



Towards a Sustainable Lunar Ecosystem: Bridging Technical Developments to Policy Priorities in Lunar PNT

2nd Joint ICG-IOAG Multilateral Cislunar PNT Workshop
Vienna, Austria

Feb. 12th, 2026

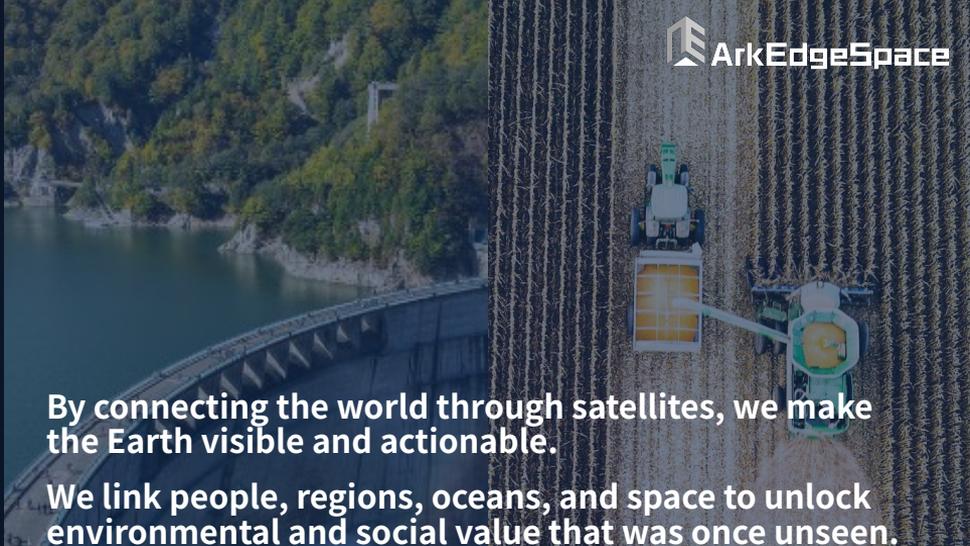
Toshihiro SHIBUKAWA

01

Introduction

Our Mission

Empowering people with satellites for a prosperous future.



By connecting the world through satellites, we make the Earth visible and actionable.

We link people, regions, oceans, and space to unlock environmental and social value that was once unseen.



Placing people at the center, we build space systems as critical infrastructure, extending new economic spheres from land to sea, and onward to space.

As a comprehensive micro-satellite system integrator, we deliver end-to-end solutions from planning and design to mass production and operations, driving real-world development and societal impact.



A General Integrator for Micro-Satellite Systems

Delivering end-to-end solutions for microsatellite constellations,
from design and development to mass production and operations.

Company Profile

(as of Jan. 2026)

Founded : July 2018

Headquarters : Tokyo, Japan

Total Funds Raised : \$74.2M+

Total Orders & Selections : \$195M+

Number of Employees : approx. 190

Launched & Operated : 17 satellites



Completion of Series B Funding (January 2025)



Empowering people with satellites for a prosperous future

Series B

JPY **8** billion

(USD 51 million)

INCUBATEFUND

VIC VENTURE GROWTH INVESTMENTS

WIL WORLD INNOVATION LAB

MUFG 三菱UFJ銀行

SMBC SMBCベンチャーキャピタル

MIZUHO みずほキャピタル

静岡キャピタル株式会社

SMBC日興証券

未来創造キャピタル Future Creation Capital

SPARX

MS&AD 三井住友海上キャピタル

HULIC

清水建設

スカパーJSAT

for Startups Capital

Key Business Growth since Series A

2022.3
(as of Series A)

2025.1
(as of Series B)

Satellite Launch and Operation

10+

In-house developed satellite 1 → 6
Third-party satellite operation 0 → 5

Accumulation of Orders & Contracts

30+ billion

JPY 2.23 B → JPY 32.19 B

Number of Team Members

4.5 x

28 → 126

Total Funds Raised

3.2 x

JPY 2.7 B → JPY 10.7 B

Satellite Bus Design and Development Capabilities

From deep space to LEO constellations, we pursue excellence in design, development and solutions.

Cutting-Edge Technologies for Lunar & Deep Space

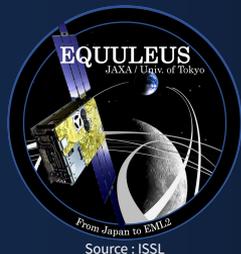
Complex & High-Level Orbit Control

Lightweight & Compact

Adaptation to Harsh Environments
(Heat, Radiation and Power)

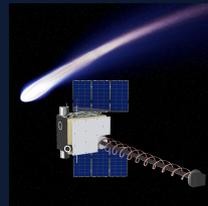
Deep-space 6U spacecraft **EQUULEUS**

- A spacecraft jointly developed by JAXA and the University of Tokyo to demonstrate Earth-Moon orbit control.
- AE participated in the spacecraft's operation.
- The 6th Space Development and Utilization Grand Prize Selection Committee Special Award



Long-period Comet Spacecraft **Comet Interceptor**

- A joint mission between ESA and JAXA, where ArkEdge Space will contribute a single spacecraft.
- Advanced mission to be placed in the orbit of the Sun-Earth Lagrange Point, in readiness to intercept a passing comet.



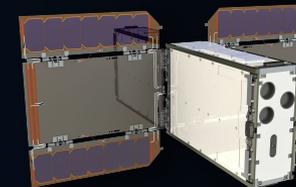
Applications to Life back on Earth

Compact & High Performance

Support Variety of Missions

Cost-Effective & Mass Production

Multi-Purpose Satellite Bus Series



Future Development into

- 16U-Class CubeSat
- 50kg-Class Micro-Satellite
- 100kg-Class Micro-Satellite



Satellite Series (Including Development and Operational Track Record)

- From development to mass production of micro-satellites, we now enter the phase of full-scale launch and utilization.
- We develop diverse micro-satellites for earth observation and positioning, while expanding into new markets.

3U Satellite

Operation

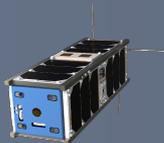
Launched in 2019



RWASAT-1

Operation

Launched in 2023

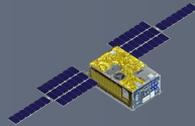


OPTIMAL-1

6U Satellite

Operational Support

Launched in 2022



EQUULEUS
©The University of Tokyo

Operational Support

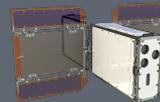
Launched in 2023



SPHERE-1 EYE
Support operation of
6U-class earth observation

Utilization Phase

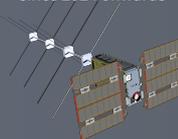
Scheduled for 7 launches since 2024 onwards, with 5 already deployed



6U Multi-Purpose Satellite Bus Series

In-Orbit Demonstration in Progress

Gen-0 was launched in Jan 2025. Scheduled for several launches since 2024 onwards

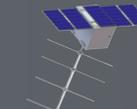


VDES Demonstration Satellite

30 to 100kg class Satellite

Under Development

Multiple satellites scheduled for launch around 2026



VDES - Maritime Observation Satellite

Under Development

Scheduled for launch around 2029

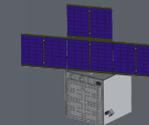


Comet Interceptor

100+ kg class Satellite

Under Development

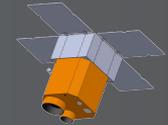
Scheduled for launch around 2028



Lunar Positioning Satellite

Under Development

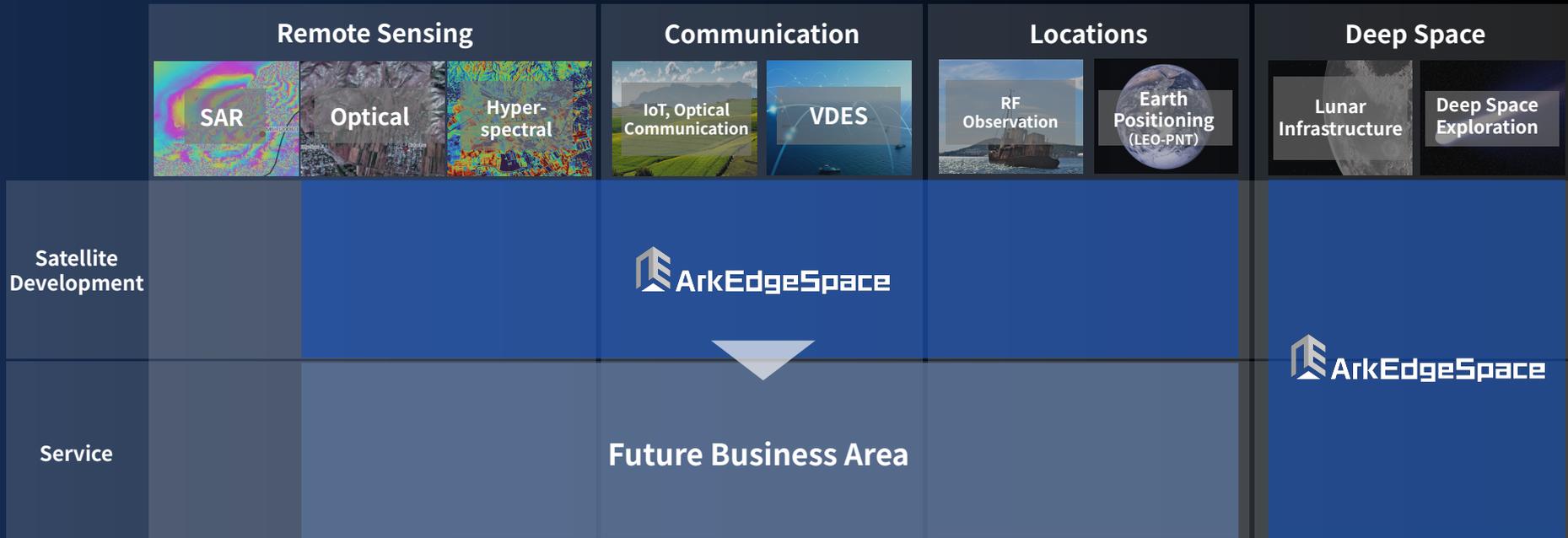
Scheduled for launch around 2027



Hyper-Spectral Remote Sensing Satellite

Capable of Supporting Diverse Missions

- Capable of developing satellites for remote sensing, IoT/VDES, radio frequency (RF) observation, positioning, as well as lunar infrastructure & deep space exploration.
- We will deliver **comprehensive solutions across fields** by utilizing satellites.



Our Lunar PNT Activities

3 Years of Feasibility Study Work with JAXA

Have been awarded multiple contracts by JAXA for work on lunar PNT

- Conceptual studies on architecture design of lunar navigation / communication infrastructure (2022 - 2023)^{*1}
- Conceptual studies on Lunar Navigation Satellite System technology demonstration mission (2022 - 2024)^{*1}
- Prototype development of onboard navigation payload of lunar navigation system (2023 - 2024)



Awarded Space Strategy Fund for Lunar Navigation System Demonstration Satellite Development

Awarded contract for JAXA Space Strategy Fund Technology Development Theme “Lunar Positioning System Technology” on November 22, 2024^{*2}

- Progressing to actual development of Lunar PNT Payload and Demonstration Satellite

Further Feasibility Studies for LANS Receivers and FOC Level Systems

Awarded 3 additional contracts from JAXA for FOC level feasibility studies^{*3} and LANS receivers

- Working on not only satellite development, but also future service providing and receiver manufacturing

*1: https://arkedgespace.com/en/news/2022-01-11_jaxa_moon

*2: https://arkedgespace.com/en/news/2024-11-29_jaxaspacestrategyfund_Inss

*3: https://arkedgespace.com/en/news/2024-12-11_jaxafeasibilitystudy_Inss

02

Lunar Navigation Satellite System (LNSS) Demonstration Mission

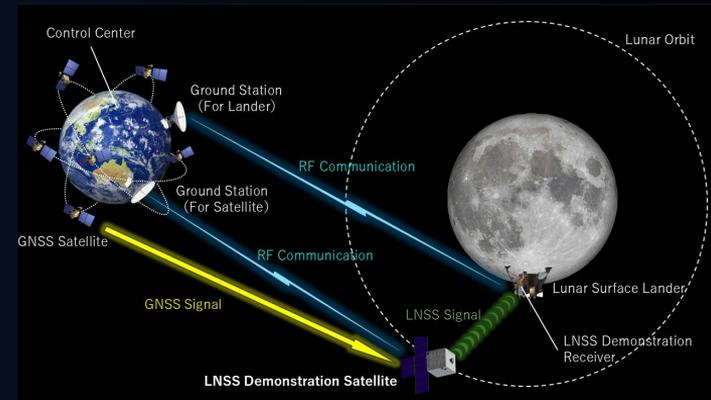
Requirements for Lunar PNT Infrastructure

- Access to reliable and accurate PNT data has reshaped our global security environment and underpinned vast economic growth on the Earth, and the same will be true on the moon.
 - Support of Mission Safety and Autonomy
 - Precise lunar orbital rendezvous
 - Accurate / Repeatable landing operations
 - Rover navigation
- Lunar PNT likely to have dual-use (governmental / commercial) requirement, carrying strategic significance.
 - **Lunar power generation, including nuclear reactors,** requires precise PNT and coordination for safe operations
 - **In-situ resource utilization** undoubtedly requires PNT infrastructure for safety and efficiency

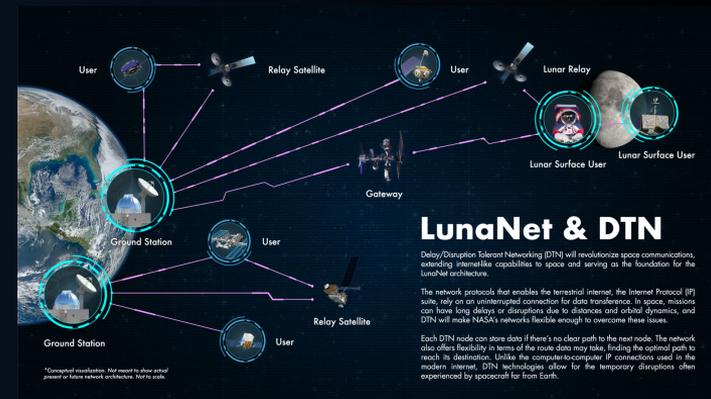


Lunar Navigation Satellite System (LNSS)

- The Japanese Lunar PNT system driven by JAXA is called the **Lunar Navigation Satellite System (LNSS)**, using a constellation of lunar-orbiting satellites.
 - Support wide range of lunar users
 - Coverage of the far side of the Moon
- Characteristics of Japanese LNSS:
 - Utilization of **weak GNSS signals** from Earth to perform onboard orbit and time determination
 - Global collaboration with LCRNS and LCNS via **LunaNet framework** for efficient development and demonstration
- The first LNSS satellite is a **demonstration mission** to validate technical challenges
 - Launch date is expected to be in 2029

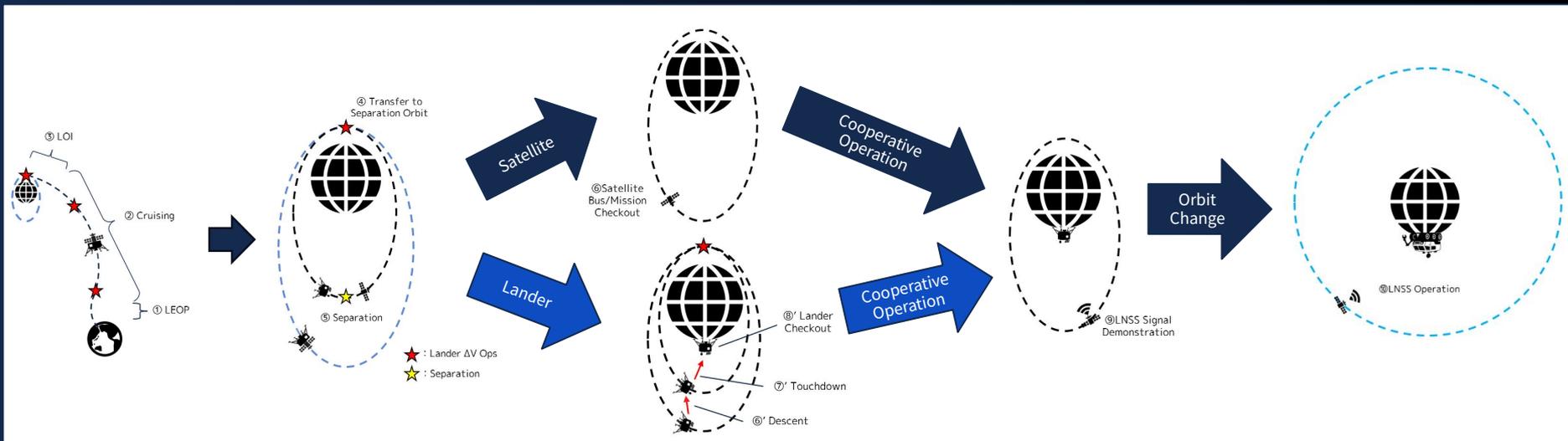


Overview of LNSS



LNSS Demonstration Mission

- The LNSS demonstration mission will comprise one satellite, one lander and a receiver on the lander
 - Interoperability demonstrations are also under consideration in LunaNet framework
- The final satellite orbit will be a lunar polar orbit, considering LOI attached to the lander
 - 6 hour circular orbit, 90 deg inclination (in Earth Orbital Plane Frame)
 - Cooperative operation between lander and satellite will be done from separation orbit



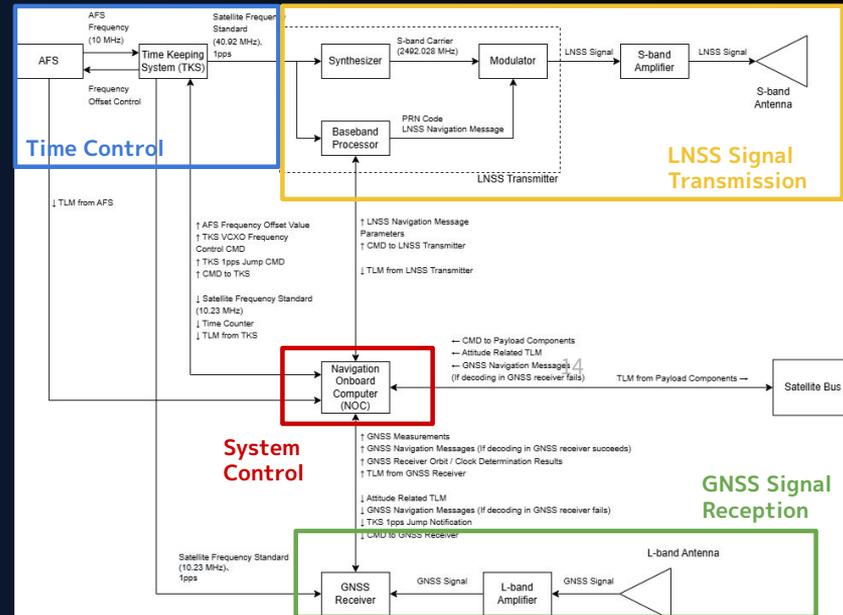
Payload System Design

The payload system is designed with the following key functions:

- Reception of weak GNSS signals and onboard ODTs
- Highly stable onboard time keeping system
- Generation and transmission of LNSS signals

We have completed our Preliminary Design Review (PDR) and moving on to further development.

Function	Components
System Control	Navigation Onboard Computer
Time Control	AFS, TKS
LNSS Signal Transmission	LNSS Transmitter, S-band Amplifier, LNSS Antenna, LNSS Antenna Gimbal
GNSS Signal Reception	GNSS Receiver, GNSS Antenna, L-band LNA



Payload Component Development

- **Time Keeping System (TKS):** Prototyping finished, manufacturing EM
- **LNSS Transmitter:** Prototyping finished, manufacturing EM
- **Onboard Navigation Computer:** Implementation of ODTS algorithm under work
- **AFS:** Cooperation with Safran Timing Technologies to develop miniRAFS
- **GNSS Receiver:** Cooperation with SpacePNT for high-sensitivity GNSS receiver



TKS Prototype



LNSS Transmitter Prototype



©Safran Timing Technologies

miniRAFS

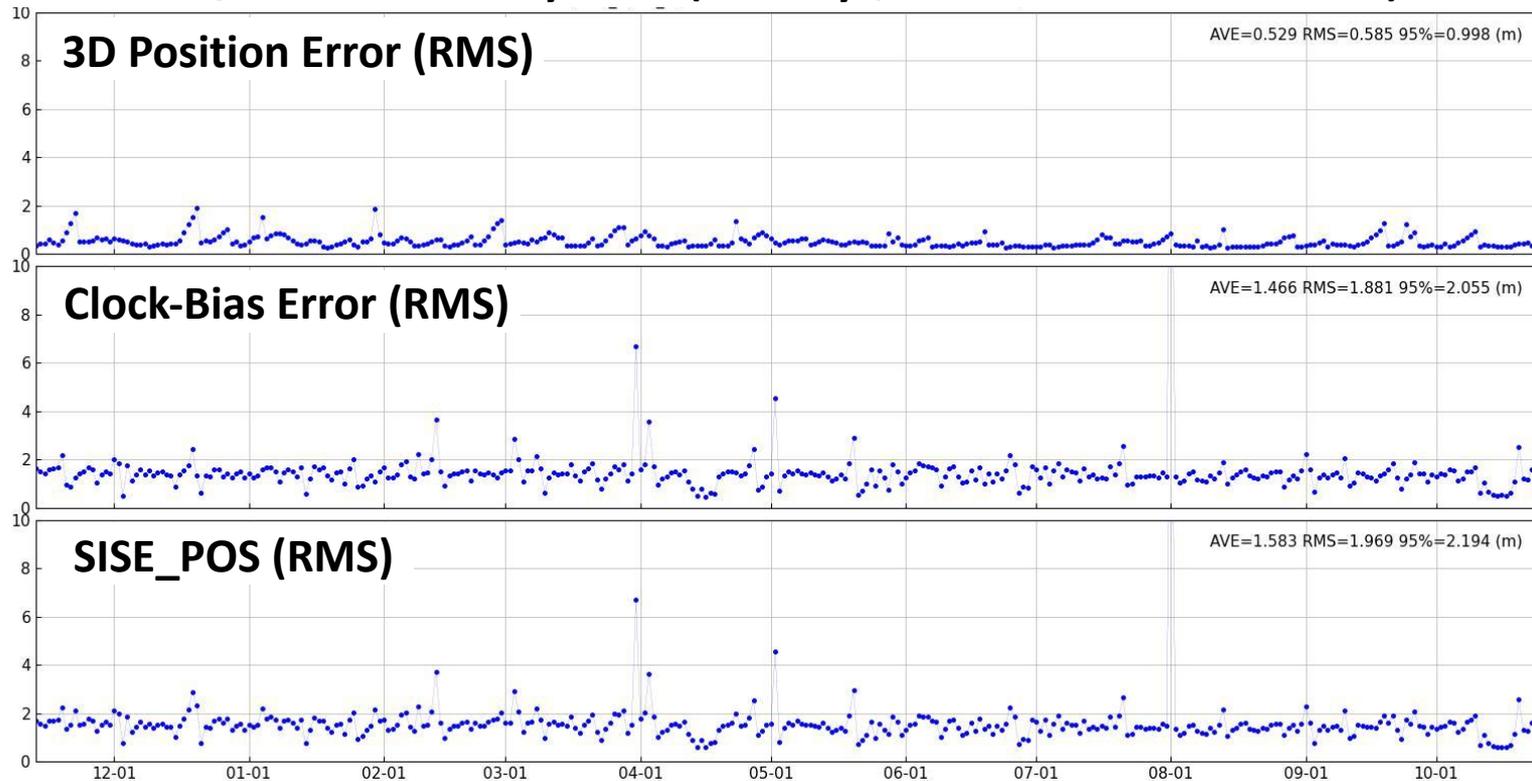
Long-Term Ephemeris (LTE)

- Difficult to decode most of GNSS NAV data on lunar orbit due to low C/N0 environment
- Therefore, LTE will be generated on the ground and provided to LNSS satellites via TTC link
 - At least 24H as effective age considering TTC link outage
 - The accuracy should be comparable to broadcast ephemeris and clock
 - Minimum data size to reduce bandwidth of TTC link
 - GPS and Galileo, number of satellites : > 60
- Design of LTE
 - Based on ultra-rapid precise ephemeris (SP3) provided by IGS ACs
 - LTE parameters generated on ground by fitting to GNSS position and clock by precise ephemeris
 - GNSS clock: satellite clock bias and rate at epoch in GPST
 - GNSS satellite orbit propagated onboard LNSS satellite by orbital dynamics model

Long-Term Ephemeris (LTE)

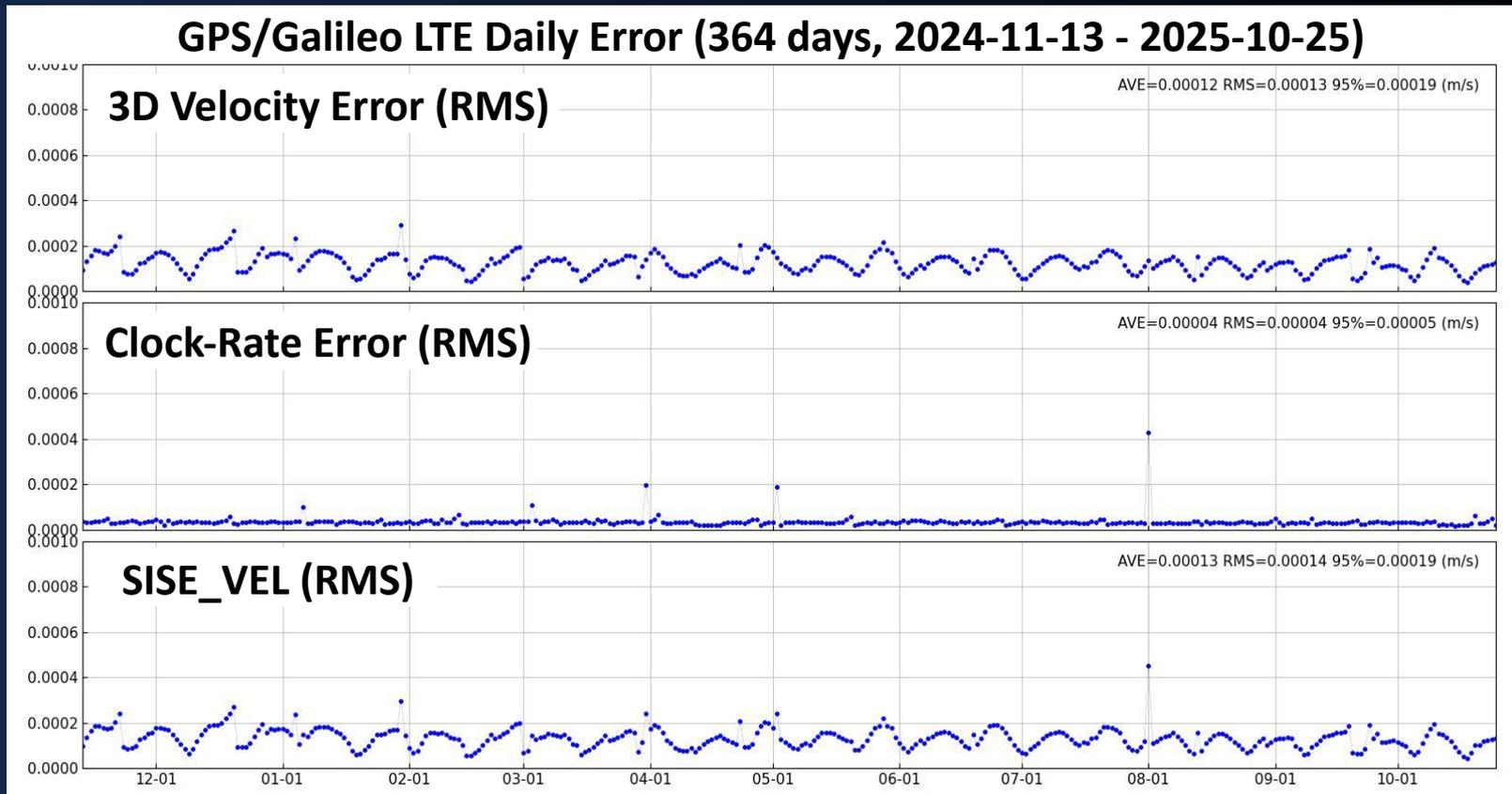
- SISE_pos (95%) = 2.2 m ※Clock Anomaly Excluded

GPS/Galileo LTE Daily Error (364 days, 2024-11-13 - 2025-10-25)



Long-Term Ephemeris (LTE)

- SISE_vel (95%) = 0.2 cm/s ※Clock Anomaly Excluded



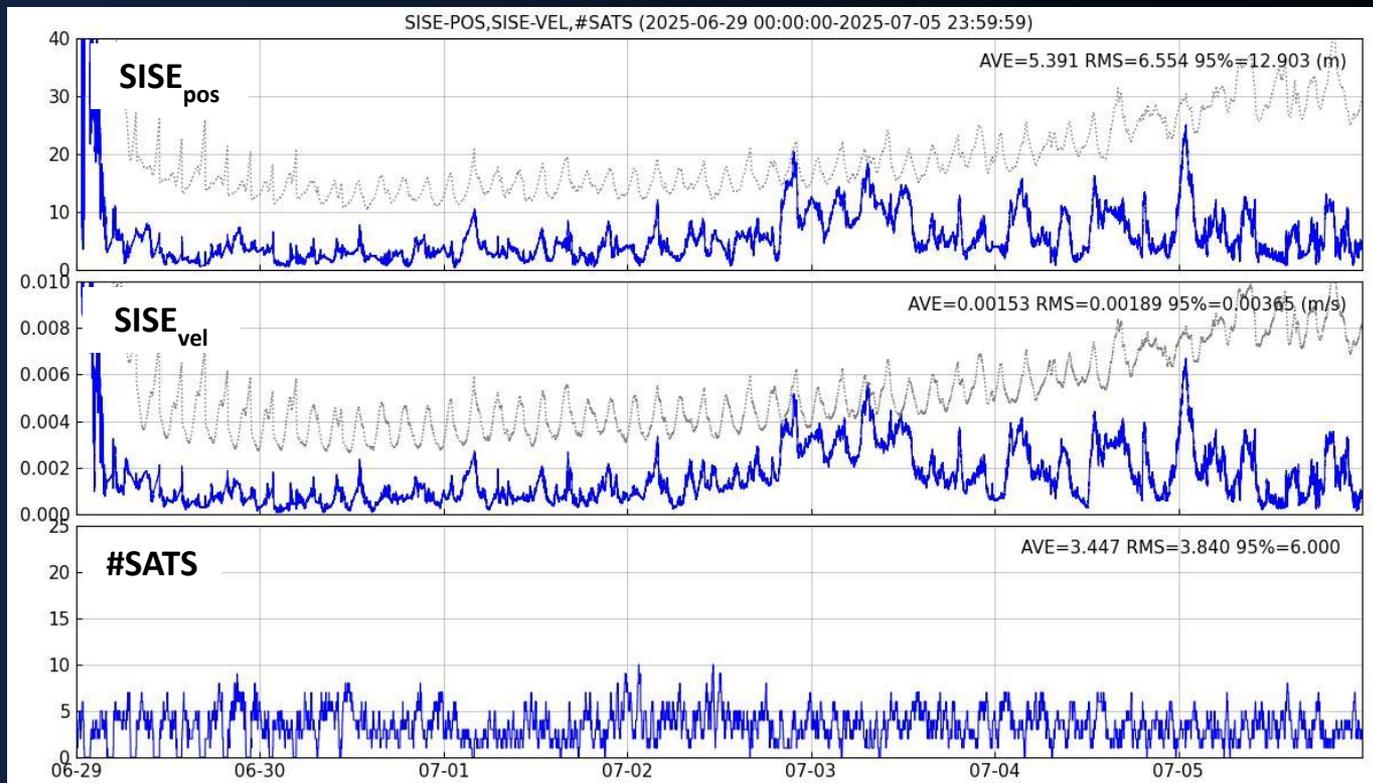
ODTS Simulations

- ODTS simulation results based on LTE
 - Does not account LNSS ephemeris fitting errors
- Results
 - SISE_pos (95%) < 20 m is expected

Time Span (GPST)	Initial Orbital Elements (PA)	Average of #SATS	Occultation /Eclipse	ODTS Error (12 ~ 168 H) ^{*1}				Notes	
				SISE_pos (95%)		SISE_vel (95%)			
2025-06-29 00:00:00 ~ 2025-07-05 23:59:59 (168 H, step 1 s)	LPO A = 3870 km, e = 0.001, i = 90°, ω = 270°, M = 0°	Ω = 0°	3.447	Yes/No	12.903	m	0.365	cm/s	
		Ω = 45°	2.970	Yes/No	8.879	m	0.269	cm/s	
		Ω = 90°	3.267	Yes/No	7.341	m	0.225	cm/s	
		Ω = 135°	3.584	Yes/Yes	13.739	m	0.376	cm/s	
		Ω = 180°	3.446	Yes/No	11.273	m	0.324	cm/s	
		Ω = 225°	2.968	Yes/No	9.714	m	0.293	cm/s	
		Ω = 270°	3.259	Yes/No	9.913	m	0.278	cm/s	
		Ω = 315°	3.560	Yes/Yes	11.113	m	0.322	cm/s	
		Total	3.313	-	10.789	m	0.310	cm/s	
		ELFO A = 6143 km, e = 0.600, i = 56.2°, ω = 90°, M = 0°	Ω = 0°	3.778	Yes/No	13.770	m	0.170	cm/s
Ω = 45°	3.191		Yes/No	14.099	m	0.195	cm/s		
Ω = 90°	3.443		-	19.940	m	0.231	cm/s		
Ω = 135°	3.644		Yes/Yes	15.029	m	0.203	cm/s		
Ω = 180°	3.473		Yes/Yes	19.764	m	0.249	cm/s		
Ω = 225°	3.240		Yes/No	14.349	m	0.179	cm/s		
Ω = 270°	3.289		Yes/No	12.390	m	0.158	cm/s		
Ω = 315°	3.454		Yes/Yes	15.694	m	0.208	cm/s		
Total	3.439		-	15.844	m	0.201	cm/s		

ODTS Simulations

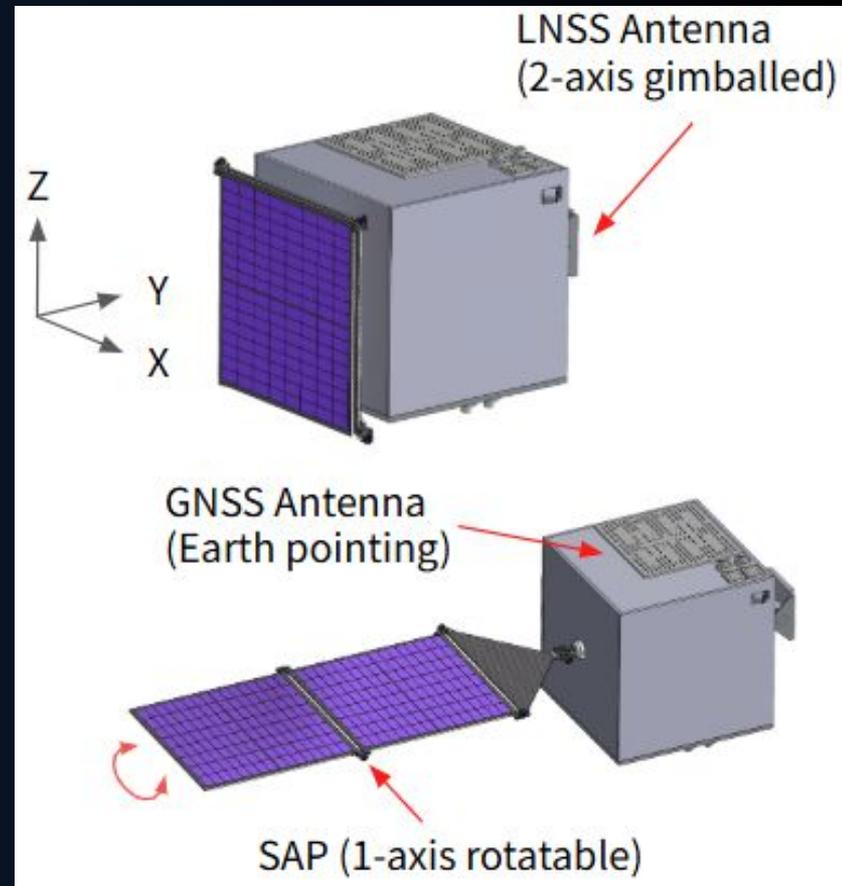
- 6hr polar orbit, $\Omega = 0$ deg
 - SISE_pos: 12.9 m (95%)



Demonstration Satellite System Development

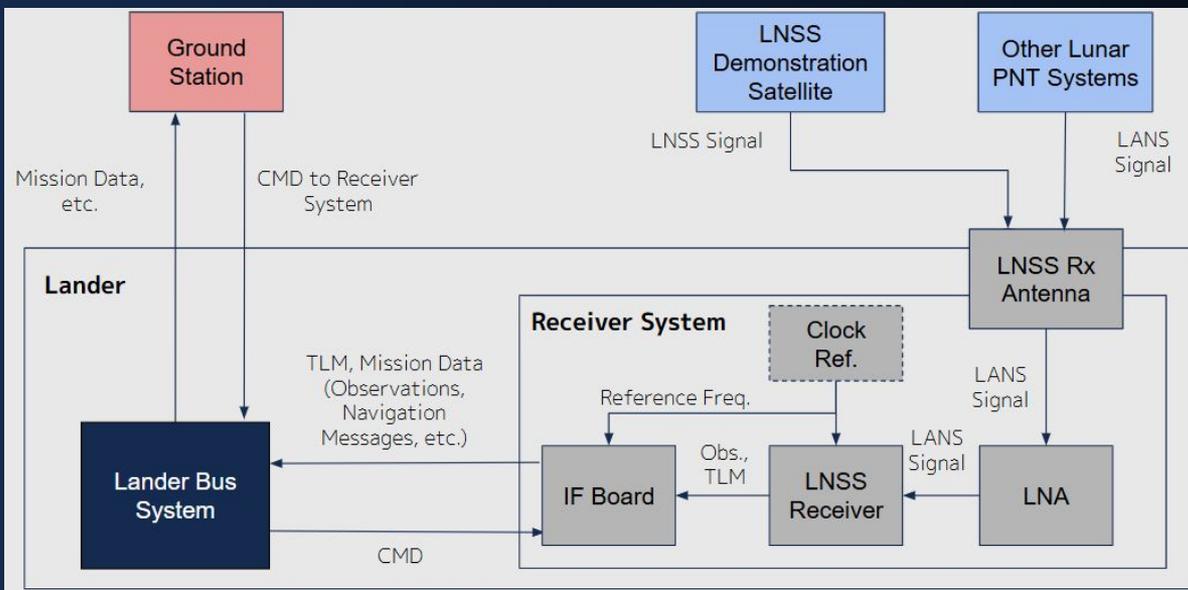
Preliminary design of satellite updated:

- Size: 700 mm x 700 mm x 700 mm
 - Excludes SAP, Gimbal
- Mass: 120 kg
- ADCS: 3-Axis Control
- Communication:
 - Wired communication between lander
 - X-band TT&C
 - S-band LNSS Signal dissemination
- Power Generation: 200 W @ EOL
- Propulsion: Chemical for dV and RCS



LANS Receiver Development

- Common hardware architecture between LNSS transmitter and LANS receiver
 - Prototype hardware developed
- Detailed design including environmental design under work
 - Entire mass of 1.5 ~ 2 kg projected



LNSS Demo Receiver System Block Diagram



LNSS Receiver Prototype

03

Industry Perspectives on a Policy Approach to Lunar PNT

Policy Related Activities from an Industry Perspective

ArkEdge Space will play a key role in the future lunar economy, and therefore has significant interest in the broader lunar policy landscape.

We have a white paper under draft which identifies three core principles for lunar PNT policy.



1. Awareness & Understanding

Education and knowledge-sharing between mission planners, operators, policy-makers

Across government, industry and NGO

2. Interoperability

Development of globally accepted foundational references

Across space agencies (e.g. LunaNet)

3. International Cooperation

Consideration of international agreements, including Artemis Accords

Utilization UN and similar organisations

UN Maritime Blueprint

ArkEdge Space, as a service provider for VDES (next generation AIS), has drawn lessons from the organisation of maritime security sector.

We are considering how a similar framework would work for lunar PNT.



04

Conclusions

Conclusions

- ArkEdge Space has been actively working on lunar PNT technology since 2022, and the selection for the Space Strategy Fund in 2024 marks the beginning of full-scale development of the LNSS payload system and demonstration satellite.
- Both the development of the payload and the satellite is progressing, aiming satellite launch in 2029.
 - Component level development and procurement is undergoing.
 - Detailed simulations of ODTs have been updated.
 - Satellite system design updates made, moving to detailed design.
- LANS receiver developments are also under work, as a component of the demonstration mission.
- Recognition of industry role in policy development:
 - Aim to publish a white paper on policy principles.
 - Considering linkages with maritime sector.
- ArkEdge Space will continue its effort toward building a sustainable lunar PNT system.

Acknowledgement

- Development of the LNSS demonstration satellite and the navigation payload is supported by the Space Strategy Fund under the project titled: Development of Lunar Positioning System Technology (Project No. JPJXSSF24ME13001). We would like to express our gratitude to JAXA for all of their cooperation.
- We would like to express our gratitude to the following members that work together with us to realize this challenging mission.
 - Mitsubishi Precision Co.,Ltd.
 - Digital Signal Technology, Inc.
 - The University of Tokyo
 - Chubu University