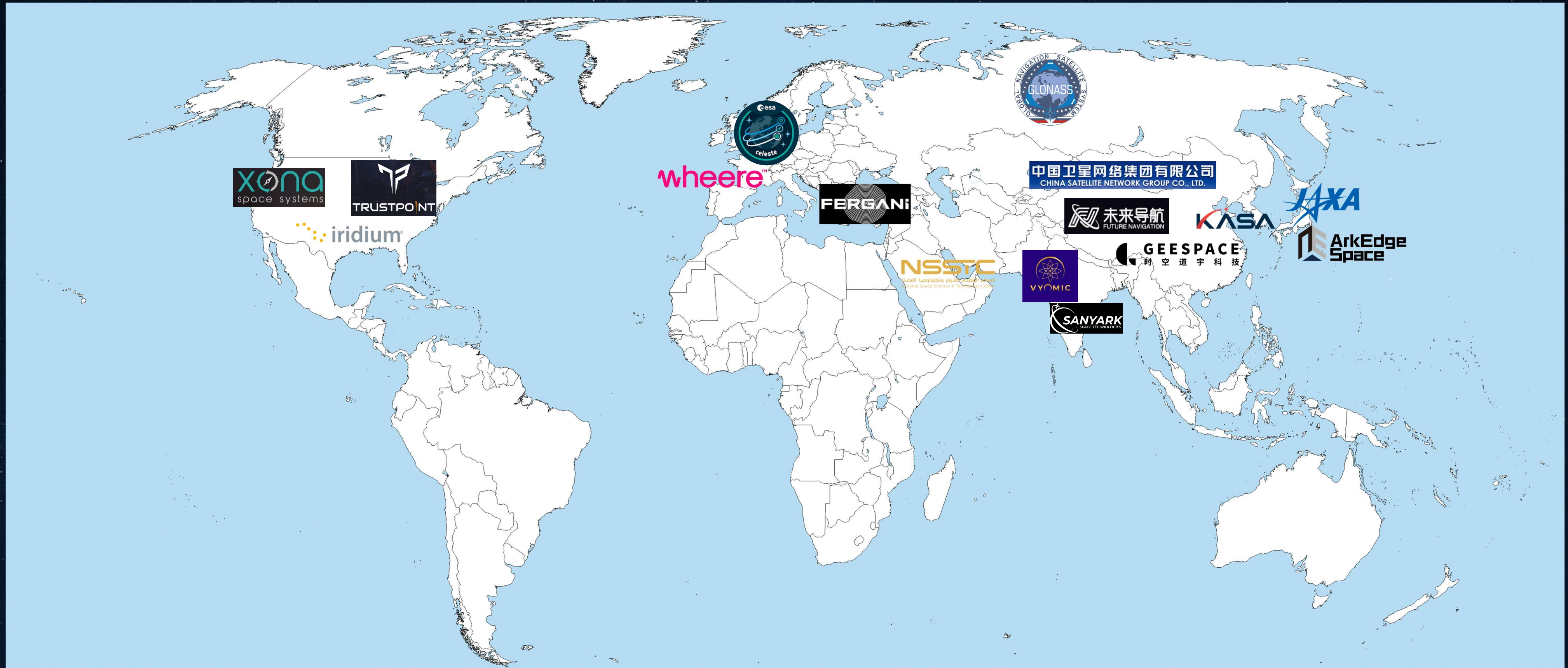


測位インフラの多層化（LEO-PNT）の国際動向

レジリエントPNTワークショップ

2026年7月29日

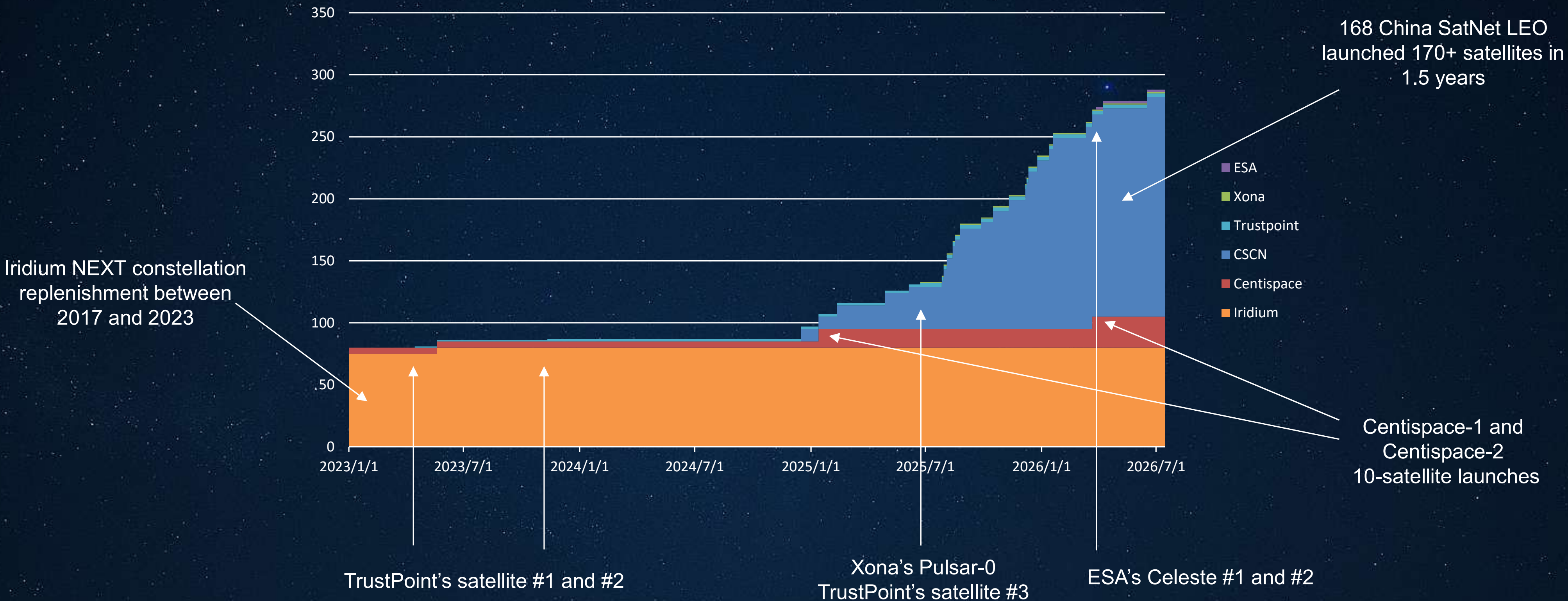
LEO-PNTプロバイダーの分布（計画時点も含む）



LEO-PNT衛星の打ち上げ数：中国の圧倒

Current status of demonstration and operational LEO satellites providing PNT services:

LEO PNT Satellites Launched



米国におけるLEO-PNTの動向

Iridium社



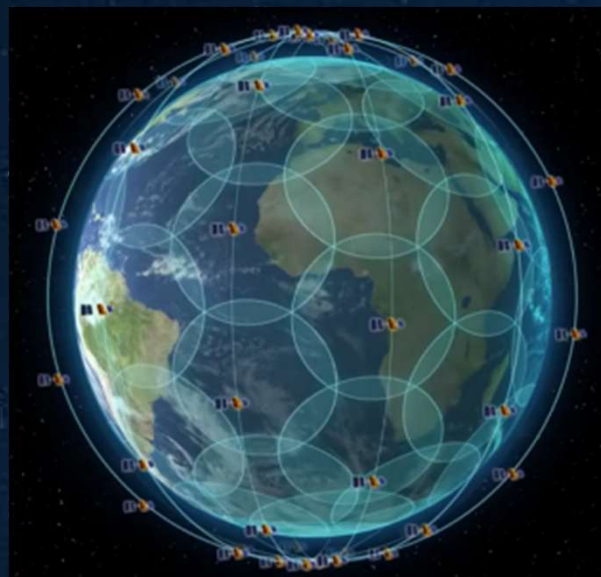
Constellation

- Current in-orbit satellites:
 - 66 operational @ 780 km, 86.4°
 - 9 spares @ 750~770km

Signals

Frequency: **L-band**

- STL: 1616-1626 MHz
- Modulation type: QPSK



Services

- GPSの代替PNTサービスを提供
- 屋内測位(特にtiming)
- グローバルカバレッジ

Fully operational

<https://iridiumwhere.com/about/>

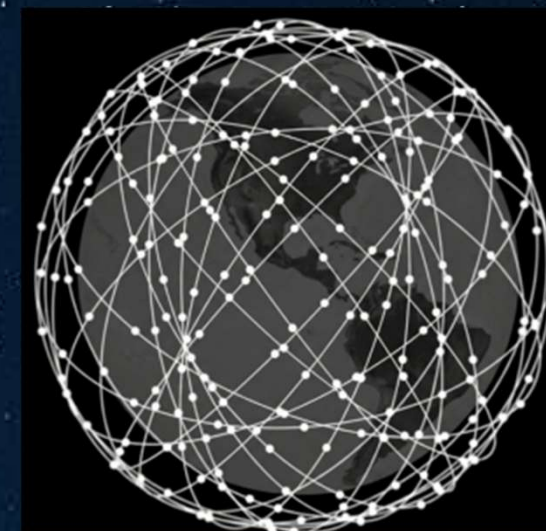
<https://www.space-track.org/#/catalog>

<https://frontiersi.com.au/wp-content/uploads/2026/03/FrontierSI-State-of-Market-Report-LEO-PNT-2025-Edition-v1.0-3.pdf#page=93&zoom=100,0,0>

Xona Space Systems社

Constellation

- Current satellites: 1
 - 520km, 97°
- Planned satellites: 258
 - 66 sats @ 1080km, 53°
 - 192 sats @ 1080km, 97°



FOC expected 2029

Signals

Frequency: **L-band**

- X1: 1593.3225 MHz, X5: 1190.51625 MHz
- Modulation type: EFQPSK

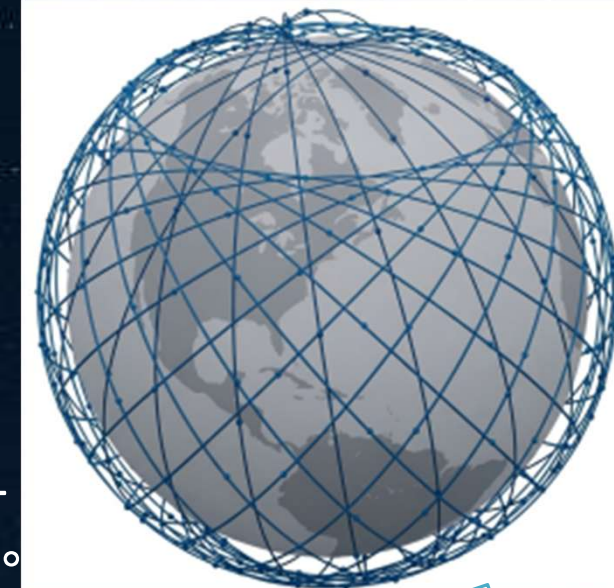
System Concept (実証フェーズ)

- 高強度・高精度な測位信号の地上への配信
- 屋内測位(Indoor PNT)
- GPSに依存しない代替PNTシステムに進化
- グローバルカバレッジ

TrustPoint社

Constellation

- Current satellites: 1
 - 520km, 97°
- Planned satellites: 300+
 - Shell 1: 550km, 97.6°
 - Shell 2: 650km, 53°



FOC expected 2029

Signals

Frequency: **C-band**,

- C1: 5020 MHz
- Modulation type: BPSK



System Concept (実証フェーズ)

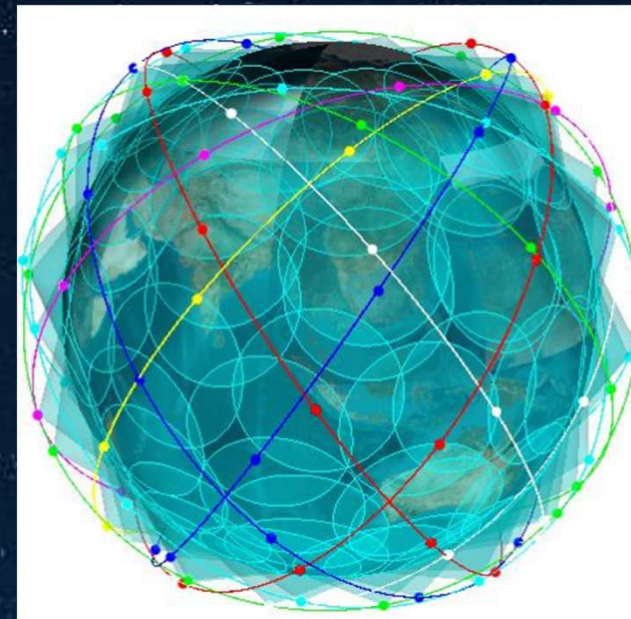
- C帯の利用による高精度かつ頑健な測位信号の地上への配信
- 地上インフラの整備(地上ノードLEONSの実証)
- GPSに依存しない代替PNTサービスを提供
- グローバルカバレッジ

中国におけるLEO-PNTの動向

CENTISPACE社（民営）

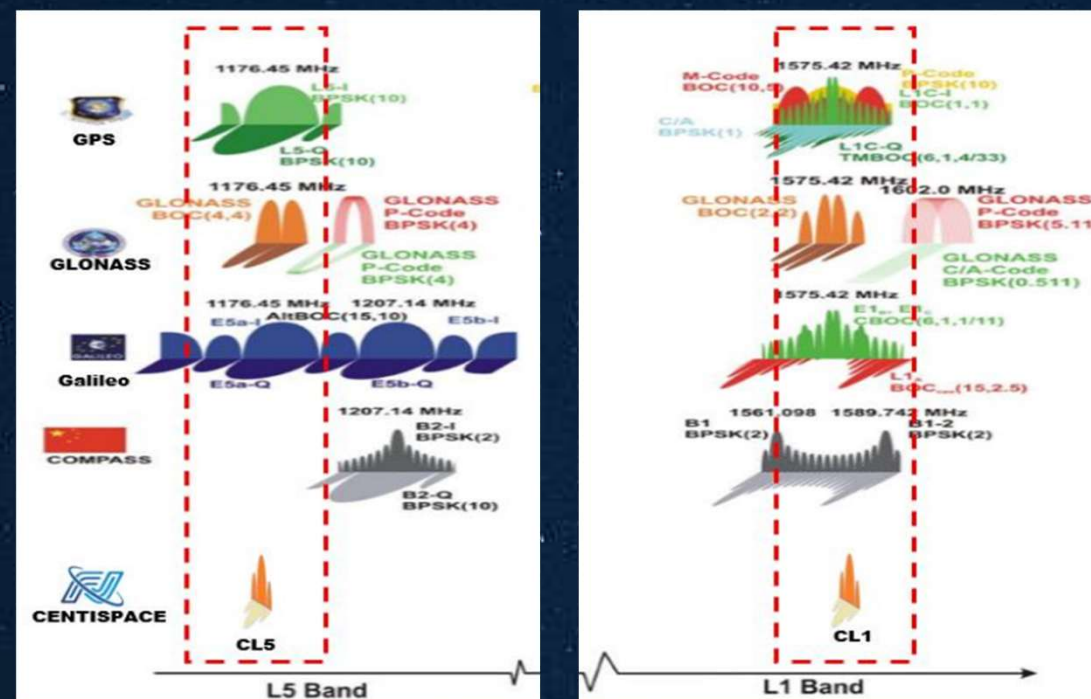
Constellation

- Current satellites: **25**
- Planned satellites: 190
 1. 975km, WALKER 55° 120/12/1
 2. 1100km, WALKER 87.4° 30/3/1
 3. 1100km, WALKER 30° 40/4/1



Signals

- Frequency: **L-band**
 - CL1 1569-1581MHz
 - CL2 1180-1182 MHz
- Modulation type: BPSK



Services

- **精密単独測位（PPP）の超高速収束サービス（1～3分か）**
- **地上インフラ**の整備（中国内にモニタリング局を多数設置）
- **衛星間リンク（ISL）**によるサービス域の拡張、グローバルカバレッジ

<https://www.unoosa.org/oosa/en/ourwork/icg/working-groups/s/wg-s-workshop-leo-pnt-2023.html>

<https://www.space-track.org/#/catalog>

<https://frontiersi.com.au/wp-content/uploads/2026/03/FrontierSI-State-of-Market-Report-LEO-PNT-2025-Edition-v1.0-3.pdf#page=93&zoom=100,0,0>

China SatNet LEO社（国営）*

Constellation

- Current satellites: **170+**
- Planned satellites: 504
 1. ~1170 km, 86.5°
 2. ~1150km, 50°

FOC expected 2030

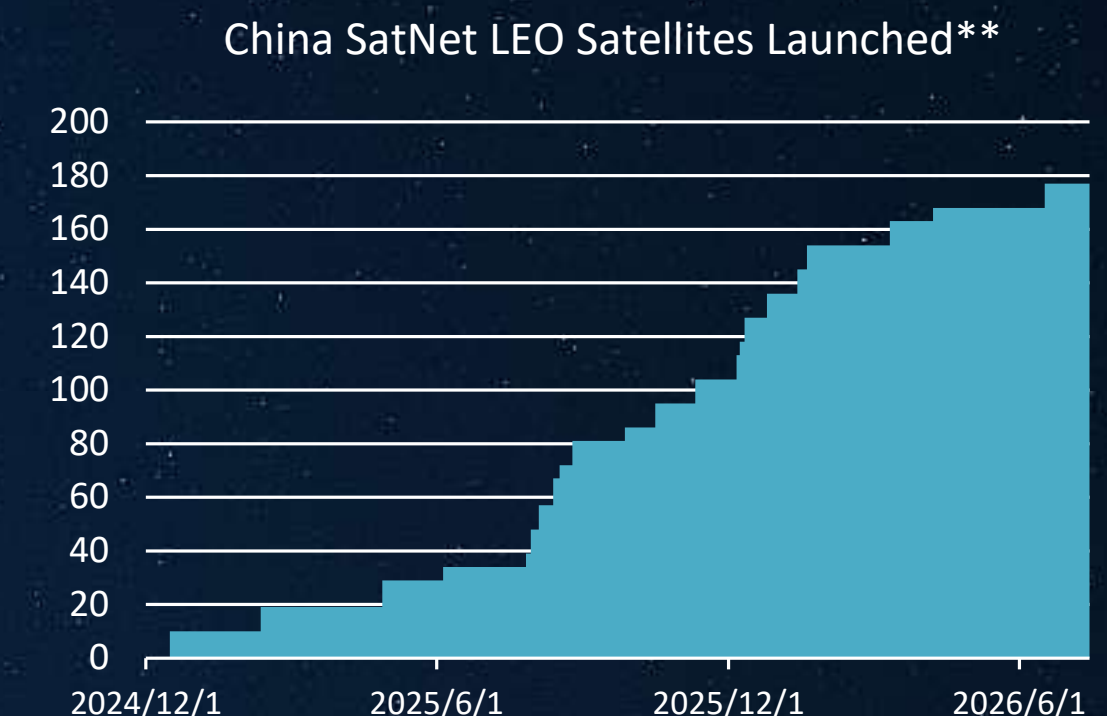
Signals

Frequency: **L-band**

Services

- **精密単独測位（PPP）の超高速収束サービス（1～3分か）**
- **地上インフラ**の整備（中国内にモニタリング局を多数設置）
- 地上でのLEO測位衛星の軌道時刻推定

※ 打ち上げ済みの衛星数が米国を大きく上回る。CENTISPACE社と類似か。CENTISPACE社との関係や違い、協力関係の有無が不明。また、dedicated-LEO PNTなのかfused-LEO PNTなのか不明（通信測位？）



欧州におけるLEO-PNTの動向

Integrated ESA / European Commission (EC) Roadmap for LEO-PNT:

ESAが技術実証を行い、その後ECが実際の運用コンステレーションを配備する長期計画

2022 2025 2028 2030+

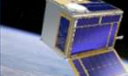
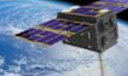
ESA-led In Orbit Demonstration (IOD)

10 satellites

- In-orbit technology demonstration
 - UHF/L/S/C-band signals transmission
 - on-board orbit determination / time synchronization
 - advanced small satellite platforms
- Services demonstration
 - Experiments with 1 satellite in view
 - Signal Tx / Rx
 - ODS and ranging accuracy
 - Experiments with 4 satellites in view
 - PVT/PPP performance

IOD1-2 satellites launched on March 28, 2026

IOD 3-10 satellites expected 2027

2 parallel contracts Each including: System and Space segment Launch services Ground segment & operations Test User segment Experimentation and Service demonstration	IOD1-2: initial demo satellites IOD11 and 12(spare) Quasi-polar orbit at ~510 km PNT signals in L and S bands De-risking and single SV experiments ITU L-band filing and Res.609 IOD11: miniaturised atomic clock and other techno	IOD 3-10: 2x4 advanced demo satellites QAR ready for launch by early 2027 Quasi-polar orbits at ~560 km PNT signals in L, S, C, UHF + 2-way Service demonstration (4-SV experiments)
 Supported by a pan-European consortium	 12U Cubesat Platform by Alén Space Payload by GMV	 100 kg microsat Platform / PL by OHB
 Supported by a pan-European consortium	 16U Cubesat Platform by GOS Payload by TAS	 ~70 kg microsat TAS Sat / PL Prime Platform by Deimos

In-Orbit Preparatory (IOP) phase by ESA

Tens of satellites (expected)

- Validation of pre-operational technologies
- Industrialisation

Operational System (OPE)

Scenarios under definition

<https://leosats.ieee.org/wp-content/uploads/2025/09/2-sarnadas-2025-05-05-esas-leo-pnt-in-orbit-dem.pdf>

<https://frontiersi.com.au/wp-content/uploads/2026/03/FrontierSI-State-of-Market-Report-LEO-PNT-2025-Edition-v1.0-3.pdf#page=93&zoom=100,0,0>

インド、韓国におけるLEO-PNT（通信測位？）の動向

インド



Building INDIA's 1st
LEO based
NAV-COM
Satellite Constellation



https://upsa-space.com/lunar/wp-content/uploads/2026/07/Lunarleo12-3_sanyark.pdf

韓国



Sunday 26 July, 2026

South Korea Formally Ratifies 2035 "K-LEO" Low Earth Orbit Constellation Plan

"The program will be backed by major investment from Hanwha Group, which plans to manufacture, launch, and operate hundreds of communications and SAR satellites using South Korean rockets through a phased rollout culminating in a fully deployed constellation by 2035." ←測位サービスも融合か？

<https://www.gsma.com/solutions-and-impact/technologies/networks/latest-news/south-korea-formally-ratifies-2035-k-leo-low-earth-orbit-constellation-plan/>

近年、LEO-PNTの互換性(Compatibility)と相互運用性(Interoperability)は、ICGのシステム・信号・サービス作業部会(WG-S)の主要な活動分野の一つになっている

• Incorporation of LEO-PNT into WG-S Work Plan at ICG-18 (2024)

Recommendation of Committee Action:

The Working Group on Systems, Signals and Services (Working Group S) recommends that the International Committee on Global Navigation Satellite Systems (ICG) endorse an update to its work plan.

The detailed work plan will include the following new areas of work:

- PPP Interoperability
- Civil Signal Authentication
- Low Earth Orbit Positioning, Navigation, and Timing (LEO PNT) Compatibility and Interoperability
- Lunar Positioning, Navigation, And Timing (PNT) compatibility (with Global Navigation Satellite Systems (GNSS)/Regional Navigation Satellite Systems (RNSS))

• Establishment of LEO-PNT Task Force at ICG-19 (2025)

- ICG-19の期間中、LEO PNTに取り組むための新しいタスクフォースが設立された
- 18-24 October 2025, Busan, South Korea



• ICG LEO PNT Systems Compatibility and Interoperability Document

- LEO PNTシステム間の互換性・相互運用性の確保を目的としたガイドライン文書を本タスクフォース内で作成中(JAXAのElenaと中国が本活動をリード)

• Annual LEO-PNT workshops on LEO PNT Systems

- 9 June 2023 (1 day), Vienna, Austria
- 26-27 June 2024 (2 days), Vienna, Austria
- 25-27 June 2025 (3 days), Vienna, Austria
- 17-19 June 2026 (3 days), Vienna, Austria

Recommendation of Committee Action:

The Working Group on Systems, Signals and Services (WG-S) will establish a Task Force (TF) on LEO PNT.

The co-chairs of the Task Force will be provided by China, ESA/EU, and the U.S.

Specifically, the Task Force will:

- Prepare technical presentations on topics related to LEO-PNT compatibility and Interoperability, to be coordinated with the "Compatibility and Spectrum" and "Interoperability and Service Standards" Subgroups as well as Working Group D.
- Organize annual LEO PNT Workshops to be held during the intersession time
- Complete the effort to develop a document within the WG-S ("LEO-PNT Systems Compatibility and Interoperability Document"), including:
 - capturing relevant inputs from the annual workshops, including from LEO PNT systems or initiatives outside ICG
 - engaging in exchanges with other ICG WGs as needed (e.g. WG-D on time and reference frames), and,
 - advancing the drafting process and coordinating with the ICG Secretariat for its endorsement.

China and JAXA will lead this task, with input from all members of the Task Force

第4回ICG LEO PNTワークショップの概要

- 今年の6月にウィーンのUNで第4回目になるLEO PNTワークショップが開催された
- 初の試みとして、受信機メーカーの参加も招待（プレゼンもあり）
- 以下にアジェンダの概要を示す：

Day 1

System Providers Session



User Segment Session

- Presentations from Rx manufacturers
- Expectations related to GNSS / LEO-PNT compatibility and interoperability
- Outcomes of pre-circulated survey

Day 2

“LEO-PNT Systems Compatibility and Interoperability Document”

- Presentation of document draft and progress
- Technical presentations on compatibility and interoperability
- Task Force working session

Day 3

- Conclusions
- Feedback
- Future steps



世界の多くの企業や宇宙機関が各々のLEO PNT構想を発表する中、どう協調関係を構築し国際調整を実施していくか、ICGでの議論に注目が集まっている。（日本からはJAXAとアークエッジスペース社が参加中）