Feb. 8, 2018

ISS Transition

The NASA Authorization Act of 2017 provided for an International Space Station (ISS) Transition Plan under section 303:

> *The Administrator, in coordination with the ISS management entity (as defined in section 2 of the National Aeronautics and Space Administration Transition Authorization Act of 2017), ISS partners, the scientific user community, and the commercial space sector, shall develop a plan to transition in a step-wise approach from the current regime that relies heavily on NASA sponsorship to a regime where NASA could be one of many customers of a low-Earth orbit non-governmental human space flight enterprise.*

This document highlights the top-level policy elements of NASA's ISS and low-Earth orbit (LEO) transition activities required to be included in the Congressionally authorized ISS Transition Report. NASA is currently developing the report, which is expected to be released this spring.

Uses of a LEO Space Platform

Preparing for Human Deep Space Missions

In order to prepare for human expeditions into deep space, the Agency must first conduct breakthrough research and test the advanced technology necessary to keep crews safe and productive on long-duration space exploration missions. An on-orbit platform like the ISS is necessary to mitigate 22 of the 33 human health risks in the portfolio identified by NASA's Human Research Program. NASA is also currently using the ISS as a testbed to fill critical gaps in technologies that will be needed for long-duration deep space missions. For example, elements of the ISS life support and other habitation systems will be evolved into the systems that will be used for deep space exploration missions and undergo long-duration testing. It is NASA's plan to first develop and demonstrate many critical technology capabilities using the ISS as a permanently-crewed testbed prior to deploying these capabilities beyond LEO. This approach is much more cost-effective and faster than conducting this research in cislunar space because of the risks inherent in operating so far from the Earth.

Global Leadership in human spaceflight

The strength of the international partnership created through the ISS Program is a testament to U.S. leadership in space and to the aerospace expertise of all the nations involved. It serves as an example of how many countries can work together to design, build, operate, and maintain large, complex human space assets. As we consider the future of ISS and potential successors and prepare for human missions of exploration into deep space, it is important to consider how to build on and improve these relationships as NASA proceeds into cislunar space. The ISS partner agencies are looking for leadership in human spaceflight and LEO from the U.S. Informally, all

of the partner agencies have indicated that they expect to continue cooperative activities with NASA.

Enabling LEO Commercialization

Through public-private partnerships centered around the ISS platform, NASA is enabling the development of a commercial space economy in LEO where NASA could be one of many customers.

Under the Commercial Resupply Services (CRS) contracts, NASA's two commercial cargo partners, Space Exploration Technologies (SpaceX) and Orbital ATK, have demonstrated not only the ability to provide cargo deliveries to ISS, but also the flexibility to recover effectively from mishaps. The addition of a third commercial service provider, Sierra Nevada Corporation, will add significant on-orbit and return capability. Both Orbital ATK and Sierra Nevada Corporation have begun to investigate options to perform significant on-orbit operations after their primary cargo mission is completed. These two providers are able to provide an on-orbit research capability independent of ISS. NASA's commercial crew partners, SpaceX and the Boeing Company, are developing the Crew Dragon and CST-100 Starliner spacecraft, respectively. These companies have made significant progress toward returning crew launches to the U.S., and NASA anticipates having these capabilities in place by 2019 to regularly fly astronauts safely to and from ISS. The crew and cargo vehicles, as well as the launch vehicles developed by these providers, have the potential to support future commercial enterprises as well as ISS.

The Center for the Advancement of Science In Space (CASIS) manages the activities of the ISS National Laboratory to increase the utilization of the ISS by other Federal entities and the private sector. CASIS works to ensure that the Station's unique capabilities are available to the broadest possible cross-section of U.S. scientific, technological, and industrial communities. The ISS National Laboratory is helping to establish and demonstrate the market for research, technology demonstration, and other activities in LEO beyond the requirements of NASA.

Benefitting Humanity

Across a range of disciplines and applications, research on a crewed space platform ultimately benefits people on Earth. In the physical and biological sciences arena, a LEO space platform can allow researchers to use microgravity conditions to understand the effect of the microgravity environment on microbial systems, fluid physics, combustion science, and materials processing, as well as environmental control and fire safety technologies. Technologies developed for use in space, such as water purification technologies, can have applications on Earth. Crewed platforms can also be the site of sensors that provide data used to support activities such as disaster relief.

Options for the Future

The NASA Transition Authorization Act of 2017 directed NASA to develop a plan to transition ISS from the current regime that relies heavily on NASA sponsorship to a regime where NASA

could be one of many customers of a LEO non-governmental human space flight enterprise. NASA has assessed options that support this vision for the future of human spaceflight in LEO. These options included:

- Extending ISS beyond 2024 as-is;
- Revising the current ISS operating model to shift to a public-private partnership operating model where NASA could be one of many customers;
- Maintaining and transitioning elements and components of the ISS to a private platform; and
- De-orbiting portions of the ISS or the entire spacecraft.

Some of the key considerations in assessing these options are:

- Whether alternative platforms for conducting necessary research and technology development are becoming available;
- The cost of continuing ISS vs. the cost of enabling the development of new capabilities that could meet NASA's long-term LEO needs and the needs of others;
- The interest among NASA's International Partners to extend, change, or terminate the existing ISS arrangements;
- NASA's strategic human spaceflight leadership;
- The potential for different management approaches for the ISS to reduce its operating costs;
- Changes to the current assessment of the technical feasibility of extending the platform beyond 2024;
- The demand outside of NASA in private industry and other Government agencies for LEO research capabilities;
- The amount of time required for ISS maintenance vs. research time; and
- The ability to add additional international participants thereby distributing costs.

Beyond these considerations are broader national policy questions concerning the importance of an ongoing U.S. human presence in LEO, the foreign policy value of international collaboration on space exploration, and the role of the U.S. Government in that ongoing presence.

NASA engages regularly with its International Partners, not only on the technical feasibility of extending the ISS, but on the policy considerations, alternative interests, and the importance of ensuring support for both LEO and future exploration activities. While each Partner is at a different stage in terms of considering the future of the ISS beyond 2024, NASA will continue to consult with the partnership regarding ISS transition in order to ensure consensus and the effective implementation of the ISS Program.

The Path Forward

The Administration has evaluated the options and considerations described above, and is proposing several policy considerations. First, the benefits to U.S. foreign policy from international collaboration on space exploration can be continued and enhanced by learning from

the ISS partnership as we turn our focus to deep space exploration. The Administration is willing to deepen its collaboration with its allies while working with a broader range of partners of all levels of capability.

Second, U.S. scientific and technical interests in LEO, which have been ably supported by the ISS, can also be supported by a diverse range of commercial LEO capabilities and operations. In support of enabling a timely development and transition of commercial capabilities in LEO where NASA could be one of many customers in the mid-2020s, the Administration is proposing to end direct Federal support for the ISS in 2025 under the current NASA-directed operating model, and is requesting $150 million in FY 2019 (with increasing investments in subsequent years) to enable the development and maturation of commercial entities and capabilities which will ensure that commercial successors to the ISS – potentially including elements of the ISS – are operational when they are needed. It is the intent of NASA and the Administration to maintain seamless access to a human platform in LEO that meets NASA's and the Nation's goals.

Third, the Administration sees LEO and deep space exploration efforts as part of a cohesive U.S. exploration strategy. Regular access to a platform in LEO is essential for providing a stable space transportation infrastructure that benefits all exploration efforts; it is essential for developing, testing, and troubleshooting technologies needed for exploration before they are used in locations where failures pose a greater risk to mission success and human life; and it is essential to maintaining a robust scientific enterprise that continues to answer fundamental questions about the effects of microgravity on the human body and on the technology with which we surround ourselves.

The decision to end direct federal support for the ISS in 2025 does not imply that the platform itself will be deorbited at that time – it is possible that industry could continue to operate certain elements or capabilities of the ISS as part of a future commercial platform. NASA will expand international and commercial partnerships over the next seven years in order to ensure continued human access to and presence in LEO.

Lastly the Administration strongly supports obtaining commercial industry's ideas on ISS transition and the commercialization of LEO, and will offer a broad range of capabilities and approaches to seamlessly transition LEO activities to the private sector. The Administration will request market analysis and business plans from the commercial sector and solicit plans from commercial industry.

In the upcoming ISS Transition Report, NASA will further elaborate on encouraging the emergence of an environment in LEO where NASA is one of many customers of a non-governmental human space flight managed and operated enterprise, while providing a smooth and uninterrupted transition.