Vision: A World of New Possibilities

Working with our partners, NASA aims to enable a robust economy in LEO, where we are one of many participants.
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.”


Four goals from Oct 2018 NASA/Commerce/State report to the National Space Council: *Strategy for Human Spaceflight in LEO and Economic Growth in Space*

1. Achieve a continuous U.S. presence in LEO and to maintain a permanent American foothold there.
2. Create a regulatory environment in LEO that enables American commercial activities to thrive.
3. Conduct human spaceflight research in LEO that will advance the technology and systems required for long-duration spaceflight.
4. Expand and extend commercial opportunity through international partnerships and engagement.

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<table>
<thead>
<tr>
<th>Strategic Objectives</th>
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</thead>
<tbody>
<tr>
<td>1.1 Understand the Sun, Earth, Solar System and Universe</td>
</tr>
<tr>
<td>1.2 Understand Responses of Physical and Biological Systems to Spaceflight</td>
</tr>
<tr>
<td>2.1 Lay the Foundation for America to Maintain a Constant Human Presence in Low Earth Orbit</td>
</tr>
<tr>
<td>2.2 Conduct Exploration in Deep Space, Including to the Surface of the Moon</td>
</tr>
<tr>
<td>3.1 Develop and Transfer Revolutionary Technologies to Enable Exploration Capabilities for NASA and the Nation</td>
</tr>
<tr>
<td>3.2 Transfer Aviation Through Revolutionary Technology Research Development, and Transfer</td>
</tr>
<tr>
<td>3.3 Inspire and Engage the Public in Aeronautics, Space and Science</td>
</tr>
<tr>
<td>4.1 Engage in Partnership Strategies</td>
</tr>
<tr>
<td>4.2 Enable Space Access and Services</td>
</tr>
<tr>
<td>4.3 Assure Safety and Mission Success</td>
</tr>
<tr>
<td>4.4 Manage Human Capital</td>
</tr>
<tr>
<td>4.5 Ensure Enterprise Protection</td>
</tr>
<tr>
<td>4.6 Sustain Infrastructure Capabilities and Operations</td>
</tr>
</tbody>
</table>
NASA’s LEO Commercialization Strategy

NASA is revamping its approach to LEO commercialization as we learn from past years

• Creating a dedicated organization and management structure
• Expansion of Enabling Policies
• Better engagement with industry
• Reshaping CASIS
• More Business-focused decision process
• Early demonstrations of success
The International Space Station

The centerpiece of exploration and model for a new future in space

Continuous and ongoing cargo and crew operations aboard space station, along with commercial and international partnerships, allows human exploration to advance at a sustainable pace.
Pre-2005: A NASA LEO Monopoly

- Platform
  - NASA ISS
- Crew
  - NASA Astronauts
- Transportation
  - NASA Shuttle
- Service Providers
  - NASA Centers
Commercial Cargo

Space X C1
Launch
December 8, 2010

SpaceX C2+
Launch
May 22, 2012

Orbital ORB-D1
Launch
September 18, 2013

Orbital A-ONE
Launch
April 21, 2013

SpaceX Dragon Capture
May 25, 2012

Orbital Cygnus Capture
September 29, 2013
Commercial partnerships enable continuous and ongoing cargo and crew operations aboard the space station and advance human exploration at a sustainable pace.
In-Orbit Commercial Facilities on the International Space Station (ISS)
Commercial Hardware on ISS

- **Alpha Space**: MISSE-FF External materials exposure platform
- **Bigelow Aerospace**: Expandable module
- **BioServe**: Space biology platforms and services
- **Space Tango**: TangoLab space biology platforms
- **NanoRacks**: Internal and external platforms; satellite deployers; airlock
- **Sierra Nevada Corp**: Small mass measurement device
- **STaARS**: Space biology platform
- **Techshot**: Bone densitometer, MVP centrifuge facility
- **Teledyne Brown Engineering**: MUSES external precision pointing platform

**Made In Space**: Additive Manufacturing Facility (AMF)

**AMF is the first** permanent commercial manufacturing platform to operate in low-Earth orbit
Pre-2005: A NASA LEO Monopoly

- **Platforms**
  - NASA ISS plus Hosted Commercial Facilities
- **Crew**
  - NASA Astronauts plus Announced PAMs
- **Transportation**
  - International and Commercial
- **Service Providers**
  - NASA Centers plus Commercial Entities

- **NASA**
- **International**
- **Commercial**

- **Commercial Customers**
- **Other Research Customers**
- **ISS NL**
- **Other Gov't Agencies (NIH, NSF)**
## Interim Pricing Policy

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

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).
Axiom Space Selected for Appendix I (Port Solicitation)
Stimulating Sustainable Demand

NASA is providing seed money to enable selected companies to mature their concepts and stimulate demand to develop their future markets.

Projects announced on April 7, 2020:

- **Apsidal**: Universal glass optics manufacturing module
- **DSTAR Communications**: Thin metal-coated optical fiber manufacturing
- **Made in Space**: Glass alloy manufacturing machine
- **Made in Space**: Semiconductor chip facility
- **Space Tango and Cedars Sinai**: Production of stem cells for personalized medicine applications
- **Space Tango and LambdaVision**: Protein-based retinal implant manufacturing
- **Space Tango and UC San Diego/Sanford Consortium**: Regenerative medicine laboratory
- **Bryce Space and Technology**: Action plan for barriers to entry to the low-earth orbit market
Commercial LEO Development

COTS Competitions
COTS Funded SAAs
CRS Competitions
CRS Contracts

Commercial Crew Dev 1&2
Commercial Crew CCiCap
Commercial Crew CCtCap

ISS National Lab
ISS NL AO (unfunded)
ISS Commercial Facilities
ISS NL BAA (funded)
ISS NRA for ISS Utilization

LEO Commercial Development Studies
1) ISS Commercial Use & Pricing Policy
2) Private Astronaut Missions
3) Commercial Destination Development
4) Stimulate Demand
5) Define NASA’s Long-Term LEO Needs
Pre-2005: A NASA LEO Monopoly

NASA

International

Commercial

Earth Centric Manufacturers and Researchers

Space Centric Manufacturers and Researchers

LEO NL

Commercial LEO Bundlers

Platforms
NASA ISS plus Hosted Commercial Facilities

Crew
NASA Astronauts plus Announced PAMs

Transportation
International and Commercial

Service Providers
NASA Centers plus Commercial Entities

Walter Reed Medical Center (Techshot)

Other Gov’t Agencies (NIH, NSF)

NASA International Commercial LEO NL Space Centric Manufacturers and Researchers Researchers
NASA’s Future LEO Demand

- Human Research
- Technology Demonstrations
- Crew Accommodations & Training
- Science
- Physical & Biological Research
- National Lab Services
Components of a LEO Economy & A New Future in Space
NASA’s Vision for Economic Development in Low-Earth Orbit (LEO)

The Goal: NASA is one of many customers in a robust LEO economy
- NASA research and development is continued on commercial platforms
- National Lab services are purchased from commercial providers
- The world has increased access to the benefits of activities done in microgravity

NASA continues partnering with industry to further develop and demonstrate the success of commercial destinations in LEO

NASA implements the agency’s plan for commercial LEO development in concert with international partners

1. Implement and update 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

Explore More at www.nasa.gov/leo-economy