ANNUAL REPORT 2023

한국항공우주연구원
Korea Aerospace Research Institute

KARI
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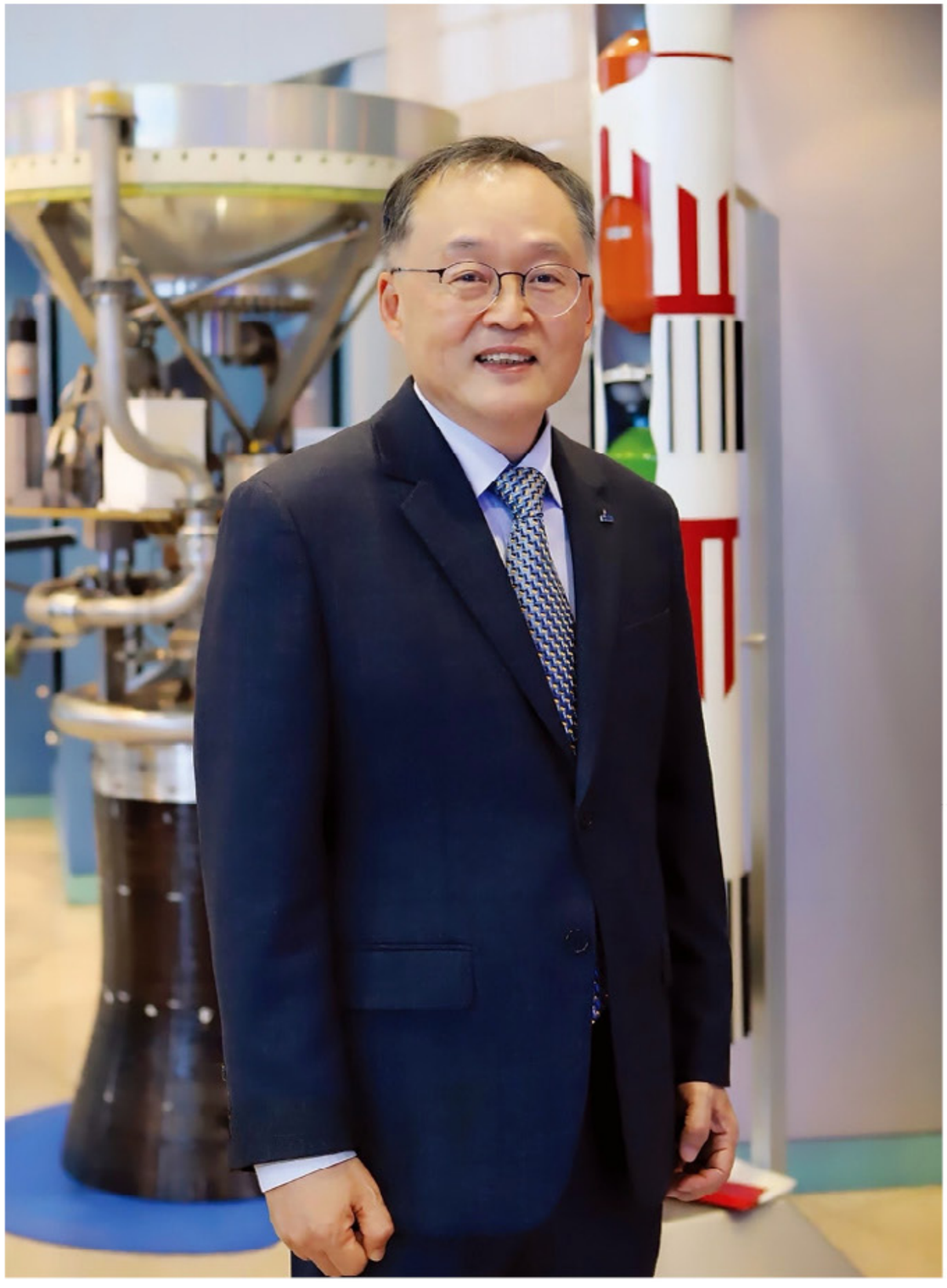


PRESIDENT'S GREETINGS

We are very pleased to release the 2023 Annual Report of the Korea Aerospace Research Institute (KARI), the leading institute of Korea's aerospace research and development (R&D).

As a national research institute specializing in aerospace sector, KARI consistently aims to drive national development through advancement in aerospace technology. It is committed to pioneering and challenging R&D efforts while expanding collaborations with industry, academia, and research institutions to foster continuous growth in the domestic aerospace industry.

Thanks to the efforts and dedication of the researchers and the unwavering backing of the public, KARI achieved significant accomplishments in its journey towards becoming a leading aerospace powerhouse in 2023.

Through the successful third launch of the Korean space launch vehicle, Nuri, we have once again demonstrated the performance of the launch vehicle developed by our hands. Building on the technological achievement accumulated through Nuri, we have embarked on the development of the next-generation launch vehicle to strengthen our future space transportation capabilities and secure autonomous space exploration capabilities.

Moreover, KARI has successfully completed the initial one-year mission operation of Korea's first Pathfinder Lunar Orbiter, DANURI, and carried out an extended mission, which is set to continue until 2025. Building upon these achievements, we successfully hosted the International Space Exploration Coordination Group (ISECG) meeting in December 2023, where leaders from space exploration organizations around the world gathered in Korea.

Alongside this, we have initiated the operation of the Korean Augmentation Satellite System (KASS), which corrects the position errors occurring when using GPS to provide precise location signals within a range of 1 to 1.6 meters. Following the United States, Europe, India, and Japan, KASS is the fifth international standard Satellite-Based Augmentation System (SBAS) to enter into service worldwide.

Furthermore, we have commenced the System Design Review (SDR) after selecting ground system development contractors for the development of the Korean Positioning System (KPS). In the aviation sector, we achieved success in the flight tests of the Optionally Piloted Personal Air Vehicle (OPPAV).

In addition to these achievements, KARI has also faced significant internal and external environmental changes that will pave the way for the future of the aerospace industry in Korea. Particularly, in response to the establishment of the Korea Aerospace Administration, often referred to as the "Korean version of NASA," KARI has proactively reevaluated its position and role to take a valuable opportunity for adaptation.

KARI is determined to continue its commitment to attain R&D outcomes that are commensurate with the institution's status and role, meeting the expectations of the people, rather than becoming complacent with past achievements.

I would like to extend my heartfelt gratitude to the dedicated individuals who have worked tirelessly to produce the 2023 Annual Report. I hope that this year's report will serve as a valuable record of our aerospace R&D history and a compass for the future.

Thank you.

May 2024

Sang-Ryool LEE

President of the Korea Aerospace Research Institute

1 HIGHLIGHTS OF THE YEAR

- Successful Third Launch of Korea Space Launch Vehicle -II (KSLV-III) "Nuri"
- KASS Certified and Operational
- Completion of DANURI's Regular Mission and Preparation for Extended Mission
- OPPAV Flight Test
- Meeting Held for KPS System Design Review (SDR)
- Polar (Greenland) Glacier Observation Test Flights Using UAV Developed in Korea
- ISECG Meeting held in Korea
- Feasibility Study Cooperation on the Establishment of a Spaceport in Thailand

Successful Third Launch of Korea Space Launch Vehicle -II (KSLV-II) "Nuri"

The "KSLV-II Enhancement Program" began in 2022 to enhance reliability through repeated launches of the fully domestically developed the Korea Space Launch Vehicle-II (KSLV-II) "Nuri" and to discover and foster system integration companies by transferring domestic launch vehicle development technology to the private sector.

In line with the plan to launch practical satellites developed domestically by utilizing Nuri, the third launch of Nuri was scheduled for 2023.

The launch took place at 6:24 p.m. on May 25 to deploy the primary payload satellite, NEXTSat-2, and seven auxiliary payload satellites, CubeSats, at an altitude of 550km.
With the third launch of Nuri, NEXTSat-2 was inserted into the target orbit, marking the first successful domestic launch of a practical satellite, thus achieving self-sufficient space development and accumulating launch reliability. Moreover, this facilitated the fabrication of Flight Model 4 (FM4) for the fourth launch of Nuri in 2025 to be led by a system integration company.

KASS Certified and Operational

The Korean Augmentation Satellite System (KASS), Korea's Satellite-Based Augmentation System (SBAS), obtained the seventh worldwide service provider Identification Number (Number 6) after a development and construction period of about nine years.

Ultimately, to provide aviation services, it received a performance certification (issued on December 27, 2023), becoming the fifth in the world to offer APV-I grade aviation services starting from December 28, 2023.

In the future, the KASS Approach Procedure plans to expand its application to other airports after performance verification through initial operations at airports such as Muan and Ulsan.

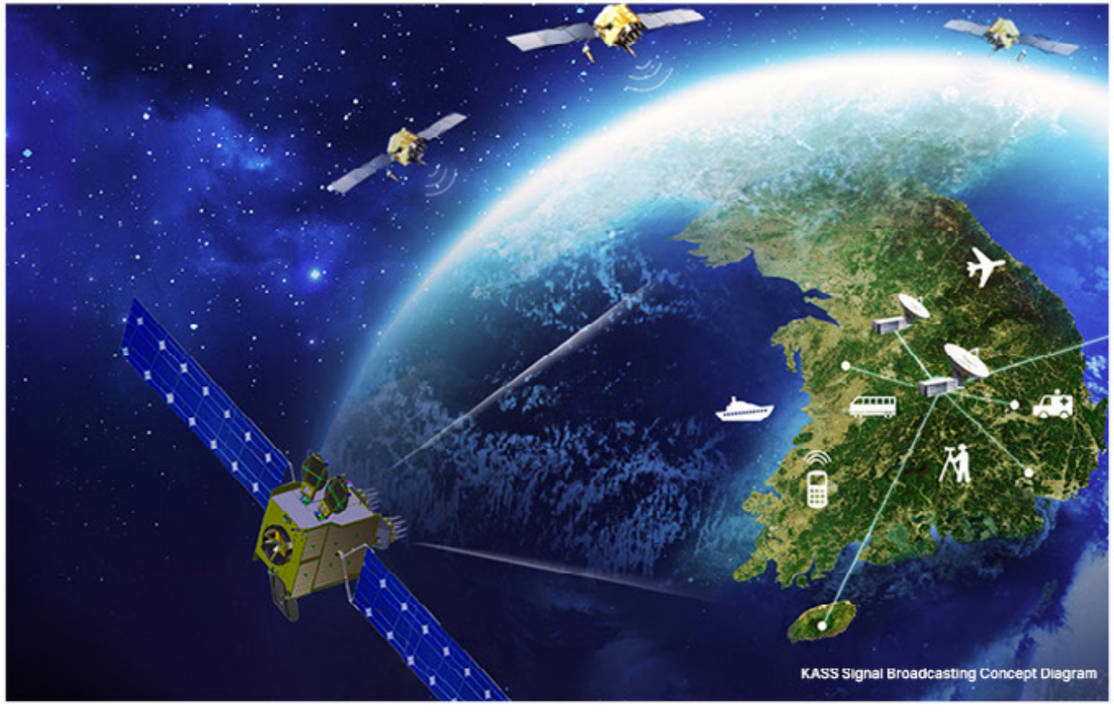
Korea's KASS now certified and operational

February 12, 2024 · By Jesse Khalil — Est. reading time: 1 minute

Image: imaginima/ iStock / Getty Images Plus/ Getty Images

The Korea Augmentation Satellite System (KASS), designed and implemented by Thales Alenia Space, has been officially certified by Korean national authorities and has entered operational service. The system was developed in partnership with the Korea Aerospace Research Institute (KARI) on behalf of the Korean Ministry of Land, Infrastructure and Transport (MOLIT).

Article on KASS Signal Authentication and Operation: GPS WORLD

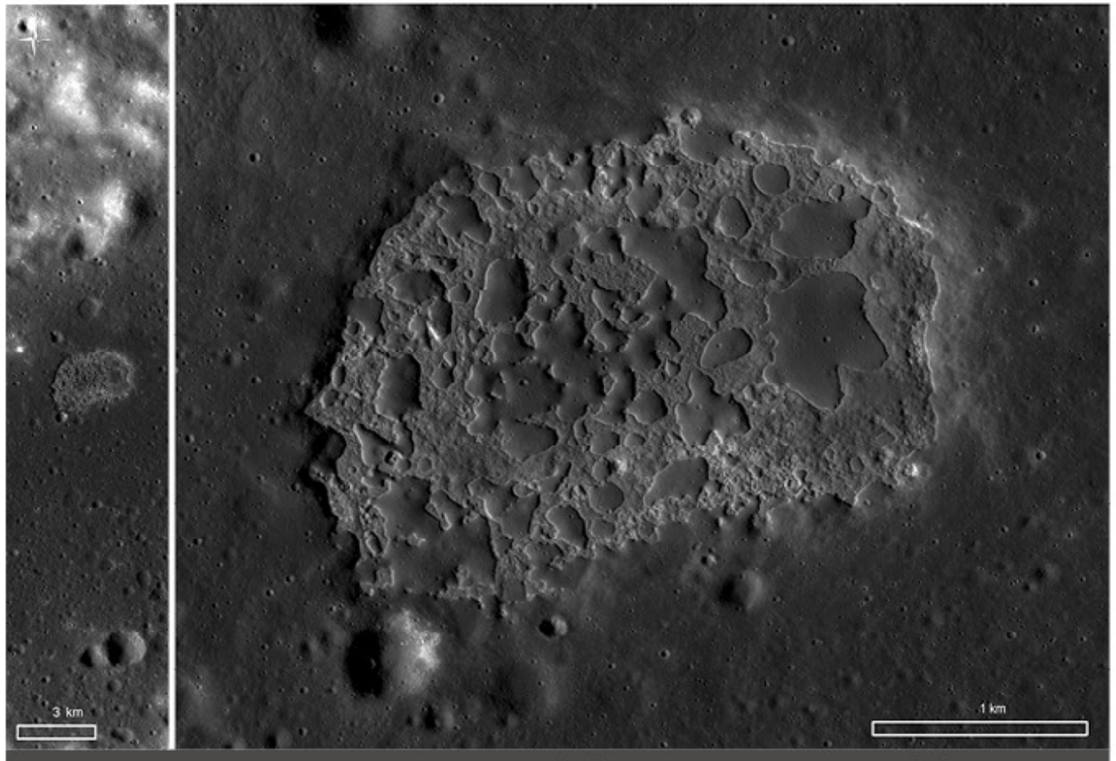


KASS Signal Broadcasting Concept Diagram

KPLO Joint South Korea-US Researchers Meeting: July 2023, Seoul

Completion of DANURI's Regular Mission and Preparation for Extended Mission

The Korea Pathfinder Lunar Orbiter (KPLO) "DANURI", Korea's first lunar orbiter, entered lunar orbit on December 27, 2022, and successfully completed its planned one-year nominal mission by December 31, 2023.

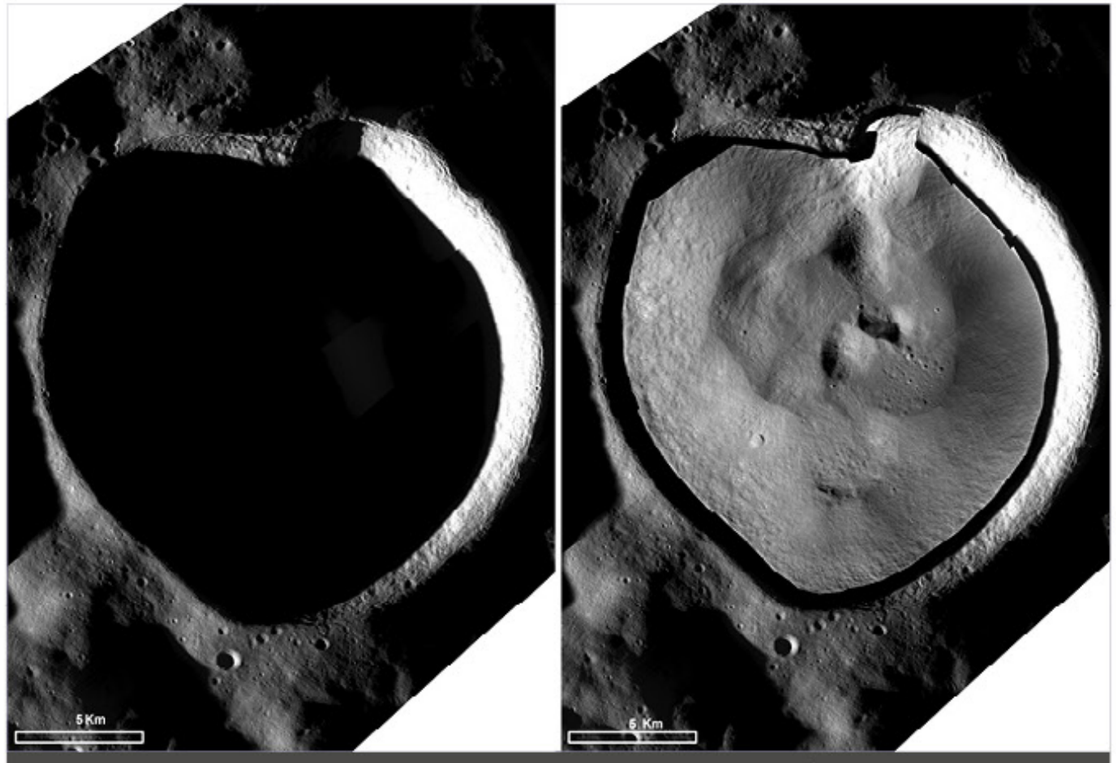


An image of the Irregular Mare Patch (IMP) INA captured by KPLO's Lunar Terrain Imager (LUTI) on December 2, 2023

After entering lunar orbit on December 27, 2022, KPLO completed its one-month commissioning phase. Over the past years, KPLO has maintained a circular lunar orbit with an altitude of 100 ± 30 km with an inclination of 90 degrees, while conducting various lunar scientific observations and technology validation missions. All five scientific payloads and one technology validation payload operated successfully. On March 24, 2023, KPLO achieved the milestone of completing 1000 orbits around the Moon. To maintain its nominal mission orbit for one year, KPLO conducted six Orbit Maintenance Maneuvers (OMMs). Additionally, Collision Avoidance Maneuvers (CAMs) were executed to avoid collisions with other spacecraft at the Moon, such as the Chandrayaan-2 orbiter.

In April 2023, the decision was made to extend KPLO's mission lifetime by approximately 2 years until December 31, 2025, exceeding its initial goal. Currently, the optimum extended mission orbits, as well as operational strategies, are actively being designed with KPLO science Principal Investigators (PIs), including NASA, to maximize science returns. In Seoul, from July 12 to 14, 2023, researchers from Korea and the United States participating in the KPLO program gathered to share the current operational status and engage in thorough discussions regarding extended mission orbits and operational plans.

To share the scientific achievements of KPLO, the American Geophysical Union (AGU) held a special session dedicated to KPLO in early December 2023. Furthermore, to celebrate the successful achievement of KPLO's original mission goals, a commemorative event took place in Seoul from December 20, 2023, to January 31, 2024. The exploration journey of KPLO will continue, even though it has already achieved its original mission objectives.



On July 9, 2023, simultaneous footage of Hermiate A crater was captured by LUTI and ShadowCam. (Left: LUTI only, Right: LUTI + ShadowCam)

OPPAV Flight Test

A flight test of the eVTOL technology demonstrator, the Optionally Piloted Personal Air Vehicle (OPPAV), capable of vertical takeoff and landing as well as high-speed flight using both manned and unmanned distributed electric propulsion, was successfully completed in December 2023.

The OPPAV development project was conducted from April 2019 to December 2023, supported by the Ministry of Trade, Industry and Energy, and the Ministry of Land, Infrastructure and Transport, with a total duration of 57 months.
The OPPAV system consists of an aircraft, data link, Ground Control Station (GCS), Ground Support System (GSS), and charging equipment. The aircraft is capable of high-speed flight and vertical takeoff and landing, utilizing a distributed electric propulsion system powered by batteries. It features four tilt props at the front and four lift props at the rear, mounted on the top of the aircraft for the safety of passengers and ground operators. Additionally, it ensures safety through a triple-redundant flight control system. The OPPAV flight testing began with the initial flight of Aircraft 1 in January 2023, during which Aircraft 1 underwent a total of 85 flights, while Aircraft 2 completed 110 flights. The tests included Transition tests based on the tilt of the front props, OEI (One Engine Inoperative) tests for emergency response, wind resistance tests, maximum speed flights, maximum endurance tests, pilot onboard tests, and Pirouette maneuver tests.

The developed OPPAV flight testbeds will serve as flight platforms for Urban Air Mobility (UAM) and the development of high-performance and large UAV. They are expected to contribute to the validation of UAM demonstration scenarios through participation in the K-UAM Grand Challenge.

OPPAV Public Flight Demonstration

OPPAV Maximum Speed Flight Test

OPPAV Flight Test 1

OPPAV Flight Test 2

Meeting Held for KPS System Design Review (SDR)

In June 2023, the KPS R&D Directorate successfully held the System Design Review (SDR) meeting, one of the core objectives of system research and development.

During the SDR process, system and navigation signal requirements were finalized, and through comprehensive system design technical consultations, the basic design of the system was completed. As a result of the meeting, final versions of system management and development documents, including the system management plan, were distributed, and follow-up measures after the system SDR were completed in October.

Russell Glacier Observation Mission Flight Video

Polar (Greenland) Glacier Observation Test Flights Using UAV Developed in Korea

As part of the 'Strategic International Collaborative Research Program,' planned and promoted as a follow-up measure to the Korea-Denmark Summit Meeting on October 20, 2018, the Unmanned Vehicle Advanced Research Center is conducting a project titled "Joint Korea-Danish UAV-based Research on Glaciers (JOKURG)" with the Korea Polar Research Institute (KOPRI) affiliated with the Korea Institute of Ocean Science and Technology and DTU-Space, a specialized Danish institution for drones and space development.

Korea Research Team During Flight Observation in Russell Glacier

This project aims to address the limitations of existing satellite observation technology in observing the melting of Greenland's glaciers, which has significant implications for sea-level rise due to global warming, by developing drone-based wide-area observation and data analysis technology. To achieve this goal, the research team conducted drone-based glacier imaging and time series analysis in Kangerlussuaq, Greenland, from September 5 to September 14, 2023.

In the local flight tests, KARI, KOPRI, DTU-Space, Hanseo University, and the drone specialist company Air Mobility Platform (AMP), represented by Hwang Myung Soo, participated. From 2021 to 2022, similar to previous efforts, they utilized Electro-Optical (EO) cameras, Spectral Sensors, and LiDAR mounted on drones to capture images of the Russell Glacier and surrounding areas in Kangerlussuaq, Greenland, securing observational data.

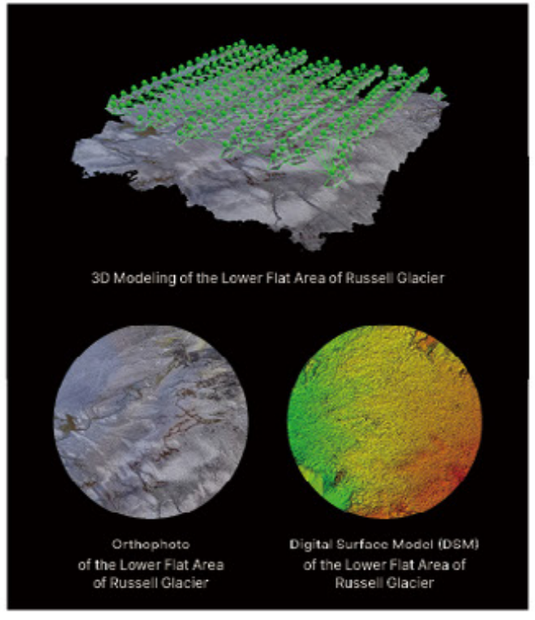
The research team conducted a comparative analysis of satellite data and drone video data from the same area over three years, from 2021 to 2023, through flight tests. They performed time-series melting studies. Using this data, they generated Digital Elevation Models (DEMs) to identify glacier collapse areas and analyzed the amount of annual terrain variation. Additionally, they analyzed the Vegetation Index (VI) of glacier boundary areas using Spectral Sensor imagery.

The Unmanned Vehicle Advanced Research Center has been continuously observing the melting phenomenon of Greenland's glaciers over the past three years using unmanned vehicles and related core technologies. They have collected and analyzed time-series data contributing to research on climate change. Additionally, they have verified the operability of small unmanned vehicles developed in Korea within polar environments, laying the groundwork for the future commercialization and revenue increase of related technologies.
It is hoped that these research findings will have a positive impact on the advancement of climate change observation and research in the future.

Greenland Glacier Observation Flight Test Drone (2023)

UAV Platform		
Company	KARI UVARC	Foxtech
Model	LC62-50B	Great Shark
Weight of take-off(kg)	45	23
Weight of Mission Equipment(kg)	3	2.5
Flight Time(Min)	40	50
Operation range(km)	10	10
Flight speed(km/h)	130	120

			
AMP	KARI UVARC	DJI	AgFagle Aerial System Inc.
AMP-WD-QD	MR	M300	eBee
6.8	1.5	9.0	0.67
0.5	0.5	2.7	0.15
25	40	≤55	50
1.5	3	5	5
50	54~72	<60	40~90



ISECG Meeting held in Korea

The annual meeting of the International Space Exploration Coordination Group (ISECG) was hosted by the Korean Aerospace Research Institute (KARI) in Korea. This was the first time that KARI hosted an ISECG event since becoming a member in 2007. The ISECG, which brings together space agencies and institutes from 27 countries on a voluntary basis, serves as a non-binding international coordination forum for space exploration.

The meeting consisted of two main components: a workshop and the Senior Agency Management (SAM) meeting. They were held in Daejeon and Songdo on December 4-6 and December 7-8, respectively. The three-day workshop brought together the entire ISECG community to share accomplishments, review the results of ISECG efforts over the past year, and plan for the coming year. This was followed by the SAM meeting, which brought together senior managers to receive updates on ISECG activities and provide strategic direction for ISECG's future activities.

During the SAM meeting, senior managers emphasized the importance of international cooperation and coordination in advancing the goals of member space agencies. They also

ISECG SAM Meeting

expressed support for the upcoming release of an updated Global Exploration Roadmap, expected in the second half of 2024. This non-binding document will expand on the 2018 Global Exploration Roadmap and its 2022 supplement, entitled "Global Exploration Roadmap Supplement - Lunar Surface Exploration Scenario Update".

In conjunction with these procedures, KARI organized side events to showcase Korea's lunar exploration achievements to participants. These events included a technical tour of the KPLO control room, a briefing on the KPLO mission, and a photo exhibition. A press meeting was also held to communicate the importance of ISECG's activities to the Korean public.

ISECG Workshop

Feasibility Study Cooperation on the Establishment of a Spaceport in Thailand

The governments of Korea and Thailand have agreed to elevate their bilateral relationship to a "comprehensive strategic partnership" in celebration of the 10th anniversary of their strategic partnership in 2023. On this occasion, both countries adopted the "Korea-Thailand Joint Action Plan" in October 2022 to maximize synergies for national development and respond to changes in the global strategic landscape.

Thailand, which has been actively promoting the development of space science expertise and infrastructure at the government level, has selected KARI as its primary partner for the feasibility study related to the establishment of a spaceport in Thailand. As part of these efforts, in May 2022, KARI and Thailand's Geo-informatics and Space Technology Development Agency (GISTDA) signed a memorandum of understanding (MOU)

Key Progress in Construction of Spaceport in Thailand

for cooperation in the space sector, and in February 2023, they entered into an Implementation Agreement (IA) for the feasibility study cooperation for establishing the spaceport.

Utilizing the launch site construction experience gained during the development of launch vehicles (such as Naro, Nuri, and KSLV-III), as well as the operational know-how from the NARO Space Center, KARI has contributed to Thailand's GISTDA in conducting feasibility studies for the construction of its own spaceport.

2 R&D ACTIVITIES

- Nuri's 3rd Launch - Successful Launch Operation (Range System, Facility Operation & Safety Control)
- Commencement of Next-generation Launch Vehicle Development Project and Holding of System Requirements Review (SRR) Meeting
- Construction of New Antennas at the Jeju National Satellite Operation Center
- Demonstration of Wireless Power Transfer for Space-based Solar Power
- Completion of Detailed Design of Stratospheric Solar Drone and Performance Verification of its Key Components
- Grand Challenge-1st stage Conducted at KARI's National Aviation Test Center (NATC)
- Development of Drone-Cop Platform·Elementary Technology and Ground Control System
- Performance Testing Completed for Core Components of Unmanned Compound Combat Rotorcraft TurboShaft Engines
- Modification and Flight Test Completed for the KLA-100x Electric Aircraft
- Pre-System Design Review for GEO-KOMPSAT-3 (Chollian 3)
- System Requirement Review and System Design Review for The Korea Coast Guard Satellite Application System
- Identification of KPS Site Candidate Locations and Conducting Site Preliminary Surveys
- Development of LEO-KOMPSAT Series
- Participation in Korea's Industry-Led CAS500
- Development of 50kg Lift & Cruise Type UAV
- Support for Tracking and Telemetry of Solid-fuel launch vehicle
- National Satellite Operations and Calibration & Correction Infrastructure Enhancement Project
- Selection and Development of Additional Projects for Space-Centered Technologies

Nuri's 3rd Launch - Successful Launch Operation (Range System, Facility Operation & Safety Control)

Mission Director Center (MDC) During the Third Launch of Nuri (KSLV-II) in May 2023

On May 25th, 2023, the NARO Space Center successfully conducted the third launch of "Nuri" (KSLV-II), which carried the NEXTSat-2 onboard. The NARO Space Center utilized tracking and telemetry resources from the range system, including facilities in Goheung, Jeju, and Palau, to provide successful launch vehicle tracking and telemetry information.

After the launch, it was confirmed that the target altitude of 550km and the target injection velocity of 7.58km/s were successfully achieved, resulting in the insertion of the spacecraft into its intended orbit. Tracking and Telemetry mission were conducted for a total of 1,074 seconds until the signal receiving was stopped. Particularly, the tracking radar successfully performed tracking missions up to a radial distance of approximately 2,700km from the launch pad. Additionally, using a high-speed camera system, video data capturing moments such as the separation of the umbilical device and the vehicle holding device (VHD) from the launch vehicle during liftoff was secured.

During the execution of the launch mission, citizens were able to witness it in real-time through live broadcasts, enabling them to share the moment of the successful launch all together.

Scene of the Umbilical Device Separation During the Liftoff Moment of Nuri (KSLV-II)

To ensure safety around the space center and along the post-launch flight path, eleven government ministries and local authorities formed the "Launch Safety Control Committee." Under the launch safety control plan, safety zones and no-fly zones were designated for inland and coastal areas, as well as airspace near the launch site. Control measures, such as regulating personnel and vehicles near the launch site and controlling ships and aircraft in the launch vehicle's path, were implemented stably, contributing to the success of the launch.

Furthermore, one month before the third launch, precise safety inspections were conducted on the main structure of the launch site to ensure their safety. This was aimed at securing the structural integrity of the facilities. Moreover, just before the launch, a final readiness check was carried out on all the infrastructure related to the launch operation to ensure that the launch proceeded smoothly without any issues.

During the launch campaign period (L-2 ~ L-0), power was supplied through gas turbine generators to ensure stable launch operation power. Additionally, support for the Nuri (KSLV-II) launch was provided by maintaining the normal operation of infrastructure facilities, including the operation of the launch vehicle transportation routes, Heating Ventilation, and Air Conditioning systems, water supply facilities, and firefighting equipment at the launch site.

Nuri (KSLV-II) Safety Control Room

Central Control Room Operation

Commencement of Next-generation Launch Vehicle Development Project and Holding of System Requirements Review (SRR) Meeting

Since July 2023, the Next-generation Launch Vehicle Development Project has commenced to address national space development demands such as satellite launches and space exploration, and to secure autonomous space exploration capabilities.

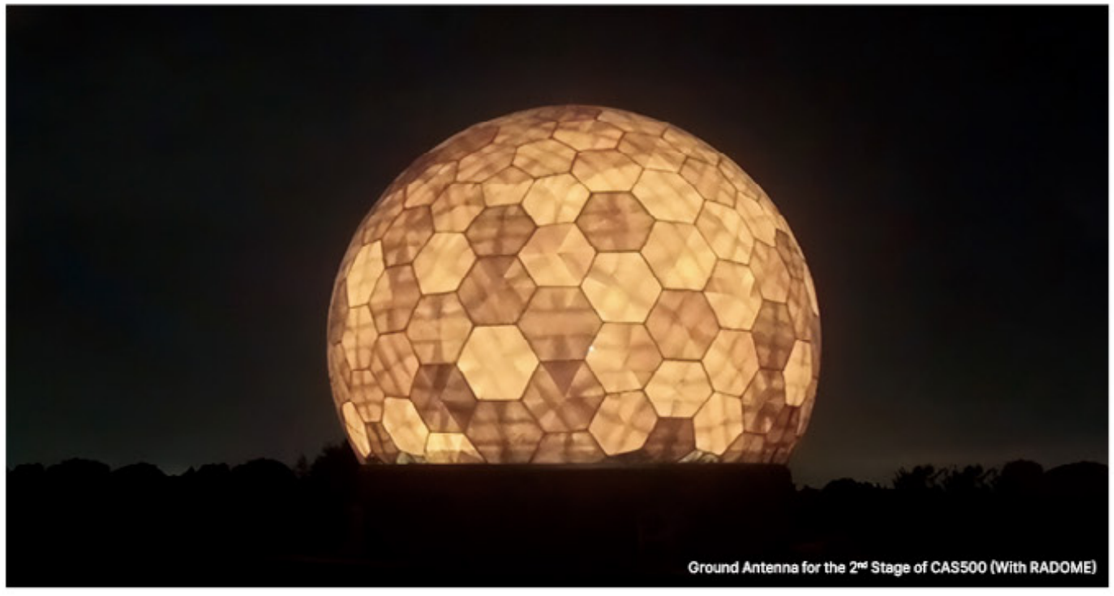
The project is to conduct three launches by securing the development and core technologies of next-generation launch vehicles for large satellite launches and space exploration by 2032. To accomplish this, conceptual design and System Requirements Review (SRR) meetings were conducted for the next-generation launch vehicle. Additionally, KARI commenced on engine test facility design and improvement according to the specifications of next-generation launch vehicle engines, as well as on the layout of launch pad systems and the establishment of launch operation plans and basic designs.

Furthermore, to enhance private sector capabilities in launch vehicle technology development and establish a foundation for a privately-led space industry ecosystem, a system integrated company will be selected for next-generation launch vehicle development. This entails collaborative research and development from design to launch operations.

Construction of New Antennas at the Jeju National Satellite Operation Center

KARI has been building and operating satellite control and operation infrastructure since the 1990s. With the expected increase in national satellites, the necessity for effective control and operation of national satellites has been presented, leading to the establishment of the Basic Plan for Promotion of Space Development. Following this plan, the National Satellite Integrated Operation System commenced in 2019, and in November 2022, the Jeju Satellite Operation Center was opened, laying the foundation for the Korea Satellite Operation System. The jeju National National Satellite Operation Center operates four national satellites and three ground antennas, including one for the Compact Advanced Satellie 500 (CAS500), which have achieved a mission success rate of over 99%. The Center has established integrated control and reception systems for nationally-led development satellites in preparation for the era of multi-satellites and satellite constellation and has laid the groundwork for Korea to leap forward as an advanced space technology country.

Ground Antenna J07B for the 2nd Stage of CAS500 (W/O RADOME)



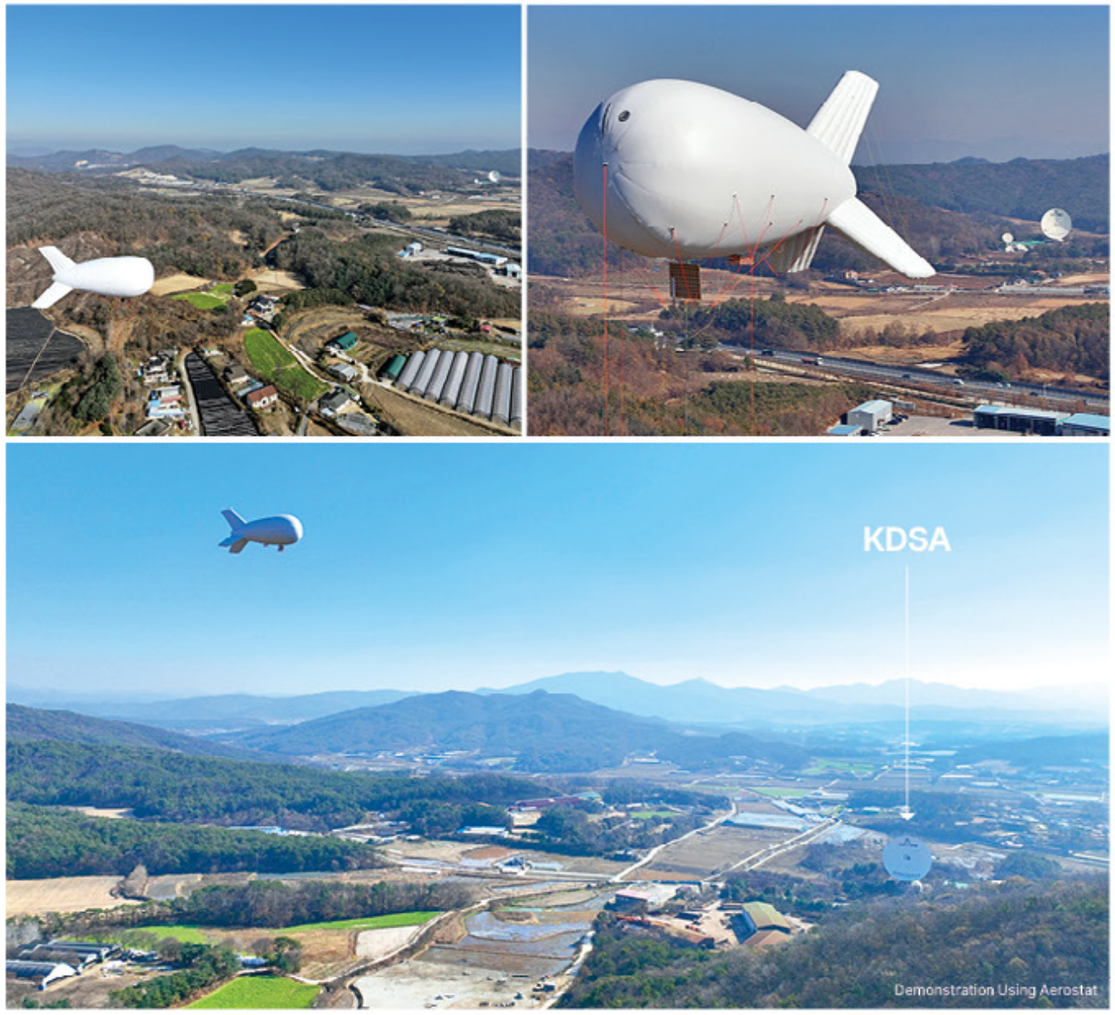
Ground Antenna for the 2nd Stage of CAS500 (With RADOME)

Demonstration of Wireless Power Transfer for Space-based Solar Power

In November 2023, KARI successfully demonstrated wireless power transmission using a 35-meter diameter deep space antenna (located in Yeoju) controlling the Korea Pathfinder Lunar Orbiter (KPLO) "Danuri". This demonstration simulated the final stage of space-based solar power, which converts electromagnetic energy beamed down to Earth into electrical energy harvested on the ground.

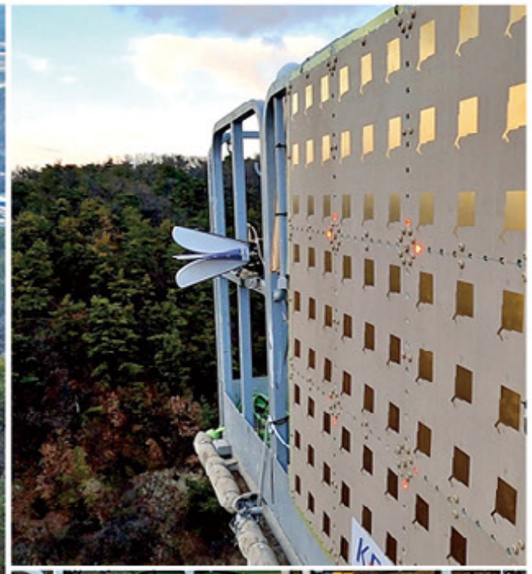
The current record for the longest distance wireless power successfully harvested is 1.5 kilometres, set by NASA JPL in 1975. It took nearly 50 years for KARI to set a new record for wireless power transmission distance. South Korea faces challenges due to its high population density and geographical/regulatory constraints that make it difficult to conduct long-range wireless power transmission tests. Therefore, KARI used a helium balloon (aerostat) and a high ladder truck to achieve this feat without modifying the space antenna and without interfering with KPLO's communication time.

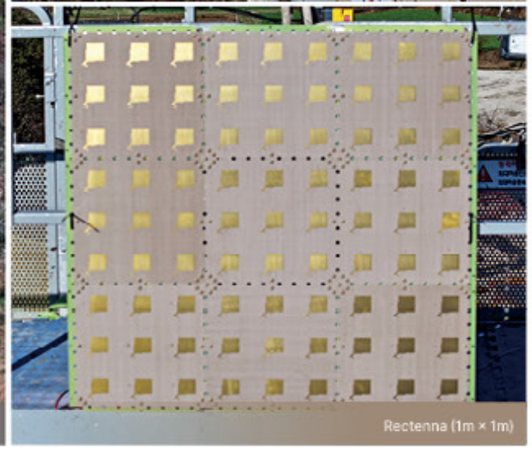
This remarkable achievement can be considered a very cost-effective research result. In the coming year, KARI will continue to improve the performance of the attitude control system for the power receiving antenna (rectenna). This improvement is aimed at strengthening the demonstration technology in 2023, thereby contributing to the research effort to secure renewable energy through space technology in the energy transition era.



Demonstration Using Aerostat

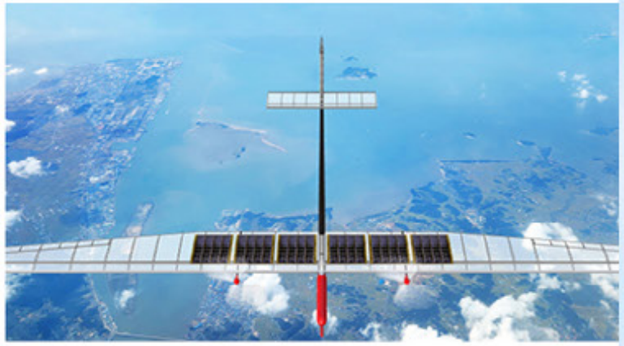

Demonstration Using High-altitude Ladder Truck



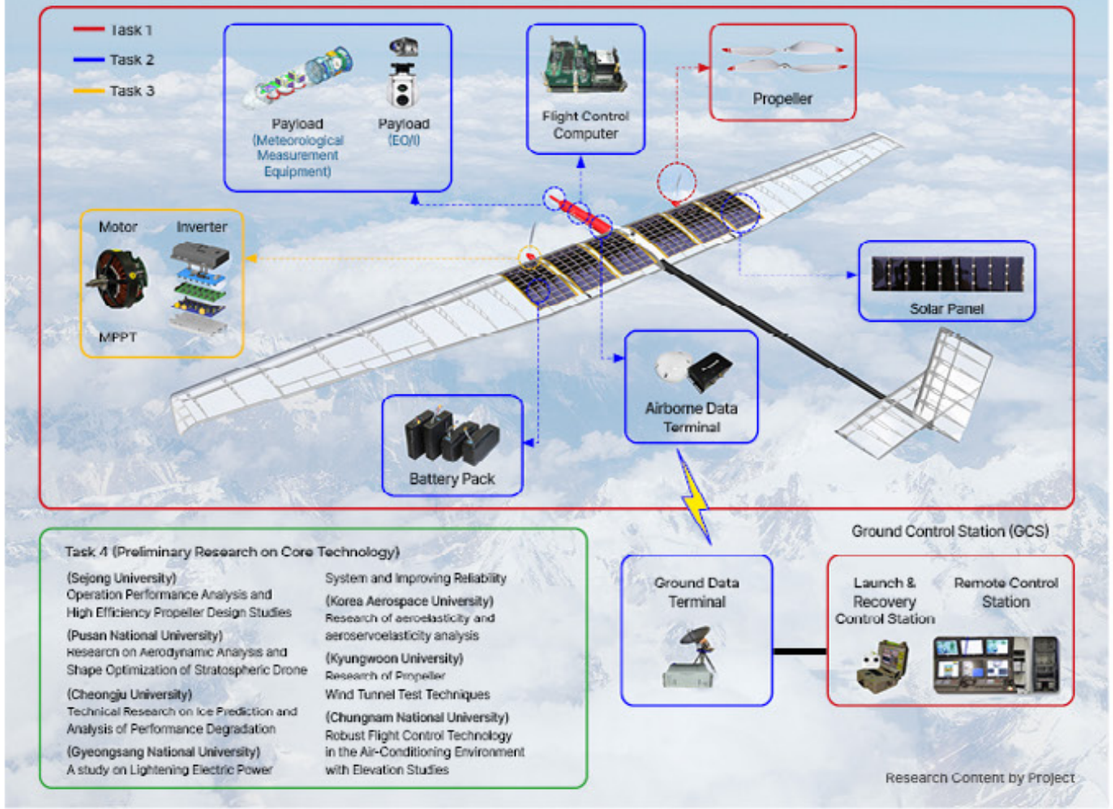

Rectenna (1m × 1m)

Completion of Detailed Design of Stratospheric Solar Drone and Performance Verification of its Key Components

After completing the detailed design of the stratospheric solar-powered Electrical Aerial Vehicle-4 (EAV-4) in May 2023, component manufacturing and performance verification were carried out. We manufactured a structural prototype and performed some structural tests. Also, we designed two types of high-efficiency propellers for high altitudes and conducted comparative wind tunnel tests. Furthermore, by conducting performance and environmental tests on some delivered solar cells and batteries, we successfully achieved our project goal for 2023, thus establishing a solid foundation for seamless research execution in the following year.



Stratospheric Solar-Powered Drone EAV-4 Conceptual Image



Grand Challenge-1st stage Conducted at KARI's National Aviation Test Center (NATC)

KARI has been tasked by the Ministry of Land, Infrastructure and Transport to recruit participating organizations for the "K-UAM Grand Challenge," select demonstration scenarios and items, and establish demonstration infrastructure.

The K-UAM Grand Challenge is a government-led demonstration project aimed at verifying safety and integrated operability before the commercialization of Urban Air Mobility (UAM) in 2025. It proceeds with Phase 1 for the open terrain demonstration and Phase 2 for the urban/Metropolitan area demonstration. To achieve this, infrastructure construction for Phase 1 open terrain demonstration commenced in Goheung, Jeollanam-do Province, in 2022, with completion of construction achieved in November 2023. Furthermore, in February 2022, participating organizations for the Grand Challenge were recruited, and agreements were signed with a total of 46 participating organizations/companies, including seven consortia and five single-field entities, by February 2023.

From August 2023, the Grand Challenge initiated a single-field demonstration, and from August 2024, it will embark on an integrated operation demonstration by seven consortia.

K-UAM Phase 1
Demonstration Infrastructure
(Goheung, Jeollanam-do Province)

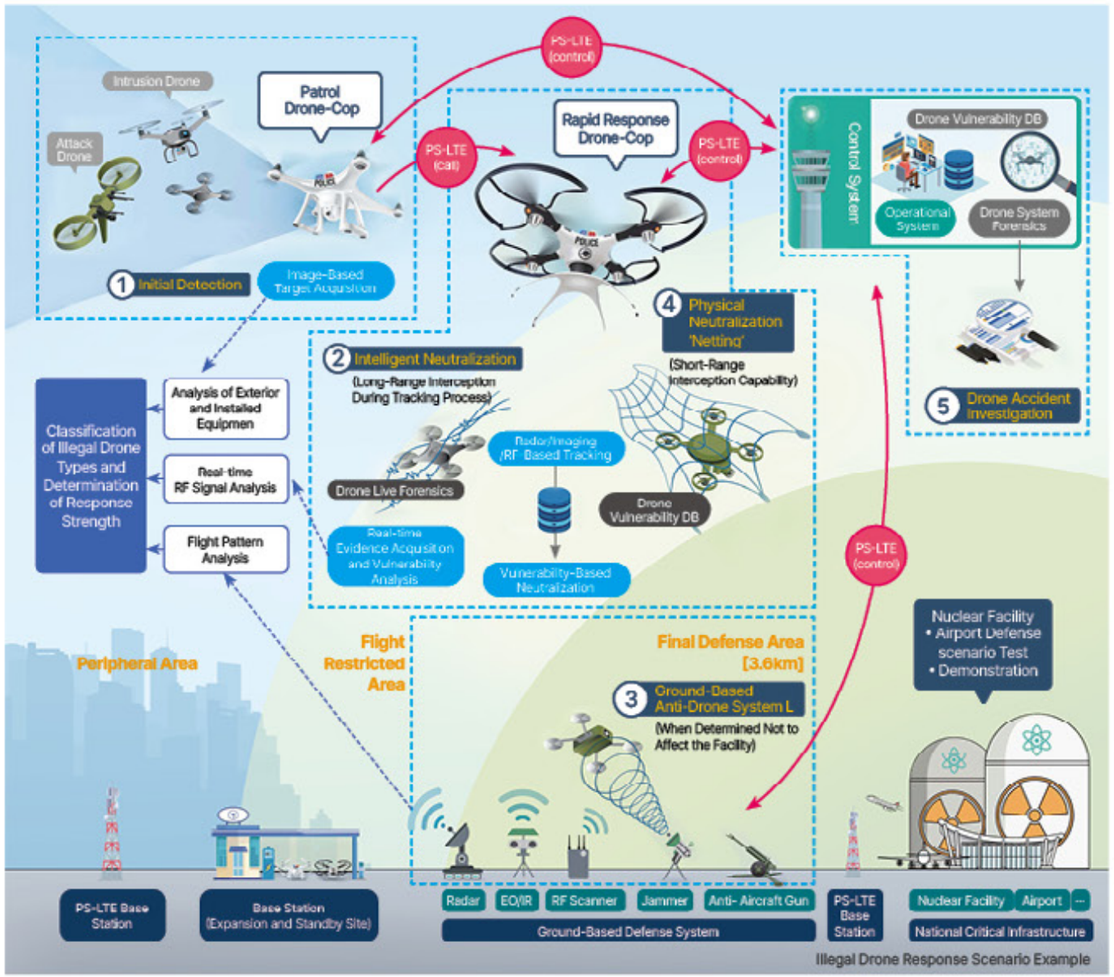
Development of Drone-Cop Platform·Elementary Technology and Ground Control System

As the drone threat to national critical infrastructure grows into a social issue, KARI is developing an aerial-based drone counter-UAS, Drone-Cop platform, to address various illegal drone activities.

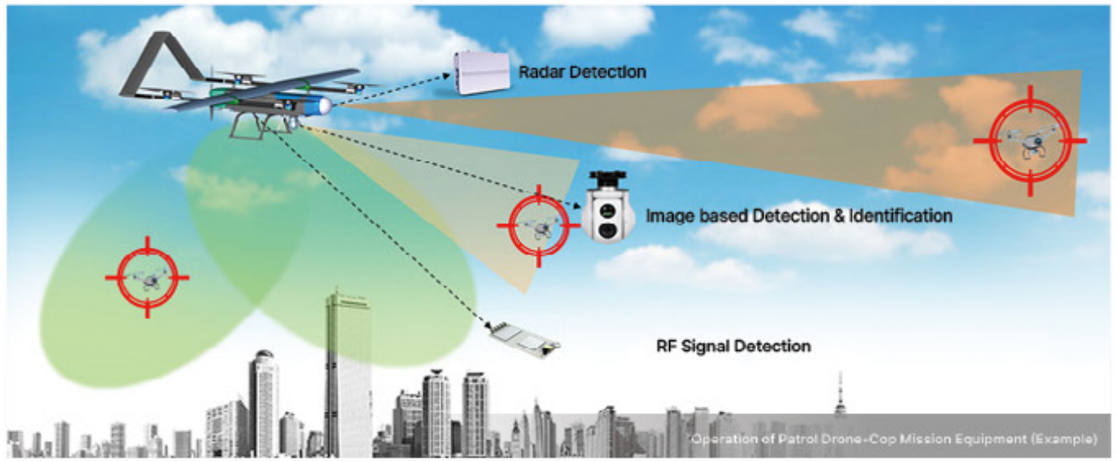
The Drone-Cop platform develops two types of drone to suit the purposes of patrol and response. The surveillance Drone-Cop is responsible for patrolling areas beyond the detection range of ground-based response equipment.

When an illegal drone is detected through patrol, the response Drone-Cop swiftly deploys to neutralize the threat, thereby conceptually ensuring a swift response to illegal drone activities through patrols and responses.

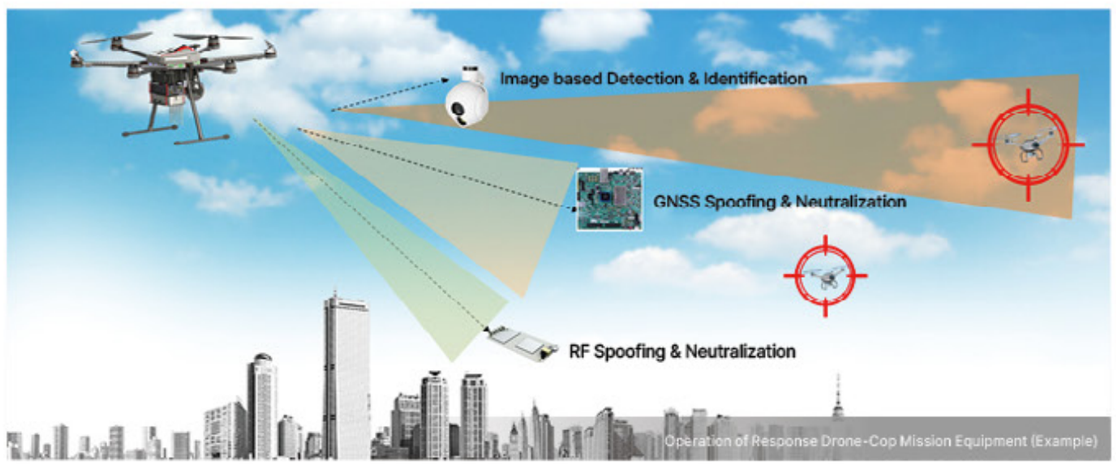
In April 2021, KARI initiated the development of the Drone-Cop platform in collaboration with the Ministry of Trade, Industry and Energy by forming a consortium consisting of 13 organizations from industry, academia, and research. Through the System Design Review (SDR), Preliminary Design Review (PDR), and Detailed Design Review (DDR) meetings, the prototypes of Drone-Cop System (airframe, drone detection & neutralization equipment, and ground control system) has been developed.
KARI has begun environmental testing and ground/flight testing for the Drone-Cop system. After verifying its functions and performance, KARI plans to integrate it with ground-based response systems for further validation.



Illegal Drone Response Scenario Example



Operation of Patrol Drone-Cop Mission Equipment (Example)



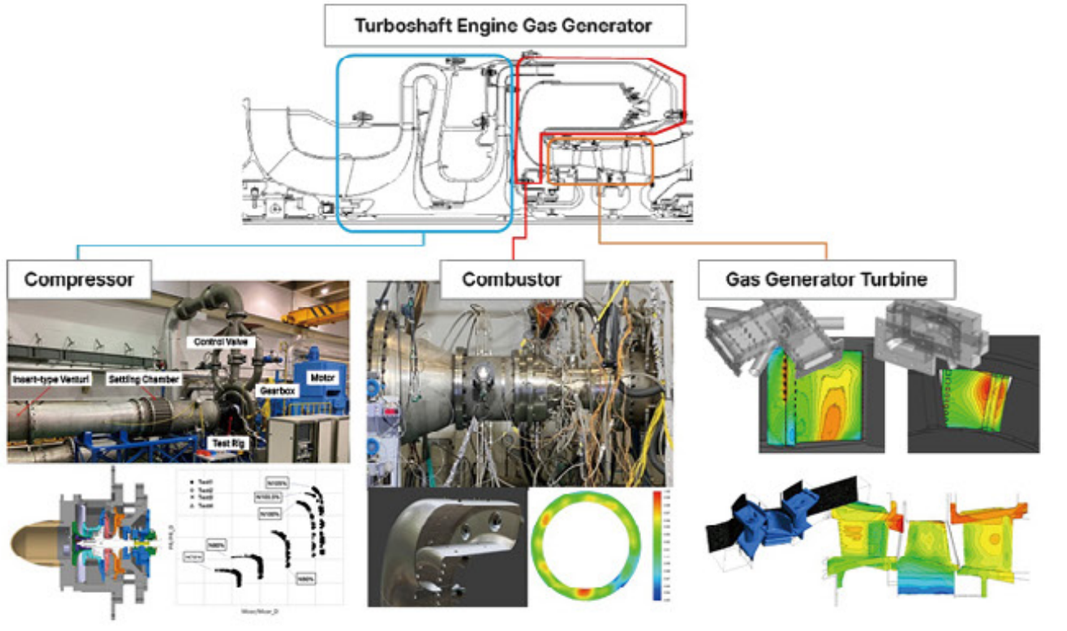
Operation of Response Drone-Cop Mission Equipment (Example)

Performance Testing Completed for Core Components of Unmanned Compound Combat Rotorcraft Turboshaft Engines

KARI participated in the core technology development project for a 1,000 horsepower-class turboshaft engine for Unmanned Compound Combat Rotorcraft (UCCR), led by Hanwha Aerospace with support from the Defense Acquisition Program Administration, from 2019 to 2023.

Successful performance testing and evaluation were conducted on the core components, featuring a high-pressure multi-stage centrifugal compressor, reverse-flow annular combustor, and gas generator turbine with complex cooling techniques.

As part of ongoing follow-up research and development efforts, KARI continues to conduct research and development to secure indigenous technology for the turboshaft engine, including integration of the gas generator module for the 1,000 horsepower-class turboshaft engine and performance testing and evaluation of core components under actual engine operating conditions.



Performance Testing and Evaluation of Core Components for 1,000 Horsepower-class Turboshaft Engine

Modification and Flight Test Completed for the KLA-100x Electric Aircraft

Flight Test of KLA-100x

In 2023, with support from the Ministry of Trade, Industry and Energy and cooperation from the Ministry of Land, Infrastructure and Transport, KARI successfully completed the flight testing of the modified and developed manned electric propulsion aircraft, known as the KLA-100x. This achievement marks the beginning of low-carbon aviation transportation in South Korea.

The target aircraft utilized the Korean-manufactured aircraft (KLA-100) equipped with the existing internal combustion engine (Rotax 911), subsequently removing its internal combustion engine and integrating a Korean-produced electric engine (model name: e-100) systematically. Before modification, the domestic electric engine (model name: e-100) was integrated into a modular configuration to verify its performance. Additionally, the front structure frame for engine installation was designed as a modular integrated structure.

The core components of the Korean-produced electric engine also adopted domestically developed propulsion motors/inverters and lithium-ion battery packs, achieving weight, power output, and efficiency. The structural integrity of the front structure frame for the electric engine was confirmed through structural analysis and static structural testing, applying load conditions defined by ASTM F2245, including flight load, propeller thrust, motor torque, and landing load. Furthermore, prior to flight testing, ground run tests were conducted to verify the performance and safety of the electric engine, and to ensure that pilots could adapt to the control environment and operation method of the electric propulsion aircraft.

The KLA-100x conducted its first flight at the Goheung Aviation Center from December 2022 to March 2023, followed by and successully completed the planned flight tests. The operation safety of the installed electric engine was confirmed. Consequently, a solid foundation has been laid for the systematic development of an electric propulsion aircraft platform (2-seater training electric aircraft) in the future.

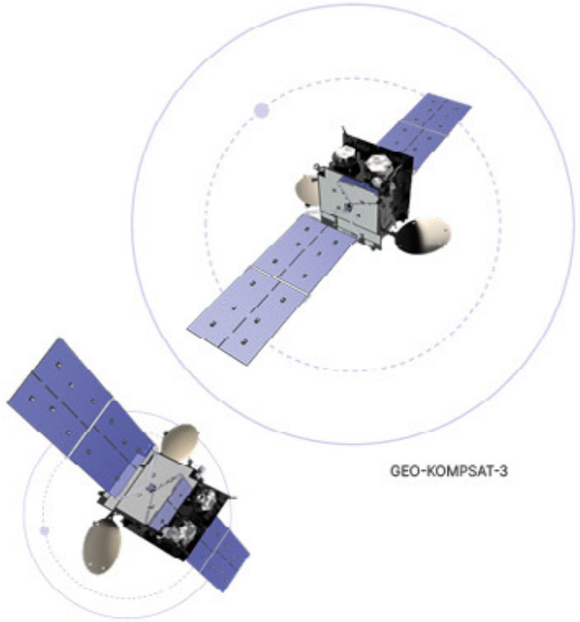
In the future development of the 2-seater training electric aircraft platform, significant enhancements in performance, including increased maximum speed and flight duration beyond current standards, are attainable. The development of such an advanced electric propulsion aircraft is expected to serve as a catalyst for South Korea's entry into the global civil aviation market.

Comparison of Propulsion System of KLA-100 and KLA-100x

Pre-System Design Review for GEO-KOMPSAT-3 (Chollian 3)

KARI is developing the Geostationary Orbit Multi-Purpose Communication Satellite (GEO-KOMPSAT-3) with the goal of launching it in 2027. In the second half of 2023, the Preliminary Design Review (PDR) was conducted.

GEO-KOMPSAT-3 is planned to carry three payloads: a Flexible Broadband Communication System (FBCS) for providing public communication services during disasters and emergencies, a Data Collection System (DCS) for gathering hydrological information from rivers and dams, and a Satellite Based Augmentation System (SBAS) for precise navigation and positioning system. Through these payloads, the satellite aims to prepare for the transition to the next generation of communication paradigms using satellites and provide emergency services and precise navigation services for disaster and emergency response.



GEO-KOMPSAT-3

Preliminary Design Review for GEO-KOMPSAT-3 (Chollian 3)

System Requirement Review and System Design Review for Korea Coast Guard Satellite Application System

The SSA Research Office is conducting research and development projects with the goal of developing a satellite application system for the operational use of maritime police satellite information. In October 2023, a System Requirement Review (SRR) was conducted to confirm the compliance of mission objectives with system requirements and to facilitate a common understanding on the requirements among project participants.

The meeting was attended by the Korea Coast Guard, the Korea Institute of Marine Science and Technology Promotion, technical review committee members, and research and development personnel. Subsequently, on December 2023, a System Design Review (SDR) was held to review system configuration approach, requirement allocations, and the adequacy of validation plans and development processes.

Identification of KPS Site Candidate Locations and Conducting Site Preliminary Surveys

Identification of Site Locations and Conducting Site Preliminary Surveys are crucial initial steps in developing the Korean Positioning System (KPS). KPS R&D Directorate developed strategies and plans for selecting suitable sites, creating a list of potential locations by assessing their infrastructure requirements.

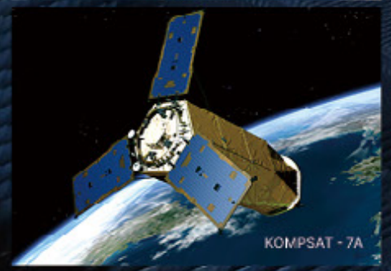
Through on-site preliminary surveys of site candidate locations, we analyzed geographical features, environmental factors, and potential advantages and disadvantages. Subsequently, we intend to validate the adequacy of equipment development and infrastructure requirements for conducting detailed investigations of the candidate sites.

Development of LEO-KOMPSAT Series

In 2023, the development of the Low Earth Orbit Korea Multi-Purpose Satellite (LEO-KOMPSAT) Series continued to fulfill precise observation and national image demands in the Korean Peninsula.

KOMPSAT-6, equipped with high-performance Synthetic Aperture Radar (SAR) for all-weather ground and ocean observation, has entered into a launch contract with Arianespace. Meanwhile, KOMPSAT-7, equipped with high-resolution optical and infrared payloads, successfully completed launch and orbit environment tests. KOMPSAT-7A, which enhances the performance of KOMPSAT-7, has commenced spacecraft bus integration and testing.


KOMPSAT-6


KOMPSAT - 7A


KOMPSAT-7

Participation in Korea's Industry-Led CAS500

KARI is participating in the Compact Advanced Satellite 500 (CAS500) project, led by Korean industries, by developing payloads and ground stations and overseeing technological management and supervision

The precise optical payload for CAS500-2, designed for land observation, has been assembled using components manufactured by Korean industries and is preparing for launch in 2025. Additionally, the wide-area electronic optical payload for agricultural and forestry monitoring on CAS500-4 has completed the assembly of its flight model components and has initiated verification testing of its Electrical Optic System (EOS). Furthermore, a system design review for the C-band image radar for water resource monitoring on the CAS500-5 has been conducted. Moreover, KARI has been carrying out technical management and supervision of spacecraft system and bus development for CAS500-3, 4, and 5, led by Korean industries, as well as the development of ground stations for satellite operation and image calibration and correction.

Integration of payload and main body of CAS500-2

Payload of CAS500-2

Development of 50kg Lift & Cruise Type UAV

KARI is developing a Lift & Cruise Unmanned Aerial Vehicle (UAV), with separate vertical takeoff and landing and forward flight rotors. Six electric motors/propellers for vertical takeoff generate thrust for a maximum takeoff weight of 50kg, while two motors/propellers on each side provide thrust for forward flight based on fixed wings. The aircraft has a target flight speed of 150 km/h and a maximum flight time of 40 minutes. The primary structures of the main and tail wings utilize the Quad Tilt-Prop (QTP) developed by KARI, and the flight control system has been improved based on open-source software with transition/reverse transition algorithms.

LC62-50 UAV is being developed in two variants based on the power source. LC62-50B utilizes only lithium polymer secondary batteries, composed of six 6S/22Ah batteries. LC62-50H, on the other hand, features a hybrid system comprising a 2.6kW hydrogen fuel cell and lithium polymer secondary battery, responsible for cruising and takeoff/landing, respectively.
LC62-50B has completed basic flight performance tests and is undergoing flight stabilization tests, external sensor integration tests, and technology demonstration mission tests.

In September 2023, the team participated in unmanned aerial vehicle flight tests in Greenland conducted jointly by Korea and Denmark, successfully performing polar environmental flight performance tests near the Kangarlussuaq Russell Glacier.

LC62-50H is undergoing ground performance tests for its hydrogen fuel cell hybrid power system and propulsion devices. The LC62-50, a 50kg-class Lift & Cruise UAV, can carry a maximum payload of 3kg, making it highly versatile and suitable for mission flights compared to smaller UAVs weighing less than 25kg. Moreover, it can be utilized for performance verification purposes in the development of larger drones up to 150kg and electric-powered aircraft systems like Urban Air Mobility (UAM) in the future.

Maximum Takeoff Weight (kg)	50
Flight Speed (km/h)	150
Flight Time (min)	40
Aircraft Length (Distance between VTOL Motor axes) (mm)	2,105
Aircraft Width (Distance between Cruise Motor axes) (mm)	2,300

LC62-50B UAV Flight Test

Support for Tracking and Telemetry of Solid-Fuel Launch Vehicle

On December 4, 2023, KARI successfully conducted the mission to track a private launch vehicle by utilizing solid propulsion technology at the Jeju tracking station. The mission utilized tracking and telemetry resources jointly provided by the NARO Space Center and the Agency for Defense Development.

The launch mission allowed the NARO Space Center to strengthen its operational capabilities for various launch scenarios utilizing the tracking and telemetry equipment available at the center. It also affirmed the center's capability to support launch services for various privately-led launch vehicles planned for the future.

Telemetry (TLM) Operations Room

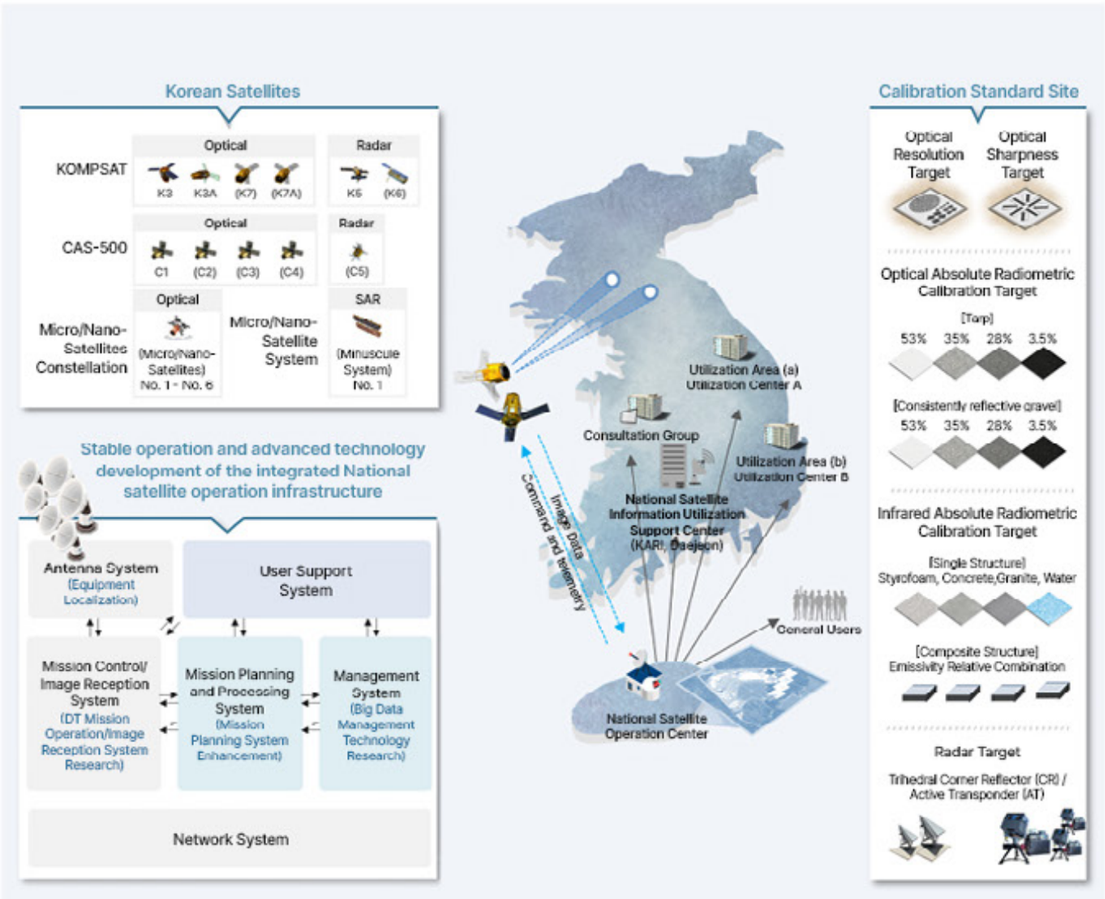
National Satellite Operations and Calibration & Correction Infrastructure Enhancement Project

This project aims to efficiently develop the National satellite image calibration & correction standard site and secure the reliability of calibration & correction and standard image products of national multi/clustered satellites through stable operation and advanced technology development of the integrated National satellite operation infrastructure (National Satellite Operation Center). The key contents are as follows.

Firstly, the project supports the integrated operation of low-orbit national satellites centered around the National Satellite Operation center as well as the activation of satellite image utilization. Secondly, research will be conducted on core technologies for the integrated mission operation enhancement and timely provision of satellite information at the National Satellite Operation Center. Lastly, the development of standard target and ground reference data observation and collection equipment necessary for calibration & correction and quality management of optical, infrared (IR), and synthetic aperture radar (SAR) satellite images during the normal operation period will be carried out.

In the first year of 2023, the following achievements were accomplished: The National Satellite Operation Center successfully operated KOMPSAT-3, 3A, 5, and CAS500-1, achieving a mission success rate of over 99%. Additionally, three ground antennas were operated normally, performing a total of 8,000 passes with a success rate of over 99%. Core technology research for integrated operation enhancement and satellite information timeliness improvement is underway. Through this, the national satellite integrated imaging plan has completed system analysis and basic design, as well as the basic design of the satellite image big data management system. Furthermore, the detailed design of ground antenna RF equipment and receiver modem test models has been completed, and research and basic design for the national satellite mission operation digital twins have been finalized. Lastly, the development of

standard sites for satellite image calibration has been carried out. Reflectance targets for optical testing were developed and tested, securing technology for optical target and equipment preliminary design through remote/automatic observation equipment production and testing, as well as production of infrared composite structure reflectance targets. Based on remote/automatic observation equipment production/testing, preliminary design for infrared targets and equipment for image calibration were performed. Additionally, preliminary design for multi-band active transponders capable of remote/automatic observation and basic civil engineering design requirements for calibration target development were derived, and design work and construction approval procedures were conducted in parallel for construction implementation.



Research and Development Composition and Execution Content

Selection and Development of Additional Projects for Space-Centered Technologies

KARI was selected as the leading agency for space technology development (Space Pioneer Program Office) for 10 years from 2021 to 2030 under the 3rd Basic Plan for Promotion of Space Development. KARI has been developing a total of 14 out of 16 space key technologies (three in the launch vehicle sector, seven in the satellite bus sector, and four in the satellite payload sector), with two new projects selected in 2023.

These Space key technologies are being pursued through an industry-centered academia-industry-research consortium model, with the aim of developing a domestic Qualification Model (QM) that integrates with the existing space system, strengthening private space techonolgy capabilities, as well as establishing a virtuous cycle of the space industry ecosystem through collaboration with systematic projects.

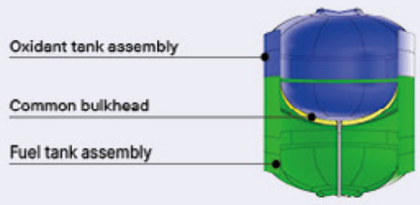
Launch Vehicle Sector

Common Bulkhead Propellant Tank (Jun. 2021~Dec. 2026)

Host Institutions: NDT Engineering & Aerospace (Lead), Korean Air, KP Aerospace Industries, GV Engineering (Industry), Aerospace University (Academy), KARI, Korea Institute of Industrial Techonology (KISTECH) (Research)

Main Objectives and Specifications: Lightweight/low-cost common bulkhead structure propellant tank for an upper core of small launch vehicles, utilizing aluminum-lithium (AL-Li) high-performance alloy material, incorporating friction stir welding and domestically developed ultra-low temperature insulation technology, applied to a 500kg-class satellite (Sun-synchronous Orbit 500km) small launch vehicle system.

Item	Size/Weight
Specifications	2.0±0.2m(D)×3.0±0.5m(L)/260kg or less

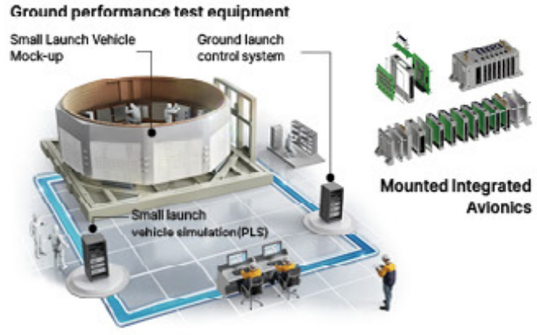


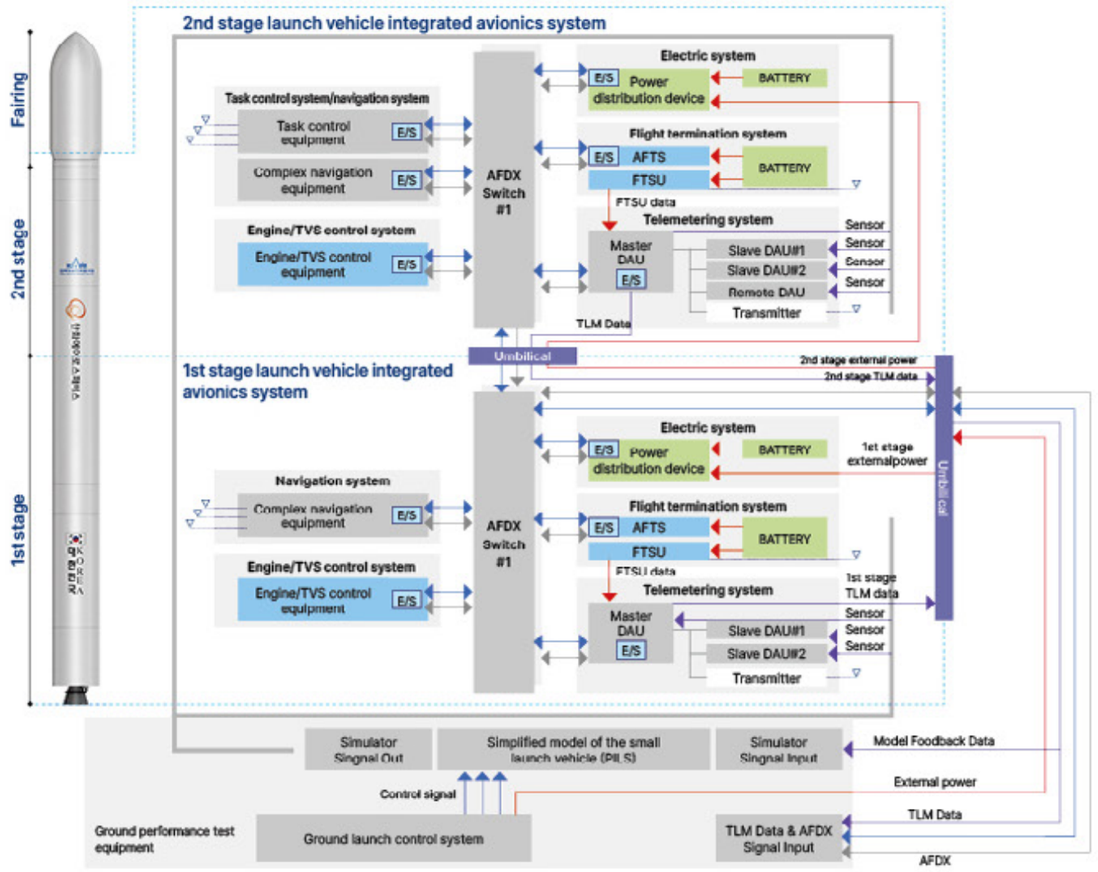
Integrated Avionics System (Mar. 2022~Dec. 2027)

Host Institutions: DANAM SYSTEMS (Lead), Korea Aerospace University (Academy), Korea Testing Laboratory, KARI (Research), Hanwha Aerospace, Hanwha Corporation, HANCOM InSpace, Bitelinx, SOLETOP (Industry)

Main Objectives and Specifications: Development of module-based integrated avionics system satisfying low cost, lightweight, and miniaturization criteria suitable for small launch vehicles (mission control, power, emergency shutdown, engine and TVC control, remote sensing)

- Mission duration: > 1,500 seconds
- Communication speed: ≥ 50Mbps
- Communication delay: < 0.1 ms
- Packet loss rate: ≤ 0.001%
- Position accuracy: ≤ 100m
- 3-axis attitude accuracy: ≤ 0.1 [degree]
- Weight: Stage 1 (≤40kg), upper stage (≤30kg)



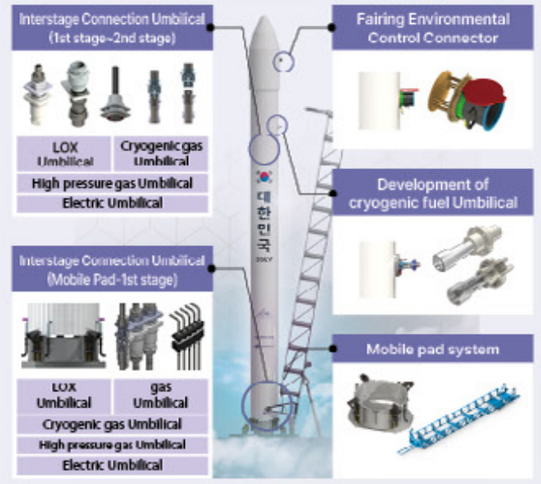


Interstage Connection Umbilical (Mar. 2022~Dec. 2027)

Host Institutions: HANYANG ENG (Lead)/Korean Air (Industry), KARI (Research)

Main Objectives and Specifications: Design of Inter-Stage Connection Umbilical Certification Model and Ground Interface Technology for Small Launch Vehicle Fuel/Oxidizer (Liquid Methane, Kerosene, Liquid Oxygen), Gas (Ambient Temperature, High Pressure, Low Temperature), and Electrical Supply.

Item	Specifications
Type and opeating flow of propellant, gas	• Liquid Methane (LCH4), Liquid Oxygen (LOX), Kerosene • Air, Nitrogen (GN2), Helium (GHe) • Operating flow rate of LCH4, LOX: 530LPM • Operating flow rate of Kerosene: 320LPM

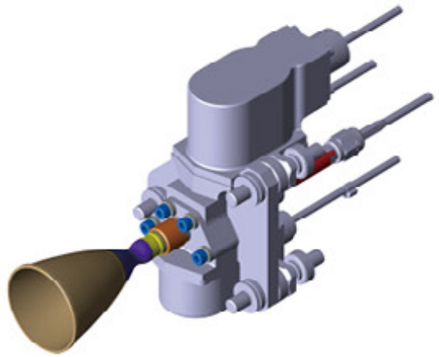


Satellite Bus Sector

Storable Bipropellant Thruster (Jun. 2021~Dec. 2025)

Host Institutions: KARI (Lead)(Research), Hanwha Aerospace, Anflux, NEXT FOAM(Industry), Chungbuk National University, Jeonbuk National University (Academy)

Main Objectives and Specifications: Development of Bipropellant Thruster using MMH (Fuel) and NTO (Oxidizer)

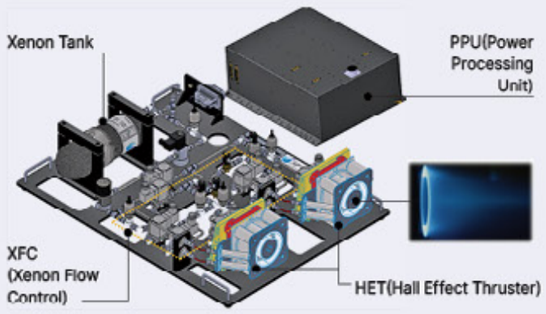


Item	Specific Impulse	Nominal Thrust
Specifications	287s	9.9N ± 0.2N

200mN Class High Thrust Electrical Propulsion System (Jun. 2021~Dec. 2026)

Host Institutions: Asia Pacific Satellite Inc. (Lead)(Industry), Korea Advanced Institute of Science and Technology, Korea Aerospace University (Academy), KARI (Research)

Main Objectives and Specifications: Development of hall effect thrusters capable of generating thrust of 200mN or more to operate Geostationary Orbit Satellites (3-ton class) from Transfer Orbits, along with High Voltage Output 5kW Power Supply Unit

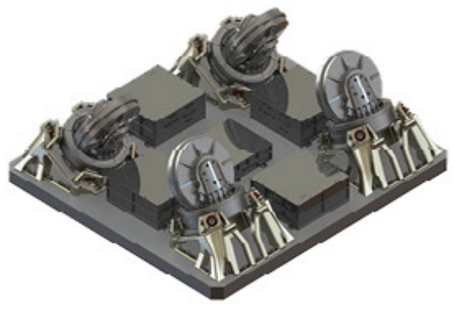


Item	Nominal Thrust	Total Impulse	Specific Impulse	Output Power	Lifetime
Specifications	200mN	1.25MNs	Min 1500s	PPU Power 5kW	1,736hr

Control Moment Gyro for high agility satellites (Jun. 2021~Dec. 2027)

Host Institutions: LIG Nex1 (Lead), LUMIR, Daeyoung M-Tech, LCTEK (Industry), Korea Advanced Institute of Science and Technology (Academy)

Main Objectives and Specifications: Development of Control Moment Gyro (CMG) as core components of Low Earth Orbit Satellite Attitude Control Systems capable of high agility medium satellites (about 500kg~1,200kg class satellites.)

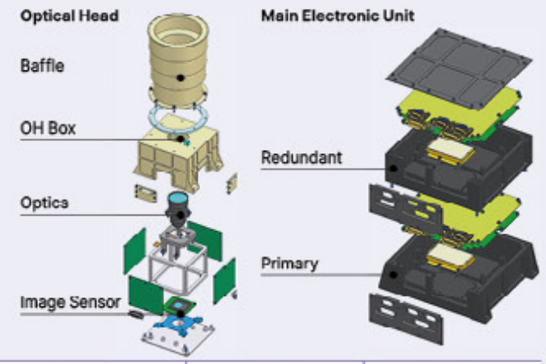


Item	Total weight	Maximum Output Torque	Maximum Angular Momentum	Maximum Gimbal Rate
Specifications	95kg or less	30Nm	15Nms	2 rad/s

Multiple Optical Head Star Tracker for Operational Satellites (Jun. 2021 -Dec. 2024)

Host Institutions: SATREC INITIATIVE (Lead) (Industry)

Main Objectives and Specifications: Development of a multi-optical head star trackers capable of satisfying the directional precision performance required by satellite systems such as multi-purpose Satellites and Compact Advanced Satellites.



Item	Configuration	Accuracy(@3 OH)	Update Rate	Slew Rate
Specifications	3 Optical Head(OH)/ Fully Redundant Electronic Unit(EU)	Bias:< 11arcsec, NEA:< 1.0 arcsec/ sqrt(Hz) @3σ,3axes	~30Hz	~10°/s

Multi-GNSS Receiver for GEO Satellites (Jun. 2021~Dec. 2024)

Host Institutions: DusiTech (Lead) (Industry), Inha University (Academiy), KARI (Research)

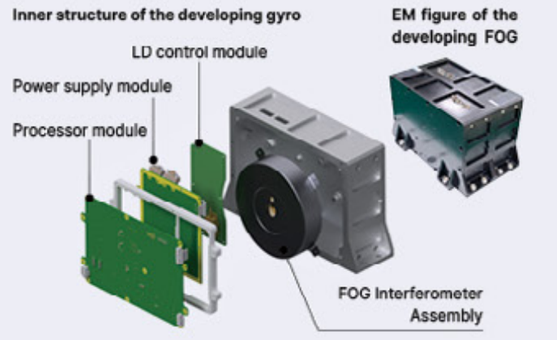
Main Objectives and Specifications: Development of a qualification model of the multi-GNSS receiver for GEO satellites

Item	RF Characteristics	Accuracy	Raw Data Accuracy	1PPS Accuracy
Specifications	GPS L2C, Galileo E1	≤30m(3D RMS), Velocity : 10cm/s	Pseudo-Range : 1m(RMS) Carrier-Phase : 10mm (RMS)	2us(RMS) / Sync to GPS Time Data

Fiber Optic Gyroscope for Practical Satellites (Jun. 2021 -Dec.2025)

Host Institutions: FIBERPRO(Lead) (Industry)

Main Objectives and Specifications: Development of fiber optic gyroscope for practical satellites utilizing light interference through optical fibers to detect rotational speed, enabling stabilization of satellite bodies and precise attitude determination



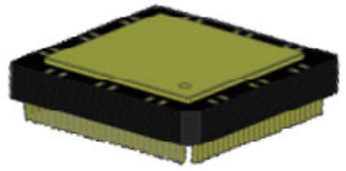
Item	ARW	Bias Stability(1-hr)	Scale Factor Stability (12-hr)	Life Span
Specifications	< 0.001°/√hr	< 0.01°/hr	< 200ppm	> 15 years(GEO)

ASIC-Based Multi-Core Controllers for Satellite-Mounted Computers (New, Jan. 2023 -Dec. 2028)

Item	Specifications
Core	2xProcessor Core Compliant 32-bit Processor
Performance	200MIPS/EDAC/Hardware Memory Scrubber
Peripheral	6 X SpaceWire Links MIL-STD-1553B BC/RT/BM Controller 2 X CAN 2.0 Controller 6 X UART SPI Master Controller/I2C Master Controller 2 X 32bit General Purpose Input Output
Total Ionizing Dose(TID)	300krad

Host Institutions: JTECH Corporation(Lead) (Industry), EDELTECH (Industry), QRT (Industry)

Main Objectives and Specifications: Development of ASIC-based multi-core controllers, development of space-grade ceramic packages for ASIC integration, and establishment of a multi-core controller testbed (functionality, space radiation, reliability, EMI, etc.)



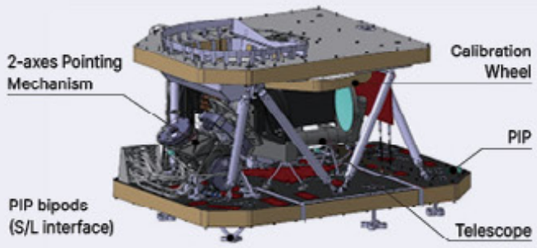
Satellite Payload Sector

SPPO Mechanism for the Next-generation Geostationary Optical(EO) Payload (Jun. 2021~Jun. 2025)

Host Institutions: JUSTEK (Lead) (Industry)

Main Objectives and Specifications: Development of one-axis and two-axis mechanism for EO payload, BM/QM grade one axis mechanism (OAM) and EM/QM grade two axis mechanism (TAM)

Item		Specifications
OAM (One Axis Mechanism)	Pointing Accuracy	<0.2deg
	Angular velocity	>24deg/s
TAM (Two Axes Mechanism)	PointingAccuracy	<0.006 deg
	Angular velocity	>1deg/s
	PointingStability	<4urad/100s

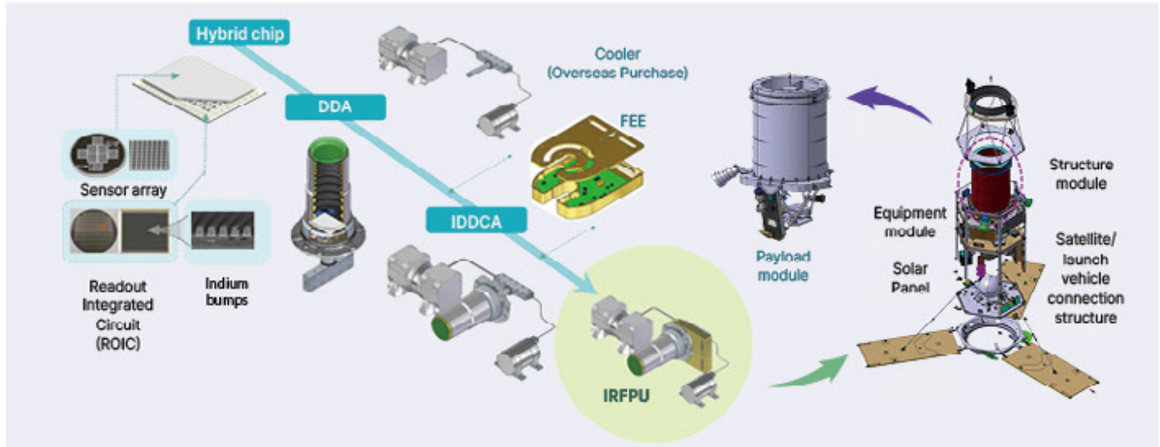


2-Dimensional Multi-band Infrared Detector (Sep. 2021~Dec. 2026)

Host Institutions: I3system (Lead) (Industry), Jeonbuk National University (Academy)

Main Objectives and Specifications: Development of localization technology for multi-channel infrared detectors based on superlattice (T2SL) for mounting on geostationary/low-orbit earth observation satellites and domestic technology for high-sensitivity/large-area infrared detectors, which are key components of satellites payload module

Item	Specifications	
	2-D multi-band MWIR detector	2-D multi-band LWIR detector
Wavelength	3~5.3μm	10~12.5μm
Format / Pixel Pitch	2048×2048/ 10μm	1024X1024 / 20μm
NETD	≤25mK (@80K)	≤35mK (@65K)

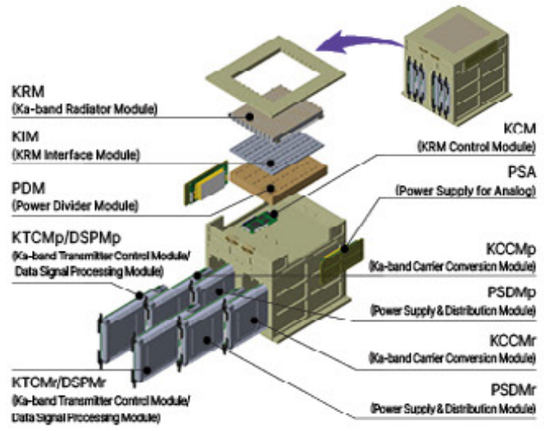


Ka-Band Transmitter and Ka-Band Active Phased Array Antenna (Jun. 2021~Jun. 2025)

Host Institutions: LUMIR(Lead). Microwave Technologies Group, SOLETOP (Industry)

Initial Integrated System: Next-generation Medium-sized Satellite (In 2025)

Main Objectives and Specifications: A high-performance, compact, and lightweight Ka-band transmitter and an active Ka-band antenna device with electronically steered antenna technology and software-defined radio technology applied as components of the downlink system in practical satellites

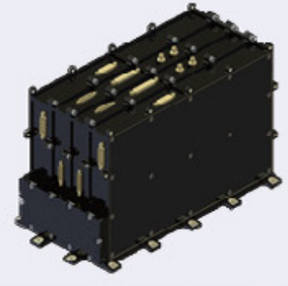


Item	Frequency	Beam Steering Range	Transmission Speed
Specifications	25.5~27GHz	Az: -60° , El: -60° to 60°	≥4GPS(2 channels)

KPS Code/Message Generator (New, Jan. 2023 ~Dec. 2026)

Host Institutions: LIG Nex1 (Lead) (Industry), MicroInfinity (Industry)

Main Objectives and Specifications: Development of KPS Code/ message generator for Korean Positioning System (KPS) payload to provide ultra-precise PNT services based on navigation and augmentation data received from ground.



Item	Chipping Rate	Self Correlation	Cross-Correlation	Data Rate
Specifications	1,023Mchip/s or above	1(Normalized Value)	0.1(Normalized Value)	50bps or above

3 EDUCATION AND PUBLIC OUTREACH

- 2023 Satellite Application Conference and 2023 Satellite Information Application Competition
- Five Types of KOMPSAT Image- Based Artificial Intelligence Training Data
- International Charter: KOMPSAT Data Support for Global Disasters
- Attendance at the 17th UN ICG Annual Meeting
- Attendance at the 41st Inter-Agency Space Debris Coordination Committee (IADC) Meeting
- Attendance at the SpaceOps and its Committee
- Participation in the Seoul ADEX 2023
- Dissemination and Promotion of R&D Achievements for the Space Pioneer Program
- She Space International, Satellite Imagery education and International Exchange Activities
- Education Implementation for users of the Government Satellite Information Application Consultation
- CDR and Workshop for the teams participating in the 2022 CubeSat Contest
- Support for University Student Paper Presentations and International Exchange at ISEB in IAC
- On-site Education and Career Mentoring in the Space Field for College Students (KARI Academy)
- Operation of Smart Math-Science Classes and Implementation of Aerospace Education for Elementary and Middle School Students
- KARI Secures Permanent Observer Status with ALCE
- Support for State Visit to NASA Goddard Space Flight Center (GSFC)
- Donation of Nuri Model to the Smithsonian National Air and Space Museum
- Participation in COP28 Space Agency Leader's Summit

2023 Satellite Application Conference and 2023 Satellite Information Application Competition

KARI held "Satellite Application Conference 2023", co-hosted by the Ministry of Science and ICT and the National Intelligence Service (NIS), from October 16th to 17th at the K Hotel in Seoul. Following last year's conference themed "The New Space Era, the Future of Satellite Information Application," where major overseas satellite application companies were invited, this year, a platform for communication on "Application of Space Big Data and Global Networks" was established. A total of 492 participants, including government agencies, universities, research institutes, and domestic and foreign industry representatives, attended. On the first day, keynote speeches were given by representatives of leading overseas satellite application companies such as PlanetLabs, Airbus D&S, Maxar, BlackSky, ICEYE, and Capella Space. Additionally, a session commemorating the first anniversary of the KPLO mission, titled "Application of KPLO Lunar Exploration Data and International Cooperation", was conducted. On the second day, alongside company presentation sessions providing opportunities for domestic satellite application companies to promote and collaborate, there were sessions on the global application of satellite information and big data applications. Twenty exhibition booths from domestic and foreign industries were set up to provide a platform for communication between users and industries regarding the latest technologies and products.

Satellite Application Conference 2023 Opening Address
(President of the Korea Aerospace Research Institute)

Satellite Application Conference 2023 Presentation session

KARI hosted the "2023 Satellite Information Application Competition" sponsored by the Ministry of Science and ICT (July 1st to September 13th) to support the discovery of new applications for satellite information big data and to promote technological development.

This competition, divided into student divisions(undergraduate and graduate students) and general divisions (industry, academia, research, government, etc.), solicited various ideas to enhance the application of satellite information, including various satellite information processing and application technologies.

It aimed to promote the value and importance of satellite information big data that can be integrated with artificial intelligence (AI) technology for solving social issues, supporting decision-making, and more.

2023 Satellite Information Application Competition Poster

2023 Satellite Information Application Competition Winners Group Photo

A total of 36 teams from the student and general divisions participated, undergoing the first round of written evaluations and the second round of presentation evaluations. Eight teams, divided into four categories, were awarded (two teams for the grand prize: the Minister of Science and ICT Award, two teams for the first prize: the Korea Aerospace Research Institute President Award, and four teams for the second prize: Korea Aerospace Research Institute President Award). The award ceremony and theme presentations for all winning teams took place at the "Satellite Application Conference 2023."

Five Types of KOMPSAT Image- Based Artificial Intelligence Training Data

Artificial intelligence training data made available through DataON

The research team at the National Satellite Operation & Application Center has newly constructed and publicly released five types of artificial intelligence training data based on Korea Multi-Purpose Satellite (KOMPSAT) imagery. These include object detection, building segmentation, road segmentation, cloud detection, and land cover land use classification. The data was made available through KISTI's DataON platform.

Previously, through the AI Hub of the National Information Society Agency (NIA), over one million pieces of KOMPSAT image-based artificial intelligence training data were made publicly available. In addition to enhancing the quality of the existing data, over 400,000 patches of newly constructed data have been added and made publicly available through DataON.

The newly released data is expected to contribute to the advancement of domestic satellite information applications by being made available to private research institutes and industries.

Example: New artificial intelligence training data

International Charter: KOMPSAT Data Support for Global Disasters

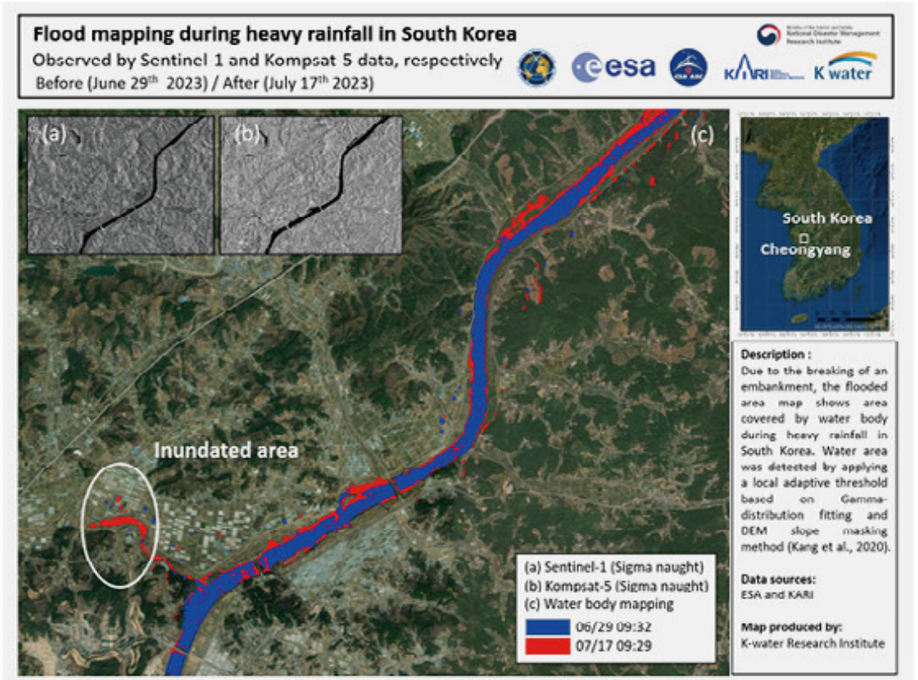
KARI has served as the lead agency of the International Charter Space and Major Disasters, a global cooperation initiative for disaster response, until April, 2023. During the 49th regular Board Meeting of the International Charter, KARI handed over the lead agency responsibilities to the United Kingdom Space Agency (UKSA). Charter member agencies expressed gratitude for Korea's leadership during its tenure (October 2022 - April 2023), especially amidst significant disasters such as earthquakes in Turkey and Syria, oil spills in the Philippines, and Cyclone Freddy in Africa. In the 50th regular board meeting held in October, UKSA assumed the lead agency role, currently overseeing the Charter's overall operations from the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

International Charter 49th Board Meeting

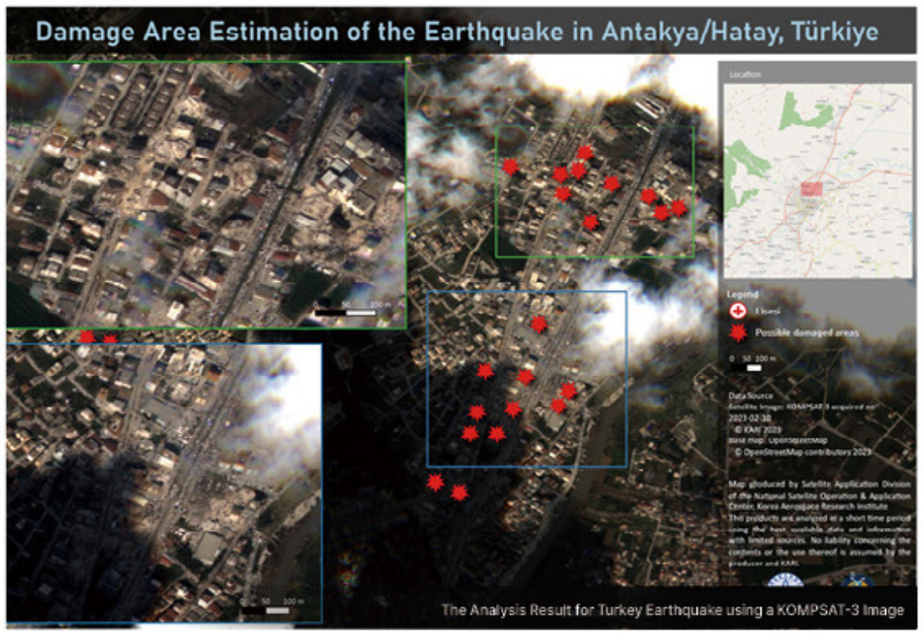
KARI provided 1,179 KOMPSAT images (as of 2023) through the International Charter for 52 national disaster incidents, including the earthquake in Turkey, Cyclone Freddy, Cyclone Yaku, floods in Somalia, Ethiopia, and Chile. In July and August 2023, in response to concentrated heavy rainfall and Typhoon Khanun on the Korean Peninsula, the Charter was activated to secure over 700 foreign satellite images.

These images were utilized in collaboration with organizations such as K-water, the National Disaster Management Research Institute, and the National Institute of Forest Science to analyze and respond to flood and landslide damage in South Korea. Additionally, KARI supported the Korean relief team for the Turkish earthquake by providing analysis results of the earthquake damage in Turkey, offering crucial information about the affected areas.

International Charter 50th Board Meeting



Domestic Flood Damage Analysis Using KOMPSAT-5 and Charter Images



The Analysis Result for Turkey Earthquake using a KOMPSAT-3 Image

Attendance at the 17th UN ICG Annual Meeting

The KPS R&D Directorate joined the delegation representing the Korean Government, consisting of relevant ministries including the Ministry of Science and ICT, Ministry of Foreign Affairs, Ministry of Oceans and Fisheries, as well as experts from research and development institutions such as the Korea Aerospace Research Institute, Korea Astronomy and Space Science Institute, and Korea Research Institute of Ships and Ocean Engineering, to attend the 17th United Nations International Committee on Global Navigation Satellite Systems (UN ICG) Annual Meeting held in October 2023.

The annual UN ICG meeting, attended by over 300 representatives from UN ICG member countries including South Korea, the United States, Japan, China, the European Union, India, and Russia, covered various topics such as coexistence and interoperability among satellite navigation systems, space service areas, Precise Point Positioning (PPP), LEO PNT, and Lunar PNT. In particular, our delegation confirmed during this meeting that South Korea will host the 19th UN ICG Annual Meeting in 2025 and presented an overview of the Korean Positioning System (KPS). We actively participated in practical discussions on international cooperation at bilateral and multilateral levels. The next UN ICG Annual Meeting is scheduled to be held in Wellington, New Zealand, in October 2024.

Attendance at the 41st Inter-Agency Space Debris Coordination Committee (IADC) Meeting

The Inter-Agency Space Debris Coordination (IADC) is a technical and scientific research body for global space development agencies related to the environmental issues of the Earth's orbits caused by space debris. It provides technical advice and guidelines to the UN and reports to it, with 13 countries currently participating as of 2023.

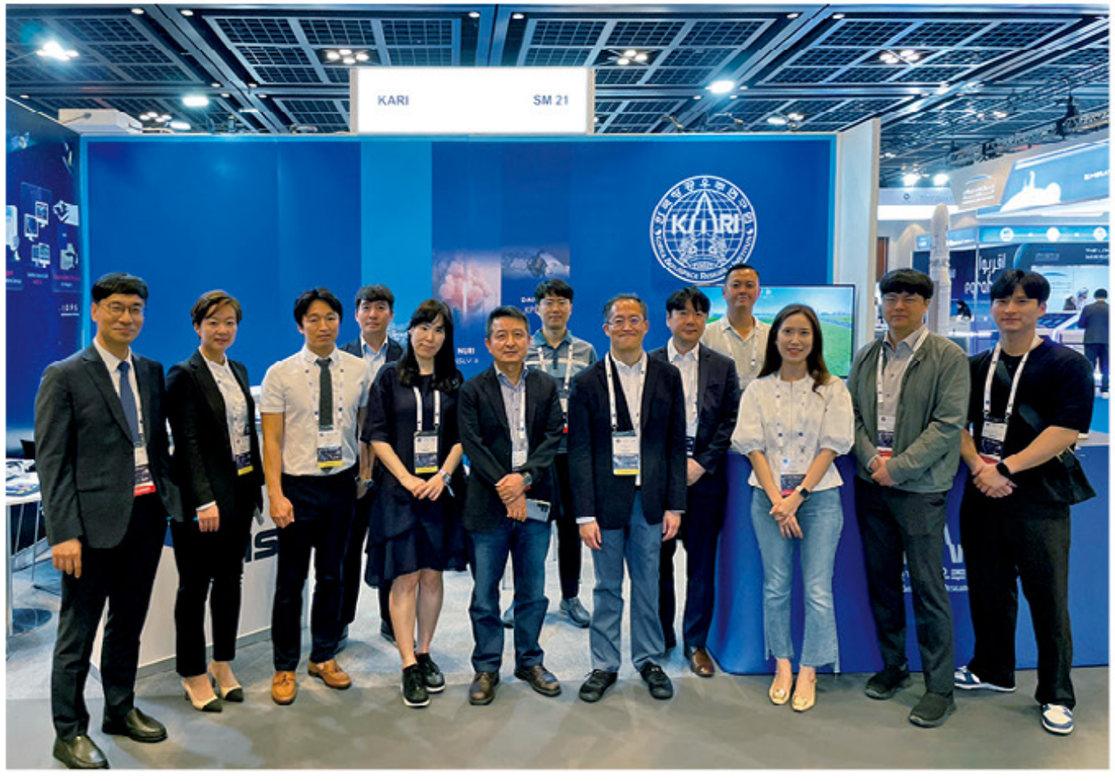
In June 2023, the European Space Agency (ESA) chaired the 41st IADC meeting held at the European Space Operations Center (ESOC) in Darmstadt, Germany. KARI participated in all four working groups consisting of the Steering Group (SG), Measurement, Environment & Database, Protection, and Mitigation, conducting discussions. The next meeting is scheduled to be held in April 2024 at the Indian Space Research Organization (ISRO). The SSA Research Office is responsible for tasks related to the IADC, including delegation composition, participation in follow-up technical meetings, development of space debris mitigation guidelines for space development agencies, and activation of domestic and international cooperation research for space environmental protection.

Attendance at the SpaceOps and its Committee

"SpaceOps" is an international committee organization established in 1992 to enhance and maintain the international community of space operation experts. Currently, 13 space agencies from 13 countries, including KARI, are active as committee executives, and a total of 28 institutions are active as committee members.

The SSA Research Office is responsible for representing the KARI members and participating in the Workshop Working Group activities. Since its establishment, SpaceOps has hosted 15 conferences every two years worldwide, providing opportunities for discussions on advanced space vehicle operation technology and facilitating technical exchanges on all aspects of space operations, including robotics, Earth orbits, manned missions, and deep space.

In 2016, KARI hosted a conference in Daejeon, and in 2023, participated in the 17th International Conference on Space Operations held in Dubai, United Arab Emirates establishing a booth to promote R&D achievements, presenting various research paperes, and networking. Additionally, as an executive organization of the committee, KARI participated in the committee's plenary meetings to facilitate the discussions on the current conference progress and prepared for the next conference.

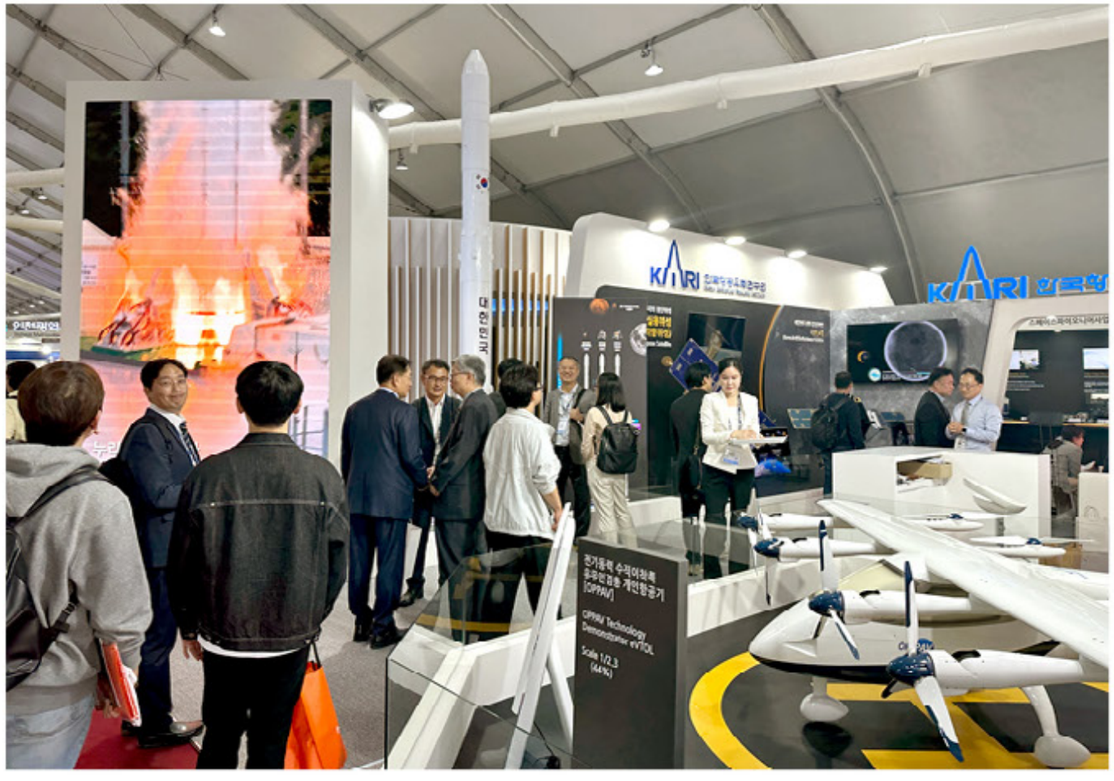


Participation in the Seoul ADEX 2023

KARI participated in the Seoul International Aerospace and Defense Exhibition 2023 (Seoul ADEX 2023), which was held at Seoul Airport on October 17th, 2023, and lasted for six days. Seoul ADEX, held once every two years at Seoul Airport in Seongnam, Gyeonggi Province, is the largest domestic aerospace and defense industry exhibition in Korea. In 2023, it featured participation from 550 companies representing 34 countries, operating a total of 2,320 booths.

At the booth of KARI scaled models of Nuri, which successfully launched for the third time in May of the same year, and KPLO, currently performing successful lunar exploration, along with related research achievements and videos, were exhibited.

Additionally, models of the Optionally Piloted Personal Air Vehicle electric vertical take-off and landing (OPPAV eVTOL), as well as KOMPSAT-6, were showcased, along with the achievements of the Space Pioneer Program. Beyond the exhibition, business meetings with overseas government officials such as the chairman of the UAE Space Agency, and private companies including Airbus were also conducted.



Dissemination and Promotion of R&D Achievements for the Space Pioneer Program

KARI operates special sessions and promotional booths at major domestic conferences to promote the dissemination and adoption of domestically developed space-centric technologies, a result of the Space Pioneer project. Additionally, KARI organizes workshops to share the progress of specific projects with domestic stakeholders from industry, academia, and research institutions, fostering mutual cooperation to maximize technology utilization. In 2023, KARI supported private companies in signing a total of nine Memoranda of Understanding (MoUs) for facilitating the utilization of space-centric technologies in the launch vehicle sector of the space project. Efforts are underway to advance contracts and collaborations for the "Integrated Avionics System" and "Interstage Connection Umbilical" technologies.

Aerospace Society Spring Academic Conference Operating OS and Promotion Booths (April 19-21, 2023)

Operation of Special Sessions at the 30th Radio Wave New Technology Workshop (April 28, 2023)

Introduction and Progress Presentation of Detailed Projects (Ventures) within the Space Pioneer Program

Signing of MoU between Launch Vehicle Companies for Systematic Integration of Project Performance Technologies (November 21, 2023)

Efforts were made to support the signing of Memoranda of Understanding (MoUs) between small launch vehicle companies to integrate the space-centric technologies of the Space Pioneer project, including "Common Bulkhead Propulsion tank", "Integrated Avionics System", and "Interstage Connection Umbilical", into the framework of private space development projects. A total of 9 agreements were concluded.

- Technology Supply Companies: NDT Engineering Co., Ltd., Danam Systems Co., Ltd., Hanyang Engineering Co., Ltd.
- Technology Demand Companies: Hanwha Aerospace Co., Ltd., Korean Air Co., Ltd., InnoSpace Co., Ltd., Unastella Co., Ltd.

Conducting Integrated Workshop for the Space Pioneer Program (June 28, 2023)

The Space Pioneer Program has hosted "Integrated Workshops" among lead agencies of detailed projects and consortium organizations to share domestic technological developments in the fields of launch vehicles, satellite bodies, and payloads. Through expert lectures, the project aims to foster research and development synergy and support smooth project execution.

Participation and Promotion at Seoul ADEX 2023 and Korea Space Forum 2023

Operation of Promotion Booth at Seoul ADEX 2023 (October 17-22, 2023)

Operation of Promotion Booth at KOREA SPACE FORUM 2023 (November 8-9, 2023)

She Space International, Satellite Imagery Education and International Exchange Activities

To expand the representation of women in the space sector, She Space International conducted satellite imagery education targeting 16 high school girls. Four of these high school girls visited Texas Tech University (TTU) in the United States from July 19th to 27th, participating in joint research presentations with the U.S. team and engaging in STEM education. Additionally, they visited the Kennedy Space Center in Florida, where they learned about the history of space development in the United States and toured cutting-edge space launch vehicles and the Space Shuttle.

Participants in the She Space International Program

Education Implementation for Users of the Government Satellite Information Application Consultation

User Education in the First Half of the Year

KARI conducts annual remote sensing and satellite information application education for users of the Government Satellite Information Application Consultation. In the first half of 2023, the institute organized an education session in Seoul with the theme "Fundamental of Remote Sensing and Satellite Imagery Utilization." The curriculum covered the overview of remote sensing and satellite imagery principles, electromagnetic radiation principles, multispectral and thermal infrared systems, as well as SAR systems and applications of satellite imagery, including case studies. A total of 21 participants from nine organizations attended the education session held on May 12th.

Consultation education in the First-Half of 2023

User Education in the Second Half of the Year

In the second half of 2023, the user education session of the Government Satellite Information Application Consultation was conducted as practical training. The session, titled "Fundamental Practices of Remote Sensing and Satellite Imagery Utilization," involved practical training using KOMPSAT DataViewer and QGIS. The second-half education session, conducted over two days from September 25th to 26th, saw participation from 19 individuals representing seven organizations.

Consultation education in the Second-Half of 2023

CDR and Workshop for the Teams Participating in the 2022 CubeSat Contest

On October 5th and 6th, 2023, KARI conducted the Critical Design Review (CDR) of the 2022 CubeSat Development Team with the participation of six teams from Seoul National University, KAIST, and others. A specialized CDR evaluation team comprising six members from KARI's CubeSat Technology Support Team conducted a thorough review of the CDR documents and plans to organize a Delta CDR in the first half of 2024, incorporating the review comments. Additionally, a workshop on satellite system engineering, CubeSat communication and attitude control, and CubeSat development know-how was conducted for the final selected teams of the 2022 CubeSat Competition from October 23rd to 24th at the Daejeon KT Human Resources Development Institute.

CDR and Workshop for the teams participating in the 2022 CubeSat Contest

Support for University Student Paper Presentations and International Exchange at ISEB in IAC

KARI selected a total of seven university students and graduate students to participate in the International Astronautical Congress (IAC) and provided education and guidance on paper presentations.

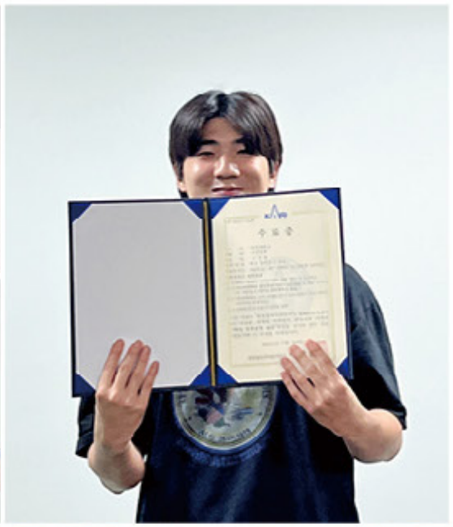
From September 26th to October 8th, 2023, the students participated in the Space Generation Congress (SGC) in Baku, Azerbaijan, engaging in exchanges with young space professionals. They also attended the IAC to present papers and acquire knowledge on the latest developments in space technology.

In particular, they participated in the International Space Education Board (ISEB) program, forming an international network among participating students to contribute to the cultivation of future global aerospace experts.

Participation in SGC Working Group Discussions and Presentation of Papers at ISEB

On-site Education and Career Mentoring in the Space Field for College Students (KARI Academy)

In the summer semester of 2023, basic education on satellites and operating training on satellite missions were conducted for 16 undergraduates. In the fall semester, an advanced aerospace system engineering and space testing was conducted for eight graduate students to enhance their understanding of essential space testing for satellite launches. By providing on-site education in the space field for university students, the aim was to foster advanced talents in the space industry and to establish self-directed learning through practical educational programs. This initiative contributed to nurturing proactive talents who will lead the New Space era and strengthened collaboration with universities interested in cultivating talents for space development, thereby enhancing the relationship between practical industry demands and academic education.



Summer Semester Undergraduate Satellite Operations Practicum Comprehensive Presentation

Operation of Smart Math-Science Classes and Implementation of Aerospace Education for Elementary and Middle School Students

KARI conducted education in the form of smart math-science classes for elementary, middle, and high school students.
A total of 10 education programs were operated 68 times, providing aerospace education programs to 1,845 students in Daejeon, Chungcheong, and Jeolla provinces.

The main programs included mentoring in aerospace careers by researchers from KARI and the practical assembly of CanSat. Special programs such as flight simulator exercises, remote sensing of artificial satellites, satellite control and operation, advanced coding drones were provided, allowing students to enhance their interest in aerospace fields and aspire to become scientists.

Operation of Smart Math-Science Classes

KARI Secures Permanent Observer Status with ALCE

ALCE*, the Latin American and Caribbean Space Agency, is an independent space agency aimed at fostering cooperation in the field of space among countries in Latin America and the Caribbean, with a target launch year of 2024. Among the 33 countries in the region, 20 are member states, with Mexico leading as the chairing country.

*ALCE: Agencia Latino americana y Caribeña del Espacio

Since 2018, KARI has actively engaged in a close cooperation network with Mexico, the chairing country of ALCE, by organizing two joint Korea-Mexico aerospace workshops, participating in the Mexico Aerospace Fair (FAMEX), providing online space education to ALCE member countries, and holding cooperative meetings with the Mexican Ministry of Foreign Affairs.

As a result of these efforts, KARI is set to become the first non-regional country to obtain the inaugural Permanent Observer status with ALCE in 2024, aligning with ALCE's launch. This achievement is expected to further enhance aerospace technology cooperation between Korea and Central and South America.

Support for State Visit to NASA Goddard Space Flight Center (GSFC)

President Yoon Suk Yeol of the Republic of Korea visited NASA's Goddard Space Flight Center last April. This visit by President Yoon comes as Korea is enhancing its space capabilities, including preparations for the establishment of the Korea AeroSpaceAdministration. By visiting NASA, the world's leading space agency, President Yoon aimed to take a significant step forward in enhancing space cooperation between Korea and the United States, a crucial element in realizing Korea's vision as a space economy powerhouse.

KARI sees President Yoon's visit as an opportunity to further activate cooperation with NASA, particularly in areas such as deep space communication and navigation, reflecting the agenda outlined in the "Joint Statement of Intent for Cooperation on Space Exploration and Space Science" signed between the Ministry of Science and ICT and NASA. This is expected to pave the way for future joint projects and collaborations with NASA.

Donation of Nuri Model to the Smithsonian National Air and Space Museum

In November, KARI donated a model of the KSLV-II (Nuri) to the Smithsonian National Air and Space Museum, the world's largest aerospace museum also known as "the nation's attic." The Nuri model, scaled at 1:15, represents a unique South Korean space launch vehicle developed with the capability to launch satellites weighing up to 1.5 tons into orbit, with an actual length of 47.2 meters and a weight of 200 tons. Alongside models of space launch vehicles from other countries, the donation of the Nuri model is expected to inspire the younger generation and contribute to the preservation and transmission of international space history.

Participation in COP28 Space Agency Leader's Summit

The Conference of the Parties (COP), an annual gathering of signatories to the climate change agreements established during the UN Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992, convened its 28th session this year in Dubai, UAE, from November 30th to December 12th.

As a sideline event of COP28, the 'Space Agency Leader's Summit' was organized to discuss collaborative responses to climate change among global space agency leaders. KARI was invited to participate as the representative of Korea and presented its activities and plans as a specialized space development institution in response to climate change. The meeting was attended by over 80 representatives and experts from space agencies worldwide, who adopted the 'Pledge for Enhancing Space-Based Climate Initiatives,' committing to collaborative efforts in addressing climate change through space-based initiatives.

OVERVIEW

VISION

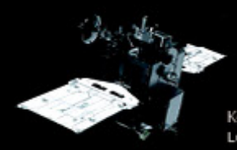
A world-class research institute realizing Korea's dream toward the sky and space.

Mission

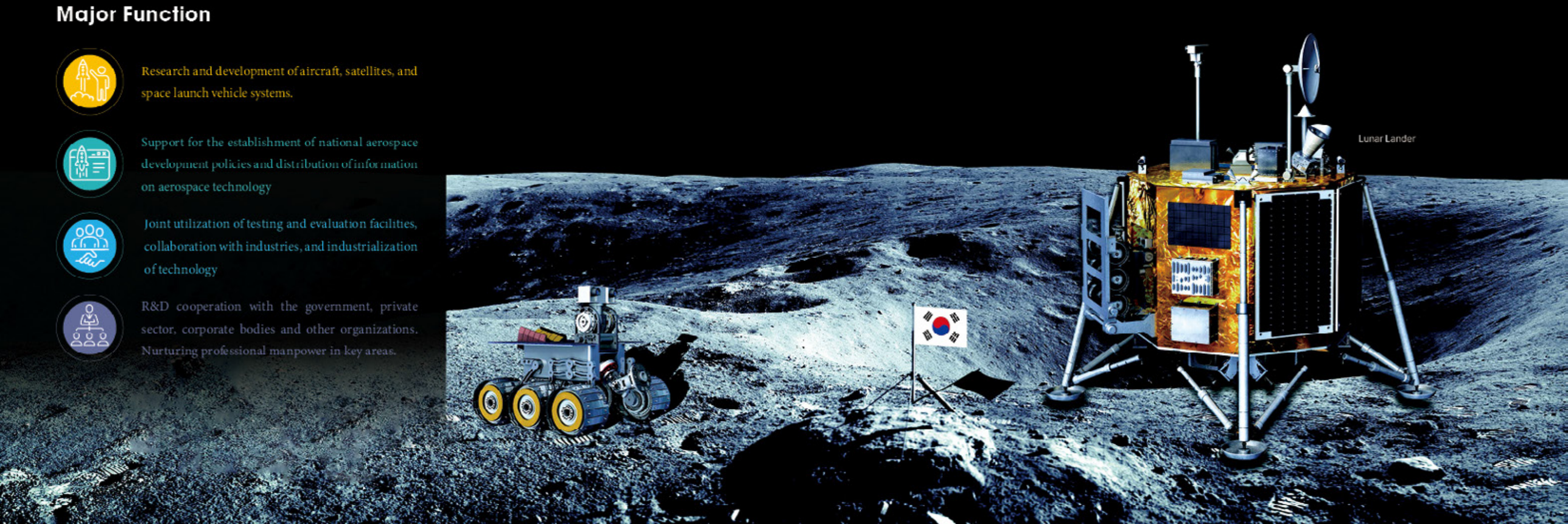
Contribution to solid development of the national economy and improving people's lives through new exploration, technology advancement, development and dissemination in the field of aerospace science and technology.

Major Function

- Research and development of aircraft, satellites, and space launch vehicle systems.
- Support for the establishment of national aerospace development policies and distribution of information on aerospace technology
- Joint utilization of testing and evaluation facilities, collaboration with industries, and industrialization of technology
- R&D cooperation with the government, private sector, corporate bodies and other organizations. Nurturing professional manpower in key areas.



Korea Pathfinder Lunar Orbiter (KPLO)



HISTORY

1989. 10

Establishment of KARI under Korea Institute of Machinery & Materials (KIMM)

1990. 12

Ground-breaking ceremony for the building of the institute

1992. 10

Building Completing Ceremony

1993. 04

Development of experimental aircraft

1993. 06/09

Launch of single-stage sounding rocket (KSR-I)

1993. 09

Development of EXPO unmanned airship

1996. 11

Incorporation of KARI

1997. 03

Development of twin-engine composite aircraft

1998. 06

Launch of two-stage sounding rocket (KSR-II)

1999. 12

Launch of KOMPSAT-1 (KOMPSAT-1)

2001. 09

Development of canard aircraft

2002. 11

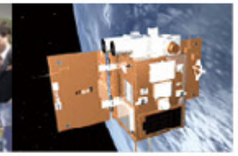
Launch of Korea's 1st liquid-propellant rocket (KSR-III)

2003. 08

Ground-breaking ceremony for the space center

2003. 09

Launch of STSAT-1

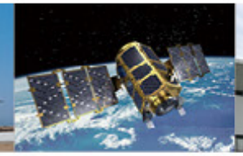


2003. 10

Development of multi-purpose stratosphere unmanned airship

2006. 07

Launch of KOMPSAT-2 (KOMPSAT-2)



2008. 04/12

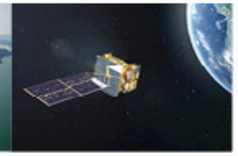
The first Korean astronaut, Development of medium aerostat

2009. 06

Completion of NARO Space Center

2010. 06

Launch of COMS (Cheollian-1)



2011. 11

Development of Smart UAV

2012. 05

Launch of KOMPSAT-3 (KOMPSAT-3)

2012. 06

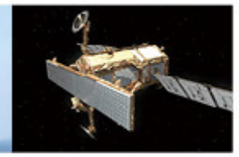
Development of dual-use core components for Korea Utility Helicopter (Surion)

2013. 01

The 3rd launch of Korea's first space launch vehicle (KSLV-I)

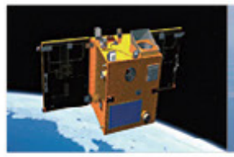
2013. 08

Launch of KOMPSAT-5 (KOMPSAT-5)



2013. 11

Launch of STSAT-3



2013. 12

Development of KT-100

2014. 05

Development of OPV

2015. 03

Launch of KOMPSAT-3A (KOMPSAT-3A)

2015. 12

Completion of building of KSLV-II engine propulsion system testing facilities

2016. 12

KARI designated as national organization for space development in Korea

2018. 11

Launch of test launch vehicle (Nuri TLV)

2018. 12

Success in automatic transition flight of OTP-UAV

2018. 12

Launch of GEO-KOMPSAT-2A (Cheollian-2A)

2020. 02

Launch of GEO-KOMPSAT-2B (Cheollian-2B)

2020. 08

Successful 53 straight hour flight of stratosphere solar-powered unmanned Electrical Aerial Vehicle-3 (EAV-3)

2021. 03

Launch of CAS 500-1

2021. 10

The 1st launch of KSLV-II (Nuri)

2022. 06

The 2nd launch of KSLV-II (Nuri)

2022. 08

Launch of KPLO (Danuri)

2023. 05

The 3rd launch of KSLV-II (Nuri)

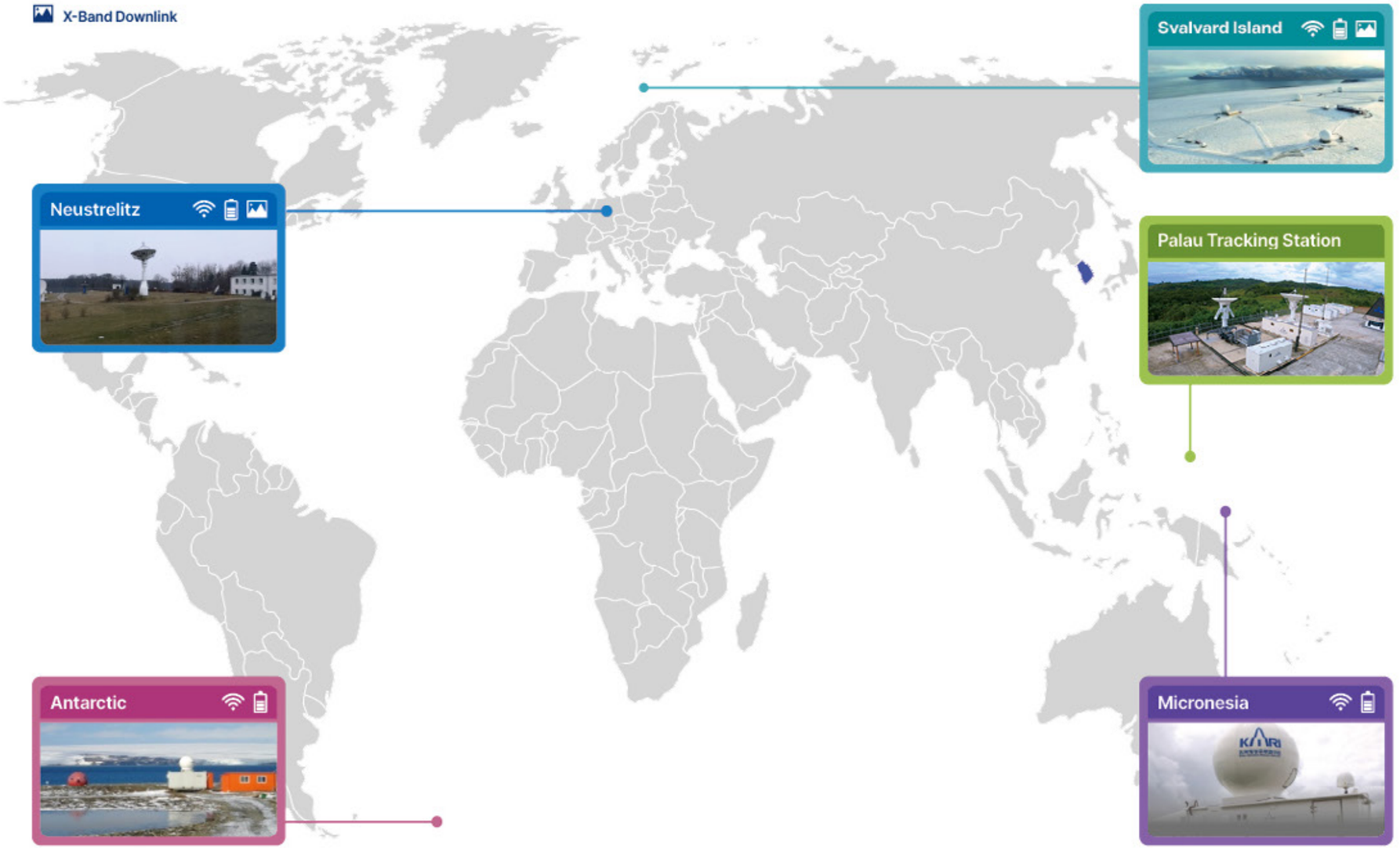
ORGANIZATIONAL CHART

FACILITIES

Unmanned Operation

S-Band Down/Uplink

X-Band Downlink

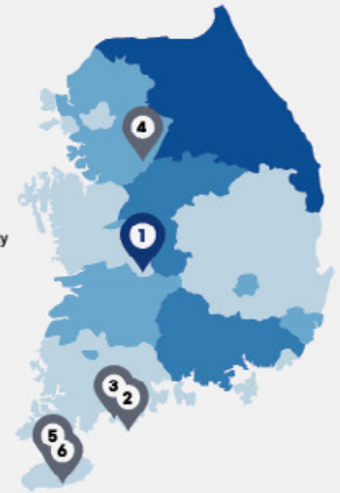


❶ KARI HQ

Site area (m²) : 317,942

Facility area (m²) : 111,603

- Satellite Test Center
- Ground Combustion Test Center
- Satellite Ground station
- Full-Scale Airframe Static Test Facility
- Rotary Wing Aircraft Test Center
- Wind Tunnel Test Center



❷ NARO Space center

Site area (m²) : 5,374,686

Facility area (m²) : 83,232

- KSLV Launch Site
- Mission Operation Center
- Tracking Radar

❸ National Aviation Test Center

Site area (m²) : 1,025,445

Facility area (m²) : 8,021

- Aircraft Test Center
- Helicopter Whirl Tower Test Facility

❹ Korea Deep Space Antenna

35 M Antenna / 750 ton

- S-Band up/downlink, X-Band downlink

❺ Jeju National Satellite Operation Center

Site area(m²) : 61,166

Facility area(m²) : 4,408

- Operation of LEO satellites

❻ Jeju Tracking Station

Site area(m²) : 114,811

Facility area(m²) : 2,031

APPENDIX

Internationally Registered Patents in 2023

THE METHOD AND SYSTEM FOR SWARM FLIGHT CONTROL

Country	Date of Patent	Patent Number	Abstract
PCT(JP)	2023-01-31	7219814	A method and system for controlling group flight. According to one embodiment of the present invention, the group flight control method includes a step for sending broadcast correction signals, essential for measuring precise positions of multiple aircrafts connected via short-range wireless communication; a step for receiving navigation signals regarding the aircraft status, which are transmitted from the above multiple aircrafts through the broadcast transmission of the above correction signals,; a step for confirming the reception status of the correction signals from the navigation signals and determining the communication state; and a step for adjusting the broadcast transmission period of the correction signals according to the determination result of the communication state, and controlling group flight among the multiple aircrafts.

SATELLITE IMAGING ACQUISITION RE-PLANNING METHOD AND APPARATUS USING SHIP AUTOMATIC IDENTIFICATION INFORMATION

Country	Date of Patent	Patent Number	Abstract
EU(DE,FR,IT)	2023-02-15	3984891	A method and apparatus for satellite imaging acquisition re-planning using ship automatic identification information are disclosed. The method for satellite imaging acquisition re-planning using ship automatic identification information may include, upon arrival of a point in time for imaging a target area based on an imaging acquisition plan set in a satellite, collecting automatic identification system (AIS) information of a ship generated in the target area, estimating a weather condition in the target area by analyzing the AIS information, and performing an imaging acquisition re-planning when it is determined that imaging by an electro-optic (EO) camera is impossible under the estimated weather condition.

ROCKET ENGINE WITH INTEGRATED COMBUSTOR HEAD AND TURBOPUMP

Country	Date of Patent	Patent Number	Abstract
US	2023-02-21	US 11,585,295 B2	The present disclosure related to a rocket engine, and more particularly, a rocket engine with an integrated combustor head and turbopump in which a turbopump of the rocket engine is formed integrally with a combustor head.

COMBUSTOR OF LIQUID ROCKET ENGINE

Country	Date of Patent	Patent Number	Abstract
US	2023-03-07	US 11,598,290 B2	A combustor of a liquid rocket engine includes a nozzle unit including a regenerative cooling channel, in which the nozzle unit includes a fuel manifold outer shell, a combustor inner shell, and a combustor outer shell having a downward channel inlet, and the combustor includes a fuel inlet connected to a nozzle neck of the nozzle unit, a fuel manifold formed between the fuel manifold outer shell and the combustor outer shell, and in which fuel introduced from the fuel inlet flows, a downward channel connected in communication with the fuel manifold through the downward channel inlet, and extending in a downward direction from an upper portion of the combustor, a diverting manifold provided at a distal end of the nozzle unit and connected in communication with the downward channel, and an upward channel connected in communication with the diverting manifold and extending in an upward direction of the combustor.

INJECTION DEVICE FOR LIQUID ROCKET

Country	Date of Patent	Patent Number	Abstract
US	2023-04-18	US 11,629,670 B2	An injection device for injecting an oxidizer for a liquid rocket includes a housing, a plate disposed inside the housing and having an injection hole to eject an oxidizer, a duct disposed above the plate to guide the oxidizer, and a manifold with one end connected to the injection hole of the plate and the other end connected to the duct, wherein the oxidizer may be distributed to the injection hole at an equal flow rate.

PROJECTILE LANDING APPARATUS FOR RETRIEVING PROJECTILE

Country	Date of Patent	Patent Number	Abstract
US	2023-07-04	US 11,691,759 B2	A projectile landing apparatus for retrieving a projectile includes a plurality of grippers disposed to be spaced apart. The plurality of grippers may include a support, a guide having one side connected to one end of the support, and a shock absorber having one end connected to the other end of the support and having the other end connected to the guide. The plurality of grippers may guide a projectile, buffer a load, and safely retrieve the projectile.

RADAR REFLECTOR SYSTEM FOR CALIBRATING SYNTHETIC APERTURE RADAR FOR ARTIFICIAL SATELLITE

Country	Date of Patent	Patent Number	Abstract
CN	2023-07-07	ZL201810929212.6	A technical problem is to provide a radar reflector system for calibrating a synthetic aperture radar for an artificial satellite, which is capable of being operated even for a short time and maintained and managed at a low cost. To this end, the radar reflector system for calibrating the synthetic aperture radar according to the present disclosure includes: a reflector which reflects electromagnetic waves; one or more flight modules which are provided on the reflector; and a control unit which controls the flight module.

APPARATUS AND METHOD FOR TRACKING AND MANAGING CODE CHANGE AMONG MULTIPLE PROJECTS

Country	Date of Patent	Patent Number	Abstract
EU (DE,FR,IT,ES)	2023-07-19	3483725	Provided is a method and apparatus for tracking and managing a code change between multiple projects. The apparatus includes a code management unit for generating function flow graphs by analyzing a structural and functional flow and annotated annotation from the project code input to a code management unit, comparing the generated function flow graphs for respective projects, and tracking changes based on information recorded in annotation formed by annotating the difference and changes deduced via comparison and generating a change tracking result, a change management unit for providing information on requirement and an ID by the request for a change of additional information as annotated annotation, receiving the change tracking result from the code management unit, and managing the change tracking result, and a display element for receiving the change tracking result from the code management unit and displaying the change tracking result on a monitor.

DRONE CAPABLE OF VARYING PROPELLER ARRANGEMENT SHAPE

Country	Date of Patent	Patent Number	Abstract
PCT(DE,FR,IT)	2023-07-25	3345831	Disclosed is a drone having a deployment device, which is configured such that the same can fly both in a folded mode and in a deployed mode, thereby being able to vary the propeller arrangement shape. A platform 300 is arranged in the middle of the drone body 400, a deployment device 200 is arranged on the radial outer side of the platform 300, a fixed support table 230 extends outwardly from the radial outer surface of the platform 300 by a predetermined length, a rotating support table 210 is coupled to an outer free end of the fixed support table 230, and the rotating support table 210 is rotatably coupled to/supported on the outer free end of the fixed support table 230 by a hinge device 220 or a motor 250. Multiple propellers 100 are mounted on the radial outer ends of the rotating support table 210, respectively, a landing structure 600 is integrally coupled to the lower portion of the body 400, and a holder 500 is integrally mounted on the inner lower surface of the landing structure 600. The drone according to the present invention differentially adjusts the angle of deployment of the propellers that operate normally in the deployed mode and thus maintains the posture balance, thereby being able to secure flight stability.

AC-DC CONVERTER CIRCUIT SYSTEM AND METHOD OF DESIGNING AC-DC CONVERTER CIRCUIT SYSTEM

Country	Date of Patent	Patent Number	Abstract
US	2023-08-29	US 11,742,773 B2	An alternating current (AC)-to-direct current (DC) (AC-DC) converter circuit system, and a method of designing the AC-DC converter circuit system. The AC-DC converter circuit system includes an AC-DC converter configured to receive an AC grid input from an electric power source and convert the AC grid input into DC battery power. The AC-DC converter may include a primary transformer including a plurality of field-effect transistors (FETs), and a secondary transformer configured to allow the DC battery power to be output from a grid that is allowed to have a positive value by the primary transformer.

LANDING APPARATUS FOR A REUSABLE LAUNCH VEHICLE

Country	Date of Patent	Patent Number	Abstract
EU	2023-11-01	4140898	A landing apparatus for a reusable launch vehicle is provided, including a landing leg pivotably mounted at one end to the reusable launch vehicle, for example, to a propellant tank part, and mounted at the other end to the propellant tank part by a detaching means such as a pyro bolt for example, a cover mounted to an outside of the landing leg along a longitudinal direction of the landing leg, and a leg landing plate mounted to a distal end of the landing leg and relatively pivotable with respect to the landing leg by its own weight when the other end of the landing leg is separated from the propellant tank part.

METHOD AND COMPUTER PROGRAM FOR CONTROLLING TILT ANGLE OF MAIN ROTOR ON BASIS OF PITCH ATTITUDE CONTROL SIGNAL LOW-SPEED FLIGHT STATE, AND VERTICAL TAKE-OFF AND LANDING AIRCRAFT

Country	Date of Patent	Patent Number	Abstract
PCT(US)	2023-11-07	US 11,809,203 B2	Provided is a vertical take-off/landing aircraft controlling a tilt angle of a main rotor, based on a vertical posture control signal during low-speed flight, wherein, when an aircraft steering signal including a vertical posture control signal for changing the pitch posture angle of the vertical take-off/landing aircraft by a first pitch posture angle is obtained, a flight controller determines a tilt angle of the main rotor with reference to the first pitch posture angle and generates a tilt angle control signal for the main rotor based on the determined tilt angle.

METHOD AND SYSTEM FOR TRANSMITTING MULTIPLE DATA

Country	Date of Patent	Patent Number	Abstract
US	2023-11-07	US 11,811,795 B2	Provided are a method and a system for transmitting multiple data, in which the method includes receiving a plurality of transmission files for transmission from a transmission device of the first network to a reception device of the second network, and temporarily storing the received files, generating flexible packets by dividing each of the plurality of transmission files by a flexible packet length determined according to size of the files, in which a transmission file in a size smaller than the flexible packet length among the plurality of transmission files is generated as one flexible packet without being divided, loading the flexible packets into a plurality of flexible frames based on a corresponding transmission file priority according to a maximum data transmission size, and transmitting the plurality of flexible frames to the second network.

METHOD OF MANUFACTURING ORIFICE

Country	Date of Patent	Patent Number	Abstract
US	2023-11-14	US 11,815,050 B2	A method of manufacturing an orifice is provided to make the orifice capable of spraying a very small amount of fluid in an ultra-high pressure and very low temperature environments. The method also makes it possible to provide the orifice with reduced volume and mass. More specifically, the method effectively realizes a desired hydraulic performance through a simple manufacturing method in which a part of a capillary pipe is pressed to form a channel region having a cross section close to a rectangular shape.

INTEGRATED DC/DC AND AC/DC CONVERTER SYSTEM

Country	Date of Patent	Patent Number	Abstract
US	2023-11-21	US 11,824,435 B2	Provided is an integrated DC/DC and AC/DC converter system including a main relay selectively connected to any one of an AC power supply unit and a DC power supply unit and a controller connecting the main relay to the AC power supply unit or the DC power supply unit. Electrical energy based on the AC power output from the AC power supply and electrical energy based on DC power output from the DC power supply unit may be selectively provided to a load.

FILTERING DEVICE AND METHOD FOR PROTECTING PHOTOSENSOR

Country	Date of Patent	Patent Number	Abstract
PCT(DE,FR)	2023-11-29	3372965	Provided is a satellite comprising a filtering unit for preventing damage to a photosensor by controlling the transmissivity of light inputted into the photosensor. The satellite can comprise: a photosensor for acquiring data associated with the satellite by using the light transmitted to the satellite; a communication unit for receiving, from a control center of the satellite, a first command signal for controlling the intensity of the light; and a filtering unit for controlling the transmissivity of the light according to the first command signal so as to prevent damage to the photosensor.

LANDING APPARATUS FOR A REUSABLE LAUNCH VEHICLE

Country	Date of Patent	Patent Number	Abstract
US	2023-12-19	US 11,845,574 B2	A landing apparatus for a reusable launch vehicle is provided, including a landing leg pivotably mounted at one end to the reusable launch vehicle, for example, to a propellant tank part, and mounted at the other end to the propellant tank part by a detaching means such as a pyro bolt for example, a cover mounted to an outside of the landing leg along a longitudinal direction of the landing leg, and a leg landing plate mounted to a distal end of the landing leg and relatively pivotable with respect to the landing leg by its own weight when the other end of the landing leg is separated from the propellant tank part.

METHOD OF MANUFACTURING A TURBINE BLISK THROUGH HOT ISOSTATIC PRESSING USING A METAL CORE

Country	Date of Patent	Patent Number	Abstract
PCT(FR,DE)	2023-12-20	3085472	Disclosed is a method for manufacturing precision parts through hot isostatic pressing using a metal core manufactured through metal rapid prototyping to manufacture a turbine blisk for driving a turbo pump of a liquid rocket. The method includes: manufacturing a metal core that has an internal vacant space having the same shape as the precision parts, using rapid prototyping; putting the metal core in a housing; filling an inside of the housing with heat resistant steel powder and creating a vacuum state in the housing; treating the housing under high temperature and pressure to produce heat resistant steel; removing the housing and a portion of the heat resistant steel to expose a portion of the metal core; performing etching to remove the exposed metal core; and removing only a portion of the heat resistant steel through mechanical machining, wherein the remaining portion corresponds to the shape of the precision part.

INTEGRATED HYBRID POWER APPARATUS

Country	Date of Patent	Patent Number	Abstract
EU (DE, GB, IT, CZ)	2023-12-20	3832087	An integrated hybrid power apparatus provided in a flying body includes a generator including a stator and a rotor, at least one engine disposed adjacent to the generator and including a cylinder, and a cooler configured to cool the generator and the engine and perform water-cooling that allows a coolant to circulate in the generator and the engine.

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