Recent Trends in LEO PNT

第12回月測位・LEOPNT研究会

2026年7月15日

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Japan Aerospace eXploration Agency

Agenda

1. Background
2. Recent international trends
3. International Committee on GNSS (ICG) latest activities

LEO satellites for enhanced, resilient PNT

低高度

- フリースペース損失が小さい
- 高周波数（例えばS、C帯）
- → 周波数の多様化，干渉に強い，広い帯域幅

Frequency diversity

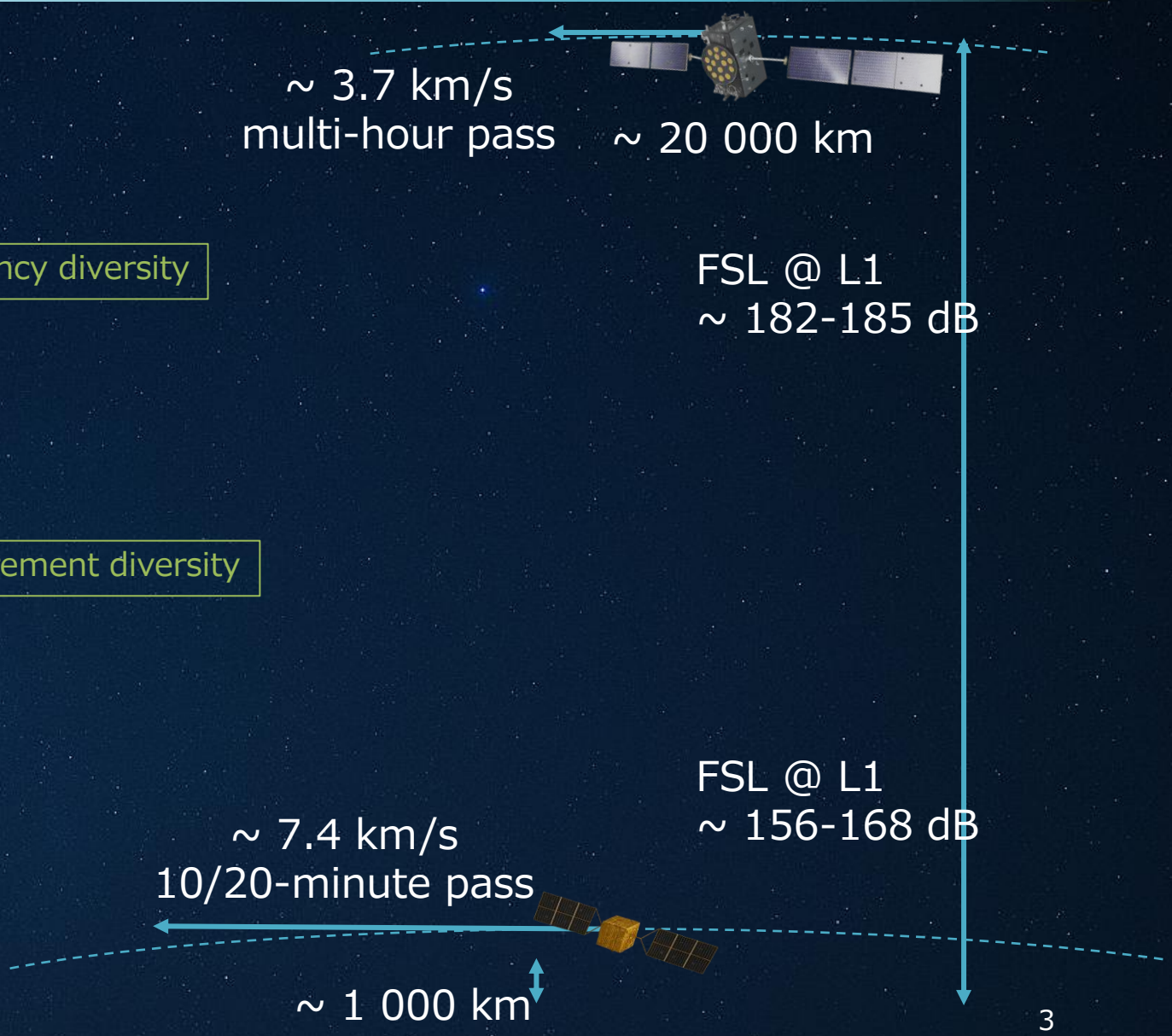
測位衛星の動きが早い

- PPPの収束時間が短い
- 測位サービスの断絶の短時間化
- マルチパス誤差の白色化

Measurement diversity

低SWaP衛星の利用

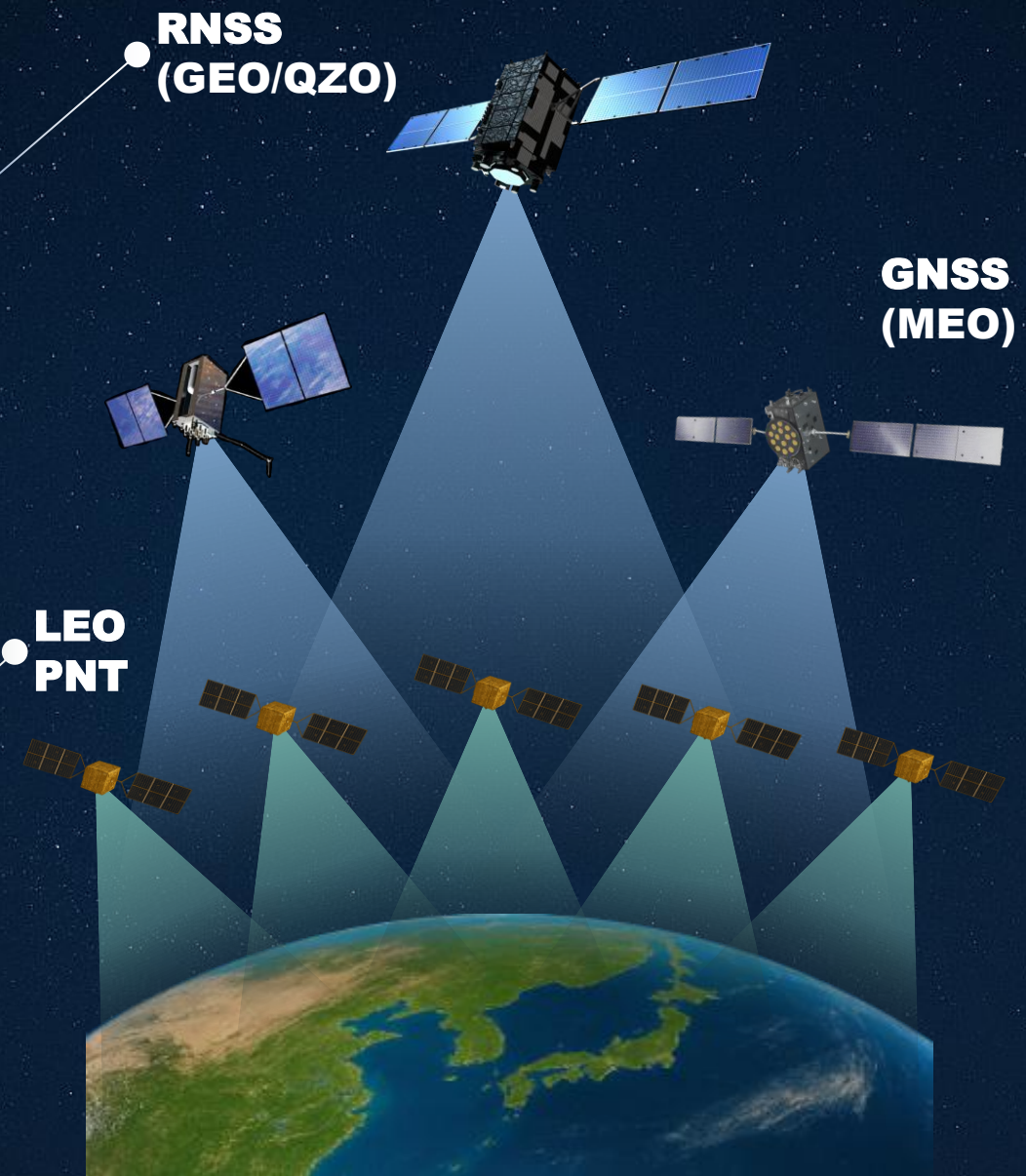
- 短いイノベーションサイクル
- 低コスト

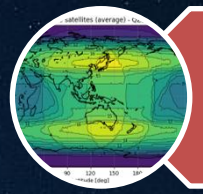


JAXA Views on Multi-Layer PNT

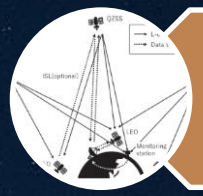
QZSS:
- GPS augmentation
  → Standalone PVT
- Regional coverage
- Wide service portfolio

LEO PNT:
- Global coverage
- Faster geometry change
- New frequency bands
- Alternative/back-up to GNSS



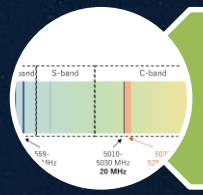


"Complementary" DOP
→ improved PNT perfo



QZSS slow geometry
→ faster LEO dynamics

Globalization of services
(e.g., MADOCA-PPP)

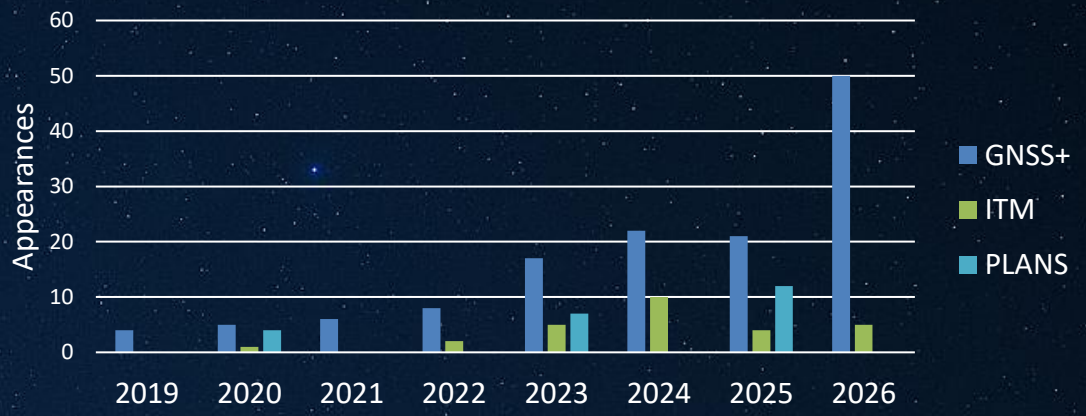


New frequency bands
& diversification

LEO-PNTの国際動向

Rising interest in LEO PNT across the research community, including academia, industry, and governments / space agencies.

"LEO/LEO PNT" key words in recent Institute of Navigation (ION) meetings programs



State of the Market Report

LEO PNT

Published since 2024 by FrontierSI (Australia)

2024 edition
(published January 2025)
9 service providers

→

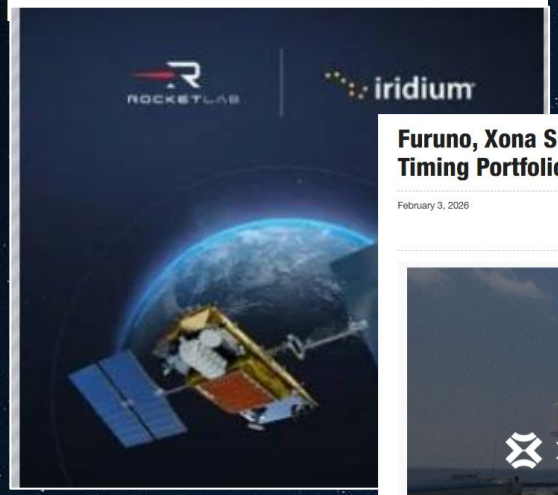
2025 edition
(published March 2026)
14 service providers

→ more continue to emerge

https://frontiersi.com.au/wp-content/uploads/2026/03/FrontierSI-State-of-Market-Report-LEO-PNT-2025-Edition-v1.0-3.pdf

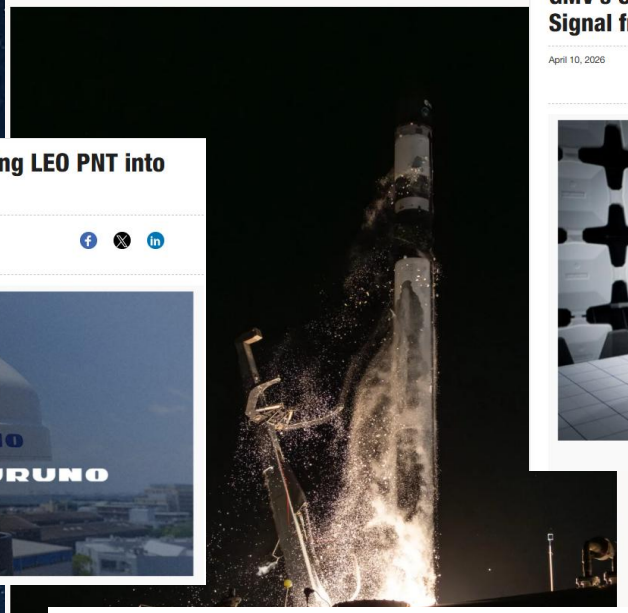
2026年におけるLEO PNT開発動向

Rocket Lab to acquire Iridium for $8 billion, expanding alternative PNT capabilities



ESA launches first Celeste satellites to test complementary LEO navigation layer

by Emma Gatti March 30, 2026



GMV's Celeste IOD-1 Transmits First Navigation Signal from LEO

April 10, 2026 By Inside GNSS

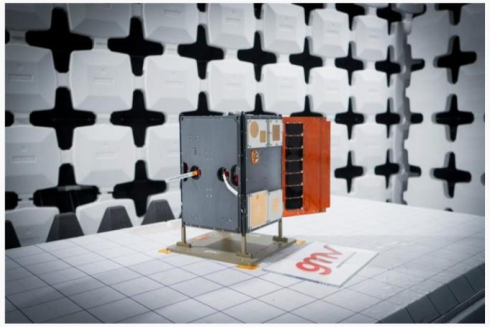


Image: GMV

Sea Launch Delivers Second Group of Ten Navigation Satellites [Jielong-3 Y10]

China Rocket's Jielong-3 has now flown from the sea for the tenth time, all successfully so far.

JACK C.
MAR 23, 2026

5 1 1 Share

Furuno, Xona Sign MoU to Bring LEO PNT into Timing Portfolio

February 3, 2026 By Inside GNSS

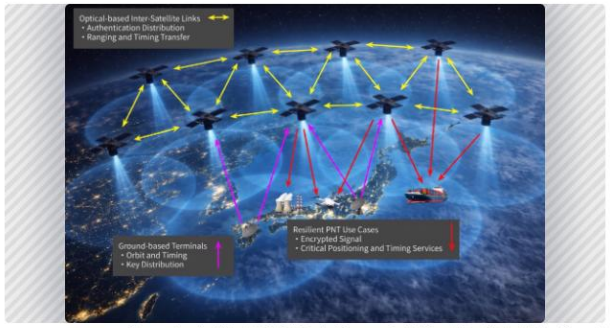
TrustPoint demonstrates non-GPS navigation for LEO satellites

The company's ground station transmitted time and tracking signals to a spacecraft in orbit

by Sandra Erwin January 15, 2026

ArkEdge Space study examines system for non-GNSS LEO PNT

By Tracy Cozzens Published May 19, 2026



Concept art of the LEO-PNT satellite constellation. (Credit: ArkEdge Space)

我国成功发射卫星互联网低轨22组卫星

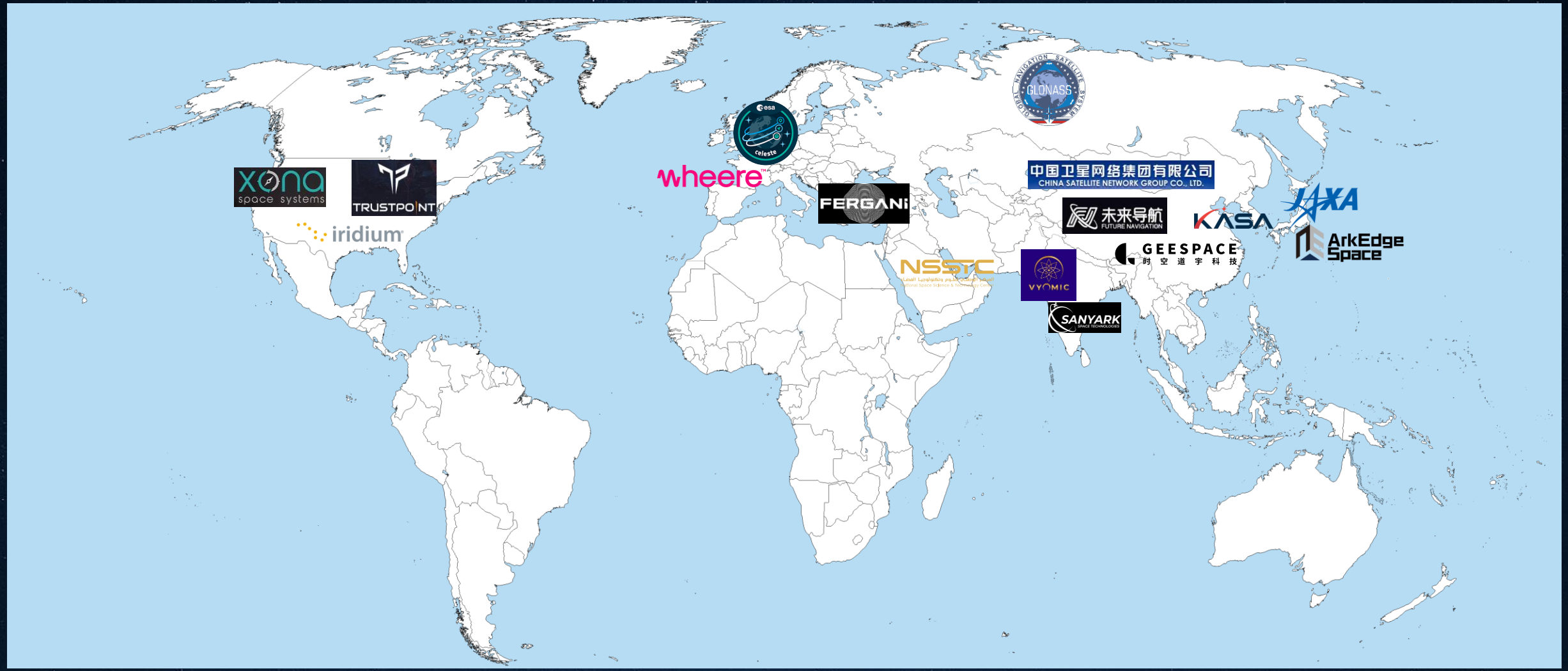
通信世界
2026-06-17 19:59 发布于湖北 通信世界官方账号

+关注

北京时间2026年06月17日10时44分，**我国在海南商业航天发射场使用长征十二号运载火箭，成功将卫星互联网低轨22组卫星发射升空**，卫星顺利进入预定轨道，发射任务获得圆满成功。

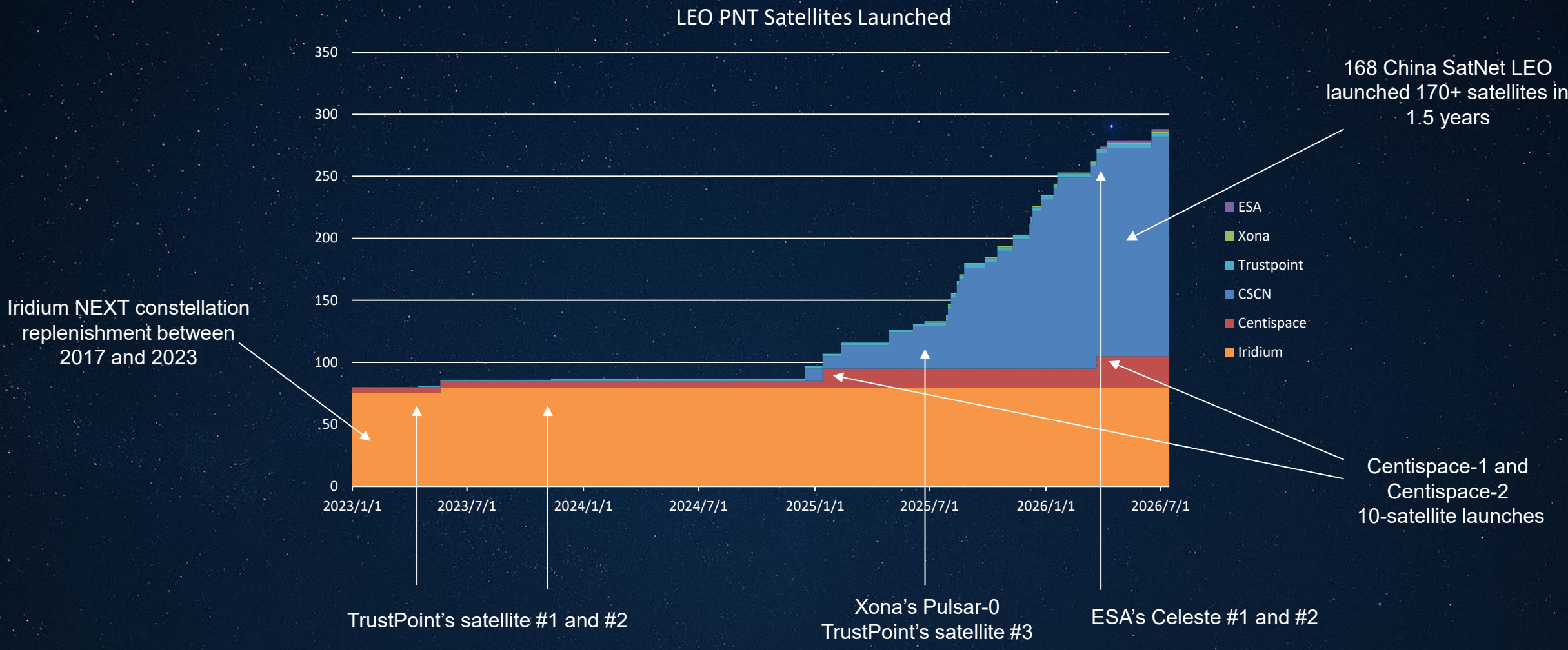
图片来源：我们的太空

LEO-PNTの国際動向



LEO-PNTの国際動向

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

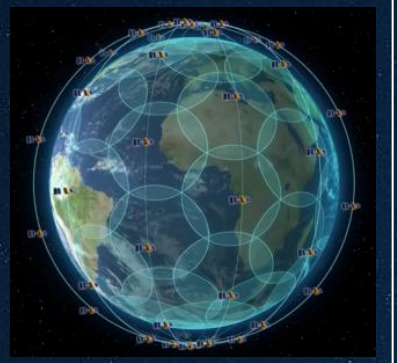


米国におけるLEO-PNTの動向

Iridium

Constellation

- Current in-orbit satellites:
  1. 66 operational @ 780 km, 86.4 °
  2. 9 spares @ 750~770km



Signals

Frequency: L-band

- STL: 1616-1626 MHz

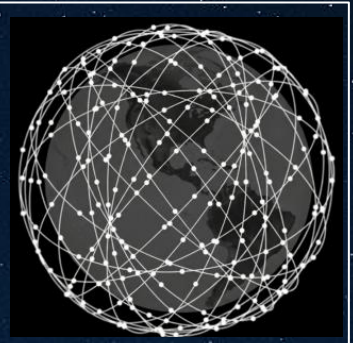
Modulation type: QPSK

Services

- Dual-mission SATCOM + PNT
- Global coverage

Fully operational

Xona



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

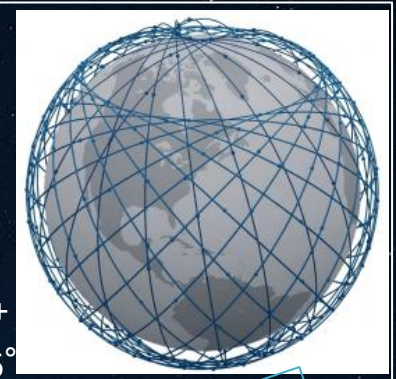
System Concept

- Timescale: GNSS + ground stations
- Nominal operations: uses GNSS
- Can operate without GNSS

Services

- PNT service, GNSS corrections, integrity service
- Heavy industry, critical infra., transportation …

TrustPoint



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

- Timescale: ground stations
- LEONS-based GNSS-independent

Services

- PNT service, GNSS corrections, integrity service
- Defence, air, road, agriculture, construction …

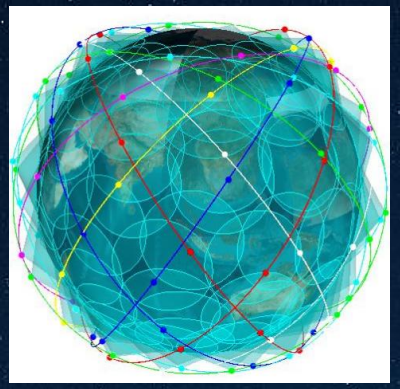
https://iridiumwhere.com/about/
https://www.space-track.org/#/catalog
https://frontiersi.com.au/wp-content/uploads/2026/03/FrontierSI-State-of-Market-Report-LEO-PNT-2025-Edition-v1.0-3.pdf#page=93&zoom=100,0,0

中国におけるLEO-PNTの動向

CENTISPACE

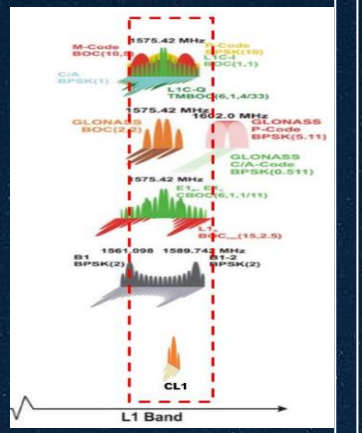
Constellation

- 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

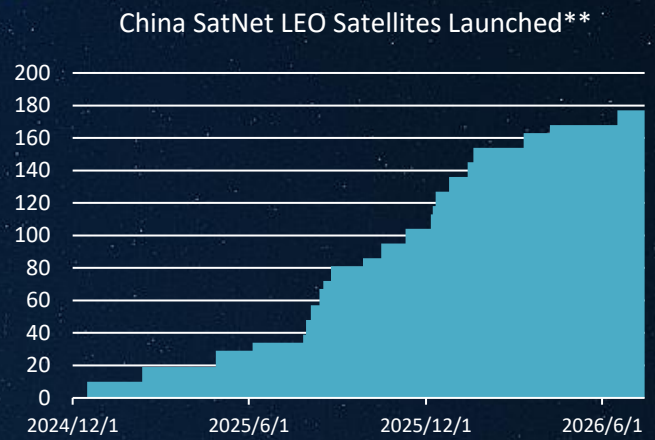
- Global High Accuracy Service
- Global Integrity augmentation Service
- Global GNSS monitoring Service

China SatNet LEO*

FOC expected 2030

Constellation

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



Signals

Frequency: L-band

Services

- Global broadband connectivity
- Global PNT service (selective payloads)

*State-owned entity responsible for the Guowang broadband mega constellation

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

欧州におけるLEO-PNTの動向

Integrated ESA / European Commission Roadmap for LEO-PNT:

2022 — 2025 — 2028 — 2030+

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
    - ODTS and ranging accuracy
  - Experiments with 4 satellites in view
    - PVT/PPP performance

In-Orbit Preparatory (IOP) phase

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

欧州におけるLEO-PNTの動向

Integrated ESA / European Commission Roadmap for LEO-PNT:

IOD1-2 satellites launched on March 28, 2026

IOD 3-10 satellites expected 2027

2022 — 2025

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
    - ODTS and ranging accuracy
  - Experiments with 4 satellites in view
    - PVT/PPP performance

2 parallel contracts	IOD1-2: initial demo satellites	IOD 3-10: 2x4 advanced demo satellites
Each including: System and Space segment Launch services Ground segment & operations Test User segment Experimentation and Service demonstration	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*	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)
gmv Supported by a pan-European consortium	12U Cubesat Platform by Alén Space Payload by GMV	OHB 100 kg microsat Platform / PL by OHB
ThalesAlenia Space Supported by a pan-European consortium	16U Cubesat Platform by GOS Payload by TAS	~70 kg microsat TAS Sat / PL Prime Platform by Deimos

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

ICGにおけるLEO PNTの取り組み

International Committee on GNSS (ICG): under the umbrella of the United Nations, promotes coordination among GNSS/RNSS/SBAS providers to ensure greater compatibility, interoperability, and transparency

近年、LEO-PNTの互換性と相互運用性は、ICGのシステム・信号・サービス作業部会（WG-S）の主要な活動分野となっている

- **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))*

- **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

- **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

Recommendation of Committee Action:

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

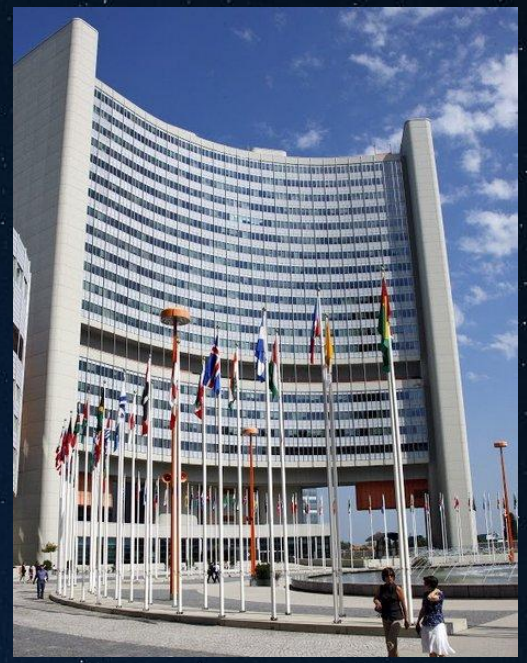
The co-chairs of the Task Force will be provided by China, ESA/EU, and the U.S.

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

LEO PNTワークショップの概要

- This year, the 4th workshop edition was held in Vienna
- For the first time, participation from both system providers and user segment
- Agenda of the workshop 2026 edition:



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" sessions

Document currently being collaboratively developed by the LEO PNT task force members.
Applicable:
- between GNSS and LEO-PNT systems
- among LEO-PNT systems

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

Day 3

- Conclusions
- Feedback
- Future steps

Thank you!

第12回月測位・LEOPNT研究会
2026年7月15日

Elena Galletti
Japan Aerospace eXploration Agency