National Aeronautics and Space Administration

2026-2027
MISSION DESCRIPTION

NASA Spacesuit User Interface Technologies for Students

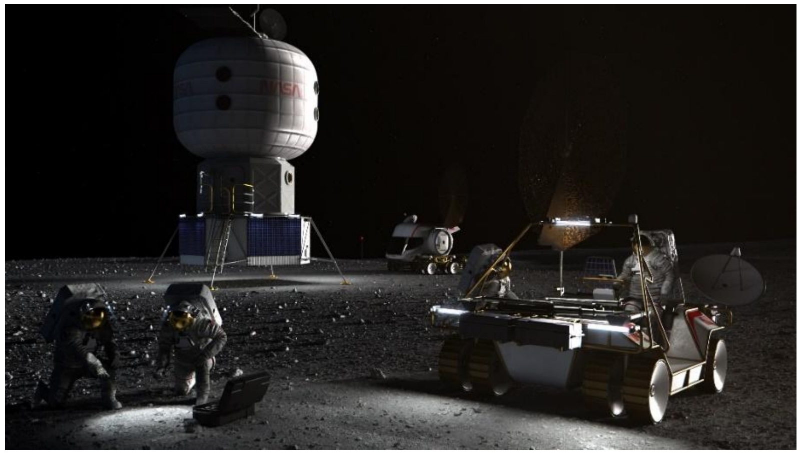
NASA STEM
Launching Tomorrow's Aerospace Workforce

Contents




1. Background

NASA SUITS (Spacesuit User Interface Technologies for Students) is a software design challenge in which college students from across the country help design solutions for future spaceflight needs. NASA is advancing development of the Moon Base, a long-term lunar exploration and infrastructure initiative designed to enable sustained human presence and expanded scientific and commercial activity on the lunar surface. NASA will send astronauts on increasingly difficult missions to explore more of the Moon for scientific discovery and economic benefits, and to build on our foundation for the first crewed mission to Mars. This means engineers are actively developing technologies needed to ensure successful completion of science and exploration missions.



NASA SUITS is a collaboration between NASA's Exploration Extravehicular Activity (xEVA) Systems Office and the Office of STEM Engagement (OSTEM), currently entering its tenth year, to prepare students for aerospace careers. Additional benefits to NASA and the public include strengthening research capacity, building technical expertise, and expanding reach in alignment with NASA missions and needs. OSTEM is preparing tomorrow's aerospace workforce providing education, industry, and government with a well-prepared talent pool equipped with skills and experiences that enable future NASA missions and strengthen the nation's aerospace workforce.

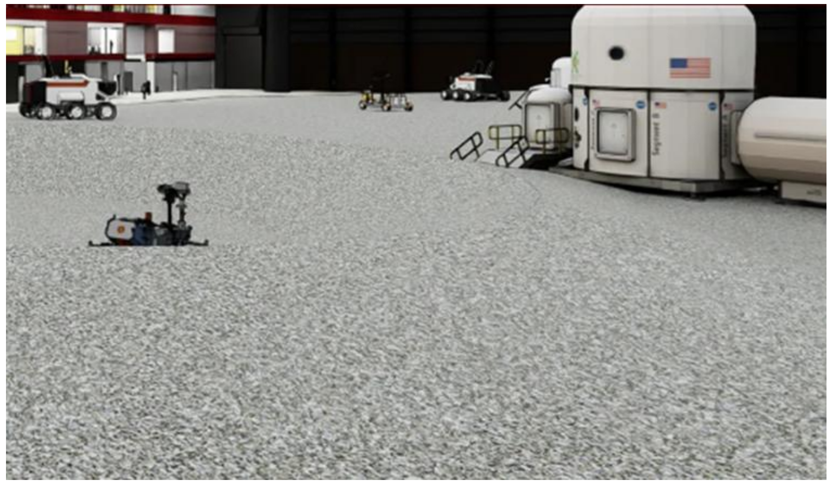
A sustained human presence on the lunar surface requires reimagining of how spacewalks are conducted. NASA SUITS contributes to this challenge through displays, voice assistants, and AI (artificial intelligence) and ML (Machine Learning) integration.

In NASA SUITS, teams design crew autonomy enabling systems and UIs (user interfaces). Teams will submit a proposal for spacesuit system~~s~~, displays, and voice assistants. Teams may design for their choice of screen or device, however, any HMDs (head-mounted displays) for the spacesuit must be **passthrough** AR to view the real world directly.

After submitting a proposal, top teams will be selected to develop a UI and background software, be mentored by NASA experts, and test and showcase their work to NASA engineers in a mock EVA (extravehicular activity) scenario at NASA's Johnson Space Center in Houston in May 2027.

2. Mission Concept

NASA SUITS is creating a lunar EVA scenario for 2027. Teams are responsible for their UI, voice assistant, display device, and background software. The testing will occur under low light conditions; therefore, teams will need to accommodate for lighting factors in the display systems, especially if an HMD is used.



The EVA scenario simulates an early lunar surface mission where EVA crew members use artificial intelligence and autonomous features to perform geology characterization and deploy scientific payloads across multiple Points of Interest (POIs). Teams aim to complete as many POIs as possible within the EVA time window. Each team will also be connected to a telemetry stream.

2a. Spacesuit

The spacesuit team will need to deploy their solution for one EVA crew member. This can be a HMD, tablet, phone, or other device of your choosing. The EVA crewmembers will be referred to as EV. The EV will rely on their user interface to accomplish their goals.

2b. Predictive Analysis Tool

NASA SUITS aims to act as a force multiplier for astronauts on the lunar surface. This is accomplished by increasing efficiency and lowering the cognitive load on the EVA crew member allowing them to focus their attention on tasks best accomplished by the human brain. Teams should use AI and ML to accomplish this goal. AI will also be critical in finding safe, efficient routes for traverse by the EV. Route planning should account for consumable limits and be able to adjust as needed. Consider using a ML algorithm for predictive consumable tracking and projections to keep the crew safe and informed. Keep in mind hallucinations can impact your goals, so you need to establish guardrails for mission-critical aspects of your design.

If using a voice assistant use normal language in an efficient way to reduce cognitive load. For example, if the EVA crew member asks for oxygen levels the response should be concise and clear. “Primary O2 47%, Secondary 99%.” Rather than, “Your primary oxygen tank level is currently at 47% and your secondary oxygen tank level is currently at 99%. Do you currently have any other questions for me?”

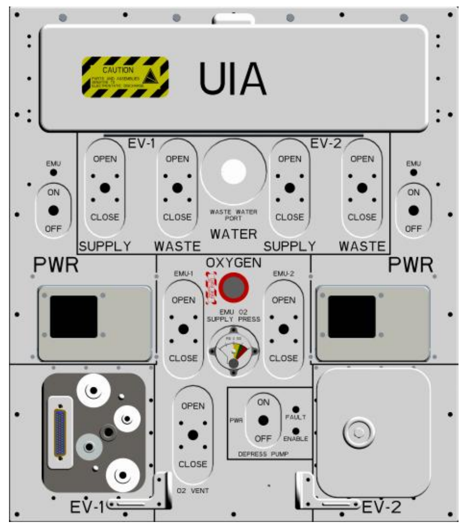
2c. Mission Tasks

Initial Scene

The scenario begins with two EV crews egressing to a starting point outside a lunar lander and performing standard operations in a known location. POIs are arranged in a loop along a pre-planned route from the lander. Each EV crew traverses from the lunar lander to a set of POIs. At each POI, the team's job is to perform geology and scientific payload tasks. At the conclusion of the EVA time window crews return to the lander.

Egress (Pre-Brief)

Egress occurs when the crew member, also known as the EV, exits the airlock to begin the EVA. Several steps must take place to ensure the crew member can safely egress.



The goal of this task is to demonstrate effective and efficient methods for completing the Umbilical Interface Assembly (UIA) procedures to initiate an EVA by preparing and checking the spacesuit's portable life support systems. The priority for the spacesuit system is the use of intuitive UIs, including display and voice. This is an opportunity to begin showcasing those abilities.

The EV will interface with tactile switches on the UIA in accordance with provided procedures. A sample of procedures is in Appendix A but is subject to change as we approach Test Week. Upon successful completion of the egress task, EV will move on to the navigation portion of the EVA.

Teams will decide the most effective method for communicating and accomplishing these procedures. This can be a text checklist, computer vision, voice commands, none of, or a combination of those listed. This is a prime opportunity to integrate AI. The UIA's switch state will be provided by the Telemetry Stream Server (TSS).

Navigation

The purpose of navigation is to ensure the crew member can traverse to POIs safely and efficiently. The goal is to implement a software system to aid crew members as they navigate to POIs on the lunar surface under low light conditions like the lunar south pole. An animation of sample lighting conditions is available at Lunar South Pole Illumination with Earth and Sun.

Teams will design a navigation solution that is effective and non-obtrusive. For the UI, teams shall design a 2D mini-map to aid navigation. Teams may also include a 3D map and/or computer vision solutions for navigation.

Navigating POIs

- POI coordinates are provided to EV team
- Team drops a pin at each POI
- Team determines best route to traverse to each POI
- Traverse to POI

Points of Interest (POI) Tasks

Portable Lunar Camera Deployment (PLCD)

Upon arrival at POI you will need to:

- Retrieve PLCD procedures
- Follow procedures to deploy PLCD
- Proceed to the next task

Geology Tasks

After PCD need to:

- Use EV camera to take photos of the terrain (camera provided by team via head mounted camera or resource)
- Collect and store physical samples in carry pack
- Retrieve physical sample marker deployment (PSMD) procedures
- Place physical sample marker at sample collection site
- Use EV camera to photograph sample collection site
- Use XRF Spectrometer to take readings of the POI and document composition
- Proceed to the next task

Unique Scientific Payload Task. Possible examples of a unique task for each POI:

- Simplified seismometer deployment
- Electrostatic/regolith charge sensor
- Retroreflector alignment
- Environmental sensor canister deployment
- Proceed to next task

Portable Lunar Camera Teardown (PLCT)

- Retrieve PLCT procedures
- Follow procedures to teardown PLTC

Ingress

Ingress is made when number of POIs are completed, or EVA time expires.

An EVA is not complete until the crewmember has arrived safely back inside their craft. Ingress is the process of returning to the airlock. Once the crewmember has completed all EVA tasks, they will begin the ingress portion of the EVA.

The EV will follow navigation cues and instructions to follow the best path for return to the lander. Once at the lander, the EV will conduct final procedures with the UIA.

Teams will decide the most effective method for navigating back to the lander. The UI shall provide a "breadcrumbs" feature for retracing a path. The ideal implementation would provide the shortest safe path back to the lander.

3. NASA Provided Systems and Equipment

3a. TSS

The Telemetry Stream Server (TSS) is a server that provides simulated telemetry values for the lunar assets. NASA will provide a Unity/Unreal plugin to assist in integrating the TSS with your device. Procedures and documents will be provided after team selection. Your device must be able to retrieve the following information from the TSS and display this information at any time:

- Spacesuit telemetry
- Display Control Unit (DCU)
- Spectrometer
- Portable Lunar Camera
- UIA
- Scientific Payload Hardware

3b. UIA

The UIA features multiple switches teams will manipulate to match the desired configuration for egress. These switches feed into the telemetry stream via Booleans, allowing teams to receive real-time feedback on their state. Teams are encouraged to explore creative solutions to convey procedures and relevant telemetry such as computer vision and voice assistant to aid in completing the procedures.

3c. Spectrometer

NASA provides the simulated XRF spectrometer, which selects simulated geological data from a database when a rock with an RFID tag is scanned. The geological data is then sent via the telemetry stream back to the user. The team will display the geological data of each rock within their UI. Spectroscopy readings are taken at each POI.

3d. Display and Control Unit

The Display and Control Unit (DCU) features multiple switches, which allow the EV to interact with different systems of the space suit. These switches feed into the TSS, allowing teams to receive real-time feedback on their position. The DCU also allows the EV to handle any errors related to these systems. The version provided does not have an integrated display, rather your spacesuit display will handle this information via the TSS.

The systems controlled by the DCU include:

- Battery (Local/UMB)
- Oxygen (Pri/Sec)
- Comms (A/B)
- Fan (Pri/Sec)
- Pump (Open/Close)
- CO2 (A/B)

NASA will provide a method for simulating the DCU location system to assist with your development.

3e. Portable Lunar Surface Camera

A [handheld camera]() will be essential for NASA astronauts on the lunar surface. NASA SUITS will use the GoPro HERO8 Black 4K Waterproof Action Camera. It is a portable streamlined camera that allows crews to swap mounts and load accessories quickly. EV crews will deploy the portable lunar surface camera at each POI, provide video feed to ground/MCC, and pack it and carried between stations. At each POI the camera is used to stream EVA at each POI.

4. Requirements

Please read and follow the requirements thoroughly. These requirements may evolve following team selection.

Note: In the requirements sections below:

Shall = required for minimally viable product

Should = requested features, but secondary priority

May = potential stretch goals for development

4a. Spacesuit Display Requirements

1. EV Telemetry:
   a. The UI shall display EV's own suit and simulated biomedical data.
2. Map:
   a. The UI shall display a 2-dimensional map.
   b. The map shall display the location of live assets, such other crew members.
   c. The UI may display 3D map of the environment.
3. Procedure List:
   a. The UI shall display correct procedures for each POI station of the EVA.
   b. The UI shall provide voice assistance using natural language.
4. Navigation:
   a. The UI shall implement a "breadcrumb" feature for navigational use.
      i. This feature will allow the user to backtrack to the ~~PR~~ lander.
   b. The UI should implement a best path navigation feature.
   c. The UI should offer navigation aids to POIs.
   d. The UI shall provide predictive maximum range based upon spacesuit life support usage and limitations.
5. Drop Pins:
   a. The design shall allow the user the ability to drop a pin on the map at any point during the EVA.
6. Caution and Warning:
   a. The UI shall feature a caution and warning system.
   b. The caution and warning system shall alert the user if his/her spacesuit or biometric telemetry enter off nominal ranges.

4b. Peripheral Requirements

These requirements shall apply to the development of peripheral device:

1. Any external or additional device must be presented at the software design review (SDR) and approved by the NASA SUITS team.
2. The device should communicate with the team's device(s) outside of the TSS (i.e., Bluetooth).
3. Devices must not have holes or openings that would allow/cause the entrapment of fingers.
4. There shall be no sharp edges on the device.
5. Pinch points should be minimized and labeled.
6. Electrical design must meet the additional requirements.

Appendix A: Sample UIA Procedures

EVA Egress

Connect UIA to DCU and start Depress

UIA and DCU	1. EV1 verify umbilical connection from UIA to DCU
UIA	2. EV-1, EMU PWR – ON
DCU	3. BATT – UMB
UIA	4. DEPRESS PUMP PWR – ON

Prep O2 Tanks

UIA	1. OXYGEN O2 VENT – OPEN
HMD	2. Wait until both Primary and Secondary OXY tanks are < 10psi
UIA	3. OXYGEN O2 VENT – CLOSE
BOTH DCU	4. OXY – PRI
UIA	5. OXYGEN EMU-1 – OPEN
HMD	6. Wait until EV1 Primary O2 tank > 3000 psi
UIA	7. OXYGEN EMU-1 – CLOSE
BOTH DCU	8. OXY – SEC
UIA	9. OXYGEN EMU-1 – OPEN
HMD	10. Wait until EV1 Secondary O2 tank > 3000 psi
UIA	11. OXYGEN EMU-1 – CLOSE
BOTH DCU	12. OXY – PRI

END Depress, Check Switches and Disconnect

HMD	1. Wait until SUIT Pressure, O2 Pressure = 4
UIA	2. DEPRESS PUMP PWR – OFF
BOTH DCU	3. BATT – LOCAL
UIA	4. EV-1 EMU PWR - OFF
BOTH DCU	5. Verify OXY – PRI
BOTH DCU	6. Verify COMMS – A
BOTH DCU	7. Verify FAN – PRI
BOTH DCU	8. Verify PUMP – CLOSE
BOTH DCU	9. Verify CO2 – A
UIA and DCU	10. EV1 disconnect UIA and DCU umbilical