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HDU Deep Space Habitat (DSH) Overview

Kriss J. Kennedy¹
NASA HDU Project Management Team²

ABSTRACT

This paper gives an overview of the National Aeronautics and Space Administration (NASA) led multi-center Habitat Demonstration Unit (HDU) project Deep Space Habitat (DSH) analog that will be field-tested during the 2011 Desert Research and Technologies Studies (D-RATS) field tests. The HDU project is a “technology pull” project that integrates technologies and innovations from multiple NASA centers. This project will repurpose the HDU Pressurized Excursion Module (PEM) that was field tested in the 2010 D-RATS, adding habitation functionality to the prototype unit.

The 2010 configuration of the HDU-PEM consisted of a lunar surface laboratory module that was used to bring over 20 habitation-related technologies together in a single platform that could be tested as an advanced habitation analog in the context of mission architectures and surface operations. The 2011 HDU-DSH configuration will build upon the PEM work, and emphasize validity of crew operations (habitation and living, etc), EVA operations, mission operations, logistics operations, and science operations that might be required in a deep space context for Near Earth Object (NEO) exploration mission architectures. The HDU project consists of a multi-center team brought together in a skunkworks approach to quickly build and validate hardware in analog environments.

The HDU project is part of the strategic plan from the Exploration Systems Mission Directorate (ESMD) Directorate Integration Office (DIO) and the Exploration Mission Systems Office (EMSO) to test destination elements in analog environments. The 2011 analog field test will include Multi Mission Space Exploration Vehicles (MMSEV) and the DSH among other demonstration elements to be brought together in a mission architecture context. This paper will describe overall objectives, various habitat configurations, strategic plan, and technology integration as it pertains to the 2011 field tests.

Key words: Deep Space Habitat, analog, operations, advanced habitation

¹ NASA Johnson Space Center, 2101 Nasa Parkway, M/S EA351, Houston, TX 77058; +1.281.483.6629; kriss.j.kennedy@nasa.gov

² NASA Habitat Demonstration Unit (HDU) Project Management Team consists of Kriss Kennedy (Project Manager, JSC), Larry Toups (HEFT Mission Architecture Lead, and X-Hab Lead, JSC), Tracy Gill (Systems Integration Lead, KSC), Terry Tri (Demo Unit Integration Lead, JSC), and Scott Howe (Design Integration Lead, JPL)

Habitat Demonstration Unit Project - Deep Space Habitat Overview

Kriss J. Kennedy¹

NASA Johnson Space Center, Houston, TX 77058

NASA HDU Project Management Team²

Abstract

This paper gives an overview of the National Aeronautics and Space Administration (NASA) led multi-center Habitat Demonstration Unit (HDU) project Deep Space Habitat (DSH) configuration that will be analog field-tested during the 2011 Desert Research and Technologies Studies (D-RATS) field tests. The HDU project is a “technology and innovation pull” project that integrates technologies and innovations from multiple NASA centers. This project will repurpose the HDU Pressurized Excursion Module (PEM) that was field tested in the 2010 D-RATS, adding habitation functionality to this operational prototype unit. The 2011 HDU-DSH configuration will utilize the 2010 HDU work with added emphasis of crew operations (habitation and living, etc), EVA operations, mission operations, logistics operations, and science operations that might be required in a deep space context for Near Earth Asteroid (NEA) exploration mission architecture. The HDU project consists of a multi-center team brought together in a rapid prototyping tiger-team approach to quickly build, test, and validate hardware and operations in analog environments. The 2011 analog field test will include Multi Mission Space Exploration Vehicles (MMSEV) and the DSH among other demonstration elements to be brought together in a mission architecture context. This paper will describe overall objectives, various habitat configurations, strategic plan, and technology integration as it pertains to the 2011 field tests

I. Introduction

A useful exploration architecture and mission operations validation assessment instrument being utilized by the NASA is analog testing of the lunar environment in desert locales. The human exploration design reference missions (DRM) being defined by NASA’s Human Exploration Framework Team (HEFT) and the Human Spaceflight (HSF) architecture team (HSF-AT) has identified deep space habitats as a critical element within the capability driven framework (fig. 1) strategy¹. Simulating mission scenarios with rapid prototype equipment and systems enables engineers, architects, and scientists insight into the utilization and characterization of the proposed systems. This analog simulation testing refines mission architectures and operations concepts during the early definition phase. A series of D-RaTS have been held in remote locations such as Moses Lake, Washington and Black Point Lava Flow (BPLF), Arizona. The most recent test 14-day test in September 2010 was performed with two MMSEVs, the HDU-PEM, and support systems such as communications, etc. The 2010 D-RaTS configuration of the HDU-PEM consisted of a surface laboratory module that was used to bring over 20 habitation-related technologies and innovations together in an operational demonstration unit (fig. 2). The 2011 session of D-RaTS is planned for BPFL where a MMSEV will operate together with a full scale DSH prototype. A graphic example of the proposed DSH NEA mission under evaluation at the Desert-RaTS 2010 campaign is pictured below in Fig. 3 and Fig. 4. The DSH to be represented by the HDU Project in 2011 is depicted in Fig. 4. This DSH concept version shows a second story inflatable volume for additional habitation and stowage functions.

¹ Architect, HDU Project Manager , NASA Johnson Space Center, 2101 Nasa Parkway, M/S EA351, Houston, TX 77058; +1.281.483.6629; kriss.j.kennedy@nasa.gov

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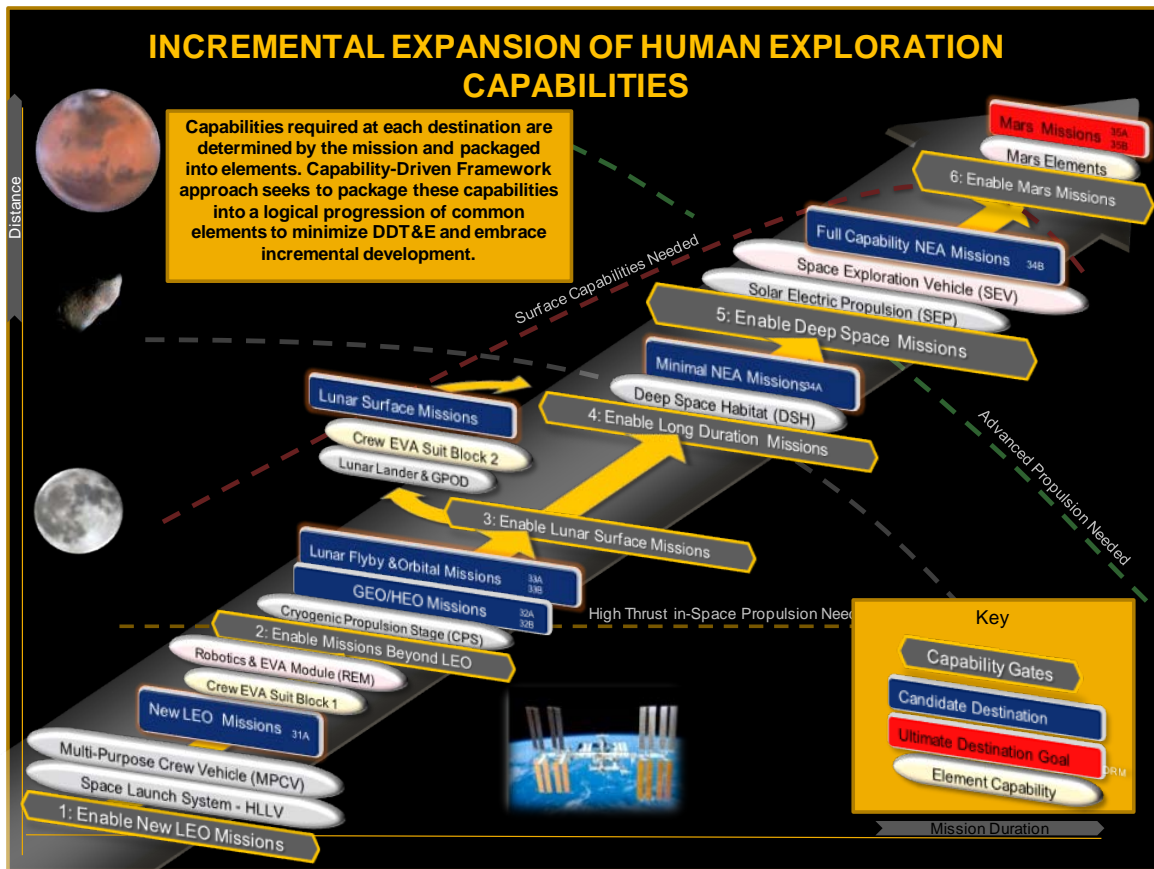


Figure 1. Human Spaceflight Architecture Team Capability Driven Framework



Figure 2. 2010 HDU-PEM at Desert-RaTS



Figure 3. Illustration of Near Earth Asteroid Mission

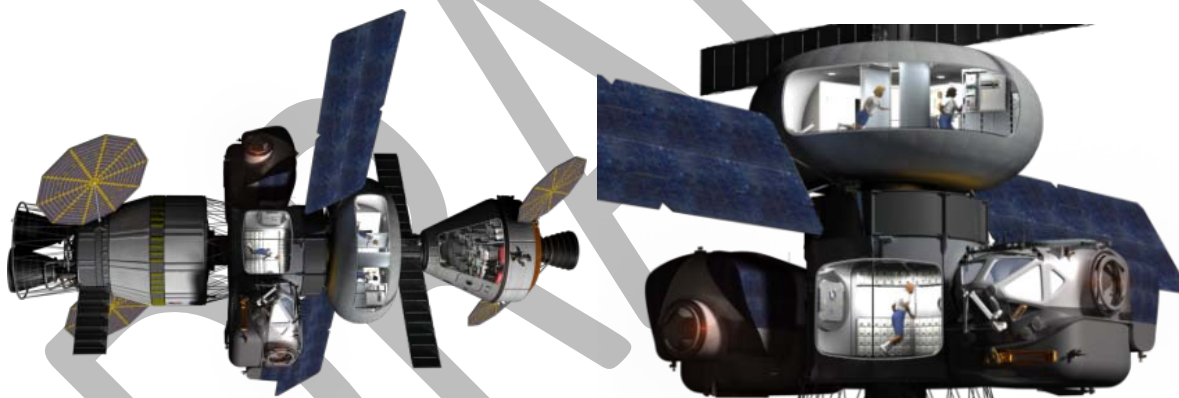


Figure 4. Near Earth Asteroid Deep Space Hab Concept

As part of the HDU Project objective, the team traces its test objectives from mission architecture deep space habitat issues and concerns (Table 1). These architecture element level questions are used to guide prioritization of test objectives and assist in validating mission architecture scenarios and concept of operations. Field analog test objectives are defined within the NASA Analog team and the appropriate supporting element and system demonstrations developed. The FY11 HDU-DSH configuration will focus on several of these architecture questions (Table 1).

Table 1. Deep Space Habitat Element, Mission Architecture Traceability Questions

Arch #	HDU-DSH	Key Habitat Questions: Deep Space Hab (as defined by mission architecture scenarios) <i>(not in priority order)</i>
DSH-1		EVA Operations: Will the capability of an integrated Airlock, Suitlock, or Suitport enable efficient EVAs for NEO exploration?
DSH-2	√	Autonomous Hab Operations: Will the capability of an autonomously-intelligent habitat management operating system enable efficient operations of a DSH saving mass and power, and increasing crew/mission safety and productivity?
DSH-3		Logistics, Maintenance and Spares Operations: Will the capability to in-situ

	√	manufacture of parts, perform remote repairs, and automated maintenance (such as self-healing or self repairing systems) enable efficient operations of a DSH saving mass and power, and increasing crew/mission safety and productivity?
DSH-4	√	Habitable Volume: Does the DSH provide sufficient long-duration mission functionality and habitable volume to enable efficient operations of increasing crew/mission safety, physiology, psychology, and productivity?
DSH-5	√	Crew Operations: Will the capability to provide more habitable volume using inflatable modules or appendages enable efficient operations of a DSH saving mass, launch volume, and increasing crew/mission productivity?
DSH-6	√	Mission Operations: Will the capability of providing tele-robotic workstation, EVA workstation, and maintenance workstation enable efficient operations of a long-duration mission DSH saving mass and power, and increasing crew/mission safety and productivity?
DSH-7	√	Medical Operations: Will the capability of providing a medical workstation enable efficient operations of a DSH increasing crew/mission safety and productivity?
DSH-8	√	GeoScience Operations: Will the capability to perform glovebox in-situ sample analysis enable efficient EVA and geological science operations for NEO exploration? Planetary Protection sample handling, procedures, practices, and operations.
DSH-9		Life Support Closure: Will the capability to “close” the life support system for a long-duration mission enable efficient operations of a DSH saving mass and power, and increasing crew/mission safety and productivity?
DSH-10	√	Sufficient Stowage Volume: Does the DSH provide sufficient stowage volume and accessibility to enable crew activity, MMSEV resupply, maintenance and housekeeping operations, and conduct overall mission operations for a long-duration mission?
DSH-11		Radiation Protection: Does the DSH provide sufficient long-duration mission radiation protection (SPE and GCR) to enable efficient operations of a DSH increasing crew/mission safety, physiology, psychology, and productivity?
DSH-12		Life Sciences Research: Does the DSH provide the capability for human and other biological life sciences research, inclusive of plant and animal research, necessary to understand the effect of the NEO environment on life processes and crew operations necessary to sustain plant food growth?

II. HDU Deep Space Habitat Configuration

The HDU-DSH configuration is based on the Human Exploration Framework Team architecture NEO Mission Deep Space Habitat concept. As previously described (fig. 4), the HDU-DSH configuration layout functionally supports crew IVA Geology science, medical operations, IVA suit and general maintenance, tele-robotics operations, crew habitation, and logistics stowage. Based on the FY10 HDU pie-shaped sectional shell configuration the HDU team modified the configuration into a DSH functional configuration, figure 5 and 6. From the workstation evaluations last year it was determined that like functionality could operate in a dual use mode. Therefore the general maintenance workstation and the EVA maintenance workstation have been combined for the DSH configuration. Likewise the Medical Ops workstation is now combined with the Life Sciences lab functions. The Geology Laboratory workstation area remained the same. A tele-robotics functionality and workstation was added to section-B. This is based on the DSH mission operations and functions to operate a robotic free flyer for sample collection. Under the floor (as last year) are the core systems which include the power input and distribution, the computer system, wireless nodes, C-RIO, data and electric wiring, and air circulation for passive cooling. A heat pump will be used for environmental conditioning. A HDU-DSH CAD representation from the systems modeling tool is illustrated in figures 6 and 7.

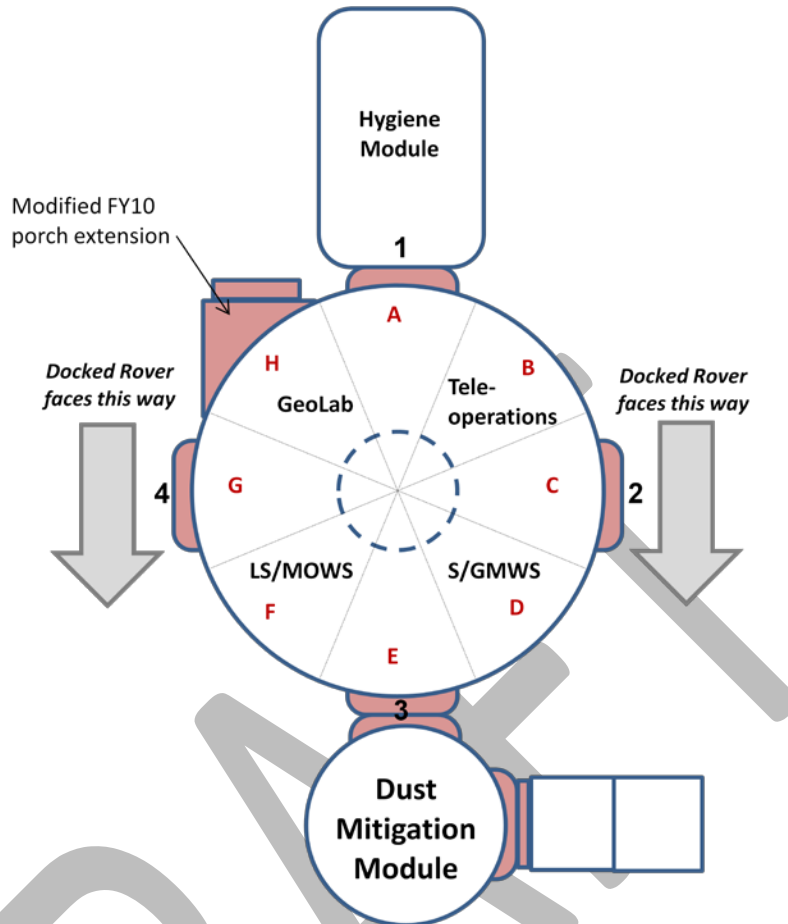


Figure 5. HDU-DSH Plan View

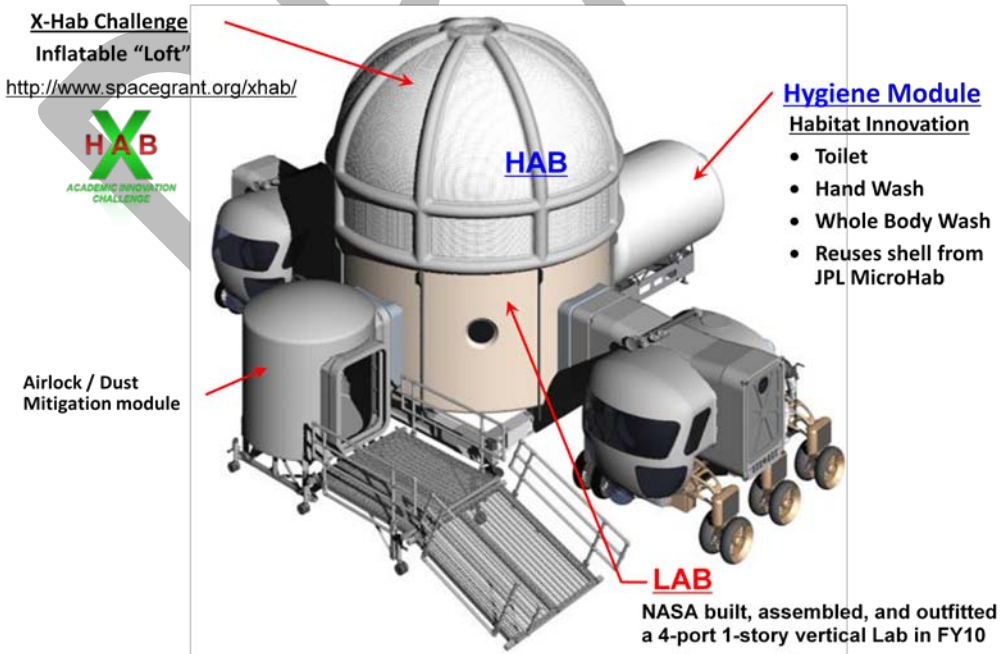


Figure 6. HDU-DSH External View



Figure 7. CAD Integration Cross-Section View of HDU-DSH

III. Advanced Habitat Systems Technology Roadmap

The NASA Office of Chief Technologists (OCT) developed 14 strategic capabilities roadmaps (drafts) during 2010. Technology Area Seven (TA07) focused on Human Exploration Destination Systems. These Space Technology Roadmaps (STR) are to strategically roadmap technology investments that will enable sustained human exploration and support NASA’s missions and goals for at least the next 25 years. HEDS technologies will enable a sustained human presence for exploring destinations such as remote sites on Earth and beyond including, but not limited to, LaGrange points, low Earth orbit (LEO), high Earth orbit (HEO), geosynchronous orbit (GEO), the Moon, near-Earth objects (NEOs)—which > 95% are asteroidal bodies—Phobos, Deimos, Mars, and beyond (fig.8).

Within this TA07 technology roadmap is the 7.4 Advanced Habitat Systems capabilities and technology area. Technology Area Six (TA06) has some habitation related technologies as well. The TA7 HEDS Technology Area Breakdown Structure (TABS) is divided into six Level-2 technology focus areas. Figure nine (9) illustrates the TABS divisions as: 7.1 In-Situ Resource Utilization; 7.2 Sustainability and Supportability; 7.3 Advanced Human Mobility Systems; 7.4 Advanced Habitat Systems; 7.5 Mission Operations and Safety; and 7.6 Cross-Cutting Systems.

The Advanced Habitat Systems (AHS) technology roadmap strategic goals align with the agency’s rapid prototyping strategy of low-cost, early mitigation of exploration deep space habitat systems. AHS will develop habitat technologies that the HDU Project will infuse into the multi-generation maturation development efforts. These two efforts are closely coupled in development, integration, and testing. The “Vision” for AHS is to provide a light-weight, safe and reliable “intelligent” habitation system that has the capability for fully-integrated intelligent systems for autonomous operation, failure detection, analysis, and self-repair facilities to support humans living and working in space and on other planetary bodies. This is analogous to a terrestrial home lasting 25 years with a low-carbon foot-print and Net-Zero resource consumption with no maintenance and operations required living in it while seamlessly providing comfortable and safe living capabilities. The AHS development strategy is to make exploration habitats development affordable by leveraging and collaborating with NASA centers, other agencies (US Army), academia, and industry. The goals of this multi-partnership approach it to develop exploration habitats through earth-based testing, to utilize flight demonstrations to increase confidence in exploration habitats, and to incorporate

a “sustainability” approach in the design, manufacturing, and testing. These strategic goals are further decomposed into lower level objectives.

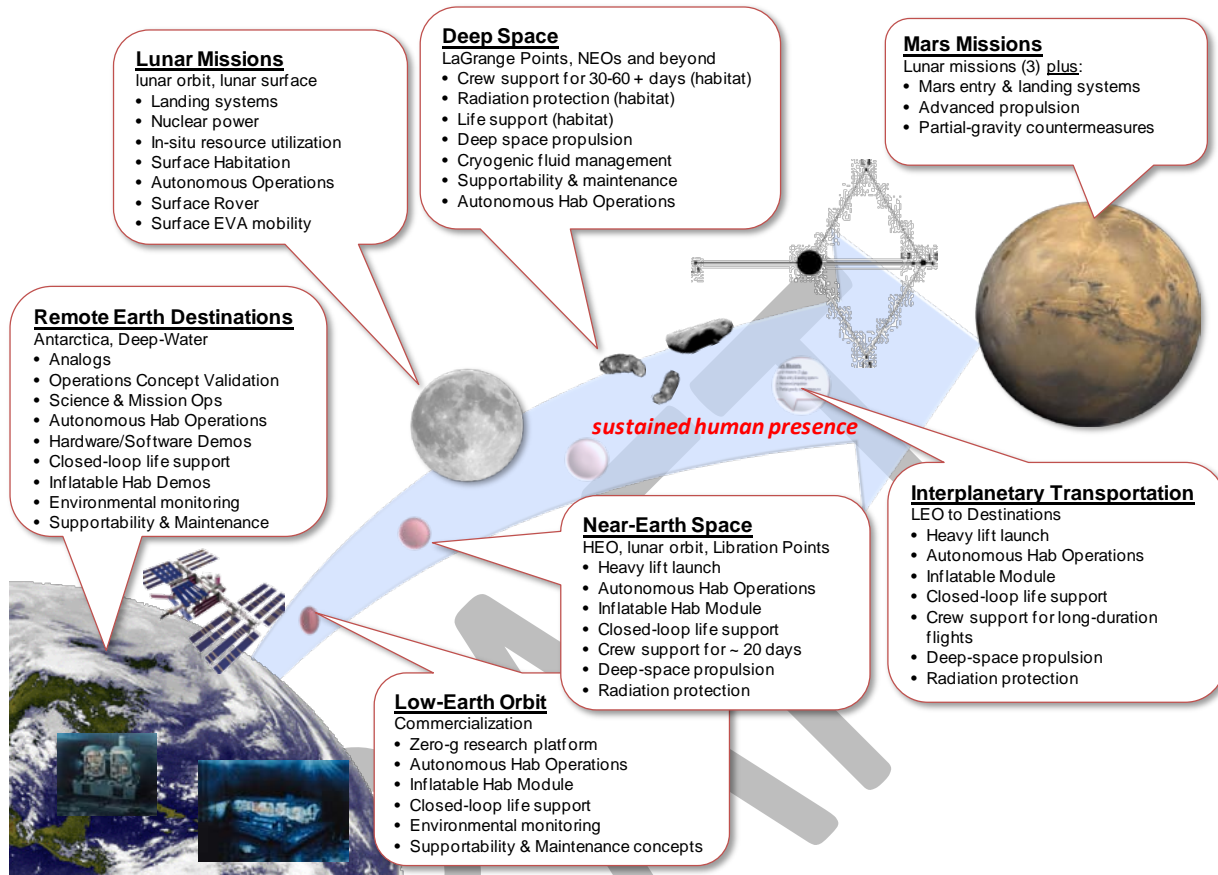


Figure 8. Human Exploration Destination Systems Enable Sustained Human Presence

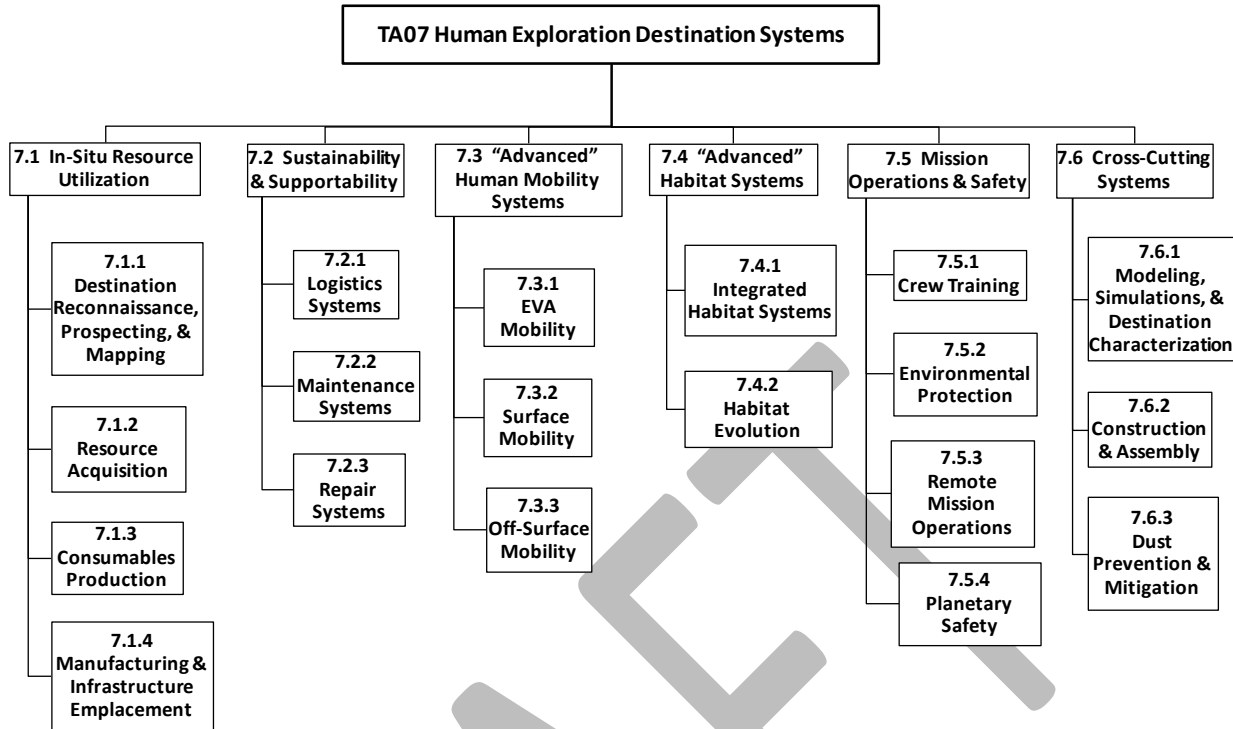


Figure 9. TA07 HEDS Technology Area Breakdown Structure

A. Technology Collaborations

The HDU Project is working to “pull” various NASA project technologies into the HDU-DSH configuration for integrated testing. Technologies being developed from Exploration Life Support, Integrated Systems Health Management, Autonomous Systems and Avionics, Dust Mitigation, Intelligent Software Design, Advanced Environmental Monitoring & Control, and Supportability Technologies are being leveraged into the demonstrations. These technologies are also being integrated into the habitat test-bed and into the software Hab architecture. A habitat technology strategic plan and interdependency (fig. 10) maps exploration habitat technologies from the NASA Office of Chief Technologist (OCT) Space Technology Roadmap (STR) Human Exploration Destination Systems (HEDS) technology area TA07 to Advanced Habitat Systems technology development that infuse technologies for maturation into the HDU Project prior to final maturation into a DSH protoflight demonstration in space.

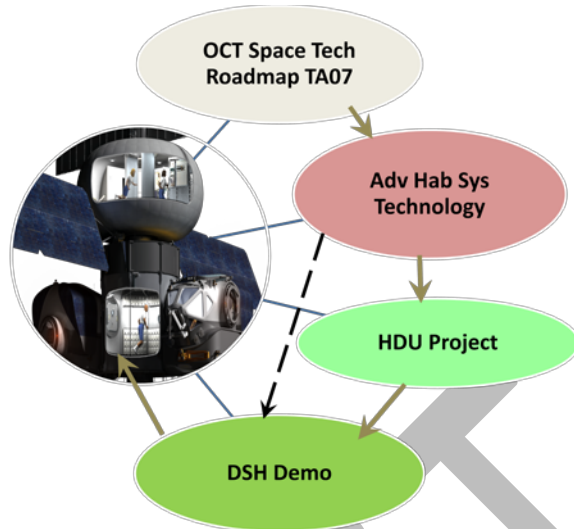


Figure 10. Exploration Habitat Technology Strategic Vision & Interdependency

IV. Habitat Demonstration Unit Project

The HDU project is a rapid prototyping project that integrates technologies and innovations from multiple NASA centers and academia. This project integrates operational hardware and software to assess habitat and laboratory functions in an operational prototype unit. This approach to early integration of hardware and software development forces risk mitigation. The 2011 HDU-DSH configuration will utilize the 2010 HDU shell and will build upon subsystems installed therein. The HDU-DSH configuration will add crew operations functions and capabilities (habitation and living) in addition to the existing, mission operations, logistics operations, and science operations that is required for a deep space habitat of a NEA exploration mission.

The HDU project consists of a multi-center team brought together in a rapid prototyping tiger-team approach to quickly build, test, and validate hardware and operations in analog environments. The HDU project collaborates and leverages center's internal research focused development efforts so that the integration of the contributions provides a sum benefit that is greater than the parts. This project is sponsored as part of the rapid prototyping development approach from the HEOMD Directorate Integration Office (DIO) strategic vision to utilize analog testing for architecture, operations concept and element definition, fig. 11.



Figure 11. Illustration of NASA Analog Strategic Vision

The HDU project leverage's previous 2009-2010 investments into the Habitat Bench-top Test-bed, Hab Systems Management Software, Hab Command, Communications, and Data Handling (CC&DH), Instrumentation, power management & distribution system (PM&D), LED lighting, geology lab glovebox, workstations hardware. The bench-top test-bed will be used as a stepping stone to mature the hardware and software interface prior to installation of updated HDU hardware, software, and technologies. The HDU is an evolutionary approach of build-a-little test-a-little to a higher-fidelity surface analog multi-element integration and testing capability.

The HDU Project "*Vision*" is to develop a fully autonomous habitat system that enables human exploration of space. This will be accomplished by development, integration, testing, and evaluation of advanced habitat systems. The HDU will be utilized as technology pull, testbed, and as an integrated test capability to advance NASA's understanding of alternative mission architectures, operations concepts, and requirements definition and validation. The HDU Project "*Mission*" is to develop a Habitat Demonstration Unit – Deep Space Habitat configuration that will "*roll-out*" operationally ready for remote testing in July 2012. The HDU Project has numerous goals and objectives as defined by the team. They are defined in the project goals and objectives list below.

Project Goals: The HDU will be utilized to accomplish the following goals:

- 1) Be a Habitation Technology Pull and Testbed for the ETDP and HRP projects and research.
- 2) Advance the NASA (Smart Buyer/Partner) understanding of surface architectures.
- 3) Advance the NASA understanding of surface architecture requirements definition and validation.
- 4) Advance the NASA understanding of surface architecture operations concepts definition and validation.
- 5) Establish a focused multi-center effort on advanced habitation systems.
- 6) Understand the key driving mission requirements and limitations that result from use of a lunar habitat
- 7) Incorporate agency wide Habitat-related assets. ETDP, Mockups, Mid-X EDU, Micro-Hab, etc.
- 8) Incorporate Sustainability and Green Engineering strategies and approaches into the project

Project Objectives: The HDU will be utilized to accomplish the following objectives:

- ◆ ...provides a capability (platform) for lean management team & approaches, rapid prototyping, and "skunk works" environment to develop and validate mission architectures, concept of operations, and requirements
- ◆ ...provides a capability (platform) for integration of internal subsystem hardware and software needed for Exploration Habitats (DSH)—independent of shell shape.
- ◆ ...provides a platform for implementation of autonomous operations, monitoring, and control of those subsystems
- ◆ ...provides a platform for Participatory Exploration, X-Hab University Competition
- ◆ ...provides a platform for maturing Hab Integration Team for of future Habs (DSH).
- ◆ ...provides a "ground based" platform to integrate ISS subsystems with future technologies.
- ◆ ...provides a "ground based" platform to assess the "Affordability" approach of modularity, commonality, reusability, and repurposing
- ◆ ...provides a "ground based" platform for technology infusion...

B. HDU Project Strategic Development

The HDU Project is a focused rapid prototyping effort to build and test various technologies and innovations early in the conceptual definition cycle leveraging and collaborations of low-cost development techniques while drawing upon the agencies best and brightest engineers, architects, and scientists. This early life-cycle tiger-team approach will help NASA to understand human exploration architectures, validate various concept-of-operations, derive habitat requirements, infuse—while maturing—technologies, and engage young engineers, academia, and industry. The HDU Project strategically links exploration habitat strategic goals and technology development with the agency's rapid prototyping strategy of low-cost early risk mitigation of deep space habitat systems. The HDU Project enables early integration of exploration habitation operational developmental hardware and software systems independent of the exploration destination or habitat shape and size. Figure 12 shows the NASA HDU Project multi-year multi-generation prototyping maturation development strategy of development a deep space habitat that will culminate with an International Space Station (ISS) flight demonstration.

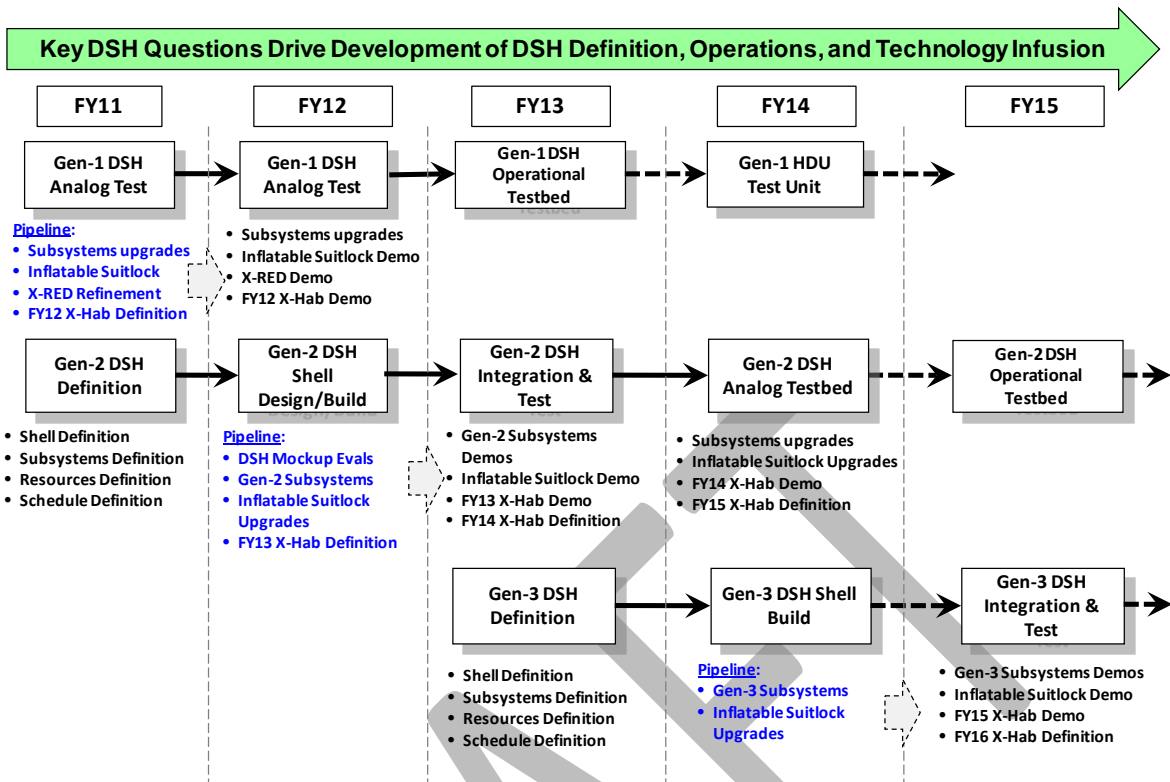


Figure 12. Deep Space Hab Rapid Prototyping Strategy

The HDU Project top-level milestones are centered on primarily developing two HDU units (Gen-1 and Gen-2). Each unit will develop various configurations each year based on the needs of the program and architecture being developed. For FY10 the first generation unit (Gen-1) focused on the PEM configuration. For FY11 a HDU Gen-1 Deep Space Habitat configuration is being developed and testing. During FY11 the second generation (Gen-2) HDU is being defined. During FY12 the Gen-2 shell and Gen-2 systems will be design and manufactured with a FY13 integrated and operational readiness for testing. The Gen-2 shell orientation (vertical or horizontal), shape and size will be determined from inputs based on the HSF-AT team. The systems development of the hardware and software integration will be the key to habitat early mitigation and will be applicable to all configurations. The second generation unit will be of higher fidelity with the ability to “seal” the module, but not pressurized. The Gen-1 HDU will continue to be used in conjunction with academia for additional field analogs. Gen-3 will be high fidelity utilizing flight like hardware and software integrated into a simulated habitat within a pressure chamber like the JSC 20 foot chamber in building-7. The crew will be able to simulate multi-day mission such as a 30 or 60 day mission. This will be the last step leading to a protoflight unit demonstration at the ISS or LEO.

C. Risk Mitigation

The HDU Project utilizes a risk-based approach to manage the project development and progress. The HDU management team and system leads determined the areas of risks and developed strategies to mitigate their impact to the project’s success. A 5 x 5 matrix is used to track the likelihood and consequence of these HDU-DSH risks. In concert with the establishment of the interface definitions, the HDU team will utilize scheduled pre-integration activities, integration tools, and the habitat test-bed to buy-down risk prior to integration of systems within the HDU shell. The HDU project uses Continuous Risk Management (CRM) to monitor and control risk. CRM is an iterative and adaptive process that promotes the successful handling of risk. Each step of in the process builds on the previous step leading to improved technical, cost and schedule control.

D. HDU Project Integration

Design Integration

The HDU team focuses early design integration through a series of early design concepts with Computer-Aided Design (CAD) and Simulations in the development flow across all efforts to test form, fit, integration, assembly, and

basic functions as subsystem designs mature. Periodic synchronization gateway reviews occur during development and validate the hardware/software align with the test objectives.

Systems Integration

The HDU team will utilize fit-check opportunities in the development flow at JSC to allow hardware to be temporarily installed for form and fit. These opportunities will occur from weeks to months prior to the hardware delivery date depending on complexity and availability. An integrated schematic has been developed that layers the subsystems and functional capabilities of the HDU-DSH configuration. This process will be the same as last year's HDU Pressurized Excursion Module integration. For a more detailed description please see reference #2.

Operations Integration

The HDU mission operations integration focuses on the concept of operations, test objectives integration, crew procedures, HDU-DSH operations manual, crew and operators training, and field test operations.

Demo Unit Integration

The HDU team will utilize the Habitat Test-Bed (HaT) in JSC Building 220 as a bench-top platform for early avionics, communications, power systems hardware, and software integration prior to final installation of components within the HDU-DSH. This early integration utilizing the test-bed will occur from weeks to three months prior to the hardware final installation into the demo unit. This process will be the same as last year's HDU Pressurized Excursion Module integration. For a more detailed description please see reference #3.

Assembly Integration

The HDU team will utilize the assembly integration team along with the JSC Building 220 facility for rapid-prototyping development and installation of components into the HDU-DSH. These opportunities will occur from approximately two weeks to three months prior to the hardware delivery date depending on complexity and availability. A Test Configuration Review is held prior to installation of components and a series of Test Readiness Reviews are held for the JSC B220 test and the analog field test.

Technology Integration

The HDU Team will utilize and leverage the Exploration Technology Development (ETD) projects expertise, technologies, and products to infuse those applicable technologies that are deemed ready for inclusion and that meet deep space habitat test objectives. Below is a list of FY11 HDU-DSH technology and innovations being integrated and tested.

1. Inflatable Loft (X-Hab Competition)
2. Logistics-to-Living
3. Autonomous Ops: "Intelligent" Habitat System Management Software
4. iHab Digital Double (D²)
5. Power management systems
6. Environmental Protection Technologies
 - 6.1. Dust Mitigation Technologies
 - 6.1.1. Electrodynamic Dust Screen to repel dust from surfaces
 - 6.1.2. Lotus Coating
 - 6.1.3. Vent Hood at the General Maintenance Workstation
 - 6.1.4. Operational Concept for End-to-End Dust Contamination Management
 - 6.1.5. Vacuum Cleaner
 - 6.2. Micrometeoroid Mitigation Technologies
 - 6.2.1. Micrometeoroid Detection
 - 6.3. Radiation
 - 6.3.1. Operational Demonstration of Cargo Transfer Bags to deployable blankets for Radiation Protection
7. HDU Core Computing, Wireless Communication and RFID
8. Standards-based Modular Instrumentation System: Wireless Sensor Nodes
9. Flat Surface Damage Detection system
10. MMOD Hab impact monitoring system
11. Delayed Tolerant Networking

12. Telerobotic Workstation
13. General Maintenance/EVA Workstation
14. Medical Ops/Life Science Workstation
15. Geo-Science Lab Glovebox/Workstation
16. Material Handling
17. Food Production: Atrium concept
18. LED Lighting
19. 3-D Layered Damage Detection System for Surfaces
20. Habitability / Habitation
21. Hygiene Module

E. Project Organization

The HDU team implements a one-NASA multi-center distributed team approach to manage the project's objectives, resources and execution. The HDU Management team uses a horizontal management and organization style as shown in figure 13. The HDU management team is comprised of focused integration functions of Mission Architecture Integration, Larry Toups/JSC; Design Integration, Scott Howe/JPL; Systems Integration, Tracy Gill/KSC; Mission Operations Integration, Sotirios Liolios/JSC; Demo Unit Integration, Terry Tri/JSC; and Assembly Integration, Ed Walsh/JSC. Each HDU subsystem functional area has an "Integration Lead" that coordinates between the design and assembly integration to ensure both the latest system updates and configuration are being incorporated into the demo unit and they will meet the test objectives.

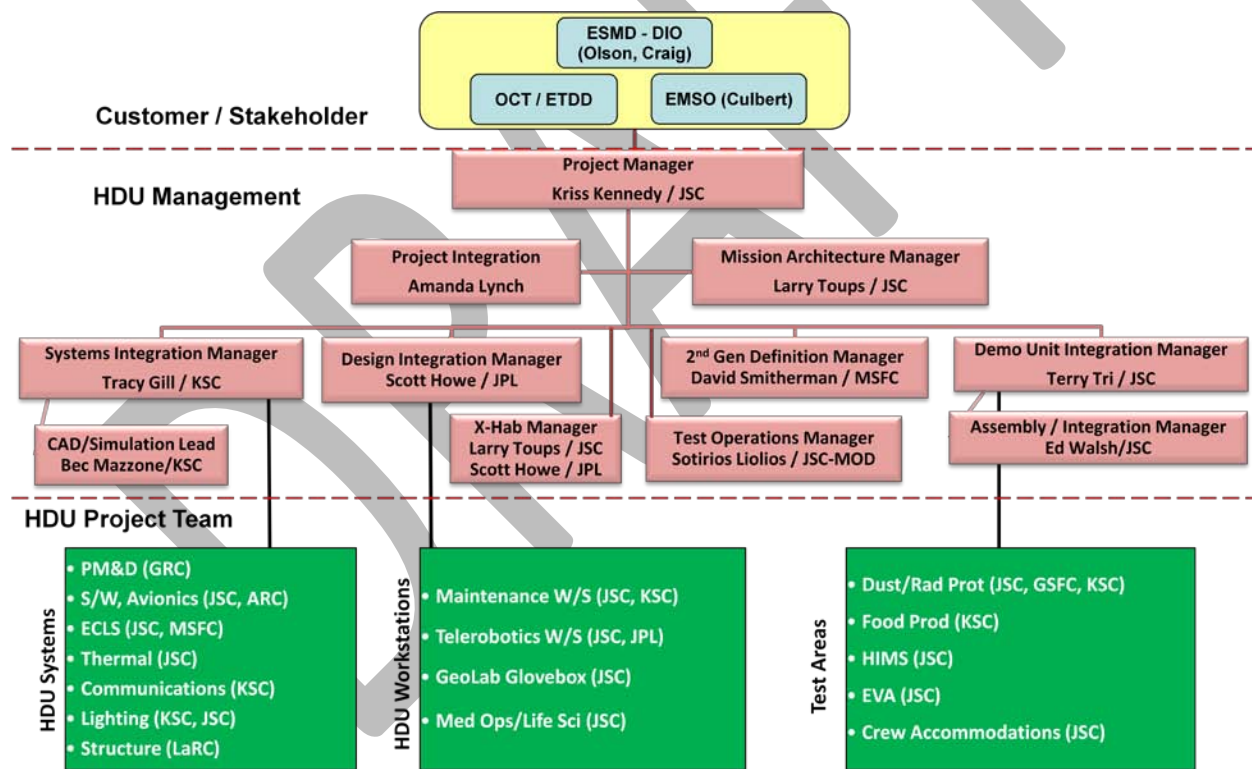


Figure 13. HDU Project Organization

F. Project Milestones

The HDU Project milestones are established as check points aligned with the rapid-prototyping approach of developing exploration habitat configurations for the yearly analog testing in September. Accordingly the project manages its objectives, resources, assembly, and check-out prior to the July and August pre-test dry-runs. The list below high lights the year long rapid-prototyping milestones that are established to focus the team on their progress. Figure 14 is a high level gant chart showing the swim lanes of the parallel development activities. The HDU Project has a ~300 line MS Project schedule that is updated and maintained though out this process.

- DRaTS 2010 Lessons Learned and Report: November 2010
- HDU Deep Space Habitat (DSH) System Design Review: October 2010
- HDU-DSH System Implementation Review: November 2010
- EVA Incapacitated Crewmember & Donn/Doff Airlock Test: January 2011
- HDU-DSH Preliminary Integration Review: January 2011
- HDU-DSH Final Integration Review: February 2011
- HDU-DSH Test Configuration Review: April 2011
- X-Hab Academic Challenge head-2-head Competition: June 2011
- HDU-DSH Integrated Systems TRR: June 2011
- HDU-DSH Field Test TRR: July 2011
- HDU-DSH VIP & DIO Tour: July 2011
- HDU-DSH "Roll-Out" to Rock Yard: July 2011
- HDU-DSH Rock Yard Dry Run: July-August 2011
- D-RATS Field Analog Testing: August-September 2011

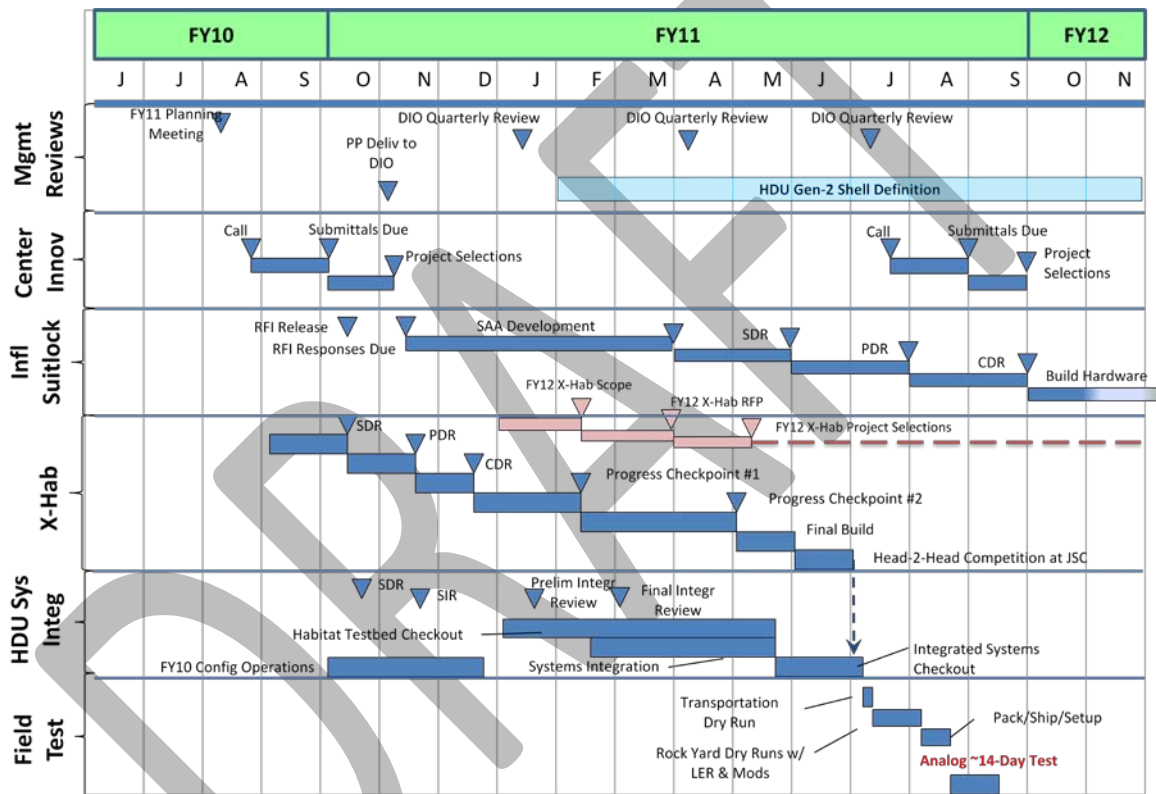


Figure 14. FY11 HDU Project Schedule

V. eXploration Habitat (X-Hab) Academic Innovation Challenge



The HDU Project has sponsored the inaugural 2011 eXploration Habitat (X-Hab-2011) Academic Innovation Challenge this past year. Three university teams were selected to design, manufacture, assemble, and test an inflatable loft that will be integrated on top of the HDU shell. The three universities consisting of the University of Maryland, Oklahoma State University, and the University of Wisconsin-Madison will compete in a head-to-head competition on June 2011 at the NASA Johnson Space Center. The winner will be integrated with the HDU-DSH

for the D-RaTS 2011 analog field test at Black Point Lava Flow, Arizona. The X-Hab 2011 occurred during the academic year of Fall-2010 and Spring-2011. The HDU Project has established the X-Hab Challenge as a way to engage and stimulate students in Science, Technology, Engineering and Mathematics (STEM). The challenge is intended to link with senior and graduate-level design curricula that emphasize hands-on design, research, development, and manufacture of functional prototypical subsystems that enable habitation-related functionality for space exploration missions. NASA directly benefits from the X-Hab challenge by sponsoring the development of innovative habitation-related concepts and technologies from academia. This will result in innovative ideas and solutions that embrace participatory exploration approaches. For more details on the X-Hab 2012 challenge, reference <http://www.spacegrant.org/xhab/>.

VI. Summary

The Habitat Demonstration Unit project has established a multi-center rapid prototyping capability for constructing exploration habitat configurations that is used for infusion of technologies and innovations early in the development life cycle to mitigate integration risk of future space habitats. The HDU assist the exploration architecture team in defining and validating various mission architectures, validating concepts of operation, and deriving habitation requirements. For 2011, the configuration represented by the HDU-DSH will be the Deep Space Habitat of the NEO mission architecture. This DSH configuration will be tested in the 2011 NASA Desert Research and Technology Studies campaign. The HDU project is using computer aided design for the layout and integration of systems and the use of fit-check opportunities with the unit to mitigate integration challenges. The utilization of a Habitat Test-bed avionics platform helps reduce the risk of integrating the systems together for the first time within the HDU-DSH. Finally, the entire HDU project Concept of Operations—from the planning of the manufacturing, assembly and integration, dry-run testing, shipment, and integration to the field operations—have all been factored into the team approach of the HDU project to streamline the rapid prototyping activities to enable the HDU-DSH to meet the ambitious timeline of deployment in July 2011.

VII. References

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