

# EXPLORE



National Aeronautics and  
Space Administration



## LEO Commercialization Using ISS to Stimulate Demand



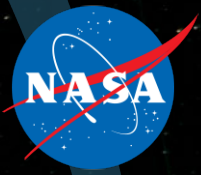
International Space Station Program  
Business & Economic Development Office  
NASA/JSC - Kevin Engelbert  
June 24, 2020



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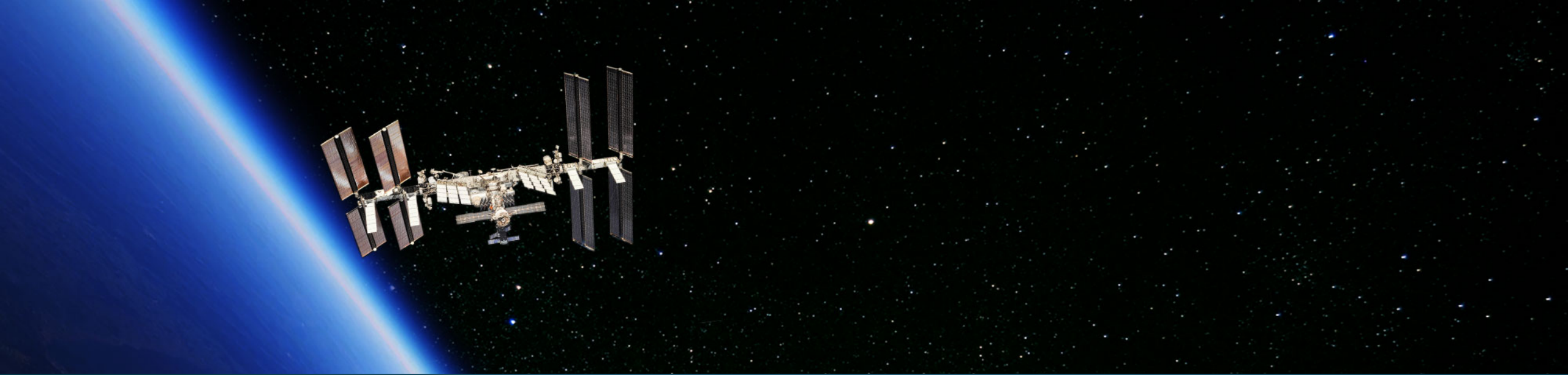


# Background: Future of Human Spaceflight in LEO

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.”

- P.L. 115-10, NASA Transition Authorization Act of 2017

1. A robust and competitive low-Earth orbit (LEO) economy is vital to U.S. national interests
2. NASA is committed to encouraging and facilitating the growth of the U.S. commercial sector
3. NASA has long-term needs for LEO services:
  - Crew training and proficiency as prep for deep space missions
  - Fundamental and applied research
  - Advanced system development and testing
4. The ISS can be an incubator for non-traditional capabilities and commercial business models
5. The ISS will be the last U.S. Government-led destination in LEO



# NASA Strategy for LEO Commercialization







# But first...what is LEO Commercialization?

Now

- Private industry using the ISS to demonstrate business models, technologies and services that have the “potential” to provide high-value return on government and private investment
- Commercial Service Providers marketing and operating their research facilities and services on ISS
- Government support as appropriate to bridge the “valley of death” to private investor confidence



Future

- Multiple privately owned and operated destinations and facilities in LEO scaled to provide products and services to sustain a growing market of public and private customers
- Low-cost access to space and an enabling regulatory environment
- Private investment and real revenues driving growth and value propositions
- NASA buying required services as one of many customers

# NASA Strategy

Agency Rollout at the NASDAQ Trading Center - June 7, 2019

LEO Commercialization website: <https://cms.nasa.gov/leo-economy/low-earth-orbit-economy>





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

LONG-TERM

- 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)

MID-TERM

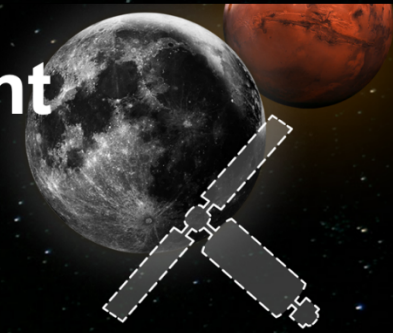
- Partner with industry to develop and demonstrate new commercial LEO destinations
- Initiate phased transition to acquire needed services from commercial destinations rather than ISS
- Seek out and pursue opportunities to stimulate sustainable demand for LEO products and services
- Initiate transition of ISS assets while still satisfying international partner agreements

NEAR-TERM

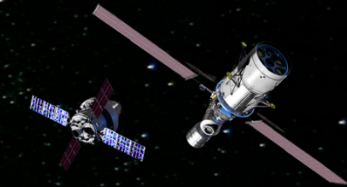
- Implement and adjust the agency's plan for commercial LEO development in concert with international partners
  1. Implement and update (as needed) ISS commercial use and pricing policy
  2. Accommodate initial private astronaut missions to ISS
  3. Award contracts for commercial development of LEO destinations
  4. Seek out and pursue opportunities to stimulate demand
  5. Quantify NASA's long-term needs for activities in LEO

**YOU ARE HERE**

Explore More at [www.nasa.gov/leo-economy](http://www.nasa.gov/leo-economy)



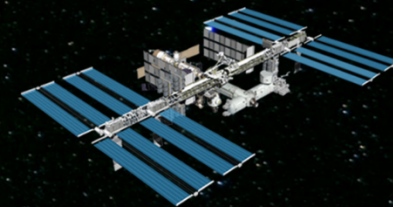
**FUTURE COMMERCIAL DESTINATIONS**



**ARTEMIS MISSIONS**



**COMMERCIAL PARTNER SPACECRAFT**



**INTERNATIONAL SPACE STATION**

Updated 1/27/20

# Part #1: ISS Commercial Use and Pricing Policy

NASA released a NASA Interim Directive (NID) for Use of ISS for Commercial and Marketing Activities

**Purpose:** to define NASA's policy for expanded commercial use of ISS consistent with congressional and administration policy direction

**Goal:** enable purely commercial activities in low-Earth orbit leading to sustainable demand for LEO, with NASA as one of many customers

**Approach:** NASA is initially making available 5% of its allocation of crew resources to stimulate the commercial market at discounted pricing

- NASA will continue to monitor the impact of published pricing on market development and will adjust as appropriate

**Initial awards:**

- Adidas: 'Boost in Space' midsole pellet tech demo in microgravity
- 3-5 more in various stages of implementation



# Part #2: Enable Private Astronaut Missions

NASA amended NASA Research Announcement (NRA) for ISS Utilization to include focus area 4

**Purpose:** to enable development of new markets, generate revenue for mission brokers, and support U.S. crew and cargo transportation providers

**Goal:** begin hosting non-traditional crew (tourists, sovereign astronauts) on the ISS starting in 2021

## **Approach:**

- Accommodate up to 2 commercial 'sortie' flights to ISS per year, up to 4 crew each, for 30 days or less
- All PAMs must use crew vehicles certified under NASA's commercial crew program (CCP)
- NASA is documenting processes and requirements to enable successful integration with ISS

## **Current Status:**

- NASA has signed Space Act Agreements and completed initial feasibility assessments with Axiom Space and Virgin Galactic to enable private astronaut missions, and is evaluating various proposals
- Initial mission could occur in Fall 2021

# Part #3: LEO Commercial Destination Solicitations

NASA developed solicitations for Public-Private Partnerships with US industry to enable development of privately owned and operated human spaceflight destinations in LEO, whether attached to ISS or free-flying

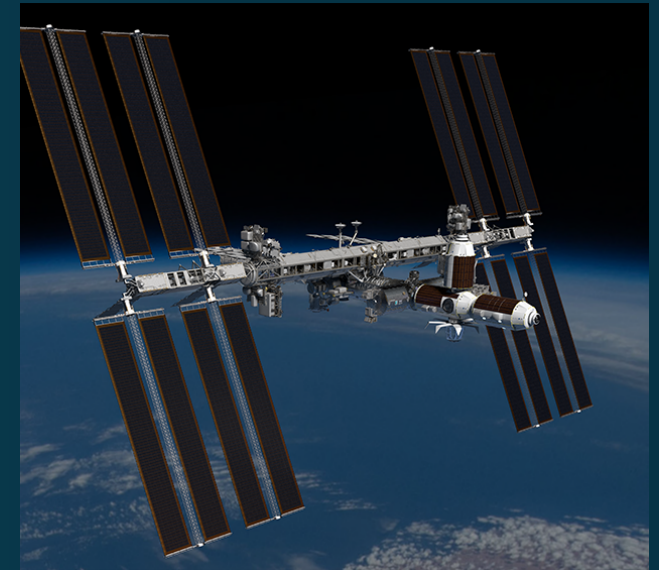
**Purpose:** Provide requested NASA expertise and resources during development, and enable on-orbit demonstrations of capabilities and business models while markets mature

**Goal:** an ISS attached commercial station at ISS, with first element launch by end of 2024. Enable multiple free-flyers as markets and funding permit

## Approach

- Conducted Industry Studies in 2018
- Released NextSTEP-2 Broad Agency Announcement Appendix I for use of ISS Node 2 forward port in 2019
- Released draft NextSTEP-2 BAA Appendix K for Free Flyer solicitation (final release on hold)

**Awards:** BAA Appendix I awarded to Axiom Space  
- First of 4 modules launching to ISS expected in late 2024





# Part #4: Stimulate Sustainable Demand for LEO

NASA amended NASA Research Announcement (NRA) for ISS Utilization to include new focus areas 1 & 3

**Purpose:** to enable use of ISS for projects leading to sustainable demand for non-NASA services in a future LEO economy

**Goal:** to provide needed support for commercial partners to demonstrate technology in microgravity and build investor and customer confidence. Enable use of the ISS for commercial and marketing activities.

## **Approach:**

- Focus Area #1 - Demand Stimulation: In-space manufacturing and regenerative medicine/bioengineering
- Focus Area #3 - Purchase of Resources for Commercial Purposes: access for companies whose objectives are not aligned with traditional research

**Awards:** see pages 15-16

# Part #5: NASA's Long-Term LEO Forecast

## **Purpose**

- Define NASA's long-term LEO requirements for commercial destination providers
- Report quantifying the NASA demand forecast for commercially-provided services

## **NASA services required**

- Crew accommodation and training
- Human research
- Physical and biological research
- Technology demonstrations

## **National Lab services anticipated**

- Traditional research for other Government Agencies, academia, commercial sector





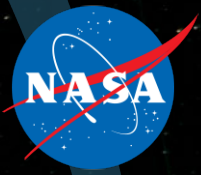
# Demand Stimulation Approach



# Stimulating Sustainable Demand

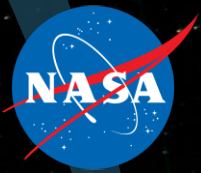
- Proposals received through the ISS Utilization NASA Research Announcement via NSPIRES
- NASA establishes appropriate agreements with selected U.S. companies to provide requested NASA expertise and resources to enable flight demonstrations on ISS; in some cases multiple iterations are required to achieve success
- Companies may obtain ISS National Lab sponsorship or purchase transportation and ISS resources (e.g. crew time)
- Companies must market their capabilities to public and private sector customers in order to close their business case.
  - NASA can be a customer, but not the only customer
- Several In Space Manufacturing projects were already underway
  - Manufacturing of Exotic Optical Fibers (3 separate projects)
  - 3D Tissue Bio-printing (e.g. heart cells)
  - Manufacturing of Industrial Crystals





# Recent Demand Stimulation Awards

- Universal Glass Optics Manufacturing Module – Apsidal
  - Objective: process various types of complex glasses from which fibers, magnetic fibers, super-continuum sources, capillary optics and adiabatic tapers can be drawn
- Thin Metal-Coated Optical Fiber Manufacturing – DSTAR
  - Objective: an external material processing platform on ISS with autonomous, high throughput manufacturing capability, including infrared optical fibers in medical & defense applications, and ultralight solar arrays for commercial and military space platforms
- Glass Alloy Manufacturing Machine – Made In Space
  - Objective: investigate how glass alloys form without the effects of gravity-induced flaws
- Semiconductor Chip Facility – Made In Space
  - Objective: develop an autonomous, high throughput manufacturing capability for production of high quality, lower cost semiconductor chips at a rapid rate



# Recent Demand Stimulation Awards (cont.)

- Production of Stem Cells for Personalized Medicine Applications – Space Tango/Cedars-Sinai
  - Objective: production of induced pluripotent stem cells (iPSC) for commercial personalized medicine applications, including human therapies
- Protein-based Retinal Implant Manufacturing – Space Tango/LambdaVision
  - Objective: produce protein-based artificial retinas in space that would be returned to Earth for surgical implant to restore sight for patients suffering from degenerative retinal diseases
- Regenerative Medicine Laboratory – Space Tango/UC San Diego
  - Objective: establish a new on-orbit biomedical sector for advancement of stem cell translational medicine, with a fully operational self-sustaining orbital laboratory anticipated by 2025

And an award through NextSTEP-2 BAA Appendix J:

- Integrated Action Plan for Addressing Barriers to Entry of LEO Market – Bryce
  - Objective: develop an action plan to address real and perceived barriers to growth of the low-Earth orbit economy and quantify impacts on estimates of future LEO demand





# What Does Success Look Like





# Commercial Transportation to ISS

National Aeronautics and  
Space Administration



## Cargo Resupply Services



SPACEX



**snc** SIERRA  
NEVADA  
CORPORATION  
Space Systems



**NORTHROP GRUMMAN**

### SpaceX Falcon-9 Development

COTS Award May 2006

1<sup>st</sup> F9 Launch Dec 2010

1<sup>st</sup> Comm'l Mission Sep 2013



### Falcon-9 Commercial

1<sup>st</sup> Stage Reusability

Starlink Constellation

Low rideshare pricing

Air Force EELV Awards

NASA enabling technology advancements that reduce cost  
U.S. private sector leading the world

## Crewed Demo – Ongoing`

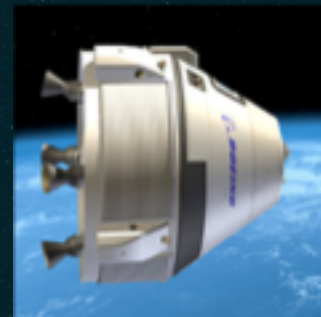
## Crewed Missions

## Crewed Demo – Spring 2021

SPACEX



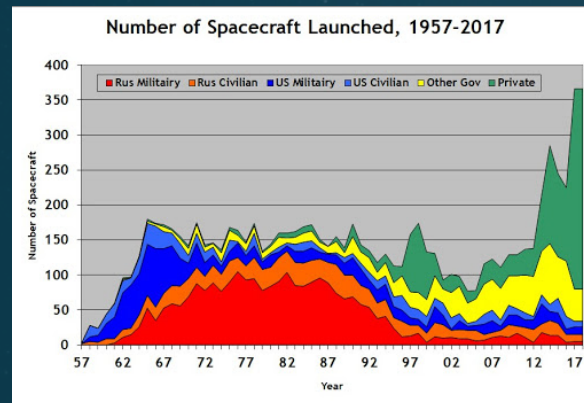
**BOEING**



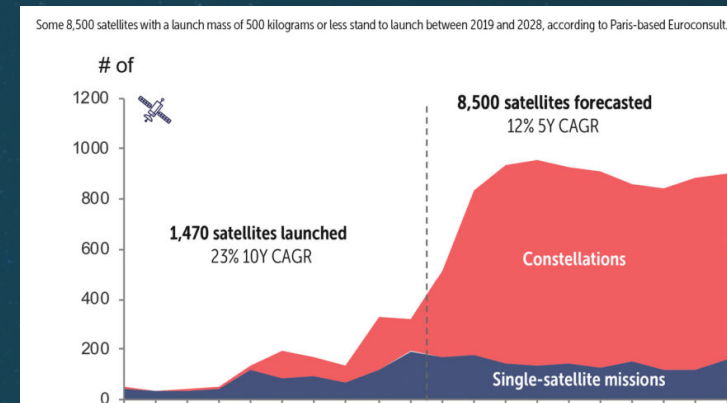


# Booming Small Satellite & Rocket Market

- NASA CubeSat Launch Initiative (CSLI) – successfully launched over 100 missions since 2012
- 1st commercial CubeSat deploy from ISS in 2012; over 200 deployed from ISS JEM Airlock
- University research and private sector driving CubeSat standardization (reduced cost, less risk)
- Significant number of new startups in the small and medium rocket market, U.S. leading the world



Source: <http://claudelafleur.qc.ca/Spacecrafts-index.html>



Source: Space News-

CubeSat  
Deploys  
from ISS



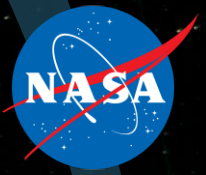
Small Satellite  
Business  
Case Proven



Increased  
LEO Small  
Sat Demand



Increased Launch  
Services Demand



# Signs of Success in Microgravity Services

- Commercial Service Provider Growth
  - Larger facilities: NanoRacks, Made In Space, Space Tango, and BioServe
  - More employees: NanoRacks and Made In Space approaching 100 employees
  - Investor interest: Made In Space announced strategic investment from Aero Equity Industrial Partners, joining together with Deep Space Systems and Adcole Space to form “Redwire”
  - More competition: multiple companies pursuing technology in exotic optical fiber, space biology, satellite deployment from ISS, and private astronaut missions
- New capabilities coming online
  - U.S. Crewed Vehicles: enables private astronaut missions starting in 2021
  - NanoRacks Bishop Airlock: U.S. alternative to JEM Airlock
  - ESA Bartolomeo Platform: U.S. division of Airbus marketing research accommodations
  - ISS Node 2 forward port award to Axiom enables a commercial destination as early as 2024



# Questions?

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# Backup



# Commercial Service Providers on the ISS

NanoRacks: Internal & External platforms; satellite deployers; Bishop Airlock



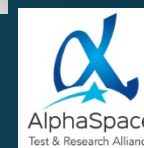
Teledyne Brown Engineering: External precision pointing platform



HNu nanoPoint: Microfluidics cell culture platform



Alpha Space: External materials exposure platform



BioServe: Space Biology platforms and services



Space Tango: TangoLab space biology platform



Craig Technologies: satellite deployer



Techshot: Bone densitometer, centrifuge facility



Made In Space: Additive Manufacturing Facility



STaARS: Space Biology Platform



Plus more!

# Internal Research capabilities on the ISS (owned and operated by Commercial Service Providers)

Made In Space  
3D Printer



Adv. Space Exp. Processor



BioFabrication Facility



Bone Densitometer



## NanoRacks

NanoLab



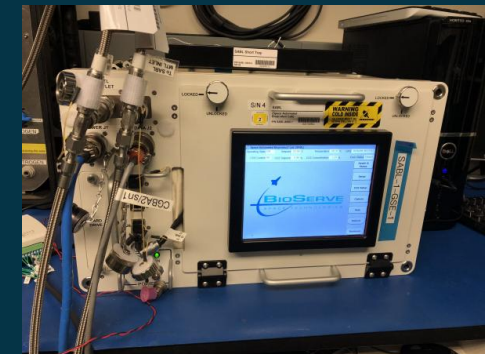
Frame-3



Space Tango  
TangoLab-1



BioServe  
SABL Incubator





## External Research capabilities on the ISS (owned and operated by Commercial Service Providers)

NanoRacks

Cubesat Deployer



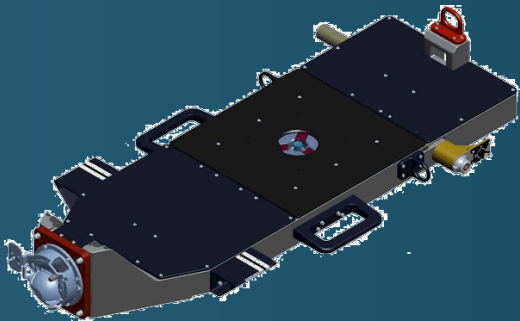
Kaber Microsatellite Deployer



External Platform



Craig Technologies  
Cyclops Small Sat Deployer



Alpha Space  
MISSE-FF



Teledyne Brown  
MUSES Earth Monitoring

