

Strengthening Positioning, Navigation and Timing (PNT) to drive world economy and society

**GEOSPATIAL
WORLD**
ADVANCING KNOWLEDGE FOR SUSTAINABILITY



RELIANCE ON PNT (GNSS) ACROSS ECONOMY

Position, Navigation, and Timing (PNT) information is a crucial input into many technologies that underpin the modern economy.

€2 TRILLION

Socio-economic benefits attributable to GNSS in the European territory (defined as the EU27 plus the UK, Norway and Switzerland)

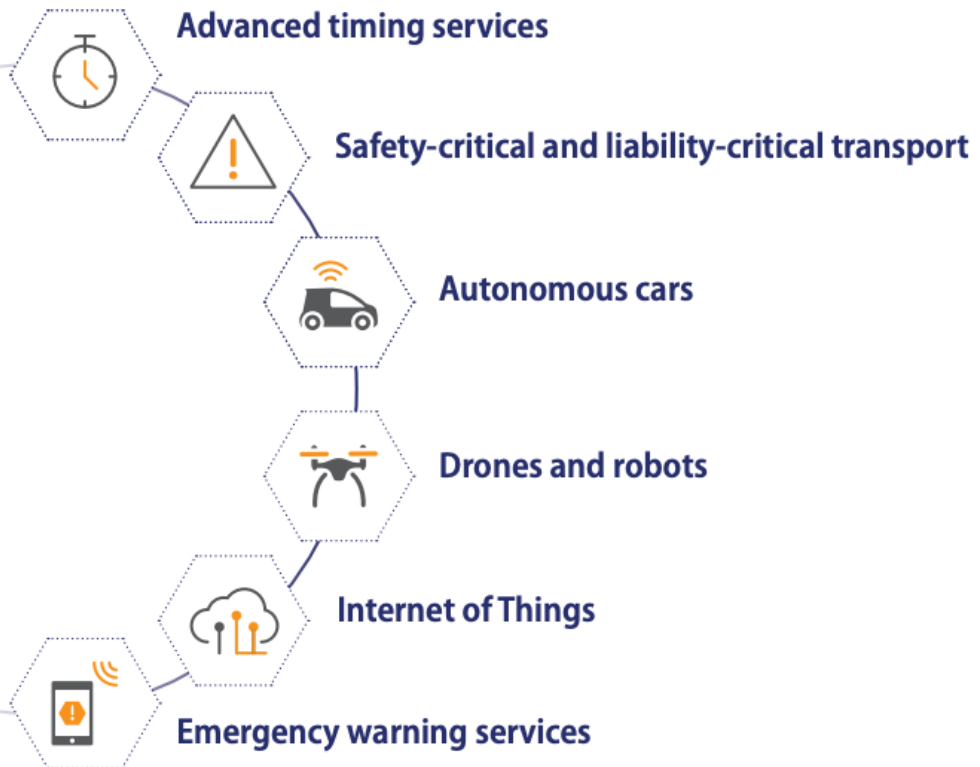
100,000 Highly-skilled Jobs

Attributable to GNSS industry during 1999-2027

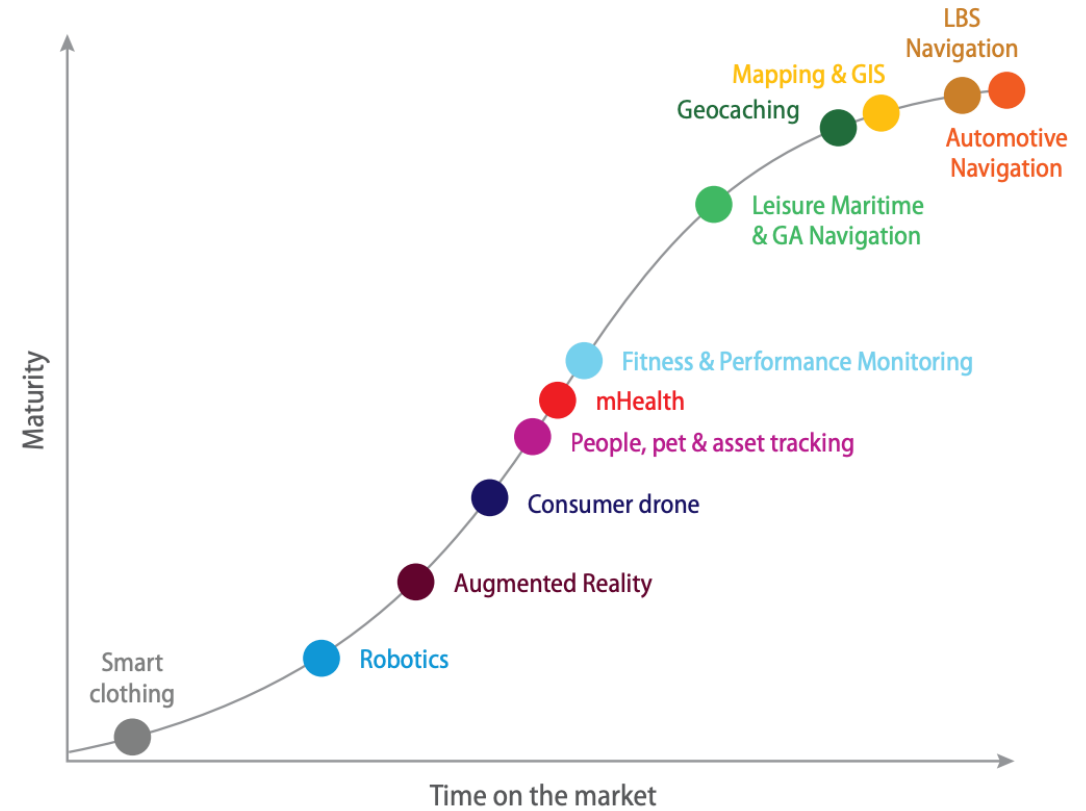


PNT MATURITY AND ITS CRITICAL ROLE IN DIGITAL AGE

Emerging applications needs are driving the evolutions of GNSS



Level of maturity of high-volume device applications



COST OF GPS/GNSS OUTAGE TO WORLD ECONOMY

According to the National Institute of Standards and Technology, GPS has generated.....

\$1.4 trillion

in economic benefits for the private sector. But what happens when there is a GPS outage?

The potential impact of a 30-day GPS outage:

\$1 billion/day
or
\$30 billion total







Source: <https://www.nist.gov/feature/default/06/gps-truck-report.pdf>
Economic Benefits of the Global Positioning System (GPS) Final Report. Sponsored by National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899. Prepared by RTI International.

30-day GPS outage costs by industry



during spring planting season

LIKELY VULNERABILITIES AND LIMITATIONS: GNSS AND BEYOND

					
JAMMING AND SPOOFING	INTERFERENCE	GNSS SEGMENT ERRORS	MULTIPATH	CYBER ATTACKS	ATMOSPHERE
<ul style="list-style-type: none">• Covert• Deception	<ul style="list-style-type: none">• Intentional• Unintentional	<ul style="list-style-type: none">• Erroneous Upload Data• SV Faults	Combination of Line of Sight (LOS) and Non-LOS reflecting off nearby obstacles	<ul style="list-style-type: none">• Non-RF	<ul style="list-style-type: none">• Scintillation• Solar Activity

EXAMPLES OF GNSS INTERFERENCES

- **2019:** Aviation association Eurocontrol says it received 3,500 reports of GPS disruption in 2019, an all-time high. Jamming is widespread across the central and Eastern Mediterranean, likely due to electronic warfare between conflicting factions in Syria, Libya and elsewhere in the region.
- **2022:** EU's Aviation Safety Agency warns of GNSS spoofing and jamming in aircrafts with noted incidents in flights over Europe
- **2022:** Russian jamming of GPS signals over the Black Sea

“The concept of resilient PNT is context and application-specific, because achieving a state of resilient PNT for a user, a company, a critical infrastructure sector, or a nation are all different things. In other words, resilient PNT takes on different meanings depending on the scale or scope of the application, or the system that is being protected and backed up”

PNT RESILIENCE SOLUTIONS

SYSTEM OF SYSTEM APPROACH

No 'silver bullet' to GNSS resiliency
→ solution needs to be 'system of system'

- Depending on application different systems will provide the answer
- Going from one 'system' to 'another' is not resilient

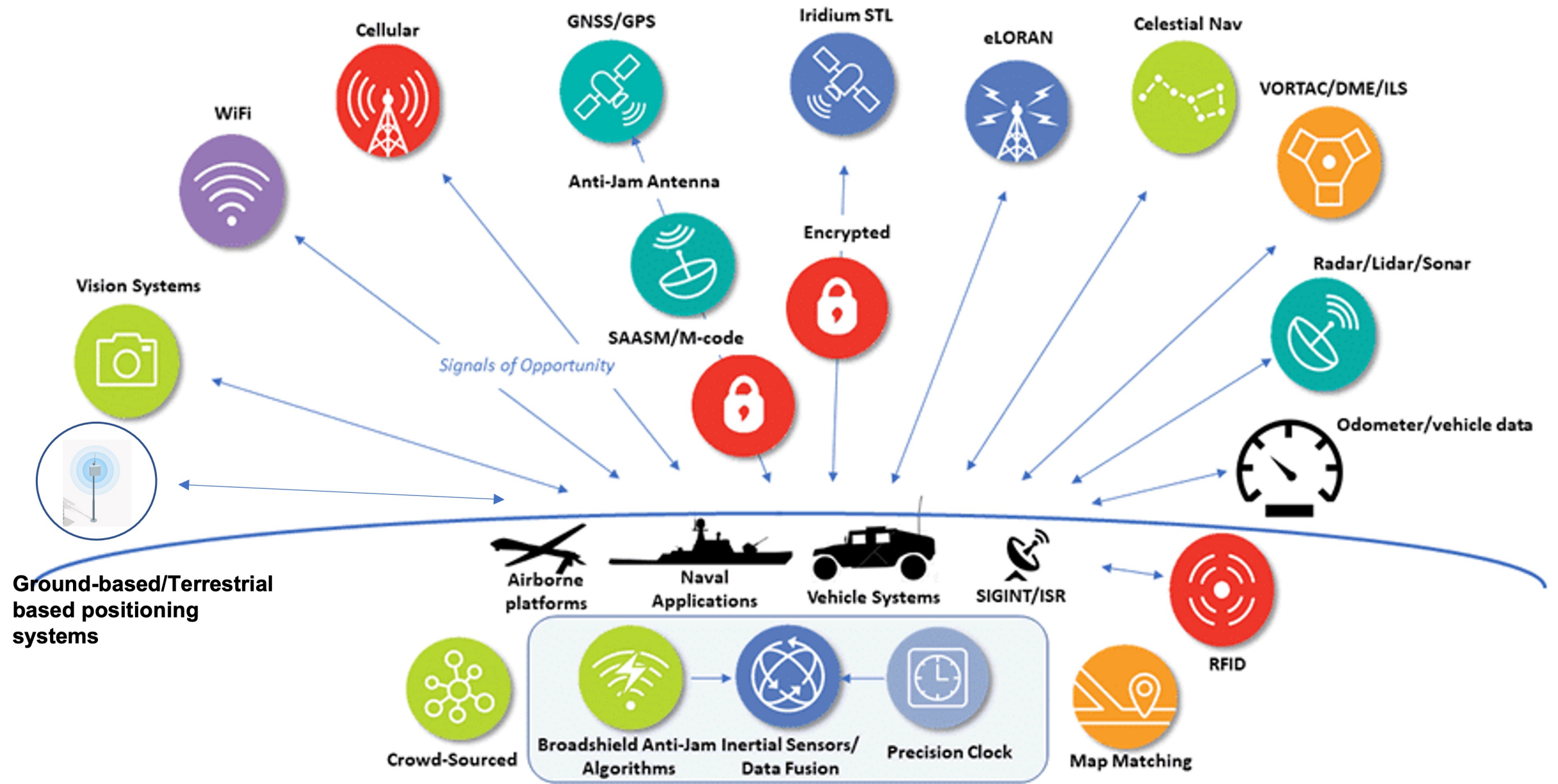
RESILIENT PNT SOLUTIONS

Fiber based system → Point to point but not suited for local distribution and mobility based applications

Terrestrial system (Dedicated & cellular) → Can provide high quality PNT services, low cost receiver, infrastructure based

Low Earth Orbit → space based, coverage in rural & more open spaces

eLORAN (predecessor to GPS) → primarily maritime applications, receiver SWAP considerations



Source: Reference image from Orolia; interpreted by Geospatial World

ALTERNATIVE/RESILIENT PNT SOLUTIONS FOR TOMORROW'S POSSIBILITIES

KPIS IDENTIFIED FOR RESILIENT PNT BY JRC

- Can deliver positioning, and/or timing information independently from GNSS;
- Act as the backup in the event of a GNSS disruption or outage;
- Able to provide the coverage for the EU European territory including in-land waters;
- Resilient to GNSS failure modes and vulnerabilities (including GNSS frequency jamming and spoofing or unintentional interference);
- (If possible) extend PNT provision to the environments where GNSS cannot be delivered, i.e.: urban canyons, indoor, underground and underwater.
- Have TRL greater than 5 for position/navigation services OR greater than 6 for timing services.
- Provide minimum performance of the alternative PNT service for at least 1 day upon GNSS loss:
 - Positioning Accuracy (Horizontal and/or Vertical 95%) < 100 m OR Timing Accuracy to UTC (3 sigma) < 1 microsec, and
 - Availability > 99%
- If the alternative PNT service provides a timing service, traceability to UTC shall be possible.

KEY HIGHLIGHTS FROM EU-JRC FROM A-PNT TEST CAMPAIGN

REGULATORY INITIATIVES

The European Commission (EC) has implemented multiple regulatory actions aimed at enhancing the resilience of PNT infrastructures and services in the EU. Those include:

- Introduction of **new Galileo services with an enhanced resilience against spoofing attacks, as the Galileo OSNMA**, plus those in the second generation of Galileo.
- The **EU Space Regulation**, requesting to protect EU Space ground infrastructure and stringent cybersecurity requirements for the EU Space Programmes.
- The Release of a **new European Radio Navigation Plan**, a reference document presenting the evolution of the landscape of PNT infrastructures in the EU to identify potential gaps and synergies in the various PNT sectoral domains.

MAIN RECOMMENDATIONS

- Energy supply networks, transport infrastructures, telecommunications, and financial networks etc., are primary users of PNT services, and countries in Europe must consider the effect of the potential disruptions. Historically those included jamming, more sophisticated spoofing attacks or a malfunction in the GNSS system infrastructure.
- Initial assessment of alternate PNT systems shows that mature commercial A-PNT technologies, which can deliver positioning, and/or timing information independently from GNSS, already exist in the commercial market.
- EU companies have excellent record in time transfer and time generation. The test campaign highlighted the important role of the NMIs across Europe as most of tested technologies work with them directly and un-directly
- A resilient EU PNT requires system of system approach with mix of technologies following, which are supported by industry standards to ensure the required interoperability. All positioning technologies should operate within the European Terrestrial Reference Frame (ETRF) and timing related to time scale of UTC from an NMI.

THANK YOU

