National Aeronautics and Space Administration

CBPSS Space Science Week Panel:

Commercial LEO Destination Plans and Research Opportunities

Vision for LEO Economy:
A World of New Possibilities

- NASA is one of many customers in a robust low-Earth orbit (LEO) economy
- Commercially-owned and operated transportation for cargo and crew
- Commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective
- Regular production, distribution, and trade of goods and services
- Ongoing research and science activities including a LEO National Lab
- Continuation of human spaceflight exploration objectives
- Sustained presence and U.S. leadership in LEO

COMMERCIAL CARGO & CREW TRANSPORTATION

Operational

Northrop Grumman

SpaceX

Final Dev

Sierra Space

Operational

SpaceX

Final Dev

Boeing

Concept Maturation

Sierra Space

Blue Origin

COMMERCIAL LEO DESTINATIONS

Axiom

Blue Origin, Sierra Space

Nanoracks, Lockheed Martin, Voyager Space

Northrop Grumman

More Elements of a Strong LEO Economy

Private Astronaut Missions & Space Tourism

Commercial Marketing, Advertisement & Entertainment Activities

Inspiration for Student STEM Activities

In-Space Manufacturing & Production

LEO National Lab

Technology Demonstrations

Human Research

COMMERCIAL LEO DEVELOPMENT PROGRAM ROAD MAP

Near Term | **Mid-Term** | **Far Term**

International Space Station (ISS) Operations

Commercial LEO Destinations (CLDs) Development

CLD Operations

Phase 1: Early Design Maturation

Phase 2: Certification & Services

Design and Development

LEO economy developed by enabling a supply side and actively maturing a sustainable demand side

Transition

Plan based on NASA readiness, maturation of destinations, and market demand

End Goal

Sustainable Commercial Operations with multiple customers

SUPPLY

Commercial Destinations on ISS (CDISS)

Commercial Destinations Free Flyer (CDFF)

DEMAND

- **Demand Stimulation** (In-Space Manufacturing, R&D to Applications)
- **ISS National Lab/CASIS** (Science, Applied R&D, Tech Dev, STEM)
- **Commercial Use of ISS** (Commercial and Marketing Activities)
- **Private Astronaut Missions** (Tourism)
- **Gov't LEO Requirements** (Human Research, Life & Physical Sciences)

Transition LEO Economy Activities from ISS to Commercial Destinations

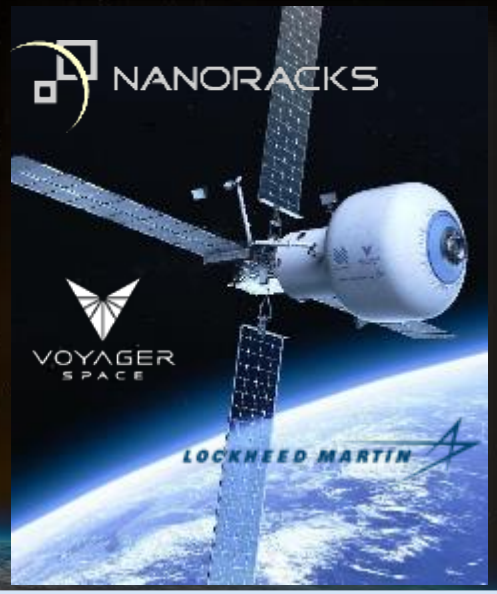
COMMERCIAL LOW-EARTH ORBIT DESTINATIONS

Hab PDR: 2021
Hab CDR: 2022
Transition to Free Flyer: 2028

- Axiom concept initially attaches Commercial Elements to ISS Node 2 Forward Port.
- Launch of first element is planned for 2024.
- Additional modules are added later, including a Power Thermal Module allowing the spacecraft to detach from ISS and operate as a free-flyer.

PDR: 2023 & CDR: 2024
Baseline Configuration: 2027
# of crew initially: 10

- Orbital Reef baseline provides for a permanent presence in space with 90% of ISS's volume, capacity for 10 astronauts, and multiple internal and external payloads.
- Point of departure orbital destination is at a 51.6 ° inclination and 500+ km altitude to optimize future transfer from ISS and match Earth-observation benefits.



PDR: 2023 & CDR: 2025
IOC: 2027
# of crew at IOC: 4

- Starlab is a large inflatable habitat and a metallic docking node, power and propulsion element, and external robotic arm.
- Four main operational departments: biology lab, plant habitation lab, physical science and materials research lab, and an open workbench.

PDR: 2025
IOC: 2029
# of crew at IOC: 4

- NG platform provides for a permanent presence of four crew approximately 30 days after launch of Element 1.
- Habitat Modules derived from Habitat and Logistics Outpost (HALO) and Cygnus structures and subsystems and are equipped as permanent crew habitat and cargo modules.