

EVOLUTION OF GNSS

Past, Present, and the Need for Modernization

Lokesh Kabdal
Co-founder, AeroDome Technologies

How Did Humans **Navigate** Before Satellites?



Magnetic Compass

Invented in China (~11th century), reached Europe by 1300s

Enabled reliable navigation in cloudy or foggy conditions



Celestial Navigation

Used Sun, Moon, and stars (notably Polaris) to determine latitude.

Tools: Mariner's Astrolabe, Cross-staff, Sextant



Dead Reckoning

Estimated position using speed, time, and heading

Essential in open sea where celestial or terrestrial references were absent

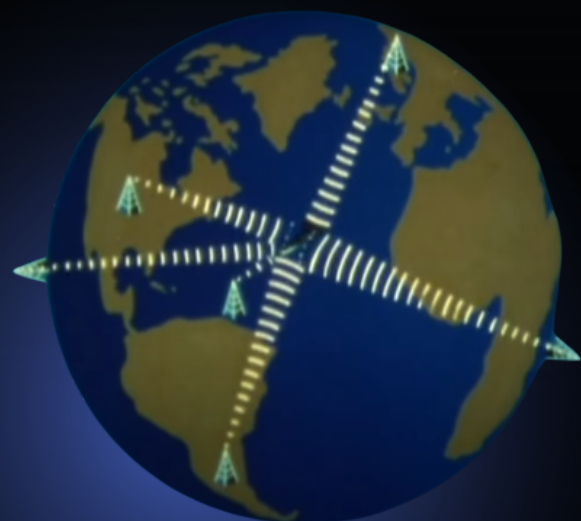
Common by 15th century.



The Era of Terrestrial Radio Navigation (1900s–1960s)

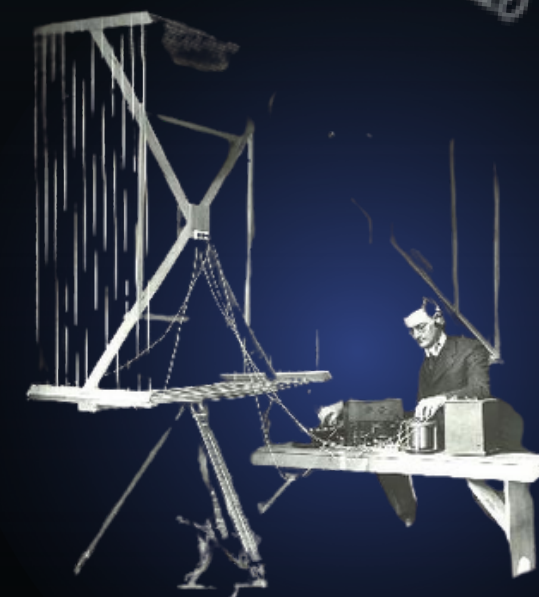


LORAN (Long Range Navigation) – USA (1940s)



Omega System (1960s)

Radio Direction Finding (RDF)



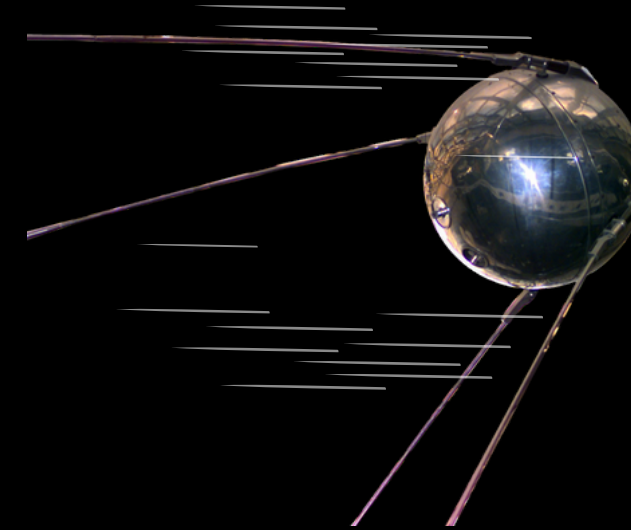
Decca Navigator System – UK



Birth of Satellite Navigation (1960s–1990s)

Sputnik & Doppler Effect

1957: Sputnik I → Enabled Doppler-based tracking
Laid the foundation for space-based positioning



TRANSIT (U.S. Navy, 1960s)

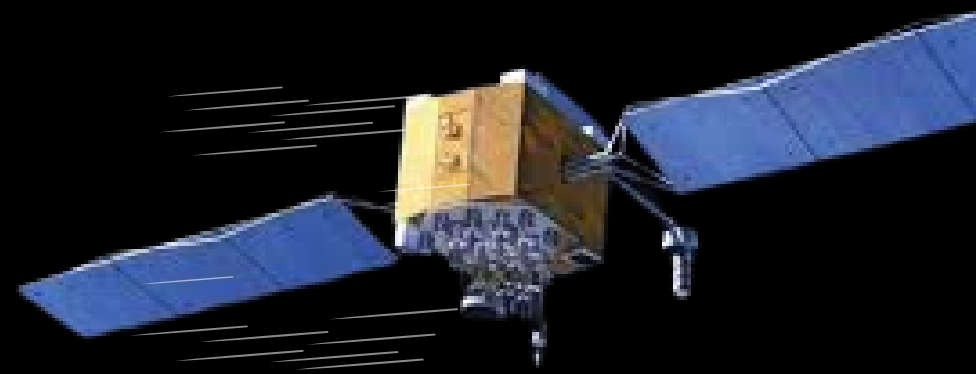
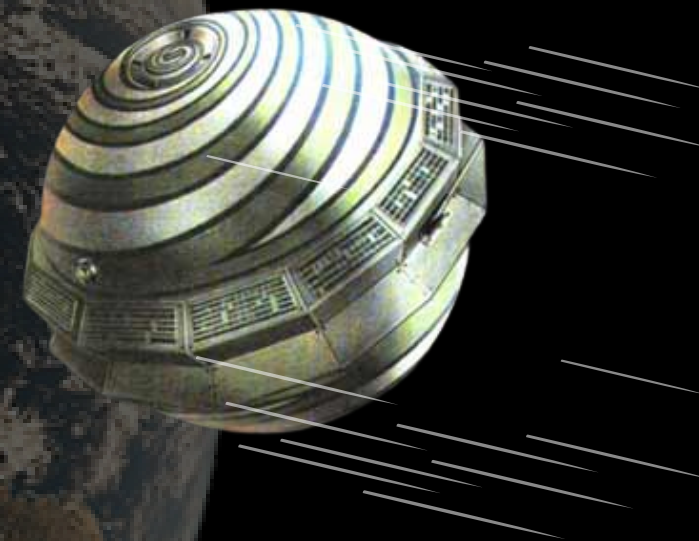
First operational satellite navigation system
Used Doppler shift to calculate position
Accuracy: ~200–500 m; Fix every satellite pass (~90 min)

NAVSTAR GPS (USA)

Initiated: 1973 | First satellite: 1978 |
FOC:1993

24-satellite MEO constellation (20,200 km)
Trilateration using signal time delay + atomic
clocks

Global, all-weather, continuous coverage
Early civilian accuracy: ~20–30 m



HOW PNT IS DONE TODAY?

Name	Country of Origin	Starting Year for first launch	Coverage	Number of Satellites
GPS	USA	1978	Global	31
GLONASS	Russia	1982	Global	24
GALILEO	European Union	2016	Global	30
BeiDou	China	2000	Global	35
NavIC	India	2013	India & 1500km beyond boundary	4
QZSS	Japan	2018	East Asia & Oceania	4

7 BILLION ACTIVE GNSS RECEIVERS AS OF TODAY

India's GNSS Journey

1999 Kargil War: Denial of GPS access by USA highlighted need for sovereign navigation

Result: Development of IRNSS/NavIC to ensure regional autonomy



Development Timeline

2006 Approved by the Government of India

2013 First satellite (IRNSS-1A) launched

2016 7-satellite regional constellation deployed

2018 Services declared operational

IRNSS System Overview

7 satellites: 3 GEO + 4 IGSO

Orbit altitude: ~36,000 km

Coverage: India + 1500 km beyond borders

Signals:

L5 – 1176.45 MHz , L1 – 1575.42 MHz

S-band – 2492.028 MHz



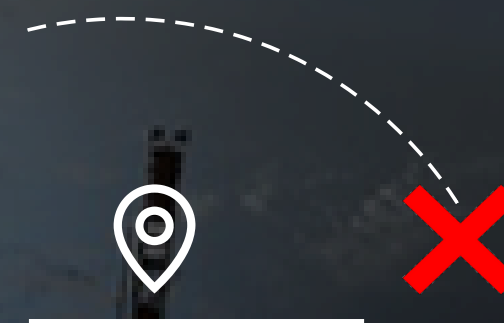
Challenges in Legacy PNT Infrastructure



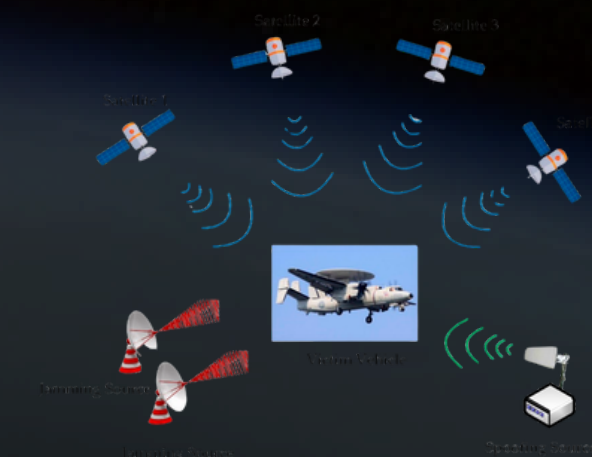
- Outdated Satellites (~15 yrs life)



- Urban Unavailability (Multipath Loss)



- Positioning Inaccuracy (3–20 m)



- Signal Vulnerability (Easy to Jam/Spoof)



- Slow Convergence (Low Angular Velocity)



- Geopolitical Risks (e.g., Kargil 1999)



- High Infra Cost (Bulky & Expensive)



PNT POWERS THE WORLD



DRONES



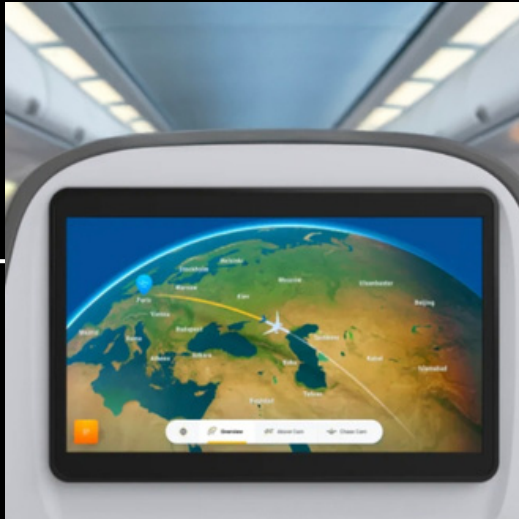
CARS



FINANCE



MARITIME



AVIATION



CONSTRUCTION

POSITION | NAVIGATION | TIME

What Happens When GNSS Fails?

USS John S. McCain Collision (2017) – GPS Spoofing Suspected

- The U.S. Navy destroyer collided with a merchant vessel near Singapore, killing 10 sailors.
- It is suspected to be electronic interference, possibly GPS spoofing, disrupted navigational awareness.
- The incident caused over \$300 million in damages and raised global GNSS security concerns.



INFRA USS John S. McCain accident raises concerns about GPS spoofing



BY DUNCAN RILEY

An accident involving a Liberian-registered ship and the USS John S. McCain has resulted in speculation that the Global Positioning System guiding the guided-missile destroyer may have been spoofed.

The accident, the fourth involving a ship from the U.S. Seventh Fleet this year, occurred in the Strait of Malacca, a stretch of water between the Malay Peninsula and the Indonesian island of Sumatra. Ten sailors remaining missing from the vessel, with the Burke-class destroyer having made its way to the



What Happens When GNSS Fails?

BrahMos GNSS Failure — January 2009

- GPS signal was lost mid-flight during a Block-II test, causing a 7 km miss.
- The missile reverted to INS, and accumulated drift extended flight time by 28 seconds.

BrahMos Test Failure During Obama's Inauguration: A Wake-Up Call for India's GPS Dependency

Published March 11, 2025 | By admin

SOURCE: AFI



BrahMos failed as US shut its eyes in the sky?

DRDO scientists have launched a probe and examining the US satellites role in the failure of the BrahMos missile.



What Happens When GNSS Fails?

Azerbaijan Airlines Flight 8243 crash (2024)

- Flight 8243 lost GPS navigation over Russian airspace, affecting flight control.
- Suspected missile damage caused system failures and emergency diversion, killing 38 people on board.
- Crash highlighted GNSS vulnerability and risks in conflict-zone airspace.



Azerbaijan crash live: 38 dead in mishap, airline suspends all flights to Gronzy

By [HT News Desk](#)

Published on: Dec 25, 2024 11:29 PM IST



Azerbaijan Airlines crash LIVE updates: The Azerbaijan Airlines flight 8243 was carrying 62 passengers and five crew members

Summary

Azerbaijan Airlines crash LIVE updates: Some visuals claimed to be of the crash have surfaced on social media, showing an aircraft crashing to the ground and turning into a fireball.

Azerbaijan Airlines crash LIVE updates: An Azerbaijan Airlines plane en route from Baku to Grozny in Russia's Chechnya crashed near the city of Aktau in Kazakhstan on Wednesday killing 38 out of 67 people onboard, AFP reported. Russian news agencies said the plane had gotten rerouted due to fog in Grozny. The



Azerbaijan Airlines plane crash live updates: A drone view shows the



What Happens When GNSS Fails?

GPS Denial During the Kargil War (1999)

- The U.S. denied India access to GPS data, limiting precision targeting in high-altitude terrain.
- This incident highlighted India's dependence on foreign GNSS and accelerated the development of NavIC, India's own satellite navigation system.



What Happens When GNSS Fails?

Flash Crash (May 6, 2010)

- The Dow dropped nearly 1,000 points, triggered by automated trading.
- High-frequency trading systems, which rely on GPS-based time-stamping, amplified the crash.
- Experts warn such dependency poses future market risks.

Could GPS Hackers Cause the Next Flash Crash?

The satellite system used to time high frequency trades could be disrupted by “spoofing” attacks, Texas professor warns.

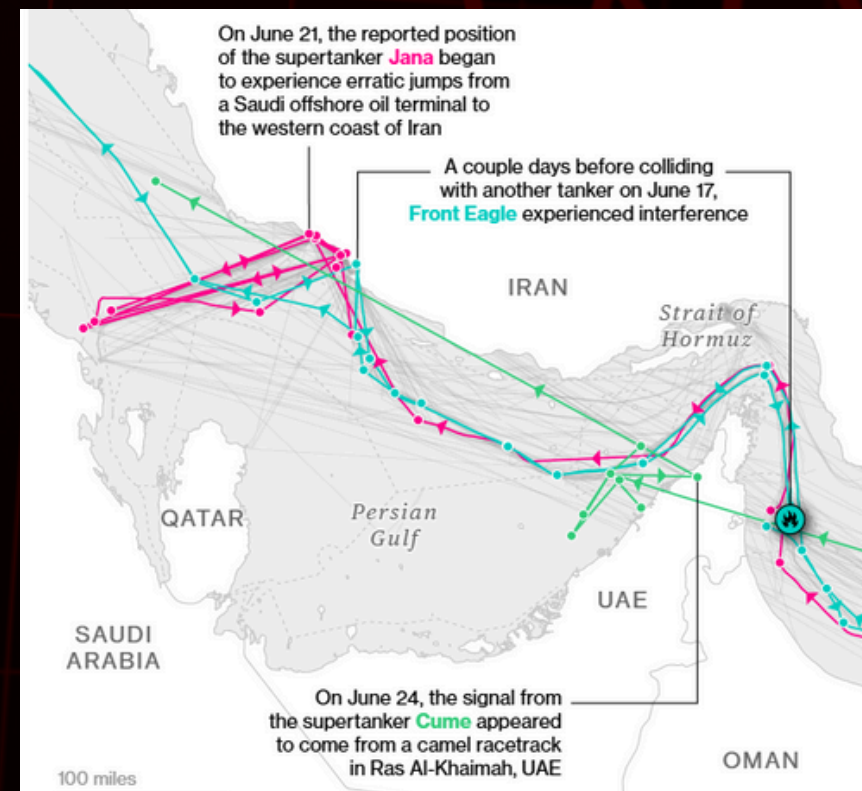
September 26, 2012



What Happens When GNSS Fails?

Electronic Warfare Disrupts Global Shipping Navigation – April 2024

- GPS jamming during the Iran-Israel conflict disrupted ship navigation in key trade routes.
- Thousands of vessels were affected, risking collisions and global supply chain delays.
- Industry and regulators now push for anti-jamming tech and backup systems.



Bloomberg

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A large tanker ship in the Strait of Hormuz transporting oil and petroleum products around the world. Photographer: Clare Louise Jackson/Shutters

World | The Big Take

Electronic Warfare Crashes Global Shipping's Navigation Systems

The Iran-Israel war highlighted a critical flaw in the satellite-based systems that makes the industry hauling 80% of global trade vulnerable to mass-jamming.



How We Can **Fix** This

LEO PNT

LEO PNT (Low Earth Orbit Positioning, Navigation, and Timing) uses constellations of small satellites in low Earth orbit to provide highly accurate and secure, resilient navigation and timing services.



THE GLOBAL PNT RACE



ESA

The European Space Agency has allocated €156.8 million to demonstrate the benefits of LEO-based PNT.



Japan Aerospace Exploration Agency

Plans to augment existing GNSS by launching 240 satellites by 2030, enabling decimeter-level positioning within three minutes.



SpaceWERX USA:

Awarded \$7.6M contracts to demonstrate a GPS-independent Ground Control System (GCS) and an advanced PNT security application.

PRIVATE START-UPS/COMPNIES

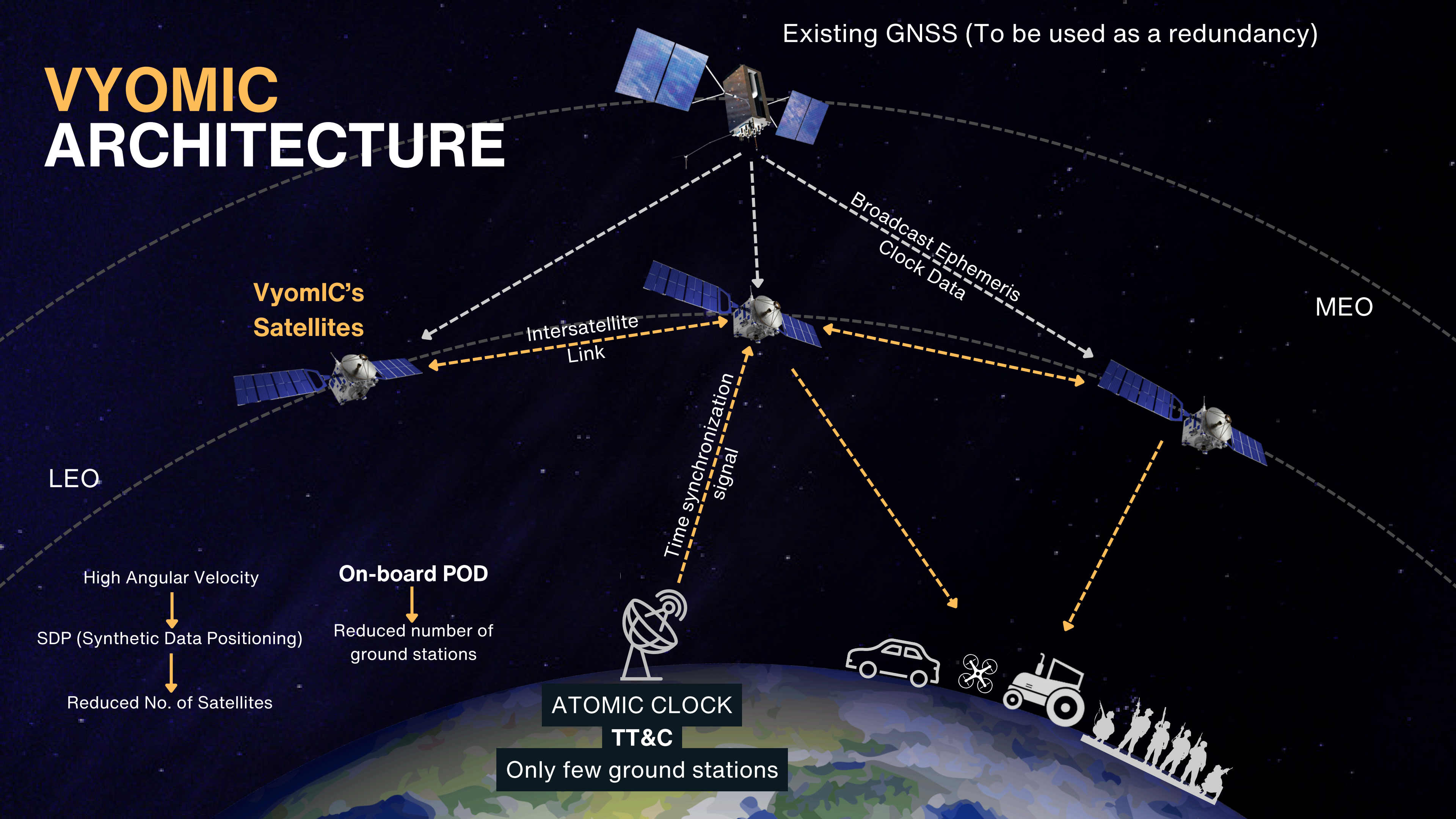
Name	Founding Year	Funding	Satellite and Technology	Constellation Size
	2019	\$92 M	LEO PNT with small satellite < 150 kg	258
	2020	\$7.4M	LEO PNT with 6U CubeSat of 10 kg	300
	2001	\$30M+	LEO with 680kg Satellite	66
	2018	\$326M		240
	2017		130 kg microsats	120

VYOMIC

**BUILDING NAVIGATION SYSTEM
FOR
NEW AGE!**

AN AERODOME INITIATIVE

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Thank you

Contact: info@aerodome.tech

Lokesh Kabdal

Co-founder - CEO, AeroDome Technologies

Mob: 7017744060