

University of Colorado Boulder

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Member Name --- Role Email Address --- Academic Year / Academic Major Faculty

Advisor Name Email Address Phone Number

## **Table of Contents**

* Auto-generate once the document is finalized to match the exact order below.
* Include all mandatory sections; keep page numbers in sync when exporting to PDF.

## **1. Introduction**

* Highlight unique value and alignment to NASA goals; leverage docs/PRD.md.
* **Team Input Needed:** Final mission statement/vision approval from project lead.

## **2. Eligibility**

* Declare compliance: all members ≥18, enrolled in eligible programs, STEM Gateway enrollment, advisor availability for orientation, SDR, onsite test.
* Note single-team participation constraint and advisor travel commitment.
* **Team Input Needed:** Enrollment verification status, advisor travel confirmation.

## **3. Letter of Intent**

* State LOI submission date, recipient email, subject line, and summary of contents.
* If no LOI submitted, document rationale.
* **Team Input Needed:** Copy of LOI email or decision to proceed without LOI.

## **4. Proposal Requirements Compliance**

* Provide checklist confirming 12 pt font, 12-page technical section limit, all sections present, figures labeled, title page complete, submission via STEM Gateway by **Thu, Oct 30, 2025**.
* Reference docs/ADMIN\_CHECKLIST.md for final verification.
* **Team Input Needed:** Confirmation of final formatting and submission process owner.

## **5. Technical Section (≤12 pages including figures)**

### **5.1 Abstract (≤500 words)**

* Summarize prototype objectives, EVA scenario coverage, planned HITL testing, and hardware/peripherals required.
* **Team Input Needed:** Final hardware list, differentiators, testing highlights.

**Tuxedo** is a paired UI system for the spacesuit and the pressurized rover, connected by the Athena AI assistant. The aim is simple: help the crew complete the 2026 SUITS EVA: locate a silent Lunar Terrain Vehicle (LTV), diagnose and repair it, and return safely: faster, safer, and with lower cognitive load.

On the rover, Tuxedo provides a clean 2D map with live assets, a search pattern around the LTV’s last known location, adaptive path planning, resource predictions with “turnaround” guidance, mission timers, caution/warning alerts, and quick drop‑pins. On the spacesuit, Tuxedo shows essential suit and bio telemetry, a 2D minimap with breadcrumb return, best‑path suggestions, drop‑pins, and concise voice guidance from Athena for UIA/DCU procedures and LTV repair steps. Both UIs consume the Telemetry Stream Server (TSS) in JSON/GeoJSON over WebSockets for PR/EV/LTV/UIA/DCU telemetry.

Athena answers natural‑language questions (“O₂ status?”) with short, numeric replies and cross‑checks mission‑critical outputs against TSS before speaking or displaying them. When navigation goals or suit status change, Athena updates routes, search patterns, and procedures with clear confirmation prompts. The design favors human‑in‑the‑loop control and sets guardrails to avoid hallucination risks.

We will test in night/low‑light conditions and with representative obstacles, following a HITL plan that measures task time, path accuracy, warnings, and crew workload. The spacesuit display will use a passthrough AR HMD or wrist tablet; the rover UI runs on a workstation tethered to DUST. All features directly trace to SUITS “shall” requirements for the PR and Spacesuit display.

### **5.2 Software & Hardware Design Description *(Rubric: Design Description 25 pts max)***

* Provide architecture overview across apps/ev-ui, apps/pr-ui, services/aia, and libs/tss-client.
* Include system diagrams, UI wireframes, audio/voice flows, telemetry integration (docs/TSS\_INTEGRATION.md), and hardware interface plans.
* Discuss autonomy, navigation, hazard detection, and mission support features.
* **Team Input Needed:** Updated diagrams/wireframes, hardware interface specs.

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### **5.2.1 System overview & architecture**

**Five layers, one mental model** :

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** – A local, lightweight LLM for fast, offline responses; optional higher‑capacity node for planning. Retrieval‑augmented with procedures and constraints; every critical value is cross‑checked with TSS before display or speech.
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 POIs, drops, timers, and status so PR and EV see the same data, even if disconnected briefly.

### **5.2.2 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.

### **5.2.3 EVA Spacesuit Subsystem**

* **Wearable Interface:** Passthrough AR (HoloLens 2) and wrist-mounted tablet display with real-time biomedical telemetry, navigation, and procedure checklists.
* **Suit & bio**: O₂, 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 (“O₂ Primary 48%, Secondary 99%”) and guides through ERM, diagnostics, and repair tasks.
* **AIA Task Engine:** RAG-enabled LLM retrieves EVA 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.)

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**Requirements**  
  
**PR “shall”**: control DUST rover; LTV beacon display; 2D map + search radius + adaptive pattern; POIs drop/share; C/W system; mission timers; autonomy (best path, hazards, updated destinations); resource tracking + predictive analytics; AIA status in natural language. **All included.**

**Spacesuit “shall”**: suit/biomed telemetry; 2D map w/ planned LTV search route + assets; breadcrumbs; predictive max range; drop pins; C/W warnings + AI‑recommended actions; procedures list + voice assist. **All included.**

**Peripheral safety**: No sharp edges/pinch points; label any moving parts; device approval at SDR. **Addressed.**

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**EVA:**

* Tasks:
* Description of goals
* System architecture plan
* Hardware concepts
* Network diagrams
* AI integration (especially into UX)
* Conceptual UI Idea (navigation, telem, geology, EVA task instruction, etc.)
* **High-Level Development Roadmap – EVA System (WIP)**

Role of Telemetry Streaming Service (TSS)

NASA’s TSS will be the source of all spacesuit telemetry, biomedical data, positional data, power, etc. This data is transmitted to our hardware via the WebSocket protocol in a standard JSON/GeoJSON format. Matt has shared TSS data from the 2025 SUITS challenge, which will help significantly with understanding the considerations of our tech.

What does integrating this look like?

* Create a mock TSS-Client library that will need to:
  + Connect to the TSS WebSocket
  + Parse all incoming data streams
  + Manage the connection

Both teams will be using this.

* The EVA system, once again, will be designed for integration into a **wearable AR headset** like the HoloLens 2.

1. Create tss-client library
   1. This is the code that helps the application receive the telemetry data.
   2. Necessary for both the EVA and rover so real-time telemetry data from NASA’s service can be interpreted similarly across the two “subsystems.”
   3. Can make a mock-up with the old data Matt found.
2. EVA Application
   1. Most likely option is to make it in Unity/C#. Typical for the HoloLens 2.
   2. Capabilities
      1. Uses the tss library to receive the tele data
      2. Logic for dictating the progression through official procedures across all the tasks the crew might need to carry out
      3. Rendering the HUD, navigation cues, points of interest markers, and other visual presentations for procedural guidance vis.
      4. AI and interface.
         1. Probably ideal to have text-speech capability as supplementary to visual cues
         2. Need to decide how to determine ongoing “sample rate” with respect to making API requests to the AI service. Unless we’ll only use the service for more complicated requests from the user. Really we just need to settle the extent of AI involvement to know where we go with respect to this.

#### **5.2.4 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 re‑sync.

### **5.2.5 Hardware and Peripheral Devices**

* **HoloLens 2 (Passthrough AR)** — Primary display for EVA; adjustable for low-light conditions per mission description, and wrist mount tablet.
* **Rover Workstation** — Ruggedized touchscreen interface with embedded compute.
* **Edge Compute Laptop**— Laptop with 16gb graphics processing to load GPT-OSS20b with gguf for on-device AI inference and local caching.
* **Communication Bus** — WebSocket to share POI between rover and eva

**5.3 Concept of Operations (CONOPS)**

**Scenario:** The LTV stops communicating. PR must search within a radius based on last known position/consumables, close enough to “wake” it (≤500 m), then support EV egress, traverse, repair (ERM, diagnosis, nav restart, physical fix), and safe ingress. Testing occurs at night in the JSC Rock Yard.

**Phase A — PR search & approach**

1. PR loads last LTV point and draws search radius based on LTV consumables. Athena selects a path using A\* and autonomously navigates obstacles as information becomes available through LIDAR sensors.
2. As beacons/LiDAR cues arrive, the pattern adapts; a proximity meter appears at ~50 m to help home in.
3. PR shows turnaround limits based on remaining power; Caution/Warning triggers if plans exceed safe return.

**Phase B — Egress (UIA/DCU)**

1. EV opens Procedures > Egress; steps appear with switch highlights and TSS‑based confirmation (e.g., O2 vent OPEN/CLOSE, OXY PRI/SEC, pump power).
2. Athena reads short prompts and listens for “Confirm/Repeat/Next.”
3. On completion, EV gets “Egress complete—proceed to Navigation.”

**Phase C — EV navigation**

1. EV follows the minimap route to the LTV with breadcrumbs on; map shows live assets.
2. In low light, the UI keeps contrast high; Athena warns about nearby hazards and suggests minor route changes.
3. Range ring updates with suit consumption; Athena alerts if return margin drops below threshold.

**Phase D — LTV repair**

1. Exit Recovery Mode (ERM): EV says “Athena, start ERM.” The checklist appears; success is confirmed before moving on.
2. Diagnosis: Athena runs checks; EV can add a visual inspection note; results yield next actions.
3. Nav restart: Steps to physically restart the LTV nav are guided and verified.
4. Physical fix: Tasks may include reconnecting a bus connector (must repair) and dust sensor replacement (repair later if time is low—Athena will recommend deferring when behind schedule).
5. Final checks: Athena re‑runs diagnostics and confirms stability.

**Phase E — Ingress**

1. Athena provides best return path and shows breadcrumbs back to PR.
2. EV runs Ingress procedures at UIA/DCU with the same verify‑as‑you‑go flow. Mission timers stop; logs sync to PR.

**EV:**

Tasks:

* ConOps description
* ConOps flowchart
  + 1. Egress
  + 2. Navigation
  + 3. LTV Repair
    - i. Exit Recovery Mode (ERM)
    - ii. System Diagnosis
    - iii. System Restart/Navigation Correction
    - iv. Physical repair task
    - v. Final System Checks/Repair Verification
  + Ingress

### **5.4 Feasibility & Production Plan *(Rubric: Feasibility 10 pts)***

* Explain implementation phases, design-to-build workflow, resource availability, fabrication/testing facilities, risk mitigations.
* Cite docs/PROJECT\_MANAGEMENT.md and docs/DEVICE\_SELECTION.md.
* **Team Input Needed:** Inventory of available hardware, lab access, fabrication partners.

### **5.5 Artificial Intelligence Integration *(Rubric: AI Integration 15 pts)***

* Describe model choices (LLMs, CV, speech), deployment strategy (edge vs. cloud), guardrails, hallucination mitigation, telemetry cross-checks.
* Align with docs/AI\_INTEGRATION.md and services/aia guardrail policies.
* **Team Input Needed:** Final model selection, licensing status, compute budgets.

**Rover:**

**Speak simply, act never:** Athena answers with exact numbers or short clauses (“Primary O₂ 47%, Secondary 99%.”) and never performs actions without explicit EV/PR confirmation.

**Plan/search:** Suggest search patterns and route updates that factor hazards, power, and time.

**Procedures:** Retrieve steps for UIA/DCU and LTV repair; advance only on confirmation and TSS state validation.

**Local small LLM** for speech & procedure guidance; optional larger planner off‑device when available.

**RAG**: Procedures, telemetry schema, and constraints indexed so Athena quotes the latest, local steps.

**Telemetry cross‑check**: Any numeric or state claim must match TSS; otherwise Athena says, “I can’t verify that—check panel.”

**Confidence & roles**: If confidence < threshold, Athena offers choices, not directives.

**No critical autonomy**: Caution/Warning yields a recommended step; human must confirm.

**Immutable rules**: Mission “shall” constraints compiled into prompts and code; Athena cannot override them.

**EVA:**

Tasks:

* This is probably just a paragraph or two
  + Build then integrate for voice command feature

### **5.6 Project Schedule *(Rubric: Schedule 5 pts)***

* Present milestone chart covering Oct proposal → Dec orientation → Apr SDR → May onsite testing → June white paper.
* Include labor allocation across subteams, sprint cadence, holiday impacts.
* **Team Input Needed:** Confirmed sprint schedule, academic calendar conflicts.

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* **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.

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Tasks:

* Gantt chart (select agile tool)
  + This may need to go to the appendix, with the milestones listed here
* Key milestones for development
* Plan testing

### **5.7 Human-in-the-Loop Testing *(Rubric: HITL 10 pts)***

* Provide testing timeline, participant demographics, protocols, metrics (NASA-TLX, task completion, comm latency), safety considerations.
* Use docs/HITL\_TEST\_PLAN.md as baseline.
* **Team Input Needed:** Subject pool access, IRB/ethics requirements, simulator booking.

**Rover:**

**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 & safety**

* 12–18 participants (students) for repeated‑measures tests; PPE; night lighting set to Rock Yard‑like levels; radio spotter for obstacles.
* Privacy: voice logs anonymized; consent forms on file.

**How results feed development**

* We prioritize fixes that reduce error rates, shorten task time, and lower NASA‑TLX. Findings gate feature graduation to Test Week readiness.

**EVA:**

Tasks:

* HITL test schedule
* HITL test protocol
* HITL possible metrics
* HITL feasible subject pools + expected population/demographics
* HITL planned safety measures
* How will this inform our development plan

*5.7.x Test Schedule:*

*5.7.x 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.

For each test, the team plans to recruit 8-12 healthy adults, with a mix of both technical and non-technical backgrounds.

### **5.8 Technical References *(Rubric: References 5 pts)***

* Cite ≥2 authoritative sources (EVA standards, XR/AI research); include inline citations and bibliography.
* Choose consistent citation style (APA/IEEE) and document it.
* **Team Input Needed:** Final bibliography owner and citation format decision.

Tasks:

* Citation method (IEEE or APA)
* Find **minimum** 2 technical references
  + [EVA-EXP-0034 Exploration EVA System Technical Standards Rev B\_CCB.pdf](https://ntrs.nasa.gov/api/citations/20205004275/downloads/EVA-EXP-0034%20Exploration%20EVA%20System%20Technical%20Standards%20Rev%20B_CCB.pdf)

## **6. Community & Industry Engagement *(Rubric: Engagement 20 pts)***

### **6.1 Community Engagements**

* Detail ≥2 events (audience, objectives, logistics, metrics) aligned with outreach goals.
* Derive content from docs/OUTREACH\_AND\_INDUSTRY\_PLAN.md.
* **Team Input Needed:** Confirmed event partners, dates, volunteer leads.

Tasks:

* *Plan:*
  + High level description of objectives and goals
  + What are the activities (minimum 2)
  + Where/when will the activities take place
  + Target audience
* *Activities:*
  + What the team will do
  + What materials will we use/reference
  + Main points of the activity
* *Additional detail for maximum points:*
  + How we will engage with the community
  + Description of audience
  + Activity objectives
  + Specific activities
  + Social media plan
  + Connection between curriculum/activity and NASA SUITS, a NASA Mission, or the team’s code
* *Event #1:*
* *Event #2:*

### **6.2 Industry Engagements**

* Provide ≥2 industry collaborations, mentorship plans, alignment with project outcomes, professional development angles.
* Include contact cadence and expected deliverables.
* **Team Input Needed:** Confirmation from identified industry partners, letters or MOUs.

Tasks:

* List of potential industry partners (based on project goals)
  + Technical expertise, skills, mentorship, certifications, resources
* Choose at least two professional development strategy (from below)
  + Summarize mentorship arrangements your team plans to target with industry experts/partners.
  + Identify skills development and certification opportunities your team members plan to seek with industry partners (e.g., software, electrical).
  + Explain how your team’s industry connections would support team members’ career goals.
  + Identify potential internship, fellowship, apprenticeship, or career opportunities your team members plan to seek.
  + Summarize the method your team will use to raise awareness about your NASA challenge participation.

## **7. Administrative Section**

### **7.1 Institutional Letter of Endorsement**

* Summarize letter status, storage location, and signer.
* **Team Input Needed:** Signed PDF delivery timeline.

Tasks:

* ~~Acquire primary institution letter of endorsement (CU Boulder)~~
* Acquire secondary institution(s) letter(s) of endorsement

### **7.2 Supervising Faculty Statement**

* Confirm required language and location within proposal.
* **Team Input Needed:** Faculty confirmation of statement text.

Tasks:

* Confirm faculty advisor
* Have faculty advisor read through and approve proposal
* Compile letter of faculty supervision with signature

### **7.3 Statement of Rights of Use**

* Decide whether to grant optional rights; include signed statements if opting in.
* **Team Input Needed:** Team consensus on IP permissions.
* MIT, open source

### **7.4 Funding & Budget Statement**

* Present budget table (travel, lodging, hardware, testing, misc) using docs/BUDGET\_TEMPLATE.md.
* List funding sources (Space Grant, institutional funds, sponsors).
* **Team Input Needed:** Updated cost estimates, confirmed funding commitments.

### **7.5 Hololens2 Loan Program**

* Declare Option A/B/C with justification and device count.
* **Team Input Needed:** Device inventory status, institutional loan agreements.

### **7.6 Proposal Scoring Method**

* Explain internal review process referencing docs/RUBRIC\_SELF\_ASSESSMENT.md.
* Document planned pre-submission scoring checkpoints.

### **7.7 Other Deliverables**

* Commit to April POV video, June white paper, and outline responsible subteams.
* **Team Input Needed:** Ownership of video production and white paper draft.

### **7.8 Logo Use**

* Confirm horizontal and vertical logo assets uploaded to STEM Gateway or include link.
* **Team Input Needed:** Marketing approval and asset repository path.

Tasks:

* Upload/acquire official logo(s) - **Tess**

## **8. Proposal Scoring Rubric**

* Include official rubric (Section 8 of guidelines) within the proposal appendix.
* Summarize internal self-assessment results referencing docs/RUBRIC\_SELF\_ASSESSMENT.md.
* **Team Input Needed:** Completed self-assessment scores once draft matures.

## **Appendices (Do Not Count Toward Technical 12-Page Limit)**

* Extended wireframes, system diagrams, logs, or additional test data.
* Letters (endorsement, rights-of-use), outreach confirmations, budget backup sheets.
* POV video storyboard, white paper outline, extended schedule (Gantt).
* **Team Input Needed:** Ownership for each appendix item and delivery deadlines.

Tasks:

* Gantt chart - **Tess**
* Compile additional content for appendix - **ALL**

## **Execution Checklist**

* Assign section owners and draft deadlines.
* Schedule rubric-based internal review one week before **Thu, Oct 30, 2025**.
* Confirm formatting compliance (12 pt font, labeled figures/tables, page limits).
* Track outstanding **Team Input Needed** items in the project tracker and escalate blockers early