more.**
  - **RTK bases upgraded. Field productivity improves more. Automotive markets drive GNSS chipset pricing down.**

# Has High-accuracy GNSS Technology plateaued?

- **For four decades, the focus to improve GNSS has been on fully populating the constellations and adding better signals, each improving performance.**
- **The constellations are now fully populated and only launch replenishments when necessary. The new satellites offer marginal increase in performance.**

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- **There are no more significant plans in the space infrastructure that will improve GNSS receiver performance on Earth.**
- **Why is that a problem?**

# The GNSS Technology Flaw

- **Even with four fully deployed constellations, it still doesn't always work where we want it to work.**

# GNSS Test Course

# The GNSS Technology Flaw

- **GNSS signals are very weak, and broadcast from 12,000 miles in space.**
- **High-accuracy GNSS requires a line-of-sight connection between the satellites and the GNSS receiver on the ground.**
- **Signals can be blocked or dithered or reflected by trees, buildings, terrain and even your body.**
- **This limitation frustrates users and project managers alike.**
- **And…**

# The GNSS Technology Flaw

- **Up to this point, we've discussed unintended consequences of weak GNSS signals. However, there are people who possess ill intentions:**

**2013 - GPS jamming device (illegal) used near Newark airport by a person who wanted to disable**

**his company's GPS tracking system.**

**$32,000 penalty proposed by the FCC**

# The GNSS Technology Flaw

- **Up to this point, we've discussed unintended consequences of weak GNSS signals**
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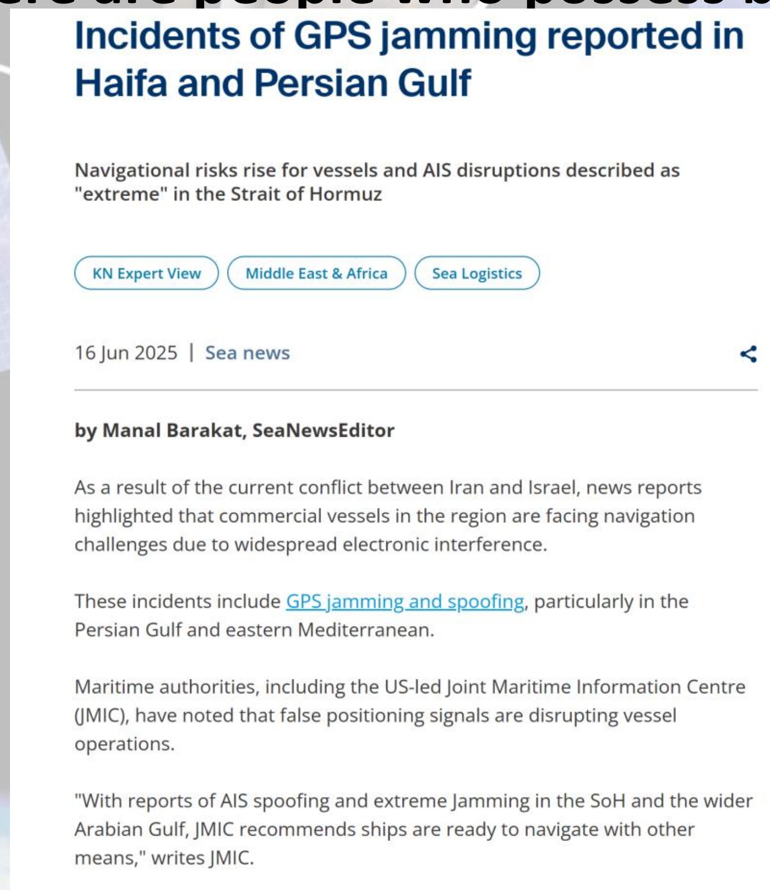


## Incidents of GPS jamming reported in Haifa and Persian Gulf

Navigational risks rise for vessels and AIS disruptions described as "extreme" in the Strait of Hormuz

KN Expert View | Middle East & Africa | Sea Logistics

16 Jun 2025 | Sea news

**by Manal Barakat, SeaNewsEditor**

As a result of the current conflict between Iran and Israel, news reports highlighted that commercial vessels in the region are facing navigation challenges due to widespread electronic interference.

These incidents include GPS jamming and spoofing, particularly in the Persian Gulf and eastern Mediterranean.

Maritime authorities, including the US-led Joint Maritime Information Centre (JMIC), have noted that false positioning signals are disrupting vessel operations.

"With reports of AIS spoofing and extreme Jamming in the SoH and the wider Arabian Gulf, JMIC recommends ships are ready to navigate with other means," writes JMIC.

# The GNSS Technology Flaw

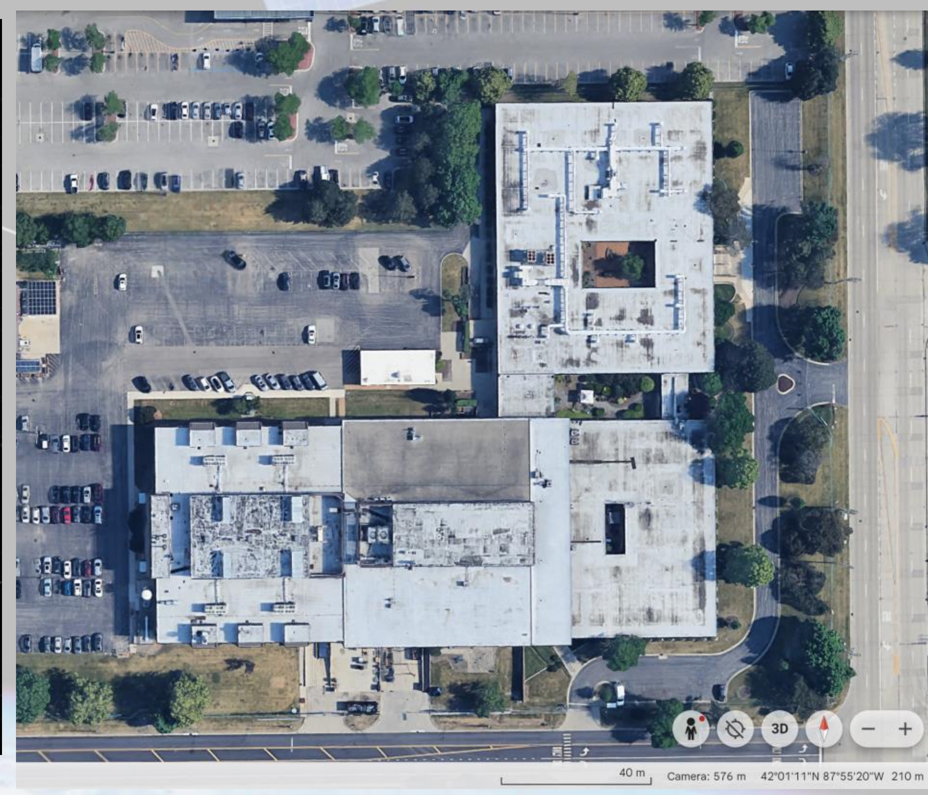
- **What are we doing about this problem?**

- **PNT Exec committee back-up proposal**

- **““Section 1618” of the Fiscal Year (FY) 2017 National Defense Authorization Act (NDAA) (P.L.114-328; December 23, 2016) requires the U.S. Department of Homeland Security (DHS) to address the needs for a GPS backup by identifying and assessing viable alternate technologies and systems.”**

# Lat/Lon/Height – The Earth's barcode

- **High-accuracy GNSS is great for getting us close. Every inch on Earth is assigned a unique ID (latitude/longitude/elevation) whether GNSS works at that location or not. Example, a valve in the GTI building basement has a unique lat/lon/height but can't be mapped.**

# A Solution – Sensor Integration

- While GNSS can get us close, other sensors can assist in finishing the last mile.
- Sensors don’t have a frame of reference (e.g. Lat/Lon/Height), so they need a starting position from GNSS.
- Mobile devices and other consumer electronics have driven sensor R&D over the past 15 years towards higher-performance, smaller size and lower cost.
- What are some of the sensors?

# IMU (Inertial Measurement Unit)

- **A combination of gyroscopes and accelerometers that measure movement, angular rate and orientation.**
- **Applications:**

**Smartphones**

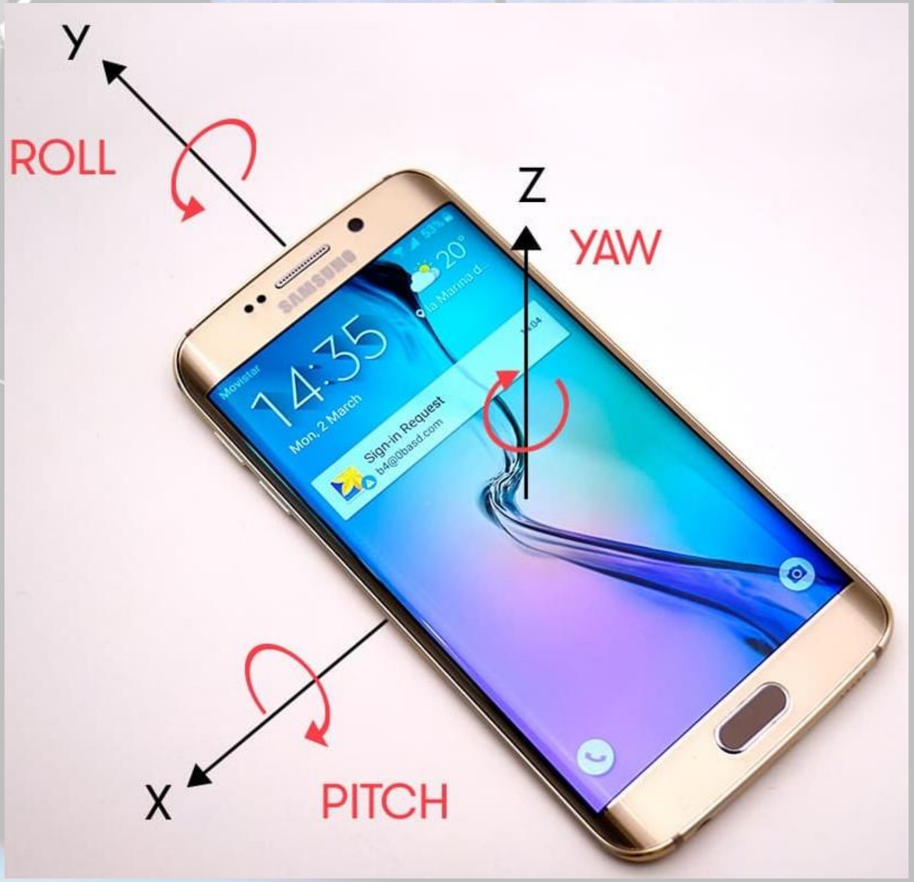
**Image stabilization in cameras**

**VR headsets**

**Smart watches**

**Drones**

**Assisted and self-driving vehicles**



# Lidar (LIght Detection And Ranging)

- **Uses a laser to measure time (thus distance) for the reflected light to return.**
- **Applications:**

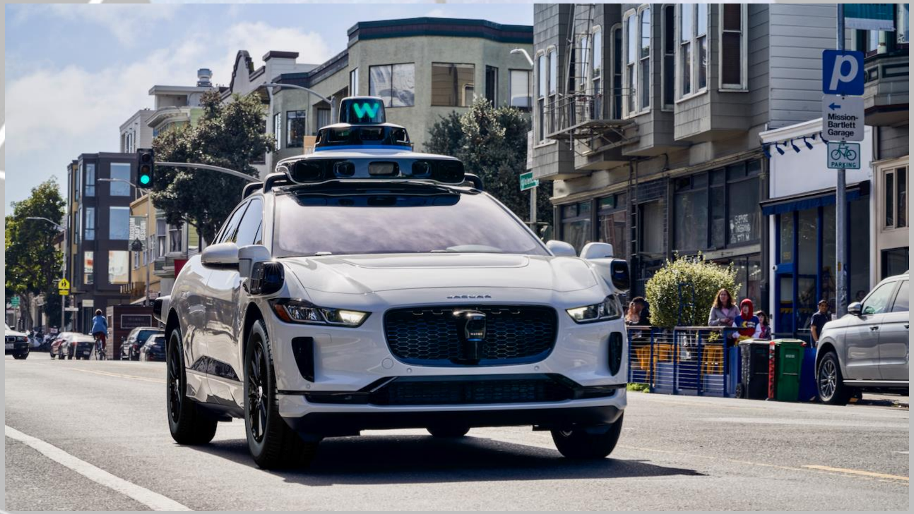
**Assisted and self-driving vehicles**

**Drones**

**Mobile mapping systems**

**Aerial mapping systems**

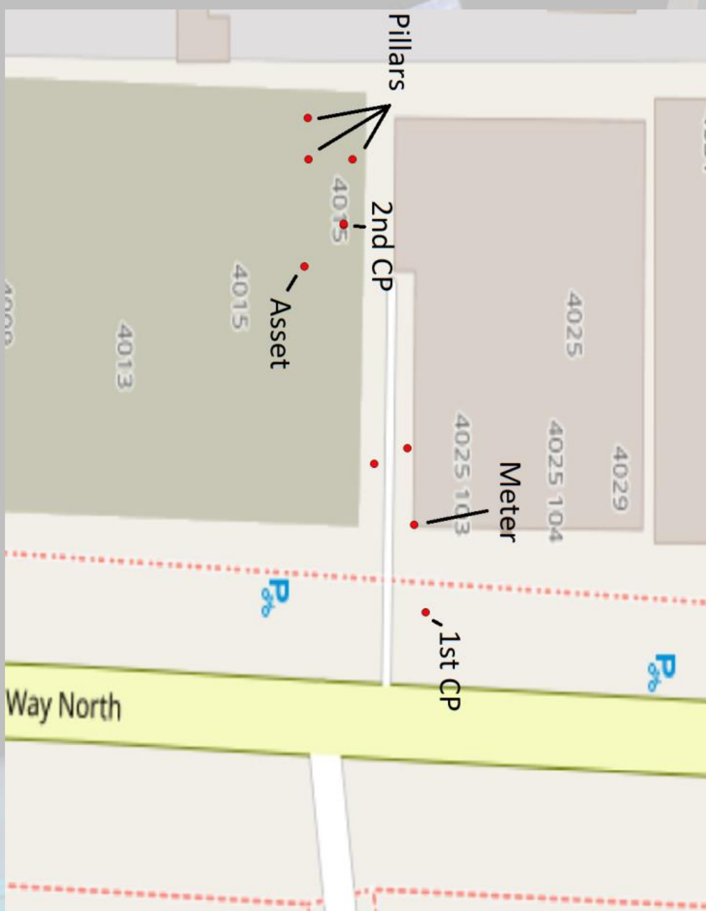
**2D/3D scanning**



# Sensor Integration

- **GNSS for identifying our location on Earth**
- **+**
- **IMU for assisting when GNSS struggles or stops**
- **+**
- **Lidar for determining distance to an object**
- **+**
- **<insert new sensor>**
- **=**
- **High-accuracy Last Mile asset mapping**

# Remember the Last Mile Problem?




# Wait, what?

- **GNSS, IMU, and Lidar technology have been around for decades!**
- **It's all about performance, size, power consumption and cost.**
- **And workflow!**
-
- **Remember this?**

  **1964**

# Questions?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