# NASA's Vision for a Low Earth Orbit Economy

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# Why is NASA Interested in Developing a LEO Economy?



- National Aeronautics and Space Act
  - "Commercial Use of Space.— Congress declares that the general welfare of the United States requires that the Administration seek and encourage, to the maximum extent possible, the fullest commercial use of space." – 51 U.S.C 20102(c)

#### National Space Policy (2010)

 "A robust and competitive commercial space sector is vital to continued progress in space. The U.S. is committed to encouraging and facilitating the growth of a U.S. commercial space sector that supports U.S. needs, is globally competitive, and advances U.S. leadership in the generation of new markets and innovation-driven entrepreneurship."

# Why is NASA Interested in Developing a LEO Economy?



- NASA Transition Authorization Act of 2017, P.L. 115-10
  - "It is the sense of Congress that an orderly transition for United States human space flight activities in low-Earth orbit from the current regime, that relies heavily on NASA sponsorship, to a regime where NASA is one of many customers of a low-Earth orbit commercial human space flight enterprise may be necessary."

Title III Section 303(b)(1)

- 2018 NASA Strategic Plan
  - "Lay the Foundation for America to Maintain a Constant Human **Presence in Low Earth Orbit** Enabled by a Commercial Market: NASA is using our resources to extend human presence in the solar system and to foster an emerging and robust commercial space market. The continuous operation of a research and technology demonstration platform in space is critical to achieving NASA's and the Nation's goals in science, technology, and human space flight."
    - Strategic Objective 2.1

### Issues in Creating and Enabling a LEO Economy through ISS



- Need for routine and affordable access to space for humans and cargo.
- Clarity on what industry is and is not allowed to do aboard the ISS, what the price is for accomplishing those activities, and how they can go about doing commercial activities.
- Development of commercial destinations is unlikely without NASA playing a significant role due to the high uncertainty of markets, and the high cost of developing and operating such systems.
- The traditional grant-funded research demand for LEO services has proven over many years to require substantial subsidies from NASA, including fully-subsidized up mass, crew time, on-orbit accommodations, power, data, etc. It is highly unlikely that future NASA budgets will be sufficient to pay virtually all of the operating costs of a commercial platform.

#### Commercial Crew & Cargo Program for ISS Transportation





- 2005 NASA Authorization Act designated the U.S. segment of the ISS as a national laboratory and directed NASA to develop a plan to "increase the utilization of the ISS by other Federal entities and the private sector..."
- Around 2005, NASA also established the Commercial Crew/Cargo Project Office at JSC. The objectives of the Commercial Crew/Cargo Project were:
  - implement U.S. Space Exploration policy with an investment to stimulate commercial enterprises in space,
  - facilitate U.S. private industry demonstration of cargo and crew space transportation capabilities with the goal of achieving reliable, cost effective access to low-Earth orbit, and
  - create a market environment in which commercial space transportation services are available to Government and private sector customers.
- In 2006, NASA entered into agreements with private industry to develop and demonstrate the vehicles, systems, and operations needed to resupply, return cargo from, and transport crew to and from a human space facility, with the ISS providing the representative requirements for such a facility.



#### NASA's Vision for Economic Development in Low-Earth Orbit (LEO)

- NASA is one of many customers in a robust LEO economy
- Complete transition of ISS assets at end of life
- Conduct NASA's continued R&D on commercial destinations in LEO
- Purchase National Lab services from commercial provider(s)
- Partner with industry to develop and demonstrate new LEO destinations
- Initiate phased transition to acquire needed services from commercial destinations rather than ISS
- Seek out and pursue opportunities to stimulate demand
- Initiate transition of ISS assets while still satisfying international partner agreements
- Share the agency's comprehensive plan for global commercial LEO development
  - 1. Establish ISS commercial use and pricing policy
  - 2. Enable private astronaut missions to ISS
  - 3. Initiate the process for commercial development of LEO destinations
  - 4. Seek out and pursue opportunities to stimulate demand
  - 5. Quantify NASA's long-term needs for activities in LEO

DESTINATIONS

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LONG-TERM

**MID-TERM** 

### NASA Interim Directive on Use of ISS for Commercial and Marketing Activities



#### 5.0 AUTHORIZED COMMERCIAL AND MARKETING ACTIVITIES

	Ongoing activities allowed today	Category A		Category B
	ISS National Lab Research & Technology Development NASA Research and Technology Development	Section 5.1 Commercial Activities with ties to microgravity, NASA's mission, or sustaining a low-Earth orbit economy	Section 5.1 Marketing Activities with ties to microgravity, NASA's mission, or sustaining a low-Earth orbit economy	All Other Activities with no ties to microgravity, NASA's mission, or sustaining a low-Earth orbit economy
NASA Astronaut Gov't Civil Servant	NASA Research and Development     ISS National Lab Research and Development     Station sustaining tasks	Section 6.3.1 • May provide support for activities on a reimbursable basis	Section 6.3.1 May provide support if - Consistent with Ethics requirements - Behind the scenos - Reimbursable	Section 6.3.2 Not Authorized
Non-Civil Servants (Private Astronaut Missions)	May support via partnership or contract	Section 6.2.1 • May conduct activities if consistent with ISS operational restrictions and ISS Resources are available	Section 6.2.1 • May conduct marketing activities if consistent with ISS operational restrictions and ISS Resources are available	Section 6.2.1 • May conduct activities in non- USG modules of ISS as agreed-to with owner

#### New Commercial and Marketing Activities

The Commercial and Marketing Activities addressed in this policy specifically include:

- Manufacturing, production, transportation, or marketing of commercial resources and goods, including products intended for commercial sale on Earth;
- Inclusion of Private Astronauts on USG or commercial missions to the ISS and associated on-orbit activities, including Commercial and Marketing Activities;
- USG Astronauts conducting coordinated and scheduled activities in support of Commercial and Marketing Activities; and
- Provision of resources available for use on the ISS for Commercial and Marketing Activities and associated pricing.

### NASA Interim Directive on Use of ISS for Commercial and Marketing Activities



Commercial and Marketing Activities conducted on the ISS and facilitated by NASA or using USG resources shall comply with all of the following:

- Shall comply with all U.S. laws and regulations;
- Shall not compromise the safety of NASA civil servant or contractor personnel, NASA facilities, ISS Crew Members, ISS Modules, or on-orbit vehicles;
- Shall not reflect unfavorably on NASA, any ISS Partner, or related entity;
- Shall be subject to the IGA, MOUs and implementing arrangements, and related obligations to the ISS Partners;
- Shall respect the intellectual property rights (including rights of publicity) of NASA, U.S. Entities, ISS Crew Members, ISS Partners, or any of their related entities;

- Shall only task USG Astronauts and other USG personnel with duties consistent with the Standards of Ethical Conduct for Employees of the Executive Branch, 5 C.F.R. Part 2635, and all other applicable USG ethics requirements;
- Shall be executed through an arrangement with a U.S. Entity or NASA;
- Shall adhere to the Code of Conduct for International Space Station Crew;
- Shall not imply or suggest NASA or USG endorsement for any Commercial Activity;
- Shall not use any image(s) of the NASA insignia or emblem, or other material(s) that could imply that the Commercial Activity is endorsed or supported by NASA;
- Shall not use any corporate name(s), logo(s), or trademark(s) depicted in marketing activities without permission

### **Commercial and Marketing Pricing Policy**



- NASA has reserved a set amount of resources intended to serve Commercial and Marketing Activities, as shown in Slide 11.
- The ISS resources identified in Slide 12 are:
  - Available for purchase
  - Shall be provided only on a noninterference basis; and
  - Subject to change if crew safety (including Private Astronauts), vehicle safety, and/or mission objectives are at risk.





	Resources	Reimbursable Value	Annual ISS Resources	Maximum Allowed per Company per Year
Available Immediately	Upmass (Passive Cargo)	\$3,000 per kg	175 kg	50 kg in a form factor of single CTBE*s
	Trash Disposal (Passive Cargo)	\$3,000 per kg	175 kg	50 kg
	Downmass (Passive Cargo)	\$6,000 per kg	125 kg	35 kg
	Conditioned Cargo (Round Trip)	\$13,500 per kg	Not available at this time	
	Powered Cargo (Round Trip)	\$18,000 per kg	Not available at this time	
	ISS Expedition Crew Member Time	\$17,500 per hr	90 hrs	25 hrs
Available for Private Astronaut Missions	Regenerative Life Support and Toilet	\$11,250 per crew per day	Available as needed	
	Crew Supplies (Food, air, crew provisions, supplies, medical kit, exercise equipment, etc.)	\$22,500 per crew per day	Available as needed	
	Stowage	\$105 per CTBE per day	Available as needed	
	Power	\$42 per kWh	Available as needed	
	Data Downlink	\$50 per GB	Available as needed	

\* Unit for size of bag used to transport cargo from visiting vehicles, such as SpaceX, Northrop Grumman, or H-II Transfer Vehicle (HTV), to the International Space Station. Dimensions are 19 in x 16.25 in x 9 in, (48.3 cm x 41.3 cm x 22.9 cm). Weight limit is 60 lbs (27.2 kg).

#### **Private Astronaut Missions**



National Aeronautics and Space Administration Johnson Space Center Human Exploration and Operations Mission Directorate 2101 NASA Parkway Houston, TX 77058

#### **RESEARCH OPPORTUNITIES FOR ISS UTILIZATION**

NASA Research Announcement: NNJ13ZBG001N

Soliciting Proposals for Exploration Technology Demonstration and National Lab Utilization Enhancements

Catalog of Federal Domestic Assistance (CFDA) Number: 43.007

ISSUED: November 14, 2012

UPDATED: August 16, 2019

PROPOSALS DUE STARTING November 30, 2012 THROUGH December 31, 2019

- NASA seeks proposals to enhance the unique capabilities of the ISS, and utilize the ISS to develop and/or operate systems or facilities that may lead to a sustainable demand for a human-rated LEO platform.
- These proposals should demonstrate an ability to provide a stimulus to the U.S. economy through development of a sustainable, scalable, and profitable non-NASA demand for LEO services.
- Focus Area 4 PA Missions to the ISS



## **Private Astronaut Missions**

- NASA defines a private astronaut mission as a commercial mission consisting of activities to be conducted on the ISS (or in a commercial segment attached to the ISS) by private astronauts, transported on a commercial launch vehicle dedicated to this private mission.
- These private missions must use U.S. transportation vehicles certified by NASA.

- Private Astronaut An ISS Crew Member who is not a US Government astronaut or an ISS International Partner astronaut.
- ISS Crew Member Any person approved for flight to the ISS beginning upon assignment to the crew for a specific government or commercial mission and ending upon completion of the post-flight activities related to their mission.



### **Private Astronaut Missions**



- NASA will identify up to 2 candidate PA mission opportunities per year based on currently available scheduling information.
- NASA holds the responsibility to manage the mission opportunities and integrated requirements for all U.S. On-orbit Segment partners, their researchers, and commercial entities.
- NASA is also responsible for integrating these requirements with the Russian and commercial vehicle provider constrains for vehicle traffic to the ISS.



# **Developing Commercial LEO Destinations**



National Aeronautics and Space Administration NASA Johnson Space Center Houston, TX 77058

Next Space Technologies for Exploration Partnerships -2 (NextSTEP-2)

Broad Agency Announcement NNH16ZCQ001K-CDISS

Appendix I: Commercial Destination Development in Low Earth Orbit using the International Space Station

> Originally Issued: June 21, 2019 NOIs Due: June 28, 2019, 5:00 PM Central Time Proposals Due: August 5, 2019, 5:00 PM Central Time



- The goal is to develop commercial markets in one or more habitable commercial elements attached to the space station. Successful ventures will leverage the capabilities of the ISS to stimulate demand and catalyze new markets, leading to a transition to a long-term, sustainable, commercial, human spaceflight enterprise in low-Earth orbit where NASA is one of many customers.
- NASA seeks commercial destinations that provide a diverse portfolio of products and services that meet both NASA and non-NASA needs, but do not rely heavily on continued NASA purchase of services in the long-term.

# **Developing Commercial LEO Destinations**



NASA

National Aeronautics and Space Administration NASA Johnson Space Center Houston, TX 77058

Next Space Technologies for Exploration Partnerships-2 (NextSTEP-2)

Broad Agency Announcement NNH16ZCQ001K-CDFF

Appendix K: Commercial Destination Development in Low Earth Orbit (LEO) Free Flyer

> Draft: October 3, 2019 NOIs Due: <mark>TBD,</mark> 2019, 4:00 PM Central Time Proposals Due: <mark>TBD</mark>, 2020, 4:00 PM Central Time



- NASA intends to purchase data deliverables and insight to support demonstration of the Free Flyer in low Earth orbit and demonstration of commercial capabilities.
- The primary objective of this Announcement is to form a public-private partnership for integration and spaceflight demonstration where the Contractor objectives to be accomplished are:
  - Successfully develop commercial markets through demonstration of products and services in LEO in habitable commercial destinations
  - Provide a plan to establish a long-term, sustainable, commercial, human spaceflight enterprise in LEO where NASA is one of many customers

### **Developing Commercial LEO Destinations**





Figure 8. NASA's framework for partnering with industry to develop commercial LEO destinations.

## **Opportunities to Stimulate Demand**



National Aeronautics and Space Administration Johnson Space Center Human Exploration and Operations Mission Directorate 2101 NASA Parkway Houston, TX 77058

#### RESEARCH OPPORTUNITIES FOR ISS UTILIZATION

#### NASA Research Announcement: NNJ13ZBG001N

#### Soliciting Proposals for Exploration Technology Demonstration and National Lab Utilization Enhancements

Catalog of Federal Domestic Assistance (CFDA) Number: 43.007

ISSUED: November 14, 2012

#### UPDATED: August 16, 2019

PROPOSALS DUE STARTING November 30, 2012 THROUGH December 31, 2019

- NASA seeks proposals for commercial concepts contributing to the development of sustainable, scalable, and profitable non-NASA demand for utilization of LEO capabilities. Specifically with a focus on in-space manufacturing and regenerative medicine/bioengineering.
- NASA seeks concepts that
  - will benefit from the scalability that commercial platform(s) can provide;
  - will have transportation needs that support the growing U.S. crew and cargo launch industry; and
  - will strengthen the LEO ecosystem that NASA seeks, as one of many customer(s) of the commercial platform(s).
- Focus Area 1 Demand Stimulation



### **Opportunities to Stimulate Demand**



Next Space Technologies for Exploration Partnerships -2 (NextSTEP-2)

Broad Agency Announcement NNH16ZCQ001K

Original Release: April 19, 2016 Amendment 1 Release: April 22, 2016 Amendment 2 Release: June 3, 2016 Amendment 3 Release: June 3, 2017 Amendment 4 Release: August 11, 2017 Amendment 5 Release: December 4, 2017 Amendment 6 Release: July 3, 2018 Amendment 7 Release: September 18, 2018 Amendment 8 Release: February 7, 2019 Amendment 8 Release: February 7, 2019 Amendment 10 Release: June 21, 2019 Amendment 10 Release: July 3, 2019 Effective through December 31, 2020

Refer To Appendices for Proposal Due Dates

Catalog of Federal Domestic Assistance (CFDA) Number: (43.003)

- NASA
- NASA is soliciting applied research proposals that could broadly foster the long-term growth of new and emerging markets for commercial activities on human-rated commercial destinations in LEO, by overcoming cost, technical, and other barriers. Specifically, NASA seeks proposals that focus on:
  - Technical approaches, such as improvements in technology, materials, processes, methods, and techniques, to reduce any aspect that drives the transportation costs to and from LEO destinations;
  - Technical approaches that can increase demand for existing and potential LEO commercial markets;
  - Technical approaches that would broaden the base of industry/academia/government researchers seeking to utilize LEO capabilities fostering long-term market growth; and
  - Technical approaches to broaden the pipeline of researchers through synergies with feeder capabilities (e.g., drop-towers, parabolic flights, sounding rockets, suborbital flights, etc.).

# **NASA's Long-Term Needs in LEO**



Future areas of NASA demand include:

- Crew Accommodation and Training
  - Minimum 2 NASA crew for 6 month stays
- Human Research
  - Ongoing LEO research focused on exploration mission analogs; private crew available as additional test subjects; ability to conduct long-duration (>one year) missions
- Physical and Biological Research
  - At current NASA research level of ~20 investigations per year
- Technology Demonstration
  - Ongoing test beds for NASA's life support, exercise equipment, medical equipment, plant growth facilities, quantum communications, in-space manufacturing, robotics, and autonomous systems
- Science
  - External sites occupied by NASA instruments
- National Laboratory: ~110 projects per year



NASA's White Paper: Forecasting Future NASA Demand in Low-Earth Orbit: Revision 2 – Quantifying Demand, June 7, 2019.

https://www.nasa.gov/sites/default/files/atoms/files/forecasting\_future\_nasa\_demand\_in\_lowearth\_orbit\_revision\_two\_-\_quantifying\_demand.pdf

# **NASA's Long-Term Needs in LEO**



For each area of future NASA demand, NASA has described:

- Intended demand quantification (the amount of the identified service that NASA intends to purchase)
- Facilities needed (the types of on-orbit facilities needed to support NASA activities)
- What NASA will provide (the unique capabilities or facilities that NASA does not anticipate purchasing and will provide; generally tied to exploration needs and risk reduction that may not have commercial application)
- Resources for NASA equipment (the "utilities" that are anticipated as needed to support desired operations)
- Services NASA will buy (the specific services NASA intends to purchase in support of desired operations)



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