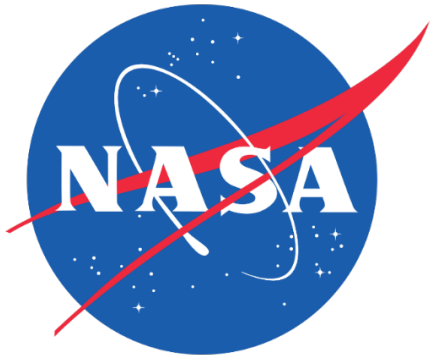


Agency Priority Goal Action Plan

Enable Sustainable Surface Capabilities for the Moon in preparation for Mars

Co-Goal Leader: Deputy Associate Administrator for Programs, Walt Engelund, Space Technology Mission Directorate

Co-Goal Leader: Deputy Associate Administrator for Exploration Steve Clarke, Science Mission Directorate

Performance.gov

Fiscal Year 2020, Quarters 1-2

Overview

Goal Statement

- Commence lunar surface science investigations, technology, and exploration demonstrations to enable a sustainable lunar surface exploration strategy. By September 30, 2021, deliver NASA science and technology payloads to the awarded Commercial Lunar Payload Services (CLPS) provider(s) for delivery to the surface of the Moon.

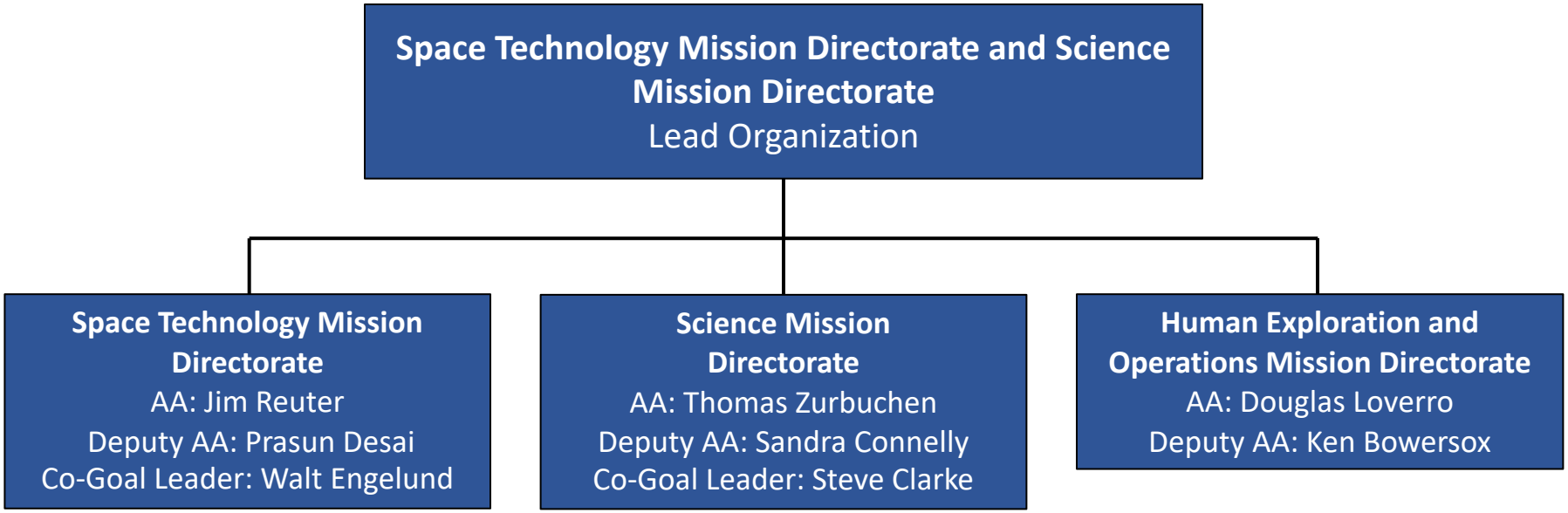
Challenge

- Establish and maintain a robust cadence of lunar surface activities.

Opportunity

- New commercial services initiative providing low-cost, frequent , and global access to the lunar surface.
- Development of new technologies to test and demonstrate vital capabilities on the lunar surface to enable sustainable lunar presence and prepare for human exploration of Mars.
- Robust pipeline of scientific payloads and investigations furthering decadal science objectives and filling exploration's strategic knowledge gaps.
- Fostering a growing American commercial sector to provide increasingly larger, more capable, more precise, and wider ranging lunar surface access.

Leadership & Implementation Team



Space Technology Mission Directorate is responsible for developing the crosscutting, pioneering, new technologies and capabilities needed by the agency to achieve its current and future missions.

Science Mission Directorate uses the vantage point of space to achieve a deep scientific understanding of our planet, other planets and solar system bodies, the interplanetary environment, the Sun and its effects on the solar system, and the universe beyond.

Human Exploration and Operations Mission Directorate provides the Agency with leadership and management of NASA space operations related to human exploration in and beyond low-Earth orbit.

AA: Associate Administrator

Goal Structure & Strategies

Achievement of this goal will require close coordination between Space Technology Mission Directorate, Science Mission Directorate, Human Exploration and Operations Mission Directorate. Strategies to support these efforts include:

- Gradual Buildup of Capability: Near-term mission opportunities with a defined cadence of compelling and integrated missions, providing for an incremental buildup for more complex missions over time.

- Scientific Exploration: exploration enables science and science enables exploration; leveraging scientific expertise for exploration of the lunar surface

- Commercial Partnerships: Leveraging the unique capabilities of NASA and the private sector, use partnerships to develop safe, reliable, and cost effective space systems.

Summary of Progress – FY20 Q1

2020 Q1 Milestone Progress: As of December 11, 2019, NASA successfully completed the 2020 Q1 milestone for this APG. On that date, the NASA Executive Council approved the Agency's strategy for meeting this priority goal, in coordination with the President's Budget Release. This approval included the approach to management and coordination across three NASA Mission Directorates as well as the following strategic elements for accomplishing the APG: gradual capability buildup, scientific exploration, and commercial partnerships. STMD, SMD, and HEOMD each have clearly defined contributions to the accomplishment of this APG as well as responsibility for individual milestone(s) in FY 2020 and FY 2021. The approved strategy positions the Agency to meet the significant challenge of establishing and maintaining a robust cadence of lunar surface activities.

Summary of Progress – FY20 Q2

2020 Q2 Milestone Progress: NASA has completed this Q2 milestone. In November 2019, NASA added five companies to the Commercial Lunar Payload Services (CLPS) contract to perform commercial deliveries of payloads to the surface of the moon, bringing the total to fourteen. All fourteen companies are now eligible to compete on future task orders for the delivery of payloads to the lunar surface. This on-ramp to CLPS not only expanded the competitive pool, but enhanced landing performance capabilities.

2020 Q3 Milestone Progress: NASA is on track for completion of this milestone during FY 2020 Q3. The Autonomous Pop-Up Flat-Folding Explorer Robot (PUFFER) team spent the last week of February 2020 conducting the first set of field tests for the new PUFFER and its multi-PUFFER capabilities. The team overcame a few initial issues and, by the end of the week, was able to demonstrate rough terrain traversal and cooperative localization capabilities. Three PUFFERs used their on-board sensors to localize themselves, as well as other PUFFERs in the environment. Together, they were able to accurately estimate their trek through the Yard. Additionally, by sharing their on-board information with the base station, the system was able to reconstruct an accurate map of the Yard that all three PUFFERs had traversed and sensed together. Field testing will continue through the end of the project in May, though this timeline may be impacted by COVID-19. This system demonstrates a capability to scout regions on the Moon and gain intel about locations that may be difficult for astronauts to investigate on foot, like hard-to-reach craters and narrow caves.

NOTE: NASA's response to the COVID-19 pandemic did not impact the Agency's ability to meet its 2020 Q2 milestone for this priority goal, nor do we anticipate it preventing the Agency from meeting its 2020 Q3 milestone.

Key Milestones

Progress update for the Lunar Surface Capabilities APG.

	N/A	FY2020 Q1	Current Status FY2020 Q2	Forecast FY2020 Q3
Quarterly Rating		Green	Green	⇨
Milestones Achieved		2 of 1*	2 of 2	

*Q2 milestone completed ahead of schedule

⇨ Unchanged ⇧ Improving ⇩ Deteriorating

Milestone Summary			
Milestones	**Responsible Mission Directorate**	**Milestone Due Date**	**Comments**
Plan strategy for APG coordinated with the President's Budget Release	STMD/SMD/HEOMD	FY 2020 Q1	Completed on Dec. 11, 2019
Complete onramp of additional CLPS providers to enhance lunar delivery capability	SMD	FY 2020 Q2	Completed on Nov. 18, 2019
Complete Autonomous Mobility Field Test	STMD	FY 2020 Q3	On track for Q3 completion
Conduct Exploration Extravehicular Mobility Unit (xEMU) Systems Requirements Review	HEOMD	FY 2020 Q4	
Complete Precision Landing suborbital demonstration	STMD	FY 2021 Q1	
Deliver selected NASA-sponsored instruments to the awarded CLPS providers for integration	SMD	FY 2021 Q2	
Complete VIPER Critical Design Review	SMD	FY 2021 Q3	
Prepare hardware for flight demonstration for lunar polar water mining technology	STMD	FY 2021 Q4	

Data Accuracy and Reliability

Verification and Validation

- NASA monitors and tracks its progress towards this goal using various Agency documents and reports, including Directorate Program Management Council (DPMC) materials, reports from the industry partners, and Baseline Performance Reviews (BPR).

Data Source(s)

- Press releases and BPR Charts indicating whether or not NASA has initiated its planned science, technology, or exploration demonstrations.

Level of Accuracy Required for Intended Use

- Using the documents and reports referenced above, the Agency is able to accurately report at the end of each quarter on whether or not it has met its planned milestones.

Data Limitations

- NASA has not identified any data limitations that would preclude it from reporting accurate, reliable, and timely performance information.

Additional Information

Contributing Programs

- **Space Technology Mission Directorate (STMD):** Within STMD, the primary contributors to this APG are the the **Game Changing Development Program** and the **Lunar Surface Innovation Initiative**, the latter of which spans all STMD programs. The Game Changing Development Program advances space exploration technologies that will enable entirely new approaches for the Agency's future space missions as well as capabilities for our nation. The program will focus efforts in the mid Technology Readiness Level (TRL) range of (3-5/6) generally taking technologies from proof of concept through component or breadboard testing in a relevant environment. The Lunar Surface Innovation Initiative funds a broad portfolio of research and development from early stage innovation to technology development and maturation to capability demonstration in order to enable human and robotic exploration on the Moon and future operations on Mars. The activities will be implemented through a combination of unique NASA work and public-private partnerships.
- **SMD Lunar Exploration and Discovery Program (LDEP):** Through LDEP's Commercial Lunar Payload Services (CLPS), NASA is contracting with American aerospace companies for the delivery of payloads to the lunar surface. Early commercial delivery missions will perform science experiments, test technologies, and demonstrate capabilities to help NASA explore the Moon and prepare for human missions. Future landers will also carry large roving instrument kits to locate life-sustaining and mission-enabling resources on the Moon.
- **HEOMD Advanced Exploration Systems (AES):** The AES division is pioneering innovative approaches and public-private partnerships to rapidly develop prototype systems, advance key capabilities, and validate operational concepts for future human missions beyond Earth orbit. AES will work to develop the Exploration Extravehicular Mobility Unit (xEMU) critical for lunar surface exploration by humans.

Stakeholder/Congressional Consultations

NASA works with its industry partners to provide updates to Congress on the status of the Commercial Lunar Payload Services contracts. NASA also consults regularly with experts from industry and academia, such as the NASA Advisory Council and the National Space Council User's Advisory Council.