CLDP Status to NASA Advisory Council (NAC) HEO Committee

COMMERCIAL LEO DEVELOPMENT PROGRAM

Robyn Gatens

September 2024

Agenda

- **Phase 1 Status**
- **Private Astronaut Missions (PAM)**
- **Phase 2 Status**

Phase 1 Status

Phase 1 Status

- NASA CLD partners continue to make progress towards design of their future CLD concepts and business case development.
- CLDP continues supporting the CLD partner milestones, providing NASA expertise, and sharing NASA technology, processes, data, and lessons learned on numerous subjects. This ensures the data gathered while developing and operating the ISS is passed on to CLD partners.
- Private Astronaut Mission-3 was successfully completed providing valuable lessons learned to Axiom and NASA in how to operate in a commercial environment on future CLDs.
- NASA is preparing for CLD Phase 2 procurement for future CLD services.

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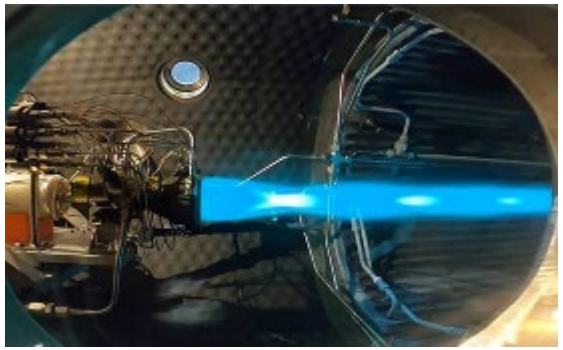
Latest Axiom Developments

Recent Accomplishments:

- HAB CDR work continues with Group 1 completed and Group 2 data package deliveries underway
- Completed and closed bilaterally approved Commercial Element Verification Requirements
- HAB 1 primary structure manufacturing continues at TASI
- Completed thruster hot fire testing at vacuum



Thruster Hot Fire Testing

Upcoming Milestones:

- Q4 2024 – Mission Concept Review for the AxStation Payload, Power, Thermal Module (PPTM)
- Q4 2024 – Docking Adapter Manufacturing Readiness Review
- Q4 2024 – Start of Phase II Safety Review Panels
- Q1 2025 – TASI proof pressure testing
- Q1 2025 – TASI primary structure delivery
- Q1 2025 – PPTM System Requirements Review
- Q1 2025 – HAB Critical Design Review completion

Hab 1 Endcone Welding Progress

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Latest Blue Origin Developments

Recent Accomplishments:

- Completed Payloads Interim Design Review and Sierra Space Life Module Full-Scale Burst Test at MSFC in June 2024
- Completed Destination Service Requirements and Standards Assessment and the Tug Mission Concept Review in August 2024
- Started Mockup construction in preparation for the Medium Fidelity Human-in-the Loop Tests planned later this year

Orbital Reef Mockup of Research Segment

Upcoming Milestones:

- September 2024 - Hardware Testing of Space Effects on Window Materials on MISSE
- October 2024 - ECLS Interim Design Review
- October 2024 - Primary Structures and Layout Assessment
- November 2024 - RPOD Interim Design Review
- November 2024 - Integrated Operations Review (Part 1)
- November 2024 - Windows Testing Characterization
- December 2024 - Water Tank and Bag Demonstration
- December 2024 - Medium Fidelity Human-in-the-Loop Test

Internal view of Orbital Reef Mockup of Research Segment

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Latest Starlab Developments

Recent Accomplishments:

- Starlab announced the addition of MDA Space of Canada and Mitsubishi of Japan to the Starlab Space Joint Venture
- Completed Launch Vehicle Mission Integration Review milestone in June, HITL Assessment – Design Increment in and Cygnus Upgrades PDR milestones in July, and Habitat Structural Test Article PDR in September

Upcoming Milestones:

- September 2024: System Integration Review
- September 2024: Integrated Operations Review

Starlab

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Latest Sierra Space Developments

Recent Accomplishments:

- Completed Project Management Review for CCSC-2 Q2 FY24
- Completed second full-scale burst test of inflatable structure in June 2024
- Made agreements with several commercial and international partners

Upcoming Milestones:

- Sept 2024: Pathfinder LEO Interim Design Review Q3 FY24
- Nov 2024: Project Management Review for CCSC-2

Sierra Space – The first Sierra Space LIFE® 285 article shown here reached 77psi before it burst, which well exceeds (+27%) NASA's recommended level of 60.8 psi.

Sierra Space second full-scale structural test, at NASA's Marshall Space Flight Center in Huntsville, Alabama. The results herald a giant leap towards building the world's first end-to-end business and technology platform in Low Earth Orbit.

Stay up to date on Sierra Space: sierraspace.com/news

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Latest Vast Developments

Recent Accomplishments:

- **Haven-1 development** continues at an accelerated pace with launch planned in the second half of 2025. Recent milestones:
  - Completed the Haven-1 preliminary design review (PDR)
  - Large window pressure test (CCSC-2 milestone)
  - Solar array deployment test (CCSC-2 milestone)
  - Fabrication of the Haven-1 primary structure pathfinder
- **NASA:** Completed Q2 NASA CCSC-2 Project Management Review and other CCSC-2 milestones mentioned above
- **Announcements:** (a) Haven-1 Lab, (b) Vast DC Office, (c) Vast & ESA MOU, (d) SpaceX Starlink laser connectivity deal for Haven-1 and potential future CLD station
- **Vast Team and Infrastructure** - Significant increase in staffing, facilities, and manufacturing capabilities at our Long Beach HQ location. Surpassed 550 employees (300 at beginning of 2024)

Upcoming Milestones:

- Haven-1 - Qualification primary structure pressure and load testing at our Mojave, CA facility
- Haven-1 - Flight primary structure manufacturing
- Ongoing development, manufacturing, and qualification of Haven-1 subsystems
- Haven Demo satellite integration and test campaign for launch in Q1 2025
- Air revitalization characterization test (CCSC-2 milestone)
- Oxygen pressurization demonstration (CCSC-2 milestone)

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Latest SpaceX Developments

Recent Accomplishments:

- Starship is progressing toward full reusability, having recently completed its 4th test flight (6/6/24) which demonstrated launch and intact reentry of both Starship and its Super Heavy booster
- Unveiled Raptor 3, the newest generation of the engine that powers Starship and Super Heavy. Raptor 3 is designed for rapid reuse, eliminating the need for engine heatshields while continuing to increase performance and manufacturability.

Upcoming Milestones:

- Flight 5 Starship and Super Heavy are ready to fly, pending regulatory approval. Additional booster catch testing and Flight 6 vehicle testing is planned while waiting for clearance to fly.
- Regular Project Management Review planned for CY 24
- Polaris Dawn private crewed Dragon mission to demonstrate first commercial EVA with new SpaceX suit design and first demonstration of Dragon-Starlink laser communications connectivity
- Fram2 private crewed Dragon mission to demonstrate first polar human space flight

SpaceX – SpaceX's proposed integrated LEO transportation architecture encompasses both near term Dragon and longer term Starship-based capabilities

[Left]: Starship Flight Test 4

Starship Flight Test 5

Starship Flight Test 5 Booster

Starship Flight Test 3

Suited Polaris Dawn Crew

First Raptor 3 Engine

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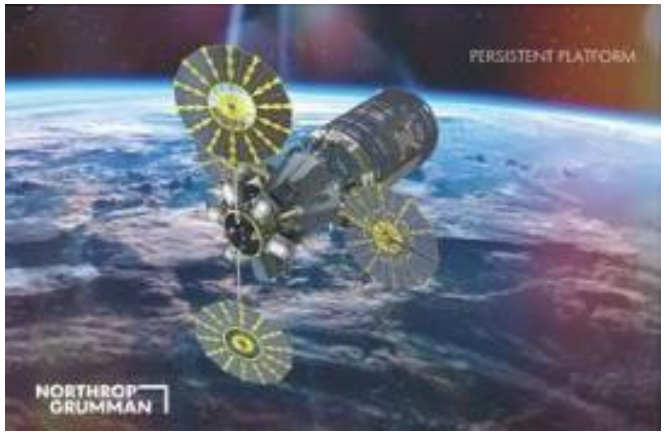
Latest Northrop and SAS Developments

Northrop Grumman:

- NG is evolving Cygnus to be the foundational platform to support the next generation of LEO ventures
- Continues to make progress on implementation of docking capability through Starlab partnership



Northrop Grumman – Uncrewed Persistent Platform that works with crewed CLDs

Special Aerospace Services (SAS):

- Announced a partnership with Godspeed Capital, the acquisition of Willbrook Solutions and Quintron Systems, and the groundbreaking of a new campus in Huntsville, Alabama
- Currently talking to several interested parties for the AMU
- Partner is currently testing telepresence on its air bearing table

Special Aerospace Services – An Autonomous Maneuvering Unit (AMU) for external CLD ops instead of EVAs. Later versions can support suited crew.

Latest ThinkOrbital Developments

ThinkOrbital:

- Progressing in development of ThinkToolkit autonomous in-space welding/cutting/x-ray inspection system
  - Testing product-ized version of toolkit robotic arm/end effector system in vacuum at Marshall Spaceflight Center in 2025
- Completed 1st test flight on Falcon 9 1st Stage in May 2024 of the first-ever autonomous in-space Electron-beam weld and return of samples for analysis being completed by NASA and ESA
- Vibration test completed and preparing 2nd test flight in Q4 2024 on SpaceX rideshare to demonstrate in-space welding, cutting and X-ray inspection.
- Won 3 US Space Force SBIRs, and developing relationships with Northrop Grumman, Sierra Space, Firefly Aerospace, Astroscale, and others.
- Targeting 3rd mission in late 2025 for ThinkToolkit demo—looking for a demo partner satellite to integrate end effector
- Working with DARPA for a potential in-space assembly demo in 2026

ThinkOrbital – First flight demo and welder close-up. ToolKit render (below)

Axiom-4 Mission Summary

PAM/Launch Provider: Axiom Space on SpaceX Falcon 9 /Crew Dragon

Mission Duration: 16 Days, 14 Docked Days

Launch Date: NET late-April 2025

- **Objectives:** Human Research, Technology Demonstrations, Outreach, Media, and Commercial Activities

- **Status**
  - Crew Identification – All four-crew member have been identified.
    - Countries represented include: USA, India, Hungary, and Poland (in coordination with ESA)
  - Crew training will begin August 2024
  - Final launch date to be determined following crew approval.

NASA is assessing plans and schedules for future PAM solicitations.

Peggy Whitson
Commander

Shubhanshu Shukla
(Indian Space Research Organization)
Mission Specialist #2

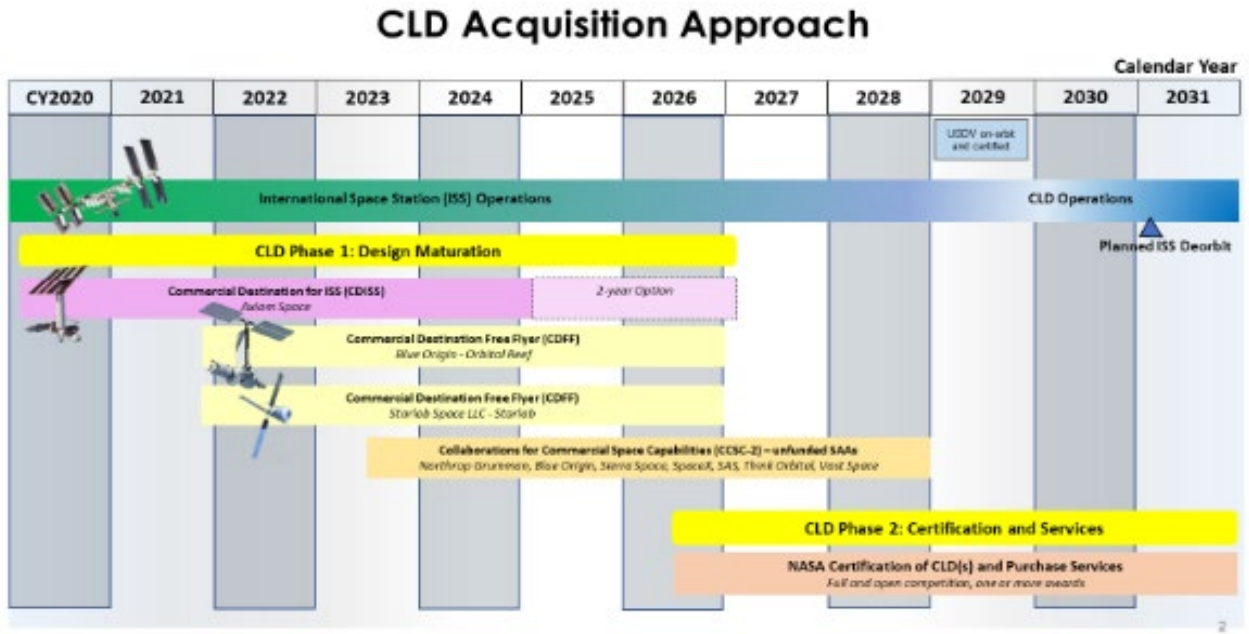
Slawosz Uznański
(ESA Project Astronaut; Poland)
Mission Specialist #1

Tibor Kapu
(Hungary)
Pilot

Phase 2 Status

Phase 2 Status

- NASA continues to make progress towards a Phase 2 procurement for future CLD services
  - Completed Mission Concept Review
  - Significant progress made on baseline of Requirements and processes required for Phase 2
  - Supported the development of Agency LEO Goals and Objectives
- Key Forward Work Items
  - LEO Goals and Objectives gap assessment and resolution of disconnects
  - Prepping for Agency Acquisition Strategy Meeting later this year



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Recent and Upcoming Industry TIMs

CLDP pivoting from the use of RFIs to public TIMs and Workshops to collect industry feedback

CLDP Utilization Requirements TIM (June 11-12, 2024 JSC)

- Provided details on the basic laboratory requirements and overall utilization concept of operations
- 90+ attendees, 22 different companies (5 of which were CLD Partners) and 2 International Partner Reps Present

CLDP Safety TIM Part 1 (August 13-14, 2024 JSC)

- Provided information on the ISS safety process, lessons learned, case studies and other information associated with future safety requirements
- Part 2 to take place in November planning to outline safety requirements in more detail

Commercial Space Food TIM (Sept 26-27, 2024 JSC)

- Planning to provide TIM as in-person and virtual event with Commercial Food Industry Companies and CLDP Partners.
- Sharing information on space food system requirements, operations and logistics, including astronaut perspectives with goal of generating a resource list for CLDP Partners and others of commercial food industry companies that would like to partner in this new market for LEO space food.

Additional TIMs/Workshops planned leading into Draft RFP in 2025
All items planned to be posted to sam.gov