National Aeronautics and Space Administration

NASA'S

LOW EARTH ORBIT MICROGRAVITY STRATEGY

Leading the next generation of human presence in low Earth orbit to advance microgravity science, technology, and exploration.

December 2024

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Contents

Foreword

In our pursuit of the stars, the low Earth orbit microgravity environment has always been a place of extraordinary opportunity – where science is advanced, technology is tested, partnerships are forged, and humanity stretches the boundaries of what is possible. As we look ahead, the continued use of this vital environment is essential to our future exploration endeavors. Low Earth orbit is not just a steppingstone to the Moon and Mars; it is a unique environment that has fueled progress in ways we could only imagine when one of humanity's greatest achievements – the International Space Station – first became operational.

NASA's Low Earth Orbit Microgravity Strategy outlines our commitment to ensuring that the U.S. remains the leader in space. With a rich history in human spaceflight, we've made transformative discoveries that have expanded the very boundaries of what we understand about space. But this is only the beginning. As we transition from a government-owned platform to a more commercial, partnership-driven future, we are creating an ecosystem that will allow both government and private entities to thrive.

This strategy is the product of extensive collaboration across many sectors: NASA's dedicated workforce, government partners, industry, international space agencies, and academic institutions. The invaluable wisdom, insight, and innovation shared by these partners has helped refine and strengthen our path forward, and we are grateful to all who contributed their expertise and perspective to create this robust, forward-looking framework.

The goals and objectives in this strategy have affirmed that a continuous human presence in low Earth orbit is a fundamental requirement for advancing space science and technology, fostering innovation, and maintaining the momentum essential for the viability of our space industry and international space partnerships. For over 24 years, the continuous crewed presence aboard the International Space Station has driven research at an accelerated pace, demonstrated what it takes to live and work in space, and fostered a launch industry that has made low Earth orbit more accessible. Maintaining this unbroken presence will enable us to reduce risk for sending humans to Mars, fuel collaboration with our international partners, preserve the transportation model, and enhance operational skills. Moreover, the goals and objectives will lay the foundation for activities that will leverage low Earth orbit as a testing ground for critical technologies that are essential to future deep space exploration, including to the Moon, Mars, and beyond.

The future of space is bright, and NASA is uniquely positioned to guide the way. Our work is part of something much bigger than ourselves – something that will inspire, innovate, and leave a lasting legacy for generations to come.

These goals and objectives are a call to action for all of us – NASA, the private sector, international partners, and every individual who believes in the power of space. We have always been bold in our ambitions, and now, more than ever, we must work together to create a future where humanity thrives in space, where we keep a continuous presence in low Earth orbit, and where the next generation of explorers, scientists, and engineers can reach for the stars.

James Free
NASA Associate Administrator

NASA's Low Earth Orbit Microgravity Strategy builds upon the agency's extensive experience in space and drives forward its future scientific and exploration goals.

Historically, NASA's human spaceflight programs – from Mercury and Gemini to Apollo and the Space Shuttle – have provided the foundation for understanding how humans can live and work in space. The International Space Station, now in its third decade of operations, has been a crucial platform for long-duration microgravity research, generating insights and technological advancements that benefit life on Earth. As the space station approaches its planned end of operational service in 2030, NASA will transition to a new model of low Earth orbit operations and continue to leverage the unique research and technology development opportunities presented by the microgravity environment.

The Low Earth Orbit Microgravity Strategy will shape the agency's future in this evolving landscape. The goals and objectives in the strategy call for maintaining and expanding upon the scientific research capabilities established aboard the International Space Station, to explore and conduct experiments that can only be accomplished in low Earth orbit and microgravity. Additionally, the strategy supports broader U.S. goals of advancing national strength and international leadership in space by furthering science and technology development essential for future deep space exploration, strengthening the U.S. industrial base, and championing broad international participation in low Earth orbit. It also emphasizes the importance of inspiring the world by continuing to engage the public and future workforce through visible and impactful missions. NASA's mission, and therefore the goals and objectives for the low Earth orbit microgravity environment, also align with long-standing U.S. civil space policy, including the NASA Transition Authorization Act of 2017, the U.S. National Space Policy of December 2020, and the U.S. Space Priorities Framework of December 2021. By fostering commercial partnerships and international collaborations, NASA aims to sustain U.S. leadership in the low Earth orbit microgravity environment and ensure the scientific and operational advancements made there continue to benefit all humanity, while supporting the development of commercial orbital platforms.

A key conclusion derived from the development of the agency's Low Earth Orbit Microgravity Strategy is the concept of "continuous heartbeat." With the planned deorbit of the International Space Station in 2030, it is clear through assessing the goals and objectives, as well as engaging with international, industry, and academia stakeholders, that NASA's primary need is long-duration flights of six months to a year to mitigate risks for future trips to Mars. Flights of 30 days to six months will have limited value, as well. Additionally, a diversity of providers is critical to assure regular, routine access to and use of low Earth orbit, as well as a competitive industrial base and robust supply chain. With the added motivation to maintain leadership in space, "continuous heartbeat" in the era of commercial low Earth orbit destinations is logically required. The consultation process with international, industry, government, and academic partners was essential to arrive at this conclusion.

Therefore, while transitioning from the International Space Station to future commercial space stations, NASA will maintain a consistent and continuous presence in low Earth orbit. This unbroken rhythm of human activity will allow NASA to reduce risk for sending humans to Mars, preserve critical operational skills, maintain a steady transportation cadence, continue advancing science, and sustain engagement with commercial and international partners.

The methodology for the Low Earth Orbit Microgravity Strategy is guided by several inter-related principles:

Articulate a Clear Vision

- Effectively communicate what NASA will achieve in the low Earth orbit microgravity environment.

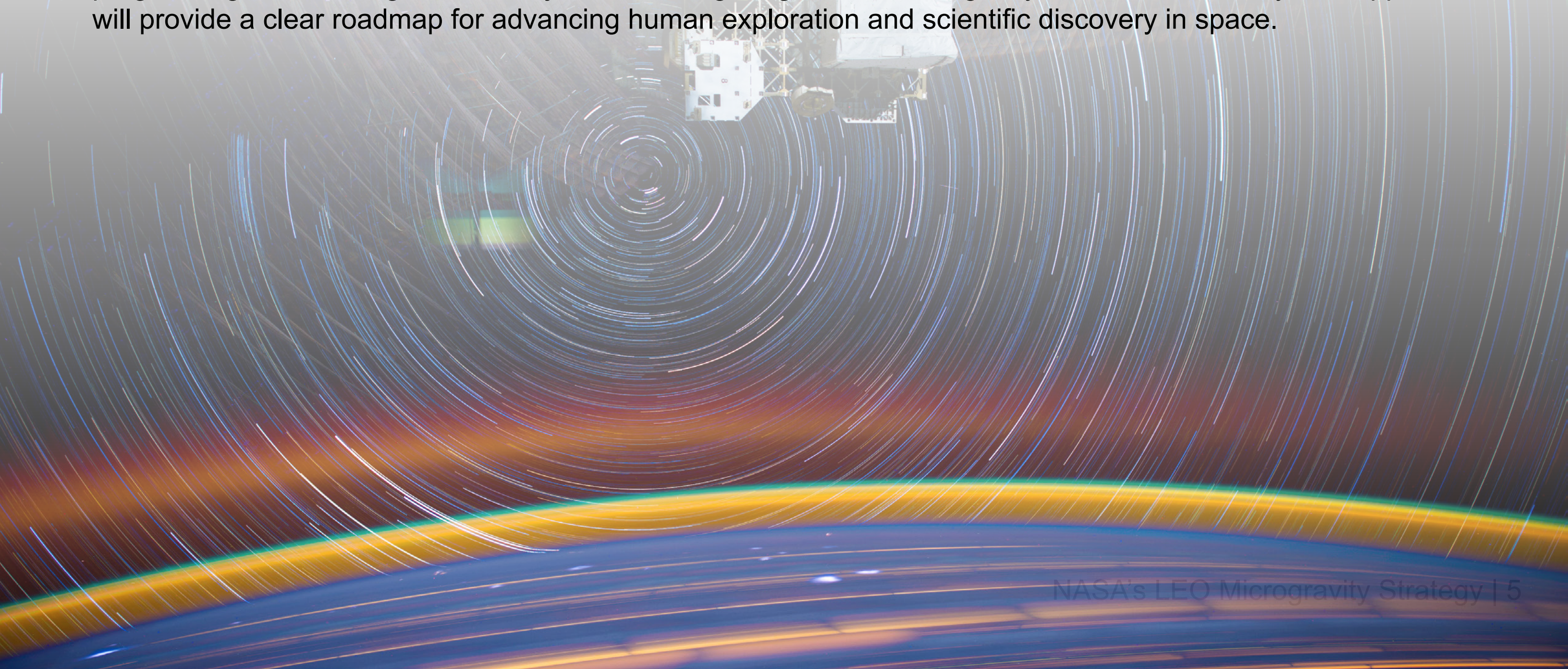
An Objectives-Based Approach

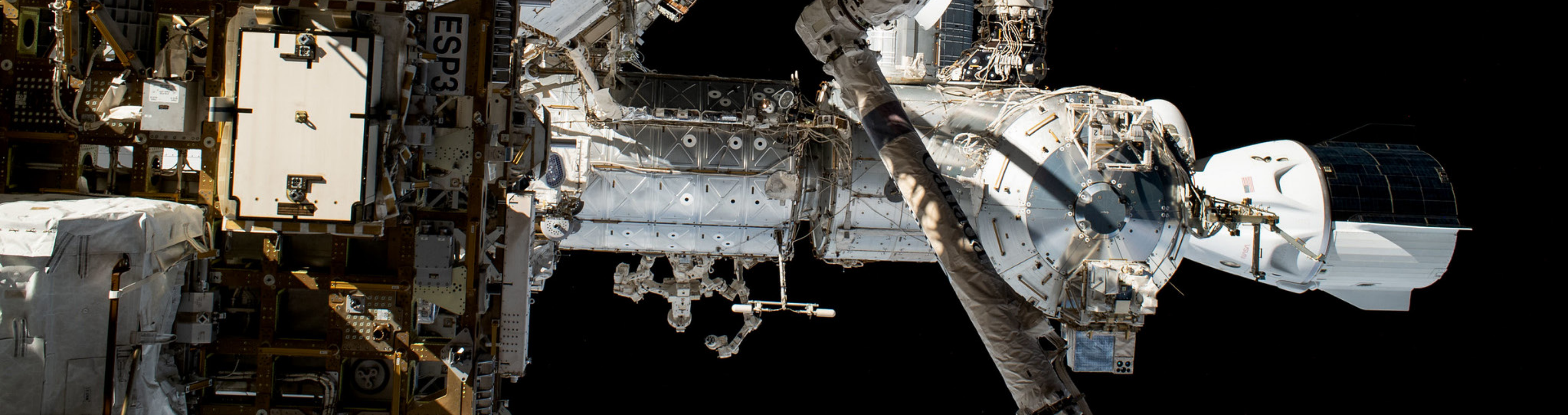
- Develop specific goals and outcomes as the primary guide for decision-making.

Architect from the Right, Execute from the Left

- Determine characteristics, needs, functions, and use cases based on clear goals and objectives.
- Develop and integrate elements systematically in line with the established work plan.

While NASA continues to maximize the scientific and technological returns from the International Space Station through its operational end of life, the Low Earth Orbit Microgravity Strategy ensures the agency has a robust framework to guide future microgravity activities. NASA will continue to leverage the unique microgravity environment in low Earth orbit for research and technology development – supporting missions close to Earth and those essential for deep space missions, including the upcoming Moon and Mars endeavors. The goals and objectives will be further broken down to determine the characteristics and needs, and functions and uses cases, which will inform detailed program plans and requirements, including those needed to support the development and utilization of commercial low Earth orbit destinations. NASA will also routinely assess progress against these goals and objectives through regular internal agency reviews. Ultimately, this approach will provide a clear roadmap for advancing human exploration and scientific discovery in space.





COMMERCIAL LOW EARTH ORBIT INFRASTRUCTURE

Transportation and Habitation

Goal	Strategically invest in U.S. private sector low Earth orbit capabilities to support NASA's activities and the U.S. space industrial base, while maximizing cost efficiency for NASA.
THI-1	Partner with the commercial sector to develop, deliver, and operate safe and reliable low Earth orbit destinations and services that are technically and financially viable over the long term and support NASA as one of many customers.
THI-2	Assure U.S. Government access to low Earth orbit through an operations tempo that sustains commercially owned and operated cargo and crew transportation capabilities.
THI-3	Promote interoperability of systems to streamline the transition between the International Space Station and commercial low Earth orbit destinations, decrease risk, and facilitate transportation and user flexibility.
THI-4	Inform the development of policy and regulatory frameworks that facilitate the use of safe and reliable commercial destinations in low Earth orbit.

Rationale:
NASA envisions being one of many customers for transportation and operations in low Earth orbit, purchasing services from commercial providers to meet the agency's needs. To enable this future in a cost-effective manner, NASA recognizes it must strategically invest in the development of safe and reliable destinations in low Earth orbit that support NASA activities, including scientific advancement, technology development and testing, human research, and crew accommodation, while also encouraging the broad investment in and use of commercial services that support the agency's activities in low Earth orbit.

COMMERCIAL LOW EARTH ORBIT INFRASTRUCTURE

National Research and Development

Goal	Support the whole of U.S. Government research and development in low Earth orbit to provide benefits to humanity.
RD-1	Facilitate U.S. Government microgravity research and development to effectively achieve national scientific, technological, educational, and commercial objectives.
RD-2	Promote the development and maturation of high-value products that benefit from production in a microgravity environment through manufacturing or processing demonstrations in low Earth orbit.

Rationale:
Through the International Space Station, NASA has demonstrated that microgravity research is critical to advancing both knowledge of ourselves and our planet. Today, the space station is used to study complex human health problems on Earth, observe the planet's changing climate, and facilitate the growth of research and development for commercial purposes. As we approach the transition from the space station to commercial platforms in low Earth orbit, NASA must enable the government's use of these platforms for further research and development across a spectrum of national objectives that strengthens economies and enhances the quality of life here on Earth for all people.

Operations

Goal	Leverage low Earth orbit operations to develop and maintain microgravity skills to support NASA's human exploration missions.
OPS-1	Create opportunities aboard commercial low Earth orbit destinations for U.S. Government astronauts to develop skills and maintain proficiency operating in microgravity.
OPS-2	Develop and maintain U.S. Government and industry ground-based workforce skills and proficiency in designing systems, preparing science and technology for use in microgravity and executing successful human exploration missions.
OPS-3	Organize joint missions in low Earth orbit with international partners to advance science, demonstrate technology, and develop joint operational experience in preparation for missions beyond low Earth orbit.

Rationale:
Living and working in the microgravity environment requires a wide range of unique skills. Through its flagship human spaceflight programs, including the International Space Station, NASA has developed this operational expertise across its astronaut corps and the agency's ground-based workforce. Low Earth orbit provides the proximity and ease of access to develop and refine these skills. While specific flight assignments for future Artemis and eventually Martian missions will not mandate previous flight experience in low Earth orbit, skills required to effectively operate in microgravity will be critical to designing and executing successful deep space exploration missions, including extended operations in microgravity. In addition, through the International Space Station program, NASA has developed institutional knowledge and expertise in jointly planning for and executing missions with international and commercial partners, which will be critical to planning and executing future joint missions beyond low Earth orbit.

SCIENCE

Biological Science

Goal	Leverage crewed platforms in low Earth orbit to advance our understanding of how model organisms, human micro-physiological systems, and plants respond to microgravity and other spaceflight conditions.
BS-1	Understand the effects of a range of exposures to microgravity and other spaceflight conditions on living systems including ecosystems of cells, tissues, and organisms.
BS-2	Identify alterations in biological mechanisms required for organisms to survive the transition and adapt to living in space and understand the changes required to re-acclimate to life on Earth.
BS-3	Investigate how genetic diversity and life history influence physiological adaptation to the space environment and how related research could directly inform the development of personalized medicine for space and on Earth.

Rationale:
NASA's biological sciences research both enables exploration and benefits life on Earth. Scientists use the unique conditions of space—including microgravity and increased radiation—to understand how life responds to harsh environments. Researchers study a range of living things—from DNA and cells to plants, animals, and microbes—to learn how they and space-based ecosystems form and change over time, as well as how they can be controlled to maintain balance. This research also has practical benefits on Earth, contributing to solutions for challenges like disease cures and food production.

SCIENCE

Physical Science

Goal	Leverage crewed platforms in low Earth orbit to probe phenomena hidden by gravity or terrestrial limitations to make groundbreaking advancements in fields such as materials science, fluid dynamics, and combustion.
PS-1	Understand the fundamental principles that organize the structure and functionality of materials to identify new states of matter, new physical phenomena, and emergent material properties.
PS-2	Investigate the fundamental laws that govern thermophysical properties, reaction kinetics, and material solubility under microgravity and other spaceflight conditions.
PS-3	Advance understanding of the chemical and physical properties and phenomena that govern the behavior of fluids and combustion under microgravity and other spaceflight conditions.
PS-4	Seek new discoveries in physics, including particle physics, general relativity, and quantum mechanics, that can only be discovered by experiments carried out in space, which will contribute to "new physics," understanding fundamental many-body quantum physics, and predictions of phase transformations in matter.

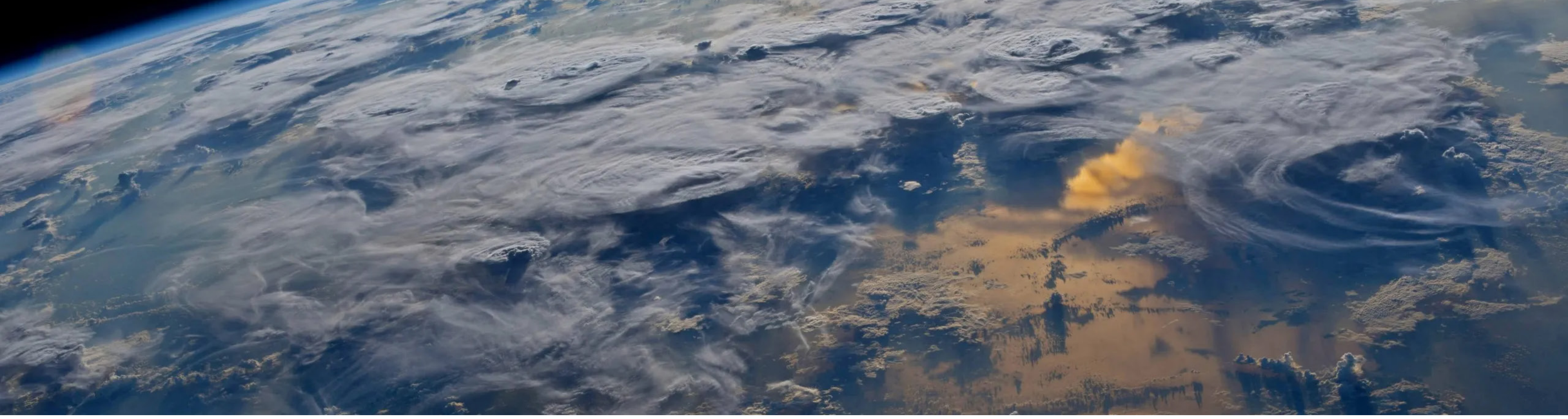
Rationale:
Outstanding questions in physics and the physical sciences remain. What are dark matter and dark energy? How can the standard model of particle physics be unified with general relativity? Important questions about the physical world, including quantum phenomena, can be answered only in the space environment, leveraging unique conditions such as microgravity. Effects of Earth's gravity hide key interactions in many experiments, and access to the space environment enables not just elegant but otherwise impossible research that opens up new insights. Physical sciences also concern the search for precise understanding of what happens to physical systems and processes in the space environment and how to use Earth-based and off-Earth materials effectively in space. Such knowledge of how to design, process, and use the solid, liquid, and gaseous materials that define the built environment of space travel and habitation is critical for sustaining long-term space exploration.

SCIENCE

Rapid Low Earth Orbit Science

Goal	Dramatically increase the pace of research in low Earth orbit through onboard analysis capabilities, in-situ measurements, sample and experimental preparation, and by having crew iterate research in real-time.
RLS-1	Develop new capabilities that provide on-orbit analysis, in-situ measurements, and sample and experiment preparation to allow for on-orbit iterative science to be conducted by trained crew.

Rationale:
The future of research requires new capabilities to accelerate the pace and rate at which science can be accomplished in low Earth orbit. It is essential to develop and employ new capabilities that enable on-orbit analysis, in-situ measurements, and sample and experiment preparation necessary to conduct science in real-time. Having trained crew iterate science experiments in real-time maximizes the science conducted in low Earth orbit and accelerates the pace at which NASA and its partners make discoveries and develop products for use on Earth and in space.

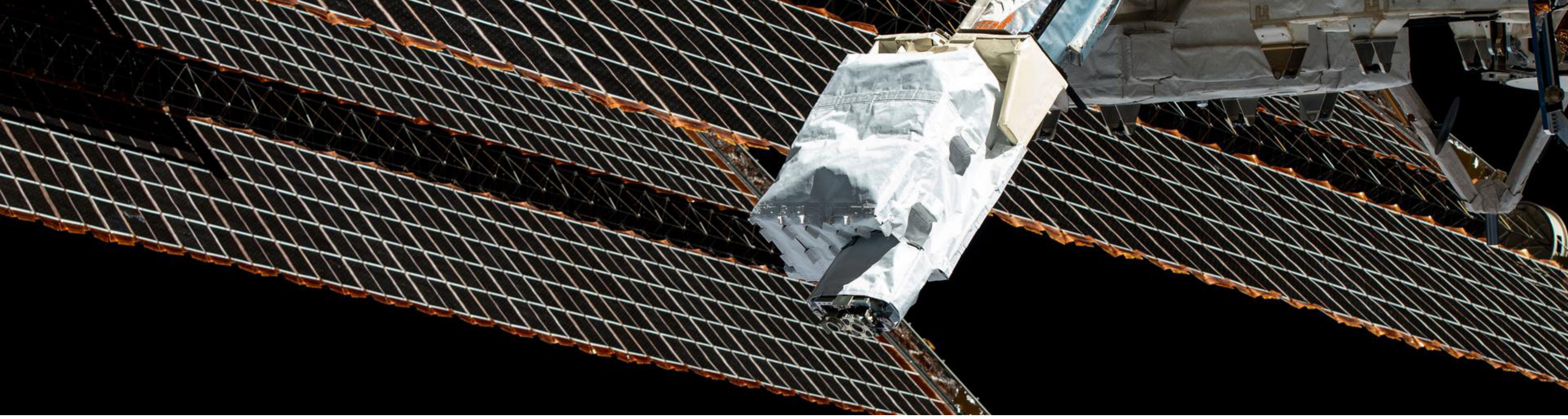


SCIENCE

Space and Earth Science

Goal	Leverage opportunities provided by crewed platforms in low Earth orbit to advance scientific understanding and observational capabilities for both space and Earth science.
SES-1	Conduct cost effective science and technology projects to demonstrate innovative space and Earth science observation techniques using crewed platforms.
SES-2	Employ crew capabilities, such as conducting Earth observations or payload deployment and repair, to enhance and supplement space and Earth science where advantageous and practical.

Rationale:
Whether observing Earth below, the universe above, or the local space environment, measurements from low Earth orbit are essential for advancing NASA's space and Earth science disciplines. The use of crewed platforms for space and Earth science results from a cost-benefit trade against other alternatives, including NASA-developed robotic missions and commercial data buys. Human presence allows for flexible operations and simplified development and deployment of high-impact demonstration projects, and the ability to repair, replace, and reposition payloads, if needed, allowing for enhanced science with lower experimental risk. Persistent crewed platforms can significantly benefit long-term space and Earth science, including reduced cost and steady flow of vital data. Crew-led observations from space also offer insights into environmental phenomena, providing real-time, qualitative observations that complement satellite data, improving our ability to monitor and respond to events like hurricanes, wildfires, and droughts.



RESEARCH AND TECHNOLOGY DEVELOPMENT FOR EXPLORATION

Exploration Technology

Goal	Leverage the unique environment of low Earth orbit to advance technologies that enable future human exploration on and around the Moon and Mars.
ET-1	Advance robotic and autonomous systems toward the independent achievement of diverse tasks.
ET-2	Demonstrate the performance of materials through exposure to the space environment to inform materials selections for future missions.
ET-3	Advance manufacturing and non-destructive evaluation techniques in the space environment to increase Earth-independence.
ET-4	Advance techniques for in-space assembly of structures towards autonomous assembly to enable increasingly complex mission concepts.
ET-5	Advance in-space performance of exploration environmental control and life support systems to enable multi-year exploration missions.
ET-6	Advance crew habitation, health, and performance technologies and systems to enable multi-year exploration missions.

Rationale:
Establishing a sustained human presence on and around the Moon and Mars, and ultimately, throughout the solar system, requires advanced technologies and capabilities. Technology advancements are necessary to enable increasingly challenging exploration missions and will need testing in relevant environments to support eventual flight operations. For many advancements, low Earth orbit provides a relevant, more accessible environment to progressively demonstrate, test, and validate critical exploration-enabling technologies that cannot be optimally tested on Earth or in deep space.

RESEARCH AND TECHNOLOGY DEVELOPMENT FOR EXPLORATION

Human Health and Performance in Exploration Analog Environments

Goal	Advance understanding of how to sustain human health and performance using relevant exploration analog environments in low Earth orbit to reduce risks and inform Moon, Mars, and deep space missions.
AR-1	Evaluate the effects of short- and long-duration exposure to microgravity and other spaceflight conditions on human health and performance.
AR-2	Evaluate and validate the efficacy of progressively Earth-independent health and performance countermeasures, systems, and crew operations, with environments and durations representative of exploration missions.
AR-3	Demonstrate and evaluate the integration of crew and exploration systems in the space environment for understanding the effects on human health and performance.

Rationale:
As human exploration extends beyond low Earth orbit, NASA must progressively demonstrate the ability to safely and effectively live and work in the lunar and Martian environments for extended durations. While some studies simulating certain conditions of exploration can be conducted on Earth, platforms in low Earth orbit provide more accessible space-based opportunities to perform intermediate, integrated applied research on crew health and performance, countermeasures, systems, and operations and to expand available data on a diverse population prior to testing or implementation in the lunar or Martian vicinity.

RESEARCH AND TECHNOLOGY DEVELOPMENT FOR EXPLORATION

Using Low Earth Orbit to Prepare for Deep Space Exploration

Goal	Validate crewed mission operations in low Earth orbit as part of a timely and effective methodology to test the agency's evolutionary approach to living and working in environments relevant to Moon and Mars exploration.
EO-1	Evaluate the effects of extended mission durations on crew and systems performance, reduce mission risk, and shorten the timeframe for readiness validation prior to an exploration campaign.
EO-2	Simulate interactions between Earth-based mission support, crew members in space, a Martian surface team, and remote surface systems, considering communication delays, autonomy levels, and time required for return to Earth in a mission abort scenario.
EO-3	Evaluate, understand, and mitigate the impacts on crew health and performance of an extended-duration deep space mission and transition to gravity for surface operations by conducting mission operations that simulate key parameters.

Rationale:
Low Earth orbit provides an opportunity to progressively work through operational aspects of Moon and Mars exploration missions that are best simulated with crew in space, including their ability to effectively function in a gravity environment immediately following extended time in microgravity. Crewed low Earth orbit platforms can provide opportunities for simulation of exploration operations and interactions between personnel on Earth and flight crew in a relevant environment. In the context of exploration operations in preparation for Moon and Mars missions, NASA would be responsible for conducting simulations and evaluations.

International Cooperation

Goal	Champion broad international participation in low Earth orbit by a diverse set of providers and users (government and non-government) to foster innovation, achieve NASA science and exploration goals, and maintain a strong, U.S.-led international presence in low Earth orbit.
IC-1	Work with international partners, industry, and academia to define pathways to partnership in low Earth orbit and ensure these pathways are adaptable as low Earth orbit activities evolve over time.
IC-2	Cultivate mutually beneficial government-to-government international partnerships with long-standing and new partners that enhance the effectiveness of NASA programs and advance U.S. national interests.
IC-3	Drive the creation of robust low Earth orbit capabilities by encouraging international governments, industry, and research organizations to engage with U.S. industry.
IC-4	Support the harmonization of legal and regulatory frameworks around the world to promote safe, responsible, and sustainable collaboration in low Earth orbit.

Rationale:
NASA's history of operations on the International Space Station exemplifies the agency's commitment to international cooperation in low Earth orbit. NASA's aim is to continue that tradition of cooperation by enabling paradigms for partnerships that will expand the global base of users. As participation in low Earth orbit expands, the international community will also benefit from a safe, sustainable, and peaceful environment harmonized global legal and regulatory regimes. By expanding opportunities for cooperation, enabling pathways for that cooperation, continuing to partner with foreign counterparts, and supporting a harmonized global legal and regulatory environment, NASA will ensure that low Earth orbit remains a frequent, accessible, and safe destination for science and exploration in the years to come.

Workforce Development and STEM Engagement

Goal	Engage, develop, and retain the diverse U.S. workforce needed to conduct future NASA missions by leveraging authentic connections to human space operations in low Earth orbit.
WSE-1	Develop a diverse U.S. workforce optimized for future science and space exploration by leveraging the knowledge, skills, and experience of the existing workforce supporting low Earth orbit operations.
WSE-2	Provide opportunities for secondary and post-secondary students to propose and develop experiments to conduct research and technology development in microgravity.
WSE-3	Build a pipeline of early career talent through career exploration and internship opportunities focused on human space flight.
WSE-4	Inspire, engage, and contribute to K-12 students' Science, Technology, Engineering, and Math (STEM) education through programming that provides connections to humans living and working in space.
WSE-5	Incorporate STEM engagement programming in onboard operations on a routine and recurring basis.
WSE-6	Leverage ground support and payload team personnel in STEM engagement programming.

Rationale:
Future space exploration, in and beyond low Earth orbit, will require a diverse, inclusive, and skilled workforce (both U.S. Government and industry). Necessary areas of expertise will include a broad array of STEM fields, with space manufacturing, maintenance, and operations, as well as in-space scientific research and technology development being particularly critical. To ensure a steady pipeline of workers today and in the future, NASA and its partners must engage students from the earliest grades through high school, trade school, undergraduate, and graduate study, involving them in authentic learning experiences and evidence-based programs designed to spark and maintain interest in STEM and space exploration and grow requisite skills. Likewise, it is critical to engage and retain the existing microgravity workforce to avoid losing expertise and creating a gap in workforce availability as we envision our future in low Earth orbit. The proximity of low Earth orbit provides routine access to the microgravity environment, enabling continuous opportunities to engage the next generation of explorers and develop and retain the workforce needed to meet NASA's future needs.

Public Engagement

Goal	Highlight agency-led efforts in low Earth orbit to educate and inform the general public to the widest practicable extent, focusing upon the many benefits humanity gains through science and technology development aboard crewed, orbiting research platforms.
CPE-1	Engage and inspire NASA's many audiences and future generations of explorers through ongoing, real-time space operations.
CPE-2	Increase public and stakeholder awareness and understanding regarding NASA and its partners' activities in low Earth orbit, efforts to open access to space, and support for future deep space exploration.
CPE-3	Collaborate with industry and international partners on communications efforts and leverage partner capabilities to best engage new and underserved audiences.

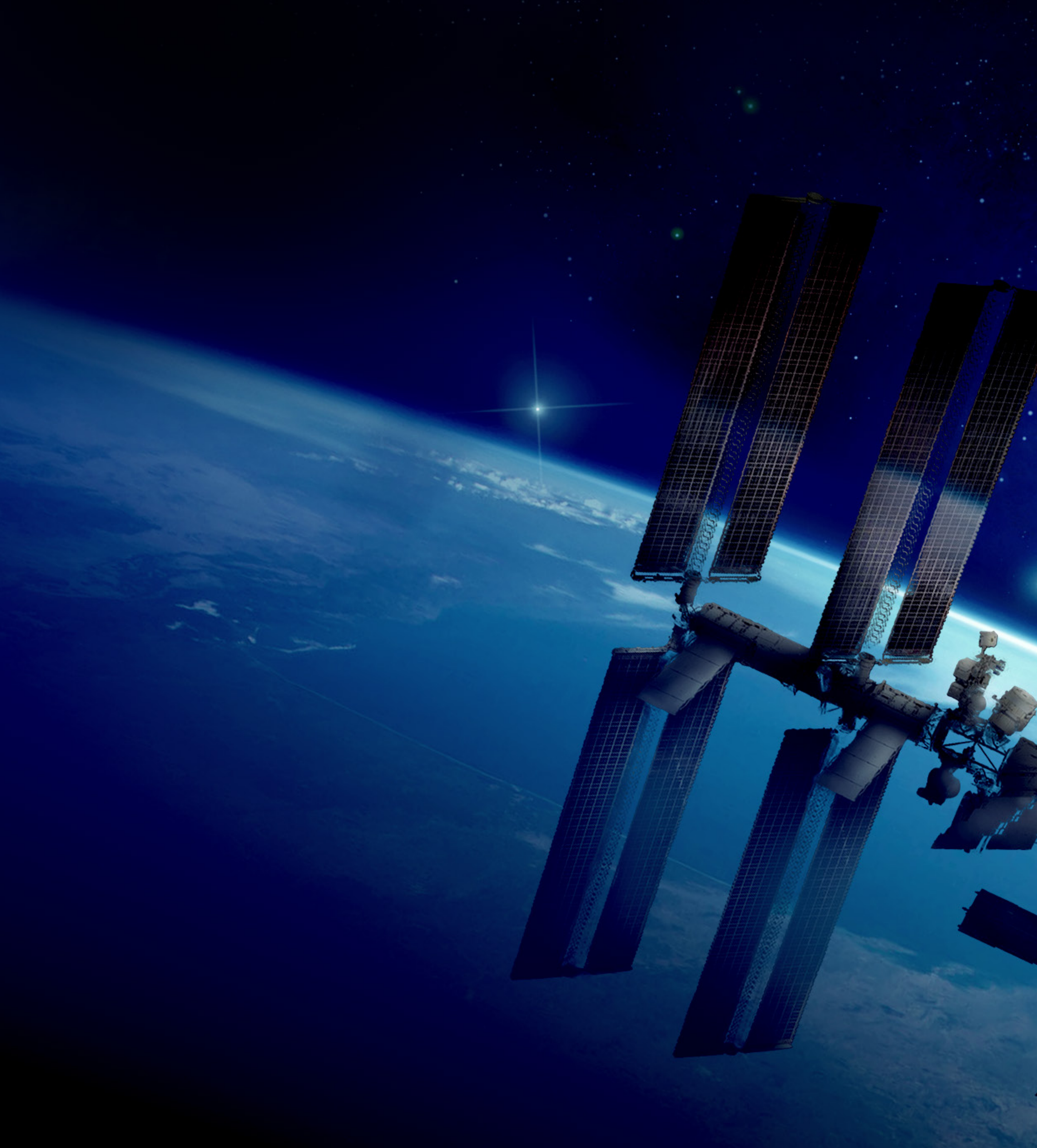
Rationale:
NASA has a responsibility to share its research, technological developments, and scientific achievements to the widest possible and appropriate extent to benefit and educate the public. NASA's operations in low Earth orbit provide a unique opportunity to inform the agency's diverse audiences and inspire the next generation of explorers. Through agency-enabled operations, future commercial destinations, and other activities, NASA will educate and engage its many stakeholders regarding the human operations, science, and technology development efforts in low Earth orbit and the many benefits returned to Earth.

Glossary

Architecture	A set of functional capabilities, their translation into elements, their interrelations, and operations. The architecture enables the implementation of various mission scenarios that achieve a set of given goals and objectives.
Autonomous Systems & Robotics	A group of capabilities which are accomplished with the use of software and hardware devices that can assist the crew and operate during uncrewed periods, either autonomously and/or via remote operator control (tele-robotics).
Commercial	Private sector enterprises that bear a substantial portion of the investment risk and responsibility and operate in accordance with typical market-based incentives for controlling cost and optimizing return on investment.
Demonstrate	Deploy an initial capability to enable system maturation in alignment with exploration architecture objectives.
Develop	Design, build, and deploy a system, ready to be operated by the user, to fully meet architectural objectives.
Earth Science	The study of the Earth's physical properties, processes, and history. It encompasses fields such as geology, meteorology, oceanography, and environmental science to understand the structure, composition, and dynamics of Earth's systems, including the atmosphere, oceans, and crust.
Evaluate	Assessing crew, technologies, systems, and operations for safe and effective performance to meet exploration architecture objectives.
Extended Duration	Time intervals approaching cumulative cruise, orbit, and return cruise times anticipated for exploration missions to Mars.
Ground-based Workforce	Includes space operations ground personnel, including flight control, mission planning, crew training, and engineering support; microgravity research and technology development scientists and engineers; and associated skilled-technical workforce.
Live	The ability to conduct activities beyond tasks on a schedule. Engage in hobbies, maintain contact with friends and family, and maintain healthy work-life balance.
Long Duration	Time intervals long enough to demonstrate desired performance, with specific interval defined by individual application.
Mission	A major activity required to accomplish an agency goal or to effectively pursue a scientific, technological, or engineering opportunity directly related to an agency goal. Mission needs are independent of any particular system or technological solution.
Partner with	NASA provides some support in the form of funding, expertise, hardware and services to industry partners for the design, development, and demonstration of space capabilities and services, leading to NASA becoming one of many customers.
Routine	Recurring subject operations performed as part of a regular procedure rather than for a unique reason.
Short Duration	Minimum time interval required for scientific analysis, with specific time interval defined by individual research application.

Glossary, continued

Space Science	The study of outer space, focusing on celestial bodies, cosmic phenomena, and the universe's origins and structure. It includes fields of study like astronomy, astrophysics, heliophysics, planetary science, and cosmology to explore the nature of the universe, the potential for life beyond Earth, and the processes shaping planets and other cosmic bodies.
Sustainable	The ability to safely, peacefully, and responsibly conduct in-space activities indefinitely to meet the needs of the present generations while preserving the outer space environment for future exploration activities and limiting harm to terrestrial life.
Unique Environment	Gravitational and radiation in the low Earth orbit environment.
Validate	Confirming that a system satisfies its intended use in a relevant environment; this should answer the question: did we build the right system?



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