Project Terms of Reference (DRAFT)

2023-01-23

### VR Comms For Field Science

(aka, EVA Link MVP)

## 

## Description

A prototype solution for real-time voice and data communications between an analog astronaut on EVA at MDRS, and a remote user in a MarsVR simulation of MDRS.

## Objective

To develop a functioning prototype to serve as a technology demonstrator of collaborative field science between analog astronauts and remote users in a virtual reality environment. Limited data sharing from astronaut to VR user shall be possible, as well as real time voice communications. Successful development and demonstration of the “VR Comms for Field Science” will inform potential follow-on efforts.

## Background

There is no permanent extended digital communications infrastructure covering the entire MDRS campus. Analog radios are used by crewmembers while on EVA between each other and with the habitat, but they are limited to line-of-sight and roughly 1 km range. A repeater has been installed at MDRS, and this project would not seek to replace that. However, it is only suitable for analog voice communications at MDRS, particularly in-simulation.

Limited communications creates safety concerns for crewmembers on EVA, which can in turn limit EVA time, distance, or scope. Also, the absence of digital communications between field and the habitat renders automated real-time science sample logging, telemetry, and location tagging all but impossible. Wifi is installed at MDRS, but it has its own range constraints, and infrastructure and environmental requirements that limit its suitability in the field.

Finally and most critically, there is presently no way to conduct joint collaborative, real-time research between analog astronauts in-simulation at MDRS, and a remote off-site researcher.

The goal of this project is to demonstrate fundamental technologies that could be used to address these gaps.

## Scope

It is essential to understand the Functional Scope of the project. As a “minimum viable product” project, it does not need to solve everything. Nor does it need to last forever, or include every bit of desired functionality. It does, however, need to demonstrate sufficient capability to meet the objective. The Functional Scope and Flow-Down scope are explained below.

#### Functional Scope

* One-way real-time data communications from an analog astronaut on EVA at MDRS to a remote user in VR, sending basic telemetry data (position, orientation)
* Bidirectional real-time voice communications between the analog astronaut on EVA and a remote user in VR, concurrent with data communications
* VR simulation of MDRS for remote user, utilizing above communications

#### Flow-Down Scope

* Technical scope: The technology elements, including hardware, network communication stack, and a basic end-user application.
* Physical scope: Delivery of functional prototypes and any needed support equipment
* Operational scope: All MDRS areas and crew activities considered “in-simulation” within 2km of the hab (NOTE: radius may change based on research.)
* Lifecycle scope: Requirements, design, development, and prototype testing.

## Anti-Scope

For the avoidance of doubt, the areas below are out of scope for this project. They may still be implemented in future phases or projects. See the long-term EVALink Roadmap for when they will be addressed.

* This project will not deliver production-ready devices for prolonged use at MDRS.
* This project will not consider or address system end-of-life.
* This project will not deliver advanced or derivative software, such as a research library built on top of the communications stack, or device integration software such as for measurement equipment.
* This project will not address requirements for other analog research stations, such as FMARS

## Approach

* The project will follow a decentralized, open collaboration approach adapted from open source projects.
* The project will be coordinated asynchronously online, such as mail, Google Docs, and Github. Video conferences will also be arranged for team meetings.
* Although not a rigid requirement, there is a preference for open source component technologies wherever possible. Furthermore, among open source options, non-viral licenses are preferred.
* Deliverables will be tested in MDRS-independent scenarios where possible, as needed by project members. For example, testing radio range in an open air public setting.

## Deliverables

* Data communications hardware. A minimum of three to four network nodes will be implemented to demonstrate meshed operation. One for each of two analog astronauts, one fixed installation in the hab, and one spare.
* Voice communications integration, enabling voice communications between an analog astronaut at MDRS and a remote user in MarsVR
* Virtual Reality development to enable MarsVR interaction with MDRS
* Meshnet communications network software stack
* Basic application software to integrate device data collection and telemetry.

## Budget and Ownership

All activities within the scope of this project will be self-funded by project participants, including time and materials. All project contributors are unpaid volunteers.

Ownership of materials and deliverables is an open issue to be resolved, but project contributors should assume they will be donated to The Mars Society, and will remain at MDRS. It is intended that all designs, documentation, and source code will be eventually released as open source. The specific open source license is to be determined.

## Risks and Constraints

* Self-funding by project participants will limit options for components, source, materials, and any supporting tools or services.
* Self-funding may limit the available pool of contributors.
* A distributed and decentralized team may be difficult to logistically coordinate.
* Although this project is organized by the Chicago chapter of the Mars Society, the chapter is not a separate legal entity, prohibiting it from handling funds, contracting, executing legal documents, etc.

## Milestones

| **Milestone** | **Target Date** |
| --- | --- |
| Initial Project Proposal |  |
| Project Terms of Reference |  |
| Concept of Operations |  |
| Alternative Options Identification |  |
| Alternatives Evaluation and Recommendation |  |
| Prototype - Hardware completion |  |
| Prototype - Network stack completion |  |
| Prototype - Reference application completion |  |
| Integrated full-stack prototype |  |
| 3-node meshed network demonstration |  |

## Resources

The VR Comms project will be coordinated by the Chicago chapter of The Mars Society, but participation is open to any active member of The Mars Society.

Below are relevant skills anticipated for the project. The extent to which some skills are employed may depend upon technology choices encapsulated within the project scope.

* Software programming
* Digital circuits
* 3D printing
* Hardware and software testing and test development
* Project management
* HAM radio license (Technician level)
* Wireless networking
* Radio Frequency technology