

# ASSURED & RESILIENT PNT

**Ananyaa Narain**

Vice President –Consulting

Geospatial World

[ananya@geospatialworld.net](mailto:ananya@geospatialworld.net)



# PNT: The Invisible Utility Layer

## DEFINITIONS<sup>5</sup>



**Positioning** is the ability to determine one's location and orientation in two or three dimensions. This position is referenced to a local or, most commonly, a global coordinate system



**Navigation** is the ability to determine a path between the current and desired positions (either relative or absolute) and navigate this path by applying corrections to course, orientation, and speed.



**Timing** is the ability to acquire and maintain accurate time locally or globally, for example, Coordinated Universal Time (UTC). This also includes a time transfer service.

**€400B+**

**Annual GNSS market value 2025**

*GeoBuiz Report 2026*

**£13.6B**

**Annual GNSS benefit to UK economy alone**

*London Economics 2021*

**93%**

**Critical infrastructure sectors PNT-dependent**

*NIST / DHS / GISA*

**~10B**

**GNSS-enabled devices by 2034 globally**

*EUSPA 2025*

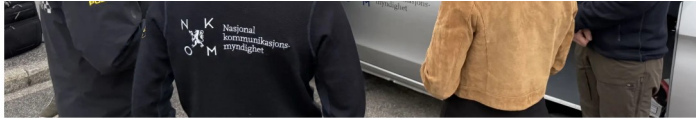
TECHNOLOGY

# Iran war: GPS jamming, spoofing upends delivery work in Gulf countries

Riders are navigating blind as military forces in the region deploy electronic signals to block drones and missiles.

[Divsha Bhat, Rest of World](#)

Apr 15, 2026 · 10:00 pm



Minister of Digitalisation and Public Governance Karianne Tung is briefed on the risks affecting GNSS-reliant systems in the airspace surrounding Kirkenes Airport, together with representatives from the Norwegian Communications Authority (Nkom), the police and mobile operator Telenor. Photo: Thomas Nilsen

## Norway boosts GPS jamming detection amid Russian escalation

Russia is intensifying GPS jamming operations on the Kola Peninsula, creating growing risks for aviation and other civilian systems in Norway's eastern Finnmark region. In response, Norwegian authorities are establishing two additional monitoring stations to measure GNSS interference in the border area.



Thomas Nilsen

22 May 2026 - 13:45



This week, government officials gathered to discuss countermeasures against Russia's

EXPLAINER

Features | US-Israel war on Iran

## Could Iran be using China's highly accurate BeiDou navigation system?

*Intelligence experts have suggested China has made its satellite navigation system available to Iran.*

Listen (7 mins) Save Share

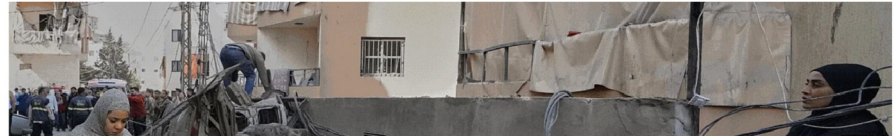
Add Al Jazeera on Google



India

## GNSS disruption, asymmetric warfare emerge as key features of widening West Asia conflict

*The Strait of Hormuz, a narrow waterway connecting the Persian Gulf to the Gulf of Oman, carries nearly 20 per cent of the world's energy supplies and is critical for India's energy security.*



# Why GNSS Alone Is No Longer Sufficient

## JAMMING

CRITICAL

Deliberate RF interference drowning GNSS signals. Low cost, high impact — military-grade jammers cost under USD 500. Documented 500+ km radius disruption around Ukraine conflict zones.

▶ **Ukraine 2022–25 / Baltic / Arctic**

## SPOOFING

CRITICAL

Broadcasting counterfeit GNSS signals to falsify position/time. Used in maritime deception globally — 300+ SCS incidents documented by C4ADS 2019–2024.

▶ **South China Sea · Strait of Hormuz**

## MEACONING

HIGH

Intercepting and re-broadcasting GNSS signals with delay, causing navigational ambiguity. Used near sensitive military and government facilities.

▶ **Middle East · DPRK border**

## ASAT WEAPONS

CRITICAL

Kinetic/directed-energy attacks on GNSS satellites. China ASAT 2007 (debris field persists). Russia Nudol DA-ASAT tested 2021. LEO debris cascade risk to entire constellation.

▶ **PRC DA-ASAT 2007 · Russia 2021**

## CYBER ATTACKS

HIGH

Targeting GNSS ground control segments and receiver software. GPS 2019 timing anomaly (13 $\mu$ s error) disrupted critical infrastructure globally.

▶ **GPS timing event 2019 | London Stock Exchange**

## SPACE WEATHER

MEDIUM

Solar flares degrade GNSS accuracy and availability. Carrington-class event probability ~12% per decade (Lloyds 2013). Estimated USD 1–2 trillion global impact.

▶ **Lloyds Space Hazard 2013**

# Documented GNSS Disruption: Five Active Theatres

## RUSSIA-UKRAINE

- GPS jamming documented >500 km radius from conflict zones (EUSPA/ESA 2022–25)
- 46,000+ ADS-B anomalies logged; commercial aviation rerouted
- Ukrainian forces relied on Starlink + INS fusion after GPS degradation
- Russian Krasukha-4 EW systems: wide-area GNSS denial capability deployed

## RED SEA / MIDDLE EAST

- GPS spoofing affecting commercial shipping near Strait of Hormuz since 2019
- AIS manipulation: vessels 'appearing' in airports and inland locations
- Israeli airspace: widespread spoofing affecting >50 civilian airports (2024)
- Houthi UAV operations exploiting GNSS disruption zones

## SOUTH CHINA SEA

- C4ADS: 300+ GNSS spoofing incidents attributed to PRC forces 2019–2024
- 'GPS Ghost Ships': AIS positions showing ships inside airports or deep inland
- PRC GNSS jamming deployed around contested island constructions

## ARCTIC & BALTIC

- Norway/Finland: persistent Russian GNSS jamming affecting civilian aviation
- Baltic states document regular interference near Russian territory during exercises
- NATO: GPS-denied training now mandated in all major exercises (Steadfast Cobalt)

300+

**Documented GNSS spoofing incidents in South China Sea attributed to PRC (C4ADS 2019–2024). This is not a future risk — it is current operational doctrine.**

# The Cost of GNSS Failure: Quantified

## RTI INTERNATIONAL / NIST

United States · 2019

# \$1B+

per day in economic losses

### 10 sectors studied

Agriculture, telecom, finance, maritime, mining, oil & gas, surveying, LBS, electricity, transport

### ~\$1.4 trillion

GPS value to US economy, cumulative 1984–2017

### Up to \$45 billion

Estimated impact of a 30-day outage (point estimate \$10.4B)

### \$1.5B/day

During April–May agriculture planting season

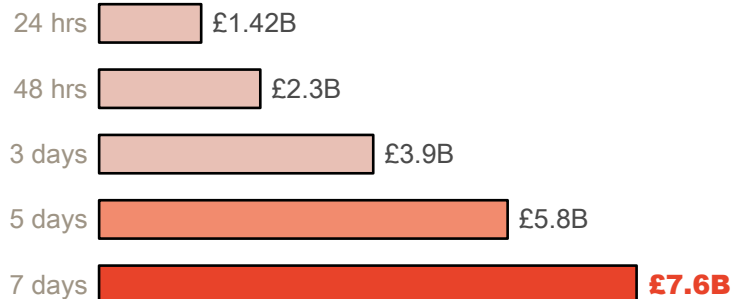
## LONDON ECONOMICS / INNOVATE UK

United Kingdom · 2021 update (published 2023)

# £7.6B

7-day GNSS outage cost

### COST ESCALATION BY DURATION



# Global Policy Response: Assuring PNT Sovereignty

## UNITED STATES

## LEADING

- Space Policy Directive-7 (2021): national PNT architecture mandate
- Executive Order 13905 on Resilient PNT
- NextGen eLoran: USD 40M+ Congress-appropriated for backup timing (NDAA)
- CHIPS Act + DoD Alt-PNT R&D: ~USD 300M/yr across DARPA, DoD programmes

## EUROPEAN UNION

## ADVANCED

- Galileo: 30-satellite constellation; PRS encrypted military signal operational
- IRIS<sup>2</sup>: EUR 10.6B LEO broadband + PNT overlay — contracts awarded 2024
- EUSPA PNT Resilience Action Plan 2023–2027
- NIS2 Directive: GNSS-dependent CNI operators must demonstrate PNT resilience

## JAPAN

## ADVANCED

- QZSS Michibiki: 7-satellite regional system by 2025 — sub-metre in Asia-Pacific
- QZSS-R (backup/resilience) programme approved in FY2024 budget
- JAXA + Cabinet Office: Space Basic Plan 2023 — national PNT sovereign mandate
- GSDP: QZSS integrated into precision-guided systems and battlefield comms

## INDIA

## DEVELOPING

- NavIC: 4/7 satellites operational (2025); NVS-02 failure Jan 2025 — under stress
- Indian Space Policy 2023 + National Geospatial Policy 2022: Require specific PNT Mandates
- BIS mandate: all smartphones sold in India to embed NavIC (2025)
- DRDO: NavIC integration in defence platforms continues despite constellation gaps

## AUSTRALIA

## ADVANCED

- NPIC: AUD 225M National Positioning Infrastructure Capability programme
- SBAS: live GPS + Galileo augmentation covering Australia and Pacific
- Geoscience Australia CORS network: reference station infrastructure
- AUKUS Pillar II: joint resilient PNT for autonomous undersea/air systems

## UNITED KINGDOM

## DEVELOPING

- National PNT Strategy 2021: 10-year sovereign resilience roadmap
- Post-Brexit: no longer in Galileo PRS; developing sovereign alternatives
- GNSS Research Programme — UKSEDS and DSIT co-funded
- eLoran study: national timing infrastructure review (NCSC 2023)

**~7% Investments (~USD 19 Billion) in Developing Sovereign PNT Resilience**  
by UK, India, USA, Australia, Japan, USA, etc.

# India: NavIC — Strategic Ambition vs. Operational Reality

**NavIC's actual operational status (2025) is significantly weaker than India's stated ambitions. Only 4 of 7 satellites are operational. NVS-02 failed at launch (January 2025). The constellation is under stress — not an advanced system.**

## NAVIC CONSTELLATION STATUS (2025)

### IRNSS-1B

△ **AT RISK**

Exceeded 10-yr mission life — failure imminent (GPS World)

### IRNSS-1F

△ **PARTIAL**

Nearing end of lifespan; partial equipment failures

### IRNSS-1I

✓ **OPERATIONAL**

Functional; expected to 2028

### NVS-01 (1J)

✓ **OPERATIONAL**

New-gen; fully operational since 2023

### NVS-02 (1K)

× **FAILED**

Engine failure Jan 2025; stranded in wrong orbit

### IRNSS-1A,1C, 1D,1E,1G

× **DEGRADED**

Atomic clock failures; non-operational or partial

## OPERATIONAL GAPS

- 4/7 satellites; 2 at-risk; NVS-02 failed launch Jan 2025
- Atomic clock failures across 5 of 7 original satellites
- Receiver ecosystem development 11 years late (CAG 2018)

## STRATEGIC INTENT (REAL)

- BIS mandate: NavIC in all smartphones sold in India (2025)
- Qualcomm, MediaTek chips now NavIC-capable
- DRDO integration: UAVs, missiles, armoured vehicles continues

## 5-10 YEAR POTENTIAL

- Full 7-sat constellation: transformational if NVS series succeeds
- NavIC as Global South / ASEAN alternative to BeiDou
- Make-in-India PNT chip exports if ecosystem matures

4 / 7  
operational

of 11 total launches, 5 considered active — only 4 fully operational. Industry experts state Seven satellites must be maintained simultaneously for full service. (IDRW Mar 2026)

# Indo-Pacific: Why PNT Sovereignty Is Existential Here

## GEOPOLITICAL DRIVERS

**14**

Active territorial disputes involving PNT-critical maritime zones

**300+**

Documented PRC GNSS spoofing incidents 2019–2024 (C4ADS)

**USD 600B+**

Annual regional defence spending driving PNT modernisation

- BeiDou deployed as geopolitical instrument — coercive dependency creation
- Taiwan Strait scenario: GNSS denial disables regional aviation and shipping
- SCS: GNSS spoofing as grey-zone tool to disrupt sovereignty claims
- QUAD + AUKUS: joint resilient PNT now formally on the agenda

## ECONOMIC DRIVERS

**USD 5.4T**

Annual trade transiting Indo-Pacific sea lanes (UNCTAD 2024)

**60%**

Global container shipping through GNSS-vulnerable straits

**12 of 20**

World's busiest ports in Indo-Pacific — all GNSS-dependent

- ASEAN digital economy: USD 1T+ by 2030 — built on GNSS-dependent infra
- LNG/oil shipping routes require precision navigation for safety
- Agricultural automation: precision farming scaling rapidly across region
- Smart ports and logistics hubs: USD billions in GNSS-dependent operations

## TECHNOLOGY & MILITARY

**USD 1T+**

ASEAN digital economy by 2030; entirely GNSS-dependent

**5G/6G**

Rollout across region — requires precise timing from GNSS or backup

**Autonomous**

UAV, USV, UUV proliferation — all require assured PNT

- AI-driven precision agriculture, logistics, smart cities at regional scale
- QUAD: joint GPS-denied doctrine and resilient PNT R&D 2023–
- 5G/6G timing synchronisation requires GNSS or certified backup
- Regional militaries modernising: PNT resilience a key acquisition gap

# IP-PNT: Strategic Priorities by Maturity Tier

## TIER 1 — ADVANCED

**Japan · Australia · South Korea**

*Established sovereign capabilities. Gaps in terrestrial backup and CNI mandates.*

- Deepen multi-GNSS fusion: QZSS + GPS + Galileo + NavIC interoperability standards
- Formalise resilient PNT mandates legally for critical infrastructure operators
- Accelerate LEO-PNT investment and indigenous/partnership constellation capacity
- Embed QUAD/AUKUS PNT cooperation into defence acquisition programmes
- Develop export-grade resilient PNT for ASEAN capacity building

## TIER 2 — DEVELOPING WITH POTENTIAL

**India · Singapore · UAE (benchmark)**

*India: strong policy intent but NavIC execution gaps. Singapore: no sovereign GNSS.*

- India: urgent NavIC constellation recovery — accelerate NVS-03/04/05 now
- India: Deploy Assured Resilient PNT as immediate backup — do not wait for NavIC full recovery
- Singapore: mandate multi-GNSS receivers + PNT resilience for CNI (ports, finance, aviation)
- Build domestic receiver/chip ecosystems (India: PLI scheme; Singapore: R&D grants)
- Align with QUAD-led resilient PNT frameworks; contribute to regional monitoring networks

## TIER 3 — DEVELOPING

**Indonesia · Malaysia · Vietnam · Philippines**

*High GNSS dependency. Minimal resilience infrastructure. Exposure is acute.*

- Adopt multi-GNSS receiver policy: GPS + Galileo + NavIC/QZSS as minimum
- Join SBAS augmentation: QZSS expansion provides near-term sub-regional coverage
- Develop national PNT strategy and conduct CNI dependency mapping
- Prioritise maritime PNT resilience — highest economic exposure via sea lane dependency
- Access QUAD capacity building support for national PNT capability development

# "Resilient PNT is the invisible strategic infrastructure of the 21st century"

**DEFENCE  
& SECURITY**

**SPACE  
INFRASTRUCTURE**

**AI &  
AUTONOMOUS**

**5G / 6G  
TELECOM**

**GEOSPATIAL  
INTELL.**

**DIGITAL  
SOVEREIGNTY**

**ASSURED & RESILIENT PNT INFRASTRUCTURE**

01

## **TREAT PNT AS CRITICAL NATIONAL INFRASTRUCTURE**

Every Indo-Pacific government must formally designate PNT as critical infrastructure — with legal frameworks, mandatory operator resilience requirements, and dedicated budget lines. The cost of inaction is asymmetric: investment required is a fraction of disruption cost.

02

## **INVEST IN SOVEREIGN ALTERNATIVES — STARTING WITH eLORAN**

The most pragmatic near-term investment is terrestrial backup. A coordinated QUAD eLoran network anchored by India, Japan, and Australia would cover 80%+ of the Indo-Pacific for ~USD 500M — deployable within 4 years without new technology development.

03

## **BUILD THE INDO-PACIFIC RESILIENT PNT COALITION**

A formal Indo-Pacific PNT Resilience Framework — through QUAD, linking ASEAN — would multiply the strategic impact of national investments through shared monitoring, standards, and capacity building. The architecture of autonomous AI-driven economies depends on this foundation.

# THANK YOU.



Ananyaa Narain  
Vice-President – Consulting  
Geospatial World  
[ananya@geospatialworld.net](mailto:ananya@geospatialworld.net)