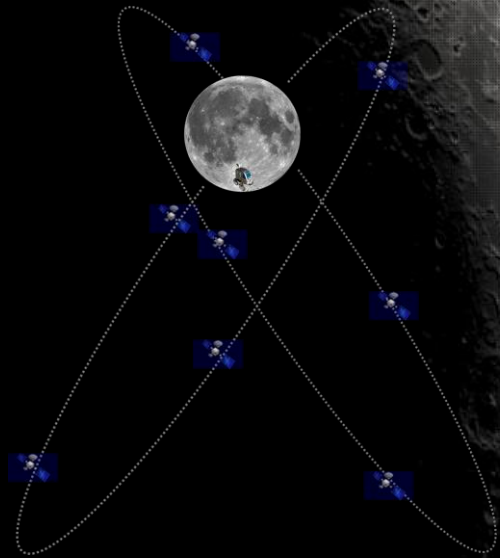


Lunar PNT and LEO PNT Conference@JAXA Tokyo Office, Japan

*Japan*

*Lunar Navigation Satellite System*



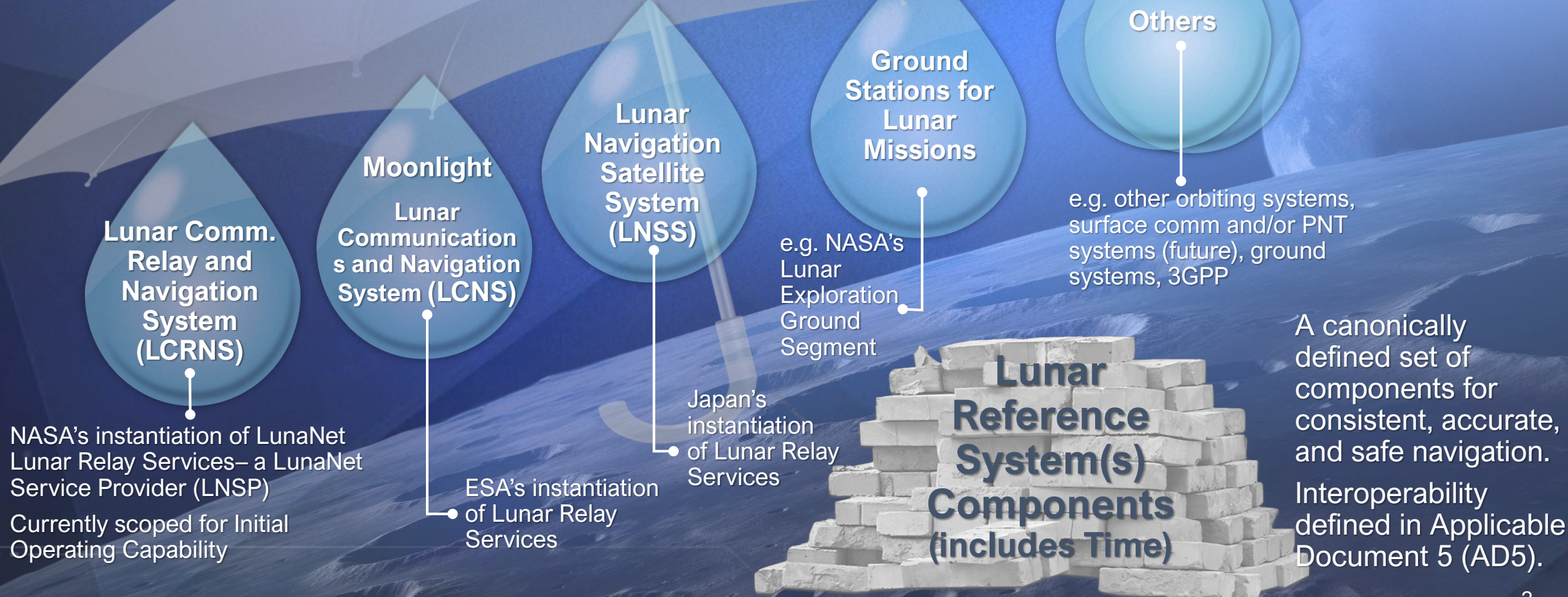
# ***Japan Lunar Navigation Satellite System (LNSS) and Towards LunaNet Lunar Augmented Navigation Service (LANS) Interoperability Demonstration***

15<sup>th</sup> July, 2026

*Masaya Murata (Japan Aerospace Exploration Agency)*

## LunaNet

Framework for Standardized Interoperable Services, umbrella under which many providers collectively work. Interoperability defined in a set of *specifications*.





# LunaNet Service Providers (LNSPs): Lunar Comm & Nav (C&PNT) systems by US, Europe, Japan



**ESA Moonlight  
LCNS  
(2028~)**

**Contractor:  
Telespazio**



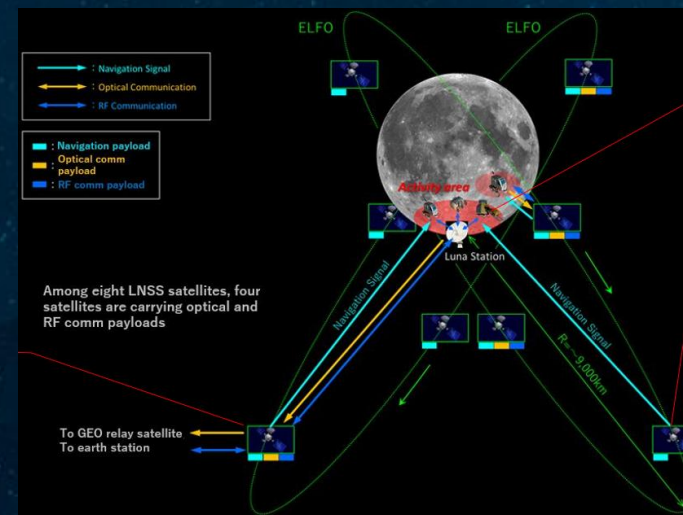
**NASA LCRNS  
(2026~)**

**Contractors:  
Intuitive  
Machines  
and TBD**



**Japan LNSS  
(2029~)**

**Contractor:  
ArkEdge  
Space**



**LCNS:  
Lunar Communication and  
Navigation System**

**LCRNS:  
Lunar Communications Relay  
and Navigation System**

**LNSS:  
Lunar Navigation Satellite System**

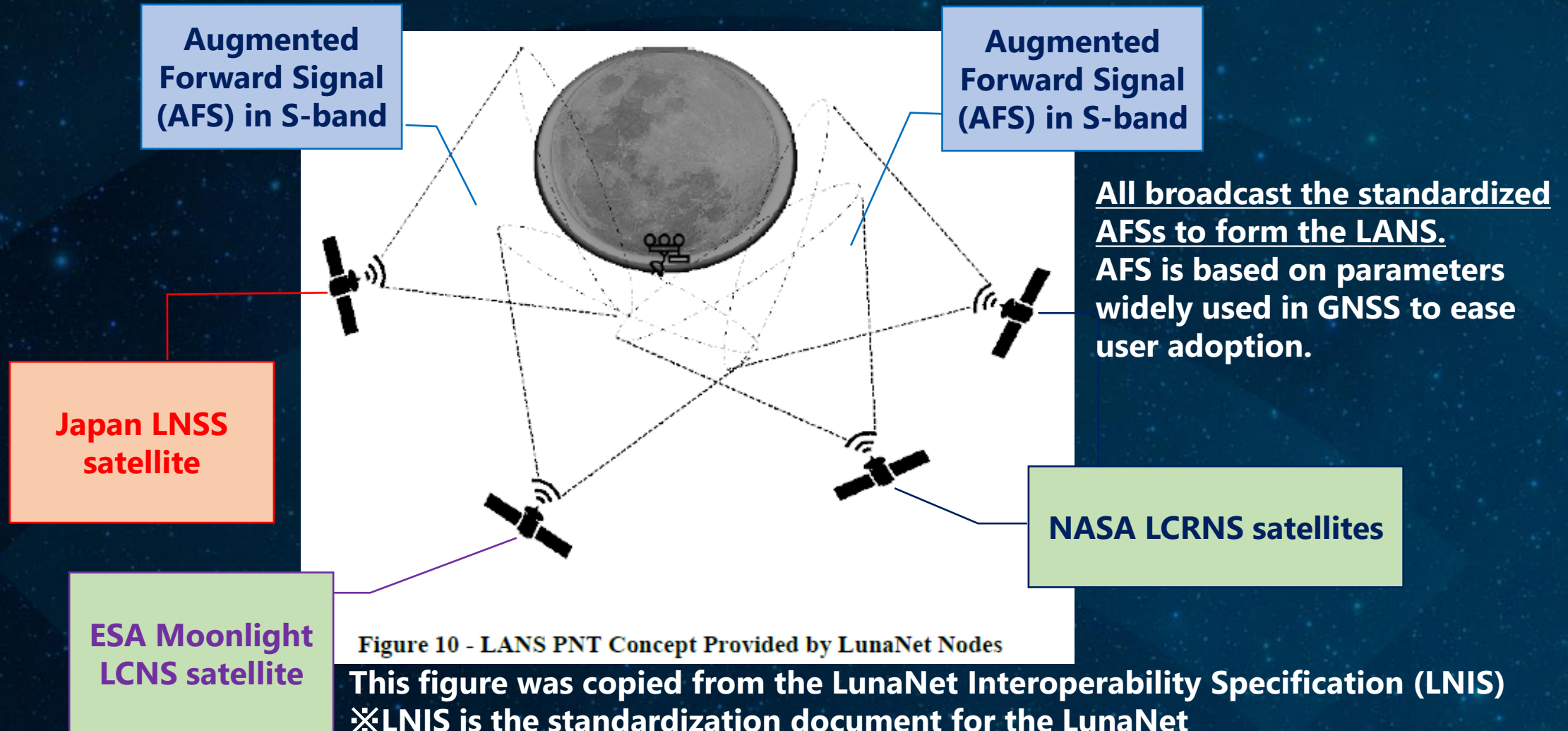


# LunaNet LANS

## Regional Lunar "GNSS"



The concept of interoperable lunar PNT system of systems  
(Lunar Augmented Navigation Service (LANS))



# LunaNet Interoperability Specification



## LunaNet Interoperability Specification (LNIS)

- A set of mutually agreed-upon specifications of standards, protocols, and interface requirements that enable interoperability.
- Provides a basis for operation of a network capable of interoperating with other LNIS-compliant networks.
- Developed cooperatively by international partners through the LNIS Working Group.

## International Communication System

**Interoperability Standards (ICSIS)** → The user-side companion document to the LNIS.

## LNIS V5 & LSIS-AFS V1 available online

[https://www.nasa.gov/directorates/somd/space-communications-navigation-program/lunet-interoperability-specification/#\\_blank](https://www.nasa.gov/directorates/somd/space-communications-navigation-program/lunet-interoperability-specification/#_blank)

## LNIS Overview

Besides the main document, includes a set of Applicable Documents:

- AD1 Volume A LunaNet Signal-In-Space Recommended Standard (LSIS) Augmented Forward Signal (AFS)
- AD1 Volume B LunaNet Signal-In-Space Recommended Standard (LSIS) Point-to-Point Signals
- AD2 LunaNet Measurement Schema and Parameters
- AD3 LunaNet Detailed Message Definition Document
- AD4 LunaNet Location Services for Users (not LunaNet 1.0)
- AD5 Lunar Reference System and LunaNet Reference Time System Standard
- AD6 LunaNet Data Services Document
- AD7 LunaNet LunaSAR Definition Document (not LunaNet 1.0)
- AD8 LunaNet Interoperability Security Specifications

Future LNIS updates will complete LunaNet 1.0 specification to cover near term needs.

# LNIS Document Schedule



2026

2027

March

April

May

July

Sept

Nov

March

May

**LNIS v6**  
Vendor  
Review

**LNIS v6**  
Published  
(summer)

**LNIS v7**  
Vendor  
Review

**LNIS v7**  
Published

**LNIS v8**  
Vendor  
Review

**LNIS v8**  
Published

Main Document v6  
AD1 VolA v2  
AD1 VolB, v0.1 draft  
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AD5, v0.1 draft  
AD6, v0.1 draft  
AD8, v0.1 draft  
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Main Document v7  
AD1 VolA v3  
AD1 VolB, v1  
AD2, v0.1 draft  
AD3, v0.1 draft

AD5, v1  
AD6, v1  
AD8, v1  
Concept of Ops, v0.1 draft

Main Document v8  
AD1 VolA v4 (opt)  
AD1 VolB, v2 (opt)

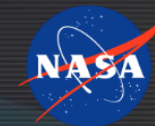
AD2, v1  
AD3, v1  
AD5, v2  
AD6, v2  
AD8, v2 (opt)  
Concept of Ops, v1

**LunaNet  
1.0**

NOTE: Draft documents are not publicly available



# Toward first-ever LANS interoperability demonstration: bringing LANS interoperability demonstration payload to the Moon



Asset deployment plan for the LANS demo in 2029

Elliptical Orbit  
(Apogee=230000km)

Lunar Orbit

④ LNSS Satellite Separation

④' Polar orbit Insertion

⑤ Power Descent  
⑥ Vertical Descent  
⑦ Landing

③ Lunar Orbit Insertion

① H3 Launch

**Japan first LNSS satellite**

**JAXA H3 rocket**

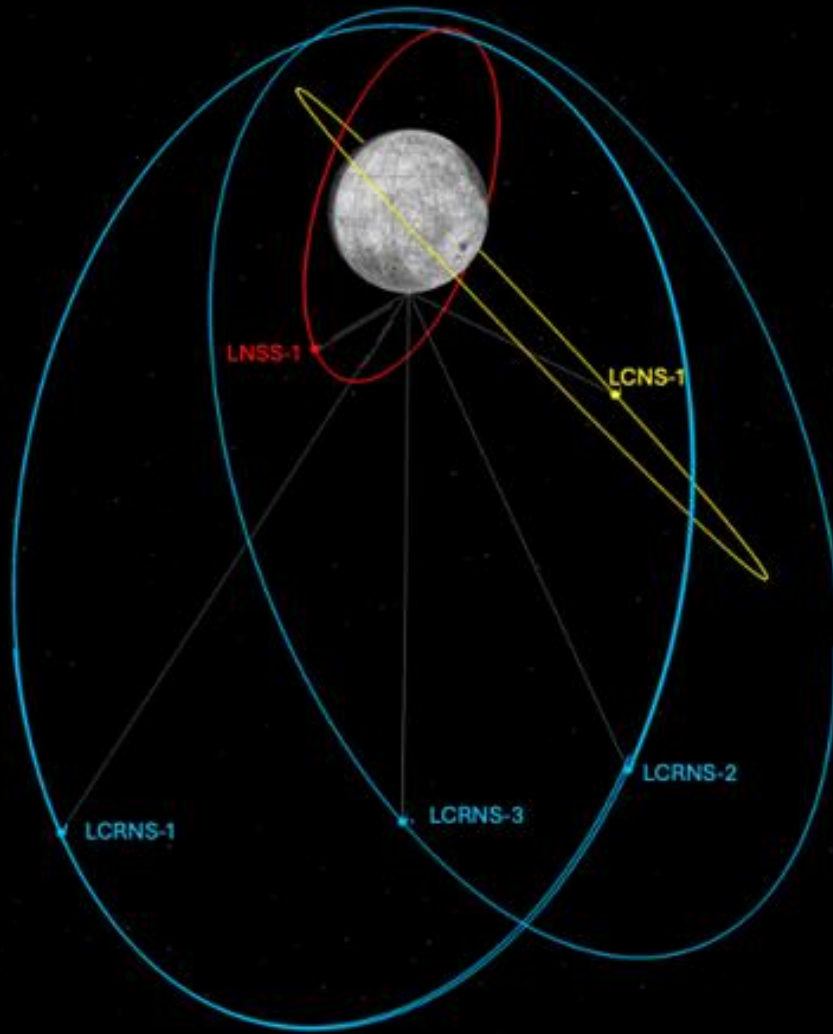
② Trans Lunar Insertion (TLI)

Lander + LNSS

**Japanese small lander carrying interoperability demonstration payload including LANS receivers**



# Expected LANS constellation in 2029 (two or three LCRNS, one LCNS, one LNSS)

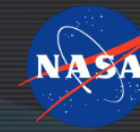


**Lunar position, navigation, and timing services jointly provided by international LNSPs (ESA's LCNS, NASA's LCRNS, and Japan's LNSS)**

## Analyzed orbital and SISE features:

|                   | ESA<br>LCNS       | Japan<br>LNSS       | NASA<br>LCRNS<br>#1  | NASA<br>LCRNS<br>#2  | NASA<br>LCRNS<br>#3  |
|-------------------|-------------------|---------------------|----------------------|----------------------|----------------------|
| Orbital<br>Period | 24 hrs<br>(ELFO)  | 6 hrs<br>(Circular) | 32.8 hrs<br>(ELFO)   | 32.8 hrs<br>(ELFO)   | 32.8 hrs<br>(ELFO)   |
| Eccentricity      | 0.7               | 0                   | 0.678                | 0.678                | 0.678                |
| SISE-pos          | 20 m<br>(2-sigma) | 20 m<br>(2-sigma)   | 13.43 m<br>(3-sigma) | 13.43 m<br>(3-sigma) | 13.43 m<br>(3-sigma) |

# The LANS receivers to be placed at the South Pole region will receive all broadcasted AFSs



GNSS satellite

Japan LNSS satellite

LANS receivers to be placed at the South Pole region

Laser ranging

weak signal

weak signal

All broadcast the standardized AFS to form LANS

ESA Moonlight LCNS satellite

NASA LCRNS satellites



# **Further International Cooperation for Lunar PNT System of Systems**

# Known Lunar Communications & Navigation Systems

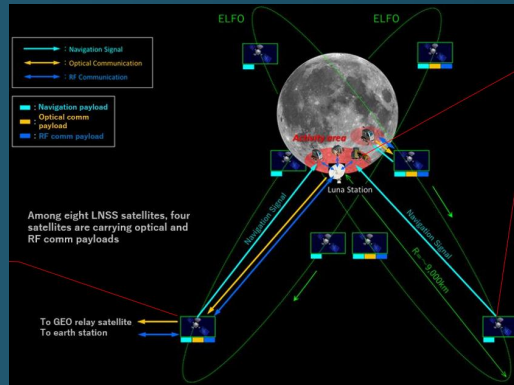
NASA  
LCRNS



ESA  
Moonlight  
LCNS



Japan  
LNSS



China  
Queqiao



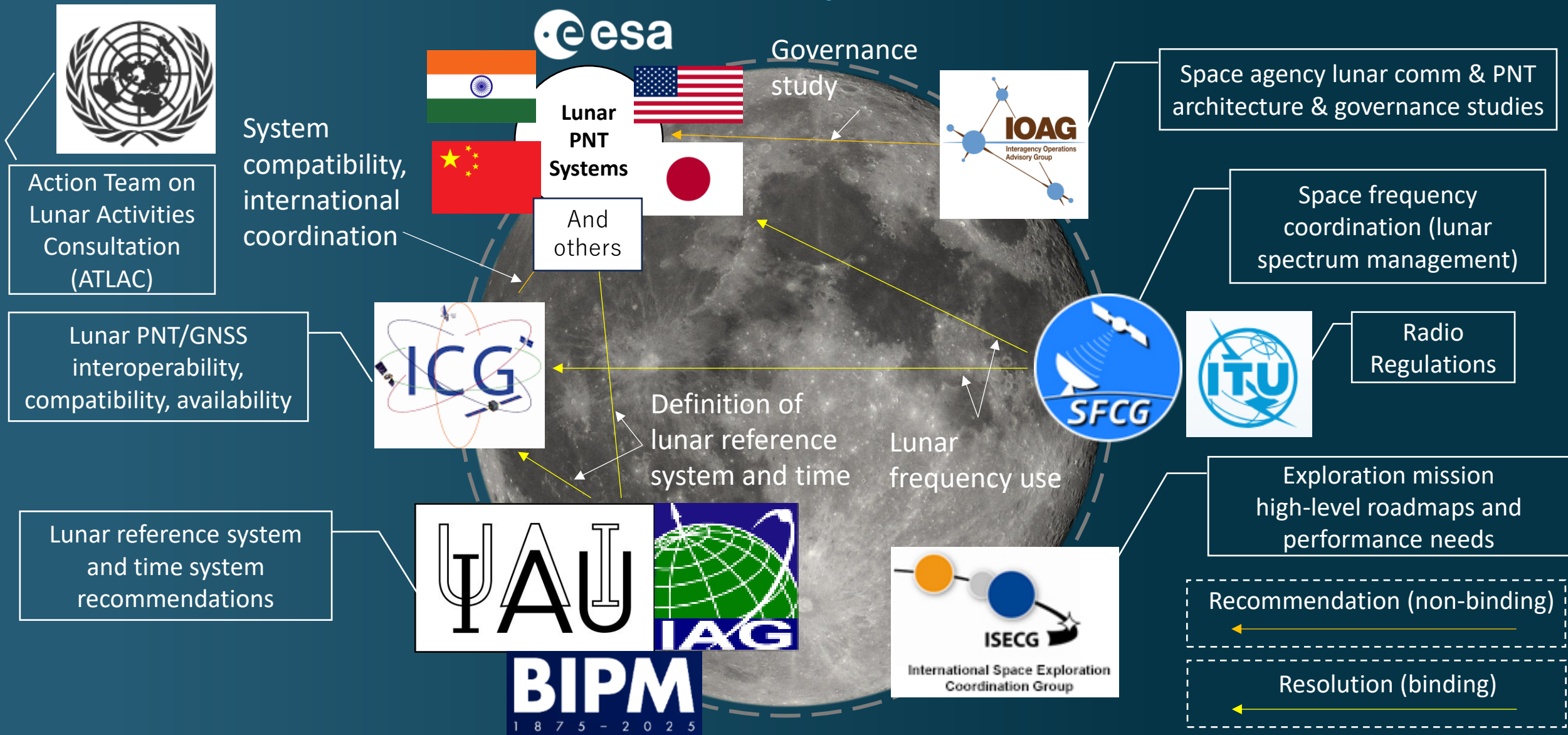
India



Announced plans by  
Italy, Korea



# International Entities Currently Involved in Lunar PNT

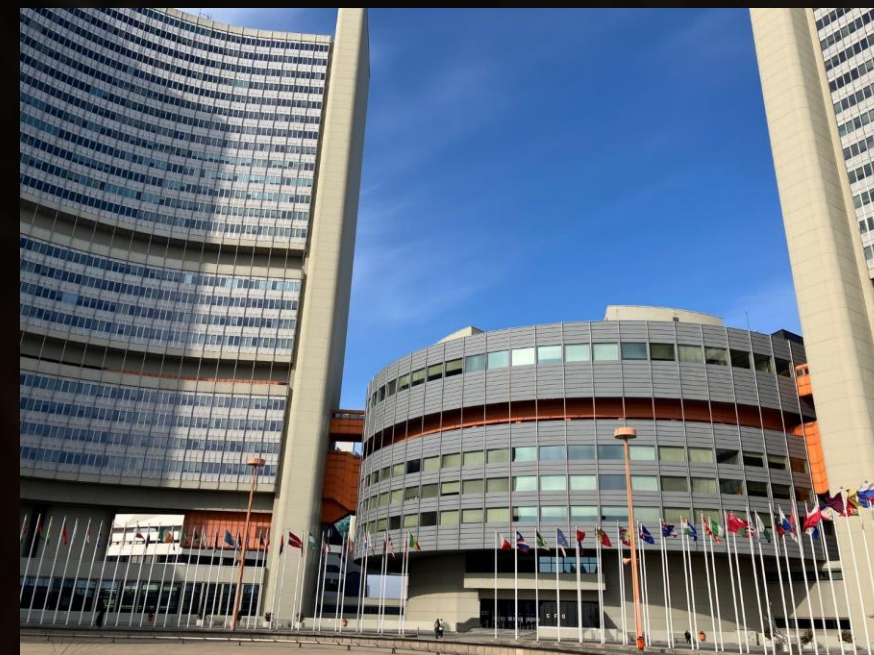




# Joint ICG-IOAG Multilateral Cislunar PNT Workshop

10–13 February 2026 | Vienna, Austria and broadcast

- Held at UN Vienna International Centre (VIC), 10–13 Feb 2026
  - <https://www.unoosa.org/oosa/en/ourwork/icg/working-groups/I/CislunarPNT2026.html>
- Approximately **90** in-person attendees from **17** nationalities
- Remote participation option with over **100** remote attendees
- **55** presentations across **8** topic-based sessions
- Final agenda and proceedings publicly available at:  
<https://ioag.org/meetings/cislunar2026>



# Conclusions

- Lunar PNT systems and services are developing rapidly by numerous international organizations, and coordination is needed to ensure compatibility and to maximize interoperability and availability.
  - The LunaNet framework is offering interoperability specification for lunar PNT.
  - Countries currently not directly involved with the LunaNet are also planning and developing their own lunar PNT asset and systems.
- My perspective is that the Moon is where international cooperation truly needs because deploying a large-scale system around/on the Moon by a single nation is simply too challenging (and costly).
- The Cislunar PNT Workshop co-organized by ICG and IOAG (Interagency Operations Advisory Group) is providing multilateral discussion venue on various important aspects of lunar PNT.
  - The 3<sup>rd</sup> Cislunar PNT Workshop in Feb. 2027 is currently under planning.