TUXEDO
Tactical User-interfaces for eXtravehicular Exploration and Dynamic Optimization

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Table of Contents

1. Introduction

During lunar extravehicular activities (EVAs) astronauts operate in complex, low-visibility environments where reliance on checklists and ground supervision increases cognitive workload and response time. To address these limitations, we present TUXEDO (Tactical User-interfaces for eXtravehicular Exploration and Dynamic Optimization), a synchronized interface system that links the Pressurized Rover and EVA suit through the onboard Athena AI assistant to enhance crew autonomy, situational awareness, and task efficiency.

TUXEDO employs Augmented Guided Reality (AGR), a telemetry-driven, pass-through AR layer that projects verified spatial cues and concise audio prompts directly onto rover and suit hardware. Each procedural step is validated through the Telemetry Stream Server (TSS) to ensure synchronization between physical system states and digital guidance. This integration enables astronauts to execute egress, navigation, and repair tasks hands-free while maintaining real-time awareness of consumables, positioning, and system health.

By combining adaptive visualization with telemetry verification, TUXEDO introduces a scalable human-in-the-loop framework that supports safe, efficient, and cognitively optimized EVA operations aligned with FY26 NASA SUITS requirements and EVA Technical Standards.

2. Technical Section

2.1 Abstract

TUXEDO integrates two synchronized user interfaces, one for the Pressurized Rover (PR) and one for the EVA suit. Both linked through the Athena onboard AI assistant to enable shared situational awareness and coordinated task execution between crew and vehicle. The system is designed to support critical surface operations such as LTV search, navigation, repair, and ingress with reduced cognitive workload and increased operational safety.

To achieve this, TUXEDO employs a telemetry-driven architecture built around Augmented Guided Reality (AGR) and the Telemetry Stream Server (TSS). The PR interface provides real-time terrain mapping, adaptive search patterns around the LTV's last known position, hazard-aware route planning, and consumable forecasting. Simultaneously, the EVA interface displays biomedical telemetry, navigation breadcrumbs, and AGR-based step cues for repair and inspection tasks. Both interfaces exchange data via WebSockets (JSON/GeoJSON) with TSS serving as the single source of truth for system state verification.

Within this framework, AGR overlays spatially anchored highlights, motion arrows, and tool prompts onto hardware elements such as the UIA, DCU, and LTV panels, allowing step progression only when telemetry confirms the nominal state. The integrated system will be evaluated at NASA's Digital Lunar Exploration Sites (DUST) simulation. Human-in-the-loop testing will measure task duration, path accuracy, and workload, validating compliance with FY26 SUITS requirements and EVA Technical Standards for autonomy, safety, and cognitive optimization.

2.2 Software & Hardware Design Description

2.2.1 System overview & architecture

The overall network diagram connecting the components below is seen in Figure 1.

1. **TSS Interface** – One client library for PR and EV to subscribe to JSON/GeoJSON telemetry via WebSockets (assets, suit, LTV beacon/UIA/DCU states, timers). Configurable SUITSNET IP for test week.
2. **Athena AI Core:** Lightweight local Large Language Model (LLM) for fast, offline answers, plus a higher-capacity node on the rover for planning. All numbers are verified against TSS.
3. **Navigation & Analytics** – A*-based path planning with slope and hazard penalties; power/consumables estimators compute safe "turnaround."
4. **UI Layer** – Two simple, glanceable UIs: PR (map + panels) and EV (maplet + tiles). Large text, high contrast for night operations.
5. **Interoperability** – A shared, minimal JSON schema for Points of Interest (POIs), drops, timers, and status so PR and EV see the same data, even if disconnected briefly.

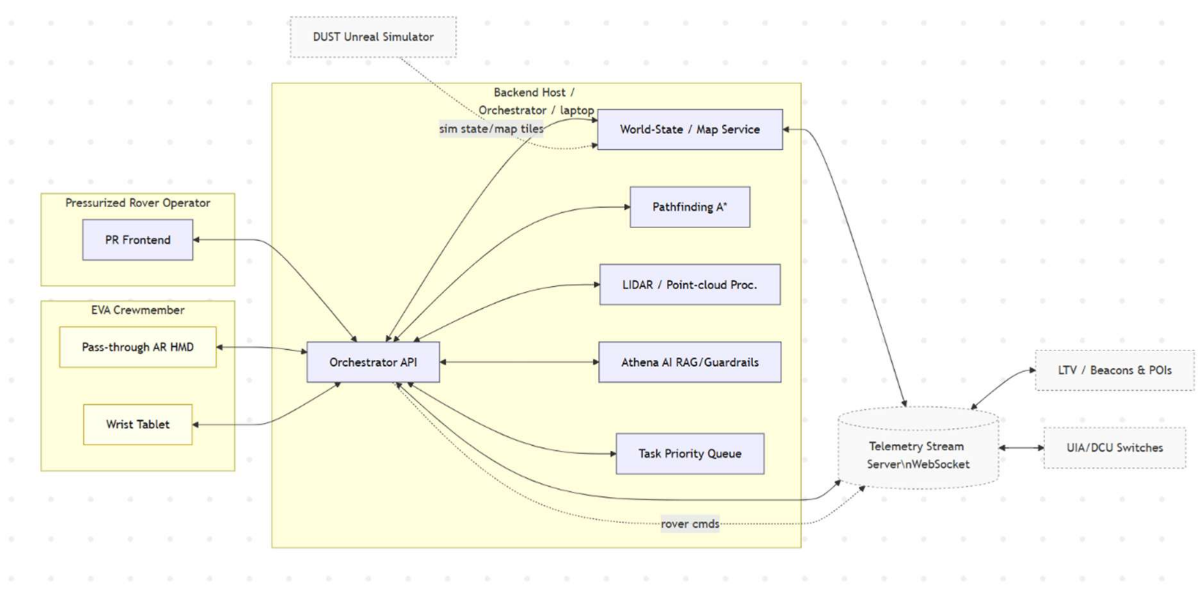

Figure 1. Network Diagram

2.2.2 Pressurized Rover Subsystem

- **Display/Control System:** Multi-panel UI with rover telemetry, 2D terrain map, caution/warning feed, and consumables chart.

- **Autonomous Navigation:** A*-based route planner optimized for hazard avoidance. Integrates adaptive search pattern (sector pie) after LTV last-known point and estimated LTV consumable range from last-known point.
- **LiDAR** – Autonomous navigation includes LiDAR detection up to 10m.
- **Resource Tracking:** Predictive estimates of rover power, life support, and fuel margins to define "turnaround radius."
- **Caution/Warning System:** Color-coded alerts and Athena generated procedural recommendations.
- **Shared POIs:** Voice activated drop-pin and annotation feature for LTV signal, terrain hazards, and EV location markers.
- **Hardware Platform:** Operates on DUST simulation PC; connected to local TSS instance via WebSocket.
- **Mission timers**: MET in **HH:MM:SS**; visible and synced.

The PR interface presents rover telemetry, a 2D terrain map, a caution/warning feed, and resource charts. Mission Elapsed Time (MET) is shown in HH:MM:SS.

Autonomy plans safe routes, adapts the LTV search pattern, and visualizes the consumable-based turnaround radius. LiDAR assists obstacle handling. Operators can drop pins by voice or touch and annotate hazards and EV markers.

2.2.3 EV Spacesuit Subsystem

Description

The EV concept focuses on creating a user interface and voice assistant for one EVA crew member conducting extravehicular tasks on the lunar surface. The system may operate on a head-mounted display, tablet, or other device. It must support the astronaut through all stages of the EVA, from performing Umbilical Interface Assembly (UIA) egress procedures, traversing the terrain under challenging lighting conditions, locating and repairing the malfunctioning LTV, and returning safely to the pressurized rover.

The UI should display real-time telemetry, provide intuitive task guidance, and assist with navigation through both 2D and optional 3D mapping. AI integration should deliver concise and context-aware communication, such as reporting oxygen levels or recommending next steps during repairs. The system should prioritize crew situational awareness, efficiency, and safety throughout the mission.

Goals

- Enable the EVA crew member to safely egress, navigate, and conduct repairs on the lunar surface.
- Develop an intuitive user interface (UI) that reduces cognitive load and improves crew autonomy.
- Integrate an AI-assisted voice interface to guide procedures and respond to real-time telemetry.

- Provide navigation tools for hazard avoidance, route planning, and return-to-base operations.
- Implement caution and warning systems that respond dynamically to off-nominal conditions.

Subsystem Breakdown

- **Wearable Interface:** Passthrough AR (HoloLens 2) and wrist-mounted tablet display with real-time biomedical telemetry, navigation, and procedure checklists.
- **Suit & bio**: O_2, battery, fans/pumps status, comms channel, heart rate—simple color states with numbers on tap.
- **Maplet**: 2D map with planned search route to LTV, asset locations, and breadcrumb toggle for return.
- **Pins**: Create/drop pins by voice or tap; edit labels quickly.
- **Best-path & range**: On select, show a clean suggested line; show predicted max range based on current life-support use.
- **Breadcrumb & Return Path:** Autonomous backtrack algorithm stores GPS/GeoJSON trail to PR and visualizes optimal return under resource constraints.
- **Voice Assistant:** "Athena" provides concise telemetry reports ("O_2 Primary 48%, Secondary 99%") and guides through ERM, diagnostics, and repair tasks.
- **AIA (Artificial Intelligence Assistant) Task Engine:** Retrieval-Augmented-Generation-enabled (RAG-enabled) LLM retrieves EV procedures from local cache and adapts instruction flow based on completion state and biometrics.
- **Caution/Warning:** Audible and visual flags for off-nominal vitals or system anomalies; contextual escalation logic for urgent events.
- **Procedures**: Scrollable steps for UIA/DCU and repair tasks; each step highlights the control/switch; state is verified from TSS. (E.g., "OXY–PRI" checked via DCU telemetry.)

The EV wearable shows suit/biomed status, a minimap, and procedure lists. Status tiles use simple colors; details appear on tap.

The map displays the planned route, assets, and a breadcrumb toggle. EV can drop pins by voice or tap. Best-path suggestions and predicted range reflect current life-support use. Athena provides concise voice prompts and verifies UIA/DCU steps via TSS booleans. Off-nominal states trigger visual and audible alerts with contextual escalation.

2.2.4 Augmented Guided Reality (AGR) Overlay Engine

Purpose: AGR reduces cognitive load and errors by projecting task-aware visual guidance onto real hardware (UIA/DCU/LTV) while keeping the astronaut's attention in-scene. Visuals are paired with short, numeric voice confirmations (e.g., "O_2 Primary 47%, Secondary 99%.").

Visual guidance types: We adopt a five-type overlay palette—(1) highlight key component, (2) motion arrows, (3) hand/gesture hints, (4) animated tool cues, (5) contextual widgets (e.g., timers)—in line with recent AR task-guidance research ("Guided Reality") demonstrating benefits of visually enriched, step-aware guidance. We map each procedure step to one of these visual types (Zhao et al., 2025).

AGR Systems Breakdown:

- **Registration:** On first use, the HMD performs a quick spatial scan (pass-through AR) to place anchors at known controls (UIA toggles, DCU knobs) and LTV access panels.
- **Detection & pose:** Tiny on-device detectors propose 2D regions; depth/scene mesh from the HMD/tablet refines 3D pose. TSS booleans remain the truth for switch state; Computer Vision (CV) never overrides telemetry.
- **Step binding:** Each procedure step references component IDs (e.g., uia.oxy_pri) tied to anchors. AGR renders the correct visual type and advances only when TSS confirms the state.
- **Interoperability:** AGR step state, POIs, and alerts sync over our PR↔EV JSON channel so both UIs remain consistent if connectivity hiccups occur.

Devices:

Spacesuit display runs on a pass-through AR HMD (e.g., HoloLens 2) and a wrist tablet; PR runs on a workstation linked to DUST. All devices subscribe to TSS via WebSocket (JSON/GeoJSON); during Test Week they point to the SUITSNET host IP only (no internet).

Compliance callouts:

- EV UI includes 2D minimap, breadcrumbs, drop-pins, caution/warning, and predictive max range.
- PR UI includes search radius/pattern, autonomous path planning, resource prediction/turnaround, and AIA status.

2.2.5 Interoperability & Data Sharing

- **Shared schema** for PR↔EV: POIs, status, timers, warnings.
- **Update cadence**: Frequent small packets; stale-data badges if lagging.
- **Offline grace**: EV keeps last route, breadcrumbs, and procedures cached; PR logs all outbound advisory messages for resynchronization.

We share a small schema across PR↔EV for POIs, timers, warnings, and status. Updates are frequent and small. If the link lags, the UI shows a stale-data badge. EV caches routes, breadcrumbs, and procedures; PR logs outbound advisories for resynchronization. HMD use is pass-through AR for mobility safety, and TSS remains the source of truth for all numbers and UIA/DCU switch states—computer vision never overrides telemetry.

2.2.6 Hardware and Peripheral Devices

- **HoloLens 2 (Passthrough AR)** - Primary display for EVA
- **Wrist mount tablet -** additional touchscreen input and screen display.
- **Rover workstation** - Rugged touchscreen for PR UI.

- **Edge laptop** - Discrete GPU with ≥16 GB VRAM; runs an offline, quantized (GGUF) open-source LLM (7–13B; 20B optional) for planning/RAG.
- **Comms** - WebSocket for shared pins/POIs between PR and EV.

The primary hardware for the EV component of this mission is the headset worn by the operator, in this case a HoloLens 2 which allows for pass-through AR. A peripheral device in the form of a wrist mounted tablet will be utilized to minimize overstimulation of the user, as well as to optimize the display of information as appropriate for the mission. For example, biometric data, high priority cautions and warnings, and relevant procedural calls for the AIA will be displayed on the headset, as well as additional visualizations to assist with the repair and diagnosis of the LTV. On the other hand, lower priority information, the compiled map with breadcrumbs, and allow for typed inputs. Hardware is all intended to minimize cognitive load for the astronaut and assist with interacting with the LTV, PR, and AIA, rather than hinder those interactions.

2.3 Concept of Operations (CONOPS)

Phase A — PR Search & Approach.
PR plans an industry-standard search from the LTV's last-known point in DUST, adapting to terrain, beacon strength, and resources. As the PR nears the LTV, search shrinks (< 500 m) and shows "warmer/colder" cues to ~50 m. MET and turn-around are visible; cautions trigger AIA advisories.

Phase B — Egress (UIA/DCU).
EV opens AGR Egress. The HMD highlights the next physical control (green halo; motion arrow if needed) and speaks a short prompt. When EV flips a switch, AGR waits for TSS to confirm before advancing (tone + "Step 3 complete—OXY PRI selected."). The UI is glanceable and pass-through per SUITS safety.

Phase C — EV Navigation.
AGR provides low-light-safe map cues, breadcrumb return, hazard pips, and a range ring based on suit consumables. Route updates as telemetry changes; AIA interrupts only for cautions/warnings to minimize chatter.

Phase D — LTV Repair.
AGR guides Exit Recovery Mode → Diagnosis → Nav Restart → Physical Repair → Verification. Each step projects the appropriate visual type (e.g., animated hand to unlatch a cover; tool cue on a connector). If time is low, AIA proposes deferring non-critical tasks; EV confirms before AGR hides those overlays.

Phase E — Ingress.
AGR computes a resource-aware return with breadcrumbs and runs Ingress checklists with the same verify-as-you-go loop. Mission timers stop and logs sync to PR.

The complete flow of ConOps has been described in **Appendix C**.

2.4 Feasibility & Production Plan

- **Compute placement.** Keep LLM off the HMD. Run ASR/CV and AGR rendering on-suit; run planning/RAG on a PR workstation or approved belt-worn edge (to be presented at SDR).
- **Pass-through AR.** HMD is passthrough for safe walking.
- **Networking.** Target SUITSNET; no internet dependency.

We will build out the required components in separate phases. First, the TSS client and UI shells, then search/pathfinding and procedures, then LTV repair flow and guardrails, followed by night tests and SDR integration. Facilities include campus labs and outdoor test areas with controlled low-light. Risks (e.g., network latency, device thermal limits, ASR robustness) have mitigations: local caching, thermal throttling, offline grammar for commands, and deterministic fallbacks.

2.5 Artificial Intelligence Integration — Athena AIA

Role: Athena is a crew force multiplier that speaks short, numeric replies, drives AGR overlays safely within consumable limits, and keeps humans in the loop. Guardrails prevent hallucination-driven behavior in mission-critical contexts, as SUITS expects.

AI run process & data sources:

- **On-Suit Node (EV AIA).** Handles offline speech I/O, AGR step logic, local hazard cues, breadcrumbs, and POI pins. All numbers are read-only from TSS.
- **Rover/Edge Node (PR AIA).** Runs path-planning, search-pattern planning, and resource forecasting; also serves AGR content selection and RAG when available.
- **Connectivity.** Both nodes consume TSS over WebSocket (JSON/GeoJSON). During Test Week, devices target SUITSNET.

AGR content:
Given a step, Athena classifies the best visual type (highlight, motion, hand, tool, widget) and renders it in-scene via AGR, then issues a one-line voice cue. This mirrors evidence that visually enriched AR guidance improves comprehension and speed.

Models & rationale:

- **On-suit: Small ASR/TTS** and lightweight CV detectors (anchoring + safety cues). No large LLM on the HMD/tablet.
- **Edge/PR:** A **quantized 7–13B** LLM (or planner) for multi-constraint reasoning (terrain × energy × time) and RAG over procedures; 20–30B optional if an approved belt/rover compute pack is used.
- **Forecasting:** Light time-series models predict consumables/range; deterministic budgets cross-check and win if conservative.
- **Knowledge:** Local Knowledge Base (KB) includes UIA/DCU & LTV procedures, telemetry schema, and base maps. AGR steps bind directly to these artifacts.

Tools API:
AIA calls structured tools—get_telemetry(), plan_route(), predict_resources(), checklist(step_id), beacon_bearing()—and emits strict JSON envelopes {utterance, evidence, tool_calls, confidence} for deterministic UI behavior and audit logs.

Safety & hallucination mitigation:

- **Source of truth:** Any numeric (O_2, battery, pressure, timers) is verbatim from TSS; AGR advances only on TSS-confirmed state.
- **Tools-before-talk:** If a tool fails, AIA replies "Unavailable" safely.
- **Confidence gating:** If <0.8, Athena responds "Confidence %, response"
- **Two-step confirmations:** Required for routing, ERM/restarts, return-to-PR.
- **Deterministic fallbacks:** Template responses and overlays driven directly by tools (e.g., "Primary O_2 XX%, Secondary YY%. Next ERM step…").
- **Mode awareness:** Checklist-only during egress/ingress; low-chatter traverse with interrupts for cautions/warnings.

2.6 Project Schedule

The overall project schedule for either the PR or EV route is outlined in the appendix, but key dates are outlined below. Due to the rapid development called for by this challenge, the team will utilize 2 week sprints with assigned tasks to complete the project.

Method: 2-week sprints, GitHub issues, weekly demos.
Key dates from SUITS: **Orientation** Dec 11, 2025; **Software Design Review** Apr 2, 2026; **Onsite testing** May 2026; **White paper** June 2026.

Milestones
Dec–Jan: TSS client + UI shells (PR & EV); core map.
Feb: Search pattern + EV navigation + procedures; C/W alerts.
Mar: LTV repair flow + AI guardrails + range/turnaround; night tests.
Apr: SDR delivery + E2E tests; fix list burn-down.
May: JSC runbook & rehearsal; onsite tests; telemetry logs.
June: White paper & code wrap.

2.7 Human-in-the-Loop Testing

We will test bi-weekly from January through April with night/low-light outdoor trials and TSS-simulated streams. Metrics include task completion time, path accuracy, hazard-avoidance rate, warning response time, and NASA-TLX workload. Safety measures include Personal Protective Equipment (PPE), spotters, terrain briefs, device straps and covers, and controlled lighting. Findings directly gate feature graduation to Test Week readiness. Human-in-the-Loop testing is both informed by, and essential for demonstrating compliance with, standards for human safety and scientific integrity as informed by EVA guidelines from NASA (NASA, 2024).

Purpose: Show our UI and Athena reduce workload and errors for each mission phase in **night/low-light** outdoor trials, with TSS simulated streams.

Schedule (Jan–Apr 2026)

- **Jan 10** – TSS client smoke test; WebSocket, JSON/GeoJSON; latency & packet integrity. Targets: <250 ms avg latency, 0% schema errors.
- **Jan 24** – PR navigation in DUST: search pattern, obstacle avoidance, turnaround alerts. Metrics: path error ≤3 m, ≥95% hazard avoidance.
- **Feb 7** – Egress procedure trial: UIA/DCU verification loop; voice confirmations. Metrics: % steps correct, time to complete, error recovery.
- **Feb 21** – EV night traverse: minimap, breadcrumbs, best-path, hazard alerts. Metrics: time-to-target, off-path events, warning response time.
- **Mar 7** – LTV repair drill: ERM → diagnosis → nav restart → physical fix; defer-repair decision logic. Metrics: total task time, error count, deferral correctness.
- **Mar 21** – Cognitive-load study: NASA-TLX across phases; goal: **<40** median.
- **Apr 4** – Full end-to-end simulation; log review and bug-burn. Targets: zero critical defects; all "shall" features pass a checklist.

Participants and Privacy

Twelve to eighteen healthy adult participants will be recruited for each test from University of Colorado Boulder students and faculty. The team will aim to include participants with relevant technical backgrounds (such as Bioastronautics and UI/UX design, for more informed feedback), as well as those with other technical and non-technical backgrounds, to ensure the technology is understandable to a broad audience. Participant privacy will be well-protected with the anonymization of any voice logs, and through the use of consent forms.

Human-in-the-Loop Feedback Integration

After each session, we will analyze both quantitative and qualitative data, including task completion time, navigation accuracy, error rates, and NASA-TLX workload scores. These metrics will guide interface refinements and system logic updates, with priority given to changes that measurably reduce cognitive load and increase operational efficiency. Each iteration will undergo re-testing to validate improvements before integration into the next build.

2.7.1 Test Schedule

The overall schedule for the project is included in section **2.6 Project Schedule** and is visualized in the Gantt chart included in **Appendix A**. HITL testing is critical for both the development of the PR and EV concepts and will comprise of various phases through the spring of 2026 to complete. HITL testing will commence with initial tests in later January, which will initially be focused on the UI for either the EV or PR, as well as the functionality of the AI voice commands. Later phases of testing cognitive load will be performed with the EV concept in March, with a more complete and optimized system. HITL testing is essential for optimizing designs. Full end-to-end tests will be performed with humans in the loop in late April, prior to the challenge at Johnson Space Center.

2.7.2 Test Protocol

- **Participants**: 8–12 healthy adults (gloves where applicable); mix of technical/non-technical.
- **Tasks**: UIA egress; nav to LTV; ERM→Diagnosis→Nav restart→Physical repair; ingress.
- **Measures**: time-to-complete; error counts; NASA-TLX; situation awareness (SAGAT-lite); alert ACK latency.
- **Safety**: low-speed movement; spotters; terrain brief; device straps & covers; night lighting controls.

2.8 Technical References

NASA. *EXTRAVEHICULAR ACTIVITY (EVA) Office Exploration EVA System Technical Standards.* NASA Technical Standards, 2024.

Zhao, A. Y., Gunturu, A., Do, E. Y-L., & Suzuki, R. Guided Reality: Generating Visually-Enriched AR Task Guidance with LLMs and Vision Models. *UIST 2025 (v2 on arXiv).*

3. Community & Industry Engagement

3.1 Community Engagements

3.1.1 Objectives

The aim of the TUXEDO's team community engagement plan is to (1) inspire interest in human-spaceflight technologies among K-12 students and early-career learners, (2) strengthen and build a lasting relationship between the primary institution, University of Colorado at Boulder, and the surrounding community, and (3) spread awareness of the use of computing and AR in the aerospace field and human spaceflight. In order to achieve this, the team will host a minimum of two public outreach events that connect the team's work with educational content about space exploration, engineering, and teamwork.

In addition, the team intends to use this project to publish and present a conference paper. This paper will summarize and share the development of this project and the project's findings. Transparent and thorough communication of information is essential to advancing the field as a whole, and as such participating in discourse with this community will contribute to innovation.

3.1.2 Events

K-12 Outreach

In order to inspire and educate students that make up the future of the world of space exploration, the team will provide engaging classroom lessons. The focus of the lessons is to introduce AR and its real-world applications, with an emphasis on how AR and AI are being developed to assist astronauts. Through current relationships between the University of Colorado Boulder and local elementary, middle, and high schools, the team will schedule visits and collaborate with teachers who are interested in introducing their students to these topics.

These visits will include brief lessons on what AR and AI are, but will focus on providing hands-on activities where students can design a simple interface and learn how to implement it with simple code. The lessons will explore how AR and AI are essential tools in NASA missions, and allow the students to share how they think these technologies can help people and space exploration.

Letters of agreement from participating schools will be acquired, and the lessons will be linked to curriculum standards for STEM education for the relevant age group.

Attend Colorado Aerospace Day at the Colorado State Capitol

A major event to connect with the aerospace community and civic leaders is the Colorado Aerospace Day at the Capitol. This event will take place in March, 2026, and is hosted by the Colorado Space Business Roundtable. Hosting a booth at this event will open opportunities for discourse between the members of the TUXEDO team and local civic and business leaders. Not only will the team share about the development of the project and the intent of the NASA SUITS challenge but also learn about the goals and priorities of leaders in the aerospace community. This opportunity is intended to share the findings of this project, goals of the NASA SUITS challenge, and develop relationships between students and civic leaders to better understand and align policy and technical interests. From participating in this event, the team will seek more intimate meetings with leaders to share priorities and gain input on policy and technical goals.

Publication of Technical Paper

One goal of this team is to publish a technical paper, which will outline the development and testing of the final product of this project. There is a particular interest in the results of the HITL testing, as well as the integration of AI into the interface. This paper is planned to be submitted by June 1st, 2025, likely with a professional organization such as AIAA. Other publication avenues of interest for publication include conferences like AIAA SciTech, IEEE Aerospace, IEEE VR/ISMAR.

Social Media Campaign

Throughout the course of this project, social media will be the method of tracking and sharing progress with a much wider audience. This will be done to share both outreach efforts and major technical milestones, with a minimum of bi-weekly posts or videos. This form of outreach is excellent for sharing the goals of the NASA SUITS challenge, as well as the possibilities of using AR for human space exploration.

3.2 Industry Engagements

3.2.1 Objectives

Complementing the community outreach, interactions with industry by the TUXEDO team are aimed to strengthen connections with professionals to provide mentorship, technical insight, and professional development for all team members. The goals are to (1) align project outcomes with real-world engineering practices as they benefit NASA's human space exploration priorities, (2) gain technical skills and certifications, and (3) expand team members' career pathways in aerospace.

3.2.2 Development Plan

The team will fulfill industry engagement objectives by utilizing existing personal contacts as well as university resources. The team will seek out technical experts to inform technical progress, two mentors for software development and two mentors for hardware development and optimization of human experience and meet consistently throughout the semester. The surplus of local companies to the lead institution—BAE, Lockheed Martin, Blue Origin, etc.—provide numerous contacts for the team to secure technical advice. Additionally, several professors at the University of Colorado Boulder have industry contacts to point the team to individuals best suited to assist the team.

Aside from technical mentorship, the team will also seek certification in the tools necessary for this project. For example, team members will seek programmer certifications for Unity and aim to develop software and development skills for all team members.

These skills not only are essential tools for working across industries, as software is a key tool in engineering, but applying those new skills to the project provide an excellent portfolio addition. Industry connections can also provide general career advice, as well as directly connect team members with career opportunities as they arise. Finally, these industry relationships are an opportunity to connect NASA and civic goals, such as from the NASA SUITS Challenge, with the goals of private industry.

4. Administrative Section

4.1 Institutional Letter of Endorsement

Ann and H.J. Smead
Department of Aerospace Engineering Sciences
UNIVERSITY OF COLORADO **BOULDER**

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October 27, 2025

Dear NASA Suits Challenge,

As the department chair of the Aerospace Engineering Sciences at University of Colorado at Boulder, I am aware of University of Colorado at Boulder students' participation in the NASA SUITS 2025 Challenge and endorse their involvement.

Sincerely,

Hanspeter Schaub, Ph.D.
Distinguished Professor, Schaden Leadership Chair
Aerospace Engineering Sciences Department Chair
Smead Fellow
Director of the Autonomous Vehicle Systems (AVS) Laboratory
LASP Senior Assoc. for Engineering Research and Education
Fellow of AIAA and AAS,
National Academy of Engineering Member

4.2 Supervising Faculty Statements

Ann and H.J. Smead
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As the faculty advisor for an experiment entitled "Tactical User-interfaces for eXtravehicular Exploration and Dynamic Optimization (TUXEDO)" proposed by a team of higher education students from University of Colorado Boulder, I concur with the concepts and methods by which the students plan to conduct this project. I will ensure the student team members complete all project requirements and meet deadlines in a timely manner. I understand any default by this team concerning any project requirements (including submission of final report materials) could adversely affect selection opportunities of future teams from their institution.

Torin K. Clark

Torin K. Clark, Ph.D.
Associate Professor
Bioastronautics Laboratory
Associate Chair for Department Affairs
Chair of Departmental Inclusive Culture Committee
Ann and H.J. Smead Aerospace Engineering Sciences
University of Colorado–Boulder

EMBRY-RIDDLE
Aeronautical University
WORLDWIDE

29 October 2025

Re: NASA 2025 SUITS Challenge

To Whom It May Concern:

My name is Dr. Tiziano Bernard and I am an adjunct professor of human factors engineering from Embry-Riddle Aeronautical University (ERAU). I write this letter in support of Brianna Botwinick's participation in your 2025 competition.

In quality of professor of human factors in virtual reality, of which Brianna is a graduate student, I support her participation in this challenge. I furthermore believe that her participation reinforces her academic curriculum and would be of great benefit to her academic career.

With kind regards,

Tiziano

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4.3 Statement of Rights of Use

As a team member for a proposal entitled “TUXEDO Proposal” proposed by a team of higher education students from the University of Colorado at Boulder and Embry-Riddle Aeronautical University, I will and hereby do grant the U.S. Government a royalty-free, nonexclusive and irrevocable license to use, reproduce, distribute (including distribution by transmission) to the public, perform publicly, prepare derivative works, and display publicly, any technical data contained in this proposal in whole or in part and in any manner for federal purposes and to have or permit others to do so for federal purposes only. Further, with respect to all computer software designated by NASA to be released as open source which is first produced or delivered under this proposal and subsequent collaboration, if selected, shall be delivered with unlimited and unrestricted rights so as to permit further distribution as open source. For purposes of defining the rights in such computer software, “computer software” shall include source codes, object codes, executables, ancillary files, and any and all documentation related to any computer program or similar set of instructions delivered in association with this collaboration. As a team member for a proposal entitled “TUXEDO Proposal” proposed by a team of higher education students from the University of Colorado at Boulder and Embry-Riddle Aeronautical University, I will and hereby do grant the U.S. Government a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States Government any invention described or made part of this proposal throughout the world.

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	Shubhakriti
Noah Hassett	Shubhakriti Gupta
Schelin Ireland	Brianna Botwinick
Schelin Ireland	Brianna Botwinick

4.4 Funding & Budget Statement

The team will seek funding through institutional funds, industry sponsorship, and general fundraising efforts supported by the team's social media campaign

Table 1: Proposed Budget

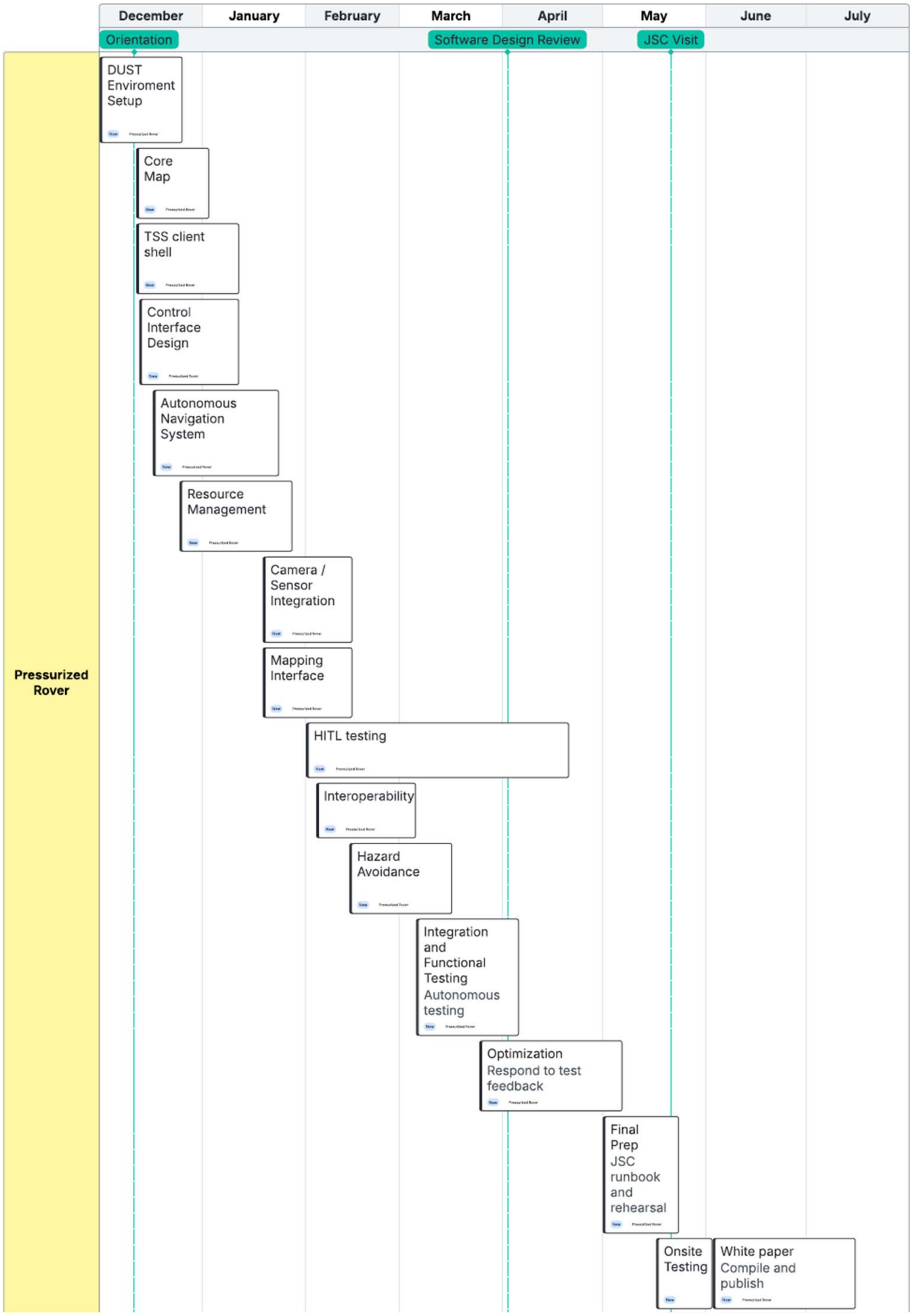
Item	**Cost**
Flights (9 people with faculty advisor)	$4,500
Hotel	$2,000
Ground transportation	$400
Operating (consumables, spares)	$600
Software/licenses	$500
Materials & Prototyping	$1500
Outreach	$300
Miscellaneous	$500
TOTAL	**$10,300**

4.5 Hololens2 Loan Program

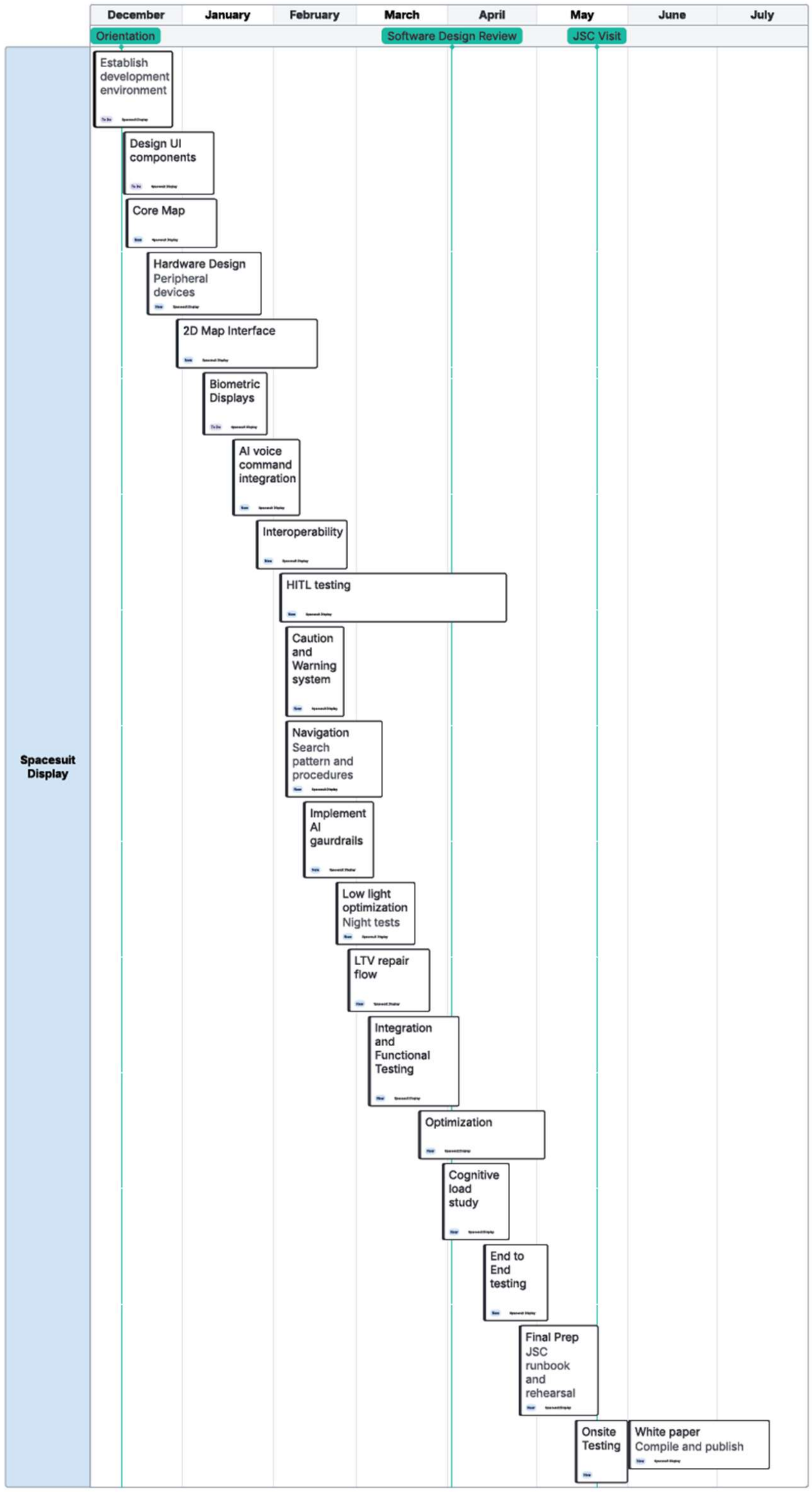
Option B: We require a loaned device to participate.

Appendix

A. Gantt Chart – Pressurized Rover



B. Gantt Chart – EV



C. ConOps Flowchart - EVA